Transformation of an Industry: A History of Energy Efficiency in Televisions

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ABSTRACT

The television industry is in the midst of a dramatic transformation, which has led to a decrease of approximately 75% in the per-unit energy use of new televisions from 2008 to 2012. This was a result of rapid and radical technological changes, such as the introduction of automatic brightness control, local dimming, and the rise of LED backlights. The transformation was pushed by non-profit advocacy, the ratcheting of voluntary ENERGY STAR specifications, the completion of a California standard, and the rise of utility programs targeted at electronics retailers. As a result, a large ENERGY STAR-qualified television could consume as many as 500 watts in 2008, and now, just four years later, consumes less than 108 watts.

The designers of energy efficiency programs and policies focused on televisions have learned a number of valuable lessons in the course of implementing these efforts, including: 1) the importance of collaboration, 2) the need to continually increase the stringency of efficiency criteria to keep pace with rapidly changing technologies; 3) the importance of simultaneously targeting various points in the supply chain; and 4) the need for clear attribution paths for utility programs.

This paper provides an overview of the drivers of energy efficiency gains in televisions, including technology changes and key policy efforts. The paper also describes lessons learned from the described policy efforts that are applicable to future programs for televisions and other products with similar market dynamics – especially those dealing with rapidly changing technologies.

Introduction

Television energy use accounts for approximately 4% of global residential energy use and has been growing due to the increased number of televisions, the increased hours of use of each television, and a trend towards larger televisions that consume more energy. As a result of these trends, televisions have been an important focus for domestic policy efforts to reduce residential energy use. These policy efforts have included voluntary and mandatory labeling programs, mandatory national and state standards, and programs funded by utilities and public benefit organizations.

Prior to 2005 these efforts focused only on standby power usage, or the power used by the television when the consumer considered it to be “off”. Since 1998, the ENERGY STAR® requirement for standby power has been ratcheted from 25 watts to as low as 1 watt.

Starting in 2005, policy efforts to address television energy use began to focus on measuring and reducing the power usage of televisions in active mode, or when the television was “on”. In 2005, the National Resource Defense Council (NRDC) published an issue paper advocating for this approach. Later that year there was an international workshop for “Measuring and Reducing Television Energy Use” with a focus on addressing active power. This workshop was sponsored by Pacific Gas and Electric (PG&E), the California Energy Commission (CEC),

NRDC, and the U.S. EPA ENERGY STAR program. Following this workshop, there have been a variety of activities by these and other market actors to address this problem, which have coincided with a rapid decrease in the per unit energy use of televisions.

At the same time, there have been a number of large technology shifts in the television market since 2005. Some of these technology changes resulted in overall reductions to the average power use of televisions (e.g., LED backlights and automatic brightness control), while others could substantially increase the energy use of televisions (e.g., increased screen sizes and higher resolution displays). The adoption of new more energy-efficient technologies has led to the rapid reduction in unit energy consumption (UEC) demonstrated in this paper. This technology adoption and UEC reduction was driven, in part, by the collective efforts of various market actors and policy efforts at play in this market.

This paper does not attempt to determine the influence or effectiveness of the individual policy efforts described, but instead describes the positive contributions of the different organizations and programs that have helped hasten the market transformation of more energy-efficient televisions.

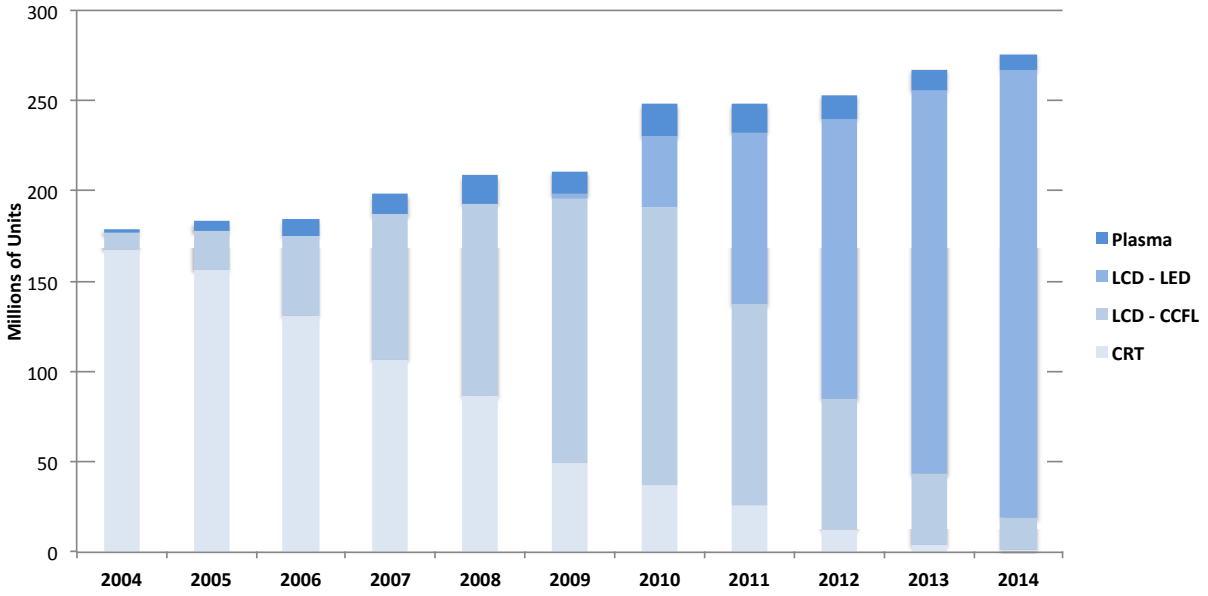
Overview of Television Technology Changes

The television market has undergone a number of sweeping technological advances in the last decade, many of which had major effects on the energy use of televisions. This section covers the key technology advances, and their effect on television energy consumption, with a focus on the

- replacement of CRT and rear projection (RP) televisions with flat panel technologies such as liquid crystal display (LCD) and plasma display panel (PDP)
- transition from analog to digital televisions
- rise of light emitting diode (LED) backlights to replace cold cathode fluorescent lamp (CCFL) backlights for LCD televisions
- introduction and adoption of other advanced power management systems for televisions

In addition, there are other energy-efficient technologies currently entering the market such as organic LED (oLED) display technology. Figure 1 shows the relative worldwide sales estimates of different display technologies over time from 2004 to 2011, and a forecast through 2014.

Figure 1. Worldwide Television Forecast by Technology



Source: Display Search 2012

The Rise of the Flat Panel

As shown in Figure 1, flat panel technologies, including plasma and LCD, started gaining significant market traction in 2004 and 2005 and quickly overtook traditional CRT televisions in 2008. The large majority of flat panel televisions in this period were LCD televisions with CCFL backlights. Although these early LCD televisions were comparable in energy use per square inch to traditional CRTs, they were available in larger screen sizes (CRT televisions were limited at about 37" screen size), and the rise of the average screen size contributed to a rise in the total energy use of televisions over this period. Early plasma displays, in contrast, used significantly more energy per square inch and were typically very expensive and available in only large screen sizes, so were heavy energy consumers, though their market share was relatively small.

The rise in flat panels coincided with an increase in both display resolution and screen size. Display resolution moved from standard definition (480 lines of native vertical resolution) to high definition (768 lines) or full high definition (1080 lines). This was significant, as high resolution displays can require more power than lower resolution displays.

For these flat panel displays, power usage tends to rise linearly with screen area. This is significant, since according to the Consumer Electronics Association (CEA) the average screen size has increased roughly 60 percent, from 22 inches in 1997 to 36 inches in 2011 (Boston Globe 2012) and is expected to continue to grow as costs of large screen televisions continue to drop.

The Analog to Digital Conversion

Another important technical change was the transition from low definition analog signals to higher definition digital broadcasts. Digital broadcasting led to a proliferation of high-definition channels, boosting consumer demand for new, higher-definition flat screen televisions that consume more energy. An important milestone in this transition was the Digital Television

Transition and Public Safety Act of 2005 whereby Congress directed the Federal Communications Commission (FCC) to terminate all licenses for full-power television stations in the analog television service, and to require the cessation of broadcasting by full power stations in the analog television service, by June 13, 2009 (DOE 2012).

Entering the Era of LEDs

More recently, there has been significant growth in the market share of LED backlit televisions. These televisions are both more energy-efficient and have better performance due to the ability to increase contrast ratios using local dimming technology. LED televisions are predicted to be over 50% of the market in 2012 and more than 75% of the global market in 2014. Edge-lit LED televisions are estimated to be 20%-30% more efficient in on-mode than CCFL backlit televisions (LBNL 2011).

Other Technologies Affecting Energy Use

In addition to these major technological shifts, there are a number of other technologies that have affected the energy use of televisions in the last decade, as described below:

- **Automatic Brightness Control (ABC).** ABC is a power management functionality that saves energy by dimming the display screen in dimmer light conditions for improved picture quality and decreased energy usage. Many manufacturers employ ABC to meet current energy efficiency specifications such as ENERGY STAR 5. The DOE is currently working on a test procedure that more accurately reflects the energy usage of ABC enabled televisions in the home, which will be used in the upcoming ENERGY STAR 6 specification.
- **Connected Televisions.** Televisions are increasingly coming with functionality to stream content through a direct or wireless Internet connection in the home. Current global market share is estimated at roughly one third of televisions, which is expected to continue to grow. Connected televisions are likely to use a few watts more than conventional televisions in active mode and can also significantly increase standby power usage (LBNL 2011).
- **Program Guides and Other Set-top box functionality.** Some televisions include a functionality known as Download Acquisition Mode (DAM). This functionality directly downloads program information from content providers, but can increase standby power usage in the process. More recently, televisions are coming equipped with technologies such as the RVU protocol that provide the television with the full functionality of a set-top box. This can eliminate the need for a separate set-top box, which may save energy as a total system, but may increase the energy use of the television on its own.
- **Other Power Management Functionalities.** Some other advanced power management features are in use or development including: occupancy sensors, proximity sensors or timer functions to control the energy use of “orphan” televisions, which are on but not being actively viewed. Some of these technologies simply darken the screen while maintaining sound for users that are nearby and may be still listening to programming.

Anticipated Future Trends

Besides the trends mentioned above, the next large trend is expected to be organic LED televisions (oLED). This display technology has only recently reached the market and is expected to have lower energy consumption, improved picture quality, and allow for thinner televisions than existing LCD technology. Due to the speed of movement in these technologies, there may be other future technologies that could rapidly take hold in the market and effect the energy use of televisions in the near-term.

Overview of Policy Efforts and Market Actors

A number of domestic policy efforts have been actively attempting to drive down the energy use of televisions. These policy efforts include mandatory standards, voluntary labeling, utility programs, and non-profit advocacy. The market actors behind these policy efforts include national and state government agencies, non-profit advocacy organizations, electric utilities, and public benefit organizations. Table 1 summarizes the major policy efforts, market actors and their role in the transformation of the television industry. The remainder of this section provides a brief description of each of these efforts. Although there are also many additional international policy efforts contributing to reductions in energy use of the global television market, this paper focuses on domestic efforts.

Table 1. Summary of Domestic Policy Efforts to Reduce Television Energy Use

Policy Effort	Identified Market Actor(s)	Role(s) in Market Transformation
Voluntary Programs	1. U.S. EPA ENERGY STAR 2. TopTen USA	- Contribute to the establishment of agreed-upon test procedures - Highlight best efficiency performers in the market
Mandatory Standards	1. U.S. DOE 2. California Energy Commission (CEC) 3. Federal Trade Commission (FTC)	- Contribute to the establishment of agreed-upon test procedures - Establish a baseline that eliminates the least efficient televisions on the market - Mandatory labeling to provide consumers information on the energy consumption of new televisions
Utility & Public Benefit Programs	1. Business and Consumer Electronics (BCE) Program, including PG&E, Southern California Edison (SCE), the Northwest Energy Efficiency Alliance (NEEA), etc. 2. Other utilities (e.g., Xcel Energy – Colorado, DTE Energy, ComEd, etc.[a])	- Contribute to the establishment of agreed-upon test procedures - Support increased stringency of specifications and standards - Engage retailers to promote energy efficiency - Collect market data to monitor market - Provide midstream or downstream incentives to retailers and consumers - Marketing to consumers
Advocacy	1. Natural Resource Defense Council (NRDC)	- Advocate for agreed-upon test procedures and more stringent specifications and standards

a. A more complete list of utility programs in the U.S. and Canada is available in the Consortium for Energy Efficiency's (CEE) Consumer Electronics Program Summary (CEE 2011)

Voluntary Labels

The U.S. EPA led the effort to label energy-efficient televisions with the voluntary ENERGY STAR program. From 1998 to 2008, the specification addressed standby power use only and the specification dropped from 25 watts to 1 watt over this time. Starting in 2005, the EPA began to switch the focus of the program to active power. As a first step, they were one of the sponsors of the workshop for measuring and reducing television energy use. Following this workshop, in September of 2005 the EPA announced the development of the Version 3 specification, which would define allowable active mode wattage levels.

During the Version 3 specification development the EPA worked with a number of national and international stakeholders to revise the IEC 62807 test procedure and distributed a number of draft specification levels based on data collected from manufacturers using that procedure. The specification took effect in November 2008, but by that time the qualification rate for new models was already close to 100% due to rapid innovations in the market.

As a result, the EPA immediately began a new specification revision process and produced the Version 4 and 5 specifications with more stringent active mode requirements. The Version 5 specification in particular included a much more stringent specification for large televisions, with a wattage cutoff of 108 watts for televisions over 1068 square inches (approximately 50" screen size). The EPA also released new "Most Efficient" specifications for televisions for 2011 and 2012 to recognize models that are significantly more efficient than standard ENERGY STAR models. The EPA is currently working on finalizing the Version 6 specification and is supporting another revised test procedure (initiated by the DOE) that more accurately tests ABC.

Manufacturers have been very responsive to the specification, indicating that they place a large importance on meeting the ENERGY STAR levels, which is also apparent from the rapid increase in market share of qualified televisions immediately following a new specification taking effect (EMI 2011). LBNL has also indicated the strength of the program indicating that ENERGY STAR 5 will largely act as a cap on on-mode power (LBNL 2011).

TopTen USA™ has also begun publicizing and promoting a list of the most energy-efficient products from the ENERGY STAR database in three size bins. TopTen USA is a new effort in the US and is sponsored by a number of non-profit advocacy organizations, utilities and public benefit organizations.

Mandatory Standards

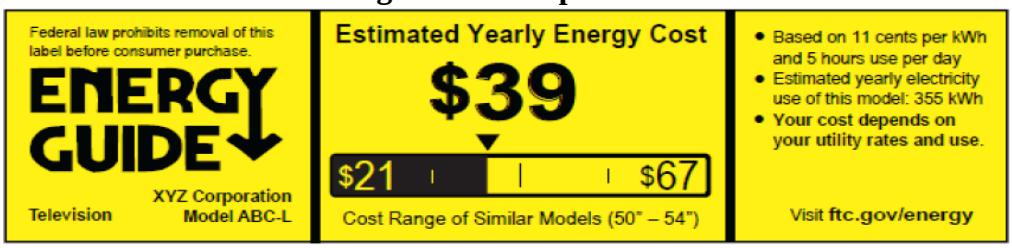
There have also been a number of domestic efforts for mandatory standards aimed at the television market. In 1978, the National Energy Conservation Policy Act (NECPA) required the DOE to establish mandatory energy efficiency standards for television sets, but televisions have since earned special status where a standard is not required under NECPA.

The DOE's Digital Television Transition and Public Safety Act of 2005 effectively ceased transmission of analog television signals effective June 13th, 2009. This sped up the transition from analog to digital televisions and caused the DOE to repeal their test procedure, which only covered analog televisions. In September of 2010, the DOE initiated the development of a new television test procedure, which is still in development (DOE 2012).

The CEC has also been active with the development of two Title 20 standards for televisions. The first standard took effect in 2006 and mandated a 3-Watt standby power requirement. The second standard took effect in 2009 and covers the active power consumption of televisions. The second Title 20 standard uses the revised IEC 62807 test procedure and includes two tiers of levels. The first Tier is close to ENERGY STAR Version 3 levels and was effective in 2011, while the second Tier is close to ENERGY STAR Version 4 levels and will take effect in 2013 (CEC 2009). Almost all televisions on the market met Tier 1 at the time it was implemented, and the same is expected for Tier 2. However, the CEC was an important player in supporting the revisions of the IEC test procedure and putting a focus on the active power consumption of televisions during the development of these standards.

An additional mandatory effort was the FTC energy label for televisions which are now required of all televisions sold after May 10, 2011. Similar to energy labels for other appliances, this requires the inclusion of a mandatory label at display at retail that compares the energy use of the model for sale to similar models. An example label is shown in Figure 2. The intention of these labels are so that "consumers will be able to make better-informed decisions about which model they choose to buy, based on how much it costs to operate per year." (FTC 2010)

Figure 2. Example FTC Label



Source: FTC 2010

Utility and Public Benefit Programs

Efforts by utilities and public benefit organizations have also played a role in reducing the energy use of televisions. PG&E was an active voice starting in 2005 with the workshop to measure and reduce energy use in televisions. PG&E also developed the Business and Consumer Electronics (BCE) program, which it launched as a pilot in 2008 in partnership with the Sacramento Public Utility District (SMUD). The California Investor Owned Utilities (IOUs) adopted the BCE program model into their statewide portfolio for the 2010-2012 program cycle, and other partners joined (NEEA in 2009 and Nevada Energy in 2010) to create the BCE Alliance, which effectively covered the whole West coast and about 15% of the US television market.

The BCE program focuses on building relationships with large national electronics retailers, such as Best Buy, Wal-Mart, Costco, and Sears. The program pays retailers per-unit incentives for sales of all qualified televisions to influence retailers to include a higher proportion of energy-efficient models in their assortment. The program utilizes a midstream model focused on retailers because the energy savings for televisions are relatively small compared to the price of the product, so cost-effective consumer-focused rebates could not be high enough to effectively influence the consumer.

Qualification levels for the BCE program are based on ENERGY STAR specifications, though they typically exceed currently effective ENERGY STAR levels. The program revises the qualification levels on a yearly basis and and has also offered higher incentives for a second, even more efficient, tier of products. The BCE program also provides in-store marketing materials and trains sales associates to properly explain efficient offerings to customers. To participate, retailers must supply the utilities with sales data, which has been critical to understanding market progress (See Figure 3).

Other domestic utilities and public benefit organizations have run similar midstream programs. Some utilities also offered direct incentives to customers, though the incentive amounts in these cases are often too low to be compelling to consumers. Although other utilities are active in this space, this paper focuses on the BCE program due to the overall size of that initiative.

The BCE program has been quite successful at building relationships with key retailers and manufacturers. Through these relationships, they have gained a deeper understanding of the television market, accessed valuable sales data, and developed new marketing opportunities for efficient televisions. Utilities have also participated in ENERGY STAR specifications development, either independently or through the Consortium for Energy Efficiency (CEE) Consumer Electronics Initiative. PG&E also advocated for the CEC Title 20 standard for televisions, bringing a work paper of policy options to the CEC in 2008. In this role, utilities play an important role in advocating for rapidly advancing more stringent standards.

Despite these successes, utility programs with net savings goals face significant evaluation risk with the midstream program model. The BCE program gives retailers incentives to stock energy-efficient models, with the assumption that this will spur manufacturers to create more energy-efficient models. Because there are many different market drivers for retailers and manufacturers to increase the energy-efficiency of televisions, it is difficult to parse out the effect of a single program from the other drivers in the market. In other words, it is difficult to construct an accurate non-intervention baseline case for the rapidly evolving television market, and even harder to determine attribution of an individual program in an increasingly national

market with such a variety of policy efforts at play. This is much more challenging than consumer-focused programs where there are standard evaluation methods to quantify the number of incented units that have been sold and to understand the influence of those incentives. In addition, utilities cannot easily claim energy savings for efforts to support stricter specifications and standards under existing regulatory frameworks. These factors threaten the ability of many utilities to run these programs, as the cost effectiveness of these initiatives cannot be proven without a clear path for the attribution of energy savings for the program.

Advocacy

The main advocacy group supporting the reduction of television energy use in this period was the Natural Resources Defense council (NRDC). The NRDC was a leading advocate for addressing active power use in televisions. The organization published a position paper on active mode energy use in televisions in March of 2005. One of the key contributions of this paper was the inclusion of test data showing the variations in active power consumption of televisions – illustrating that differentiating televisions by active power use was possible. NRDC was also a cosponsor of a workshop for measuring and reducing television energy use in June of that year. In the 2005 NRDC issue paper for televisions (NRDC 2005), NRDC gave three recommendations, all which were eventually accomplished. These were:

- Key stakeholders should revise IEC 62087, the test procedure for active power of televisions, to more closely mimic in-home energy use (Finalized October 2008).
- A revised national specification should be developed that addresses active power use in televisions for voluntary programs such as ENERGY STAR (Finalized February 2008).
- The DOE should begin mandatory EnergyGuide labels for televisions sold at retail (Finalized October 2010).

After ENERGY STAR announced the development of the Version 3 specification to cover active mode energy use in September of 2005, NRDC took an active role in supporting the specification development at stakeholder meetings and through written public comments, which provided key support to EPA for the development of more stringent specifications for active mode energy use.

Timeline of Policy Efforts

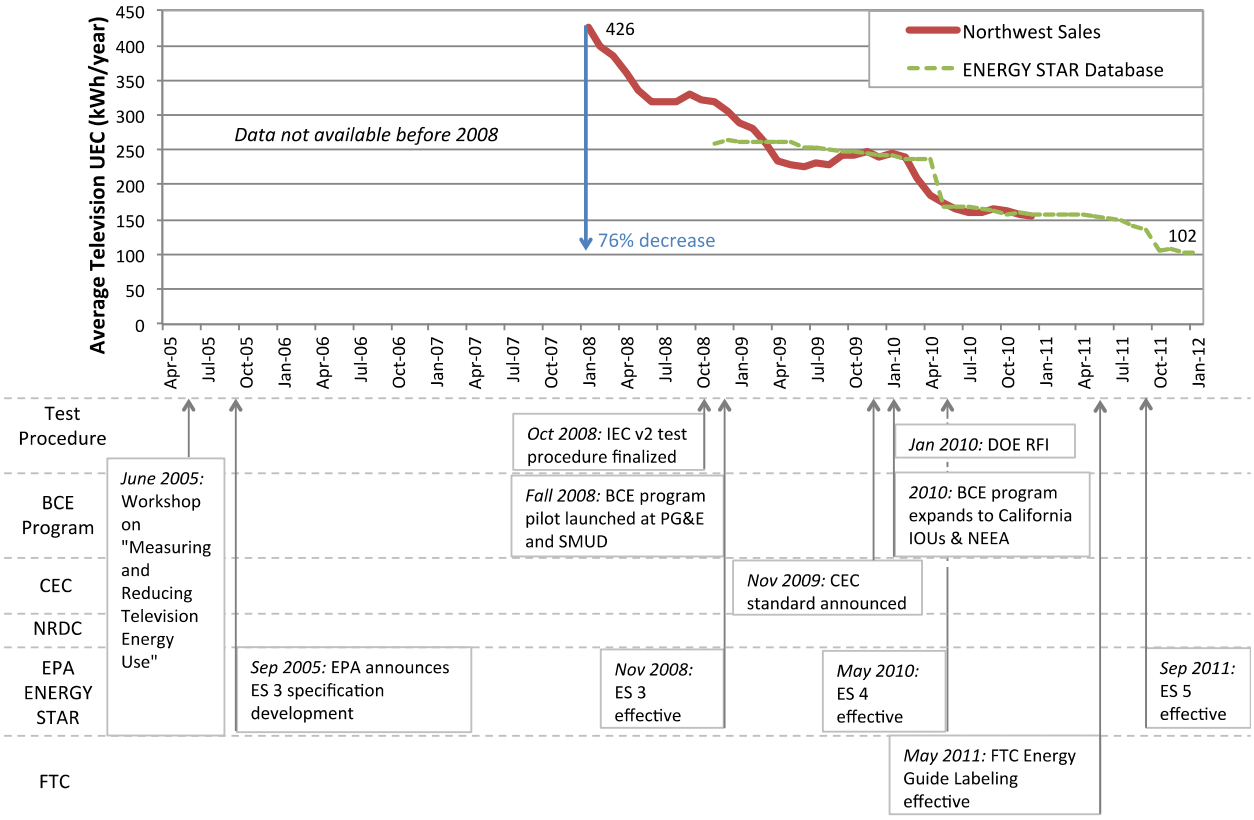
Figure 3 illustrates the timeline of milestones for the significant policy efforts discussed above. Along with this timeline, the average unit energy consumption (UEC) of televisions is shown from January 2008 through January 2012. UEC data is not available prior to 2008, as this was before the draft IEC 62807 test procedure allowed comprehensive tracking of active mode power use.

The UEC chart uses two different sources. The first is the average UEC of television sales in the Northwest based on data from the 2010 evaluation of the NEEA Television Initiative. The television market is essentially a national market, as the major national retailers that make up over 80% of the market chose their product assortment on a national basis, so the UEC of televisions in the Northwest is not expected to vary widely from national averages. The second

source shows the average UEC from ENERGY STAR models from the onset of the Version 3 specification in February 2008 through January 2012. Because of the rapid adoption of new technologies to meet the ENERGY STAR standards, this second data set closely matches the average UEC from the NEEA data and shows the expected additional drop in UEC in 2012.

Note that both data sets show a "stair step" reduction in UEC. The NEEA data drops substantially in the spring, which is when old product models are flushed from stores and the new, more energy-efficient product models enter stores. The ENERGY STAR data, in contrast, drops when a new specification takes effect and the ENERGY STAR database is changed to only contain models that meet the new, more stringent levels. Although these data sets drop at slightly different times, for both 2009 and 2010 they level off at roughly the same level. Therefore, the ENERGY STAR data set appears to be a good proxy for actual sales data in this period.

Figure 3. Timeline of Major Energy-Efficient Television Initiatives with the Average UEC of New Television Sales 2005 to the Present



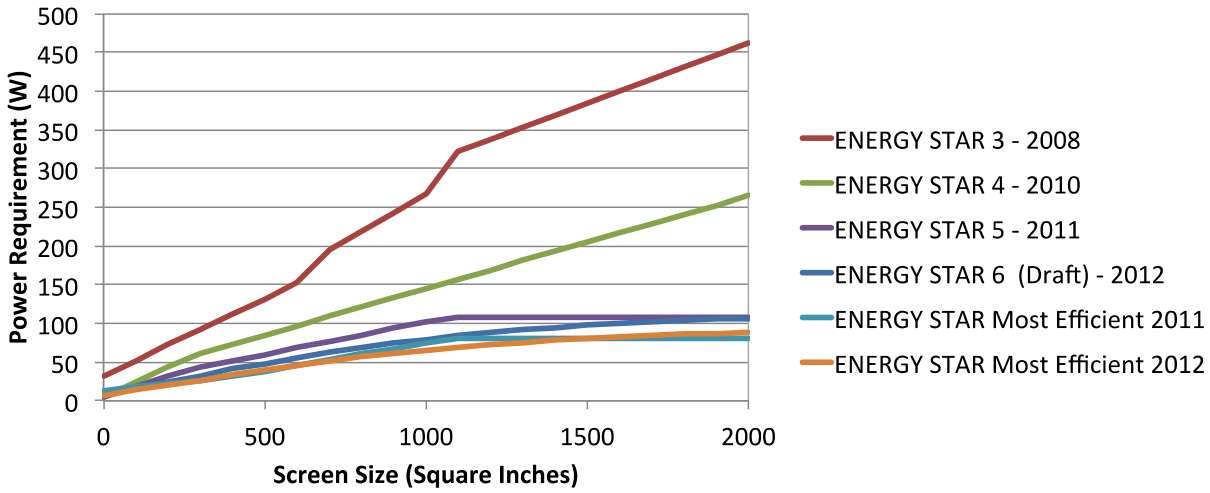
Sources: EMI 2011, EPA 2012a

This timeline of policy efforts illuminates several interesting findings related to the efforts of these many stakeholders to address energy use in this area. The first is that multiple parties collaborated to reach the common goal of measuring and reducing active mode energy use. In kicking off this new focus with a workshop on "Measuring and Reducing Television Energy Use", multiple concerned parties (PG&E, CEC, NRDC, and EPA) demonstrated that they shared a common interest. These multiple stakeholders then contributed to the development of the new IEC 62807 test procedure to more accurately test the active mode power usage of televisions. The EPA also officially began its development of the Version 3 specification late in

2005 to cover the active mode power consumption of televisions. Due to these efforts, by the end of 2008 the new test procedure for active mode power use had been finalized and there was consensus around a universal method for defining the energy efficiency of televisions based on the screen area of the display. This then led to a rapid acceleration of activities, including two additional ENERGY STAR tiers (with a third now under development), the ENERGY STAR "Most Efficient" designation, and a mandatory CEC efficiency requirement (with a second tier due in 2013). This also led to the rise of utility sponsored programs with increasingly rigorous criteria that were more stringent than ENERGY STAR qualification levels, and the mandatory FTC label displaying the energy use of new televisions for sale on the market. In addition, the DOE has initiated the development of a new test procedure with an improved method for testing ABC.

To further illustrate progressive efforts to decrease the energy use of televisions, Figure 4 shows the progressive ratcheting of ENERGY STAR levels for active mode of televisions over this time. Note the large initial decreases, followed by smaller incremental gains with each successive specification level.

Figure 4. ENERGY STAR HD Television Active Mode Specification Levels



Source: EPA 2012b

All these efforts are focused on a common goal of reducing active mode power use of new televisions and, as indicated in Figure 3, the data show a rapid drop in energy consumption during this period.

Lessons Learned

The designers of energy efficiency programs and policies focused on televisions have learned a number of valuable lessons in the course of implementing these efforts.

The Impact of Collaboration with Other Market Actors to Reach A Common Goal

A first challenge in addressing the energy usage of different devices is to determine how to define an energy-efficient model and subsequently how to consistently measure products to

test them against this metric. The television market is a clear example of where this was done effectively. Various policy stakeholders came together in 2005 to discuss measuring and addressing the active power of televisions and worked together through 2008 to update the IEC test procedure and work out definitions and a framework for efficiency criteria through the ENERGY STAR program. With a common test procedure, stakeholders were then able to implement diverse programs and policies with increasingly strict, universally recognized standards and metrics. These included the EPA ENERGY STAR program, CEC efficiency standards and utility programs.

The Need to Continually Increase the Stringency of Efficiency Criteria to Keep Pace with Rapidly Changing Technologies

The television market in this period moved very rapidly, with yearly advances in technology. These advances were driven, in part, by the yearly retailer model refresh cycle. This can be seen in the yearly dropping of television UECs (see Figure 3). The ENERGY STAR program and utility programs quickly realized the fast-moving nature of the market and began increasing the stringency of their requirements. After finalizing the first ENERGY STAR Version 3 requirements in 2008, EPA immediately began developing Version 4 and Version 5 requirements, as well as giving additional recognition for the "Most Efficient". Version 4 took effect in 2010 and, due to the speed of the market and support from other market actors such as the BCE program, the Version 5 effective date was moved up from 2012 to 2011. EPA is currently working on a draft Version 6 specification that is due to take effect in late 2012. The utility-sponsored BCE program took a similar approach by increasing the stringency of their specifications for retailer incentives on a yearly basis, and aiming to always be more stringent than ENERGY STAR in order to capture only the top of the market.

The Importance of Simultaneously Targeting Various Points in the Supply Chain

Another success of this market transformation effort was that the various market actors targeted different sections of the supply chain, including: 1) The EPA strongly influenced manufacturers with its voluntary energy efficiency specifications that attempted to highlight the more energy-efficient models on the market; 2) the CEC state-level standards worked to eliminate the least efficient models from the market; 3) the BCE program attempted to accelerate the adoption of more energy-efficient models by retailers through the use of midstream incentives and targeted consumers directly through in-store promotional materials and other marketing; and, 4) the FTC is providing more information to consumers directly through the requirement for mandatory energy labeling at retail. By simultaneously pushing on many segments of the market, these approaches motivate a range of decision makers to accelerate energy-efficient choices throughout the entire market.

The Need for A Clear Attribution Path for Utility and Public Benefit Programs.

Through the BCE program, utilities and public benefit organizations such as PG&E, SCE and NEEA played a number of important roles in supporting the market transformation of the television market, including: 1) supporting the initiation of the coordinated intervention in this market; 2) engaging and attempting to influence retailers to increase the proportion of energy-

efficient models in their assortment; 3) accessing retailer sales data that would not otherwise be available to better understand what is happening in the market, and 4) providing needed support to EPA and CEC to increase the stringency of voluntary specifications and state standards. Unfortunately, under current regulatory models utilities typically cannot easily claim energy savings from these activities to help meet their regulatory savings goals. In addition, the difficulty in assessing attribution for midstream programs has caused a number of utilities with net savings goals to choose not to enter this market and threatens the cost-effectiveness of current programs. Therefore, any utility or public benefit organizations creating midstream programs to address televisions or other consumer electronics should ensure that they have a clear evaluation plan and attribution model to ensure reliable savings can be claimed for their program efforts.

Conclusion

Many policy efforts have contributed to accelerating the manufacturing and adoption of more energy-efficient televisions in the market, which has led to a dramatic reduction in television UEC since 2008. Two essential elements that drove these efforts were the development of a universally accepted test procedure and a metric for assessing the efficiency of a product model. In addition, the development of energy efficiency specifications and standards such as those developed by ENERGY STAR and the CEC were important for influencing manufacturers to design and sell more energy-efficient models. Support from other energy efficiency advocates (e.g., NRDC) and utilities (e.g., BCE program sponsors) were essential to the successful development of all of these efforts. In the case of televisions, these organizations specifically played an important role in initiating and supporting state standard development and supporting more stringent specifications, initiated on more aggressive timelines, to keep pace with this rapidly changing market. In addition, utility programs played an important role in engaging retailers through a mid-stream incentive model and by actively marketing more energy-efficient televisions to consumers.

While this paper has not attempted to determine the specific influence or effectiveness of these individual efforts, it is apparent that the combined contribution of these market actors have helped draw attention to the important issue of active mode power consumption in televisions and helped accelerate the adoption of new energy-efficient technologies in the market, which has led to a dramatic reduction in the per-unit energy consumption of televisions in the US market.

Over the course of implementing these efforts, these market actors faced new challenges and learned a number of important lessons. These lessons should be applied to help drive market transformation in other products, as well as being continually applied to the television market.

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