Codes and Standards Enhancement (CASE) Initiative For PY2008: Title 20 Standards Development

Title:
Analysis of Standards Options for Televisions

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Version: Preliminary CASE Report
Last Modified: April 2, 2008

This report was prepared by Pacific Gas and Electric Company and funded by the California utility customers under the auspices of the California Public Utilities Commission.

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1 Executive Summary

The Pacific Gas and Electric Company (PG&E) Codes and Standards Enhancement (CASE) Initiative Project seeks to address energy efficiency opportunities through development of new and updated Title 20 standards. Individual reports document information and data helpful to the California Energy Commission (CEC) and other stakeholders in the development of these new and updated standards. The objective of this project is to develop CASE Reports that provide comprehensive technical, economic, market, and infrastructure information on each of the potential appliance standards. This CASE report covers standards and options for televisions.

Televisions are the dominant media device in today's homes. The market is rapidly shifting; the formerly ubiquitous cathode ray tube TV with an analog signal will soon be surpassed by new types of digital televisions. In general, consumers are buying TVs that: a) utilize new types of technologies (e.g., plasma, LCD, and projection), b) have larger screen sizes, and c) have increased functionality (e.g., high definition). These factors, coupled with the fact that households are watching record amounts of TV each year, are significantly increasing the annual energy consumption from TV usage, nationally and in California. Statewide energy consumption is currently an estimated 6,360 million kWh/yr (GWh/yr), or roughly 2% of California's gross system electricity usage. This percentage is expected to increase as the current stock (mostly analog CRTs) is replaced by the newer and larger TV types mentioned above.[1]

The current Title 20 television standard (effective as of January 1, 2006), sets the maximum standby mode power for all televisions at 3.0 watts. An important next step is to set a standard that targets active mode[2] energy consumption, which is responsible for over 95% of the total energy consumption of TVs being sold in California[3]. At present, there is an established international test procedure to test active mode power and a new revised Energy Star® specification (Version 3.0, effective November 1, 2008) that will include active mode specification levels.

We recommend that the Commission adopt a technology-neutral standard that sets a maximum active mode power consumption level based on the TV's resolution and screen area. We recommend that the Commission utilize the same definitions and test procedure as the Final Version 3.0 Energy Star specification for TVs. This includes adopting Energy Star's guidelines for testing and certifying TVs with Automatic Brightness Control and its guidance for testing TVs at factory default settings. We suggest that the standard becomes effective on November 1, 2009, which is one year later than the new revised Energy Star specification effective date. Energy savings from our proposed standard will be substantial but highly variable since the market is so dynamic. We present three scenarios with first year electricity savings estimated between 118 and 406

[1] See Energy Solutions (2006) for a more in depth discussion of the TV market trends, usage characteristics and technical factors influencing TV energy consumption.
[2] "Active" and "On" mode are used interchangeably throughout this report.
[3] This is higher than the national average due to the California Title 20 standard that addresses standby mode power.

GWh/yr. Savings after stock turnover is estimated at between 850 and 4219 GWh/yr. The corresponding coincident peak demand reduction for the first year sales is between 16 and 56 MW, and between 117 and 580 MW after the entire stock turnover.

2 Product Description

We recommend that the Commission adopt a standard that is closely harmonized with the Final Version 3.0 Energy Star TV specification. Many of the major TV manufactures and have been engaged in the multi-year stakeholder process to develop the new specification and will be certifying a wide range of TVs using the specification requirements. Therefore, using the same product definitions as Energy Star should help to minimize acceptance issues.

Appendix A contains the Final Version 3.0 Energy Star TV specification. We recommend that the Commission adopt a Title 20 efficiency standard for the following products, as described in the Section 2 of the Energy Star specification:

> "Any TV, TV Combination Unit, Television Monitor, or Component Television Unit that is marketed to the consumer as such (i.e., focusing on television as the primary function), which meets the respective product type definition in Section 1, and is capable of being powered from either a wall outlet or a battery unit that is sold with an external power supply….This specification does <u>not</u> cover monitors with computer capability (e.g., a computer input port, such as VGA that are marketed and sold as 1) computer monitors or 2) dual function television and computer monitors."

A list of key definitions relevant to this proposed standard is contained in Section 1 of the Energy Star specification.

<u>Since California already has a Title 20 standard for maximum standby mode power, this report only recommends a standard for On Mode/Active Power.</u>[4] Thus, the analysis throughout this report focuses on energy savings related to setting an active mode efficiency standard.

3 Energy Usage

3.1 Test Methods

3.1.1 Current Test Methods

The most relevant test method is IEC 62087, Ed. 2.0: *Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, Section 11, "Measuring conditions of television sets for On (average) mode."* This test method has been developed over the past couple years with input from multiple international stakeholders. As footnoted in the Energy Star specification (footnote 2, Appendix A), the test method is

[4] On Mode / Active Power is defined in the Energy Star Specification as "The product is connected to a power source and produces sound and a picture. The power requirement in this mode is typically greater than the power requirement in Standby and Download Acquisition Modes." This report uses the term "active" and "on" mode interchangeably to describe this usage mode.

still in draft form and under IEC committee review, as of the writing of this report. However, significant changes to the relevant portions of the IEC document are not envisioned by its authors. The EPA will review the final version, when available, to ensure that no material changes have been made to the applicable sections of the documents.

3.1.2 Proposed Test Methods

We propose that the Commission use IEC 62087, Ed. 2.0 (as discussed above) for the Title 20 testing requirements. We also recommend that the Commission adopt the test methodology requirements pertaining to active mode testing in Section 4 of the Version 3.0 Energy Star TV specification. This Section of the specification gives guidance on the following:

- Test conditions
- Models capable of operating at multiple voltage/frequency combinations
- Approved meter
- Accuracy
- Implementation of IEC 62087
    - Accuracy of input signal levels
    - Use of broadcast test materials for testing
    - True power factor
    - Testing at factory default settings
    - Testing of TVs with automatic brightness control.

3.2 Baseline Energy Use Per Product

In order to assess the potential energy and cost implications of a proposed standard, we have established the following three TV categories:

- **Non-Energy Star:** includes all TVs *would not* pass the Tier 1 Version 3.0 Energy Star TV specification levels.

- **Energy Star Version 3.0:** includes all TVs that *would* pass the Tier 1 Version 3.0 Energy Star TV specification levels.

- **Title 20 Proposal:** includes all TVs that *would* pass our proposed Title 20 levels.

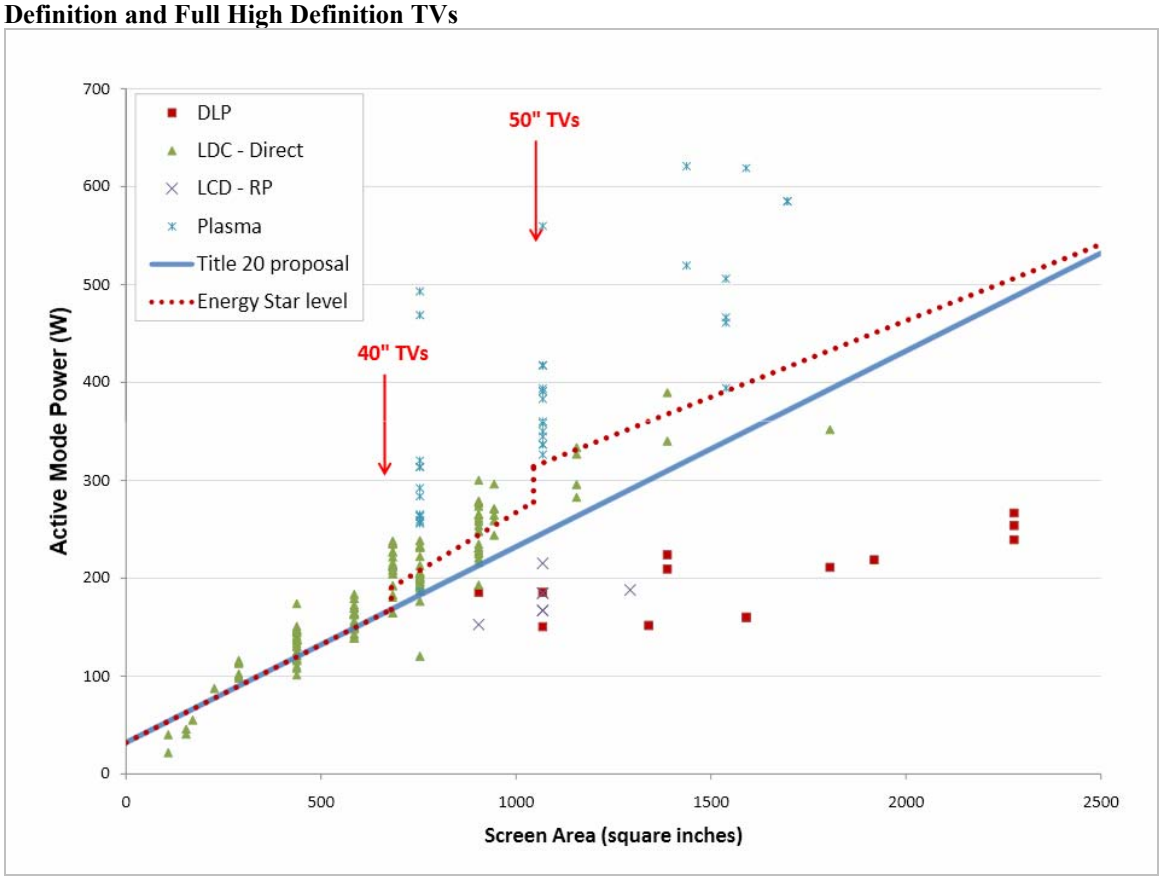
The On mode power level requirements for Energy Star TVs are shown in Table 1 of Appendix A. The Tier 1 requirements become effective November 1, 2008 and are separated into "Non-High Definition TVs (i.e., ≤ 480 Native Vertical Resolution)" and "High Definition and Full High Definition TVs (i.e., > 480 Native Vertical Resolution)" categories. The maximum allowable power consumption is a function of the viewable screen area for both categories. More stringent Tier 2 requirements are anticipated to become effective September 1, 2010, but the exact levels are still "to be determined (TBD)".

Figure 1 shows the Energy Star specification levels compared to the Title 20 proposal

levels for high definition (HD) and full high definition (FHD) TVs. The Energy Star specification level has a notable power allowance for TVs with larger screen sizes. The first "step" increase allowance occurs for TVs with screen areas between 680 and 1045 $inch^2$ (roughly 40" to 49" TVs) and then again for TVs with areas over 1045 $inch^2$ (roughly for TVs with a screen size 50" and greater).

Based on results discussed in future sections, we recommend a Title 20 standard level that does not give a power allowance for larger-sized TVs. For consistency with the Energy Star specification, we choose the same levels for screen sizes up to 680 $inch^2$ but then keep the equation constant for all screen sizes. 213 HD and FHD TVs are plotted in the figure and are distinguished between DLP (Digital Light Processing rear projection TVs), Direct View LCDs, Rear Projection LCDs, and Plasma TVs. See Appendix B for more specific technical data on the television data set.

Figure 1. Final Version 3.0 ENERGY STAR Specification versus Title 20 Proposal Level for High Definition and Full High Definition TVs

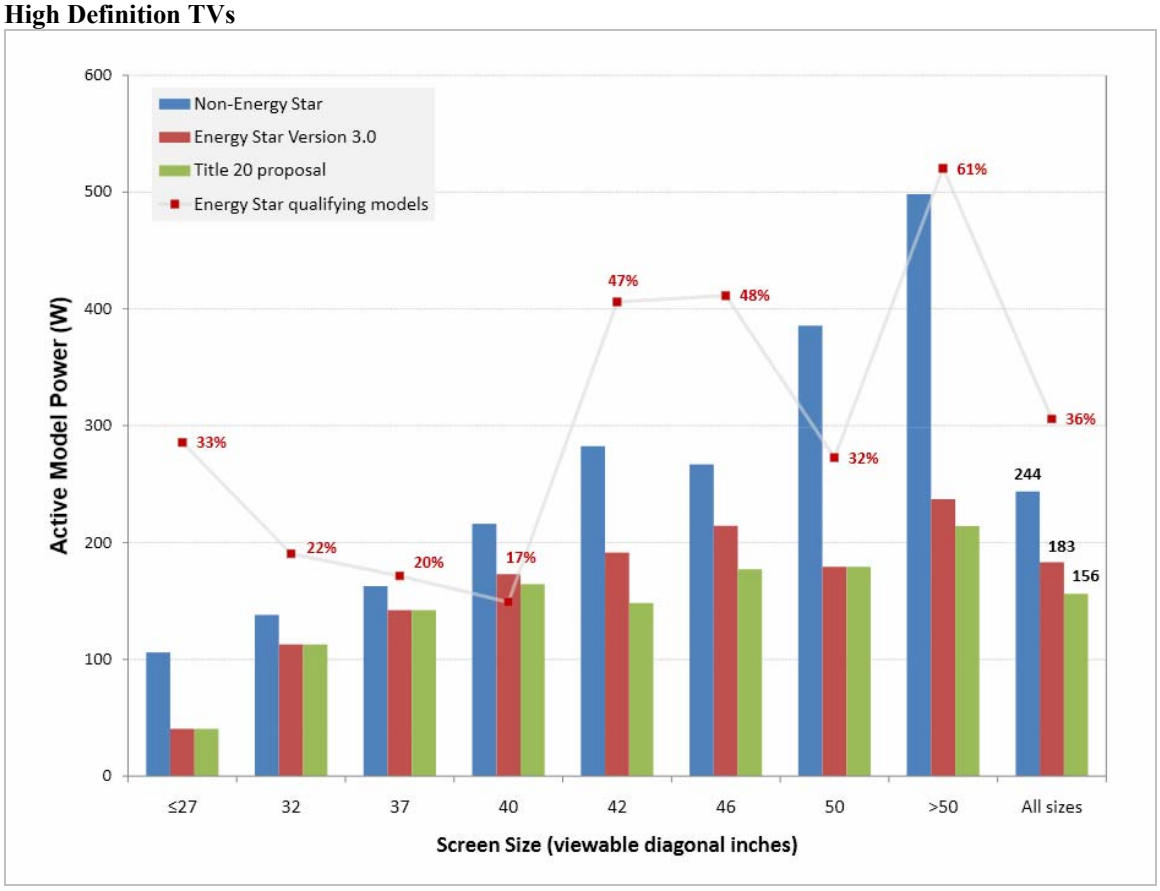


Notes: See Appendix B for details on TV data set. DLP = Digital Light Processing rear projection TV. RP = rear projection TV; Direct = direct view TV.

Figure 2 shows the active mode power by screen size for HD and FHD TVs. As expected, the average active mode power increases as screen size increases. The figure also shows the expected percentage of TVs on the market today that would qualify for Version 3.0 Energy Star active mode specification levels. The average for all models is 36% and this is expected to increase between now and the November 1, 2008 effective

date. The qualification levels for larger screen TVs are well-above the typical Energy Star goal of 25%. For example, 42-inch TVs have a 47% qualification rate; TVs over 50 inches qualify at a rate of 61%. These qualification rates will likely increase between now and the November 1, 2008 effective date. Thus, there is a strong motivation to set a Title 20 standard that is more stringent than Energy Star Tier 1 levels for larger size TVs in order to achieve significant savings by the time a Title 20 standard becomes effective.

Figure 2. Active Mode Power by Screen Size and Efficiency Category for High Definition and Full High Definition TVs



Note: See Appendix B for details on TV data set.

Tables 1 and 2 show the energy profiles for the three TV categories described above. Table 1 provides the values for non-high definition TVs and Table 2 shows values for HD and FHD TVs. For non-HD TVs, our Title 20 proposal level is the same as the Energy Star level and thus the values for those respective categories in Table 1 are the same. For HD and FHD TVs, our Title 20 proposal is more stringent than the Energy Star specification and therefore the "Title 20 Proposal" power draw and energy consumption average values are less than the "Energy Star Version 3.0" levels.

Table 1. Energy Use per Product: Non-High Definition TVs (≤ 480 Native Vertical Resolution)

TV category	Power Draw (W)	Annual Operating Hours	Consumption (kWh/yr)
Non-Energy Star	69.5	1882	130.8
Energy Star Version 3.0	56.6	1882	106.5
Title 20 Proposal	56.6	1882	106.5

Note: See Appendix B for detailed values and sources.

Table 2. Energy Use per Product: High Definition and Full High Definition TVs (> 480 Native Vertical Resolution)

TV category	Power Draw (W)	Annual Operating Hours	Consumption (kWh/yr)
Non-Energy Star	243.6	1882	458.5
Energy Star Version 3.0	183.1	1882	344.5
Title 20 Proposal	156.1	1882	293.9

Note: See Appendix B for detailed values and sources.

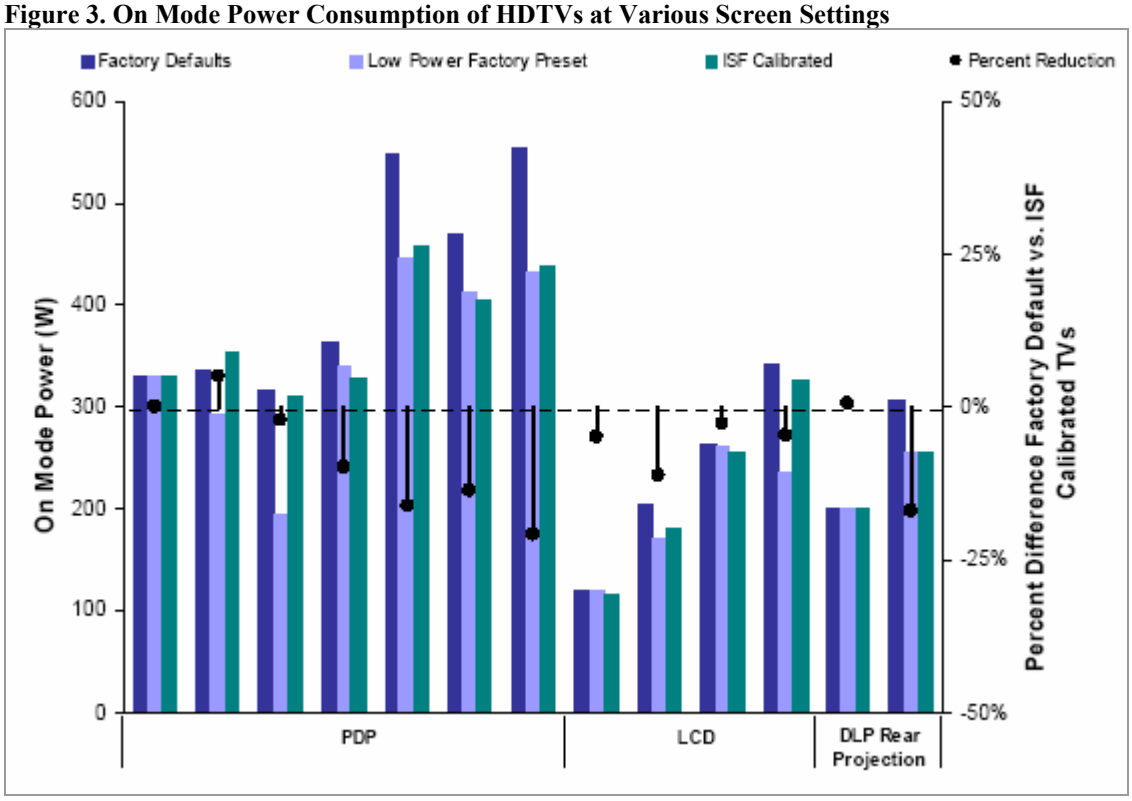
3.3 Efficiency Measures[5]

Figure 3 shows the on mode power consumption of 13 different TVs at various screen settings, based on testing conducted by Ecos Consulting. Ecos received input from the Imaging Science Foundation (ISF) to test the TVs at an optimized level both for energy efficiency and picture quality (labeled as "ISF Calibrated" on the figure). Initial results suggest that the TV's screen settings can significantly influence power consumption picture quality and therefore could be utilized as an efficiency strategy.[6]

[5] Author's note: this section is currently not completed and will be updated in subsequent versions of this CASE report and/or within CEC workshop materials.

[6] This analysis was conducted by Ecos Consulting for a CEC PIER project. More detailed report findings are available upon request.

Figure 3. On Mode Power Consumption of HDTVs at Various Screen Settings



Note: results are based on testing conducted by Ecos Consulting. ISF = Imaging Science Foundation.

3.4 Standards Options Energy Use Per Product

The average energy use for TVs that meet the proposed Title 20 levels was shown previously in Tables 1 and 2. Table 3 shows the energy savings for the proposed Title 20 standard relative to non-Energy Star and Energy Star TVs.

Table 3. Energy Savings for Proposed Title 20 Standard

TV category	Power Draw (W)	Annual Operating Hours	Unit Electricity Consumption (kWh/yr)	Estimated % of sales (2008)
Non-High Definition				
Savings relative to Non-Energy Star	13	1882	24	6%
Savings relative to Energy Star	0	1882	0	3%
High Definition				
Savings relative to Non-Energy Star	61	1882	114	58%
Savings relative to Energy Star	27	1882	51	32%
Weighted Savings (all models)			**84**	**100%**

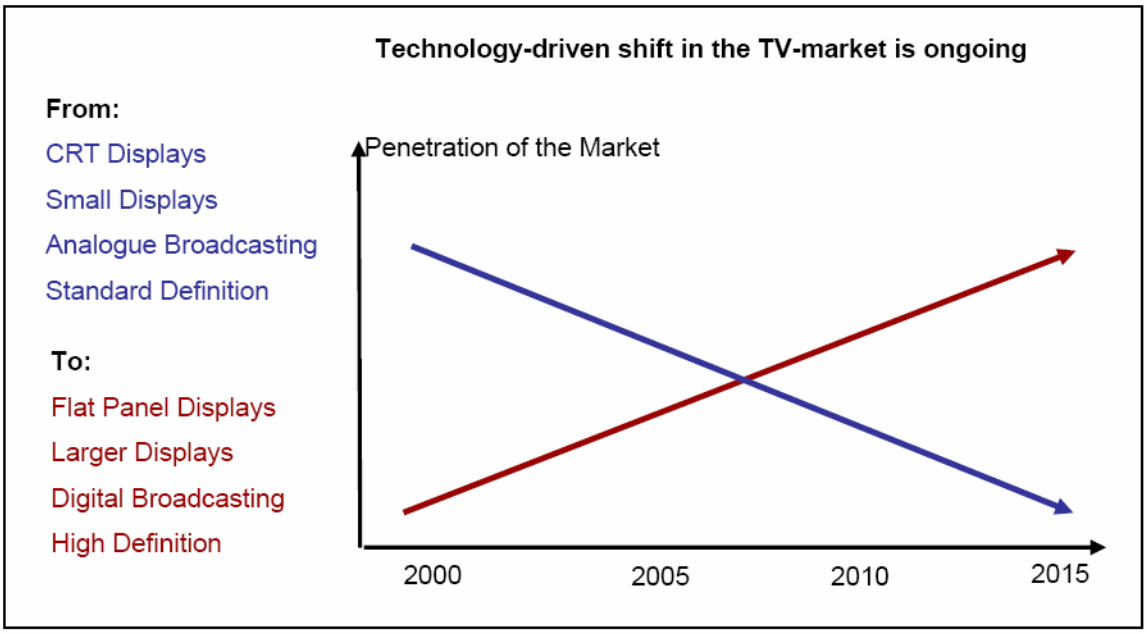
Note: See Appendix B and C for detailed values and sources.

4 Market Saturation and Sales

4.1 Current Market Situation

Televisions are the dominant media device in today's homes. The market is rapidly shifting; the formerly ubiquitous cathode ray tube TV with an analog signal will soon be surpassed by new types of digital televisions. In general, consumers are buying TVs that: a) utilize new types of technologies (e.g., plasma, LCD, and projection), b) have larger screen sizes, and c) have increased functionality (e.g., high definition). These factors, coupled with the fact that households are watching record amounts of TV each year, are significantly increasing the annual energy consumption from TV usage, nationally and in California. These trends are highlighted in Figure 4 below. We are currently at a crossroads where market situation five years from now will be radically different than the market five years ago.

Figure 4. Technology Shit in TV market

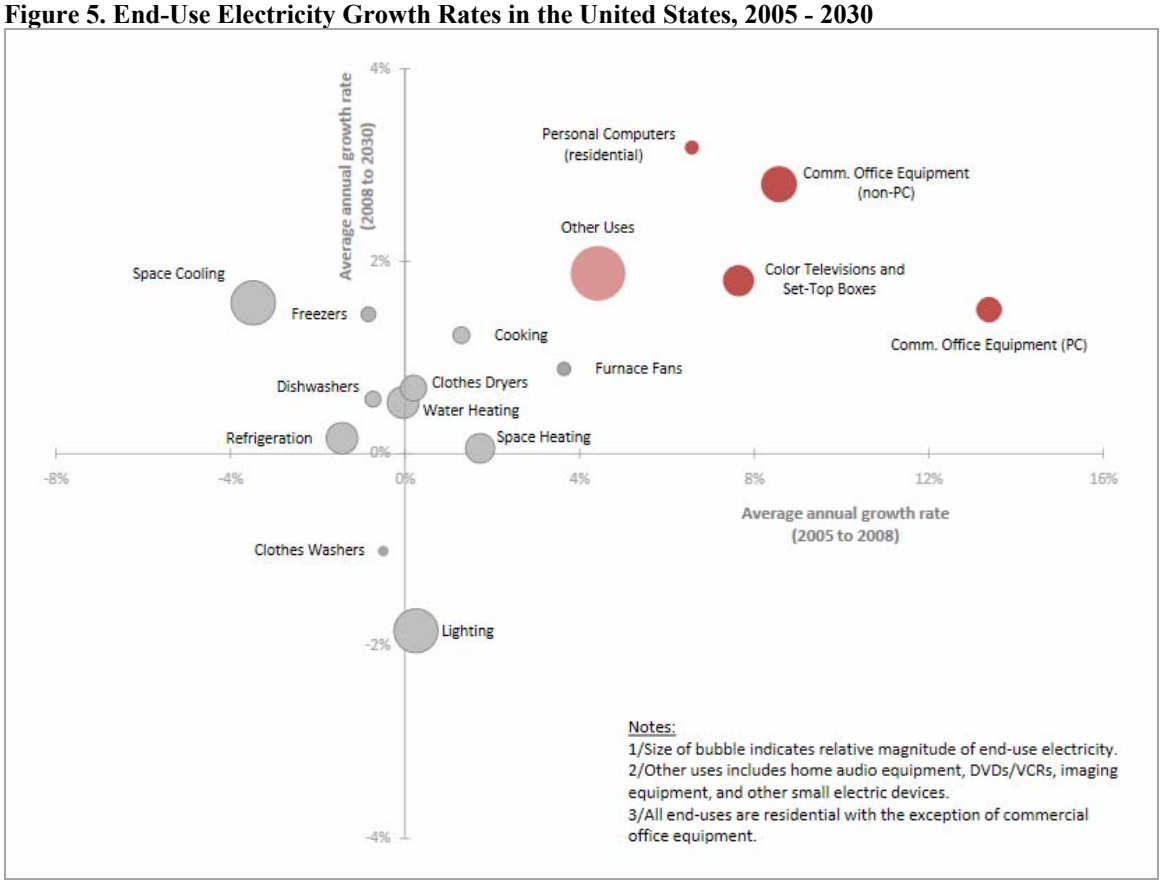


Source: EuP, 2007 (Task 2 Report, pg 5).

Relying on projections in the *2008 Annual Energy Outlook* (EIA 2008), we analyzed the load growth of TVs in the United States relative to other electrical end uses (Figure 5). 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 electronics such as home audio equipment, DVDs, and hand-held rechargeable devices, but also includes 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 from 2005 to 2008 for consumer electronics and information technology equipment was significantly more than all other end-uses (shown by the horizontal x-axis in Figure 5). Color TVs and STBs had 7.6% growth rate, which was only surpassed by commercial office equipment. The forecasted growth rate from 2008 to 2030 (shown by the vertical y-axis in Figure 5) 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. The TVs and STBs category is expected to increase at 1.8% per year.[7]

Figure 5. 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.

Table 4 displays current estimates for the California stock and annual sales. The estimated current California stock is 35.3 million televisions. The estimated annual sales in 2010 is 4.27 million units.

[7] 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 Roth R. & K. McKenney (2007).

Table 4. California Stock and Sales

TV category	California Stock Units (millions)	California Annual Sales (2010 est.) Units (millions)	Average Annual Growth Rate
All TVs	35.3	4.27	1.8%

Note: California stock estimate based on 2008 value in Table 4.2-8 of Energy Solutions (2006) and annual sales based on 2009 value in Table 4.2-7 and assumes a 1.8% average annual growth rate. Both values are scaled based on PG&E's estimated population relative to California (assumes PG&E territory represents 36% of California's total population). The average annual growth rate is based on EIA 2008 (as shown in Figure 5).

4.2 Baseline Case

The "baseline" TV market is highly variable based on the dynamics discussed above. The baseline power draw levels for TVs will be largely dependent on the success of the Version 3.0 Energy Star specification—specifically in terms of how quickly the market gravitates to Energy Star levels and beyond. Therefore, in order to model energy savings from the proposed Title 20 standard, we developed three Energy Star saturation scenarios: High, Mid, and Low. The "Mid" scenario is based on the qualifying levels when analyzing the data set described in Appendix B. The "High" scenario assumes a higher and quicker saturation rate and therefore incremental savings from the proposed Title 20 level are lower—vice versa for the "Low" scenario. Appendix C shows the estimated market share for each scenario from 2008 to 2020. Appendix D shows the estimated California annual sales during this time period for each scenario.

4.3 Future Market Adoption of High Efficiency Options

As described in the previous section, the future market adoption of TVs that would meet the Energy Star and Proposed Title 20 levels is unknown and highly variable. Appendix C and D shows the modeling estimates used in the three scenarios described above.

5 Savings Potential

5.1 Statewide California Energy Savings

The estimated annual energy consumption of the TV stock in California is 6,360 GWh/yr (see Table 5). This is approximately 2% of California's total electricity consumption. The coincident peak demand is an estimated 875 MW, or roughly the equivalent to the capacity of a medium-sized power plant.

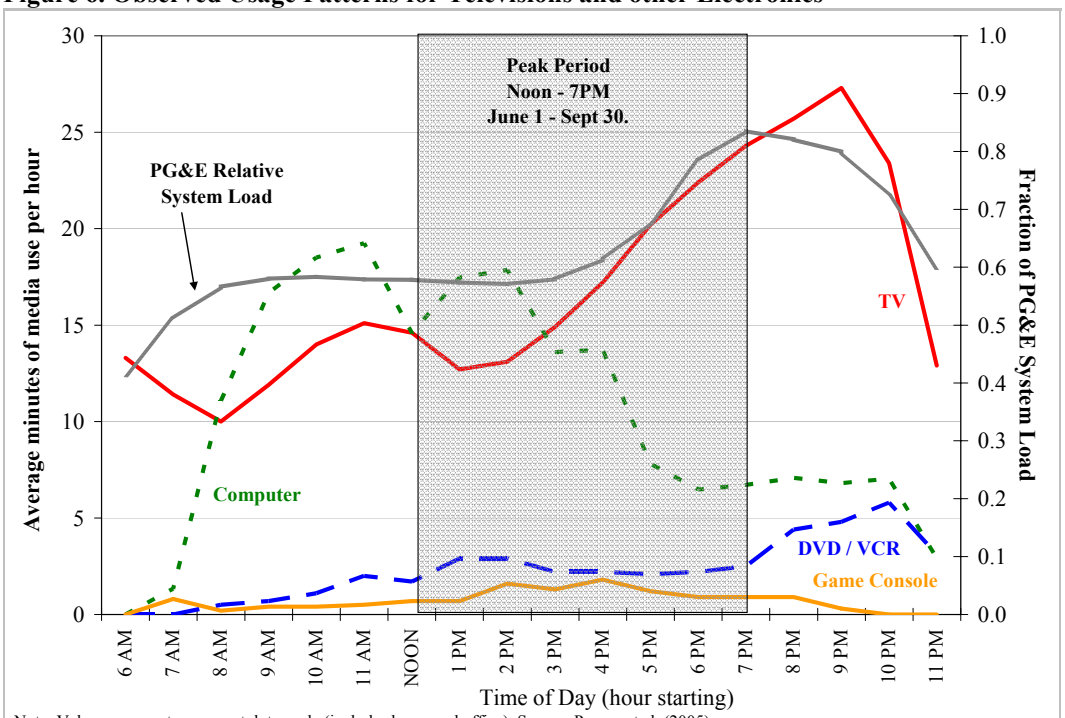
Table 5. California Statewide Energy Use

	For Entire Stock	
	Coincident Peak Demand (MW)	Annual Energy Consumption (GWh/yr)
All TVs	875	6360

Note: Annual Energy Consumption is based on the Roth and McKenney (2007) U.S. estimate in Table 5-55 and scaled based on California's population relative to the U.S. A 0.83 load factor, as presented in Brown and Koomey (2002), is used to calculated coincident peak demand.

Figure 6 provides some insights into how a TV is used throughout the day and subsequently affects the California system load (computers, DVDs, and game consoles are also included). The usage patterns are based on an observed study of media usage trends (Paper et al, 2005) and are shown from 6:00 am to midnight compared to the relative PG&E system load. The TV usage is fairly flat throughout the morning and into the afternoon. At 2:00 pm, usage ramps up to a peak around 9:00 pm. This ramp-up occurs in the latter half of the peak period and keeps increasing until about two hours after the peak period ends. Additional studies are warranted to better understand the peak demand implications of TV usage but this figure provides an illustrative example of how closely the TV usage profile matches relative system load profile. Thus, the potential for demand reductions from our proposed standard is significant.

Figure 6. Observed Usage Patterns for Televisions and other Electronics



Note: Values represent usage, not duty cycle (includes home and office). Source: Papper et al. (2005).
*PG&E System Load line represents relative load profile for PG&E Residential E1 accounts in 2000. Source: PGE (2006)

Table 6 shows the estimated California statewide energy savings for our proposed Title 20 standard. Values are shown for the three scenarios described in Section 4.2. The first year electricity savings for the three scenarios are estimated at between 118 and 406 GWh/yr. Savings after stock turnover are estimated at between 850 and 4219 GWh/yr. The corresponding coincident peak demand reduction for the first year sales is between 16 and 56 MW, and between 117 and 580 MW after the entire stock turnover.

Table 6. Estimated California Statewide Energy Savings for Proposed Standards Option

	For First-Year Sales (in 2010)		**After Entire Stock Turnover**	
Scenario	Coincident Peak Demand Reduction (MW)	Annual Energy Savings (GWh/yr)	Coincident Peak Demand Reduction (MW)	Annual Energy Savings (GWh/yr)
Low Energy Star saturation	56	406	580	4219
Mid Energy Star saturation	32	233	206	1498
High Energy Star saturation	16	118	117	850

Note: savings after stock turnover is based on an estimate useful life of 10 years (EuP, 2007). See Appendix E for detailed values and sources.

5.2 Other Benefits and Penalties

The research described in Section 3.3 suggests that energy efficient TV settings can also significantly improve the overall picture quality of the set.

We are not aware of any adverse environmental impacts that will be created by the proposed standard.

There is also evidence that more efficient TVs can utilize less materials (both toxic and non-toxic) and therefore save manufacturing costs and reduce end-of-life landfill waste. Reduced materials use could also improve the end-of-life material recovery rates for TVs. The following excerpt from an article in Appendix F expands on the potential benefits of TV energy efficiency:

> SID President-Elect Larry Weber, a pioneer in plasma technology, called luminous efficacy the "No. 1 display parameter" makers of all the television technologies are trying to increase. The higher the ratio of lumens per watt, the better the luminous efficacy, Weber explained. And the better the luminous efficacy, the less energy it takes to power a display. Higher luminous efficacy means lower costs because television manufacturers do not have to spend as much on circuitry, cooling fans, and power supplies. It can also help engineers to build TVs that have brighter displays and are easier to operate.
>
> "All of the technologies have a good strategy for increasing the luminous efficacy—LCDs, plasmas, OLEDs and projection TVs," Weber said. "So all these major technologies are racing to try to make efficacies better, and plasma displays are no different than the rest. Plasma displays have a tremendous opportunity to increase their luminous efficacy, and what you saw in Japan at

the (October 2005) CEATEC is just sort of an indication of what's to come." [8]

6 Economic Analysis

6.1 Incremental Cost

There is limited publically available data that can provide a statistically significant incremental cost (positive or negative) for our proposed Title 20 standard. A detailed cost analysis of TVs is provided in Section 2.4 of the European Commission's *EuP Preparatory Studies "Televisions" (Lot 5), Report on Task 2 "Economic and Market Analysis;"* however, incremental cost is not discussed.

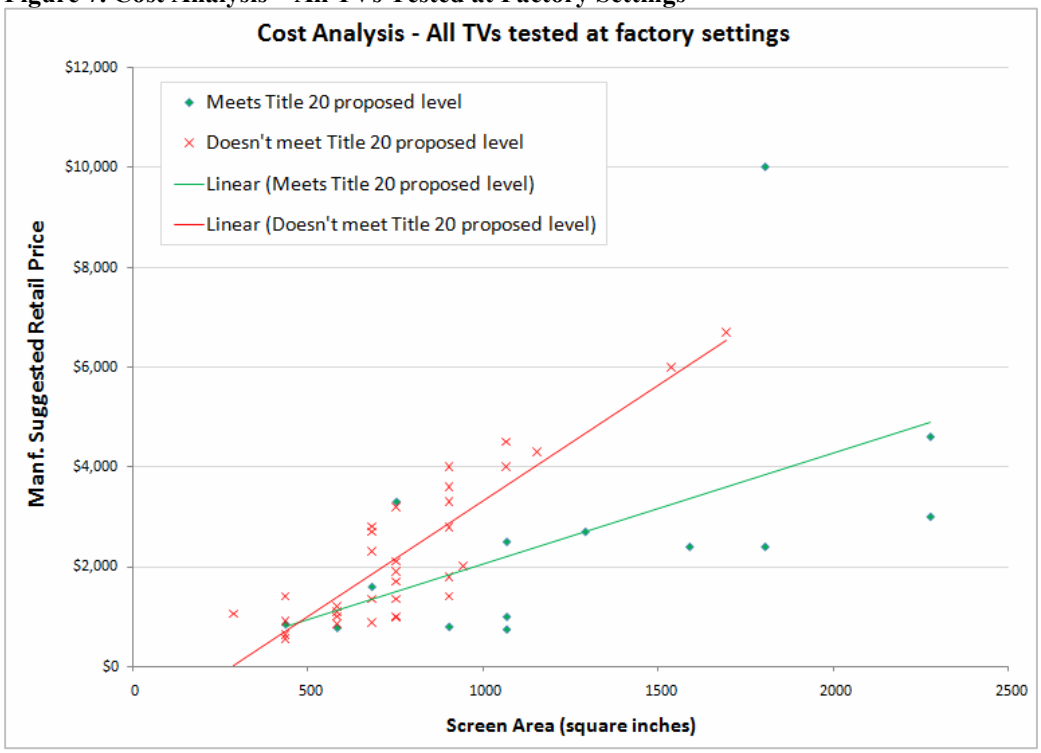
We do attempt a first-order incremental cost analysis using a data-set collected by Ecos Consulting for a CEC PIER project (see Figure 7 and 8). Figure 7 is a scatter plot showing the TV's screen area and manufacturer suggested retail price. A linear trend line is shown for TVs that meet and do not meet the proposed Title 20 level, respectively. The general trend line for TVs that meet the Title 20 proposal is less (on a $ per screen area basis) compared to the TVs that do not meet the proposal—indicating a negative incremental cost for TVs in this dataset.

The rear projection TVs with generally larger screen sizes relative to cost (the data points in the lower right portion of the figure) are a significant factor in lowering the trend line for TVs that meet the Title 20 proposal. Therefore, we show a similar analysis in Figure 8 that only includes direct view TVs (excludes rear projection). In this data set, the general incremental cost is negative for smaller screen TVs and positive for larger screen sizes. However, the small sample size is largely skewed by an outlier TV that costs nearly $10,000.

Additional research using a more robust data set is warranted to determine a more refined incremental cost. We recommend that the Commission solicit feedback from industry stakeholders with better access to cost information. As discussed in Section 5.2, there is evidence that increased efficiency can lead to less materials and thus lower costs.

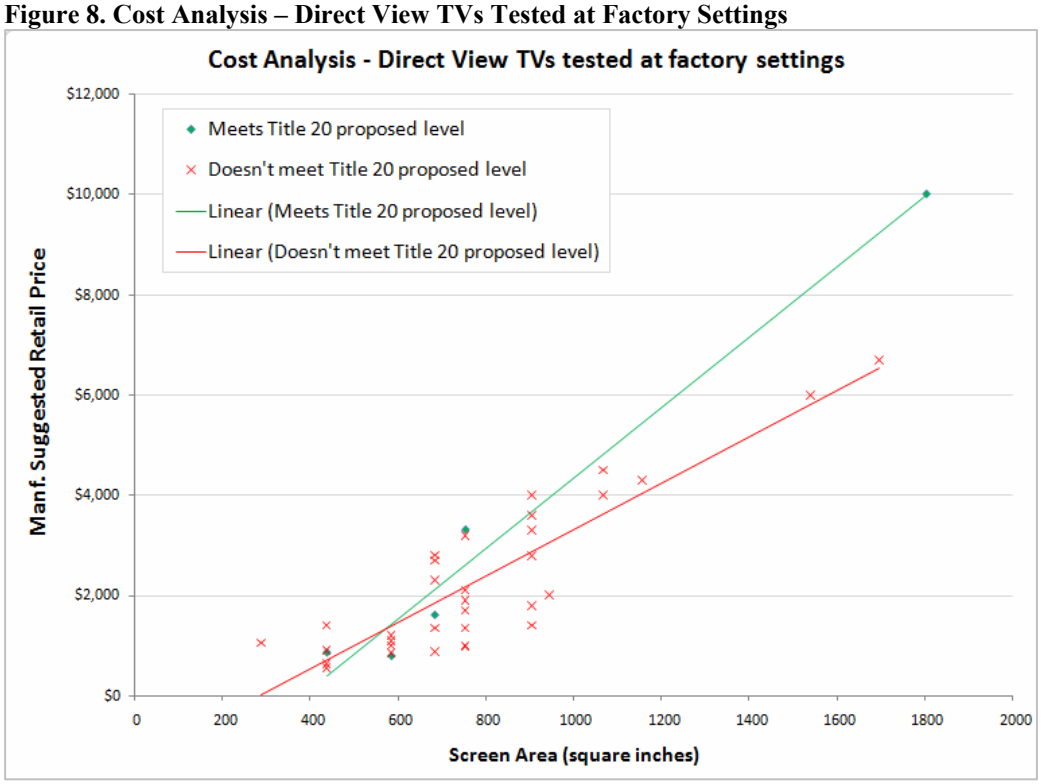
[8] See Appendix F, "Matsushita, Hitachi, Pioneer Jointly Develop Low-Power PDP", January 2006.

Figure 7. Cost Analysis – All TVs Tested at Factory Settings



Note: Figure values are based on a data set developed by Ecos Consulting for CEC PIER. The TV sample size in the figure is 45 (14 qualifying; 39 non-qualifying).

Figure 8. Cost Analysis – Direct View TVs Tested at Factory Settings



Note: Figure values are based on a data set developed by Ecos Consulting for CEC PIER. The TV sample size in the figure is 41 (5 qualifying; 39 non-qualifying).

6.2 Design Life

A literature review indicates that the product life of TV sets is cited to be between 7 and 15 years (EuP 2007, Final Report Task 2, pg. 29). The EuP (2007) analysis assessed sales and stock data and estimated that TV sets are in use for 10 years. We use this 10 year design life for the purposes of energy and cost savings presented in this report.

6.3 Lifecycle Cost / Net Benefit

Based on previously discussed energy savings and design life, the lifecycle benefits from energy savings are presented in Table 7. The savings are shown for each scenario as described in Section 4.2.

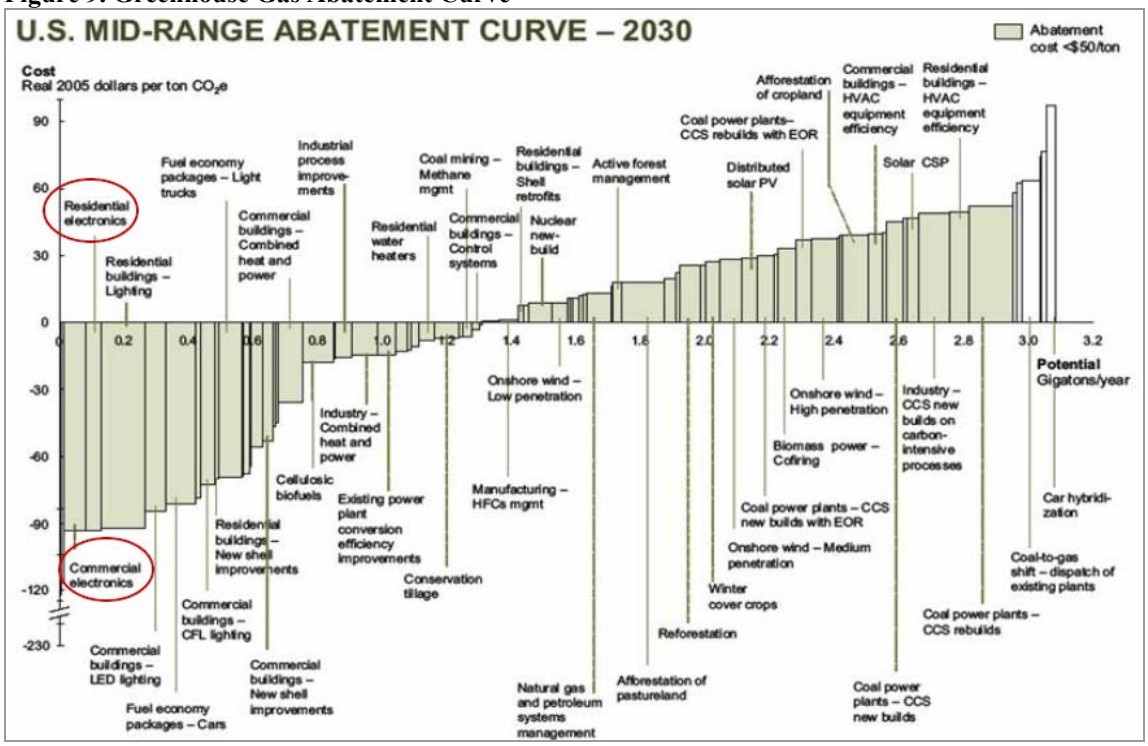
Table 7. Lifecycle Benefits for Standards Options

		Lifecycle Benefits from Energy Savings (Present Value $)		
Scenario	Design Life (yrs)	Per Unit ($)	For First Year Sales ($M)	After Entire Stock Turnover ($M)
Low Energy Star saturation	10	$84	$404	$4,193
Mid Energy Star saturation	10	$84	$232	$1,489
High Energy Star saturation	10	$84	$117	$845

Notes: PV = Present Value; Calculated using the CEC's average statewide present value statewide energy rates that assume a 3% discount rate (CEC 2004). Design Life estimate is from EuP (2007)

Figure 9 below is from a recent December 2007 McKinsey & Company report showing a cost-benefit analysis of various options for reducing greenhouse gas emissions. Their analysis indicates that increasing the efficiency of residential and commercial electronics represents a significant opportunity (shown by the width of the bars of the bars) and is also the most cost-effective strategy (shown by the negative marginal cost on the y-axis). By setting an active mode Title 20 efficiency standard for televisions, California can leverage these opportunities as an important strategy for reaching its ambitious AB 32 greenhouse gas reduction goals (1990 levels by 2020).

Figure 9. Greenhouse Gas Abatement Curve



Source: McKinsey & Company (2007). Note: circles added by author to emphasize the residential and commercial electronics categories.

7 Acceptance Issues

7.1 Infrastructure issues

The new international test procedure (as described in Section 3.1) and the recently finalized Version 3.0 Energy Star TV specification should help to minimize any acceptance issues. We propose that the Title 20 standard becomes effective a full year after the Tier 1 Energy Star specification has been effective, thus allowing manufactures an adequate transition time for their product offerings.

There is also significant interest from the California IOUs (and to a degree municipal utilities) to add a television measure to their energy efficiency program portfolios. The Consortium for Energy Efficiency (CEE) has also launched a Consumer Electronics Initiative with a stated goal to: "facilitate efficiency programs in their efforts to increase the sale and market share of energy-efficient consumer electronics."[9] These efforts will likely lead to incentives for retailers and/or manufacturers to sell high-effciency TVs and should thus help to prepare the market for the proposed Title 20 standard.

7.2 Existing Standards

As discussed previously, the current Title 20 television standard (effective as of January

[9] http://www.cee1.org/resid/rs-ce/rs-ce-main.php3

1, 2006), set the maximum standby mode power for all televisions at 3.0 watts.

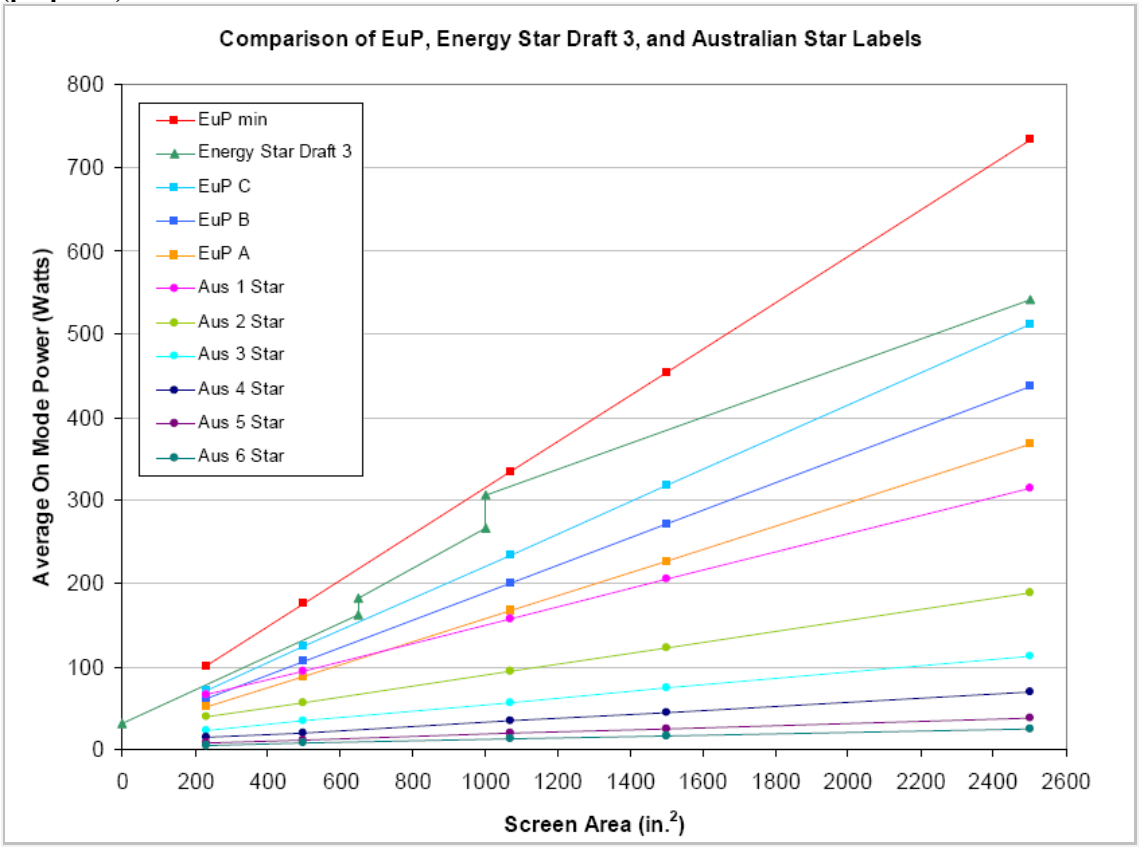
There is currently not a federal U.S. standard for televisions. The most relevant U.S. specification is the Version 3.0 Energy Star Specification for TV Products (contained in its entirety in Appendix A).

The European Commission has finalized its preparatory study recommending ways to improve the environmental performance of the televisions. The studies provide the necessary information to prepare for the next phases (carried out by the Commission) of possibly establishing "eco-design" labeling requirements and efficiency standards. The detailed reports are available at http://www.ecotelevision.org/index.php. The documents were finalized in late 2007 and the next phase discussed above is being considered in 2008.

Australia and New Zealand are also considering establishing minimum energy performance standards (MEPS) for televisions. The most recent activity was a stakeholder meeting on December 20, 2007 to discuss MEPS and labeling. Subsequent workshops in Australia and New Zealand are planned for April 2008, and regulatory proposals are expected to be put to Ministers in June 2008. Details on the process are available at: http://www.energyrating.gov.au/forums-2007-televisions.html.

Figure 10 shows the various proposed levels for the EuP, Australia (same for New Zealand), and the draft 3 Energy Star specification (for the purposes of this figure, the draft 3 Energy Star level is roughly similar to the final specification). It is important to note that the EuP and Australia levels have not been approved to date and some of the levels are only for product labeling purposes, not for MEPS. The proposed Title 20 level is most similar to the "EuP C" level in the figure below. These international activities should also help to minimize acceptance issues for manufactures since many of them sell products internationally. The CEC should continue to closely track the international developments; however, depending on the timing of 2008 CEC proceedings, California may be the leading government agency to establish an energy performance standard for TV active mode power.

Figure 10. Comparison of EuP (proposed), Energy Star Draft 3, and Australian Star Labels (proposed)



7.3 Stakeholder Positions

The stakeholder process for the Final Version 3.0 Energy Star Specification for TV Products was a multi-year process going back to at least June 28, 2005 when an international workshop on measuring and reducing television consumption was held in San Francisco, CA. Between then and now, the EPA has collected and responded to numerous stakeholder comments and has attempted to address significant concerns in the various drafts, and ultimately the final version of the new Energy Star specification. All these comments and responses are documented on the TV Products Specification page: http://www.energystar.gov/index.cfm?c=revisions.tv_vcr_spec. To the extent possible, we recommend that the Commission adopt the definitions, test procedure and guidance given in the Energy Star specification (pertaining to active mode). This should help to address many of previously addressed stakeholder concerns and positions.

PG&E is aware that the proposal contained in this CASE Report may appear to limit the sale of plasma TVs in California based on the efficiency performance levels contained in the data set used in this analysis. The plasma industry has a demonstrated record of efficiency improvement over time and specific plasma manufactures have made claims of large efficiency improvements relative to what is in the market at this time. For example, Panasonic states in a January 7, 2008 press release that they have developed a 42-inch panel prototype "with double efficiency technology that halves energy consumption

while maintaining the same brightness". Thus, we would expect that a number of qualifying products will be available by the time this standard takes effect. (The full press release is accessible in Appendix F along with other plasma efficiency claims and developments.)

To weaken the proposed standards sufficiently to ensure that a significant proportion of the currently available plasma TVs in the over 40 inch category also qualify for the proposed California standard would mean substantial lost savings from the more efficient LCD products, which represent the vast and growing majority of TV sales. It is PG&E's strong preference to avoid technology differentiated standards unless clearly necessary to address a substantively different consumer utility level between two possible product classes (plasma versus LCD). In this case, especially in view of expected advances in LCD technology, it is not clear that now and especially by 2010, that plasma will offer substantially different consumer utility. Because of the expected convergence in the visual performance of these two types of product (at least for the majority of consumers), the expected improvements in plasma efficiency, and the fact that California represents only a small slice of the American market, PG&E is neither proposing a weakened overall standard (e.g., Energy Star) nor proposing a separate plasma standards level that is less rigorous that that for LCD TVs.

8 Recommendations

8.1 Recommended Standards Options

Effective November 1, 2009 (assuming this rule is completed in 2008), TVs, TV Combination Units, Television Monitors, and Component Television Units shall not exceed the maximum On Mode power consumption (P_{MAX}) found from the equations in Figure 11. The maximum On Mode power consumption is expressed watts and rounded to the nearest whole number. In the following equations, A is the viewable screen area of the product, found by multiplying the display width by the display height. Equations are provided in standard units (inches^2).

Figure 11. Proposed Title 20 Standard Levels

Resolution Type	Maximum On Mode Power Consumption (A expressed in inches^2)
Non-High Definition (i.e., ≤ 480 native vertical resolution)	$P_{MAX} = 0.12*A + 25$
High Definition and Full Definition TVs (i.e., > 480 native vertical resolution)	$P_{MAX} = 0.20*A + 32$

We recommend that the Commission adopt the key definitions and test procedures related to active mode power as outlined in the final Version 3.0 Energy Star TV specification.

Specifically, we recommend that the Commission adopt the following provision from the Energy Star specification:

TV Products with Automatic Brightness Control: To account for the power savings achieved through automatic brightness control, where the feature is activated by default when shipped to the end user, On Mode power consumption should be determined as follows: $P_{a1_broadcast} = 0.55* P_{o_broadcast} + 0.45*P_{abc_broadcast}$, where $P_{a1_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, taking into consideration that the TV will be in low ambient light level conditions 45% of the time; $P_{o_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, and tested with a minimum ambient light level of 300 lux entering directly into the sensor; and $P_{abc_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, BUT when tested with an ambient light level of 0 lux entering directly into the sensor. (See Section 4.E.2 of the Energy Star specification in Appendix A for further information on how to test TVs with Automatic Brightness Control). When determining Title 20 compliance, products which ship with automatic brightness control enabled should compare their On Mode power consumption ($P_{a1_broadcast}$), found using the equation above, to the maximum On Mode power consumption allowed (P_{Max}), determined using the equations in Figure 11, above.

8.2 Proposed Changes to the Title 20 Code Language

The following is proposed language, by Section, for the Title 20 Appliance Efficiency Regulations.

Section 1601. Scope.
(x) TV, TV Combination Unit, Television Monitor, or Component Television Unit that is marketed to the consumer as such (i.e., focusing on television as the primary function), which meets the respective product type definition in Section 1602, and is capable of being powered from either a wall outlet or a battery unit that is sold with an external power supply. Excludes monitors with computer capability (e.g., a computer input port, such as VGA that are marketed and sold as 1) computer monitors or 2) dual function television and computer monitors.

Section 1602. Definitions.
"Television (TV)" means a commercially available electronic product designed primarily for the display and reception of audiovisual signals from terrestrial, cable, satellite, Internet Protocol TV (IPTV), or other transmission of analog and/or digital signals, consisting of a tuner/receiver and a display encased in a single housing. The product usually relies upon a cathode-ray tube (CRT), liquid crystal display (LCD), plasma display, or other display device.

"Television Monitor" means an electronic product intended to display a video signal from an *external tuner or other video source* such as a VCR or DVD player on a CRT, LCD, plasma display, or other display device. This definition includes analog and digital television monitors.

"Rear-Projection TV" means a type of TV in which the display device is a projector that focuses images onto a screen located within the housing of the TV.

"Direct-View TV" means a type of TV whose display device emits light either directly from the screen surface or transmits light from a source mounted directly behind the screen. Examples include CRT, LCD, and plasma display technologies.

"TV Combination Unit" means a system in which the TV and an additional device(s) (e.g., DVD player, HDD, VCR, etc.) are combined into a single unit and which meets all of the following criteria: the additional device(s) is included in the television casing; it is not possible to measure the power requirements of the two (or more) components separately without removal of the television casing; and the system is connected to the wall outlet through a single power cable.

"Component Television Unit" means a television system composed of two or more separate components (e.g., display device and tuner) marketed and sold as a television under one model or system designation. The system may have more than one power cord.

"Analog" means analog televisions have an NTSC, PAL, or SECAM tuner and may have analog video inputs (e.g., composite video, component video, S-video, RGB).

"Digital" means digital televisions include at least one digital tuner or at least one digital video input (e.g., HDMI). Products with an analog tuner and both analog and digital inputs should be considered digital units.

"Native Vertical Resolution" means the physical pixel count for the vertical axis of the television. For example a television with a screen resolution of 1920 x 1080 would have a native vertical resolution of 1080.

"Download Acquisition Mode (DAM)" means the product is connected to a power source, produces neither sound nor a picture, and is downloading channel listing information according to a defined schedule for use by the electronic programming guide, monitoring for emergency messaging/communications and/or otherwise communicating through a network protocol. The power use in this mode is typically greater than the power requirement in Standby and less than that in On Mode.

"On Mode/Active Power" means the product is connected to a power source and produces sound and a picture. The power requirement in this mode is typically greater than the power requirement in Standby and Download Acquisition Modes.

Section 1604. Test Method for Specific Appliances.
(x) TVs, TV Combination Units, Television Monitors, and Component Television Units

Table X: Test Procedures TVs, TV Combination Units, Television Monitors, and Component Television Units

Specification Requirement	Test Protocol	Source
On Mode	*Draft*[10] IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, Section 11, "Measuring conditions of television sets for On (average) mode."2	www.iec.ch

Guidance on Implementation of IEC 62087: Below, the CEC provides guidance on using IEC 62087, Ed. 2.0 for measuring TV On Mode power. For purposes of determining Title 20 compliance, the below exceptions and clarifications apply.

a. Accuracy of Input Signal Levels: *Section 11.4.12,, "Accuracy of input signal levels"* reminds testers that video inputs used for testing should be within +/- 2% of reference white and black levels. *Section B.2 of Annex B, "Considerations for On (average) mode television set power measurements"* describes the importance of input signal accuracy in further detail.

b. Use of Broadcast Test Materials for Testing: To measure average On Mode power consumption, manufacturers should measure '$P_{o_broadcast}$' as described in *section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."*

c. True Power Factor: Due to increased awareness of the importance of power quality on the part of EPA and electric utilities, manufacturers shall indicate the true power factor of their sets during On Mode measurement.

d. Testing at Factory Default Settings: In measuring the On Mode power consumption of TVs, CEC is interested in capturing first and foremost the power consumption of products as they are shipped from the factory. TV models that do not make use of a forced menu at initial start up, and are shipped in a "retail" or equivalent mode, must be tested in that "retail" mode for Title 20 compliance. Picture level adjustments that need to be made prior to testing On Mode power consumption should be made per section 11.4.8, "Picture level adjustments," if applicable.

Section 11.4.8 reads: "The contrast and brightness of the television set and the backlight level, if it exists, shall be set as originally adjusted by the manufacturer to the end user. In the case that a setting mode must be chosen on initial activation, the "standard mode" or equivalent shall be chosen. In the case that no "standard mode" or

[10] Remove "*Draft*" once IEC 62087, Ed 2.0 is finalized.

equivalent exists, the first mode listed in the on-screen menus shall be selected. The mode used during the test shall be described in the report. "Standard mode" is defined as "recommended by the manufacturer for normal home use.""

For products shipped with a forced menu where the customer must select upon initial start up the mode in which the product will operate, section 11.4.8 states that testing must be conducted in "standard mode." To further consistent messaging to consumers about how to set their TVs for home use, the forced menu option should provide two choices: "home" or "retail." CEC will consider alternative proposals regarding the words selected to describe these two modes on a case-by-case basis. If the user selects the "retail" setting, he/she will be prompted one additional time to confirm this choice. This additional prompt is only required the first time that the user turns on the TV and selects "retail." A manufacturer may substitute the second prompt if "retail " is selected with information on the start-up menu relaying that the "home" setting is the setting in which the product complies with Title 20 Effienciency Standards.

Information relaying that the product complies with Title 20 Effienciency Standards in the "home" setting and that this is the setting in which power savings will be achieved will be included with the product in its packaging and posted on the partner's Web site, where information about the model is listed.

e. Testing of TVs with Automatic Brightness Control: If an automatic brightness control exists and is enabled by default, the TV should initially be tested in a room with a minimum ambient light level of 300 lux entering the sensor to obtain the '$P_{o_broadcast}$' measurement, as described in section 11.4.7, "Power saving functions" and in section 11.6.1. A second measurement should subsequently be taken with the TV tested in a room with an ambient light level of 0 lux entering the sensor to obtain the 'P abc_broadcast' measurement, as described in section 11.4.7, "Power saving functions" and in section 11.6.2. The average On Mode power consumption for the TV will subsequently be determined using both '$P_{o_broadcast}$' and '$P_{abc_broadcast}$', as described in Section 1605.3.

Section 1605.3 State Standards for Non-Federally-Regulated Appliances.
(x) TVs, TV Combination Units, Television Monitors, and Component Television Units

Effective November 1, 2009, TVs, TV Combination Units, Television Monitors, and Component Television Units shall not exceed the maximum On Mode power consumption (P_{MAX}) found from the equations in Table X below. The maximum On Mode power consumption is expressed watts and rounded to the nearest whole number. In the following equations, A is the viewable screen area of the product, found by multiplying the display width by the display height. Equations are provided in standard units (inches^2).

Table X. Standards for TVs, TV Combination Units, Television Monitors, and Component Television Units

Resolution Type	**Maximum On Mode Power Consumption (A expressed in inches^2)**
Non-High Definition (i.e., ≤ 480 native vertical resolution)	$P_{MAX} = 0.12*A + 25$
High Definition and Full Definition TVs (i.e., > 480 native vertical resolution)	$P_{MAX} = 0.20*A + 32$

TV Products with Automatic Brightness Control: To account for the power savings achieved through automatic brightness control, where the feature is activated by default when shipped to the end user, On Mode power consumption should be determined as follows: $P_{a1_broadcast} = 0.55* P_{o_broadcast} + 0.45*P_{abc_broadcast}$, where $P_{a1_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, taking into consideration that the TV will be in low ambient light level conditions 45% of the time; $P_{o_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, and tested with a minimum ambient light level of 300 lux entering directly into the sensor; and $P_{abc_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, BUT when tested with an ambient light level of 0 lux entering directly into the sensor. (See Section 4.E.2 of the Energy Star specification in Appendix A for further information on how to test TVs with Automatic Brightness Control). When determining Title 20 compliance, products which ship with automatic brightness control enabled should compare their On Mode power consumption ($P_{a1_broadcast}$), found using the equation above, to the maximum On Mode power consumption allowed (P_{Max}), determined using the equations in Figure 11, above.

9 References

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Appendix A: Final Version 3.0 ENERGY STAR TV Products Specification

The following ten pages contain the Final Version 3.0 ENERGY STAR TV Products Specification.

ENERGY STAR® Program Requirements for Televisions

Partner Commitments

Commitment

The following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacturing of ENERGY STAR qualified televisions (TVs). The ENERGY STAR Partner must adhere to the following program requirements:

- comply with current ENERGY STAR Eligibility Criteria, defining the performance criteria that must be met for use of the ENERGY STAR certification mark on TVs. EPA may, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at EPA's request;

- comply with current ENERGY STAR Identity Guidelines, describing how the ENERGY STAR name and mark may be used. Partner is responsible for adhering to these guidelines and for ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance;

- qualify at least one ENERGY STAR labeled TV model within six months of activating the TV portion of the agreement. When Partner qualifies the product, it must meet the specification (e.g., Tier 1 or 2) in effect at that time;

- provide clear and consistent labeling of ENERGY STAR qualified TVs. The ENERGY STAR label must be clearly displayed on product packaging, in product literature (i.e., user manuals, spec sheets, etc.), and on the manufacturer's Internet site where information about ENERGY STAR qualified models is displayed. In addition, ENERGY STAR qualified TVs must be labeled according to one of the following three options: 1) permanent label on the top/front of the TV; 2) temporary label on the top/front of the TV; or, 3) use of an electronic label so that the ENERGY STAR certification mark appears on the TV's menu-screen for pre-set picture settings.

- provide to EPA, on an annual basis, an updated list of ENERGY STAR qualifying TV models. Once the Partner submits its first list of ENERGY STAR labeled TVs, the Partner will be listed as an ENERGY STAR Partner. Partner must provide annual updates in order to remain on the list of participating product manufacturers;

- provide to EPA, on an annual basis, unit shipment data or other market indicators to assist in determining the market penetration of ENERGY STAR. Specifically, Partner must submit the total number of ENERGY STAR qualified TVs shipped (in units by model) or an equivalent measurement as agreed to in advance by EPA and Partner. Partner is also encouraged to provide ENERGY STAR qualified unit shipment data segmented by meaningful product characteristics (e.g., capacity, size, speed, or other as relevant), total unit shipments for each model in its product line, and percent of total unit shipments that qualify as ENERGY STAR. The data for each calendar year should be submitted to EPA, preferably in electronic format, no later than the following March and may be provided directly from the Partner or through a third party. The data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

- notify EPA of a change in the designated responsible party or contacts for TVs within 30 days.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures and should keep EPA informed on the progress of these efforts:

- consider energy efficiency improvements in company facilities and pursue the ENERGY STAR label for buildings;
- purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes;
- ensure the power management feature is enabled on all ENERGY STAR qualified monitors in use in company facilities, particularly upon installation and after service is performed;
- provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified product models;
- feature the ENERGY STAR mark(s) on Partner Web site and in other promotional materials. If information concerning ENERGY STAR is provided on the Partner Web site as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at www.energystar.gov), EPA may provide links where appropriate to the Partner Web site;
- provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, communicate, and/or promote Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR Web pages, etc. The plan may be as simple as providing a list of planned activities or planned milestones that Partner would like EPA to be aware of. For example, activities may include: (1) increase the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrate the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) provide information to users (via the Web site and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products, and (4) build awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event;
- provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.

ENERGY STAR® Program Requirements for Televisions

Eligibility Criteria (Version 3.0)

Below is the product specification for ENERGY STAR qualified TVs (Version 3.0). A product must meet all of the identified criteria to be labeled as ENERGY STAR by its manufacturer.

1) **Definitions**: Below is a brief description of TVs and other terms as relevant to ENERGY STAR.

   A. Television (TV): A commercially available electronic product designed primarily for the display and reception of audiovisual signals from terrestrial, cable, satellite, Internet Protocol TV (IPTV), or other transmission of analog and/or digital signals, consisting of a tuner/receiver and a display encased in a single housing. The product usually relies upon a cathode-ray tube (CRT), liquid crystal display (LCD), plasma display, or other display device.

   B. Television Monitor: An electronic product intended to display a video signal from an *external tuner or other video source* such as a VCR or DVD player on a CRT, LCD, plasma display, or other display device. For purposes of this agreement, this definition includes analog and digital television monitors. Television monitors with computer capability (e.g., computer input port) may qualify as ENERGY STAR under this specification as long as they (i) are marketed and sold to consumers as focusing on television/video as the primary function, and (ii) incorporate Display Power Management Signaling (a standard from the VESA consortium for managing the supply of power of video monitors for computers through the graphics card) so that users may benefit from power management, allowing the product to automatically enter a low power mode after a certain period of inactivity, when it is being driven by a computer through a computer input port. Television monitors are considered to have computer monitor capability under this specification if any input on the product is intended by the manufacturer to be used as a computer input, and, as such, the product complies with the FCC's Class B Computer Peripheral requirements and is authorized under the FCC's Declaration of Conformity program.

   C. Rear-Projection TV: A type of TV in which the display device is a projector that focuses images onto a screen located within the housing of the TV.

   D. Direct-View TV: A type of TV whose display device emits light either directly from the screen surface or transmits light from a source mounted directly behind the screen. Examples include CRT, LCD, and plasma display technologies.

   E. TV Combination Unit: A system in which the TV and an additional device(s) (e.g., DVD player, HDD, VCR, etc.) are combined into a single unit and which meets all of the following criteria: the additional device(s) is included in the television casing; it is not possible to measure the power requirements of the two (or more) components separately without removal of the television casing; and the system is connected to the wall outlet through a single power cable.

   F. Component Television Unit: A television system composed of two or more separate components (e.g., display device and tuner) marketed and sold as a television under one model or system designation. The system may have more than one power cord. For purposes of meeting ENERGY STAR criteria, the total power for the system is considered.

   G. Analog: For purposes of this agreement, analog televisions have an NTSC, PAL, or SECAM tuner and may have analog video inputs (e.g., composite video, component video, S-video, RGB).

   H. Digital: For purposes of this agreement, digital televisions include at least one digital tuner or at least one digital video input (e.g., HDMI). Products with an analog tuner and both analog and digital inputs should be considered digital units.

I. Native Vertical Resolution: The physical pixel count for the vertical axis of the television. For example a television with a screen resolution of 1920 x 1080 would have a native vertical resolution of 1080.

J. Electronic Program Guide (EPG): An interactive, onscreen menu of TV program information (e.g., time, date, description of TV programs, etc.) downloaded from an external source.

K. External Power Supply: A component contained in a separate physical enclosure external to the television casing and designed to convert line voltage ac input from the mains to lower dc voltage(s) for the purpose of powering the television. An external power supply must connect to the television via a removable or hard-wired male/female electrical connection, cable, cord or other wiring.

L. Point of Deployment (POD) Module: A conditional access module for digital cable signal reception.

M. Standby The lowest power consumption state which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. For purposes of this specification, Standby is defined as the time when the product is connected to a power source, produces neither sound nor picture, neither transmits nor receives program information and/or data (excluding data transmitted to change the unit's condition from Standby to On Mode), and is waiting to be switched to On Mode by a direct or indirect signal from the consumer, e.g., with the remote control.

N. Download Acquisition Mode (DAM): The product is connected to a power source, produces neither sound nor a picture, and is downloading channel listing information according to a defined schedule for use by the electronic programming guide, monitoring for emergency messaging/communications and/or otherwise communicating through a network protocol. The power use in this mode is typically greater than the power requirement in Standby and less than that in On Mode.

O. On Mode/Active Power: The product is connected to a power source and produces sound and a picture. The power requirement in this mode is typically greater than the power requirement in Standby and Download Acquisition Modes.

P. Disconnected: The product is disconnected from all external power sources.

2) **Qualifying Products**: Any TV, TV Combination Unit, Television Monitor, or Component Television Unit that is marketed to the consumer as such (i.e., focusing on television as the primary function), which meets the respective product type definition in Section 1, and is capable of being powered from either a wall outlet or a battery unit that is sold with an external power supply is eligible to earn the ENERGY STAR. This specification does not cover monitors with computer capability (e.g., a computer input port, such as VGA) that are marketed and sold as 1) computer monitors or 2) dual function television and computer monitors. In addition, to qualify as ENERGY STAR under both tiers of this specification, TVs must not exceed power consumption of 1 watt in Standby. TVs that do not have a state meeting the definition of Standby (e.g., Public Alert CEA2009A certified models which offer 24/7/365 active features to alert users) are not able to qualify for ENERGY STAR. Additionally, this lowest power consuming Standby state must be the default Standby state for the TV as shipped to consumers.

3) **Energy-Efficiency Criteria**: Only those products listed in Section 2 that meet the following criteria may qualify as ENERGY STAR. The effective date for these Version 3.0 requirements are provided in Section 6 of this specification. To qualify TVs, TV Combination Units, Television Monitors, or Component Television Units as ENERGY STAR, they must be tested according to the protocol outlined in Section 4, Test Methodology.

EPA will make On Mode and Standby data available on the ENERGY STAR Web site for interested consumers. Additionally, EPA will also provide consumers with an estimate of each ENERGY STAR qualified TV's annual energy consumption through publication of a kWh/year number. This annual power consumption estimate will be based on a daily usage pattern of 5 hours in On Mode and 19 hours in Standby.

A. On Mode/Active Power

1. To qualify as ENERGY STAR, all TVs, TV Combination Units, Television Monitors, and Component Television Units must not exceed the maximum On Mode power consumption (P_{Max}) found from the equations in Table 1, based on the unit's native vertical resolution and visible screen area. The maximum On Mode power consumption is expressed in watts and rounded to the nearest whole number. In the following equations, A is the viewable screen area of the product, found by multiplying the display width by the display height. Equations are provided in standard units (inches^2) as well as in the metric equivalent (cm^2). As an example, maximum allowed power consumption for TV products of various screen sizes is provided below in Table 2.

Table 1: On Mode Power Level Requirements for TV Products

	Tier 1: Effective November 1, 2008		Tier 2: Effective September 1, 2010	
Screen Area	**Maximum On Mode Power Consumption (A expressed in inches^2)**	**Maximum On Mode Power Consumption (A expressed in cm^2)**	**Maximum On Mode Power Consumption (A expressed in inches^2)**	**Maximum On Mode Power Consumption (A expressed in cm^2)**
Non-High Definition TVs (i.e. ≤ 480 Native Vertical Resolution)				
All Screen Areas	P_{Max} = 0.120*A + 25	P_{Max} = 0.01860*A + 25	TBD	TBD
High Definition and Full High Definition TVs (i.e. > 480 Native Vertical Resolution)				
A < 680 inch^2 (< 4,387 cm^2)	P_{Max} = 0.200*A + 32	P_{Max} = 0.03100*A + 32	TBD	TBD
680 inch^2 ≤ A < 1045 inch^2 (4,387 cm^2 ≤ A < 6,742 cm^2)	P_{Max} = 0.240*A + 27	P_{Max} = 0.03720*A + 27	TBD	TBD
A ≥1045 inch^2 (≥ 6,742 cm^2)	P_{Max} = 0.156*A + 151	P_{Max} = 0.02418*A + 151	TBD	TBD

For example, under Tier 1, the maximum power consumption for a TV with 768 pixels of native vertical resolution, a width of 36.6 inches and a height of 20.6 inches (that has a screen area of 754.0 square inches) would be: 0.24(754.0) + 27 = 207.96 or 208 watts when rounded to the nearest whole number. Examples of On Mode power requirements for other sample screen sizes are provided below in Table 2.

Table 2: Average Tier 1 On Mode Power Level Requirements for Example TV Screen Sizes

Viewable Diagonal Screen Size (Inches)	Aspect Ratio	Viewable Screen Size in Inches	Screen Area in Inches^2 (cm^2)	Maximum On Mode Power in Watts	
				480 Lines of Native Vertical Resolution	768 or 1080 Lines of Native Vertical Resolution
20	16:9	17.4 x 9.8	170.5 (1,100)	45	66
32	16:9	27.9 x 15.7	438.0 (2,826)	78	120
42	16:9	36.6 x 20.6	754.0 (4,865)	115	208
50	16:9	43.6 x 24.5	1068.2 (6,892)	153	318
60	16:9	52.3 x 29.4	1537.6 (9,920)	210	391

2. TV Products with Automatic Brightness Control: To account for the power savings achieved through automatic brightness control, where the feature is activated by default when shipped to the end user, On Mode power consumption should be determined as follows: $P_{a1_broadcast} = 0.55^* P_{o_broadcast} + 0.45^*P_{abc_broadcast}$, where $P_{a1_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, taking into consideration that the TV will be in low ambient light level conditions 45% of the time; $P_{o_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, and tested with a minimum ambient light level of 300 lux entering directly into the sensor; and $P_{abc_broadcast}$ is the average On Mode power consumption in watts and rounded to the nearest whole number, BUT when tested with an ambient light level of 0 lux entering directly into the sensor. (See Section 4.E.2, below, for further information on how to test TVs with Automatic Brightness Control to determine ENERGY STAR qualification.) When determining ENERGY STAR qualification, products which ship with automatic brightness control enabled should compare their On Mode power consumption ($P_{a1_broadcast}$), found using the equation above, to the maximum On Mode power consumption allowed (P_{Max}), determined using the equations in Table 1, above.

3. TV Products Using an External Power Supply: To qualify, the external power supply must be ENERGY STAR qualified or meet the no-load and active mode efficiency levels provided in the ENERGY STAR Program Requirements for Single Voltage Ac-Ac and Ac-Dc External Power Supplies. The ENERGY STAR specification and qualified product list can be found at www.energystar.gov/powersupplies.

B. Standby: To qualify as ENERGY STAR under both Tier 1 and Tier 2 of this specification, TVs, TV Combination Units, Television Monitors, and Component Television Units must not exceed power consumption of 1 watt in Standby. Additionally, this lowest power consuming Standby must be the default Standby for the TV as shipped to consumers. Measurements are to be taken without a POD module, if present on the product, installed.

C. User Information Requirement: In order to ensure that consumers are properly informed of the benefits of keeping their TVs in the default modes as shipped, particularly for those models that incorporate additional features and functionality that, if employed, would result in increased energy use beyond that intended by the ENERGY STAR requirements for On and Standby, the manufacturer will include with each TV one of the following:
   - Information on ENERGY STAR and the benefits of keeping the TV at its factory default settings that meet ENERGY STAR criteria in either a hard copy or electronic copy of the user manual. Where necessary, manufacturers will also include language advising consumers that enabling certain features and functionality in their TV (e.g., instant-on) will increase its energy consumption, possibly beyond the limits required for ENERGY STAR qualification. This information should be near the front of the user manual; or,
   - A package or box insert on ENERGY STAR and the benefits of keeping the TV in its factory default modes. Where necessary, manufacturers will also include language advising consumers that enabling certain features and functionality in their TV (e.g., instant-on) will increase its energy consumption, possibly beyond the limits required for ENERGY STAR qualification.

4) **Test Methodology**: Manufacturers are required to perform tests and self-certify those models that meet the ENERGY STAR guidelines.

- In performing these tests, partner agrees to use the test procedures outlined in Table 3, below, with the clarifications outlined in Section 4.E.1.
- The test results must be reported to EPA.

Additional testing and reporting requirements are provided below.

A. Test Conditions:

Supply Voltage:	North America/Taiwan:	115 (± 1%) Volts AC, 60 Hz (± 1%)
	Europe/Australia/New Zealand:	230 (± 1%) Volts AC, 50 Hz (± 1%)
	Japan:	100 (± 1%) Volts AC, 50 Hz (± 1%)/60 Hz (± 1%)
		Note: For products rated for > 1.5 kW maximum power, the voltage range is ± 4%
Total Harmonic Distortion (THD) (Voltage):	< 2% THD (< 5% for products which are rated for > 1.5 kW maximum power)	
Ambient Temperature:	23°C ± 5°C	
Relative Humidity:	10 – 80 %	

(Reference IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power, Sections 4.2, 4.3)

B. Models Capable of Operating at Multiple Voltage/Frequency Combinations: Manufacturers shall test their products based on the market(s) in which the models will be sold and promoted as ENERGY STAR qualified. For products that are sold as ENERGY STAR in multiple international markets and, therefore, rated at multiple input voltages, the manufacturer must test at and report the required power consumption or efficiency values at all relevant voltage/frequency combinations. For example, a manufacturer that is shipping the same model to the United States and Europe must measure, meet the specification, and report test values at both 115 Volts/60 Hz and 230 Volts/50 Hz in order to qualify the model as ENERGY STAR in both markets. If a model qualifies as ENERGY STAR at only one voltage/frequency combination (e.g., 115 Volts/60 Hz), then it may only be qualified and promoted as ENERGY STAR in those regions that support the tested voltage/frequency combination (e.g., North America and Taiwan).

C. Approved Meter: Approved meters will include the following attributes[1]:

- An available current crest factor of 3 or more at its rated range value; and
- Lower bound on the current range of 10mA or less.

The power measurement instrument shall have a resolution of:

- 0.01 W or better for power measurements of 10 W or less;
- 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1 W or better for power measurements of greater than 100 W.

The following attributes in addition to those above are suggested:

- Frequency response of at least 3 kHz; and
- Calibration with a standard that is traceable to the U.S. National Institute of Standards and Technology (NIST).

It is also desirable for measurement instruments to be able to average power accurately over any user selected time interval (this is usually done with an internal math calculation dividing accumulated energy by time within the meter, which is the most accurate approach). As an alternative, the measurement instrument would have to be capable of integrating energy over any

[1] Characteristics of approved meters taken from IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power

user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.

D. Accuracy: Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

All power figures should be in watts and rounded to the second decimal place. For loads greater than or equal to 10 W, three significant figures shall be reported.

E. Test Procedures:

Table 3: Test Procedures for Measuring Operational Modes

Specification Requirement	Test Protocol	Source
Standby	IEC 62301, Ed 1.0: Household Electrical Appliances – Measurement of Standby Power	www.iec.ch
On Mode	*Draft* IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, Section 11, "Measuring conditions of television sets for On (average) mode."[2]	www.iec.ch

1. Guidance on Implementation of IEC 62301: Below, EPA provides specific guidance on using IEC 62301 for measuring TV Standby power. For purposes of determining ENERGY STAR qualification of a product, the below clarifications apply:

   a. All Standby measurements shall be conducted and reported to EPA first at factory default conditions. Measurements are to be taken with the POD module, if available, not installed.

   b. Manufacturers must make additional measurements as necessary, in addition to the Standby power consumption of the product at factory default settings, to report the highest observed power consumption of the product in Standby.

2. Guidance on Implementation of IEC 62087: Below, EPA provides guidance on using IEC 62087, Ed. 2.0 for measuring TV On Mode power. For purposes of determining ENERGY STAR qualification of a product, the below exceptions and clarifications apply.

   a. Accuracy of Input Signal Levels: *Section 11.4.12,, "Accuracy of input signal levels"* reminds testers that video inputs used for testing should be within +/- 2% of reference white and black levels. *Section B.2 of Annex B, "Considerations for On (average) mode television set power measurements"* describes the importance of input signal accuracy in further detail. EPA would like to emphasize the importance of using accurate/calibrated video inputs during On Mode testing and encourages testers to use HDMI inputs wherever possible.

   b. Use of Broadcast Test Materials for Testing: To measure average On Mode power consumption, manufacturers should measure '$P_{o_broadcast}$' as described in *section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."*

[2] IEC 62087, Ed 2.0 is still in draft form and under IEC committee review, as of the writing of this Version 3.0 specification. While significant changes to the relevant portions of the IEC document are not envisioned by its authors, EPA will review the final version, when available, to ensure that no material changes have been made to the applicable sections of the document. The Version 3.0 specification specifically references the committee draft version of IEC 62087, Ed. 2.0.

c. True Power Factor: Due to increased awareness of the importance of power quality on the part of EPA and electric utilities, manufacturers shall indicate the true power factor of their sets during On Mode measurement.

d. Testing at Factory Default Settings: In measuring the On Mode power consumption of TVs, EPA is interested in capturing first and foremost the power consumption of products *as they are shipped from the factory*. TV models that do not make use of a forced menu at initial start up, and are shipped in a "retail" or equivalent mode, must be tested in that "retail" mode for ENERGY STAR qualification. Picture level adjustments that need to be made prior to testing On Mode power consumption should be made per *section 11.4.8, "Picture level adjustments,"* if applicable.

Section 11.4.8 reads: "The contrast and brightness of the television set and the backlight level, if it exists, shall be set as originally adjusted by the manufacturer to the end user. In the case that a setting mode must be chosen on initial activation, the "standard mode" or equivalent shall be chosen. In the case that no "standard mode" or equivalent exists, the first mode listed in the on-screen menus shall be selected. The mode used during the test shall be described in the report. "Standard mode" is defined as "recommended by the manufacturer for normal home use.""

For products shipped with a forced menu where the customer must select upon initial start up the mode in which the product will operate, *section 11.4.8* states that testing must be conducted in "standard mode." To further consistent messaging to consumers about how to set their TVs for home use, the forced menu option should provide two choices: "home" or "retail." EPA will consider alternative proposals regarding the words selected to describe these two modes on a case-by-case basis. If the user selects the "retail" setting, he/she will be prompted one additional time to confirm this choice. This additional prompt is only required the first time that the user turns on the TV and selects "retail." A manufacturer may substitute the second prompt if "retail " is selected with information on the start-up menu relaying that the "home" setting is the setting in which the product qualifies for ENERGY STAR.

Information relaying that the product qualifies for ENERGY STAR in the "home" setting and that this is the setting in which power savings will be achieved will be included with the product in its packaging and posted on the partner's Web site, where information about the model is listed.

e. Testing of TVs with Automatic Brightness Control: If an automatic brightness control exists and is enabled by default, the TV should initially be tested in a room with a minimum ambient light level of 300 lux entering the sensor to obtain the '$P_{o_broadcast}$' measurement, as described in *section 11.4.7, "Power saving functions"* and in *section 11.6.1*. A second measurement should subsequently be taken with the TV tested in a room with an ambient light level of 0 lux entering the sensor to obtain the '$P_{abc_broadcast}$' measurement, as described in *section 11.4.7, "Power saving functions"* and in *section 11.6.2*. The average On Mode power consumption for the TV will subsequently be determined using both '$P_{o_broadcast}$' and '$P_{abc_broadcast}$', as described in Section 3.A.2 of this document.

5) **Effective Date**: The date that manufacturers may begin to qualify products as ENERGY STAR will be defined as the *effective date* of the agreement. Any previously executed agreement on the subject of ENERGY STAR qualified TVs shall be terminated effective October 31, 2008.

A. Qualifying Products Under Tier 1 of the Version 3.0 Specification: Tier 1 of this Version 3.0 specification will commence on **November 1, 2008**. All products, including models originally qualified under Version 2.2, with a **date of manufacture** on or after **November 1, 2008** must meet the new Version 3.0 requirements in order to qualify for ENERGY STAR. The **date of manufacture** is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.

B. Qualifying Products Under Tier 2 of the Version 3.0 Specification: The second phase of this specification, Tier 2, will commence on **September 1, 2010**. All products, including models originally qualified under Tier 1, with a **date of manufacture** on or after **September 1, 2010**, must meet the Tier 2 requirements in order to qualify for ENERGY STAR.

C. Elimination of Grandfathering: EPA will not allow grandfathering under this Version 3.0 ENERGY STAR specification. **ENERGY STAR qualification under previous versions is not automatically granted for the life of the product model.** Therefore, any product sold, marketed, or identified by the manufacturing partner as ENERGY STAR must meet the current specification in effect at the time of manufacture of the product

6) **Future Specification Revisions**: EPA reserves the right to revise the specification should technological and/or market changes affect its usefulness to consumers or industry or its impact on the environment. In keeping with current policy, revisions to the specification will be discussed with stakeholders. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's date of manufacture.

Appendix B: Technical Data for Television Data Set

Non-High Definition TVs (i.e. ≤ 480 Native Vertical Resolution)

Screen Size (viewable diagonal inches)	**≤27**	**32**	**37**	**40**	**42**	**46**	**47**	**50**	**>50**	**All sizes**
Sample Size (n)										
Non-Energy Star	22	2	0	0	1	0	0	0	0	**25**
Energy Star Version 3.0	5	2	0	0	0	0	0	0	0	**7**
Title 20 Proposal	5	2	0	0	0	0	0	0	0	**7**
Total	*27*	*4*	*0*	*0*	*1*	*0*	*0*	*0*	*0*	***32***
Active Mode Power (W)										
Non-Energy Star	59.3	91.1	na	na	238.0	na	na	na	na	**69.5**
Energy Star Version 3.0	47.1	80.5	na	na	na	na	na	na	na	**56.6**
Title 20 Proposal	47.1	80.5	na	na	na	na	na	na	na	**56.6**
Active Mode Hours per Year	1882	1882	1882	1882	1882	1882	1882	1882	1882	**1882**
Active Mode Electricity Consumption (kWh/yr)										
Non-Energy Star	111.5	171.4	na	na	447.9	na	na	na	na	**130.8**
Energy Star Version 3.0	88.6	151.5	na	na	na	na	na	na	na	**106.5**
Title 20 Proposal	88.6	151.5	na	na	na	na	na	na	na	**106.5**
Qualifying Models - Current dataset										
Energy Star Version 3.0	19%	50%	na	na	0%	na	na	na	na	**21%**
Title 20 Proposal	19%	50%	na	na	0%	na	na	na	na	**21%**
Energy Savings per TV for proposed Title 20 (kWh/yr)										
Relative to Non-Energy Star TVs	23.0	19.9	na	na	na	na	na	na	na	**24.3**
Relative to Energy Star TVs	0.0	0.0	na	na	na	na	na	na	na	**0.0**

High Definition and Full High Definition TVs (i.e. > 480 Native Vertical Resolution)

Screen Size (viewable diagonal inches)	**≤27**	**32**	**37**	**40**	**42**	**46**	**47**	**50**	**>50**	**All sizes**
Sample Size (n)										
Non-Energy Star	10	28	16	19	20	13	5	15	11	**137**
Energy Star Version 3.0	5	8	4	4	18	12	1	7	17	**76**
Title 20 Proposal	5	8	4	2	2	3	0	7	13	**44**
Total	*15*	*36*	*20*	*23*	*38*	*25*	*6*	*22*	*28*	***213***
Active Mode Power (W)										
Non-Energy Star	105.9	138.0	162.7	216.1	282.5	266.9	272.1	385.5	498.2	**243.6**
Energy Star Version 3.0	40.6	112.9	142.1	172.9	191.5	214.4	243.8	179.2	237.1	**183.1**
Title 20 Proposal	40.6	112.9	142.1	164.3	148.2	177.1	na	179.2	214.3	**156.1**
Active Mode Hours per Year	1882	1882	1882	1882	1882	1882	1882	1882	1882	**1882**
Active Mode Electricity Consumption (kWh/yr)										
Non-Energy Star	199.3	259.7	306.1	406.8	531.7	502.4	512.1	725.6	937.7	**458.5**
Energy Star Version 3.0	76.3	212.4	267.4	325.5	360.4	403.4	458.9	337.2	446.2	**344.5**
Title 20 Proposal	76.3	212.4	267.4	309.2	278.9	333.3	na	337.2	403.3	**293.9**
Qualifying Models - Current dataset										
Energy Star Version 3.0	33%	22%	20%	17%	47%	48%	17%	32%	61%	**36%**
Title 20 Proposal	33%	22%	20%	9%	5%	12%	0%	32%	46%	**21%**
Energy Savings per TV for proposed Title 20 (kWh/yr)										
Relative to Non-Energy Star TVs	122.9	47.3	38.8	97.6	252.8	169.0	na	388.4	534.4	**164.6**
Relative to Energy Star TVs	0.0	0.0	0.0	16.3	81.5	70.1	na	0.0	42.9	**50.7**

Notes for Appendix B:

1/Data is based on Energy Solutions analysis of an Energy Star (2008) data set of 175 TVs and an Ecos Consulting data set of 70 TVs. Based on sales data from the Consumer Electronics Association, Energy Star attempted to make the data set representative of today's TV market. The Ecos Consulting data set was compiled in preparation for an ongoing CEC PIER project and has not been publicly released at the time of this report (available upon request).

2/Source for active mode hours per year is Roth and McKenney (2007).

3/Qualification levels are for *active* mode power draw.

Appendix C: Estimated Market Share for Energy Star Saturation Scenarios

Estimated Market Share	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Low Energy Star saturation scenario													
Non-Energy Star Tier 1	70%	60%	55%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Energy Star Tier 1 or beyond	30%	40%	45%	50%	50%	50%	50%	50%	50%	50%	50%	50%	50%
Proposed Title 20 or beyond	*17%*	*23%*	*26%*	*29%*	*29%*	*29%*	*29%*	*29%*	*29%*	*29%*	*29%*	*29%*	*29%*
Mid Energy Star saturation scenario													
Non-Energy Star Tier 1	64%	50%	25%	20%	15%	10%	5%	0%	0%	0%	0%	0%	0%
Energy Star Tier 1 or beyond	36%	50%	75%	80%	85%	90%	95%	100%	100%	100%	100%	100%	100%
Proposed Title 20 or beyond	*21%*	*29%*	*43%*	*46%*	*49%*	*52%*	*55%*	*58%*	*61%*	*64%*	*67%*	*70%*	*73%*
High Energy Star saturation scenario													
Non-Energy Star Tier 1	50%	25%	5%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Energy Star Tier 1 or beyond	50%	75%	95%	97%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Proposed Title 20 or beyond	*29%*	*43%*	*55%*	*56%*	*58%*	*58%*	*63%*	*68%*	*73%*	*78%*	*83%*	*88%*	*93%*

Notes for Appendix C:
1/ The scenario values are estimated by the author to showcase that the varying level of future savings are dependent on how quickly the market shifts towards the more efficient levels of "Energy Star" or "Proposed Title 20".
2/ The 2008 values in the "Mid" scenario are based on the Energy Star (2008) dataset and are also shown in Appendix B.
3/ The "*Proposed Title 20 or beyond*" values are a subset of the "Energy Star Tier 1 or beyond" values. Therefore, the "Non-Energy Star Tier 1" and "Energy Star Tier 1 or beyond" values add up to 100%.

Appendix D: Estimated California Annual Sales for Energy Modeling, 2008-2020

Annual sales (Million)	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Total TV sales	3.83	4.19	4.27	4.34	4.42	4.50	4.58	4.66	4.75	4.83	4.92	5.01	5.10
% Non-High Definition	10%	8%	6%	4%	2%	0%	0%	0%	0%	0%	0%	0%	0%
% High Definition	90%	92%	94%	96%	98%	100%	100%	100%	100%	100%	100%	100%	100%
Non-High Definition													
CA annual sales: Low E* saturation (M)													
Non-Energy Star Tier 1	0.26	0.19	0.13	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Tier 1 or beyond	0.11	0.13	0.11	0.08	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Proposed Title 20 or beyond	*0.11*	*0.13*	*0.11*	*0.08*	*0.04*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
CA annual sales: Mid E* saturation (M)													
Non-Energy Star Tier 1	0.24	0.16	0.06	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Tier 1 or beyond	0.13	0.16	0.18	0.13	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Proposed Title 20 or beyond	*0.13*	*0.16*	*0.18*	*0.13*	*0.06*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
CA annual sales: High E* saturation (M)													
Non-Energy Star Tier 1	0.19	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Tier 1 or beyond	0.19	0.24	0.23	0.16	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Proposed Title 20 or beyond	*0.19*	*0.24*	*0.23*	*0.16*	*0.08*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
High Definition													
CA annual sales: Low E* saturation (M)													
Non-Energy Star Tier 1	2.42	2.32	2.21	2.09	2.17	2.25	2.29	2.33	2.37	2.42	2.46	2.50	2.55
Energy Star Tier 1 or beyond	1.04	1.55	1.81	2.09	2.17	2.25	2.29	2.33	2.37	2.42	2.46	2.50	2.55
Proposed Title 20 or beyond	*0.60*	*0.90*	*1.05*	*1.21*	*1.26*	*1.30*	*1.33*	*1.35*	*1.37*	*1.40*	*1.42*	*1.45*	*1.48*
CA annual sales: Mid E* saturation (M)													
Non-Energy Star Tier 1	2.23	1.93	1.01	0.84	0.65	0.45	0.23	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Tier 1 or beyond	1.23	1.93	3.02	3.34	3.69	4.05	4.35	4.66	4.75	4.83	4.92	5.01	5.10
Proposed Title 20 or beyond	*0.71*	*1.12*	*1.75*	*1.94*	*2.14*	*2.34*	*2.52*	*2.70*	*2.89*	*3.09*	*3.29*	*3.50*	*3.72*
CA annual sales: High E* saturation (M)													
Non-Energy Star Tier 1	1.73	0.97	0.20	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Energy Star Tier 1 or beyond	1.73	2.90	3.82	4.06	4.34	4.50	4.58	4.66	4.75	4.83	4.92	5.01	5.10
Proposed Title 20 or beyond	*1.00*	*1.68*	*2.21*	*2.35*	*2.52*	*2.61*	*2.88*	*3.17*	*3.46*	*3.76*	*4.08*	*4.40*	*4.74*

Notes for Appendix D:

1/ 2008 and 2009 annual sales based on values in Table 4.2-7 in Energy Solutions (2006). 2010 to 2020 values assume a 1.8% average annual growth rate based on EIA 2008 (as shown in Figure 5). 2008 and 2009 values are scaled based on PG&E's estimated population relative to California (assumes PG&E territory represents 36% of California's total population).

2/ Percentage of high definition versus non-high definition in 2008 is based on Energy Star (2008) dataset that is based on sales data from the Consumer Electronics Association. Energy Star aimed to make the data set representative of today's TV market.

3/ Sales for each scenario are based on estimates in Appendix C.

Appendix E: Detailed Electricity Savings and Peak Demand Reduction Estimates by Year

Electricity Savings (GWh/yr)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
First Year Annual Energy Savings													
Low Energy Star saturation	427	420	406	391	405	418	426	434	441	449	458	466	474
Mid Energy Star saturation	399	364	233	211	187	161	131	100	94	88	83	76	70
High Energy Star saturation	328	226	118	109	94	96	86	76	65	54	43	31	18
Aggregate Annual Energy Savings (if Title 20 proposal becomes effective Nov 2009)													
Low Energy Star saturation			406	797	1188	1593	2011	2437	2871	3312	3762	4219	
Mid Energy Star saturation			233	444	655	842	1003	1133	1233	1327	1415	1498	
High Energy Star saturation			118	227	336	430	526	612	688	753	807	850	
Coincident Peak Demand Reduction (MW)													
First Year Reduction													
Low Energy Star saturation	59	58	56	54	56	58	59	60	61	62	63	64	65
Mid Energy Star saturation	55	50	32	29	26	22	18	14	13	12	11	11	10
High Energy Star saturation	45	31	16	15	13	13	12	10	9	7	6	4	3
Aggregate Reduction (if Title 20 proposal becomes effective Nov 2009)													
Low Energy Star saturation			56	110	163	219	277	335	395	456	517	580	
Mid Energy Star saturation			32	61	90	116	138	156	170	183	195	206	
High Energy Star saturation			16	31	46	59	72	84	95	104	111	117	

Notes:
1/ Electricity savings are calculated based on values in Appendix B and D.
2/ Coincident peak demand reduction is calculated using of 0.83 load factor for TVs (as presented and defined in Brown and Koomey 2002).
3/ Aggregate energy savings and demand reduction are shown for an estimated useful life of 10 years, based on EuP (2007).

Appendix F: Plasma Efficiency Developments

The following text boxes show selected excerpts from press releases and news stories between 2005 and 2008 that describe efficiency developments for plasma TVs. The web link for each story is provide and is current as of April 2, 2008. The stories are truncated and the efficiency claims are bolded in **red** for emphasis.

http://www2.panasonic.com/webapp/wcs/stores/servlet/prModelDetail?storeId=11301&catalogId=13251&itemId=215174&modelNo=Content01072008044330094&surfModel=Content01072008044330094

PANASONIC INTRODUCES NEXT-GENERATION PLASMA DISPLAYS AT 2008 INTERNATIONAL CES

Revolutionary Plasma Technologies Boast Dramatic Energy Efficiency, Less Than One-inch Super-thin Profile and 150-inch Ultra-large Screen

Las Vegas, NV (January 7, 2008) – Panasonic, the leading brand by which Matsushita Electric Industrial Co., Ltd. is known, today announced that the company has developed three prototype plasma display panels (PDPs) using ground-breaking technologies. The prototypes include a 42-inch panel with double efficiency technology that halves energy consumption while maintaining the same brightness*, a less than one-inch super-thin 50-inch PDP and the world's largest 150-inch advanced high definition (HD) PDP. The three prototypes are on display at the 2008 International Consumer Electronics Show (CES) that starts on January 7 in Las Vegas.

At the core of these cutting edge PDP's lies the double efficiency technology used in the 42-inch prototype. After thoroughly reviewing its existing IC technology and panel structures, Panasonic developed new phosphors and cell design technology for improved discharge and new circuit and drive technology to significantly reduce power loss. As a result, the 42-inch prototype has twice the luminance efficiency and provides the same brightness as the existing 42-inch 1080p full HD PDP, while cutting the power consumption by half.

The double-efficiency technology forms the base for next-generation PDPs, enabling even thinner profiles, larger screens, brighter images, higher definition and lower power consumption. The revolutionary technology promises to open up new possibilities for PDPs. Higher density HD PDP's that can be used as master monitors for movie studios will become possible through this innovative technology.

http://www.eetasia.com/ART_8800455864_480700_NP_24a70954.HTM **3/9/07**

PDP driver cuts power consumption by 35%

Samsung Electronics Co. Ltd announced that its new, broad 256-channel display driver IC (DDI) for PDP offers a lower power-consumption rate over conventional PDP driver ICs, and creates greater cost efficiencies by reducing the number of DDIs per panel. According to the company, it has again implemented its energy-recovery circuit technology in its new driver IC to recycle energy loss within the circuit. **The feature lowers the DDI power consumption of a conventional PDP TV by over 35 percent,** eliminating the need for a separate power-saving component feature and enabling a slimmer and lighter TV module.

http://www.eetasia.com/ART_8800460668_765245_NT_f951330b.HTM

Korean engineers tout power-saving tech for PDPs 4/13/07

A team of engineers from the Korea Advanced Institute of Science and Technology (KAIST) led by professor Choi Kyung-cheol has developed a highly efficient, power-saving technology for light-emitting plasma display panels (PDPs) that are used in digital TVs, according to a report from the *Korea Herald*.

The technology boasts of a new cell structure and driving method for light-emitting PDPs that **can boost power efficiency by four times compared to existing methods**. According to the report, the technology features a four-electrode cell structure, which is the core technology for saving power in light-emitting solutions.

"The existing PDPs have used up about 1.5 times more electric power compared to LCDs. However, with this technology, PDP power consumption can be less than LCD consumption supposing the two are emitting the same degree of light," Choi said in the report.

At present, local PDP developers use Fujitsu's three-electrode cell structure. Choi noted that if local developers will use their power-saving technology, "they won't have to pay fees for using Japan or American PDP technologies."

http://news.thomasnet.com/companystory/500654 **11/27/06**

"Panasonic is also making progress on reducing the amount of energy each Plasma TV consumes," said Mr. Thompson. "There is an inaccurate but persistent myth that Plasma TVs consume much more energy than other types of digital television. The truth is that large screen TVs consume more energy than the smaller screened CRT-based TVs they replace. Our research indicates that energy consumption by large-screen Plasma, LCD and DLP TV sets is on average comparable. **But as a relatively new technology, compared with LCD, Plasma is capable of becoming considerably more energy-efficient, and Panasonic plans to lead the way to this goal."** - David Thompson, Panasonic Corporation of North America's director of environmental affairs.

http://www.nzherald.co.nz/section/story.cfm?c_id=5&objectid=10461566&ref=rss
9/4/07

Hiro Wada, who is in charge of planning for visual products and display devices at Panasonic, said he believed plasma could maintain a share of at least 30 per cent of the market for flat-screen TVs bigger than 37 inches in the medium term.

"We have a chance because demand for bigger screens is increasing," Wada told Reuters

in an interview at IFA. He said Matsushita, which is investing $1.5 billion ($NZ2.1bn) in a plasma panel factory in Japan, aimed to stay number one in the plasma market.
He added that plasma technology, which has only been commercial for about 10 years, still had plenty of room to improve. LCD television technology has been commercial for more than 30 years.

He also said Panasonic aimed to reduce the power consumption of its sets by about 20 per cent per year.

http://www.eetasia.com/ART_8800378669_480700_NT_a4acaa62.HTM **10/11/05**

A joint plasma display R&D company in Japan has **announced that it has improved luminous efficiency to 5.7 lumens per watt for an 11-inch display prototype and 3.5 lumens per watt for 43-inch prototype**, both being exhibited at CEATEC Japan here this week.

The joint R&D company, Advanced PDP Development Center Corp. was formed in July 2003 by Japanese PDP makers Fujitsu Ltd, Hitachi, Ltd, Matsushita Electric Industrial Co., Ltd, Pioneer Plasma Display Corp. and Pioneer Corp., to develop a low power consumption PDP and a low energy consuming production process.
One target was to achieve a 5 lumen per watt efficiency by refining gas discharge mechanisms, fluorescent materials and driving circuitry for plasma displays. If the luminous efficiency is improved, less power is required to display at the same brightness. Though PDP makers have been working to improve the efficiency for years, they have been previously limited to producing no more than 2 lumens per watt.

The Advanced Plasma Display Development Center expects that a 40-inch panel with the 5-lumen per watt efficiency can lower the power consumption from typical 390 watts to 100 watts.

The other target is to develop a new production process that can cut the energy required to manufacture panels by two-thirds. APDC plans to reduce the 250kWh of energy required to produce one panel in 2003 to 80kWh.

New Energy and Industrial Technology Development Organization (NEDO), an affiliate of the Ministry of Economy, Trade and Industry (METI), subsidized APDC as a part of low power consumption next generation PDP project, which APDC plans to complete in the third year of the project next year. "We have managed to achieve the targets," said Osamu Yamada, president of APDC.

APDC plans to transfer the technologies, whose details were not disclosed, to the founder PDP companies and related organizations when the project ends in March 2006.
Both 3.5 and 5.7 lumens per watt are the top emitting efficiencies achievable, said a spokesman of APDC. But it will take time until the panel with 5.7 lumens per watt actually hits the market, he said.

http://www.informationdisplay.org/article.cfm?year=2006&issue=01&file=art2 **1/06**

Matsushita, Hitachi, Pioneer Jointly Develop Low-Power PDP

TOKYO—In an effort to eliminate what many believe is the biggest shortfall of plasma televisions, Japan's top three plasma-display-panel (PDP) makers have joined forces to create a plasma display that uses less than half the power of a conventional PDP. Matsushita Electric Industrial Co., Hitachi, and Pioneer Electronics have been working together as the Advanced PDP Development Center Corp. (APDC) for about two years to create a low-power PDP, which they debuted in October at the 2005 CEATEC show in Makuhari Messe (Chiba), Japan. High power consumption has long been regarded as one of the biggest drawbacks of plasma displays. But **with power usage of 3.5 and 5 lm/W, the two models developed by the APDC are 2.5 and 4 times more efficient than a conventional PDP,** respectively, according to APDC General Manager Toyoo Kanai. The three electronics giants began work on the low-power PDP in June 2003, Kanai said, and the partnership on the present project will continue through March 2006, when each individual company will integrate the new technology into its own products.
"The main reason for the joint develop-ment is that the scale of development is too high to be borne by each company, in terms of monetary and human resources," Kanai explained.

The APDC has also been receiving funding from the Japanese Ministry of Economy, which is hoping the low-power plasma will help combat global warming and enhance international competitiveness through technological breakthrough, Kanai added.
SID President-Elect Larry Weber, a pioneer in plasma technology, called luminous efficacy the "No. 1 display parameter" makers of all the television technologies are trying to increase. The higher the ratio of lumens per watt, the better the luminous efficacy, Weber explained. And the better the luminous efficacy, the less energy it takes to power a display. Higher luminous efficacy means lower costs because television manufacturers do not have to spend as much on circuitry, cooling fans, and power supplies. It can also help engineers to build TVs that have brighter displays and are easier to operate.
"All of the technologies have a good strategy for increasing the luminous efficacy—LCDs, plasmas, OLEDs and projection TVs," Weber said. "So all these major technologies are racing to try to make efficacies better, and plasma displays are no different than the rest. Plasma displays have a tremendous opportunity to increase their luminous efficacy, and what you saw in Japan at the (October 2005) CEATEC is just sort of an indication of what's to come."

At this point, there is no specific date when low-power PDP TVs will be available to consumers, since each of the three companies will decide separately when to market its own products, Kanai said.

"It's generally understood that the newly developed technologies will be applied to the products in two to three years," he added.