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Proposal Information Template for: **Televisions**

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Proposal Information Template – Televisions

2008 Appliance Efficiency Standards

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Purpose

This document is a report template to be used by researchers who are evaluating proposed changes to the California Energy Commission's (Commission) appliance efficiency regulations (Title 20, Cal. Code Regs, §§ 1601 – 1608). This report specifically covers televisions.

Background

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 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 energy consumption, which is responsible for over 95% of the total energy consumption of TVs being sold in California[2]. 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.

[1] See Chase et al (2006) for a more in depth discussion of the TV market trends, usage characteristics and technical factors influencing TV energy consumption.
[2] This is higher than the national average due to the California Title 20 standard that addresses standby mode power.

We recommend that the Commission adopt a technology-neutral standard that sets a maximum "on mode" (active) power consumption level based on the TV's resolution and screen area. We also recommend that a standard addresses the factory default TV screen settings to ensure additional energy efficiency benefits. 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. Adopting these standards will also allow California to gain savings during the important holiday shopping season.

Overview

<table>
<tr><td>Description of Standards Proposal</td><td>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, which is calculated using the equations in the figure below, based on the unit's resolution type and visible screen area, expressed in watts and rounded to the nearest whole number. Screen area is expressed in inches^2 and is calculated by multiplying the display width by the display height.
<table>
<tr><th>Resolution Type</th><th>Maximum On Mode Power Consumption (A expressed in inches$^{2)}$</th></tr>
<tr><td>Non-High Definition
(i.e., ≤ 480 native vertical resolution)</td><td>P_{MAX} = 0.12*A + 25</td></tr>
<tr><td>High Definition and Full Definition TVs
(i.e., > 480 native vertical resolution)</td><td>P_{MAX} = 0.20*A + 32</td></tr>
</table>
We also recommend that a standard addresses the "out-of-the-box" TV screen settings to ensure additional energy efficiency benefits.</td></tr>
<tr><td>California Stock and Sales</td><td>The estimated current California stock is 35.3 million televisions. Estimated annual sales are 4.19 million units. Today, two years before the standard's effective date, it is estimated that 25% (1.05 million units) meet our proposed "Title 20 standards option" level. See Table 2 for details.</td></tr>
<tr><td>Energy Savings and Demand Reduction</td><td>The average per unit energy savings from the proposed standard is estimated to be 183 kWh/yr (see Table 1). For first-year sales, energy savings are estimated to be 208 GWh/yr and the coincident peak demand reduction is 29 MW. After the entire stock turnover, energy savings would be 1660 GWh/yr and coincident peak demand reduction would be 228 MW (see Table 4).</td></tr>
<tr><td>Economic Analysis</td><td>The present value lifecycle benefits from the proposed standard are: $153 per television, $173 million for first year sales, and $1.4 billion after the entire stock turnover (see table 5). In addition, McKinsey & Company (2007) performed a cost-benefit analysis of various options for reducing greenhouse gas emissions and reported that increasing the efficiency of residential and commercial electronics has a negative marginal cost and represents the most cost-effective strategy of all options analyzed (see Figure 9).</td></tr>
</table>

Non-Energy Benefits	Preliminary research suggests that more energy efficient TV settings can also significantly improve the overall picture quality of the set.
Environmental Impacts	We are not aware of any adverse environmental impacts that will be created by the proposed standard.
Acceptance Issues	The new international active mode[3] test procedure and the upcoming Version 3.0 Energy Star TV specification should help to minimize any acceptance issues. We presume that all the major TV manufacturers will be certifying a wide range of TVs through Energy Star; therefore, we recommend that a proposed Title 20 standard utilize the same definitions and test procedure as the Energy Star specification. Again, the standard would take effect a full year after Energy Stay has been in effect. This delay allows manufacturers transition time and an opportunity to stage their product offerings as the market adjusts.
AB 1109 (California Lighting Efficiency and Toxics Reduction Act) [if applicable]	Not applicable.
Federal Preemption or other Regulatory or Legislative Considerations	Televisions are not a federally preempted product. They will be added to the Federal ENERGY GUIDE labeling program in late 2009. The current Title 20 standards require that a TV's standby power be less than or equal to 3 watts, but does not address the active mode. Therefore, our proposed recommendation more significantly impacts active mode power.

Methodology

In an effort to assess the most accurate and up-to-date market trends and energy characteristics of TVs, we relied primarily on the following two sources:

1. **Energy Star data set:** Energy Star is developing a new TV specification that includes active mode power levels and will become effective November 1, 2008. Energy Star used a dataset of 175 TVs to help inform its stakeholder revision process (Energy Star, 2008). Based on sales data from the Consumer Electronics Association, Energy Star attempted to make the data set representative of today's TVs market. We used this data set to estimate baseline energy consumption and savings for the proposed recommendation.

[3] "Active" and "On" are used interchangeable throughout this report.

2. **Consumer Electronics Association (CEA) commissioned study:** The CEA commissioned TIAX to prepare a report assessing the energy consumption by consumer electronics in U.S. residences (Roth and McKenney, 2007). We used this report as a basis for usage patterns (e.g., annual hours of usage in each operating mode) and annual energy consumption of the existing stock.[4]

The Energy Star stakeholder process that revised its TV specification, resulted in three major drafts of the Version 3.0 specification. Figure 1 below shows a summary of the active mode power consumption levels for Draft 2 and for Draft 3 (labeled as "New Proposal"). The maximum active mode power consumption specification levels are based on the following features: 1) the TVs native vertical resolution (e.g., 480, 768, and 1080) and 2) viewable screen area. The Energy Star specification also sets a 1W maximum standby power level.

Figure 1. Summary of Version 3.0 Energy Star TV Products Specification Proposals

	Draft 2	New Proposal
Vertical Resolution	Maximum On Mode Power Consumption Draft 2 (A expressed in inches^2)	Maximum On Mode Power Consumption (A expressed in inches^2)
480	$P_{Max} = 0.13*A + 25$	$P_{Max} = 0.12*A + 25$
768	$P_{Max} = 0.20*A + 40$	***All HD and FHD TVs (768 & 1080)*** $P_{Max} = 0.20*A + 32$ ($A \leq 650$ inch^2) $P_{Max} = 0.24*A + 22$ (650 inch^2 < $A \leq$ 1000 inch^2) $P_{Max} = 0.15*A + 190$ ($A >$ 1000 inch^2)
1080	$P_{Max} = 0.20*A + 40$ ($A \leq 650$ inch^2) $P_{Max} = 0.24*A + 14$ ($A >$ 650 inch^2)	

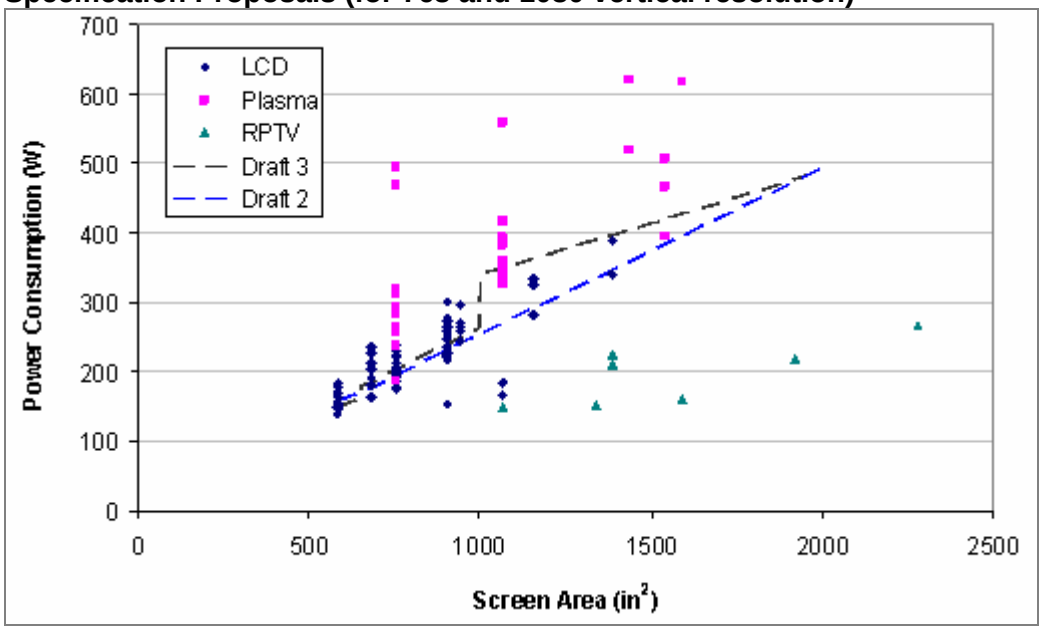
Note: Figure is from an Energy Star stakeholder communication (Energy Star 2007). The column labeled "New Proposal" is the specification level for "Draft 3" of the specification. A = screen area.

Figure 2 plots the Draft 2 and Draft 3 specification lines and shows the LCDs, plasmas, and rear projection TVs (RPTV) from the Energy Star data set that would meet or fail the specification levels. Draft 3 has a notable power allowance for TVs with larger screen sizes. Note the step increase when Draft 3's spec line reaches 1000 inch^2 screen area. This change effectively weakens the specification levels for TVs 47 inches and larger and has significant implications for overall energy savings (we discuss this further in the Analysis and Results section).[5]

[4] The January 2007 study commissioned by the CEA only includes analog TVs because the authors were waiting for an established test method to accurately characterize digital TV active mode power draw. A subsequent report is expected soon that includes digital TVs (Roth and McKenney, 2007).

[5] It is important to note the Energy Star has released a subsequent updated "Draft Final" specification that has modified the specification levels (see Energy Star, 2008). The results in this report are based on the comparing the specification levels in Figure 1. The new "Draft Final" specification still has a similar power allowance for large screen TVs and results in this report can serve as a proxy for comparing "straight line" standard (similar to the draft 2 spec line) versus a standard that gives an power allowance for larger TVs. Subsequent versions of this report template , future PG&E CASE reports, and/or CEC workshop materials will update all savings estimates based on the what ultimately becomes the "Final" Version 3.0 Energy Star TV specification.

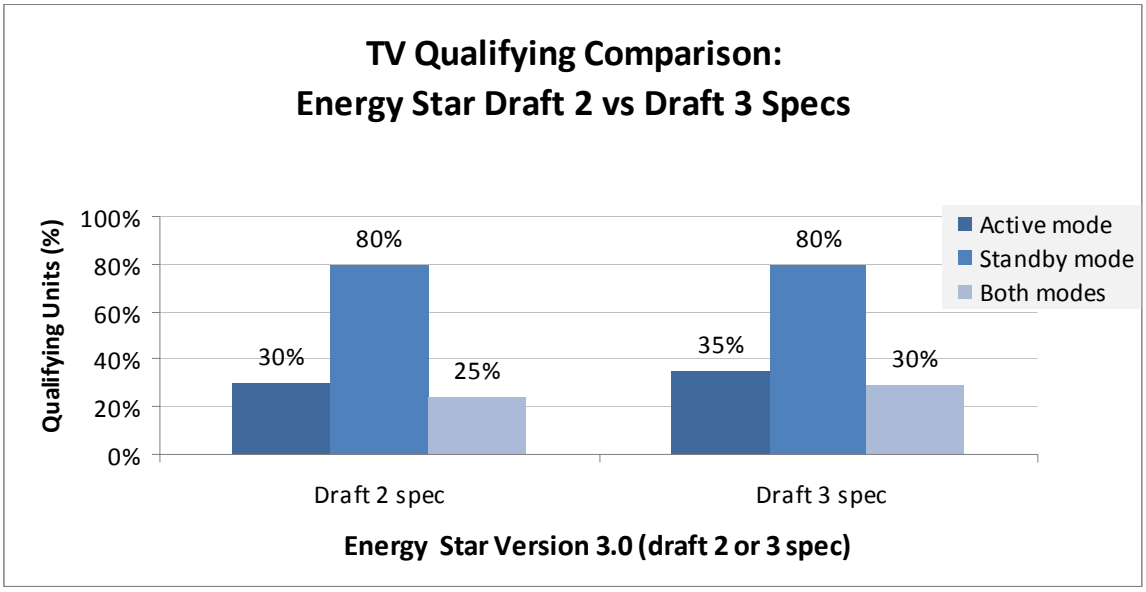
Figure 2. Active Mode Power Consumption Comparison of Version 3.0 Energy Star TV Specification Proposals (for 768 and 1080 vertical resolution)



Source: NRDC 2007

Figure 3 shows the percentage of TVs in the Energy Star data set that would qualify for each respective specification level. Overall, 25% of the TVs meet the draft 2 specification and 30% meet the less-stringent draft 3 levels. From an overall energy consumption perspective, it is more important to look at the qualifying levels for the active mode, since an overwhelming majority of the energy consumption occurs in this mode (especially in California with a maximum 3W standby level.). The active mode qualifying levels increase by 5% for each draft specification (30% for Draft 2 and 35% for Draft 3).

Figure 3. Estimated Initial Qualifying Levels for Version 3.0 Energy Star TV Specification Proposals



Note: Values derived using Energy Star data for Version 3.0 TV specification (Energy Star 2008).

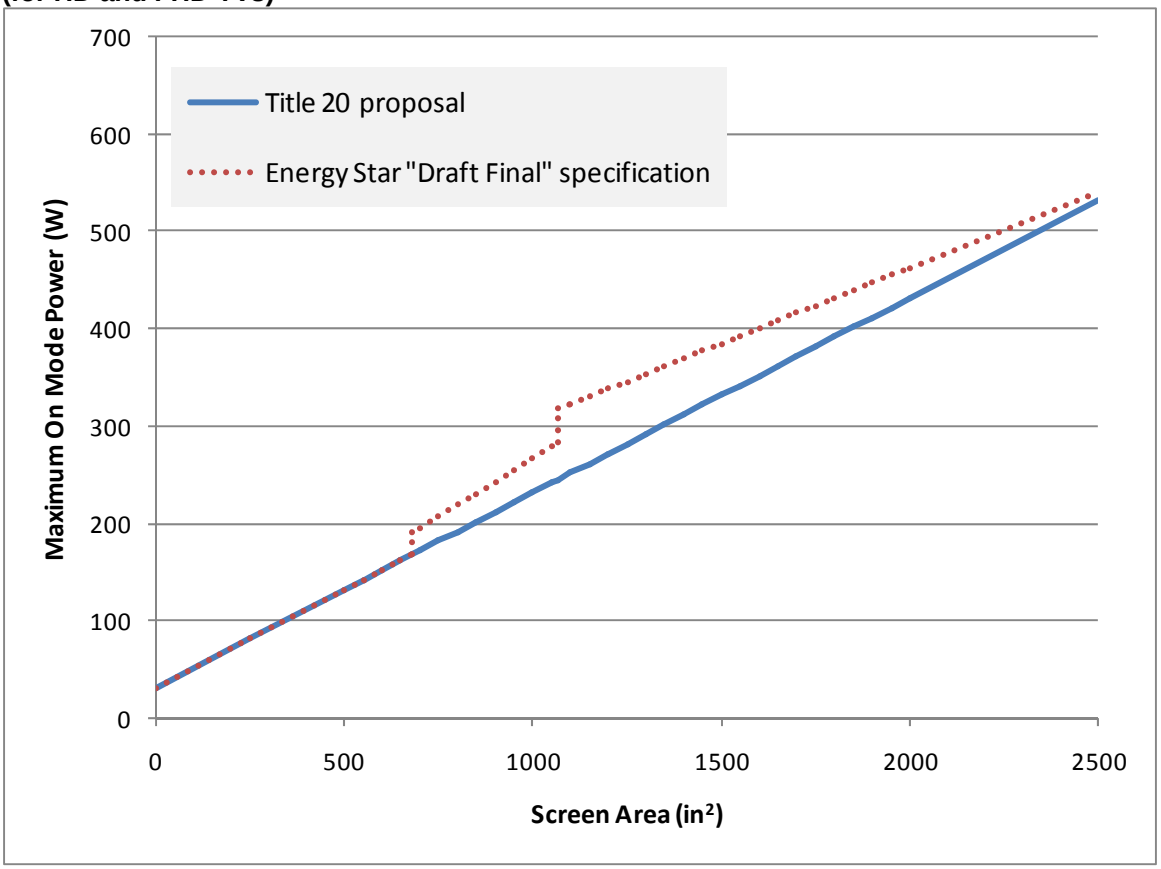
Based on stakeholder feedback to the Draft 2 and Draft 3 specifications, Energy Star recently released updated "DRAFT FINAL" specification levels, which are expected to be released as "FINAL" on February 4, 2008. The On Mode power requirements are shown in Figure 4. A key change is that TVs with a native vertical resolution of 768 (HD) and 1080 (FHD) are combined to have the same levels. The "DRAFT FINAL" still gives a power allowance similar to the "Draft 3" spec discussed above. There will also be more stringent "to be determined" levels effective September 1, 2010.

Figure 4. Energy Star "DRAFT FINAL" On Mode Power Requirements

	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 < 1068 inch^2 (4,387 cm^2 ≤ A < 6.890 cm^2)	P_{Max} = 0.240*A + 27	P_{Max} = 0.03720*A + 27	TBD	TBD
A ≥1068 inch^2 (≥ 6,890 cm^2)	P_{Max} = 0.156*A + 151	P_{Max} = 0.02418*A + 151	TBD	TBD

Based on the results discussed in the next section, we recommend a technology-neutral Title 20 standard level that does not give a power allowance for larger-sized TVs. Figure 5 shows the "DRAFT FINAL" specification level compared to our Title 20 proposed level. For consistency with the Energy Star spec, we choose the same levels for screen sizes up to 680 inches^2 but then keep the equation constant for all screen sizes.

Figure 5. Comparison of Energy Star 3.0 "Draft Final" Specification versus our Title 20 Proposal Level (for HD and FHD TVs)



Analysis and Results

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

- **Baseline Units:** includes all TVs that would not pass our proposed specification levels.
- **Title 20 Standards Option:** includes all TVs that would pass our proposed levels.

It is important to note that the results in this report are based on the comparison of specification levels in Figure 1 (e.g., draft 2 and draft 3 levels). The new "Draft Final" specification still has a similar power allowance for large screen TVs, so it is a useful "proxy" for comparing our "straight line" standard versus a standard that gives a power allowance for larger TVs. Subsequent versions of this report template, future PG&E CASE reports, and/or CEC workshop materials will update all savings estimates based on what ultimately becomes the "Final" Version 3.0 Energy Star TV specification.

Table 1 shows the energy profiles for the "baseline units" and the "Title 20 Standards Option". The active mode power draw for the baseline units is almost 100 watts more than our proposal (233W versus 135W, respectively). The average incremental savings for TVs

47 inches and larger is significantly more, roughly 150W per unit. The fact that these large TVs are being used in applications with high active mode hours (e.g., hotel lobbies, bars, and airports) further increases active mode energy consumption.

An inspection of the CEC Title 20 database for TVs shows that the average standby mode power for certified products is less than 1 watt. Therefore, for the purposes of this analysis, we focus on active mode power and keep the standby mode levels equal (0.6W) for both TV categories. Figure 6 illustrates why active mode power is far more significant a factor compared to standby power. About 99% of the baseline model's energy consumption occurs in active mode. This is greater than the national average (more in the 85% to 95% range) because the CEC has addressed TV standby power with the existing Title 20 standard.

Table 1. Energy Use Estimates per Product

TV category	Power Draw (W)		Annual Operating Hours		Unit Electricity Consumption (kWh/yr)
	Active mode	Standby mode	Active mode	Standby mode	
Baseline units	233	0.6	1882	6878	442
Title 20 standards option	135	0.6	1882	6878	259
Savings relative to baseline	97	0	n/a	n/a	183

Note: Power draw estimates derived by using the draft 3 Energy Star dataset (Energy Star 2008). Source for Annual Operating Hours is Roth and McKenney (2007).

Figure 6. Energy Consumption by Mode for Baseline Units

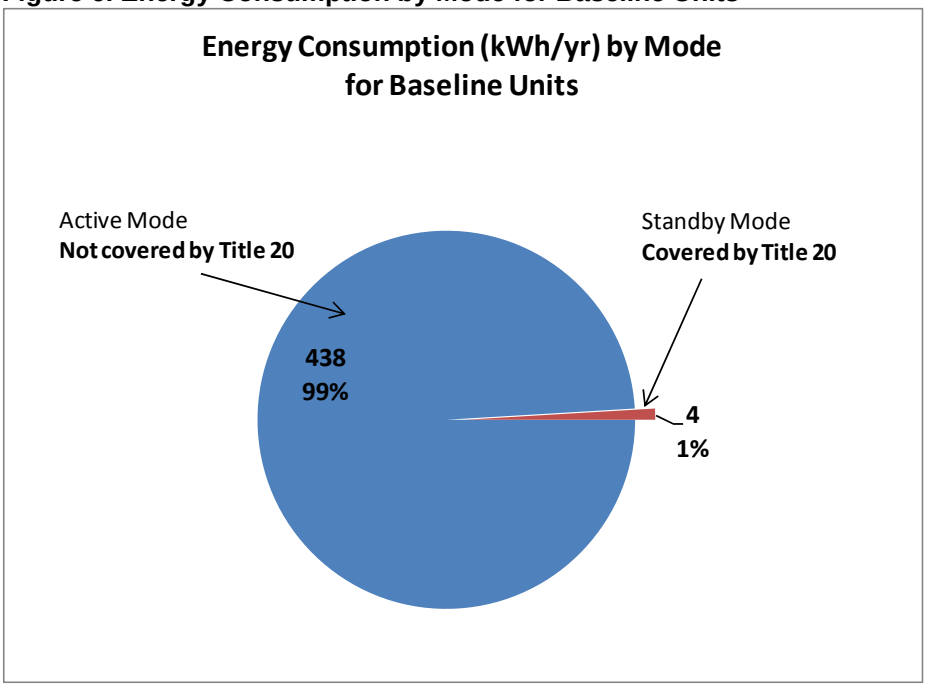
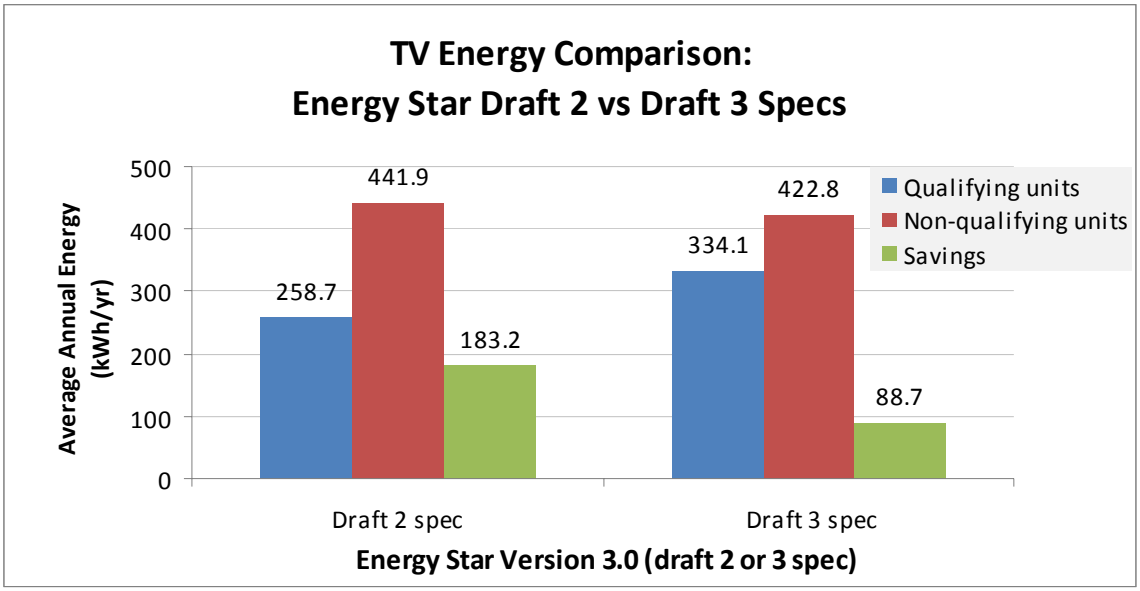


Figure 7 compares the average annual energy consumption of qualifying and non-qualifying TVs, when applying the Draft 2 or Draft 3 specification levels. It is clear that the Draft 3

levels are less stringent compared to the Draft 2 levels (due to the allowance for large screen TVs). Our proposed Title 20 standard recommendation is modeled off of the Draft 2 specification levels and the savings are estimated at 183 kWh/yr per TV.

Figure 7. Estimated Average Energy Usage for Version 3.0 Energy Star TV Specification Proposals



Note: values derived using the draft 3 Energy Star TV dataset (Energy Star 2008).

Table 2 displays current estimates for the California stock and annual sales. The estimated current California stock is 35.3 million televisions. Estimated annual sales are 4.19 million units. Roughly 75% of these sales (3.15 million units) are "baseline" units and 25% (1.05 million units) meet the proposed "Title 20 standards option" levels.

Table 2. California Stock and Sales

	California Stock	California Annual Sales	
TV category	Units (millions)	Units (millions)	Percent of forecasted sales
All TVs	35.3	4.19	100%
For future savings analysis:			
Baseline units	N/A	3.15	75%
Title 20 standards option	N/A	1.05	25%

Note: California stock estimate based on 2008 value in Table 4.2-8 of Chase et al (2006) and annual sales based on 2009 value in Table 4.2-7. 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 estimated percent of forecasted new sales is based on the draft 3 Energy Star dataset (2008).

The estimated annual energy consumption of the TV stock in California is 6,360 GWh/yr (see Table 3). This is approximately 2% of California's total electricity consumption. The coincident peak demand is an estimated 875 MW, or roughly equivalent to the capacity of a medium-sized power plant.

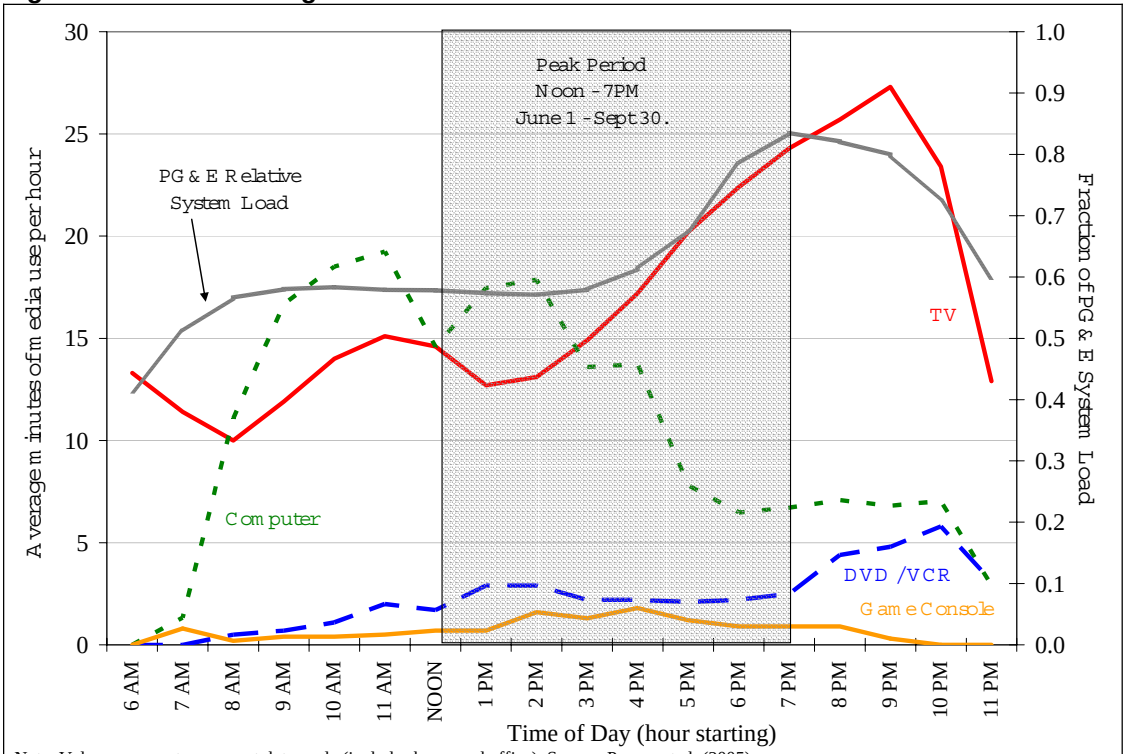
Table 3 California Statewide Energy Use

	For Entire Stock	
TV category	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 8 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 8. 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 4 shows the estimated California statewide energy savings for our proposed Title 20 standard. The estimated annual savings for the first-year sales is 208 GWh/yr and the coincident peak demand reduction is 29 MW. After the entire stock turn over, annual energy savings are estimated to be 1,660 GWh/yr and coincident peak demand reduction is 228 MW.

Table 4 Estimated California Statewide Energy Savings for Proposed Standards Option

For First-Year Sales		After Entire Stock Turnover	
Coincident Peak Demand Reduction (MW)	Annual Energy Savings (GWh/yr)	Coincident Peak Demand (MW)	Annual Energy Savings (GWh/yr)
29	208	228	1660

Note: savings after stock turnover is based on an estimate useful life of 8 years (EPA, 2006)

The present value lifecycle benefits from the proposed standard are: $153 per television, $173 million for first year sales, and $1.4 billion after the entire stock turnover (see table 5).

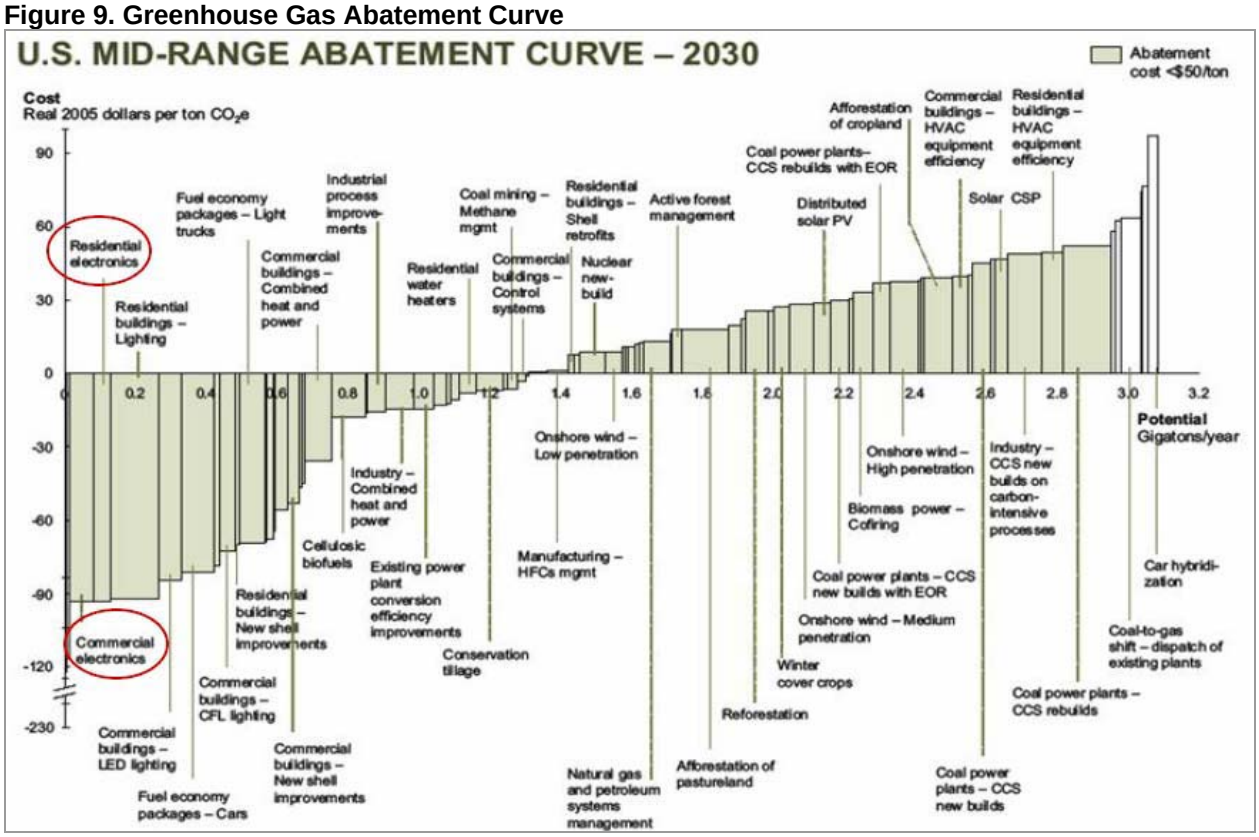
Table 5 Lifecycle Benefits for Standards Options

TV category	Design Life (yrs)	Lifecycle Benefits from Energy Savings (Present Value $) Per Unit ($)	For First Year Sales ($M)	After Entire Stock Turnover ($M)
Title 20 standards option	8	$153	$173	$1,383

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 EPA (2006)

Figure 9 below is from a recent December 2007 McKinsey & Company report showing a cost-benefit analysis for 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.

Recommendations

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 found from the equations in Figure 10. Screen area (A) is expressed in inches^2 and is calculated by multiplying the display width by the display height.

Figure 10. 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 outlined in the final Version 3.0 Energy Star TV specification.

We also recommend that a standard addresses the default factory shipment TV screen settings (i.e., "out-of-the-box" settings) to ensure additional energy efficiency benefits. We will recommend specific language in subsequent versions of this report template and/or future CASE reports for these settings (and will also update savings values based on those recommendations). Preliminary research indicates that optimizing screen settings can lead to increased energy efficiency and more optimal picture quality (see the Appendix for a brief discussion on this topic).

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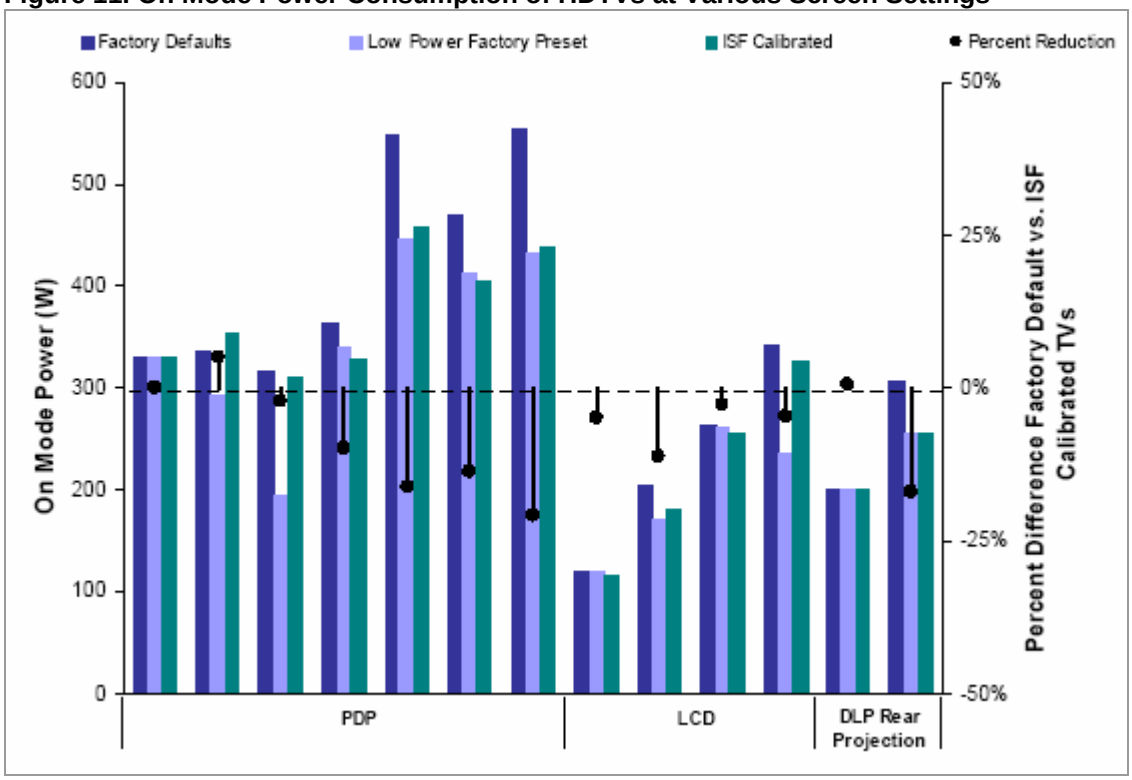
Appendix

Figure 11 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 TVs screen settings can significantly influence power consumption picture quality and therefore should be considered during the proposed Title 20 rulemaking process.

Figure 11. On Mode Power Consumption of HDTVs at Various Screen Settings



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