Power Consumption Trends in Digital TVs produced since 2003

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Purpose and Approach

This study collates Active mode and Sleep (Standby) mode power consumption data from multiple digital TV (DTV) manufacturers' best-selling models of Liquid Crystal Display (LCD) and plasma TVs over the period from 2003 to 2010. LCD TVs ranged in size from 13" to 65", measured diagonally; plasma TVs ranged in size from 42" to 65", measured diagonally. Domestic (American), European, and Asian manufacturers' TVs were included. The data were measured using a consistent set of tests, measuring Active mode per IEC 62087 and Standby mode per the EnergyStar® Test Method.

The report additionally describes the trend of features found in these TVs, along with some of the enabling technologies driving lower power draw.

Executive Summary

Power use trends from 2003 to 2010 show a marked reduction, primarily in Active mode but in Standby mode as well. For LCD TVs, the Active mode power density dropped from 0.35 W/in^2 in 2003 to 0.13 W/in^2 in 2010, representing a 63 percent decrease; for Standby mode it dropped from a high of 6.1 mW/in^2 in 2004 to 0.77 mW/in^2 in 2010, representing an 87 percent decrease. In plasma TVs, for Active mode it dropped from 0.22 W/in^2 in 2008 to 0.13 W/in^2 in 2010, representing a 41 percent decrease; for Standby mode it dropped from 0.46 mW/in^2 in 2008 to 0.07 mW/in^2 in 2010, representing an 85 percent decrease.

Features

Today's digital TVs contain a number of new and innovative features not found just a few years ago. Virtually all are high definition TV (HDTV). LCD and plasma technologies still dominate the market, though some newer display types are just beginning to appear. The standard fluorescent backlighting for LCD TVs is being replaced with light emitting diodes (LEDs), making them much more efficient and giving them enhanced brightness and contrast. These are being marketed as LED TVs, but since the basic display technology is still LCD, both florescent and LED backlighting methods have been grouped together in the LCD category for this study. True LED TVs are just around the corner, with the maturation of organic LEDs (OLEDs) and other LED-based display technologies.

A wide range of display sizes is available, but the increased resolution has made the larger screens more viable and pleasing to view. The LCD TVs in this study range in size from 13" to 65", while the plasmas range from 42" to 65".

Countless differentiating features present the user with a multitude of choices. Beyond the basic display technology, as reviewed above, some additional features include:

- Greater resolution (1920 x 1080 commonly available) for clearer definition
- Superior 'scanning' (progressive instead of interlaced) for less judder (non-fluid frame-to-frame motion)
- Enhanced refresh rates (120 and 240Hz) for smoother LCD picture
- Faster pixel response time
- Greater contrast for improved dynamic range
- V-Chip parental controls
- Digital comb filters
- Multilingual on-screen menus
- Picture in picture for viewing from more than one source at a time
- A/V inputs, including Composite Video, S-Video, Component Video, High Definition Multimedia Interface (HDMI)
- PC Video input, memory card slots, USB ports
- Analog Audio output, Optical Digital Audio output

Perhaps the most significant new feature is 3D viewing technology, which is beyond the scope of this document.

Trend toward Lower Power Draw

Energy Star, competition, innovation, and technology improvements have all been responsible for lower power draw. Energy Star guidelines have been evolving since the inclusion of Active mode power draw in Version 3.0. Version 4.1 took effect on May 1, 2010, while Version 5.3 takes effect on September 30, 2011. These place progressively more demanding limits on Active mode maximum power draw, while additionally specifying a Standby mode maximum power draw of 1.0 Watt. Although these are voluntary, merchants are eager to sell products which carry the Energy Star logo, and thus the manufacturers have responded in kind. In fact, the majority of the TVs in this survey meet Energy Star Version 4.1.

Plasma TVs as a group traditionally drew more power than LCD TVs, primarily due to their relatively larger screen sizes. Recent technology advances are closing the gap, with the two technologies having similar power densities in 2010 models. Significant improvements in energy efficiency of plasmas have been made in the optimization of the xenon/neon gas mixture which produces UV light that energizes the visible light-producing phosphors, electronic driving circuits and waveforms which initiate the gas discharge, the phosphors themselves, the panel cell structure, the electrodes on the front piece of glass, and the front filter and anti-reflection coatings.

LCD TVs require backlighting, since the liquid crystals can only block or allow the passage of light; they are not capable of producing light by themselves. Most LCD TVs currently employ fluorescent lighting to accomplish this. But LED backlighting uses significantly less power, thus establishing the category of LED-LCD TVs. Some use edge lighting, with the LEDs surrounding the screen, directing light toward the center of the screen and then outward. Newer models place the LEDs directly behind the LCDs, allowing areas of the screen to output more or less light. This greatly enhances the contrast, by producing blacker blacks and relatively whiter whites, selectively in the portions of the screen which require it. Thus, the darkened areas of the screen draw less power, reducing overall power draw.

Every DTV, as well as almost all consumer electronics devices, uses direct current (DC) internally even though they are drawing power from an alternating current (AC) source, the utility grid. Thus a DC power supply must make this conversion. Additional conversions (DC to DC) take place within the unit, since more than a single DC voltage is required for the constituent functions. Each of these conversions is less than 100% efficient, thereby leading to unavoidable power losses. Advancements in power supply design, more chip-level integration of newer hardware topologies, and clever power management algorithms have led to more and more efficient supplies. Specifically in the Standby mode, where the TV is drawing far less power than in Active mode, significant increases in efficiency have been made. Traditionally, supplies were designed with a ‘sweet spot’ for maximum efficiency at maximum output; newer designs are nearly as efficient at lower power draw as they are at full output, basically shutting themselves down when power draw falls off.

Data Analysis

According to TIAX (2008), digital TVs have one of the highest Unit Electricity Consumption (UEC) of any consumer electronics device. For this study, CEA has commissioned a survey of various digital TV manufacturers to get better insights related to power consumption trends and overall energy efficiency of digital TVs over the past several years.

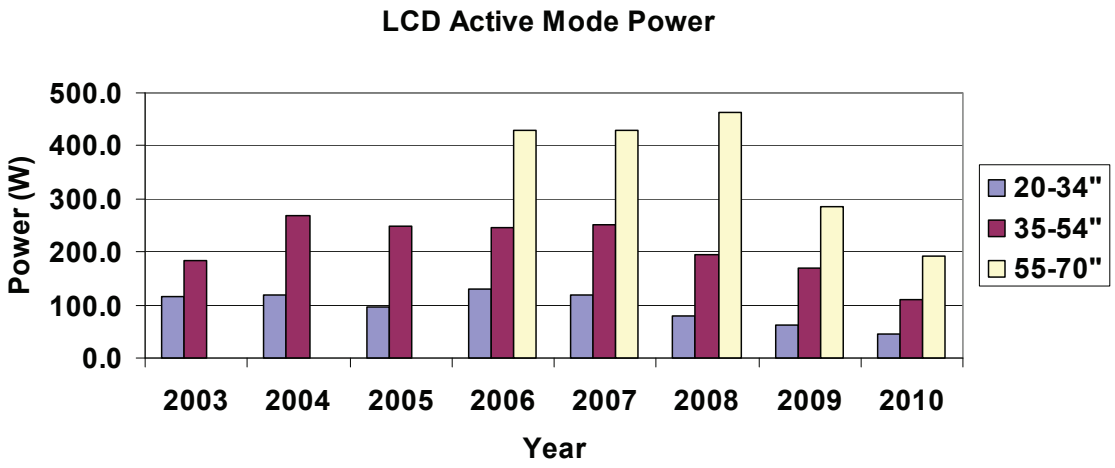

Figure 1: Comparison of LCD Active mode power draw for 3 predominant screen size ranges

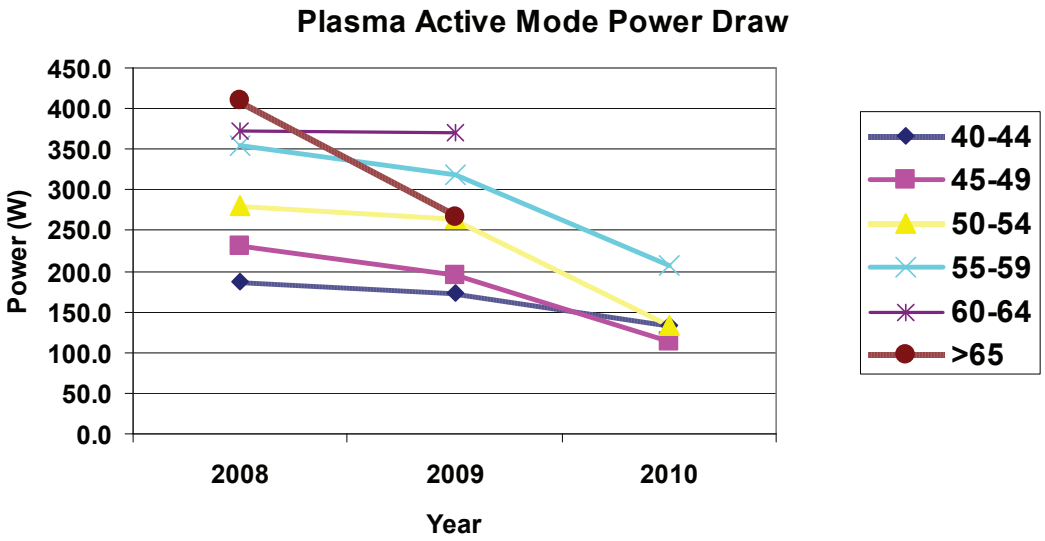

Figure 2: Comparison of plasma Active mode power draw by screen size

Digital TVs generally have two main operating modes, Active and Standby, although Active mode generally dominates the UEC, particularly for larger displays and/or units that are used regularly. Approximately 90% of total digital TV annual energy

consumption is attributed to Active mode, and therefore offers the largest opportunity for energy savings (TIAX, 2010). The power draw of TVs is largely a function of three parameters: screen size, display type, and brightness settings. Figure 1 and Figure 2 along with Figure 3 and Figure 4 show the power consumption data from the survey for LCD and plasma TV for each year in Active and Standby modes respectively. It can be seen that the Active mode power has a declining trend for each subsequent year whereas the Standby mode, with the exception of a few outlying data points, tends to have similar values capping at around 1W. It is also indicative that TV Active mode power draw generally increases with screen size, assuming the same display technology. TV Standby mode power draw does not depend on screen size.

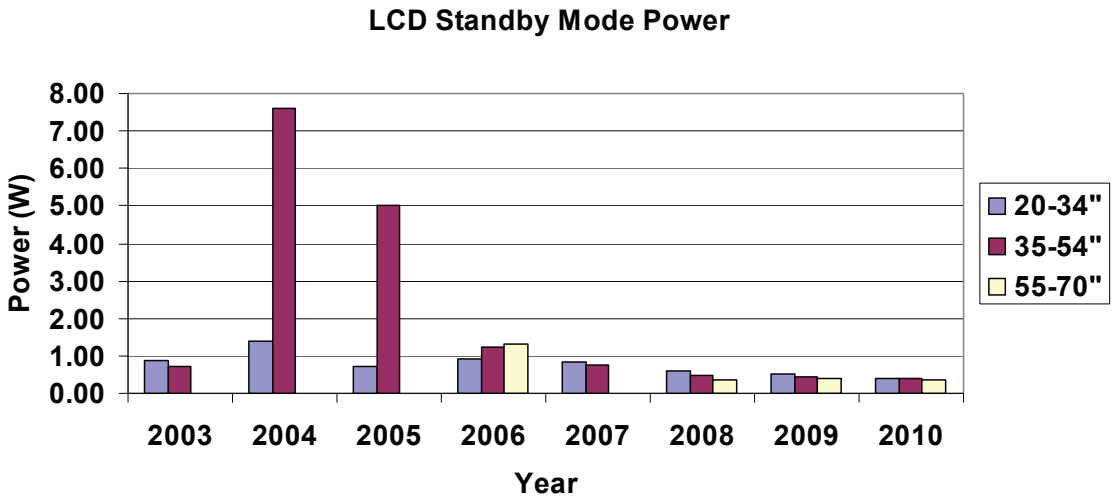

Figure 3: Comparison of LCD Standby mode power draw for 3 predominant screen size ranges

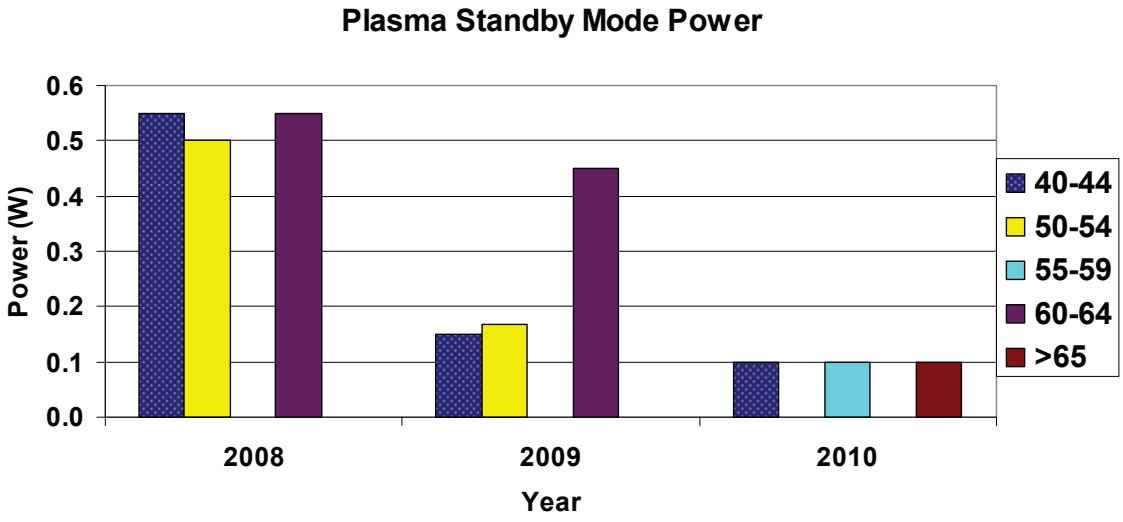

Figure 4: Comparison of plasma Standby mode power draw by screen size

Figure 5 through Figure 7 and Figure 8 and Figure 9 show, for each year, the distribution of Active mode power draw for LCD and plasma TV models, respectively, from the industry survey sample. Each diamond symbol in the plots below represents at least one digital TV model. The general trend for all these plots is a wide distribution of power draw up until 2008 to 2010, when the distribution becomes more narrow and overall declines. This can be attributed to version 3.0 Energy Star TV products specification which was finalized on February 4, 2008. Version 3.0 Energy Star, for the first time, set limits for the Active mode power draw of TV products. Energy Star guidelines are evolving as well with Version 4.1 taking effect on May 1, 2010 and Version 5.3 on September 30, 2011.

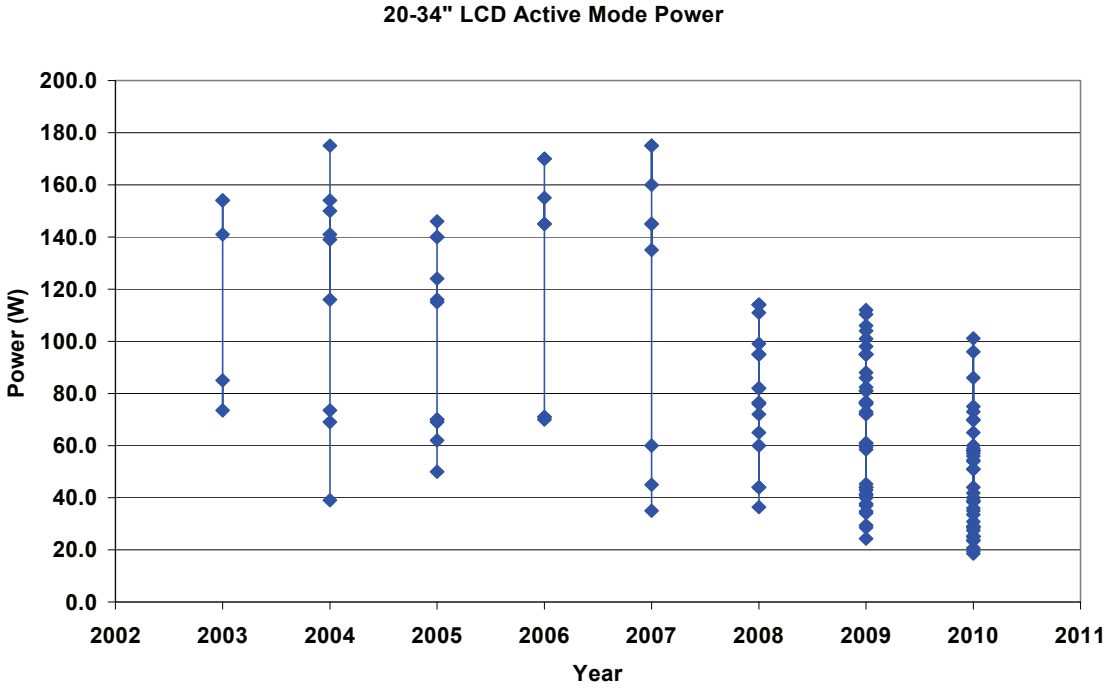

Figure 5: Distribution of 20-34" LCD Active mode power draw from the industry survey sample

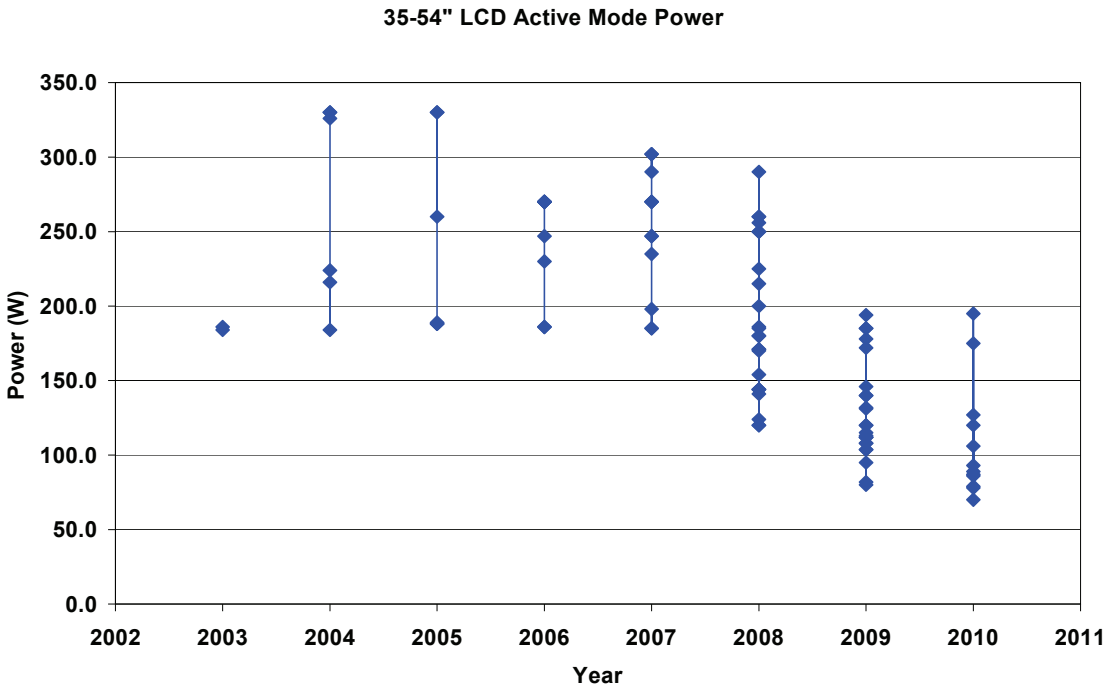

Figure 6: Distribution of 35-54” LCD Active mode power draw from the industry survey sample

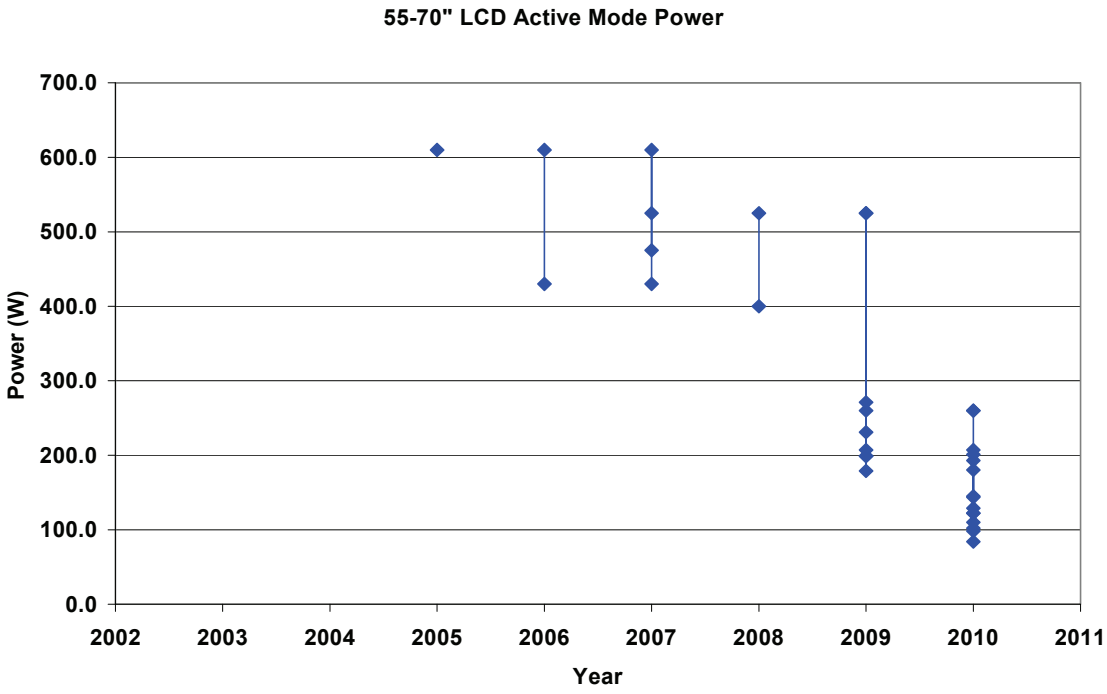

Figure 7: Distribution of 55-70” LCD Active mode power draw from the industry survey sample

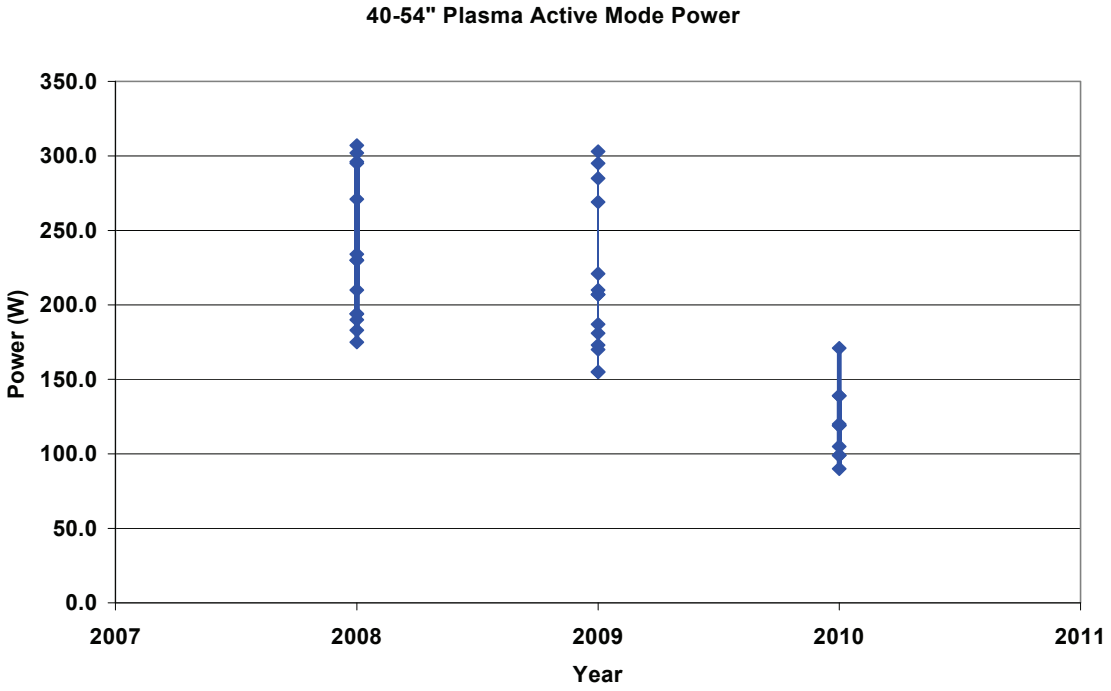

Figure 8: Distribution of 40-54” plasma TV Active mode power draw from the industry survey sample

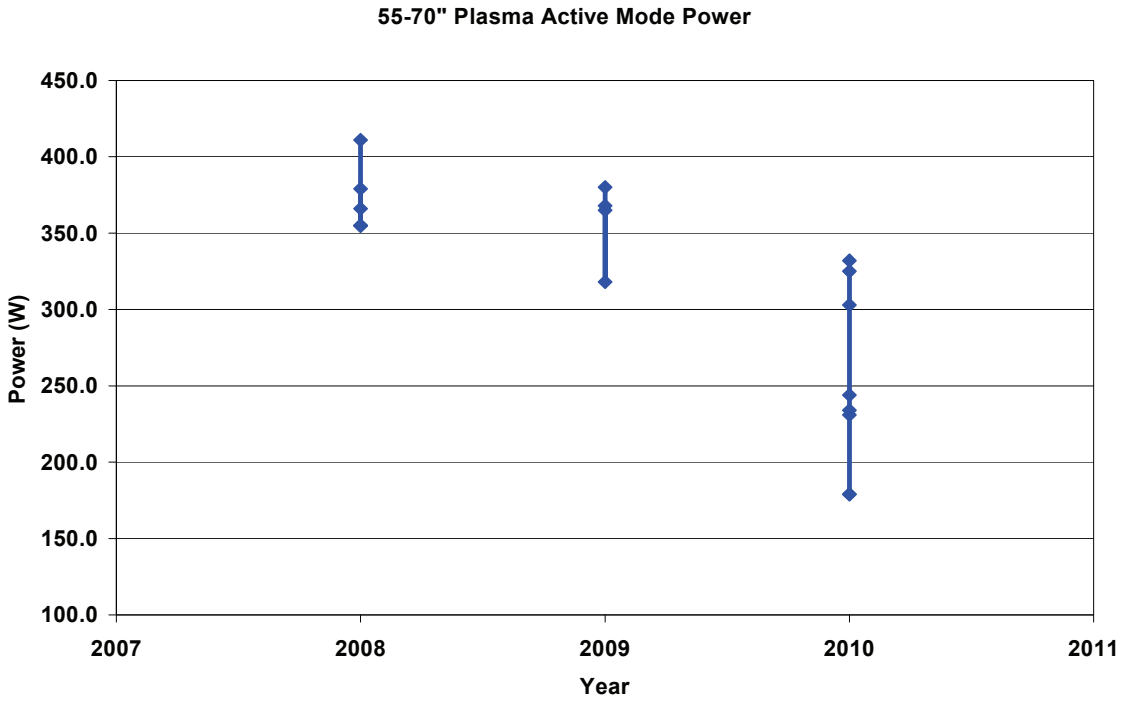

Figure 9: Distribution of 55-70” plasma TV Active mode power draw from the industry survey sample

Figure 10 through Figure 12 and Figure 13 and Figure 14 show, for each year, the distribution of Standby mode power draw for LCD and plasma TV models, respectively, from the industry survey sample. Note that there is limited data in certain plots with a few outlying data points resulting in some deviation in the general declining trend of Standby mode power for subsequent years. Compared to the Active mode plots, Standby mode is relatively more constant through all the years due to the fact that the Energy Star program has had an established maximum Standby mode power draw threshold since 1999.

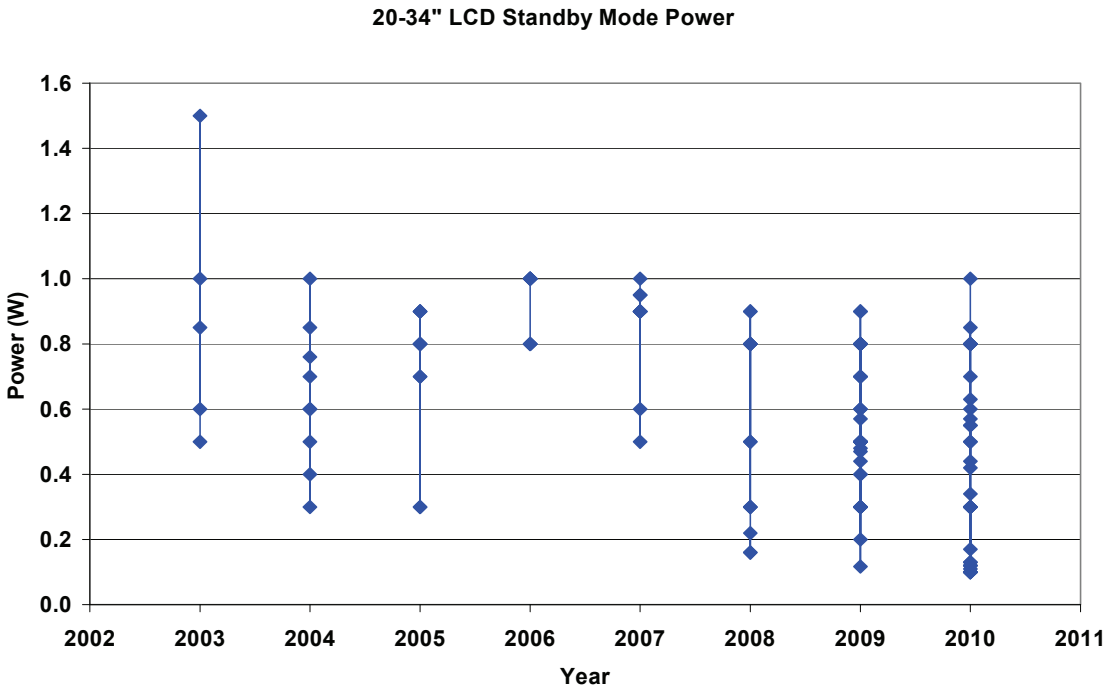

Figure 10: Distribution of 20-34" LCD Standby mode power draw from the industry survey sample

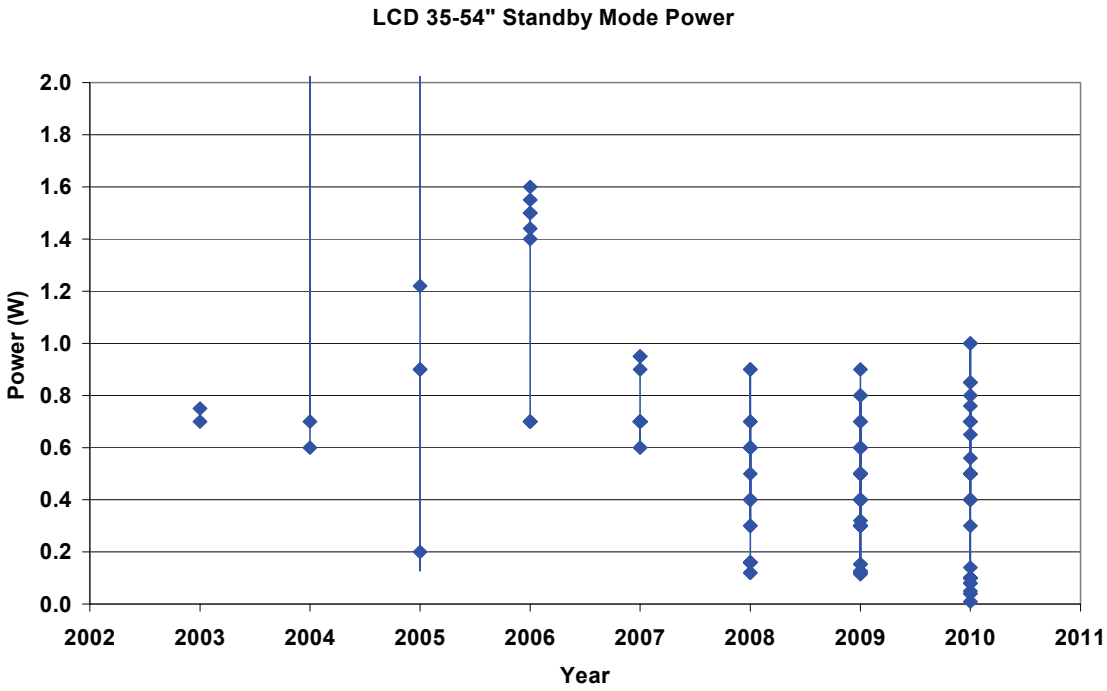

Figure 11: Distribution of 35-54" LCD Standby mode power draw from the industry survey sample

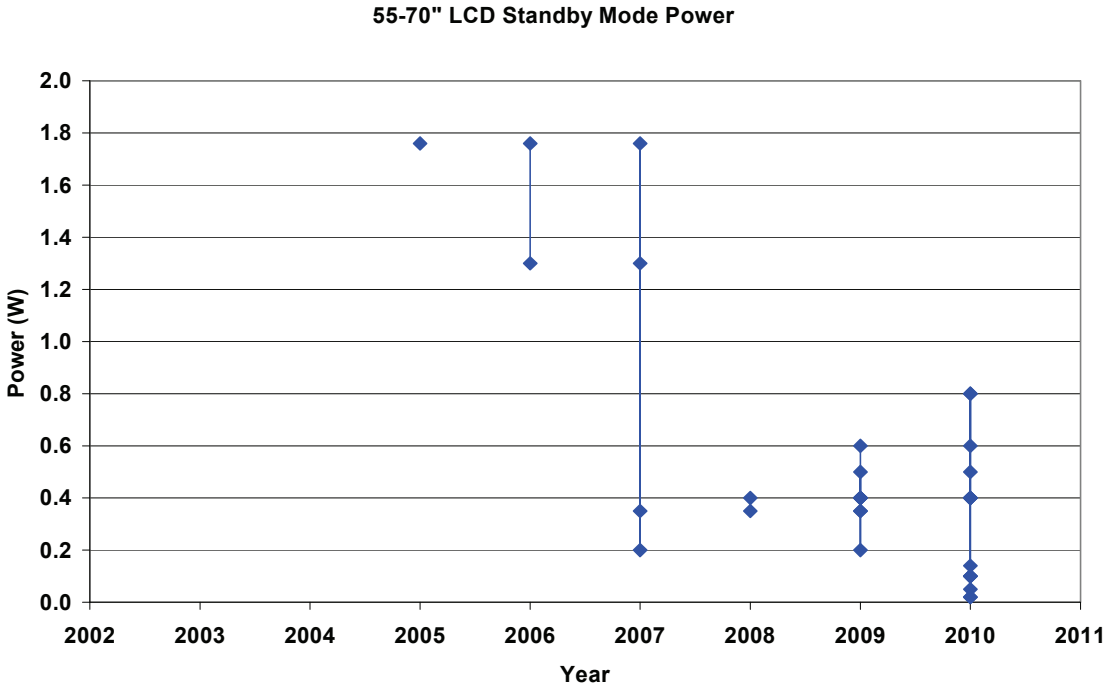

Figure 12: Distribution of 55-70" LCD Standby mode power draw from the industry survey sample

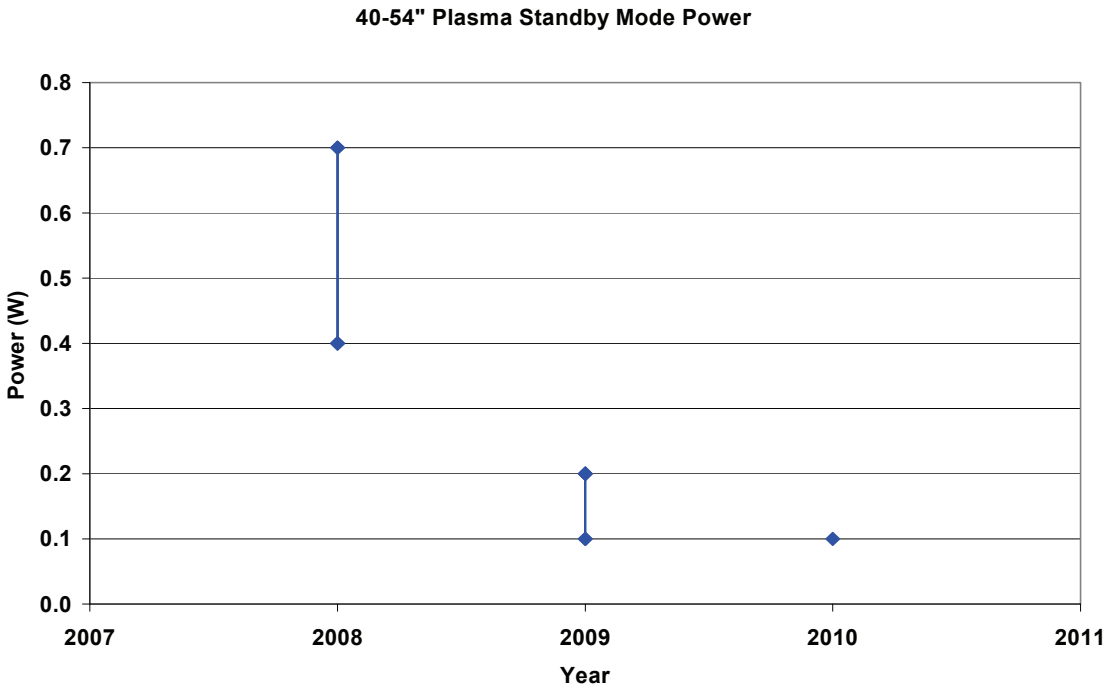

Figure 13: Distribution of 40-54" plasma TV Standby mode power draw from the industry survey sample

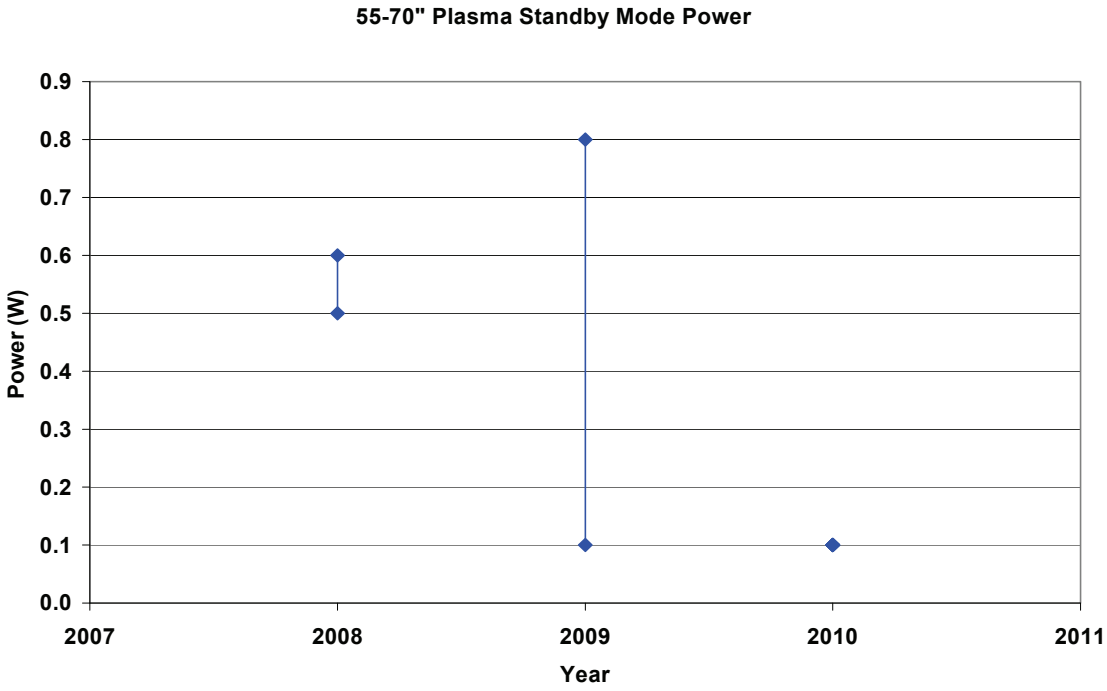

Figure 14: Distribution of 55-70" plasma TV Standby mode power draw from the industry survey sample

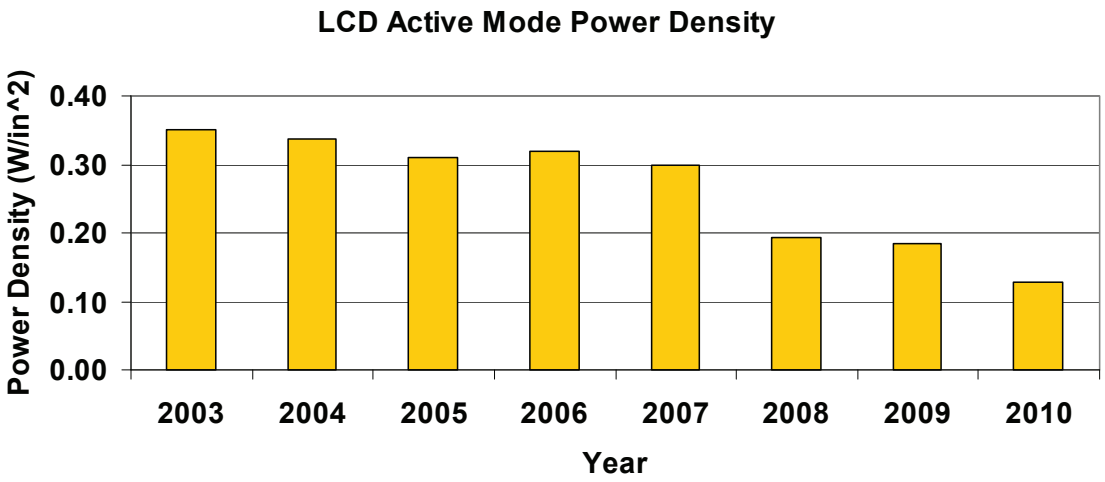

Figure 15: Average LCD Active mode power density for all screen sizes in the industry survey sample

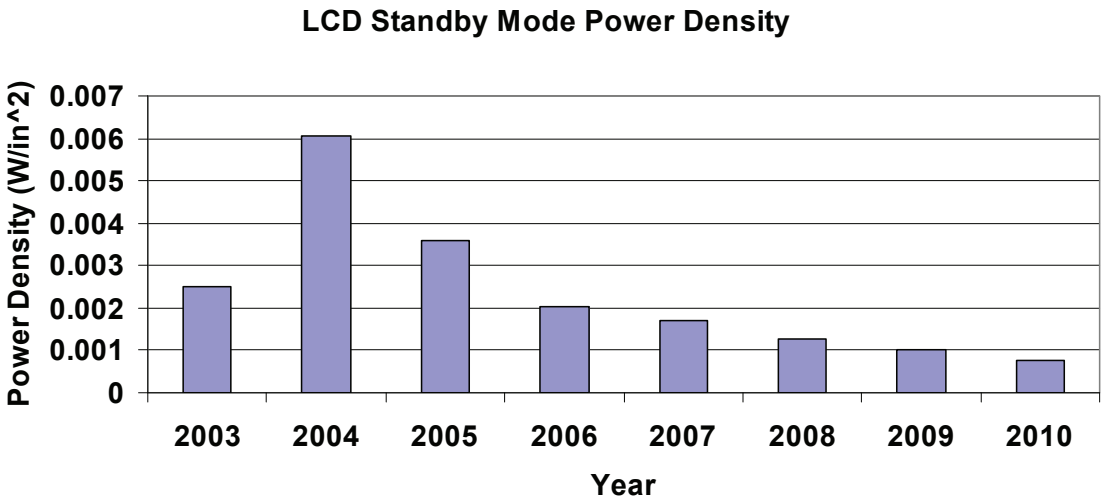

Figure 16: Average LCD Standby mode power density for all screen sizes in the industry survey sample

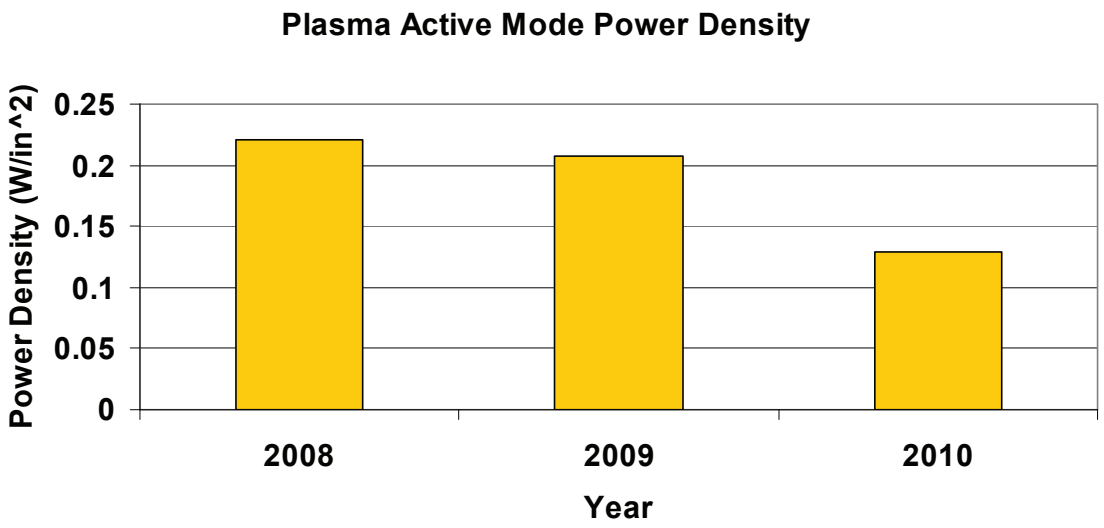

Figure 17: Average plasma TV Active mode power density for all screen sizes in the industry survey sample

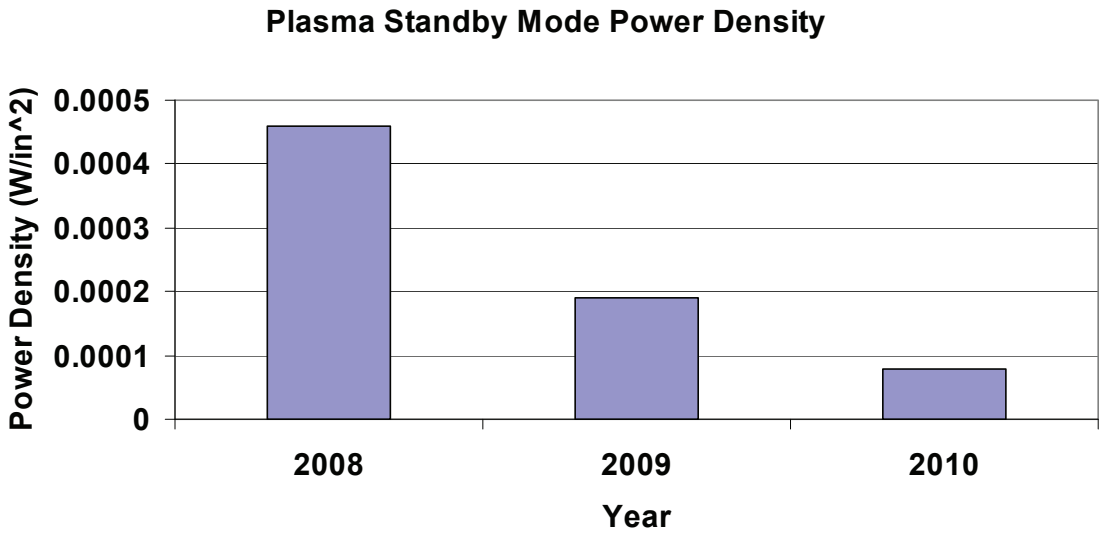

Figure 18: Average plasma TV Standby mode power density for all screen sizes in the industry survey sample

Assuming a prevalent 16:9 aspect ratio for digital TVs, the average power density of all TV models in the survey data was calculated for each year. As seen in Figure 15 through Figure 18, it is evident that the there is a decline in power density and thus energy consumption for both Active and Standby modes in subsequent years. This declining trend can be attributed to aforementioned enabling technologies that increase efficiency, as well as the Energy Star program, in which manufacturers strive to meet or exceed Energy Star specifications targeting digital TVs.

References

Energy Star, 2010, "TV, VCR, and Combination Units Products List". Available at: http://www.energystar.gov/ia/products/prod_lists/tv_vcr_prod_list.pdf

TIAX, 2007, "Energy Consumption by Consumer Electronics in U.S. Residences", Final Report to the Consumer Electronics Association (CEA), January, 2007. Available at: http://www.ce.org/pdf/Energy%20Consumption%20by%20CE%20in%20U.S.%20Residences%20(January%202007).pdf

TIAX, 2008, "Residential Miscellaneous Electric Loads: Energy Consumption Characterization and Savings Potential in 2006 and Scenario-based Projections for 2020", Report to Building Technologies Program/DOE, February, 2008

TIAX, 2010, "Residential Miscellaneous Electric Load National Energy Savings Potential in 2008", Report to Building Technologies Program/DOE, May, 2010