Consumer Electronics Association
1919 South Eads Street
Arlington, VA
22202 USA
(866) 858-1555 toll free
(703) 907-7600 main
(703) 907-7601 fax
www.CE.org

Via e-mail
docket@energy.state.ca.us

November 2, 2009

California Energy Commission
Docket No. 09-AAER-1C
Docket Unit
1516 Ninth Street, Mail Station 4
Sacramento, CA 95814-5504

Subject: Comments Regarding Draft 45-Day Language on Appliance Efficiency Standards for Televisions and Related Documents [Docket No. 09-AAER-1C]

To the Members of the California Energy Commission:

The Consumer Electronics Association ("CEA") respectfully submits these comments in opposition to the Notice of Proposed Action, Proposed Amendments to Appliance Efficiency Regulations, CEC Docket No. 09-AAER-1C (Sept. 18, 2009) ("NOPA").

CEA opposes the Commission's mandatory performance-based restrictions on energy consumption as detrimental to innovation, consumers, and industry. The Commission bases its proposed regulations on a stacked deck consisting of demonstrably false assumptions, admittedly stale and outmoded data, basic mathematical errors, and conceptual mistakes, that both exaggerate the "problem" to be solved and overestimate the potential energy savings. The regulations violate California law. They will cost consumers far more than they may save and will interfere with consumer enjoyment of one of today's most dynamic and desired products.

The regulations are unnecessary. Energy consumption by today's digital television models approximates the energy required for two light bulbs. That's it: two average light bulbs. And through continuous improvements, manufacturers are bringing those levels even lower. Contrary to the disinformation spread by certain proponents of regulation, digital TVs are hardly the electronic equivalent of gas-guzzling Hummers.

CE manufacturers already have dramatically reduced the amount of energy used by digital televisions – without regulation. Starting years before the CEC began investigating potential TV energy consumption regulations, consumer electronic ("CE") manufacturers

began developing and implementing improved energy-saving digital TV technologies. The latest figures from Energy Star list more than 1,240 television products that comply with the Version 3.0 On Mode efficiency as well as Standby Mode requirements for televisions.[1] **In less than two years, the energy efficiency of Energy Star digital TVs has been improved by more than 41 percent.** These successful efforts occurred not because of any government mandates. They resulted from competition among manufacturers to reduce costs to consumers in the global marketplace. The CEC is not properly accounting for these TV energy savings that contribute substantially to the state's greenhouse gas emissions reduction goals.

Moreover, the kind of performance-based regulation proposed by the Commission will be detrimental to consumers, innovation, and every business that manufactures, sells, and relies on availability of the highest quality digital televisions at the lowest prices. Considering the importance of televisions as the central source for home entertainment, information, and education, and the tremendous gains already achieved by TV manufacturers, regulation based on artificial and arbitrary energy use limits is both utterly unnecessary and foreseeably harmful.

CEA urges the Commission to take a bold step. Stop viewing mandated energy use limits as the only means to address energy efficiency regulation. Combining voluntary industry efforts – which already have drastically reduced the energy consumption of digital televisions – with new initiatives to educate and encourage consumers to conserve TV energy, and new requirements related to energy-saving features, the Commission and industry can cooperatively realize the desired energy savings without impeding technological progress or consumer enjoyment.

---

[1] *See* http://downloads.energystar.gov/bi/qplist/tv_prod_list.pdf (Oct. 16, 2009).

Summary of Comments

Point I: The CEC Staff Report findings rely on flawed assumptions, erroneous calculations, and outdated technical data that do not support the proposed regulations.

The CEC Staff Report provides no meaningful and relevant data on which the Commission can base energy performance regulations. First, despite the CEC's recognition that television manufacturers have made substantial reductions in energy use in the last two years alone, the Staff Report relies on outdated energy use studies and the July 2008 Pacific Gas & Electric Company ("PG&E") "CASE" report, that concededly exclude any new models with lower energy consumption. This inflates the baseline, which in turn exaggerates the potential savings estimates. Second, the Staff Report indisputably makes mathematical and conceptual errors that improperly calculate potential energy savings.

When just these math errors are corrected, the Staff's estimated savings of "$8.1 billion" collapses to a far smaller number: $2.4 billion – approximately the same amount of savings that the Staff estimates from the purely voluntary Energy Star program. When calibrated to reflect energy savings achieved *after* the July 2008 CASE paper, that number reduces further to $548 million.

These and other errors are described in the attached report from C. Paul Wazzan, Ph.D. and Dawn Eash, M.S. of LECG, "The September 2009 Regulations Proposed by the California Energy Commission: 1) fail to satisfy the consumer cost standard imposed by the California Public Resources Code; and 2) are likely to result in increased costs to California consumers" (hereinafter "LECG Report").

Because of these errors, the Staff Report:

- Overstates the "baseline" measurement of energy consumption by today's digital TVs
- Overestimates the potential savings from the regulation through 2022 when compared to that inflated baseline
- Understates the energy efficiencies gained by CEA's proposed alternative approaches
- Skews the results in favor of regulation, when a fair measurement would show that the savings do not justify the costs to consumers.
- Lacks current, hard data to support the regulation
- Prejudices TV manufacturers and consumers who are being asked to shoulder all costs of the regulations.

Therefore, the Commission's proposed regulations would violate the fundamental requirement of California law by imposing greater costs on consumers. **When the potential energy savings from the proposed regulations are more reasonably calculated, the costs to consumers outweigh the benefits.** Today's energy-saving TVs can cost hundreds of dollars more than comparable models, but any potential savings from the regulation would be offset by an $17 increase in the price of televisions. Moreover, by denying consumers access

to the full line of television models, the impact on consumers, manufacturers, and retailers would cost California more than 4,000 jobs and approximately $46.8 million in tax revenue.

Point II: Mandatory limits on the energy performance of digital TVs will stifle future innovation and harm consumer and state interests in the highly dynamic and competitive technology market.

Over the last decade, digital television has undergone a remarkable transformation in terms of technological innovation, performance, size, and price. Energy-hogging analog cathode ray tube TVs that dominated the market ten years ago now have been displaced in the market by thinner, sharper, lower-priced, and lower-energy digital TVs across a multitude of technologies: DLP, LCD, and plasma, and more under development.

As we noted at the October 13th hearing, the Commission's regulations would stifle innovation in new screen technologies. **Had the CEC's proposed regulations been in place in 2001, the millions of plasma and LCD TVs currently in consumers' homes and retailers' shelves never could have come to market.** When a TV technology first is developed, it undergoes a decade or more of development before it is ready for market, and years of refinement to improve its performance and lower its cost. Manufacturers need those early sales to learn whether there is sufficient demand for the product to warrant further investment, and to obtain the revenue necessary to fuel those improvements, and to create cost-reducing development and manufacturing technologies. Without the ability to market new products to "early adopters," industry cannot innovate. That is as true for TVs as it is for PCs, semiconductors, cameras, iPods, and dozens more products that bring value and enjoyment to consumers' lives.[2]

Mandating levels of energy performance such as those proposed in the NOPA will stifle technological innovation in the most dynamic and advanced digital entertainment products in consumers' homes. Put simply, televisions are not like toasters -- or air conditioners, clothes washers, ovens, refrigerators, or other "white goods" appliances that channel energy to utilitarian purposes. Consumers acutely perceive the differences in audiovisual characteristics such as sharpness, color, brightness, saturation, refresh rate, viewing angle, and sound quality among television sets and display technologies, and these differences can matter deeply to consumers. That is particularly true in California where hundreds of thousands of professionals earn their living in the motion picture, television, game development, and high technology industries.

Subjecting all display technologies to a "one size fits all" performance standard ignores that television technologies are neither static nor monolithic. At a time when companies each are investing tens of millions of research dollars to develop new display technologies (such as

---

[2] Thus, as we responded at the October 13th hearing, there is no inconsistency in the CEA position. Even under a best case scenario where regulations have no adverse impact on innovation into energy saving technologies, or technologies ancillary to the screen, the regulations unavoidably will impede development and marketing of new screen technologies whose energy efficiency may not meet the performance mandates at the time of commercialization, but whose efficiency would be improved substantially over time.

OLED and 3D) and myriad improvements to existing display technologies, any attempt to impose mandatory limits on the technology of television can only harm progress in these vital economic and consumer interests.

The CEC's narrow focus solely on energy requirements ignores these realities. The proposed regulations would:

- Increase the costs to consumers of television receivers
- Increase costs to manufacturers of research, development, and manufacture of digital TVs
- Reduce consumer choice by denying retailers access to popular television models
- Constrain innovation into new display technologies and product features

Choosing a new television is one of the most important buying decisions consumers make. Given information about the benefits and costs of owning a particular model television, consumers know how to judge for themselves the best value for the money. The Commission should focus its efforts to encourage consumer education, not to constrain consumer choice.

Point III: The Commission should adopt alternative measures that, in conjunction with industry's voluntary efforts and existing market-oriented programs, will yield energy savings at least as great, if not greater, than would otherwise be achieved by regulating power consumption – but without the costs to consumers, business, and innovation.

The Commission can achieve its energy savings goals without harming the highly dynamic TV industry through the following steps:

1. Support compliance with the federal Energy Star program. In just the first years of the Energy Star 3.0 program for TVs, manufacturers reduced power consumption on average by 29.3%, and improved efficiency by 41.4%. CEA encourages the CEC to continue to monitor the successes of the manufacturing industry in lowering energy consumption, and consult with the industry on ways to improve performance.

2. Adopt mandatory functional requirements that will lower energy consumption. CEA supports a Commission adoption of two regulatory requirements that digital TVs sold in California include "forced menus" and automatic shut-off. These features can reduce energy consumption by 190 GWh per year or more, without mandating unrealistic performance levels.

3. Educate consumers about energy efficient use of TVs. The greatest and fastest gains can be achieved by changing consumers' behavior with respect to the tens of millions of TVs already in their homes. Simple steps such as encouraging consumers to

lower the brightness settings of their current TVs and to turn off TVs not in use can save as much as 555 GWh per year – more than half of what the Commission estimates its regulations would achieve. CEC should support and defer to the Federal Trade Commission's ("FTC") efforts already well underway to adopt nationwide uniform energy use labeling standards for electronics products, including digital TVs.

4. Reward consumers for buying energy-efficient televisions. Incentive and rebate programs can reduce energy use by encouraging consumers to trade-in or retire less efficient TVs for newer, more energy-efficient models. Such efforts are estimated by California utilities and CEA to reduce energy consumption by as much as 70 GWh per year.

Many of these savings are described in the attached peer-reviewed report by Kurt Roth and Bryan W. Urban of the Fraunhofer Center For Sustainable Energy Systems, "Assessment of the Energy Savings Potential of Policies and Measures to Reduce Television Energy Consumption, Final Report to the Consumer Electronics Association" (hereinafter, "Fraunhofer Report").

POINT IV: Additional Proposed Regulations, Including those Concerning Power Factor and Product Labeling, Should Be Rejected as Costly and Ineffective.

The Commission's proposed regulations concerning TV power factor would prove expensive for manufacturers. As the Commission and the U.S. Environmental Protection Agency admit, any actual savings realized by consumers from power factor regulation would be negligible. Consequently, the Commission's power factor proposals do not satisfy the statutory prerequisites to regulation.

CEA supports a uniform national labeling program that sensibly provides consumers with product information, without imposing unrealistic costs and requirements on manufacturers or retailers. The Commission should reject micromanagement of type size and placement in favor of the many, more sensible, marketplace alternatives successfully used for TVs and other products that will provide consumers the information they need prior to purchase.

* * *

In summary, the CEC has failed to demonstrate that the proposed regulations meet the statutory criteria. The regulations would impose higher costs on consumers than any rationally-measured potential energy savings. By stifling innovation, the regulations further would interfere with the efficacy of digital TVs for the California consumer. A fair assessment of the facts shows that voluntary market-oriented efforts, in concert with reasonable regulations requiring forced mode menus and automatic shut-off, will result in savings at least as great as those anticipated by the CEC. Consequently, the regulations cannot be justified and should not be promulgated by the Commission. The costs to consumers, and the unavoidable damage the regulations will cause to technological progress, design freedom, retailer interests, and consumer rights, clearly outweighs any foreseeable benefit.

CEA COMMENTS

Point I: The CEC Staff Report findings rely on flawed assumptions, erroneous calculations, and outdated technical data that do not support the proposed regulations.

Under California Resources Code § 25402(c), the Commission cannot issue regulations without a clear finding, *inter alia*, that the regulation will not burden consumers with added costs. Pursuant to the California Administrative Procedures Act, such a finding must be supported by substantial evidence. As shown below, the Staff Report provides no such foundation for its regulations.

The CEC Staff Report relies almost exclusively on the conclusions supplied by the July 2008 PG&E "CASE" paper. Aside from the questionable value of relying solely on a non-peer reviewed report submitted by a stakeholder with obvious vested interests, CASE suffers from manifold errors, stale data, and fallacious assumptions. The CASE paper provides no reliable estimates of energy consumption or energy savings. Consequently, it provides no sound foundation for the regulations. Knowing of these fatal flaws, any attempt by the Commission to regulate based on the CASE paper necessarily would be arbitrary and capricious.

A. The CEC Study Overstates the Problem to be Solved.

As one of many flaws, the Staff Report overestimates TV energy use and, thus, inflates the magnitude of the problem it seeks to solve. For example, the Staff Report uncritically repeats estimates that TVs use 10 percent of residential energy.[3] The citation for that assertion, however, comes from an "Issue Paper" issued by the National Resources Defense Council ("NRDC"). While NRDC can hardly be deemed a disinterested or impartial commenter in this proceeding, the Staff ignored that the NRDC figures are facially unsupported and unreliable. The cited NRDC issue paper, now four-and-a-half years old, concerned the energy consumption of set top boxes, not TVs. That issue paper presented neither evidence nor any citation to credible research or studies so as to support that number.

---

[3] *See*, CEC responses to consumer complaint forms in Docket 09-AAER-1C, asserting "TVs use about 10 percent of the electricity in most homes, … ." http://www.energy.ca.gov/appliances/2009_tvregs/documents/comments/TN%2053260%2009-18-09%20CEC%20Response%20to%20Complaint%20Form%20from%20R.%20Girling.pdf, and http://www.energy.ca.gov/appliances/2009_tvregs/documents/comments/TN%2053267%2009-18-09%20CEC%20Response%20to%20Compliant%20Form%20from%20D.%20Provenghi.pdf

NRDC, "Cable and Satellite Set-Top Boxes: Opportunities for Energy Savings" March 2005 at 2.[4]

A more credible source, the Energy Star website, cites a figure far smaller than the 10 percent figure relied upon by the Commission: "There are about 275 million TVs currently in use in the U.S., consuming over 50 billion kWh of energy each year — or 4 percent of all households' electricity use."[5]

In short, the Staff Report overstates the magnitude of TV energy consumption (*i.e.*, the reason supporting its desired regulation) by approximately 150%. This error fundamentally skews the rest of the Report. By overstating the amount of actual energy consumption, the Report begins the debate by uncritically assuming "facts" most favorable to regulation. Thus, the Staff Report proceeds from assumptions highly prejudicial to TV manufacturers and consumers, who are being asked to shoulder the cost and burden of the regulations. Had the Report proceeded from a more credible assessment, or from actual evidence, it would have been clear that the magnitude of the problem was not nearly so great as to justify a draconian regulatory mandate.

B. The data used by the CEC to support the regulations are stale and out of date.

Throughout the NOPA and the Staff Report, the CEC cites the tremendous strides made by consumer electronics manufacturers in voluntarily reducing the energy consumption of digital televisions. As noted above, voluntary efforts from December 2007 to October 2009 have improved the energy efficiency of digital TVs by more than 41 percent. While this too begs the question of why any regulation is needed, it highlights a critical flaw in the CEC's methodology. To estimate potential energy savings with any reasonable degree of accuracy, the CEC should rely on current data reflecting the effects of these voluntary efforts. But to the contrary, the CEC continues to use data that is long out of date. Consequently, the CEC grossly exaggerates both the extent of the problem it claims to solve, and the alleged potential energy savings that it claims would result from regulation.

The primary source for CEC's conclusions as to the potential savings from the regulations is, again, the July 3, 2008 CASE paper from Pacific Gas and Electric. While CASE is now more than one year old, CASE further relies on data sets that have not kept pace with current products. For example, the PG&E CASE paper:

- Uses energy tests performed by the online technology site, CNET. While the CNET site may provide valuable information for consumers considering purchasing a

---

[4] Indeed, not even the NRDC apparently stands behind their 10% claim. An August 2009 NRDC presentation to California legislators claims that TV energy consumption is ">5%" -- again with no citations.

[5] *See* http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=TV

particular model of television, the site does not supply statistical data that reasonably could be relied upon by regulators. The CNET data set includes TVs that may be as old as 2004-2005 model TVs. As CNET's current website states, "This chart contains 150 TVs tested by CNET for power consumption between roughly January 2006 and April 2009." http://reviews.cnet.com/green-tech/tv-consumption-chart/?tag=nav Tests performed in January 2006 necessarily would have included older model TVs built before Energy Star 3.0. And obviously, the July 2008 CASE paper could not have included any of the recent TV models that achieved better energy performance.

- Cites to a data set from the UK Market Transformation Programme, titled "An Energy Efficiency Index for Televisions" from February 12, 2007, which also included TVs marketed years before Energy Star 3.0. Although the data for this set came from manufacturers, the authors observed that it was likely that TV energy use was not measured using consistent standards.
- Neglects to indicate that the data PG&E relied upon do not test TVs in the same way. Many of the tests could not have been conducted under the same standard as the Commission now uses, inasmuch as IEC 62087 did not even exist in a first Committee Draft until March 2007, and was not published until October 2008.
- Estimates TV purchasing trends using a 2007 study from a consulting group, "DisplaySearch Global TV Shipment and Forecast Report"
- Admits that specific TV models may have been used more than once in compiling its figures. There is no identification of which models, what types of TVs, or what results were used in the calculations. CASE at 7.[6]
- Admits that its savings estimates do not account for natural market improvements of nonstandard units, or corresponding efficiency improvements of the TVs that do qualify under proposed standards.
- Concedes that the data plots based on these older TVs in Figure 3 of the paper are "not necessarily indicative performance for all plasma TVs on the market today and in the near future"; and notes further that even as of July 2008, many leading plasma manufacturers marketed TVs that satisfied energy standards. CASE at 11.
- Admits with respect to each of its calculations that its estimate of energy savings "does not account for natural market adoption of higher efficiency models" or the increasing prevalence of Energy Star model TVs. *See* CASE at 16; CASE Table 8 at p. 17; CASE Table 9 at p. 18; and CASE Table 10 at p. 19

Indeed, although the CEC Staff Report places its primary reliance on the CASE paper, on the front page of the CASE paper even PG&E itself warns against such reliance:

> "**Neither PG&E nor any of its employees makes any warranty,** express or implied; or assumes any legal liability or responsibility **for the accuracy, completeness or usefulness of any data, information, method, product, policy or process disclosed in this document**… ."

[6] While the CASE paper states that the complete annotated data set "is available to interested stakeholders upon request," PG&E has not provided that data to CEA despite written requests.

CEA suggests the Commission would be better advised to take PG&E at its word. By using these old, outdated figures based on pre-Energy Star 3.0 TVs, the CASE paper grossly overstates the current level of energy consumption and potential energy savings.

C. By adopting the outdated CASE data, the Staff Report artificially inflates the estimated energy "savings" from regulation.

Energy "savings" must be measured against a baseline starting point. If the baseline is inflated, so are the "savings." If the baseline is lower, the savings too are less.

By uncritically adopting the CASE estimates, the Staff Report exaggerates the baseline of current energy usage. Consequently, the Staff Report and the NOPA grossly overstate the potential energy savings from the proposed regulations.

As is evident from the growing ranks of Energy Star TVs, the fact is that substantial improvements already have been achieved, voluntarily, by TV manufacturers to reduce energy use. In the absence of government regulations, TV manufacturers expect additional energy reductions to continue. The Energy Star data from December 2007 to October 2009 show a total 41% increase in efficiency, or approximately 22% per year.[7] A manufacturer of LCD TVs reports that it expects screen power efficiency to improve 15% per year. Other manufacturers of plasma and LCD TVs expect annual energy savings of 17% through 2010.

As noted in the previous section, the PG&E CASE paper caveats virtually each of its power consumption and savings estimates with an admission that their estimates do not reliably or reasonably reflect current TV energy consumption. On each chart that purports to demonstrate its conclusions on energy consumption and savings, PG&E states that its analysis "*does not account for natural market adoption of higher efficiency models*" or the

---

[7] These figure are based on an analysis of power saved from December 2007 to October 2009, based on Energy Star datasets by size range. The analysis applies a size-based sales weighting based on CEA 2008 sales data, as follows:

-- 27,688,156 televisions were sold in the U.S. in 2008
-- Power Consumption: 5,034,956 kW, based on the Energy Star December 2007 dataset
-- Power Consumption: 3,558,724 kW, based on the October 2009 Energy Star database
-- Power Saved: 1,476,232 kW, from one year sales of improved TVs
-- Energy Saved: 2,695,968,870 kWh/year, from improved TVs, assuming 5 hours per day on time

Over this 22 month time frame, the industry reduced power consumption of the average television by 29.3% (sales weighted). This also can be stated as a 41.4% efficiency improvement.

increasing prevalence of Energy Star model TVs. *See* CASE Table 8 at p. 17; Table 9 at p. 18; and Table 10 at p. 19.[8]

The CEC cannot fairly or objectively base crucial policy decisions on such facially inaccurate figures. TV manufacturers collectively have invested scores, if not hundreds, of millions of dollars to improve the energy performance of today's digital TVs. These manufacturers stepped up to the plate long before the Commission began this process. Manufacturers deserve to have their achievements recognized and accounted for by the CEC in hard, reasonable, and reliable numbers before the Commission decides that regulation is necessary or justified.

D. The Staff Report contains serious mathematical and conceptual errors that negate the essential findings claimed to support the regulations.

The essential finding of the CASE paper and accepted by the Staff Report – that the proposed regulations will save Californians $8.1 billion in energy costs – is wrong. Putting aside the demonstrable flaws in the underlying facts as described in the preceding sections, the number was miscalculated because of a fundamental mathematical error, and artificially inflated by a conceptual error. The specific errors and their consequences are detailed in the attached analysis by LECG, summarized below.

1. The Staff Report's mathematical misinterpretation.

The CASE paper estimates annual incremental energy savings which cumulate to 6.5 TWh per year. As noted above, the estimated savings themselves are inflated by use of a baseline that effectively assumes Energy Star TVs only came to market in 2011. Regardless of that bias, PG&E's estimated savings occur only in 2022, after a complete turnover of TVs that do not meet the regulatory mandates. The CEC misinterprets this finding and assumes that the annual cost savings for *each* year between 2011 and 2022 are 6.5 TWh per year.[9]

---

[8] Further conceding the irrelevance of the CASE estimates, PG&E was compelled to raise the bar to its 2009 retailer rebate program because *too many televisions exceeded Energy Star standards by 15% or more*, far more quickly than PG&E expected. "The program started in January paying retailers $20 for each TV sold that is 15 percent more efficient than Energy Star, but it moved the target to 30 percent more efficient than Energy Star 'as we saw more and more products qualifying,' said Tim Michel, PG&E senior program manager." Consumer Electronics Daily, Nov. 2, 2009, at 2. Thus, while one reasonably can question PG&E's wisdom of limiting a program that successfully was reducing energy consumption, PG&E's actions further demonstrate the tremendous voluntary manufacturer response to energy savings.

[9] The California utilities acknowledge that the purported energy savings is achieved only in the final year, yet perpetuates the error by applying that savings to each prior year. *See* Utilities October 13, 2009 Support Letter: "The proposed TV standards will generate an estimated 6,515 GWh in energy savings annually *after all existing stock is replaced.* … The overall energy cost savings for our customers is expected to be *approximately $8.1 billion*." http://www.energy.ca.gov/appliances/2009_tvregs/documents/comments/California%20Utilities%20Joint%20Support%20Letter%20for%20TV%20Standards.pdf (emphasis added).

Correcting the savings estimates (even assuming the figures were reliable, which they are not) so as to reflect a progressive savings from 2011 to 2022, *reduces the CEC estimate of $8.1 billion in savings to $3.5 billion. See* LECG Report and Exhibit 2.

2. The Staff Report's conceptual mistake.

To determine the net present value of the estimated energy savings, the CEC applied a discount rate of 3 percent. While CEA cannot state the actual cost of capital to the California consumer, no one realistically could contend that a consumer could obtain credit at a 3 percent rate. A 3 percent rate essentially reflects a risk-free rate to obtain capital, which no consumer could obtain. The average rate of interest on credit card debt in California is more than 13%. By assuming an unrealistically low discount rate, the CEC Staff Report artificially inflated its energy savings estimates.

Assuming a more appropriate 10 percent discount rate***, the energy savings that the CEC Staff should have calculated using the CASE paper's figures would have been $2.4 billion***.[10]

3. Adjustment for already-occurring improvements.

As noted above, the PG&E CASE paper clearly overstated the baseline television energy consumption (thus exaggerating potential energy savings) because it did "not account for natural market adoption of higher efficiency models." The LECG Report addresses this additional shortcoming, albeit also in a very conservative way.

LECG's adjustment was based on input from TV manufacturers suggesting that it was reasonable (in fact, conservative) to state that they had achieved a 17 percent annual increase in television energy efficiency for their 2009 and 2010 TVs. Lacking actual information beyond 2010, LECG assumed only a continuing minimal annual increase of 1 percent from 2011 through 2022. The near term drop is based on input received from manufacturers and expected voluntary movement in the market toward compliance with the Energy Star 3.0 standard, whose on-mode power consumption level is similar to that for the Commission's proposed. Tier 1 standard. As the Staff Report noted (p. 36), Energy Star's own estimates for Energy Star 3.0 compliance have proven to be "an extreme underestimation." And the Fraunhofer Center's study conservatively projects that 95 percent of LCD TVs and 73 percent of PDP TVs would meet the Energy Star 3.0 standard before 2011.

Consequently, the LECG study is based on the recognition that implementation of the Tier 1 standard would have *no* impact on the average power consumption by LCD TVs, in contrast to PG&E's assumption, relied upon by the CEC, that Tier 1will create 97.2 kW/hr per set

---

[10] *See* LECG Report and Exhibit 3. Even this 10 percent assumption is likely to be lower than a true consumer discount rate. Using a higher figure, which more realistically represents the actual cost of capital to consumers, results in even lower potential energy savings from the proposed regulations.

annual savings *for every LCD set sold in the state of California from 2011 through 2022* (CASE, Tables 6 and 7). The savings from Tier 2, which begins in 2013, would similarly be reduced due to this "natural market adoption of higher efficiency models."

When this flaw is corrected, the present value of the regulations energy savings to consumers (at a 10 percent discount rate) is revealed as ***not* $8.1 billion but, rather, $548 *million***. *See* LECG Report and Exhibit 4. As the LECG Report observes, the actual net present value savings that might be enjoyed by the TV purchaser would be outweighed by a cost to the consumer of $17. And, as shown below in section F, $17 is well below the actual price impact of compliance with Energy Star 3.0 and beyond, which can be hundreds of dollars per TV.

In sum, when the potential energy savings from the regulations are correctly calculated from a rational assessment of the per-set energy consumption baseline, it is clear that the cost of the regulation to consumers far outweighs any potential energy savings. Therefore, the Commission cannot as a matter of law proceed based on its current analysis with its proposed regulation.

E. Had the Staff correctly calculated these estimates, even based on the flawed CASE paper, the Staff should have supported CEA's market-based approach.

In its summary of Stakeholder Comments and Responses, the Staff Report dismisses the recommendations of the CEA, the Custom Electronic Design and Installation Association (CEDIA), the Consumer Electronics Retailers Coalition (CERC), the California Retailers Association, Cyber Manor, Rich Green Ink, Best Buy Inc., Independent retailers, and the Plasma Display Coalition, to forego regulation in favor of following the current marketplace improvements. These comments represent the informed views of businesses and individuals who have actual hands-on experience with the design, manufacture, and marketing of digital TVs, and with consumer response to product features and designs, and to product information.

Using the Energy Star 2007 Annual Report of expected nationwide energy savings, the Staff estimated that "the voluntary ENERGY STAR program would only obtain 27 percent of the calculated $8.1 billion in potential energy efficiency savings for the consumer that would result from the proposed efficiency standards." Staff Report at 28. However, had the Staff not made the mathematical and conceptual errors in its report as noted above, it would have calculated energy savings of $2.4 billion from the proposed regulations – a figure that is 29 percent of the demonstrably inaccurate $8.1 billion estimate. (And, of course, no one disputes that even the 2007 Energy Star Annual Report underestimates actual energy savings, since it did not anticipate the rapid pace of energy improvements achieved by TV manufacturers through October 2009.)

By using corrected calculations from the Staff's own numbers, the Commission is left with the task of justifying its overly stringent regulatory mandates based on only a possible two percent (2%) improvement in energy consumption.

Indeed, the NOPA, states (at p. 16) an alternative Staff conclusion that Energy Star compliance would achieve 35% of the claimed $8.1 billion savings from the regulation. Had the Staff used more current data rather than the outmoded assumptions from the PG&E CASE paper, this 35% would eradicate *any* claimed savings from the regulations.

In sum, based solely on correcting erroneous calculations and assumptions, the Commission cannot conclude that the record supports *any* of the determinations in the Staff Report, including its determination that "no alternatives to the proposed action … would be more effective, or as effective and less burdensome" than the proposed regulations. To the contrary, the Commission has no evidence to dispute that the alternative proposals by CEA, and the many manufacturers, associations, and retailers who are intimately involved and deeply knowledgeable about digital television, will achieve results at least as robust as the CEC regulations, without incurring any of the risks or costs.

F. The CEC's wishful thinking as to the costs of compliance and the costs to consumers ignores the facts.

The CEC Staff Report recognizes that "the cost of compliance can be negative, zero, *or positive*, depending on the route a manufacturer chooses to pursue." Report p. 14 (emphasis added). Nevertheless, CEC asserts that it "*assume[s]* that there is no unit price increase as a result of compliance and that competition will continue to keep prices stable." CEC suggests, with little evidence, that "there will be no increase in the purchase price of televisions due to the proposed efficiency standards because existing technologies … reduc[e] the total cost to build the television." Report p.13 (emphasis added).

In other words, the CEC pins its regulations on two false hopes: that energy saving technologies reduce the costs to manufacture TVs; and that competition will cause manufacturers to absorb the additional costs of energy-saving technology.[11] Such hopes, however, cannot mask the true costs that compliance with the regulations will foist on manufacturers and consumers.

---

[11] The Staff also incorrectly suggested at the October 13th hearing that some 297 sets already meet the Tier 2 regulatory requirement. These sets meet only the Standby-passive mode and On-Mode test for power consumption. If tested for compliance with the other elements of the Tier 2 regulation (including luminance, auto power down, and power factor correction), virtually none of those sets could be on the market today under the Tier 2 regulations. Moreover, while noting that many of these sets are some percentage away from meeting the On-Mode tests, the Staff apparently presumes, without evidence and contrary to actual experiences described below, that these additional improvements can be achieved with little effort or cost.

Further, CEA understands that one or more manufacturers do not agree with specific comments by the Staff concerning the current state of Energy Star 4.0 compliance of certain of their models, and that the Staff has both overestimated the current state of compliance and underestimated the difficulty and expense involved in achieving those specifications.

1. The CEC's erroneous assumptions as to the costs of compliance among DTV technologies ignore the true costs to manufacturers.

The many innovations in energy savings achieved to date by TV manufacturers did not just sprout up overnight. Virtually since the introduction of digital TV technology, manufacturers began investing in technologies to reduce energy consumption. Most TV manufacturers sell their TV models in a global market. Many of these manufacturers' major markets (in some cases, their home markets) import almost all their energy needs; and many of these countries recognized before the United States the crucial need to conserve energy. The breakthroughs achieved by TV manufacturers resulted from many years of research and development, many tens of millions of dollars of investment, and experience in manufacturing millions of units.

The costs to develop these technologies are only the beginning. Material and manufacturing costs can be very significant. For example:

- A leading LCD digital TV manufacturer compared its costs for two LCD TVs of the same screen size with similar features, one using backlighting with the higher energy consumption CCFL lighting, and the other using lower-consumption HCFL technology. Between those two models, the manufacturer reported that:

  - Costs for the TV screen panel are 32% higher
  - Costs for the electronics are 10% higher
  - The price of the TV is $200 higher (12% more than the comparable CCFL model)

  The estimated annual energy savings to the consumer from use of that compliant TV was $8.16. If we assume, as does the CEC, that a TV has a 10-year life, and that the net present value of energy savings should be calculated using a 3 percent discount rate, the consumer who purchased the compliant TV would experience a net loss of approximately $128.31. If we assume that the average digital TV has a shorter life in the home, and that consumers pay more for the cost of credit than just 3 percent, then that loss is even greater.

- Another manufacturer informs CEA that the costs of using LED backlighting technology in its LCD TVs run:

  - $10-30 for TVs less than 26"
  - $35-60 for TVs between 26" and 32"
  - $130 for a 42" TV
  - $160 for a 46" TV
  - $250 for a 55" TV

  That manufacturer further states the costs for using CCFL backlighting as:

  - $10-15 for a 42" TV
  - $30-40 for a 46" TV
  - $40-50 for a 55" TV

Similarly, the CEC does not take into account the costs to manufacturers of licensing or purchasing energy efficient technologies from third parties. For example, one manufacturer informs CEA that the film technologies for LCD TVs cited in the Staff Report burden TVs with the following costs:

- For less than a 32" TV -- $1-3
- For a 32" TV -- $5-7
- For a 42" TV -- $10-15
- For a 55" TV -- $25-35

The Commission also ignores that the obligation to implement energy-saving technologies may, by creating artificial demand for the technologies, increase the incentive to *raise* the price of these technologies. TV manufacturers unfortunately have experienced in other contexts how technology mandates result in exploitative price gouging by patent owners, which substantially increases the price of certain government-mandated features that most consumers never even use.

Moreover, the rate of energy reduction and the costs of compliance are likely to be very different for each technology. As a result, the CEC ignores the disproportionate impact that its one-size-fits-all regulation will impose on certain manufacturers.

These are the types of risks faced by manufacturers by performance-based mandates. In contrast, other measures suggested by CEA have far less of a cost impact, but achieve substantial energy savings. Manufacturers report that automatic brightness controls, as noted above, can reduce energy consumption by 10-15 percent, but cost manufacturers about $3 regardless of the size of the set.

Finally, as noted above, by forcing manufacturers to absorb the costs of innovation, the regulation reduces R&D funds available to manufacturers to stoke additional innovation into the features consumers most want. By setting aggressive energy standards, the CEC will deprive television manufacturers of profits needed to fuel innovation and to bring features and performance quality to consumers.

2. The Staff Report ignores evidence that energy saving technologies increase the prices of digital TVs to consumers.

The Staff Report claim that its regulations will not increase prices of digital TVs for consumers ignores evidence already in the record. For example, the Staff Report (at p. 30 and n. 72) cites a July 28, 2009 presentation by federal government representatives of the Energy Star program as support for a finding of no price impact. Inexplicably, the Report ignores that page 11 of that same presentation shows that the lowest price for Energy Star models had cost more across the board than the most popular models, as much as 40 percent more for 40-inch models. That presentation shows that the MSRP for models said to meet the Energy Star 4.0 requirements:

- For 32" TVs, was from $20-100 more than the most popular model
- For 40" TVs, was from $100-350 more
- For 46" TVs, was as much as $200 more

Best Buy notes a price difference of 34% between July and September 2009, between Energy Star and non-Energy Star qualified televisions. *See* October 20, 2009 comments of Best Buy, Inc. to the Commission. Previous evidence submitted to the CEC by Best Buy showed on average a $167 differential (in November-December 2008) between Energy Star sets and non-Energy Star sets. *See* Comments of Best Buy, submitted to the CEC January 19, 2009.

At the October 13, 2009, hearing, Mr. Kenneth Lowe, Vice President and Co-Founder of Vizio, Inc., a leading LCD television manufacturer, testified: "Currently, the cost addition [attributable to compliance with the regulation] for the Vizio consumer is from tens to hundreds of dollars, depending on the screen size." Transcript at p. 73, available online at http://www.energy.ca.gov/appliances/2009_tvregs/documents/2009-10-13_hearing/2009-10-13_TRANSCRIPT.PDF

A CEA representative similarly testified at the hearing that, because of increased material and manufacturing costs, an LCD TV with energy-saving HCFL lighting was priced $200 higher than its otherwise identical model with CCFL lighting. Transcript at p. 106.

It is self-evident R&D and manufacturing costs must be passed on to the consumer in one way or another. These costs raise prices to consumers now, or delay cost decreases that otherwise would more rapidly occur, or potentially delay investment in innovations that would benefit consumers sooner. Removing certain television models from the market moreover will reduce competition and, therefore, potentially increase prices to consumers. LECG Report at 8. Even assuming that all TVs on the market use energy-saving technologies, price competition nevertheless will proceed based on the higher prices and higher costs of these technologies.

These flaws undermine the Staff Report conclusions that long-term energy savings can outweigh the immediate higher cost to the consumer, and that the payback period under the new regulations is zero. Report p.13. Because these conclusions by statute must be proven true, based on credible evidence, before the Commission can issue its regulation, the Commission cannot proceed based on the current record.

Point II: Mandatory limits on the energy performance of digital TVs will stifle future innovation, and harm consumer and state interests, in the highly dynamic and competitive technology market.

Consumer demand for digital televisions reflects its importance to the American household. There is no consumer electronics product more widely owned. Consumers appreciate the greatly improved picture quality and performance of digital televisions. And that improved picture quality has changed television programming itself. Analog televisions could not reproduce enough detail to watch the entire field of a sporting event, the entire stage of a theatrical or dance performance, or the entire screen of a motion picture presentation. On a wide-screen digital television consumers watch sports plays unfold from a field's eye view and see not just the main characters of a play or motion picture but all characters, as the directors intended.

And this is just the beginning. Innovations on the horizon will continue to improve technical performance such as resolution, sharpness of figures in motion, and color reproduction, and landmark developments like 3D HDTV will bring new benefits to consumers from digital TV.

While consumers and the economy as a whole applaud the consumer electronics industry for these innovations, the CEC Report assesses innovation only through the prism of energy consumption. In the view of CEC, innovation into any aspects of television performance *other than* energy reduction apparently portends harm rather than benefits to society:

> All of these changes have set the stage for a television industry that is experiencing furious competition, lightning-fast evolution and astonishing innovation. … The popularity and increase in demand of televisions has led to strong competition and rapid innovation to provide consumers more functionality and features. *As a result the energy consumption of televisions has been growing rapidly over recent years, and this trend is expected to continue in the near future*… ." Report p. 2 (emphasis added).

The cure, according to the CEC report, is not to let loose the economic engine of innovation, but instead to *rein in* innovation through market interference:

> "The goal of the regulations are *to cause a market transformation* in the remaining energy wasting televisions being sold today so they will be manufactured to meet the minimum efficiency standards by 2011 and 2013. … *to cause the desired market change* to greater efficiency and significant statewide energy savings." Report p.14 (emphasis added).

Stifling innovation is not the solution. It creates different and potentially more severe problems for manufacturers and consumers. As set forth below, the CEC's wrongheaded approach should be rejected. Freeing innovation will give consumers both better performance and energy savings.

A. The Staff Report Ignores a Key Statutory Factor: The Impact of the Regulation on the Efficacy of Televisions to Consumers.

CEC ignored a key statutory factor in its analysis: the impact of the regulation on the product efficacy of televisions for the consumer.[12] The CEC treats this factor as equivalent

---

[12] Under Calif. Resources Code § 25402(c)(1), the factors that the CEC must consider include the following:

> The standards adopted or revised pursuant to this subdivision shall not result in any added total costs for consumers over the designed life of the appliances concerned. **When determining cost-effectiveness, the commission shall consider** the value of the water or energy saved, **impact on product efficacy for the consumer,** and the life cycle cost to the consumer of complying with the standard. The commission shall consider other relevant factors, as required by Sections 11346.5 and 11357 of the

to efficacy in reduction of energy costs. Yet, that is not what the statute provides. The CEC must consider the overall efficacy in terms of the functions performed by the product *for the consumer*.

"Efficacy" may be susceptible to objective measures for appliances such as light bulbs, refrigerators and air conditioners, which consumers buy to fulfill a utilitarian role in their homes. But televisions are anything but utilitarian.[13] The efficacy of a television to the consumer cannot be assessed by merely its energy consumption or, indeed, by purely objective standards. The CEC must consider how and why consumers use televisions, and what aspects of television displays matter most to consumers.

Television plays a central role in the life of the American family. It is the modern hearth where families and friends gather for entertainment and information; to learn about our history, our culture, our world, and our universe, or just to play games together. Television is the consumer's primary source for entertainment, information, and education among families and friends. The most-watched television episode of all time – the final chapter of M*A*S*H – attracted more than 50 million households. Almost an equivalent number watched the 2008 Super Bowl. One year ago, more than 71 million Americans watched Election Night 2008 coverage on television. In short, television is where people gather to watch and share life's experiences as their favorite sports teams do battle, compelling stories unfold, and history is made.

Consumers care greatly about the audiovisual performance characteristics of the television display. Considerations of reproduction quality, color, brightness, sharpness, response time, screen size, screen depth, viewing angle, picture-in-picture, and many other factors, are judged subjectively in the eye of the beholder. And consumers can readily perceive differences among television technologies and qualities. As evidence of the significance of these characteristics, a wide array of publications and websites exist just to inform consumers about TV model performance and to rate and rank products.

Television technologies are not fungible. Each has different characteristics. Whether a consumer prefers the picture produced by CRT, DLP, LCD, OLED, plasma, or front or rear projection is highly subjective. A particular type of TV may be better suited to the particular viewing environment in a consumer's room. Each technology has different attributes in terms

---

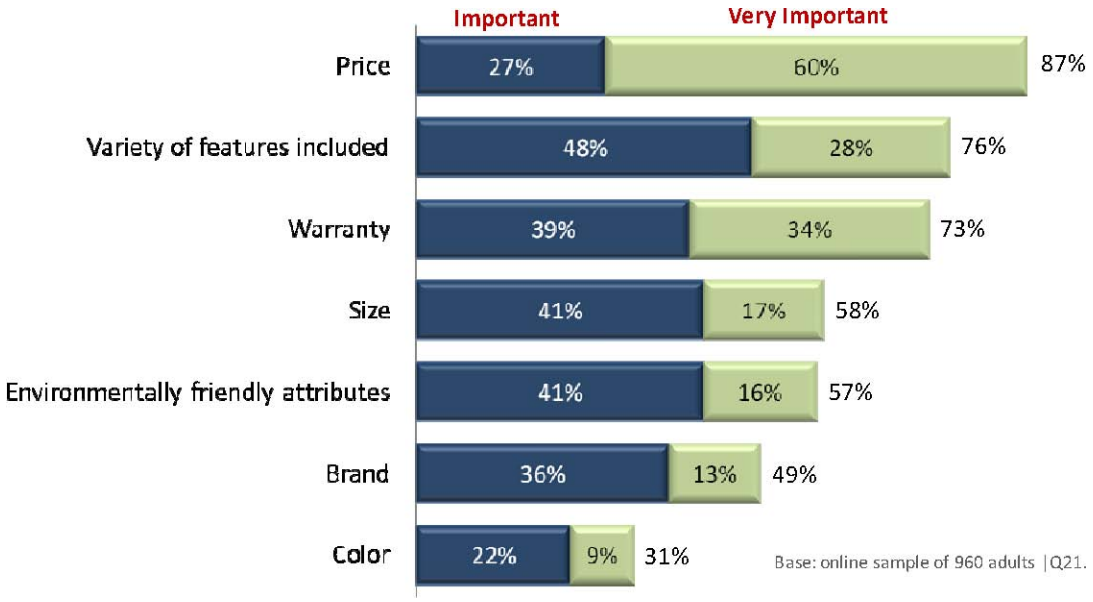
> Government Code, including, but not limited to, the impact on housing costs, the total statewide costs and benefits of the standard over its lifetime, economic impact on California businesses, and alternative approaches and their associated costs.

(Emphasis added.) Notably, the CEC omits any mention of the efficacy factor in its recitation of statutory considerations. NOPA at 12.

[13] Exemplifying this difference, the federal Energy Star program establishes separate categories for "Appliances" (like clothes washers, refrigerators, and air cleaners) and "Home Electronics" (including cordless phones, DVD players, home audio, and televisions). *See http://www.energystar.gov/index.cfm?fuseaction=find_a_product.*

of quality, size, and price. Which set gives the best performance at an agreeable price is a very personal choice, and one of the more important purchasing decisions a consumer will make. If every set was as much the same as the CEC assumes, one would never see consumers taking time standing before dozens of models arrayed in a retailer's display, judging for themselves which TV performs best for their specific needs.

Energy consumption is one element affecting consumers' purchasing decisions. But as shown in a recent CEA research poll, it is fifth on consumers' list beneath price, features, warranty terms, and size.



If energy consumption were the only consideration, then the most efficient technologies also would be the most popular. But, as the Staff Report observes, the current display technologies that consume the least energy have attracted less interest from consumers, constituting only .5 percent of today's market. Staff Report at 10. What consumers want and deserve most from their television experience are high performance and new features, at the lowest possible price.

"Efficacy" cannot be judged by energy consumption alone. The CEC assessments therefore must give due consideration to the impact of its proposed regulations on those aspects of television displays that matter most to consumers -- including innovative features, price, and size.

B. Innovation Takes Time, Effort, Experience, and Funding – All of Which would be Impaired by the CEC Proposed Regulations.

Technological improvements result from years of research and product development. Investment in research and development, in turn, depends on the experience gained and profits earned through mass production of early generation products.

The first generations of products inevitably are less efficient in every way than later generations of products. Manufacturers obtain through experience knowledge vital to achieving future cost savings and product improvements. Once a product shows the promise of future success, manufacturers have the business rationale and funding to seed further investment in efficiencies in design and production. Functions performed in first generation products by multiple parts can be integrated into fewer, cheaper, and more energy-efficient components. Product performance is improved. New features are added. Economies of scale bring costs down further. And, as manufacturers already have demonstrated by their highly successful voluntary efforts in the Energy Star program, with time, experience, and funding from earlier generations of products, manufacturers also can make their products more energy efficient.

The Staff Report recites a list of breakthroughs achieved in energy efficiency for LCD, plasma and DLP display panels, *see* Staff Report at 18-25 and October 13 staff presentation slides 33-38 and 55-59, as if these innovations occurred effortlessly overnight. In reality, these technological improvements only became possible because TV manufacturers dedicated more than two decades of experience and research into the digital TV technology. But any company's ability to invest tens of millions of dollars into such research depends upon first establishing market demand for the technology.

In the words of one of the leading Panasonic researchers who developed plasma television display technologies: "You can't schedule invention." Innovation takes time, not timetables. No product designer, no less a government regulator, can dictate when particular breakthroughs will occur, or when today's inventions in the laboratory will become economically feasible in the factory, or whether or when even the best-designed products will be successful in the market. The CEC's attempt to force energy innovation to its regulatory calendar defies logic and experience. The Commission's proposed regulations only will interfere with research and development efforts that already, voluntarily, are underway.[14]

C. Regulation will stifle development and marketing of new television display technologies.

As noted above, the CEC regulations will disrupt the development of television technology. The regulations will create obstacles to progress by imposing higher costs on research, development, and manufacture of digital televisions.

Companies have only a finite pool of skilled technical engineers and funding with which to conduct research and development efforts. By necessity, the forced re-allocation of resources to comply with the CEC regulations will divert engineering efforts away from other improvements that consumers may find more important and desirable. And it will require companies to divert resources toward meeting energy requirements to meet the

---

[14] CEC suggests that the regulations provide industry "with complete flexibility on how they design their products to achieve the required levels." Report p.13. This ignores industrial reality. CEC may not specify *how* manufacturers must achieve the required consumption levels, but the mandate *to* achieve specified levels within a limited time *per se* reduces design freedom.

CEC's artificial timetable. Manufacturers have made steady progress on energy reduction, while continuing to meet consumer demand for improved features and lower prices. This balanced approach already has yielded tremendous successes for both advanced displays and energy savings, and in the absence of regulation will continue apace.

In addition to the impact on today's developments, the CEC regulations will stifle progress toward tomorrow's technologies. To illustrate, suppose the only technologies currently on the market were CRT and DLP. This year, a company invents the plasma display. Next year, a company invents LCD TV. But both plasma and LCD TVs, when first introduced to the market, exceeded the mandatory CEC energy limits. Consequently, **if the CEC regulations had been in place in 2001, they would have prohibited either plasma or LCD TV technology from being introduced to the market at all.**

Of course, as experience has shown, many consumers prefer the price and performance of plasma and LCD over other existing technologies. And major energy consumption improvements have occurred to both technologies in the years since its introduction. Indeed, plasma and LCD TVs from every major television manufacturer today meet or exceed Energy Star voluntary standards.

Consumers benefited from all these innovations because the marketplace allowed manufacturers the time, experience, and profits that enabled plasma displays to succeed and mature. None of this would have occurred had the CEC regulations been in place.

Digital TV is still in its infancy. Californians share the global public interest in the development, introduction, and potential success of the next new technologies.[15] The CEC regulations will prohibit companies from commercializing and improving any new screen technologies that cannot meet the CEC's artificial timetables. If manufacturers cannot test consumer demand and allow the market and the technology symbiotically to develop, advanced, potentially better performing television displays may never reach consumers. The costs to innovation are far too high a price to pay for what is, at bottom, an unnecessary regulation.

D. The Regulations Will Have an Immediate and Long-Term Impact on California Businesses, including Retailers and the Entertainment Industry.

The Commission's proposed regulations unduly burden interstate commerce. While the CEC claims, on the one hand, that the regulations will impose no costs on manufacturers or consumers, conversely the Commission concedes that the regulations will be disruptive to manufacturers and interstate commerce generally.

In truth, the CEC admits that its regulation will leave market disruption in its wake – indeed, that upending the consumer electronics market is its purpose: "The goal of the regulations are **to cause a market transformation** in the remaining energy wasting televisions being sold today so they will be manufactured to meet the minimum efficiency standards by 2011

---

[15] Research and development into TV technologies bring innovation to a variety of non-TV display platforms, such as computer and medical displays. For example, if not for the scores of millions of research dollars and years of effort to develop LCD TVs, would consumers today have other evolutionary products like the video iPod?

and 2013. … **to cause the desired market change** to greater efficiency and significant statewide energy savings." Report at p.14 (emphasis added).

As discussed below, the premise of the Commission's thesis is thoroughly misguided. Market forces already have compelled manufacturers to voluntarily and dramatically reduce TV energy consumption. Competition will continue this downward trend without regulatory interference. And the additional steps recommended by CEA will have documented benefits, as shown in the Fraunhofer report.

What the Commission fails to appreciate, however, are the rippling effects of regulation on other businesses and industries essential to the health and growth of the California economy, briefly discussed below.

1. <u>The regulations will unduly burden California retailers</u>.

CEA submitted for the record in this regulatory proceeding a March 23, 2009, study by Resolution Economics, LLC, describing the potential impact of energy regulations on the California economy. As a result of comments received with respect to that study, the authors revised their analysis, as reflected in the attached Update. These revised figures indicate that California could lose more than 4,000 jobs and approximately $46.8 million in tax revenue as a result of the proposed regulations.

Among those most directly affected by the regulations are electronics retailers and installers. The CEC attempts to limit the impact from the mandates on certain specialty retailers by arbitrarily, although only temporarily, exempting from the proposed regulations TVs 58-inches and above. This exemption, by definition, concedes that the potential impact on California retailers is real. Indeed, comments submitted by mass retailers, specialty installers, and many others, demonstrate that the CEC regulations will have a potentially devastating impact on commerce. Moreover, these comments explain that the impact falls on retailers of all sizes of TVs, down the line. Specialty retailers as well as major mass electronics retail companies sell a large number of sets from 42" to 58" that remain subject to the regulations. The impact of the regulations on these sets, in terms of price and availability, will substantially harm the retail market.

The Staff Report notes that because of the regulations, "there may be television models which may not be sold or offered for sale in California." Report, p.14. It observes that the nature of commerce in televisions and in retail likely means that these non-compliant sets may have to be taken off the market in the U.S. "In addition manufacturers, retailers, and distributors take a risk by producing non-compliant models for sale in the U.S. but not in California. It is very difficult to manage supply chains to the accuracy of state borders and much of the television market is organized into a much larger 'North America' market. Therefore, continuing to produce and sell non-compliant televisions becomes a discouraging legal liability with potential violations of California State law." Report, p. 15.

Thus, the Commission concedes that its regulation will wreak inventory management problems for major retailers that cannot so readily control flow of products between California and other states. The impossibility of micromanaging mass retailer inventory is a theme echoed and amplified in comments from the retailer community. While perhaps the Commission sees this as a wash or, perhaps a net positive, the retailers who will suffer the

consequences of this regulation do not. What likely will occur is a shift away from retailers that have heavily invested in a physical presence in California, toward internet retailers whose connection with California is no more than a delivery truck. As a result, Californians will lose jobs, and California will lose tax revenue.

Ultimately, the costs of the regulation will be borne by consumers. As reported by retailers such as Best Buy, and confirmed by the U.S. Department of Energy as well as TV manufacturers, Energy Star TVs cost more to produce, and tens to hundreds of dollars more at retail. Higher TV prices means fewer sales, or more sales of low-priced/low-profit models. As a result, retailers will have fewer models to sell, fewer TV sales, and lower TV sales revenues.

2. The regulations will unduly burden California's entertainment industry.

The entertainment industry relies on high performance televisions. Studios spend hundreds of millions of dollars to produce, market, and distribute a motion picture, with the expectation that it likely will only achieve a return on investment in the home video market. With the transition to digital TV earlier this year, television producers of entertainment, news, and sporting events have adjusted their production methods and techniques to take advantage of the benefits of wide screen high definition home viewing platforms. As these companies seek new business models to bring in much needed revenue, they look increasingly to the home consumer. The consumer desire for Blu-ray discs, HD pay-per-view and video-on-demand, broadband delivery, online rental, and purchase by downloading, all are fueled primarily by the availability of wide screen digital televisions. Without digital HD TVs, there simply would be no market for these new products and industries.

Beyond question, motion pictures made for the big screen in a theater also look better on a big screen at home. The regulations will compel many California consumers to purchase only smaller screen televisions that may not yield the same entertainment experience, when a larger screen TV would in fact still use less additional energy than a single light bulb.

Moreover, the entertainment industries are looking to TV manufacturers for new innovations to fuel demand for motion picture products. Hollywood and TV manufacturers are working very closely on development of innovations such as 3D television. While the Staff Report assumes that the regulations will have no impact on 3D, there is no basis to make any assumptions about a technology that has yet to come to market. To the contrary, 3D technology is primarily a visual display phenomenon that may or may not affect energy consumption. At this point, no one knows how the regulations will stifle development of 3D TV. What is clear, however, is that the Commission has not demonstrated that any potential benefits from its draft regulations can possibly outweigh the clear risks to innovative California industries.

Finally, TV manufacturers make professional as well as consumer model TVs. Professional model TVs are manufactured to more exacting requirements that in many respects will draw

more energy than a comparably sized consumer model.[16] The regulations make no accommodations whatsoever for professional uses. The fundamental nature of this oversight by the Commission further demonstrates that the Commission is regulating in haste, without due diligence or care for the realities or needs of the marketplace.

E. The Commission regulations will burden other California businesses and institutions.

The scope of the proposed regulations is unclear in its application to non-consumer uses. As noted above, the regulation on its face would appear to preclude sale of professional model TVs to California entertainment and production industries requiring exacting and high performance TVs. But it appears that the regulations also would affect and potentially preclude numerous other uses of TVs in commonplace commercial and institutional environments.

The regulations define a "television" as any device designed primarily for the display and reception of video broadcasts and transmissions. The next sentence states that TVs "include … any unit that is marketed to the consumer as a TV." The clause regarding the marketing of TVs to consumers therefore appears to be only an example, and not a substantive limitation. Consequently, it also appears that many model TVs commonly used in commercial and institutional applications also would be affected by the regulations. As a result, the regulations also would affect every TV in every airport gate, dentist office, hospital waiting room, or sports bar in California. Many of these environments may require additional brightness and luminance to provide satisfactory performance in otherwise suboptimal conditions, which would exceed the power requirements of the regulations.

Again, the failure of the Staff to recognize the differences among consumer, professional, commercial and institutional uses demonstrates that the rush to regulate has overshadowed the needs of manufacturers and the market. Moreover, as demonstrated in the next section, not only has the Commission failed to consider all relevant facts and needs of the marketplace; the Staff Report misinterprets and miscalculates the facts it has collected. As a result, the proposed regulations do not meet the statutory requirements and cannot be promulgated by the Commission.

---

[16] For example, the Staff Report cites a 63-inch plasma model television as evidence that digital TVs draw energy comparable to refrigerators. Obviously, a professional monitor must have greater capabilities and must meet more exacting performance requirements than residential consumer TVs with respect to brightness, color saturation, and resolution, among other factors, all of which may require greater energy consumption. Not only does the Staff Report ignore this crucial difference, it fails to mention that all other comparable consumer plasma models from the same manufacturer – including its 63-inch consumer models – are Energy Star compliant. In any event, the detailed October 13th hearing testimony by Panasonic exposes as a canard the oft-repeated false contention that televisions and refrigerators consume equivalent energy.

Point III: The Commission should adopt alternative measures that, in conjunction with industry's voluntary efforts and existing market-oriented programs, will yield energy savings at least as great, if not greater, than would otherwise be achieved by regulating power consumption – but without the costs to consumers, business, and innovation.

Tremendous strides in energy savings already have been achieved by digital TV manufacturers, *without* any regulatory mandates. Comparing Energy Star 3.0 data from December 2007 to October 2009, consumers who have bought newer digital TVs have benefited from:

- **29.3% average power savings (weighted, all sizes)**
- **41.4% efficiency improvement**

The Fraunhofer Report estimates future voluntary savings during the period of 2011 through 2022 (the period covered by the CEC estimates) using a very conservative approach. While CEA anticipates that actual savings over that time would be substantially greater, the magnitude of the savings estimated in the Fraunhofer report demonstrates that no regulation is needed.

Baseline: The Fraunhofer Report uses the CASE baseline assumption that 34 percent of LCD TVs and 5 percent of plasma TVs comply with Energy Star 3.0 as of 2011, and that no TVs meet the Energy Star 4.0 requirements. In so doing, Fraunhofer enables a better apples-to-apples comparison of anticipated savings as between the CEC regulations and the CEA-proposed voluntary measures. Notwithstanding, compared to the October 2009 Energy Star data, the baseline numbers are in fact extremely low. More than 1240 digital TVs already meet Energy Star 3.0, and approximately 300 models meet at least certain elements of the Energy Star 4.0 requirements.

Standby Mode: The Fraunhofer Report assumes no savings in standby or passive mode, inasmuch as more than 90 percent of TVs sold in 2009 meet the Energy Star levels. *See* Staff Report at 9 n.4 (94.5 percent of televisions between 6/1/2008 and 6/1/2009 report less than 1 watt in standby mode).[17]

Other Factors: The Fraunhofer Report uses the same assumptions as the CEC as to Annual Active Mode Usage, Future TV Sales, and Average TV Lifetime. One additional element affecting power consumption, but not considered in the Fraunhofer Report, is screen size. In the last year, the purchasing trend smaller-sized (37" or less) to larger-sized TVs has shifted

[17] In contrast, the 1999 report by K. Rosen, A. Meier, and S. Zandelin of Lawrence Berkeley National Laboratory, National Energy Use of Consumer Electronics in 1999, reported TV standby-mode power usage on average of 8.8 watts. http://eetd.lbl.gov/EA/Reports/45988.doc This is just one illustration of the remarkable energy improvements made voluntarily by the consumer electronics industry over the last decade.

from 1:1 to 3:2 in favor of smaller TVs.[18] This trend promises further reductions in total power consumption.

Using these conservative assumptions, the Fraunhofer Report estimates annual energy savings as follows.

A. Energy Star Savings

In assessing potential Energy Star savings, the Fraunhofer Report again conservatively assumes that all TVs draw the maximum amount of power under the Energy Star 3.0 and 4.0 guidelines. Fraunhofer recognizes that, in fact, a substantial portion of TVs will use less power than the calculated values, and Energy Star 5.0 compliance would yield additional savings. However, in keeping with its cautious approach, Fraunhofer does not estimate these additional savings or include them in its calculations. With these and other caveats, compared to the baseline, Fraunhofer estimates compliance with the Energy Star 3.0 and 4.0 programs would yield a minimum of 11.1 TWh and 27 TWh , respectively, between 2011 and 2022.

CEA believes that these numbers significantly understate the actual potential savings that will be realized from the voluntary Energy Star program. First, many TVs already consume less than the maximum Energy Star levels used in the Fraunhofer analysis. Second, Energy Star 3.0 compliance has occurred much faster than previously contemplated. CEA expects that, with increased competition for energy savings, this trend will continue toward earlier energy improvements under Energy Star 3.0, 4.0 and 5.0 targets.

B. Auto Power Down Functionality

The Auto Power Down function turns off the TV after a specified period of time or of inactivity. Fraunhofer assumes this feature would terminate power after three hours, so as not to interfere with consumers watching a movie. Fraunhofer estimates the annual maximum range of electricity savings from the Auto Power Down feature at between 145 to 190 GWh per year.

These assumptions also are likely to be conservative. Some manufacturers' TVs will (or already do) power down if there is no user input to the TV after less than three hours. Other manufacturers will adopt technologies such as sensors that will turn off the TV if no motion is detected for some shorter period of time.[19] These technologies can significantly improve the anticipated energy savings over and above the Fraunhofer estimates.

---

[18] *See* G. Tarr, "Ratio of Small TVs to Large Shifts to 3:2," This Week in Consumer Electronics, September 28, 2009 http://www.twice.com/article/355641-Ratio_Of_Small_TVs_To_Large_Shifts_To_3_2.php

[19] At least one manufacturer has noted the inherent difficulties in applying an auto shut-off feature without interfering with the consumer experience, and increasing costs to respond to consumer complaints. *See* testimony of Kenneth Lowe of Vizio, Inc., October 13, 2009 at 63-64.

C. Forced Menu Functionality

Using forced mode menu functionality, at set-up the consumer would be presented with the option to set the TV brightness level at a standard "home" setting or a "bright" mode. As the Fraunhofer Report notes (but the CEC Staff Report ignores), manufacturer adoption of this functionality is already very high. Of the TVs offered for sale in 2009, approximately 80 percent of LCD TVs and approximately 50 percent of plasma TVs either ship at the "home" brightness configuration or include a "forced mode" menu. Fraunhofer assumes conservatively that the difference in energy savings is 20 percent,[20] and that some 80 percent of consumers will either not change or will select the default "home" option. Using these assumptions, Fraunhofer estimates a savings of 17 percent, or a total of 47 GWh per year.

Forced Menu functionality is not the only feature that reduces energy consumption by controlling brightness. Many manufacturers' TVs feature automatic brightness control sensors that, with no user input, adjust the brightness of the picture in response to ambient light conditions. One manufacturer reported that this feature reduces energy consumption in its TV screens by 10-15 percent. This figure would not be additive to the "forced menu" savings, but would incrementally achieve improved energy savings for even those consumers who opted for the brighter settings.

D. Consumer Education and Advertising

One of the biggest unmined sources of energy savings is to improve the energy consumption levels of TVs already in consumer homes. While many consumers already may have televisions with lower default settings, many consumer TVs currently are set to the higher brightness levels, or have been reset by consumers who do not recognize the potential impact on power consumption. According to phone surveys referenced by Fraunhofer, more than 50 percent of consumers said they would be likely or very likely to use their remote to decrease screen brightness and save electricity. Fraunhofer Report at 27. In addition, consumers could be notified by service provider visits of the opportunity to save energy through brightness settings. As the report notes, "[i]f applied to the approximately 90 percent of the 2008 installed base of TVs estimated to be in a "bright" mode, switching to a lower power mode could have reduced the [average energy consumption] of the installed base of TVs in California by approximately 1,000 GWh in 2008." Report at 26. Factoring in the likelihood that informed consumers might take this voluntary action, Fraunhofer estimates a potential savings as great as 555 GWh per year.

In addition to savings from reducing brightness, CEA believes that consumer education will achieve additional savings in even more fundamental ways. A simple reminder to turn off TVs when leaving the room, or to use sleep timer settings available on many current model TVs, will contribute to energy conservation. And, as discussed below, education on Energy Star labeling and energy use disclosures will help consumers make better informed decisions when purchasing new digital TVs.

---

[20] Some manufacturers report 25% less energy consumption using the "home" setting.

E. DTV Acceleration Program

From 1999 to 2002, the vast majority of TVs sold in the United States were CRTs, followed by high-energy consuming early models of LCD TVs. If all of these sets were to be retired and not replaced, the maximum annual savings could reach as high as 560 GWh per year. A survey performed by Fraunhofer found that a significant number of consumers (just under 50 percent) would respond favorably to an incentive of $50 to retire their older TVs and purchase instead a newer, energy saving model. Fraunhofer suggests that, given the number of consumers actually likely to respond to such a program, and the incremental energy savings to be achieved, a one-year program could be expected to reduce energy consumption by 10 GWh.[21] Such savings would persist through the anticipated remaining life of those retired TVs.

In summary, Fraunhofer estimates that the savings from Energy Star, forced menu functionality and auto shut-down are likely to save a minimum of 440 GWh per year over the current baseline of Energy Star and other models. Savings from consumer education could reach 550 GWh per year, and the potential gains through consumer incentive programs could be as high as 560 GWh. These savings estimates by Fraunhofer, though overly conservative, will result in substantial reductions in consumer energy costs. As noted above, CEA reasonably expects actual savings in many of the above categories to be far greater than the Fraunhofer estimates. But given that they proceed from a reasonable baseline, use empirical evidence, and were subject to peer reviewed, the Fraunhofer Report estimates are much more reliable than the deeply flawed and inherently-biased stakeholder views that lie at the foundation of the CEC proposals.

POINT IV: Additional Proposed Regulations, Including those Concerning Power Factor and Product Labeling, Should Be Rejected as Costly and Ineffective.

In light of the above reasons compelling rejection of the proposed power consumption regulations, the Commission has no justification to promulgate any of the additional regulations it has proposed. CEA understands that a number of TV manufacturers will submit separate comments on a number of these additional issues, such as power factor, standby-passive power regulation, and so forth, and adverts to those CEA member comments. We address two of these supplemental issues below, concerning power factor regulation and labeling and disclosure.

A. Power factor regulation will increase costs to manufacturers with no palpable energy savings for consumers.

The proposed CEC regulations include a requirement for power factor greater than 0.9 for televisions that consume 100 watts or more power and are manufactured on or after January

[21] PG&E reports that its current program, which provides a $20 rebate to retailers for sets that exceed Energy Star 3.0 by 30 percent, saved 6 MWh in 2009. Consumer Electronics Daily, Nov. 2, 2009, at 2-3. The consumer-based program proposed by CEA should be expected to yield far greater savings in the near and long terms.

1, 2011. The CEC Staff Report acknowledges that "While improving power factor will not significantly alter the consumption of energy within a device, it will save energy in external ways." The Report continues to note that "One important cause of energy loss due to low power factors is heat loss over wiring." While the CEC staff may believe there may be other causes of energy loss due to low power factors, these causes are not specified nor analyzed in the Staff Report.

Since the only "benefit" of increased power factors listed in the Report is reduced heat loss over wiring, the report progresses to calculate power factor energy savings purportedly achieved by minimizing heat loss over wiring. The Report relies on the April 13, 2009 PG&E Case Study entitled *Energy Savings Estimate for Power Factor Correction in Televisions*. The PG&E Case Study similarly focuses on minimizing wiring losses through power factor correction circuitry in televisions.

The Staff Report concludes that "The energy savings are estimated to be 6 kWh per year for a 37 inch television which just meets Tier 1 standards and 3 kWh per year for a 37 inch television which just meets Tier 2 standards." Since the public does not have access to the CEC staff's calculations, we cannot say what assumptions were made about wire type, size, and length. Some of these factors would obviously vary widely from home to home. However, even if we assume the savings are as claimed (6kWh/year and 3 kWh/year), the result is that the dollar savings to consumers are negligible. Specifically, assuming an electricity rate of 14.53 cents per kWh:

- CEC Tier 1 (37-inch TV) wiring loss 6 kWh per year, saving **87 cents per year**
- CEC Tier 2 (37-inch TV) wiring loss 3 kWh per year, saving **44 cents per year**

This limited savings does not justify the added cost of power factor correction circuitry in televisions that don't already have such circuitry. The PG&E Case Study estimates the total cost of power factor correction circuitry of between $1.00 and $2.00. One television manufacturer estimates the costs as two to three times these numbers. Once the cost of redesigning a television's internal layout to accommodate the new circuitry is factored in, plus the inevitable increased costs passed to consumers are added, several dollars will be added to the cost of a particular TV. The negligible cost savings estimated by the CEC staff will not outweigh the cost increase for a television requiring the addition of power factor correction circuitry.

We also note that a typical household includes many different electric loads which must be combined to determine the characteristics of energy consumption for that particular house. The proposed power factor regulation on televisions is of questionable benefit. A typical household will contain many other reactive loads such as compact fluorescent light bulbs (CFLs), motors, pumps or air conditioners that may often present a low power factor. While it is desirable to have a high power factor for the combined load of the house, there are better points for power factor correction. For example, a more efficient mechanism would be to seek power factor correction at the whole-household level in order to correct all the household devices that may also present a low power factor.

Accordingly, the dollar saving to consumers are negligible. These minimal savings are outweighed by the added cost of implementing power factor correction circuitry in televisions. As the EPA concludes on its web site "Power factor correction devices improve power quality but do not generally improve energy efficiency (meaning they won't reduce your energy bill)."

Neither Energy Star nor any other regulatory agency has included a requirement on the power factor. We strongly recommend that the CEC regulation also eliminate the power factor requirement. This harmonization is important in that it allows manufacturers to design "world market" products which are in compliance with all of the relevant standards. This results in the most efficient and cost-effective product available to consumers.

In comparison to another industry, CFLs are subject to the EPA Energy Star Program Requirements and Criteria for CFLs Version 4.0 which specifies that the CFL power factor must be at least 0.5. The proposed CEC value for a TV's minimum power factor of 0.9 is almost twice that required for CFLs. Given the large market penetration of CFLs and the widespread acceptance of their energy savings, it does not seem appropriate to apply a much more stringent requirement to TVs. The potential overall impact to household energy use by the adoption of CFLs seems to be greater than that of TVs, so it does not seem appropriate to mandate far tougher power factor standards for TVs compared to CFLs. (The CFL was chosen for comparison because most of its electrical power is consumed in the production of light as is the case with televisions. Furthermore, nearly all LCD TVs use fluorescent back lights to produce their illumination. Plasma TV pixels also produce light in a manner similar to tiny fluorescent lamps, but use neon gas instead of mercury gas as used by conventional fluorescent lights and CFLs.)

B. The Commission's proposed performance marking and disclosure regulations are unworkable, and should instead follow CEA's labeling recommendations to the FTC.

At the outset, CEA wishes to make clear that manufacturers strongly support disclosure of information regarding the energy consumption of consumer electronics, including appropriate labeling. Disclosure educates consumers and further promotes existing competition among manufacturers to lower energy consumption. In comments submitted earlier this year to the FTC in its current proceeding to develop disclosure requirements for consumer electronics, CEA noted that energy use disclosures should be welcomed by consumers eager to have more information about the power consumption and operating cost of electronics they purchase. Providing such information would give consumers another point of comparison as they consider various factors in their purchase decisions. It also would increase consumer awareness and understanding of the operating costs of a particular product, at least in terms of electricity cost and consumption. Comments of the Consumer Electronics Association, Federal Trade Commission Consumer Electronics Labeling Project No. P092401 at 3-4 (May 14, 2009).

Our FTC comments noted, however, that in determining the most appropriate method or methods for disclosure, the FTC should inform its decision on the basis of consumer research

into the effectiveness of particular approaches, and weigh the costs to industry of developing, implementing, administering, and maintaining energy use disclosure requirements. Thus, we stressed that cost-effective requirements for energy use disclosures could be established by focusing on simple disclosures of information and providing flexibility for implementation in the marketplace. *Id.* at 4.

CEA believes that the FTC's rulemaking process, taking into consideration the concerns of multiple stakeholders, offers the best avenue to developing and implementing disclosure standards for California consumers. CEC reference to FTC standards would also minimize the manufacturers' and retailers' costs for developing and maintaining state-specific disclosure methods.

Nonetheless, CEA does not object to moving forward with energy consumption disclosures even as the national standards process moves forward. However, we urge the CEC to avoid needlessly costly requirements that may have little incremental value.

The Commission's proposed draft section 1607(d)(11) establishes two requirements for disclosure of a television's on-mode power consumption in watts: (A) the TV itself must display this information permanently on an "accessible and conspicuous place on the unit, in characters of equal size to the largest font used within the menu screen within the television's built in menu;" and (B) "[a]ny publication, website, document or retail display that is used for sale or offering of a television set manufactured on or after July 1, 2010" must also include this information if it also includes a description of the television's physical dimensions.

These requirements represent another clear example of the CEC's imposition of regulatory requirements without attempting to quantify—or even to attempt to study—the specific costs they would impose on manufacturers and retailers. Further, they impose the most burdensome of these requirements without regard to other more cost-effective ways of making this information available.

CEA opposes permanent marking on a TV for both safety and logistical reasons. With respect to safety, any new requirement for energy labeling on the product itself will cause confusion and conflict with existing Underwriters Laboratory ("UL") labeling. The UL safety standard for audiovisual products, UL 60065, requires a permanent label on the product indicating its supply type and "rated supply voltage." UL 60065 also requires that the "rated current consumption" or "rated power consumption" appear on this same label (or optionally in the product's instruction manual). UL's "rated current" and "rated power" consumption numbers are based on measurements made at virtually the product's <u>highest</u> user settings and input voltage conditions. *See* UL 60065 sections 2.3, 4.2 and 5. Even though UL refers to this combination of settings as the product's "normal operating condition," in terms of possible energy consumption it is actually the most unfavorable combination of conditions.

UL's purpose in disclosing the highest potential power usage on these product is to enable electricians, installers and knowledgeable consumers to plan which product(s) can safely go

together on a household circuit, so as to avoid overloading that circuit and its corresponding wires and safety device (breakers or fuses).

If the CEC regulation goes into effect, TVs will thereafter be marked with two different ratings. An installer, electrician or consumer that unknowingly or inadvertently uses the CEC power consumption number (watts) and divides that by the typical U.S. household voltage (120 VAC), will get a current (Amps) which is too small. As a result, the home could be fitted with extension cords with inappropriately sized wire or the connection of too many devices to one circuit in a home. To avert such safety hazards, the UL rating clearly is the appropriate rating to be marked on the TV.

As to the logistical concerns, the CEC's proposed requirement of physical marking is unreasonable and ineffective. Many flat-panel displays are intended to be mounted on a wall and are installed in this manner for purposes of preservation of space and enhancing room aesthetics. There is no "accessible and conspicuous" place on a wall-mounted TV except on the front, and a permanent marking in this manner imposed solely on California residents would be more likely to generate consumer backlash than to promote energy consciousness.

Similarly, permanent marking is of no utility to the hundreds of thousands of TVs used in commercial settings, such as in California airports, hospitals, stores, and hotel rooms. The actual viewers using these TVs likely will never see the markings. They use the products for a relatively short time and on a limited basis, and ultimately have no control over the total energy uses of these devices. The only result of such regulation would be to foist additional cost and burden on manufacturers.

Such unintended effects would be exacerbated by the font-size requirements. On-screen menus may be of a relatively large size, particularly in the case of large screens for which it is assumed that the menus will be viewed a distance. Indeed, some manufactures may employ bigger fonts to enable convenient menu use by older users or others with reduced distance vision. Consequently, an energy disclosure of matching font size might well be significantly larger than a brand name or logo or, potentially, the outside frame of a flat panel display. Conversely, manufacturers might reduce menu size to avoid having to place an absurdly large energy label on the set. However, the resulting reduced menu sized might make more difficult the menu's use by those with limited vision — an outcome the CEC surely cannot intend.

Further, it is unclear how useful such physical on-TV disclosures would be after a consumer's purchase. It is CEA's assumption that the secondary market for televisions is primarily among friends and relatives, or at bargain prices to facilitate a residential move. In such a circumstance, the substantial discount compared to a new set is likely to make budgetary concerns regarding electric usage a minimal concern -- and of minor effect, since digital TVs subject to the rule can be expected to be relatively energy efficient compared to the analog and early-generation TVs of just a few years ago. The availability of manufacturer, CEC, Energy Star, and third-party online information should enable any interested secondary market consumer easily to check a model's energy consumption.

For similar reasons, requiring energy consumption in printed documentation, particularly by July 1, 2010, is impracticable. Adjustments that improve power consumption may be finalized only shortly before a model series is set for shipment. However, users' manuals and related documentation need to be finalized several months before shipment. Such documentation may encompass whole model families or multiple screen sizes for a similar model. Unlike physical dimensions, known well in advance, a change in power-affecting setting could occur much closer to shipment date, potentially necessitating the expense of an on-going series of errata sheets. Thus, the regulation could create perverse incentives to forego last-minute improvements to energy performance so as to avoid the added expense solely imposed by the regulations.

Consequently, CEA recommends that the CEC limit any on-mode power consumption disclosures to: (1) manufacturers' web sites or other online resources; (2) specification sheets made available to retailers (and which information most likely would be available on retailers' websites); and (3) if the CEC insists on TV-specific disclosures, labels to be placed on shipping cartons, which can be generated at lower expense at the time of shipment to an inventory location that may serve California consumers.

CONCLUSION

The Commission has not made the case for mandating regulatory limits on TV power consumption. There can be no reasonable dispute but that the Staff Report inflates current estimated TV energy usage and miscalculates potential savings. The Commission has been presented with an erroneous picture of the present, and false promises for the future. As a result, the Commission has no reliable evidence on which to base its regulations.

CEA believes the proposed mandates are completely unnecessary and counterproductive. Voluntary efforts and market-oriented programs already well underway will achieve the same or greater energy savings in cooperation with federal and state governments. Competition, combined with consumer education, will reap substantial benefits in energy savings. And unlike the proposed regulations, these voluntary efforts will succeed in reducing energy consumption without interfering with the normal operation of the highly competitive and intensely innovative consumer electronics market.

Rather than imposing artificial controls over one of America's most dynamic products, the Commission should work with CEA and the consumer electronics industry to continue on the path of energy savings already begun by TV manufacturers. Augmented by forced menu and auto-shut-off mandates, the Commission and industry together can achieve energy savings exceeding the proposed limits on power use alone. Cooperation has a far better chance of successfully reducing energy consumption, without any interference with consumer enjoyment, professional uses, the State's general fund, or the California economy. We look forward to working with the Commission and others in this endeavor.

Respectfully submitted,

Douglas Johnson
Senior Director, Technology Policy
djohnson@ce.org

Enclosures (2): "The September 2009 Regulations Proposed by the California Energy Commission: 1) fail to satisfy the consumer cost standard imposed by the California Public Resources Code; and 2) are likely to result in increased costs to California consumers" ("LECG Report")

"Assessment of the Energy Savings Potential of Policies and Measures to Reduce Television Energy Consumption, Final Report to the Consumer Electronics Association" ("Fraunhofer Report")

The September 2009 Regulations Proposed by the California Energy Commission: 1) fail to satisfy the consumer cost standard imposed by the California Public Resources Code; and 2) are likely to result in increased costs to California consumers

C. Paul Wazzan, Ph.D.*

Dawn Eash, M.S.

Abstract

The California Energy Commission ("CEC") seeks to impose on-mode standards for power consumption of televisions (*e.g.,* watts used) subject to Section 25402(c) of the California Public Resources Code ("CPRC"). The CPRC requires that standards must "not result in any added total costs to the consumer over the design life of the appliances concerned." In September 2009, the CEC proposed regulations that allegedly would result in consumers saving $8.1 billion in energy costs. We find that the CEC analysis suffers from grave computational and conceptual errors. We further find not only are consumers unlikely to save dollars from reduced energy costs; they are rather more likely to incur dollar costs and to suffer from reduced access to technologies and innovations.

November 2, 2009

*This paper was commissioned by the Consumer Electronics Association. The authors are with LECG in Los Angeles, CA. Corresponding author is Wazzan who can be reached at 310-556-0622 or pwazzan@lecg.com.

TABLE OF CONTENTS

I. INTRODUCTION 3

II. THE CEC'S ESTIMATED $8.1 BILLION IN PROPOSED SAVINGS IS PREDICATED ON A MATHEMATICAL ERROR WHICH IF CORRECTED, REDUCES THE ALLEGED SAVINGS TO $3.4 BILLION 3

III. THE CEC'S USE OF A 3% DISCOUNT RATE ARTIFICIALLY INCREASES THE PERCEIVED COST SAVINGS OF THE PROPOSED REGULATION AND CANNOT BE JUSTIFIED 4

IV. THE CEC IGNORES THAT COMPETITION – WITHOUT REGULATION - IS DRIVING THE PRODUCTION AND ADOPTION OF MORE EFFICIENT DTV MODELS 5

V. THE CEC INCORRECTLY ASSUMES ZERO COST OF COMPLIANCE WITH THE PROPOSED REGULATIONS 7

VI. A COST OF COMPLIANCE GREATER THAN $17 ELIMINATES ANY POTENTIAL SAVINGS 8

VII. A CLARIFICATION OF THE CEC'S CONFUSION REGARDING THEIR PERCEIVED CONTRADICTION OF OPPOSING EFFICIENCY REGULATIONS WHILE PROMOTING VOLUNTARY STANDARDS 9

VIII. CONCLUSION 10

I. INTRODUCTION

The September 2009 CEC Staff Report contains proposed amendments to the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through 1608) to be considered as part of the 2009 Appliance Efficiency Rulemaking, Phase I, Part C (Docket # 09-AAER-1C). The primary conclusion was that proposed regulations would result in overall energy cost savings to consumers in California of approximately $8.1 billion plus the savings gained by avoiding construction of an approximately $615 million natural gas plant. This conclusion is predicated on demonstrably false assumptions, arithmetic errors, and a misinterpretation of underlying data.

II. THE CEC'S ESTIMATED $8.1 BILLION IN PROPOSED SAVINGS IS PREDICATED ON A MATHEMATICAL ERROR WHICH IF CORRECTED, REDUCES THE ALLEGED SAVINGS TO $3.4 BILLION

The CEC analysis is based in large part on the analysis contained in the PG&E Revised CASE Study; see Exhibit 1.[1] The CEC misinterprets and misapplies the figures from that CASE study, resulting in an incorrect estimate of energy cost savings from the proposed regulations. The CASE study reports annual incremental energy savings, which cumulate to 6.5 TWh/yr *after* complete stock turnover in 2022.[2] In other words, annual savings are 6.5 TWh/yr only in the final year of the study – 2022. The CEC misinterprets this finding and concludes that annual cost savings for each year between 2011 and 2022 are 6.5 TWh/yr. The correct application of the CASE study (assuming one agrees that it is correct in

1 See PG&E Revised CASE study. July 3, 2008. Page 17. Table 8.
2 See PG&E Revised CASE study. July 3, 2008. Page 14. Table 3.

the first place) is to compute the cumulative year on year energy savings in a step-wise fashion. Failing to do so causes the CEC to grossly overstate the amount of energy savings from the proposed regulation. Simply correcting this error reduces the estimated $8.1 billion in savings to $3.5 billion; see Exhibit 2.

III. THE CEC'S USE OF A 3% DISCOUNT RATE ARTIFICIALLY INCREASES THE PERCEIVED COST SAVINGS OF THE PROPOSED REGULATION AND CANNOT BE JUSTIFIED

The discount rate used should reflect the consumer's cost of capital, effectively approximated in this case by the consumer's opportunity cost. The United States Department of Energy and other regulatory agencies recognize the importance of selecting the right measure: "The Department calculated the NPV as the difference between the present value of operating cost savings and the present value of increased total installed costs."

The estimation of the California average consumer cost of capital is beyond the scope of this analysis. In order to comply with the CPRC, and provide legislators with an accurate estimate of perceived savings, the CEC should conduct such a study (after all it is the burden of the CEC to satisfy the requirement that all proposed regulation be consumer neutral). In the absence of such an analysis, one can nevertheless posit a reasonable discount rate based on certain known facts.

First, consumer borrowing rates for the purposes of purchasing a television can be assumed to be between the long-term debt on depreciable assets (e.g., car loans) and short term debts (e.g., credit card debt). In California, the average interest rate paid on credit card debt by consumers is approximately 13.05%. On October 14, 2009, Bank of America showed automobile interest rates ranging between

4.5% and 9.75% (this is likely too low for consumer electronics products but no better comparator is readily available)[3].

Second, the equity premium (the amount above the risk free rate) is approximately 5%-6%. Given that 30-year constant maturity US treasuries currently yield approximately 4%, the opportunity cost of investing in the market can be taken as approximately 10%. Given these data points, there is little doubt that the appropriate discount rate to apply is at least 10%. This is likely conservative, but the CEC should determine a precise rate by computing the actual average consumer cost of capital for California.

The application of a more appropriate (and still conservative) 10% discount rate to the corrected projected savings reduces the expected savings to $2.4 billion; see Exhibit 3.

IV. THE CEC IGNORES THAT COMPETITION – WITHOUT REGULATION - IS DRIVING THE PRODUCTION AND ADOPTION OF MORE EFFICIENT DTV MODELS

The third major flaw in the CEC analysis is the lack of accounting for technological improvements that would occur as a result of competition even – or perhaps especially - in the absence of government regulation. The Revised CASE study is based on the power consumption of models on the market as of 2008 (going back to 2006), and assumes that no improvements in DTV energy

3 Best Buy's credit card program states: "Deferred Interest Info: Plan A: Variable Standard APR is 24.24% as of 10/01/09. Variable Default APR: 29.24% as of 10/01/09. Plan B: Variable Standard APR: 27.99% as of 10/01/09. Variable Default APR: 29.99% as of 10/01/09 Fixed payment, 11.9% fixed APR plan. Applies to all purchases $299 and up." http://www.bestbuy.com/site/null/null/pcmcat97200050032.c?id=pcmcat97200050032.

efficiency are made between that baseline and 2022.[4] PG&E itself recognizes this limitation and states repeatedly that their analysis "does not account for natural market adoption of higher efficiency models."[5] The CEC analysis similarly fails to account for this limitation.

It is a known fact that the energy efficiency of DTVs has improved remarkably over time, including from 2006 to 2008, and from 2008 to the present, and continues to improve. Improved efficiencies have been generated as a result of the competitive nature of the consumer electronics industry, not as a result of regulation. It is inconceivable that future efficiencies would not be obtained in the absence of government regulation.

Consequently, one must measure the cost savings of the proposed regulations against the expected energy efficiency of televisions in 2010, 2011, 2012… 2022, not simply against the efficiency of 2006-2008 DTVs (as the CEC has done).

The television industry itself believes that the average energy efficiency (across all DTVs, not just Energy Star compliant models) will continue to improve. For example, one manufacturer believes that energy efficiency of DTVs will improve by 17% annually between 2007 and 2010.[6] They further believe that they will obtain a 10% annual improvement between 2010 and 2022. Similarly, another manufacturer indicates that from December 2007 to October 2009 the energy efficiency of DTVs improved by 22% annually.[7]

---

4 See PG&E Revised CASE study. July 3, 2008. Page 16. Table 7.
5 See e.g., PG&E Revised CASE study. July 3, 2008, page 16, table 7, fn 5.
[6] Per discussions with the manufacturer.
[7] Per discussions with the manufacturer.

Conservatively assuming an annual efficiency gain of 17% between 2008 and 2010 and 1% annually thereafter would reduce the previously estimated $2.4 billion figure to $548 million; see Exhibit 4.

V. THE CEC INCORRECTLY ASSUMES ZERO COST OF COMPLIANCE WITH THE PROPOSED REGULATIONS

The fourth major flaw in the CEC analysis is the assertion that the cost of compliance – that is the cost to consumers of the proposed regulation, setting aside energy efficiencies – is zero. The CEC's support for this claim is simply that compliant models currently exist and that certain manufacturers and technology providers support the proposed regulation. Moreover, the CEC ignores economic principles and factual evidence indicating the contrary.

First, *ceteris paribus*, if manufacturers could satisfy demand (in terms of customer-demanded price/feature combinations) with models that are both more energy efficient and cheaper to the consumer they would already be doing so. The economic gains would be divided between the supplier and the consumer resulting in economic improvement for both parties.

Second, current model prices reflect a number of factors including, among other things, supply and demand conditions, manufacturing cost, marginal cost, marginal revenue, and product quality and feature mixes. The mere existence of models which satisfy the proposed regulations does not address any of these issues. Consider that the cost to the consumer can be divided into two components: 1) the increased cost from required components resulting in a higher marginal cost of production; and 2) increased prices resulting from reduced competition (or reduced supply). Were manufacturers able to produce these

higher efficiency models at no cost they would already have done so. Consequently, there is no question that the regulations will remove some models from the market – thereby reducing competition. Even if the eliminated models are replaced by other models, the feature/quality/price mix will have been changed. Consequently there is no question that there will be some reduction in supply competition and prices will effectively move higher. Put more simply, the existence of less expensive energy inefficient models constrains the price of the efficient models. Removal of the inefficient models will necessarily result in higher prices.

Finally, setting aside actual economic principles, the CEC staff ignores considerable evidence contradicting the zero cost assumption. This evidence includes estimates provided by Vizio, Best Buy and others.[8]

VI. A COST OF COMPLIANCE GREATER THAN $17 ELIMINATES ANY POTENTIAL SAVINGS

Ultimately, a cost of compliance of approximately $17 per television would eliminate the estimated $548 million in savings. Any costs above $17 would immediately cause the proposed regulations to be consumer net-negative; see Exhibit 5.

We recognize that the specific energy efficiency improvement percentages resulting from competition and the increased consumer cost figures may be

8 For example, At the October 13, 2009 CEC hearing, Vizio, Inc., a manufacturer of DTVs, stated that the proposed regulation would raise the price of their sets by "tens to hundreds of dollars." The January 2009 CEC submission from Best Buy indicates that Energy Star compliant DTVs sell for a significant premium ($167) above non-energy star DTVs.

disputed by the CEC. There can be little doubt, however, that some combination of these two factors needs to be addressed by the CEC.

In our opinion, a cost increase of $17 is highly likely to be exceeded should the regulations be put into effect. Consequently, the proposed regulations are likely to be consumer net-negative.

VII. A CLARIFICATION OF THE CEC'S CONFUSION REGARDING THEIR PERCEIVED CONTRADICTION OF OPPOSING EFFICIENCY REGULATIONS WHILE PROMOTING VOLUNTARY STANDARDS

At the October 2009 CEC hearing the Commission expressed concern over a perceived inconsistency, or contradiction in the CEA's position: if market forces are driving innovation that reduces energy consumption, how can the CEA claim that regulations will stifle innovation?

Consider first that competition does not preclude new technologies (which may or may not be energy efficient) from reaching the market. For example, suppose a manufacturer developed an *energy inefficient* technology that resulted in DTVs being paper-thin, but that these DTVs cost pennies. Consumers would very likely want such a television, but the regulations in force would preclude the investment in necessary R&D being made in the first place or would preclude these models from the California market. This example is grounded in reality; it is our understanding that had the proposed regulations been in place at earlier dates, plasma DTVs would not have been invested in as a plausible concept by manufacturers. It is beyond the scope of this paper (and we would suggest this is

true of the CEC as well) to predict what innovations may or may not be precluded by the proposed regulations.

Second, it has been demonstrated that energy efficiency is a feature that some consumers want. Manufacturers are cognizant of this fact and consequently participate in voluntary standard setting processes such as Energy Star. Free market competition allows manufacturers the flexibility to manage energy efficiency improvements while balancing the economic demands of research and development.

Third it should be noted that regulatory-free competition has resulted, and should continue to result, in significant energy efficiency improvements over time. For example, under Energy Star Version 5.0, the maximum power consumption allowance for a 50" DTV would be slightly more than a single 100 watt light bulb.

VIII. CONCLUSION

The CEC fails to prove that the proposed regulations are consumer neutral. Rather, the evidence seems to indicate, to the contrary, that consumers will suffer from increased overall costs and potentially reduced access to future innovations and technologies.

Inasmuch as there are no cost savings from the proposed legislation (to say nothing of potential costs) the economic stimulus figures presented by the CEC should be discarded as being without merit.

Exhibit 1

Replication of PG&E Revised CASE Study[1]

		Unit Percentage		Units (M)		Energy Savings Tier 1		Energy Savings Tier 2		Assumed % of units to claim incremental Tier 1 savings		Assumed % of units to claim incremental Tier 2 savings		1st year incremental savings from Tier 1 (TWh/yr)			1st year incremental savings from Tier 2 (TWh/yr)			1st year incremental savings from Tier 1 and 2 (TWh/yr)		
Year	CA DTV Sales (M)	LCD	PDP	LCD	PDP	LCD	PDP	LCD	PDP	LCD	PDP	LCD	PDP	LCD	PDP	Total	LCD	PDP	Total	LCD	PDP	Total
	[A]	[B1]	[B2]	[C1] = [A]* [B1]	[C2] = [A]* [B2]	[D1]	[D2]	[E1]	[E2]	[F1]	[F2]	[G1]	[G2]	[H1] = [C1] * [D1] * [F1]	[H2] = [C2] * [D2] * [F2]	[H] = [H1] + [H2]	[I1] = [C1] * [E1] * [G1]	[I2] = [C2] * [E2] * [G2]	[I] = [I1] + [I2]	[J1]= [H1] + [I1]	[J2]= [H2] + [I2]	[J] = [J1] + [J2]
2011	4.36	88%	10%	3.8	0.4	97.2	251.3			66%	95%			0.24	0.10	0.34				0.24	0.10	0.34
2012	4.45	87%	10%	3.9	0.4	97.2	251.3			66%	95%			0.25	0.10	0.35				0.25	0.10	0.35
2013	4.55	87%	10%	4.0	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.26	0.12	0.38	0.16	0.09	0.25	0.42	0.21	0.63
2014	4.65	87%	10%	4.0	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.26	0.12	0.38	0.16	0.09	0.25	0.42	0.21	0.63
2015	4.75	87%	10%	4.1	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.26	0.12	0.38	0.17	0.09	0.26	0.43	0.21	0.64
2016	4.86	87%	10%	4.2	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.27	0.12	0.39	0.17	0.09	0.26	0.44	0.21	0.65
2017	4.96	87%	10%	4.3	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.28	0.12	0.40	0.18	0.09	0.26	0.45	0.21	0.66
2018	5.07	87%	10%	4.4	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.28	0.12	0.40	0.18	0.09	0.27	0.46	0.21	0.67
2019	5.18	87%	10%	4.5	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.29	0.12	0.41	0.18	0.09	0.27	0.47	0.21	0.68
2020	5.29	87%	10%	4.6	0.5	97.2	251.3	41.1	176.3	66%	95%	100%	100%	0.30	0.12	0.41	0.19	0.09	0.28	0.48	0.21	0.69
2021	5.41	87%	10%	4.7	0.5			41.1	176.3			100%	100%				0.19	0.09	0.28	0.19	0.09	0.28
2022	5.53	87%	10%	4.8	0.6			41.1	176.3			100%	100%				0.20	0.11	0.30	0.20	0.11	0.30
Total																						**6.52**

[1] Values reflect savings to TVs in PG&Es dataset (2008) and does not fully account for natural market adoption of higher efficiency models. Savings based on an estimated useful life of 10 years (see April 2008 CASE report).

Exhibit 2
Estimated Savings
[Error Corrected, 3% Discount Rate, Zero Efficiency Improvement, Zero Cost of Compliance][1]

Year	1st year Incremental Savings from Tier 1 and 2 (TWh/yr)[2]	Actual Cumulative Incremental Savings from Tier 1 and 2 (TWh/yr)	CEC Assumed Incremental Savings from Tier 1 and 2 (TWh/yr)	Annual Energy Prices ($/kWh)[3]	CEC Assumed Energy Savings ($M)	Corrected Energy Savings ($M)	Present Value (@3%) of Cumulative Incremental Savings from Tier 1 and 2 ($M)	Present Value (@3%) of Cumulative Incremental Savings from Tier 1 and 2 ($M)
a	**b**	**c(t) = b(t) + c(t-1)**	**d**	**e**	**f = d * e**	**g = c * e**	**h = f / (1 + r)^(a - 2011)**	**i = g / (1 + r)^(a - 2011)**
2011	0.34	0.34	6.52	$0.1453	$947	$49	$947	$49
2012	0.35	0.68	6.52	$0.1429	$932	$98	$904	$95
2013	0.63	1.31	6.52	$0.1419	$925	$186	$872	$176
2014	0.63	1.94	6.52	$0.1410	$919	$274	$841	$251
2015	0.64	2.58	6.52	$0.1407	$917	$363	$815	$323
2016	0.65	3.23	6.52	$0.1403	$914	$453	$789	$391
2017	0.66	3.89	6.52	$0.1409	$918	$548	$769	$459
2018	0.67	4.56	6.52	$0.1406	$917	$641	$745	$522
2019	0.68	5.24	6.52	$0.1408	$918	$738	$725	$583
2020	0.69	5.93	6.52	$0.1405	$916	$834	$702	$639
2021	0.28	6.22						
2022	0.30	6.52						
Total							**$8,109**	**$3,487**

[1] Values reflect savings to TVs in PG&Es dataset (2008) and does not fully account for natural market adoption of higher efficiency models. Savings based on an estimated useful life of 10 years (see April 2008 CASE report).

[2] See Exhibit 1: Column J.

[3] Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.

Exhibit 3
Estimated Savings
[Error Corrected, 10% Discount Rate, Zero Efficiency Improvement, Zero Cost of Compliance] [1]

Year	1st year Incremental Savings from Tier 1 and 2 (TWh)[2]	Actual Cumulative Incremental Savings from Tier 1 and 2 (TWh)	Annual Energy Prices ($/kWh)[3]	Corrected Energy Savings ($M)	Present Value (@10%) of Cumulative Incremental Savings from Tier 1 and 2 ($M)
a	**b**	**c(t) = b(t) + c(t-1)**	**d**	**e = c * d**	**f = e / (1 + r)^(a - 2011)**
2011	0.34	0.34	$0.1453	$49	$49
2012	0.35	0.68	$0.1429	$98	$89
2013	0.63	1.31	$0.1419	$186	$154
2014	0.63	1.94	$0.1410	$274	$206
2015	0.64	2.58	$0.1407	$363	$248
2016	0.65	3.23	$0.1403	$453	$281
2017	0.66	3.89	$0.1409	$548	$309
2018	0.67	4.56	$0.1406	$641	$329
2019	0.68	5.24	$0.1408	$738	$344
2020	0.69	5.93	$0.1405	$834	$354
2021	0.28	6.22			
2022	0.30	6.52			
Total					**$2,364**

[1] Values reflect savings to TVs in PG&Es dataset (2008) and does not fully account for natural market adoption of higher efficiency models. Savings based on an estimated useful life of 10 years (see April 2008 CASE report).
[2] See Exhibit 1: Column J.
[3] Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.

Exhibit 4
Estimated Savings
[Error Corrected, 10% Discount Rate, Efficiency Improvement, Zero Cost of Compliance][1]

Year	1st year LCD Incremental Savings from Tier 1 and 2 (TWh/yr)[2]	1st year PDP Incremental Savings from Tier 1 and 2 (TWh/yr)	1st year Incremental Savings from Tier 1 and 2 (TWh/yr)	Actual Cumulative Incremental Savings from Tier 1 and 2 (TWh/yr)	Annual Energy Prices ($/kWh)[3]	Energy Savings ($M)	Present Value (@10%) of Cumulative Incremental Savings from Tier 1 and 2 ($M)
a	**b**	**c**	**d = b + c**	**e(t) = d(t) + e(t-1)**	**f**	**g = e * f**	**h = g / (1 + r)^(a - 2011)**
2011	0.00	0.01	0.01	0.01	$0.1453	$1	$1
2012	0.00	0.01	0.01	0.02	$0.1429	$3	$2
2013	0.12	0.10	0.22	0.24	$0.1419	$34	$28
2014	0.11	0.10	0.21	0.44	$0.1410	$63	$47
2015	0.10	0.09	0.20	0.64	$0.1407	$90	$61
2016	0.09	0.09	0.18	0.82	$0.1403	$116	$72
2017	0.09	0.09	0.17	1.00	$0.1409	$140	$79
2018	0.08	0.08	0.16	1.16	$0.1406	$163	$84
2019	0.07	0.08	0.15	1.31	$0.1408	$185	$86
2020	0.06	0.08	0.14	1.46	$0.1405	$205	$87
2021	0.05	0.08	0.13	1.59			
2022	0.05	0.09	0.14	1.72			
Total							**$548**

[1] Values reflect savings to TVs in PG&Es dataset (2008). Savings based on an estimated useful life of 10 years (see April 2008 CASE report).
[2] See Exhibit 7: Column L.
[3] See Exhibit 8: Column L.
[4] Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.

Exhibit 5
Estimated Savings
[Error Corrected, 10% Discount Rate, Efficiency Improvement, Cost of Compliance set to $17.14][1]

Year	1st year LCD Incremental Savings from Tier 1 and 2 (TWh/yr)[2]	1st year PDP Incremental Savings from Tier 1 and 2 (TWh/yr)[3]	1st year incremental savings from Tier 1 and 2 (TWh/yr)	Actual Cumulative incremental savings from Tier 1 and 2 (TWh/yr)	Annual Energy Prices ($/kWh)[4]	Energy Savings ($M)	Units Sold (M)[5]	Cost of Compliance ($M)	Net Savings ($M)	Present Value (@10%) of cumulative incremental savings from Tier 1 and 2 ($M)
a	**b**	**c**	**d = b + c**	**e(t) = d(t) + e(t-1)**	**f**	**g = e * f**	**h**	**i = h * $17.14**	**j = g - i**	**k = j / (1 + r)^(a - 2011)**
2011	0.00	0.01	0.01	0.01	$0.1453	$1	4.36	$75	-$73	-$73
2012	0.00	0.01	0.01	0.02	$0.1429	$3	4.45	$76	-$74	-$67
2013	0.12	0.10	0.22	0.24	$0.1419	$34	4.55	$78	-$44	-$37
2014	0.11	0.10	0.21	0.44	$0.1410	$63	4.65	$80	-$17	-$13
2015	0.10	0.09	0.20	0.64	$0.1407	$90	4.75	$81	$9	$6
2016	0.09	0.09	0.18	0.82	$0.1403	$116	4.86	$83	$32	$20
2017	0.09	0.09	0.17	1.00	$0.1409	$140	4.96	$85	$55	$31
2018	0.08	0.08	0.16	1.16	$0.1406	$163	5.07	$87	$76	$39
2019	0.07	0.08	0.15	1.31	$0.1408	$185	5.18	$89	$96	$45
2020	0.06	0.08	0.14	1.46	$0.1405	$205	5.29	$91	$114	$48
2021	0.05	0.08	0.13	1.59			5.41			
2022	0.05	0.09	0.14	1.72			5.53			
Total										**$0**

[1] Values reflect savings to TVs in PG&Es dataset (2008). Savings based on an estimated useful life of 10 years (see April 2008 CASE report).
[2] See Exhibit 7: Column L.
[3] See Exhibit 8: Column L.
[4] Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.
[5] See Exhibit 1: Column A.

NOTE:
$17.14 is the cost of compliance at which the net present value of the estimated savings is zero. This value is solved via an iterative process.

Exhibit 6
Annual Energy Prices Estimation

Year	Annual Energy Prices EIA ($/kWh)	Growth Rate	Estimated CEC Annual Energy Prices ($/kWh)	Present Value (@3%) Estimated CEC Annual Energy Prices ($/kWh)
a	b	c(t) = b(t) - b(t-1)/b(t-1)	d(t) = d(t-1) * (1 + c(t))	e = d / (1 + r)^(a - 2011)
2011	$0.1478		$0.1453	$0.1453
2012	$0.1454	-1.62%	$0.1429	$0.1388
2013	$0.1443	-0.74%	$0.1419	$0.1337
2014	$0.1435	-0.59%	$0.1410	$0.1291
2015	$0.1431	-0.23%	$0.1407	$0.1250
2016	$0.1427	-0.30%	$0.1403	$0.1210
2017	$0.1433	0.40%	$0.1409	$0.1180
2018	$0.1430	-0.16%	$0.1406	$0.1143
2019	$0.1432	0.14%	$0.1408	$0.1112
2020	$0.1430	-0.19%	$0.1405	$0.1077
2021	$0.1421	-0.62%	$0.1397	
2022	$0.1409	-0.81%	$0.1385	
Total				$1.2440

The CEC staff report cites the Staff Forecast: Average Retail Electricity Prices 2005-2018 as its source for computing the present value of one kwh over a 10 year design life. Since the estimation period extends until 2022, it is unclear which forecasted prices were used after 2018. The growth rates from Energy Information Administration 2009 Annual Energy Outlook (Early Release) and the net present value of $1.244 were used to solve backwards for the annual energy prices that CEC must have used. See EIA, 2009 AEO (Early Release) End-Use Residential sector of California for 2009-2018. See Table 84. Electric Power Projections for EMM Region, Western Electric.

Exhibit 7
Energy Efficiency Improvements
[LCD]

Year	Base Case Unit Energy Consumption (kWh/yr)[1]	Efficiency Improvement Estimate[2]	Corrected Base Case Unit Energy Consumption (kWh/yr)	Tier 1 Unit Energy Consumption (kWh/yr)[1]	Tier 2 Unit Energy Consumption (kWh/yr)[1]	Tier 1 Unit Energy Savings (kWh/yr)	Tier 2 Unit Energy Savings (kWh/yr)	Units Sold[3]	Tier 1 Estimated Savings (TWh/yr)[4]	Tier 2 Estimated Savings (TWh/yr)[5]	1st year Incremental Savings from Tier 1 and 2 (TWh/yr)
a	b	c	d(t) = c(t) * (1 - d(t-1))	e	f	g = max(0 , d-e)	h = max(0 , d-f)	i	j = g * i * 66%	k = h * i * 100%	l = j + k
2008	335.2		335.2								
2009	335.2	17%	279.3								
2010	335.2	17%	232.8								
2011	335.2	1%	230.5	238.0		0.0		3.8	0.00		0.00
2012	335.2	1%	228.1	238.0		0.0		3.9	0.00		0.00
2013	335.2	1%	225.9	238.0	196.9	0.0	29.0	4.0	0.00	0.12	0.12
2014	335.2	1%	223.6	238.0	196.9	0.0	26.7	4.0	0.00	0.11	0.11
2015	335.2	1%	221.4	238.0	196.9	0.0	24.5	4.1	0.00	0.10	0.10
2016	335.2	1%	219.2	238.0	196.9	0.0	22.3	4.2	0.00	0.09	0.09
2017	335.2	1%	217.0	238.0	196.9	0.0	20.1	4.3	0.00	0.09	0.09
2018	335.2	1%	214.8	238.0	196.9	0.0	17.9	4.4	0.00	0.08	0.08
2019	335.2	1%	212.6	238.0	196.9	0.0	15.7	4.5	0.00	0.07	0.07
2020	335.2	1%	210.5	238.0	196.9	0.0	13.6	4.6	0.00	0.06	0.06
2021	335.2	1%	208.4		196.9		11.5	4.7		0.05	0.05
2022	335.2	1%	206.3		196.9		9.4	4.8		0.05	0.05

[1] LCD Unit Energy Consumption (kWh/yr). See PG&E Revised CASE Study, Table 6.

[2] One manufacturer believes that energy efficiency of DTVs will improve by 17% annually between 2007 and 2010. They further believe that they will obtain a 10% annual improvement between 2010 and 2022. Similarly, another manufacturer indicates that from December 2007 to October 2009 the energy efficiency of Energy Star DTVs improved by 22% annually. We have conservatively assumed an annual efficiency gain of 17% between 2008 and 2010 and 1% annually thereafter.

[3] See Exhibit 1: Column C1.

[4] "LCD percentages is based on the percentage of LCDs in the PG&E dataset that did not qualify for Tier 1 level." See PG&E Revised CASE Study, Table 7. Footnote 5.

[5] "Assume 100% for Tier 2 incremental savings." See PG&E Revised CASE Study, Table 7. Footnote 6.

Exhibit 8
Energy Efficiency Improvements
[PDP]

Year	Base Case Unit Energy Consumption (kWh/yr)[1]	Efficiency Improvement Estimate[2]	Corrected Base Case Unit Energy Consumption (kWh/yr)	Tier 1 Unit Energy Consumption (kWh/yr)[1]	Tier 2 Unit Energy Consumption (kWh/yr)[1]	Tier 1 Unit Energy Savings (kWh/yr)	Tier 2 Unit Energy Savings (kWh/yr)	Units Sold[3]	Tier 1 Estimated Savings (TWh/yr)[4]	Tier 2 Estimated Savings (TWh/yr)[5]	1st year Incremental Savings from Tier 1 and 2 (TWh/yr)
a	b	c	d(t) = c(t) * (1 - d(t-1))	e	f	g = max(0 , d-e)	h = max(0 , d-f)	i	j = g * i * 95%	k = h * i * 100%	l = j + k
2008	719.7		719.7								
2009	719.7	17%	599.8								
2010	719.7	17%	499.8								
2011	719.7	1%	494.8	468.4		26.4		0.4	0.01		0.01
2012	719.7	1%	489.8	468.4		21.4		0.4	0.01		0.01
2013	719.7	1%	484.9	468.4	292.1	16.5	192.8	0.5	0.01	0.10	0.10
2014	719.7	1%	480.1	468.4	292.1	11.7	188.0	0.5	0.01	0.09	0.10
2015	719.7	1%	475.3	468.4	292.1	6.9	183.2	0.5	0.00	0.09	0.09
2016	719.7	1%	470.5	468.4	292.1	2.1	178.4	0.5	0.00	0.09	0.09
2017	719.7	1%	465.8	468.4	292.1	0.0	173.7	0.5	0.00	0.09	0.09
2018	719.7	1%	461.2	468.4	292.1	0.0	169.1	0.5	0.00	0.08	0.08
2019	719.7	1%	456.6	468.4	292.1	0.0	164.5	0.5	0.00	0.08	0.08
2020	719.7	1%	452.0	468.4	292.1	0.0	159.9	0.5	0.00	0.08	0.08
2021	719.7	1%	447.5		292.1		155.4	0.5		0.08	0.08
2022	719.7	1%	443.0		292.1		150.9	0.6		0.09	0.09

[1] PDP Unit Energy Consumption (kWh/yr). See PG&E Revised CASE Study, Table 6.

[2] One manufacturer believes that energy efficiency of DTVs will improve by 17% annually between 2007 and 2010. They further believe that they will obtain a 10% annual improvement between 2010 and 2022. Similarly, another manufacturer indicates that from December 2007 to October 2009 the energy efficiency of Energy Star DTVs improved by 22% annually. We have conservatively assumed an annual efficiency gain of 17% between 2008 and 2010 and 1% annually thereafter.

[3] See Exhibit 1: Column C2.

[4] "PDP percent is an estimate." See PG&E Revised CASE Study, Table 7. Footnote 5.

[5] "Assume 100% for Tier 2 incremental savings." See PG&E Revised CASE Study, Table 7. Footnote 6.

Fraunhofer USA

Fraunhofer Center for Sustainable Energy Systems

ASSESSMENT OF THE ENERGY SAVINGS POTENTIAL OF POLICIES AND MEASURES TO REDUCE TELEVISION ENERGY CONSUMPTION

FINAL REPORT TO THE CONSUMER ELECTRONICS ASSOCIATION

28 OCTOBER 2009

Prepared by:

Kurt W. Roth
Bryan Urban

Disclaimer

This report was commissioned by the Consumer Electronics Association on terms specifically limiting Fraunhofer USA's liability. Our conclusions are the results of the exercise of our best professional judgment, based in part upon materials and information provided to us by the Consumer Electronics Association and others. Use of this report by any third party for whatever purposes should not, and does not, absolve such third party from using due diligence in verifying the report's contents.

Any use which a third party makes of this document, or any reliance on it, or decisions to be made based on it, are the responsibility of such third party. Fraunhofer USA accepts no duty of care or liability of any kind whatsoever to any such third party, and no responsibility for damages, if any, suffered by any third party as a result of decisions made, or not made, or actions taken, or not taken, based on this document.

This report may be reproduced only in its entirety, and may be distributed to third parties only with the prior written consent of Fraunhofer USA.

Contents

Disclaimer 2

List of Figures 4

List of Tables 5

List of Acronyms and Abbreviations 6

Acknowledgements 7

1 Executive Summary 8

2 Introduction 10

3 Analysis Methodology 11

3.1 Key Assumptions for UEC Calculations 12
3.2 Installed Base Formulation 14
4 Measure-Specific Analyses and Findings 16

4.1 Energy Star Version 3.0 and Version 4.0 16
4.2 Auto Power-Down TV Functionality 19
4.3 Forced Menu Functionality 23
4.4 Advertising Campaign to Convince TV Owners to Operate TVs in Less Bright Preset Viewing Modes 25
4.5 DTV Acceleration Program 29
5 Conclusions 33

References 36

List of Figures

Figure 1: Projected Viewable Screen Areas of Prototypical LCD and PDP TVs 13
Figure 2: California TV Installed Base Projects, by Display Technology 15
Figure 3: Summary of TV Power Draw Levels 17
Figure 4: Projections for Portion of Annual Sales Meeting Energy Star® v3.0 and 4.0 Specifications 18
Figure 5: Annual Energy Savings from Units Sold Meeting Energy Star® v3.0 and 4.0 Specifications 19
Figure 6: Cumulative Distribution Curve for the Potential Reduction in Active Hours Per Day 21
Figure 7: Average Potential Reduction in Daily Active Hours from Auto Power-Down Functionality (for the 3 Most-Used TVs in Household).....21
Figure 8: Achievable Annual Energy Savings from Auto Power-Down Functionality for California TVs Sold in a Given Year.....22
Figure 9: Maximum Annual Energy Savings from Auto Power-Down Functionality for California TVs Sold in a Given Year.....23
Figure 10: Distribution of Responses to the Question "Would you use your remote to decrease screen brightness and save electricity if you could?" 27
Figure 11: Estimated Number of TVs Sold in California from 1999 to 2002, by Display Technology 30
Figure 12: Survey Respondent's Average Incentive Desired to Replace Older TV with Energy Efficient New TV 32

List of Tables

Table 1: Summary of Annual Electricity Consumption (AEC) Savings Potential Estimates for Measures Evaluated, for TVs in the State of California 8
Table 2: Summary of TV Active-Mode Power Draw Calculations 12
Table 3: Active-Mode Power Draw and UEC Values for Prototypical TVs, Baseline and Energy Star® Cases 14
Table 4: Summary of Annual Electricity Consumption Savings Potential Estimates for Measures Evaluated 16
Table 5: Estimated Distribution of Default Viewing Mode for TVs Shipped in 2009 24
Table 6: Energy Savings Potential of Forced Menu Functionality, Applied to ALL LCD and PDP TVs Sold in California in 2009 25
Table 7: CNET HDTV Test Summary: Potential Reductions in TV Active Mode Power Draw from Lower Power Modes 26
Table 8: Average Reduction in TV Active-Mode Power Draw from Entering a Preset Viewing Mode that Draws Less Power 26
Table 9: Maximum Annual Electricity Consumption Reduction Potential from Entering Lower Power Modes for the Installed Base of TVs in 2008 28
Table 10: Energy Savings Potential, Replacing 1999 to 2002 Vintage TVs with TVs Consuming 30% Less Energy Than Energy Star® v3.0 31
Table 11: Summary of Annual Electricity Consumption Savings Potential Estimates for Measures Evaluated, for TVs in the State of California 33

List of Acronyms and Abbreviations

AEC	Annual Electricity Consumption
CEA	Consumer Electronics Association
CEC	California Energy Commission
CRT	Cathode Ray Tube
EPA	Environmental Protection Agency
FMF	Forced Mode Functionality
LCD	Liquid Crystal Display
PDP	Plasma Display Panel
TV	Television
UEC	Unit Electricity Consumption

Acknowledgements

We would like to acknowledge the contributions of several people to this report. Doug Johnson, Senior Director of Technology Policy at the Consumer Electronics Association (CEA), commissioned this study. Jessica Booth, Manager of Strategic Research at CEA, helped devise and oversaw the consumer survey commissioned by CEA to support the analyses. Moreover, we would like to thank the reviewers of the draft Final Report for their helpful comments and suggestions that enhanced the quality of the Final Report.

B. Belt	Consumer Electronics Association
D. Johnson	Consumer Electronics Association
B. Nordman	Lawrence Berkeley National Laboratory
M. Sanchez	Lawrence Berkeley National Laboratory
H.-P. Siderius	SenterNovem

1 Executive Summary

We conducted a study to evaluate the energy savings potential of six policies and measures that could reduce television (TV) energy consumption. To predict the energy saving potential for each measure, we developed models for how each measure modified the average power draw in active mode and/or the annual time spent in active mode relative to the baseline case. The models are based on prior research into TV energy consumption and information provided by the Consumer Electronics Association (CEA) and its member companies. In addition, we developed information based on responses from a telephone survey of 1,000 representative US households that was conducted to address knowledge gaps about how TV owners might respond to different measures.

Table 1 summarizes the estimated annual electricity consumption (AEC) savings potential for the measures applied to TVs in the State of California. To provide context, the installed base of TVs in California consumed approximately 8,800 GWh in 2008. The AEC savings from combining several different measures are not, however, necessarily additive. For example, the combined energy savings for the two Energy Star® specifications and auto power-down and forced-menu functionality would equal approximately 400 to 440 GWh in 2011.

Table 1: Summary of Annual Electricity Consumption (AEC) Savings Potential Estimates for Measures Evaluated, for TVs in the State of California

Measure	AEC Savings Potential [GWh]	Comments
Energy Star® v3.0	140	For TVs sold in 2011
Energy Star® v4.0	140	For TVs sold in 2011
Auto Power-Down	90 – 145	For TVs sold in 2011
Forced Menu Functionality	47	For TVs sold in 2009; assumes default is "home"/"standard" preset viewing mode
Advertising Campaign – Change Preset Viewing Modes	555	Maximum savings potential; actual savings likely much lower and would depend on advertising campaign; 2008 installed base
DTV Acceleration Program	10	For 2009; assumes one-year program duration and $50 incentive level

The Energy Star® v3.0 and v4.0 specifications reduce TV energy consumption by limiting maximum active-mode power draw as a function of TV screen area. We estimated the incremental energy savings potential that sales of Energy Star® TVs would realize relative to the baseline projections for the energy consumption characteristics of future TVs sold in California used by the CEC to develop proposed active-mode power draw regulations. The Energy Star® savings are projected to increase over time as the market share of TVs meeting the specifications increases.

The "Auto Power-Down" measure reduces energy consumption by automatically switching off TVs that are left on after a period of time without user input, assumed to be three hours. Based on phone survey data for TV usage, we estimate that this feature could

reduce the average daily TV on-time by about 0.5 hour. Furthermore, 62% of respondents indicated they would enable such a feature, yielding an average of about 0.3h of attainable savings per day per TV. The energy savings potential range shown in Table 1 assumes that all TV sold in 2011 have auto power-down functionality, with enabling rates of 60 to 100 percent. If auto power-down functionality is not enabled as a default option, we expect the savings to be much less.

The "Forced Menu" measure aims to reduce energy by prompting users to select a "home" viewing mode (instead of a "bright" mode) when the television is first powered on. The total savings depends on the energy saved by switching to a less bright preset viewing mode and the fraction of TV owners that would switch to such a mode. We estimate a 20% average energy savings associated with switching from "bright" to a "home" mode for all TVs shipped in 2009. If the "standard/home" is the default forced menu option, we estimate that 80% of users will select and maintain that option. Calculated savings assume that all TVs sold in 2009 have this forced menu capability.

The "Advertising Campaign" measure seeks to convince viewers to switch their televisions from a "bright" preset viewing mode to a "standard" or "home" viewing mode. Prior to November, 2008, nearly all TVs were shipped in "bright" mode, and we estimate that 90% of installed TVs remain in this mode. Switching from "bright" to a "standard" mode reduces active-mode power draw by approximately 10, 17, and 15 percent for the installed base of CRT, LCD, and PDP technologies, respectively. Whereas other measures apply only to new TVs, this measure applies to all TVs that have multiple preset viewing modes, making the maximum savings potential very high.[1] In practice, we expect that many – if not most – owners would not be willing or able to go through the hassle of changing the viewing mode, nor would many be willing to potentially compromise their viewing experience (since consumers rank picture quality far higher in importance than energy efficiency). In sum, we believe that there is a great chance that such a campaign would not achieve significant participation, nor energy savings.

The "DTV Acceleration Program" measure would reduce TV energy consumption by accelerating the retirement of old, inefficient televisions through a monetary incentive. This incentive would apply to anyone trading in an older (2002 or earlier) TV for a similarly sized new TV that uses at least 30% less energy than Energy Star® v3.0. As many of these older TVs will be likely be retired relatively soon anyway, we assessed the incremental benefit of accelerating that retirement. Key drivers for the impact of such a program include the magnitude of the incentive and the sensitivity of consumers to price. Survey data suggest that about 70 percent of the population would expect to collect at least $50 for trading in their old TV. Our assessment assumes a $50 credit, an average television price of $450, and elasticity of demand of 1.2. Overall, we estimate that a one-year program would increase TV sales in the relevant size range by about 13 percent.

[1] The energy savings from this measure will decrease over time as pre-November, 2008 TVs are replaced by TVs shipped in default preset viewing modes that draw less power, eliminating the energy savings potential from this measure for those TVs.

2 Introduction

Televisions (TVs) account for approximately 5 percent of U.S. residential sector electricity consumption (Roth and McKinney 2007). As a result, TV electricity consumption has received significant attention, particularly over the last several years. Most notably, the Energy Star® specification for TVs added a maximum active-mode power draw in November, 2008 (EPA 2008) and more stringent specification will take effect in 2010 and 2012 (EPA 2009). Moreover, the California Energy Commission (CEC) has proposed a two-tiered regulation for TV active-mode power draw.

In this context, the Consumer Electronics Association (CEA) asked the Fraunhofer Center for Sustainable Energy Systems (CSE) to evaluate the energy savings potential of several proposed measures that could reduce TV active-mode power draw. The measures analyzed are:

1. Energy Star Version 3.0 – Energy saved by the incremental installed base of TVs that meet the active-mode power draw specification.
2. Energy Star Version 4.0 – Energy saved by the incremental installed base of TVs that meet the active-mode power draw specification.
3. Auto Power-Down TV Functionality – Energy savings from adding a feature to new TVs that would automatically turn off those TVs after an extended period of time without user input.
4. Forced Menu Functionality – Shipping a new TV so that a menu for selecting a preset viewing mode appears when the TV is initially set up.
5. Advertising Campaign to Convince TV Owners to Operate TVs in Less Bright Preset Viewing Modes– Until very recently, almost all TVs were shipped with a very bright preset viewing mode as the default. This measure would attempt to convince owners to change their TVs to a less bright preset viewing mode that draws less power while still maintaining an acceptable viewing experience.
6. Digital TV (DTV) Acceleration Program – Offering incentives to consumers to replace older analog TVs with newer, similarly sized DTVs that draw appreciably less power.

Our analysis focuses on the energy savings potential for these measures as applied to TVs in the State of California.

It is important to note that this is not a comprehensive list of potential measures, i.e., other measures, such as ambient brightness control, could also achieve appreciable energy savings. Moreover, future TVs may have features, such as network connectivity, with the potential both to increase energy consumption and enable additional energy-saving opportunities.

3 Analysis Methodology

This study focuses on evaluating the energy savings potentials of the six measures described in the prior section. Consequently, we mostly take the energy consumption baseline from the main analyses used by the CEC to develop proposed standards (Chase 2008a,b; CEC 2008) as a given and base our analyses on the baseline energy consumption estimates and assumptions used in those studies. This includes applying the concept of using prototypical TV sizes to represent the entire installed base and future sales of different display technologies. Although such simplifying assumptions introduce inaccuracies in the energy savings evaluations, we believe that they are acceptable given the other uncertainties in characterizing the performance of future TVs and the energy savings potential of different measures.

Our analyses reflect several common assumptions, including:

1. *Analysis Timeframe* – From 2011 through 2022, consistent with Chase (2008b) and CEC (2008).
2. *Relevant Display Technologies* – Our analyses only consider liquid crystal displays (LCD) and plasma display panels (PDP) for sales in the future years, since these are the display technologies that currently have a meaningful installed base and are expected to have appreciable sales over the analysis period; this simplification is consistent with Chase (2008b) and CEC (2008). For our assessment of measures that impact the installed base, we also include CRTs. Although other technologies will likely become relevant over the timeframe of the projections, estimates for their energy performance and, in particular, their sales volumes remain highly uncertain.
3. *Future TV Sales in California* – We use the projections by display technology presented in Chase (2008b), albeit with the caveats noted under "relevant display technologies."
4. *Energy Star® Baseline Penetration* – We use the baseline (no regulation) case from Chase (2008b) for the entire 2011 through 2022 period, i.e., 34% of LCDs[2] and 5% of PDPs meet the proposed CEC Tier 1 (the same as Energy Star® v3.0 for TV screen sizes <40 inches, lower for larger TVs) and no LCD or PDP TVs sold meet the proposed CEC Tier 2, which is the same as Energy Star® v4.0.
5. *TV Annual Active Mode Usage* – We use the average value of 1,907 hours per year for all TVs from Chase (2008b), and assume that the TVs remain in off mode for the other 6,853 hours.
6. *Equivalent Carbon Dioxide Emissions Impact* – We use the value of 0.50 kg $CO_{2,e}$ per kWh of electricity agreed upon by the CEC and CPUC in 2007 (CPUC and CEC 2007).
7. *Standby Power Draw* – Our analysis focuses upon the energy savings potential of measures that primarily reduce TV active-mode energy consumption. Moreover, over 90 percent of TVs sold in 2009 meet the Energy Star® v3.0 requirement that the TVs draw less than 1W when off, the same level required by the proposed CEC regulation. Therefore, we decided to ignore standby power draw for TVs sold during the analysis period. On the other hand, since there are appreciable

[2] This estimate is a unit-weighted average, not a size-weighted average.

differences between the standby power draw of current and older TVs, we do consider the energy consumption in standby mode when analyzing the impact of measures that affect the installed base of TVs.

8. *Average TV Lifetime* – We use the estimate of 10 years of Chase (2008a), although we note that this likely exceeds actual TV lifetimes, e.g., *Appliance Magazine* estimates an average TV lifetime of around 6 years (Appliance Magazine 2006).

In addition, we explain several additional assumptions related to unit electricity consumption (UEC) and installed base estimates in the following subsection.

3.1 Key Assumptions for UEC Calculations

The unit energy consumption (UEC) of televisions equals the product of the average TV power draw in the two main modes that TV operate, on (also referred to as active) and off (also referred to as standby) and the time that the average TV spends in each mode. As noted above, we assume that the average TV operates for 1,907 and 6,853 hours per year in active and off modes, respectively. For this analysis, we use the equations for the power draw of the installed base and TVs that do not meet the regulations proposed by the CEC from Chase (2008b), as a function of viewable screen area, A_{screen} (see Table 2).

Table 2: Summary of TV Active-Mode Power Draw Calculations

Case	Power Draw [W], as Function of A_{screen}	Source
Installed Base	*CRT*: $P = 0.23 * A_{screen}$ *LCD*: $P = 0.27 * A_{screen}$ *PDP*: $P = 0.36 * A_{screen}$ *Projection*: $P = 0.14 * A_{screen}$	CEC (2008)*
Baseline – Non-Compliant	*LCD*: $P = 0.24 * A_{screen} + 30.81$ *PDP*: $P = 0.26 * A_{screen} + 99.66$	Chase (2008b)
Energy Star® v3.0	$A_{screen} < 680\ in^2$: $P_{max} = 0.20 * A_{screen} + 32$ $680 \leq A_{screen} < 1{,}045\ in^2$: $P_{max} = 0.24 * A_{screen} + 27$ $A_{screen} \geq 1{,}045\ in^2$: $P_{max} = 0.156 * A_{screen} + 151$	EPA (2008)
Energy Star® v4.0	$A_{screen} > 275\ in^2$: $P_{max} = 0.12 * A_{screen} + 25$	EPA (2009)
CEC Tier 1 – *Proposed*	$A_{screen} \leq 1{,}400\ in^2$: $P_{max} = 0.20 * A_{screen}(in^2) + 32$	CEC (2008)
CEC Tier 2 – *Proposed*	$A_{screen} \leq 1{,}400\ in^2$: $P_{max} = 0.12 * A_{screen}(in^2) + 25$	CEC (2008)

*Based on Table 3 of CEC (2008). Although we assumed that the W/in^2 values apply to other screen sizes than the average, that would be an atypical relationship between A_{scree} and active-mode power draw.

In addition, we use the values of Chase (2008b) for the average screen size of the current installed base of TVs and the projected prototypical size for future LCDs and PDPs, with small modifications. Chase (2008b) assumed different prototypical TV sizes for the LCDs analyzed in the Tier 1 and Tier 2 cases, i.e., 37.6" for the Tier 1 case and 39.1" in the Tier 2 case. This reflects projected increases in LCD screen size between 2011 and 2013, the years that the Tier 1 and 2 standards would take effect. Unfortunately, Chase (2008) used

the same TV size (i.e., 37.6") for the Tier 2 case as the Tier 1 case, even though the baseline TV size would, presumably, also increase during this period. Instead, for our analysis, we assume that the prototypical size of LCD TVs for *all* cases equals the average TV size projected by DisplaySearch, as shown in Chase (2008b). This yields the average screen size and screen area, A_{screen}, values over the analysis period shown in Figure 1.[3]

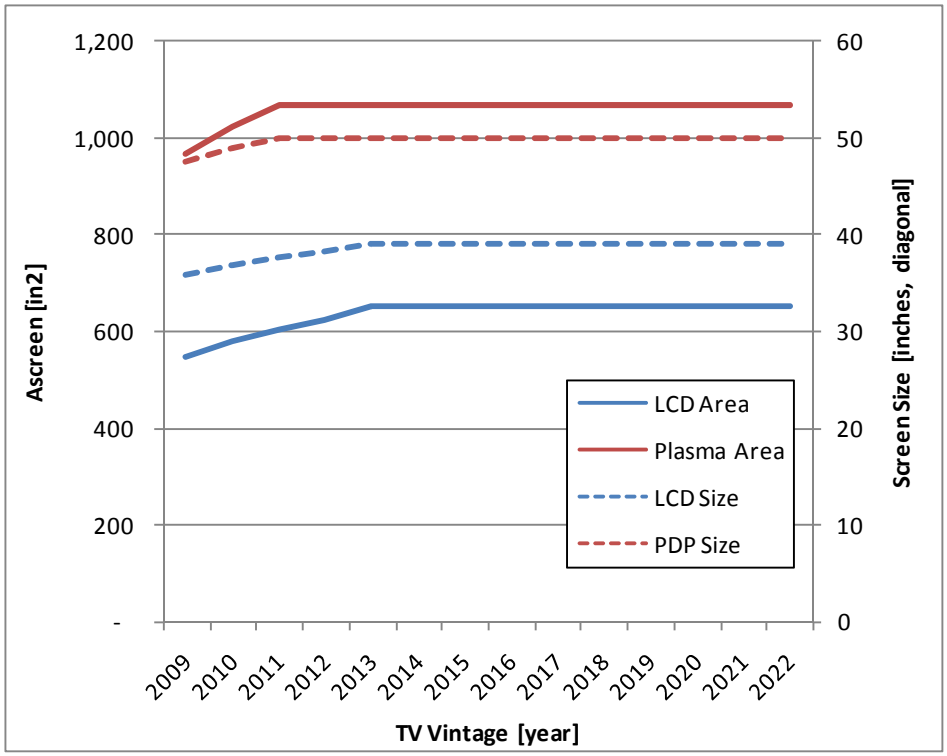


Figure 1: Projected Viewable Screen Areas of Prototypical LCD and PDP TVs

Applying the TV power draw equations from Table 3, we obtain the average power draw and UEC values for several different cases shown in Table 3. The "non-compliant" data are for units that meet neither the proposed CEC regulations nor the Energy Star® specifications

[3] In addition, Chase (2008b) set the LCD A_{screen} equal to the projected average A_{screen} for *all* TVs sold in a given year. Assuming that the estimate for the average PDP A_{screen} is correct and taking into account the unit sales shares for LCD and PDP while ignoring other display technologies, calculations for the average LCD A_{screen} suggest that A_{screen} estimates for LCD TVs are over-estimated by approximately 8 percent in 2009, decreasing to around 6 percent in 2013 and subsequent years.

Table 3: Active-Mode Power Draw and UEC Values for Prototypical TVs, Baseline and Energy Star® Cases

Power Draw [W]		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Non Compliant	*LCD*	162	170	176	181	188	188	188	188	188	188	188	188	188	188
	PDP	351	366	377	377	377	377	377	377	377	377	377	377	377	377
EnergyStar v3.0	*LCD*	142	148	153	157	163	163	163	163	163	163	163	163	163	163
	PDP	259	273	318	318	318	318	318	318	318	318	318	318	318	318
EnergyStar v4.0	*LCD*	91	94	97	100	103	103	103	103	103	103	103	103	103	103
	PDP	141	148	153	153	153	153	153	153	153	153	153	153	153	153

UEC [kWh]		2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Non Compliant	*LCD*	309	324	335	346	358	358	358	358	358	358	358	358	358	358
	PDP	670	697	720	720	720	720	720	720	720	720	720	720	720	720
EnergyStar v3.0	*LCD*	270	282	291	300	310	310	310	310	310	310	310	310	310	310
	PDP	495	520	606	606	606	606	606	606	606	606	606	606	606	606
EnergyStar v4.0	*LCD*	173	180	186	191	197	197	197	197	197	197	197	197	197	197
	PDP	269	282	292	292	292	292	292	292	292	292	292	292	292	292

3.2 Installed Base Formulation

For 2008, we used the installed base estimate for TVs in California from CEC (2008), including its breakdown of TVs by display technology. To model the evolution of the installed base in subsequent years, we used the Chase (2008b) projections for LCD and PDP TV sales through 2022, developing values for 2009 through 2011 based on a 4 percent increase in total California TV sales per year (from Display Search 2007 North American sales projections for TVs presented in Chase 2008b) and a 2 percent annual growth rate for subsequent years (same source).[4]

We used a very basic model for the retirement of TVs: all TVs are removed from the installed base exactly ten years (assumed average TV lifetime) after they entered the installed base. To estimate the number of TVs sold in California by display technology from 1999 through 2008, we used national TV shipments data from CEA (2009) for that period and assumed that the proportion of national TV sales to California sales for all years equaled the ratio of an estimate for California's total shipments in 2008 to the CEA national sales estimate in 2008. The California shipments estimate for 2008 was derived using the aforementioned projected 4 percent growth rate for 2009 through 2011 (shown in Chase 2008b) and applying those retrospectively relative to the Chase (2008b) estimate for California TV sales in 2011. We then apportioned the TVs sold over this period by display technology using the national sales data categorized by display type from CEA (2009). Figure 2 summarizes the composition of installed base by display technology from

[4] We assigned the estimated 1-2 percent of TVs sold each year that use other display technologies to LCD and PDP sales in proportion to the predicted unit sales volume breakdown used in Chase (2008b).

2008 through 2022. In the assessment of the energy savings potential of specific measures, we take into account the UEC values of the different vintages of TVs.

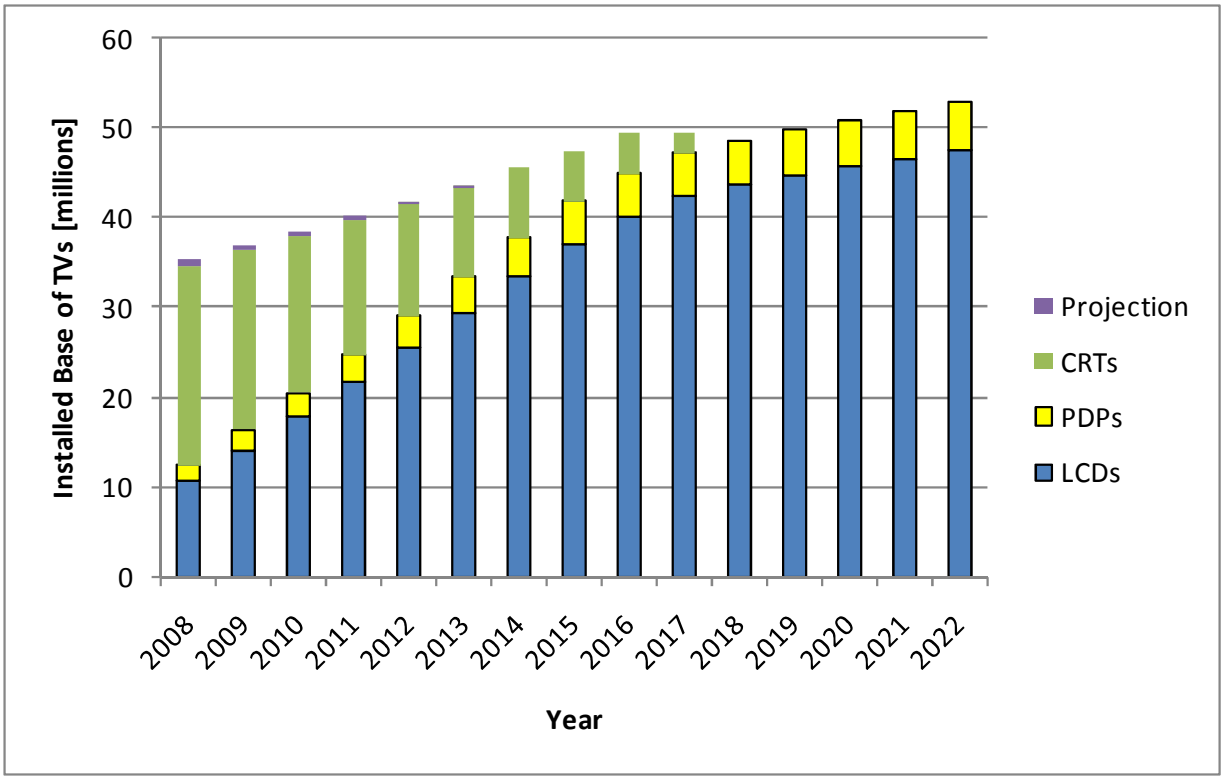


Figure 2: California TV Installed Base Projects, by Display Technology

We considered using a more sophisticated model, such as a linear or Weibull distribution, but decided against it because we didn't feel that that would significantly improve the accuracy of the energy savings potential assessments due to the many other uncertainties in the energy savings assessments.

4 Measure-Specific Analyses and Findings

Table 4 summarizes our estimates for the energy savings potentials of the different measures. Subsequent subsections discuss the findings in greater detail.

Table 4: Summary of Annual Electricity Consumption Savings Potential Estimates for Measures Evaluated

Measure	AEC Savings Potential [GWh]	Comments
Energy Star® v3.0	140	For TVs sold in 2011
Energy Star® v4.0	140	For TVs sold in 2011
Auto Power-Down	90 – 145	For TVs sold in 2011
Forced Menu Functionality	47	For TVs sold in 2009; assumes default is "home"/"standard" preset viewing mode
Advertising Campaign – Change Preset Viewing Modes	555	Maximum savings potential; actual savings likely much lower and would depend on advertising campaign; 2008 installed base
DTV Acceleration Program	10	For 2009; assumes one-year program duration and $50 incentive level

The AEC savings from combining several different measures are not, however, necessarily additive. In general, the measures that impact the installed base are additive, whereas those that impact new products are not. For example, the combination of the two Energy Star® specifications with deployment of auto power-down and forced-menu functionality would yield AEC savings of approximately 400 to 440 GWh in 2011.

4.1 Energy Star Version 3.0 and Version 4.0

For these two cases, we estimated the *incremental* energy savings potential that the sale of TVs satisfying the Energy Star® specification would realize relative to the baseline case of no Energy Star® program for active mode (i.e., the baseline case of Chase 2008b). Specifically, the baseline case still assumes that a percentage of all new LCD (34%) and PDP (5%) units sold from 2011 to 2022 perform at the Tier 1 level proposed by the CEC, which has the same power draw levels required to meet Energy Star® v3.0 for TVs with screen sizes of less than 40 inches and lower levels for larger TVs. On the other hand, the baseline assumes that no LCD or PDP TVs sold during this period meet the Energy Star® v4.0 level (identical to the CEC's proposed Tier 2; Chase 2008b). Figure 3 compares the maximum active-mode power draw levels for the Energy Star® v3.0 and 4.0 specifications, the two Tiers proposed by the CEC, and the estimated average power draw for LCD and PDP units that do not comply with the CEC's proposed Tier 1.

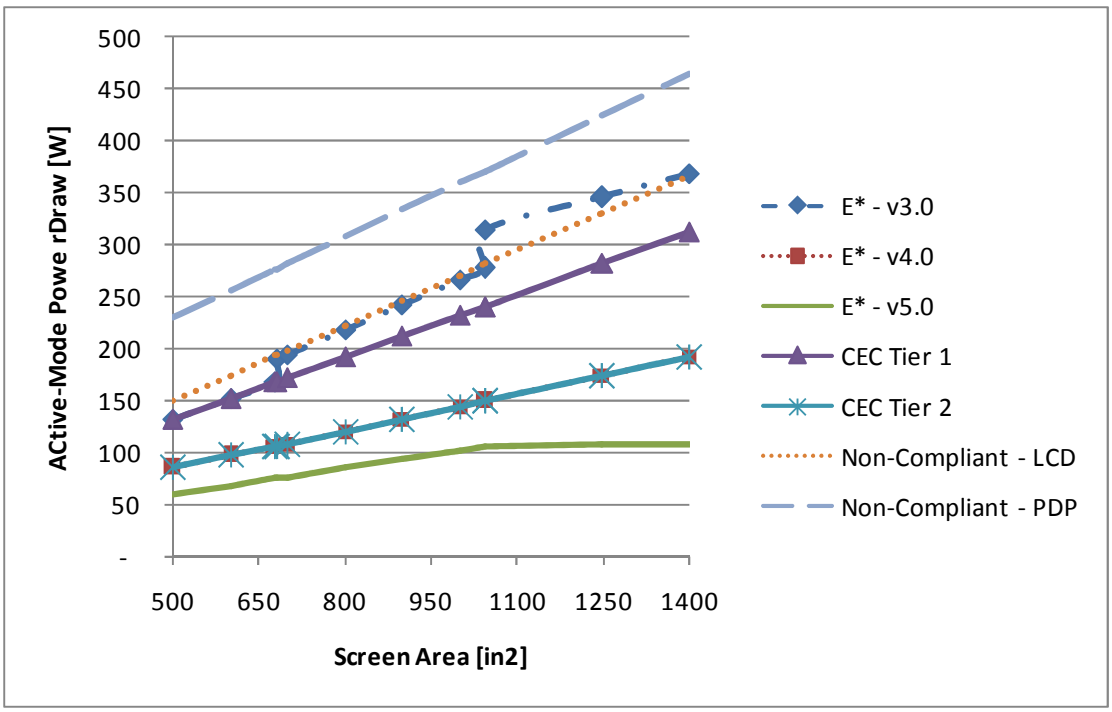


Figure 3: Summary of TV Power Draw Levels

Clearly, developing reasonable projections for the fraction of future TVs sold that meets the two Energy Star® specifications is crucial for developing credible assessments of the energy savings potential. We developed such projections using a combination of current sales data, along with projections for the future market share from the Energy Star® program (CCAP 2008). Specifically, TV sales data from a major retailer for the 2nd quarter of 2009 reveal that more than 92 percent of flat-panel TVs sold meet the Energy Star® v3.0 specification; unfortunately, that source did not provide additional data for the portion of LCDs and PDPs that met the Energy Star® specification (Best Buy 2009). In general, LCD TVs are more likely than PDPs to meet the Energy Star® specification, and we use this to inform our estimates for the portion of LCDs and PDPs that meet the specification. First, we assume that the projected split for 2009 TV sales between LCD and PDP sales by DisplaySearch, i.e., ~89% LCD and ~11% PDP (published in 2007, noted in Chase 2008b).[5] Then, if we assume that 95 percent of LCD TVs meet the Energy Star® specification, calculation finds that 73 percent of PDP units meet the specification. An upper bound calculation, i.e., 100% of LCDs meet Energy Star v3.0, finds that 31% of PDPs meet the specification. This does not seem plausible, and we use the 95 and 73 percent values in our analysis.

For both LCDs and PDPs, the current penetration levels exceed those projected by CCAP for most of the period of 2009-2022 (CCAP 2008). Consequently, we assumed that the portion of LCDs and PDPs meeting the Energy Star® v3.0 specification equaled 95 and 73 percent, respectively, for all years from 2009 through 2022. In contrast, we used the

[5] For the purposes of this analysis, we ignore OLED and MD RPTV sales, which were projected to total less than 1 percent of TV sales in 2009.

CCAP projections for the portion of LCDs and PDPs meeting the v4.0 specification.[6] Figure 4 summarizes the projections for the percentages of TVs sold each year that meet the two Energy Star® specifications.

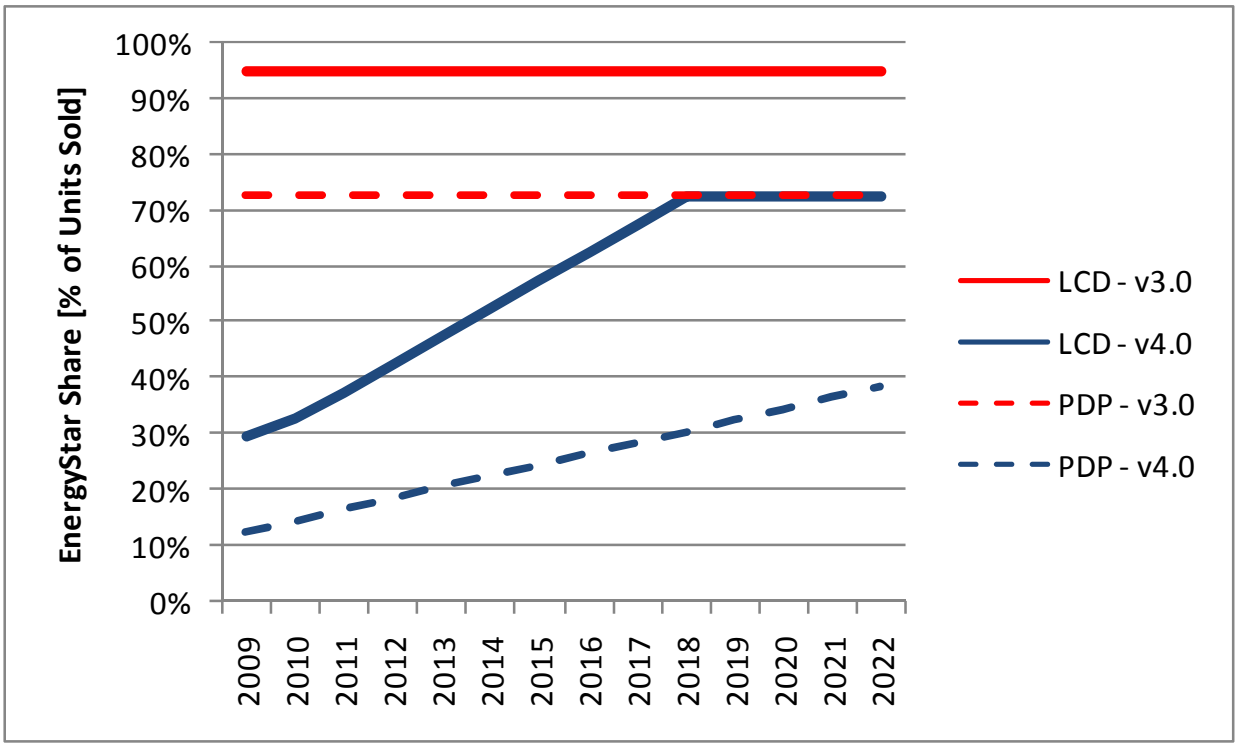


Figure 4: Projections for Portion of Annual Sales Meeting Energy Star® v3.0 and 4.0 Specifications

Based on these values, we develop projections for the annual electricity consumption (AEC) of all of the TVs sold throughout the analysis period (2011-2022) that are in the California installed base, for the Baseline, Energy Star® v3.0, and Energy Star® v4.0 cases. For the Energy Star® cases, we assume that all TVs that meet the specification *just* draw the maximum power allowed. In practice, some portion of those units would almost certainly draw less power than demanded by a given specification, resulting in additional energy savings beyond the calculated values.

Figure 5 presents the difference between the AEC values, i.e., the energy savings of the Energy Star® cases. Over the entire 2011-2022 period, v3.0 yields a total projected electricity savings of 11,100 GWh, while the v4.0 specification reduces electricity consumption by an additional 17,600 GWh relative to the baseline case. This translates into $CO_{2,e}$ reductions of 5.5 and 14.3 million metric tons (MMT), respectively.

[6] Our assessment (as do CEC 2008 and Chase 2008a,b) assumes that the Energy Star® market share does not vary as a function of A_{screen}. To the degree that this assumption does not hold, it would impact the AEC savings projections in multiple ways, since both power draw and usage vary as a function of screen size (Roth and McKinney 2007).

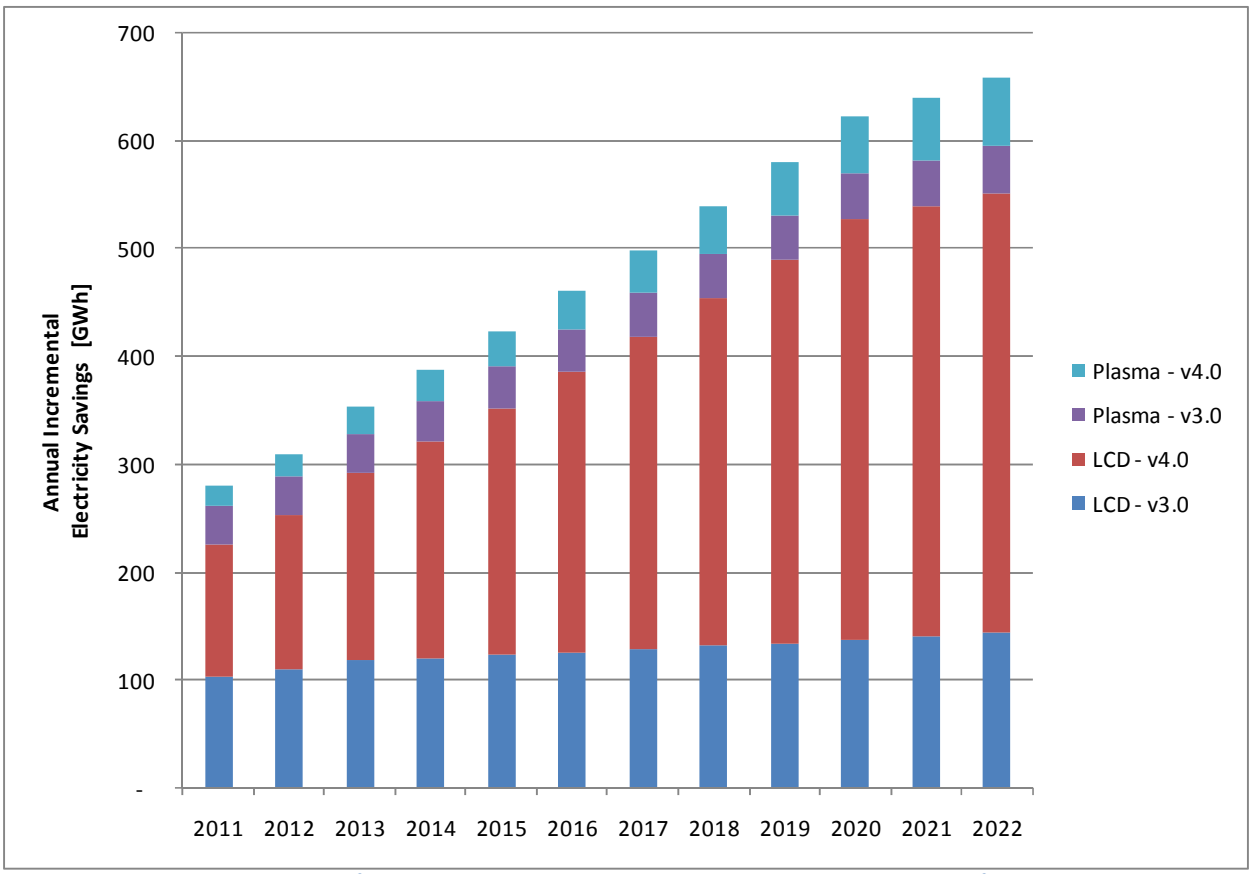


Figure 5: Annual Energy Savings from Units Sold Meeting Energy Star® v3.0 and 4.0 Specifications

TV technology continues to rapidly change and projections for the portion of current and future TVs shipments that would meet the Energy Star® specification has significant uncertainty, notably for LCDs and PDPs for v4.0 and PDPs for v3.0. The energy savings would change linearly with the (relative) percent increase or decrease in the proportion of units meeting the different specifications. In addition, v5.0 has been finalized and will take effect in May, 2012, with additional revisions almost certain to follow. Undoubtedly, some portion of TVs sold would meet these more stringent specifications, leading to additional energy savings beyond those projected for v4.0

4.2 Auto Power-Down TV Functionality

Auto Power-Down functionality would sense when a TV is on but has been operating unattended for an extended period of time, e.g., based on a lack of operator inputs and/or an occupancy sensor. After that period, likely somewhere between 1 and 4 hours, the TV would turn off to save energy.

The crux to assessing this measure is to better understand the portion of TVs that can take advantage of the functionality, particularly the number of hours that TVs spend on but not actively being viewed, hereafter referred to as "active-unattended", $T_{a\text{-}u}$, and the number of consecutive hours that TVs spent in active-unattended. Ideally, such measurements would exist for a significant number of households, but we know of no such study. Moreover, performing such a study would be time-intensive and costly. Instead, we opted

to perform a phone survey about TV usage to develop estimates for the time that a larger population of TVs spends in active-unattended mode.

The CEA carried out a phone survey of 1,000 demographically representative households and asked the respondents the following questions for each the three TVs used most often in their household. Data from Roth and McKinney (2007) suggest that these TVs represent about 88% of all residential TVs and account for more than 90% of TV AEC. The survey asked the following questions

1. Thinking of the TV that you own, during the PAST 24 HOURS, how much time was it turned on? If you are not sure, please use your best estimate.
2. Thinking of the TV that you own, during the PAST 24 HOURS, how much time was it in active use? If you are not sure, please use your best estimate.
3. In the PAST 24 HOURS, was your TV on for one hour consecutively without being actively used?
4. If your TV had an option to recognize periods of INACTIVE USE, time you are not actively watching or listening to your TV, and automatically turn off your TV, would you activate this option? *Answers: Yes, No, Don't Know.*

Due to the nature of the survey, the responses to these questions have significant uncertainty. On the other hand, we would expect that the respondents would be more likely to remember instances when TVs are left on for longer periods of time, i.e., the instances where this auto power-down feature would realize the greatest energy savings.

Based on the responses, we calculated two values, the Maximum Savings Potential and the Achievable Savings Potential, for different minimum periods of $T_{a\text{-}u}$, 1, 2, 3, and 4 hours. The maximum savings potential calculates $T_{a\text{-}u}$ for each TV based on difference between the first two questions *if* Q3 = "yes"; if Q3 equals "no", $T_{a\text{-}u} = 0$. The Achievable Savings Potential calculation also takes into account question 3, and sets $T_{a\text{-}u}$ equal to the calculated value if Q4 = "yes", and $T_{a\text{-}u} = 0$ for all other responses. Figure 6 shows the distribution of $T_{a\text{-}u}$ for the respondents for the Achievable Savings Potential sorting metrics, for different minimum periods of $T_{a\text{-}u}$, while Figure 7 presents the Maximum and Achievable potential reductions in active hours, averaged over *all* the TVs in the survey.

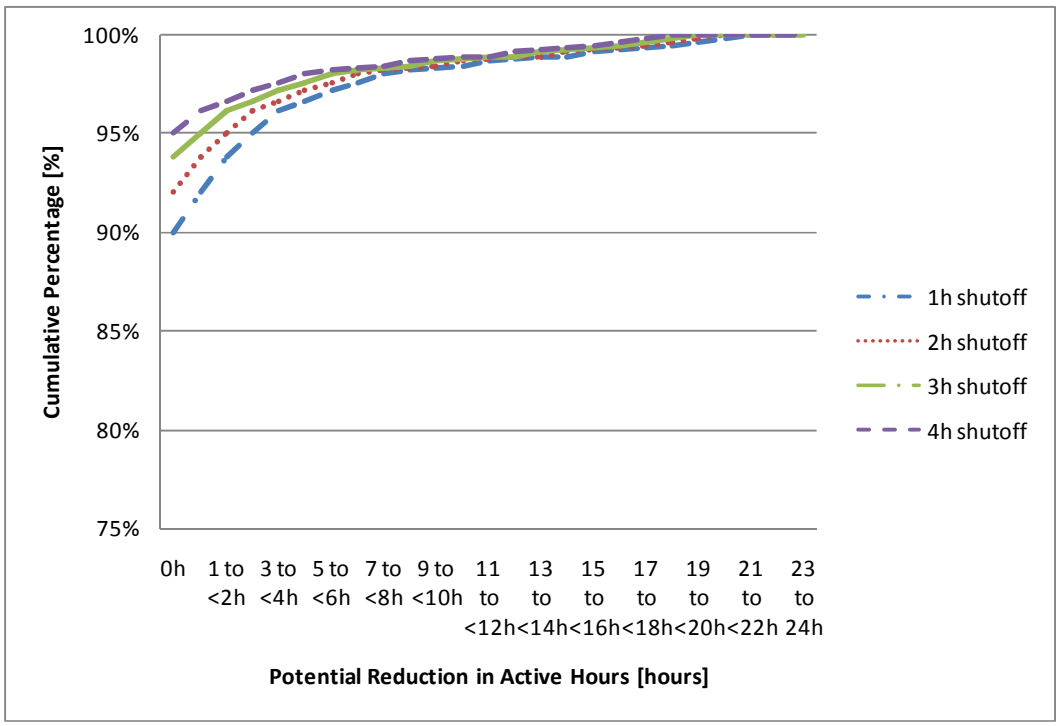


Figure 6: Cumulative Distribution Curve for the Potential Reduction in Active Hours Per Day

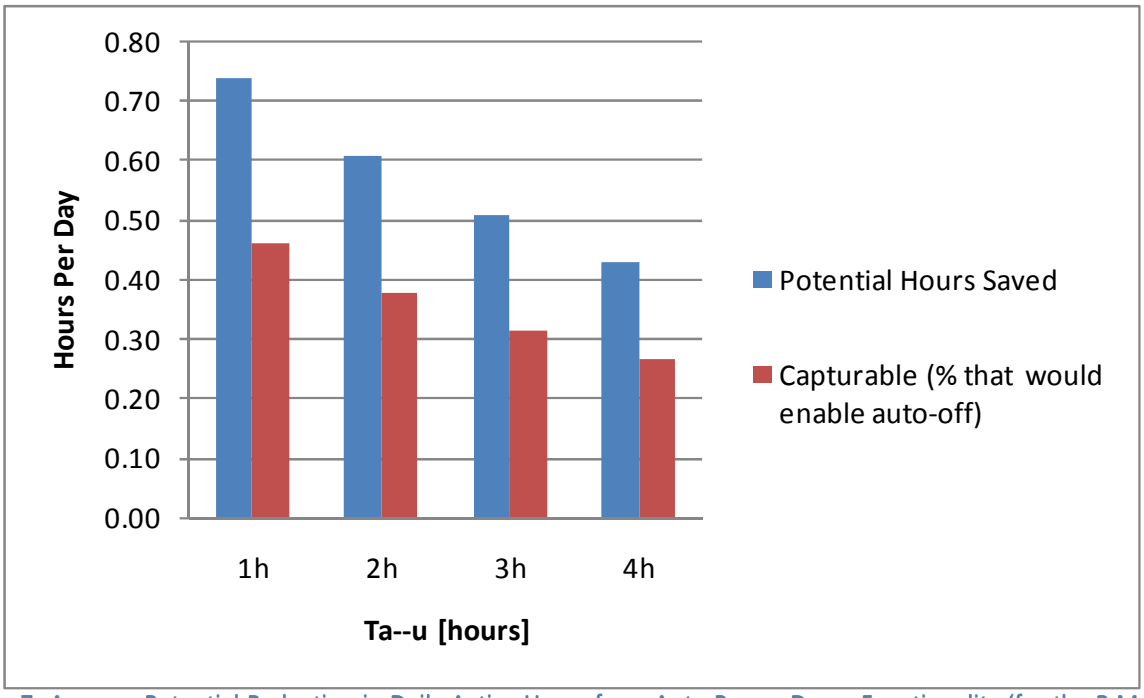


Figure 7: Average Potential Reduction in Daily Active Hours from Auto Power-Down Functionality (for the 3 Most-Used TVs in Household)

Unsurprisingly, the figures show that increasing the minimum $T_{a\text{-}u}$ reduces the potential decrease in active hours. In practice, we believe that manufacturers would likely select at least a three-hour period for $T_{a\text{-}u}$, as this would avoid most situations where the TV would

shut off while viewing a movie. This suggests a Maximum Potential Reduction of approximately 0.5 hours per day per TV and an Achievable Reduction of 0.3 hours per day per TV. For an average TV,[7] this translates into potential active mode UEC reductions of about 10 and 6 percent, respectively.

We then applied the reduction to all the TVs sold in a given year, based on the baseline projections described in Section 3 for installed base, active mode usage, and power draw by mode. Figure 8 summarizes the annual electricity savings potential from auto power-down functionality for all the TVs added to the installed base of TVs in California for each year from 2011-2022, assuming that *all* of the new TVs from that year incorporate this functionality. To be clear, the values shown do *not* represent the cumulative savings potential from auto power-down functionality for the years from 2011-2022.

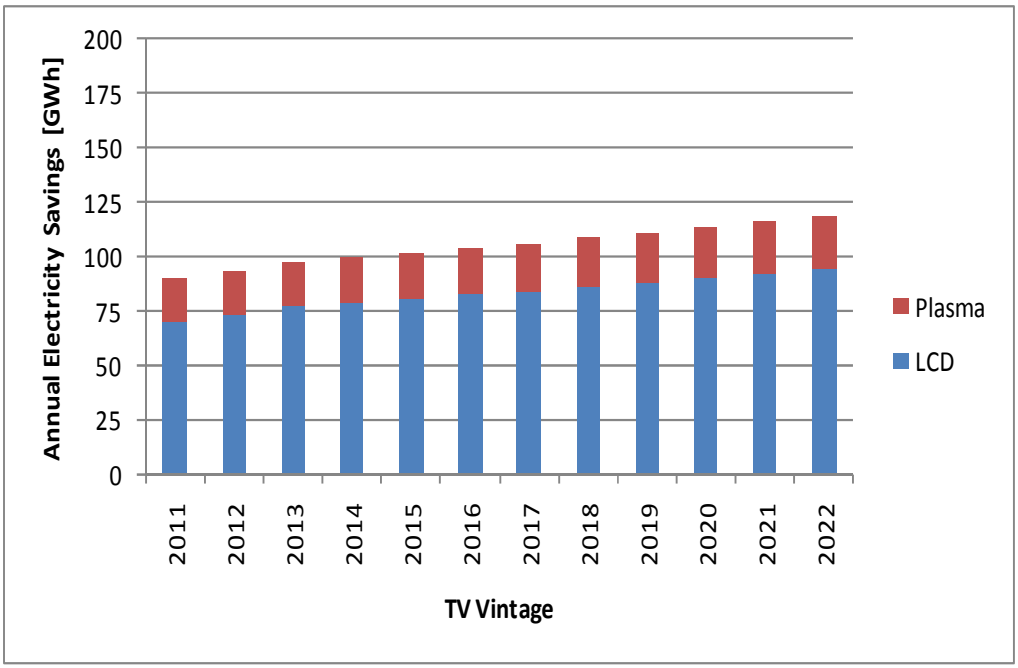


Figure 8: Achievable Annual Energy Savings from Auto Power-Down Functionality for California TVs Sold in a Given Year

In sum, the achievable annual savings potential for each *vintage* ranges from 90 to 120 GWh a year, an amount equivalent to 0.04 to 0.06 MMT $CO_{2,e}$ per year.

Two factors could reduce the achievable savings. First, data flows to the TV from the internet or operation in download acquisition mode (DAM) could prevent the controller from determining that a TV has entered a prolonged period of inactivity. That would, in turn, decrease the reduction in hours spent in active mode and the energy savings realized from auto power-down functionality. Second, if the implementation of auto power-down

[7] We considered limiting this analysis to only residential TVs, but decided not to because it would have a very small impact on the estimates (much smaller than other uncertainties) and we could envision situations in commercial buildings that could yield similar savings (e.g., hotel rooms, hospital rooms, etc).

functionality requires consumers to opt-in, we would expect the realized savings to be much less. Specifically, we would expect a large portion of consumers to not carry through on their expressed wish to employ the auto power-down.[8] If auto power-down is enabled as the default option, i.e., *opt-out*, we would expect its use – and, hence, electricity and $CO_{2,e}$ savings – to be closer to the Maximum Achievable scenario (see Figure 9). Depending on the year, the annual electricity savings range from about 145 to 190 GWh, with $CO_{2,e}$ reductions of 0.07 to 0.09 MMT $CO_{2,e}$.

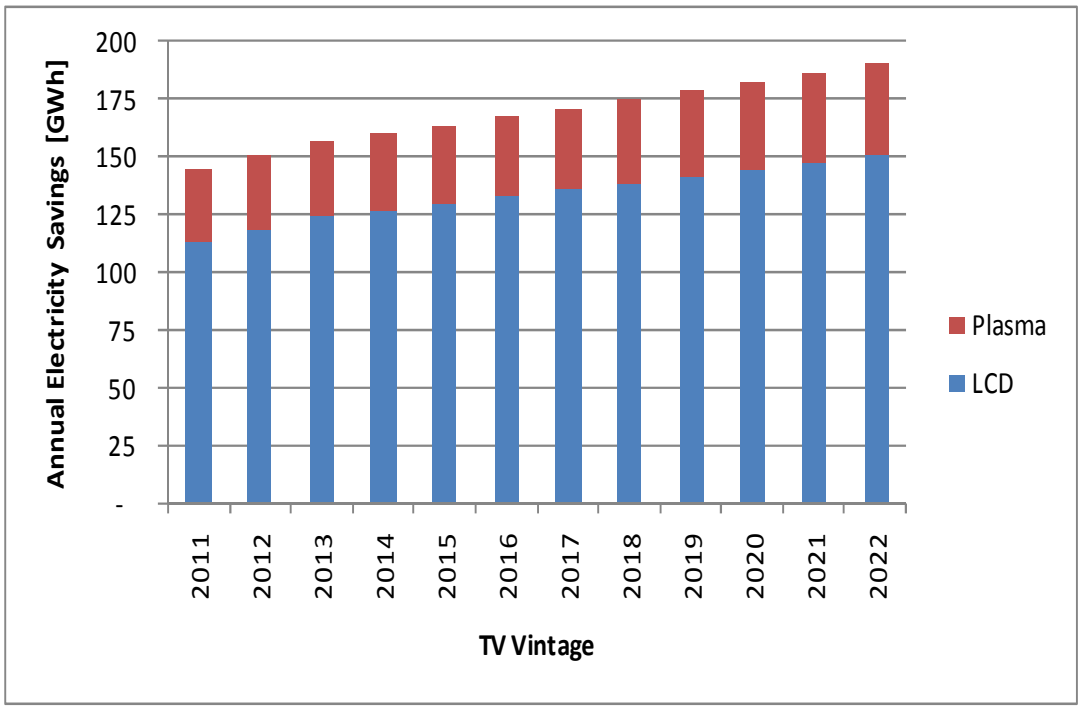


Figure 9: Maximum Annual Energy Savings from Auto Power-Down Functionality for California TVs Sold in a Given Year

4.3 Forced Menu Functionality

The energy savings potential of forced menu functionality (FMF) depends upon two factors: the energy saved by switching into a less bright preset viewing mode that draws less power and the fraction of TVs that owners would switch their TVs into such a mode due to FMF.

Until very recently, almost all TVs were shipped to operate in a very bright preset viewing mode[9] tailored for in-store operation (Ecos 2007, CEC 2008, Discussions with TV Manufacturers). Since November of 2008, some TV manufacturers have shipping some or

[8] Thaler and Sunstein (2008) cite one well-known example that illustrates the potent impact of opt-in versus opt-out. Specifically, the participation rate in one organization's defined contribution retirement plan (such as a 401-k) using an opt-in approach equaled only 20 percent after three months and 65 percent after 36 months. In contrast, when that organization switched to an opt-out approach, initial enrollment rates for new employees were 90 percent and grew to 98 percent after three years (Madrian and Shea 2001, from Thaler and Sunstein 2008).

[9] Several different names for this mode are used, including dynamic and vivid.

all of their TVs in a "standard" mode that draws less power than the brightest viewing mode. In addition, some manufacturers use a forced menu that requires consumers to select a mode when the TV is initially installed.

Through the CEA, we asked TV manufacturers to provide data for the percentage of TVs shipped in 2009 in different default modes. Based on responses received from five manufacturers, we estimate that a majority of LCD TVs shipped in 2009 are either shipped with "standard" as a default mode or with FMF. We received fewer data from PDP manufacturers; the limited data suggest less use of FMF and "standard" as a default mode for PDPs. For neither technology did we receive information from enough manufacturers to enable precise calculation of percentages, so our estimates summarized in Table 5 have significant uncertainty, particularly for PDPs.

Table 5: Estimated Distribution of Default Viewing Mode for TVs Shipped in 2009

Viewing Mode Shipped	*LCD*	*PDP*
Standard	40%	20%
Bright	20%	50%
Forced Mode	40%	30%

Adding FMF has the potential to reduce energy consumption of TVs shipped in "bright" modes, particularly if the default mode for the FMF is "standard" or a lower power mode. In particular, findings from behavioral science indicate that consumers are much more likely to select the default option in situations where they have limited knowledge (e.g., Thaler and Sunstein 2008). As a result, if the default selection for a forced menu is a "bright" mode, the FMF will likely achieve much smaller savings since a much smaller portion of users would likely choose a less bright preset viewing mode.

Assuming that the FMF has "standard"/"home" as the *default* preset viewing mode and that 80 percent[10] of users select that default option, this suggests that incorporation of FMF into all TVs could achieve energy savings for approximately 16 percent of LCD TVs and 40 percent of PDP TVs.

Very limited data exist for the magnitude of the energy savings potential from operating in "standard" instead of the "bright" mode. Tutt (2009) presents measurements for the difference between "bright" and "home" modes for 14 TVs that showed an average difference of 20 percent, i.e., the "bright" mode draws an average of 20 percent more power than the "home" mode. Unfortunately, the sample size is very small and does not breakdown the savings estimates by display type, so we consulted additional data sources to attempt to improve the accuracy of the energy savings potential. Measurements from CNET (2009) indicate that switching LCDs and PDPs from their *default* mode – which can be either a "bright" or "standard" mode – to a low-power active mode can reduce TV energy consumption by around 25 and 41 percent, respectively. That source does not,

[10] This is estimate has appreciable uncertainty. It is, however, consistent with the typical acceptance rate for opt-out organ donor programs (Johnson and Goldstein 2003, from Thaler and Sunstein 2008).

however, provide estimates for the magnitude of savings from switching from "bright" to "standard" mode. If we assume, very roughly, that the savings from operating in "standard" instead of "bright" mode equals half of the savings from switching from the default mode to a low-power active mode, the estimate is generally consistent with the data presented in Tutt (2009). Thus, we use 17 percent as an approximate estimate for the energy savings potential for this measure.

Table 6 characterizes the energy savings potential of the opt-out FMF, assuming that all new TVs sold in California in 2009 have this functionality with "standard"/"home" as the default mode. If a "bright" preset viewing mode were the default for the FMF, however, we expect that the energy savings potential of the FMF would be a small fraction of the calculated savings potential.

Table 6: Energy Savings Potential of Forced Menu Functionality, Applied to ALL LCD and PDP TVs Sold in California in 2009

Display Technology	Projected 2009 Sales [Millions]	Total AEC of New Units, Active Mode [GWh]	Estimated Energy Savings [%]	Approximate Relevant Portion of Units*	AEC Savings Potential [GWh]*
LCD	3.6	1,070	17%	16%	28
PDP	0.4	280	17%	40%	19
Total	4.0	1,350	N/A	N/A	47

*Assumes "standard" mode as default mode and 80% of owners select the default mode.

4.4 Advertising Campaign to Convince TV Owners to Operate TVs in Less Bright Preset Viewing Modes

The energy savings potential of this measure depends primarily upon the magnitude of the reduction in active-mode power draw that can be achieved and the percentage of TV owners that implement the measure (i.e., its uptake). Feedback received from several TV manufacturers indicates that almost all TVs produced for the U.S. market prior to November, 2008 were shipped in a "bright" mode (as discussed in the prior section), and that almost all TVs shipped over the last decade could operate in multiple preset viewing modes.

CNET (2009) has measured the power draw of more than 150 HDTVs since late 2005. Of particular interest are measurements made to understand the potential energy savings from entering less bright preset viewing modes. Specifically, the TVs were first tested in their default mode,[11] i.e., the preset viewing mode for the TV as shipped; when there was not a default mode, the "home" mode was selected. Since TV repair shop data from the UK indicate that most (~90%) TVs are viewed in the default mode, this provides a reasonable estimate for the fraction of TVs that remain in the default mode (MTP 2009). It

[11] Until recently CNET did not carry out tests using IEC Standard 62087. Chase (2008b) cites an "industry contact" that estimates the difference between the CNET and IEC test procedures to be no more than 10 percent for PDPs and 3 percent for LCDs; unfortunately, we have not seen any data to corroborate these estimates.

is not clear, however, how representative the TVs tested are of TVs sold since 2005. In particular, we have focused on TVs released prior to November, 2008, since information provided by TV manufacturers suggests that many TVs after that date were shipped in a lower power mode to meet the Energy Star® v3.0 specification that took effect then. Table 7 summarizes the CNET test results for those TVs. To be clear, the "average maximum reduction" estimates reflect data gathered for *all* TVs, i.e., it includes data (0 percent reduction) for TVs that could not enter a lower power mode than the default.

Table 7: CNET HDTV Test Summary: Potential Reductions in TV Active Mode Power Draw from Lower Power Modes

Display Type	*% of TVs Entering Lower Power Mode*	*Average Maximum Reduction in Active Power Draw, All TVs [%]*	*Sample Size*
LCD	41%	17%	28
PDP	61%	15%	56

Fewer data were found for the potential reduction in CRT power draw from entering a less bright preset viewing mode. One study did measure the potential decrease in CRT power draw by decreasing screen luminance (Novem 1998), finding that a decrease from 230 to 130 cd/m^2 reduced average power draw by about 10 percent. These data have at least two major limitations that limit their accuracy and applicability. First, the TVs were tested with static color bar signals instead of typical TV viewing content used in the current test procedure for TV active-move power draw, IEC 62087. Second, the TVs were all older than the main vintages considered in the current study, so the results would not reflect the impact of any advances or changes in CRT TVs since the mid to late 1990s. Nonetheless, due to a dearth of more recent data, we use the 10 percent estimate in our analysis.

Table 8 summarizes our estimates for the potential reduction in active mode power draw for different display technologies, for the entire installed base of TVs circa 2008.

Table 8: Average Reduction in TV Active-Mode Power Draw from Entering a Less Bright Preset Viewing Mode

Display Technology	*Average Reduction in Active-Mode Power Draw, [%]*	*Source*
CRT	~10%	Novem (1998)
LCD	17%	CNET (2009)
PDP	15%	CNET (2009)

If applied to the approximately 90 percent of the 2008 installed base of TVs estimated to be in a "bright" mode,[12] switching to a lower power mode could have reduced the AEC of the installed base of TVs in California by approximately 1,000 GWh in 2008. This value will decrease over time as pre-November, 2008 TVs are replaced by TVs shipped in default preset viewing modes that draw less power than "bright" modes, eliminating the energy savings potential from this measure for those TVs.

[12] Estimates exclude projection TVs, due to very limited data and AEC impact.

In theory, the energy savings potential of this measure is large because it could impact the entire installed base of TVs. On the other hand, it does not appear likely that the measure would be implemented for a significant fraction of TVs. As part of our phone survey, we asked respondents the following question to determine how likely they would be to implement this measure.

> If you could use your remote to decrease the brightness of your screen which would reduce the electricity used by the TV, how likely or unlikely would you be to do so? Would you be . . .
>
> 01 Very likely
> 02 Likely
> 03 Neither likely nor unlikely
> 04 Unlikely
> 05 Very unlikely
> 99 DON'T KNOW

Figure 10 summarizes their responses. Based on assigning weightings of 90%, 75%, 50%, 25%, and 10% to these answers, the average respondent would have a 56% likelihood of implementing the measure.

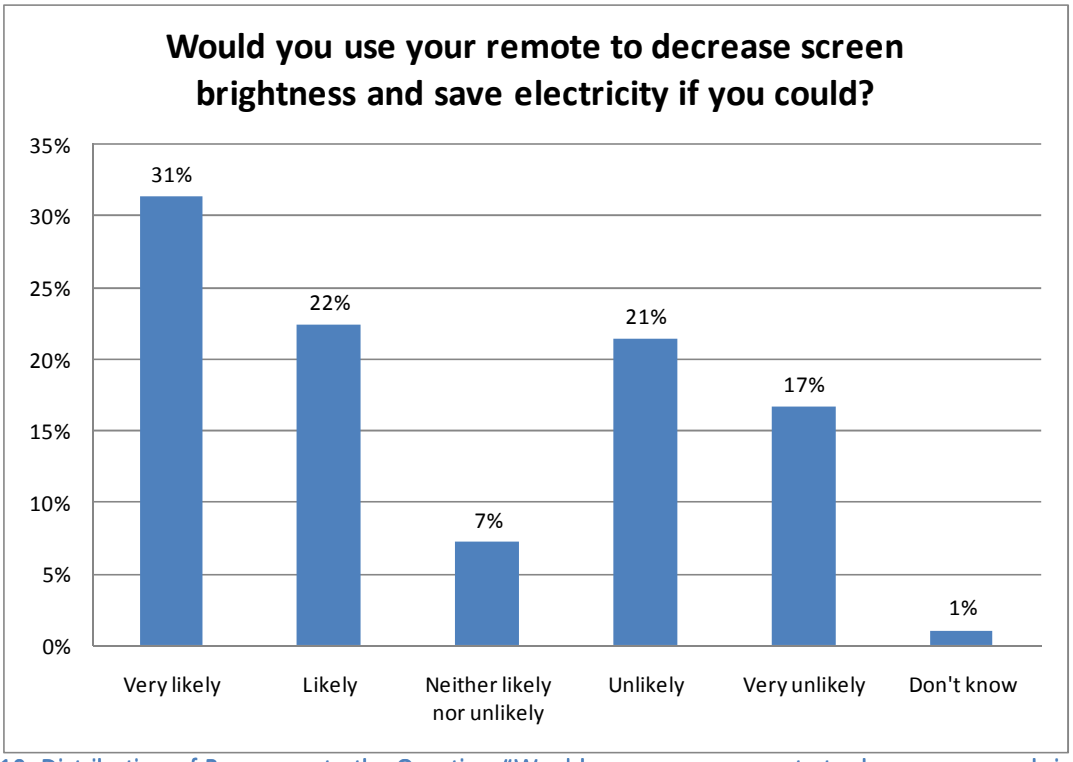


Figure 10: Distribution of Responses to the Question "Would you use your remote to decrease screen brightness and save electricity if you could?"

Applying this weighting along with the earlier estimate that 90 percent of TVs are in a "bright" mode suggests that approximately 50% of TV would be switched from a "bright" mode to a less bright preset viewing mode. This yields the maximum annual savings

potential show in Table 9, i.e., 555 GWh of electricity, reducing greenhouse gas emissions by 0.28 MMT $CO_{2,e}$.

Table 9: Maximum Annual Electricity Consumption Reduction Potential from Entering Lower Power Modes for the Installed Base of TVs in 2008

Display Technology	*Active-Mode Power Draw Reduction [%]*	*California Installed Base [millions]*	*AEC* [GWh]*	*Imple-mentation Rate*	*AEC* Savings [GWh]*
CRT	10%	22.3	4,300	50%	215
LCD	17%	10.6	2,920	50%	248
PDP	15%	1.8	1,220	50%	91
TOTAL		34.7	8,440		555

*AEC values in this table only reflect active mode.

Clearly, this represents an upper-bound estimate for the portion of people that would actually switch the preset viewing mode of their TVs. In reality, a significant portion of owners would not implement this measure. Peters et al. (1998) performed a study to assess the likely efficacy of a TV-based energy conservation campaign that targeted three energy-efficiency measures, including adjusting thermostat settings. We believe that this measure has relevant similarities with the proposed TV measure, namely that both measures require home occupants to change the settings of devices that many people appear to find moderately challenging to modify. The study projected that the advertising would lead to insignificant change in the number of households that would be willing to lower space heating temperature setpoints because the campaign did not appreciably alter peoples' attitudes toward changing temperature setpoints.

There are at least two important caveats in this estimate. First, the annual energy cost savings from reducing temperature setpoints is roughly an order of magnitude greater than from changing TV viewing modes, which would tend to reduce the number of people who would change TV viewing mode relative to changing temperature set point. On the other hand, Peters et al. (1998) notes that another study found that a large portion of households reduced thermostat settings in the period of 1973-1981, leading them to "suspect that consumers may have already gone as far as willing to go in reducing thermostat settings." Put another way, the people generally willing to reduce thermostat settings have already done so, to the greatest extent they feel comfortable. This is almost certainly not the case for changing TV viewing modes, which suggests that the thermostat findings could be somewhat pessimistic relative to changing TV viewing modes.

In addition, we presented this measure to two experts in communications (Weissman 2009, Lerbinger 2009). Both thought that such a media campaign would have, at best, limited success due to the small cost savings that consumers would realize (approximately $3 to 15/year) and the relative complexity of implementation (i.e., limited ability to change preset viewing modes).

Finally, consumers consider picture quality a much higher priority than energy efficiency when making decisions about televisions. For example, in a series of interviews focused on understanding potential TV buyers' perceptions of energy efficiency, 38 percent of consumers rated picture quality as the most important factor to them, while only 15 percent stated that energy efficiency was their top priority. Crucially, the raw percentages almost certainly overstate the importance of energy efficiency, as the study summary notes (GfK 2008): "Given the context in which this question was asked (i.e., in a survey about energy efficiency), this is likely to be an inflated result for this factor." Similarly, another study of how consumers make decisions about purchasing TVs rates all energy-related factors as "less often or not considered", while picture-related attributes are ranked among the "factors considered" (Winton Sustainable Research Strategies 2008). This should not come as a surprise – fundamentally, people purchase TVs for the viewing experience and would be unlikely to compromise that experience.

In sum, we expect that an advertising campaign to convince TV owners to place their TVs into less bright preset viewing modes would achieve very low penetration rates due to the hassle of changing the viewing mode relative to the energy cost savings and an unwillingness to potentially compromise the viewing experience. As a result, only a very small fraction of the large maximum savings potential of this measure would likely be realized.

One alternative way to implement the basic idea at the core of this measure, i.e., changing the preset viewing mode of the installed base of TVs to one that draws less power, would be to have TV system installers, satellite TV providers, and cable TV providers include this measure as part of regular service calls to homes. If these providers were willing to make these changes during home visits, this could dramatically increase the uptake of the measure, since initial estimates suggest that satellite and cable TV providers currently visit the homes of approximately 15 to 25 percent of their subscribers per year (Comcast 2009, Langille 2009) and up to 83 percent of U.S. households subscribe to video services[13] (The Bridge 2009, Kim 2009, DOE 2008). On the other hand, such organizations are wary about implementing this approach because it would not yield a tangible benefit to the service provider while likely increasing the number complaint calls from (and follow-up home visits to) customers who dislike the dimmer picture.

4.5 DTV Acceleration Program

The DTV Acceleration program would save energy by replacing older, less efficient TVs with newer TVs of the same screen size that draw less energy in active mode. For our analysis, we consider TVs from 2002 or earlier as potential candidates for replacement and assume that the new TVs draw 30 percent less power than the maximum active-mode power draw allowed by Energy Star® specification v3.0.[14] Figure 11 summarizes estimates for the

[13] The 83 percent estimate equals the sum of household subscriptions for satellite and cable services, divided by the total number of U.S. households. The actual percentage of households may be somewhat lower than 83 percent, because some households may receive both cable and satellite TV services.

[14] We selected this level because the utility incentives paid in California to retailers currently require this level of performance (Michel and Chase 2009). In practice, some TVs will draw less power, which will tend to increase the energy saved.

number of TVs sold in California between 1999 and 2002, by display technology, based on historic U.S. (i.e., national) sales data for this period (CEA 2009) and estimates for the installed base of TVs in California in 2008 (CEC 2008). CRTs dominate, accounting for more than 90 percent of all TVs sold during that period.

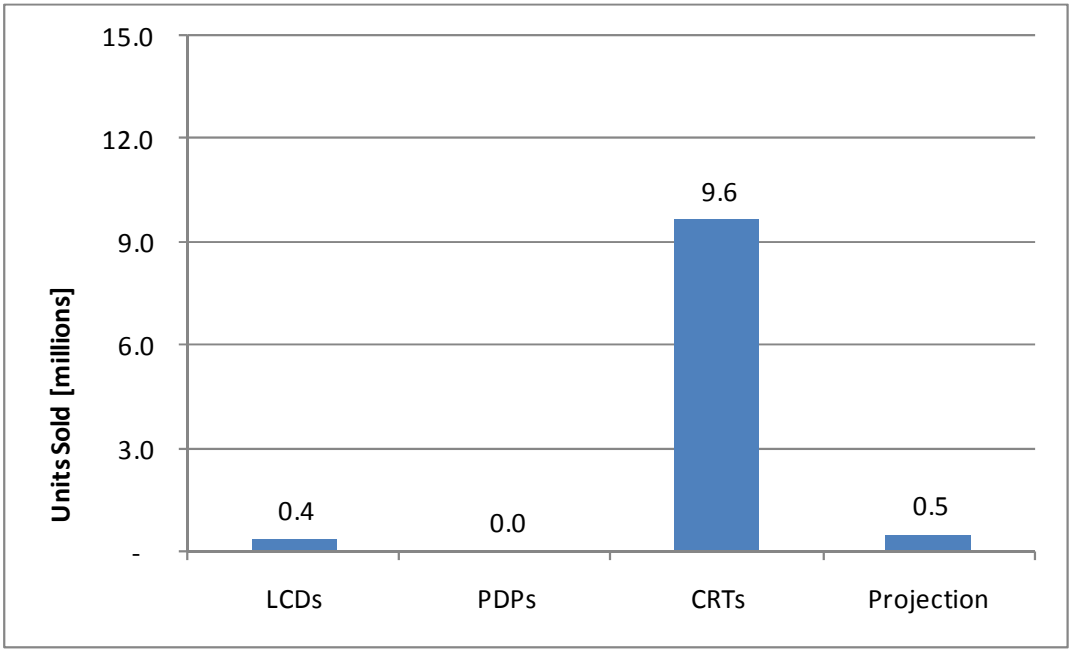


Figure 11: Estimated Number of TVs Sold in California from 1999 to 2002, by Display Technology

Next, we compare the active-mode power draw of the baseline TVs, using again the Chase (2008b) estimates for the prototypical TV sizes and power draw for the installed base of different TV technologies (see Table 10), as well as the total UEC savings per TV taking into account both active and off modes.[15] In practice, the estimated UEC reductions are probably optimistic, since older TVs would probably be less likely to be a household's primary TV. Since primary TVs are, on average, the only TVs in households that operate in active mode more hours per day than the average TV,[16] these older TVs probably operate in active mode fewer hours per year, decreasing the UEC and energy savings potential.

[15] As noted earlier, most TVs sold today meet the EnergyStar v3.0 requirement to draw <1W when off. Data presented in Roth and McKinney (2007) show that between 40 and 50 percent of TVs sold from 1999 to 2002 satisfied the EnergyStar® requirement that they draw less than 3W when off. Rosen and Meier (1999,) estimated that pre-EnergyStar® TVs drew an average of 5W when off, suggesting that 4W is a reasonable estimate for the average off-mode power draw of 4W for all TVs sold between 1999 and 2002. Multiplying the 3W difference by 6,853 hour in off mode per year (=8,760-1,907) yields a UEC savings of 21kWh/year in off mode. We assume that the average power draws of TVs from 1998-2002 does not vary appreciably from the averages for TVs of the same size and display technology over the 1999-2008.

[16] Roth and McKinney (2007) report that primary TVs spend an average of 7.1 hours/day in active mode, while the 2nd, 3rd, and 4th TVs spend an average of 4.2. 3.3, and 3.2 hours/day, respectively, in active mode.

Table 10: Energy Savings Potential, Replacing 1999 to 2002 Vintage TVs with TVs Consuming 30% Less Energy Than Energy Star® v3.0

Display Technology	California Units Sold [millions]	Average Screen Area [in^2]	Power [W]		UEC Savings [kWh]
			Baseline	*Energy Star® v3.0 – 30%*	
CRT	9.6	439	101	84	54
LCD	0.4	533	144	97	110
Projection	0.5	1,750	245	297	None

Thus, the *maximum* annual energy savings potential if *all* CRTs and LCDs of this vintage were retired equals about 560 GWh per year (CRT=520 GWh, LCD=40 GWh).

In practice, many of these TVs would expect to be replaced reasonably soon because they are older. As such, what matters is the *incremental* energy savings achieved by accelerated replacement of older TVs. Presumably, the incremental energy savings would, in turn, vary with the magnitude of the incentive offered, and we evaluated this effect in two ways: based on the elasticity of TV sales for different incentive levels and through phone surveys. The economic literature indicates the price elasticity of demand for TVs is approximately 1.2 (cited in Anderson et al. 1997). That is, a 10 percent reduction in TV price would increase TV sales by 12 percent.

The average CRT in the installed base has a screen size of approximately 30 inches,[17] and the costs of the best-selling similarly sized LCD TVs range from approximately $300 to 600 (CEA 2009, Best Buy 2009). Assuming an average sales price of $450, a rebate on the order of $50 (11 percent discount), and a 1.2 price elasticity of demand for TVs yields a 13 percent increase in sales. Currently, LCDs dominate TV sales in this size range, and screen sizes between 24 and 34 inches account for about 40 percent of all LCD TVs sold. Based on projected total LCD sales in California of 3.6 million units in 2009, a $50 rebate that persisted for all of 2010 would lead to incremental replacement sales of approximately 0.2 million units (= 3.6 million * 40% * 13%). Multiplication by the UEC savings of 54 kWh per year yields a projected AEC savings of about 10 GWh.

In addition, the phone surveys asked the respondents the following question:

> If you could receive a credit for turning in an older, that is, before 2002, television to help purchase a new television of the same size that reduces energy, what amount of money would you expect to collect for your older television, assuming you had one?

The cumulative distribution for their responses shows that about 30 percent of respondents would expect to collect at least $50 for trading in their old TV (see Figure 12).

[17] For a fixed rebate quantity per TV, TV owners would be likely to retire in smaller TVs since the relative subsidy is larger. On the other hand, this would result in greater response to the program, increasing the number of smaller units actually retired.

In practice, the percentage of people that would actually trade in their TVs at a given incentive level would undoubtedly be smaller, since not everyone will act as they respond. Nonetheless, this supports the idea that a rebate would need to be in the $50 range to entice significant *incremental* sales.

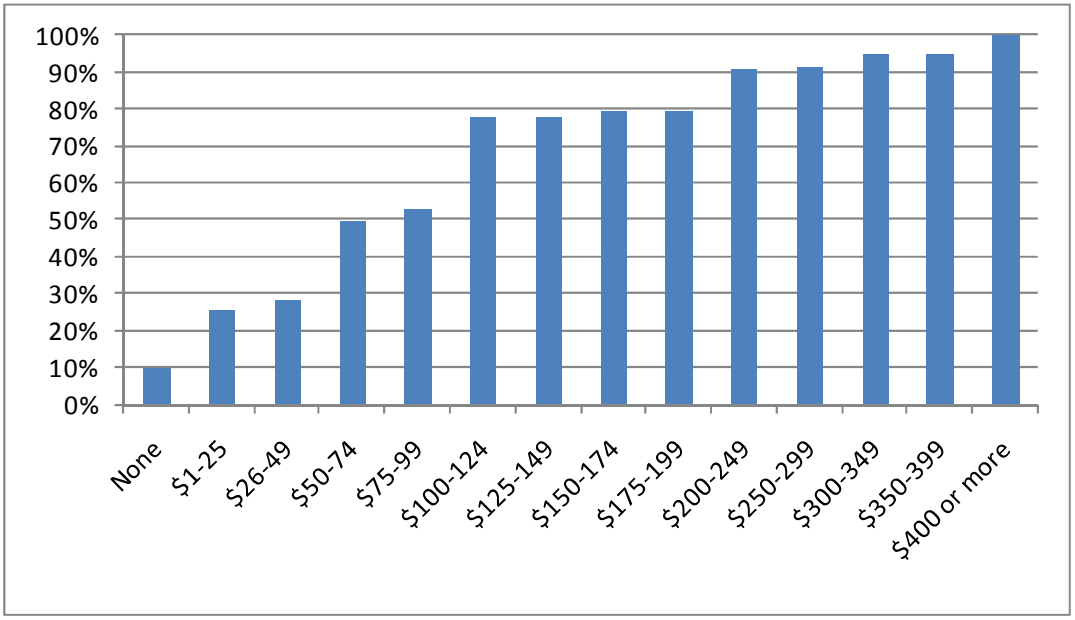


Figure 12: Survey Respondent's Average Incentive Desired to Replace Older TV with Energy Efficient New TV

5 Conclusions

We conducted a study to evaluate the energy savings potential of six measures and policies that could reduce TV energy consumption. To evaluate the energy saving potential for each measure, we developed models for how each measure modified the average power draw in active mode and/or the annual time spent in active mode relative to the baseline case. The models reflect prior research into TV energy consumption and information provided by the Consumer Electronics Association (CEA) and its member companies. In addition, we developed information based on responses from a telephone survey of 1,000 representative U.S. households that was conducted to address gaps in how TV owners might respond to different measures.

Table 11 summarizes the annual electricity consumption AEC savings potentials of the measures, when applied to TVs in the State of California. We evaluated the incremental energy savings potential of each measure relative to estimates for current and projected TV energy-consumption characteristics, specifically the same estimates used by the CEC to develop their proposed TV active-mode power draw regulations.

To provide context, the installed base of TVs in California consumed approximately 8,800 GWh in 2008. Some measures are additive in their effect, e.g., those that impact only the installed base are additive with those that affect uniquely new TVs. In other cases, however, the AEC savings from combining several different measures are not additive. For example, combining the two Energy Star® specifications and auto power-down and forced-menu functionality would reduce TV AEC by approximately 400 to 440 GWh in 2011.

Table 11: Summary of Annual Electricity Consumption Savings Potential Estimates for Measures Evaluated, for TVs in the State of California

Measure	AEC Savings Potential [GWh]	Comments
Energy Star® v3.0	140	For TVs sold in 2011
Energy Star® v4.0	140	For TVs sold in 2011
Auto Power-Down	90 – 145	For TVs sold in 2011
Forced Menu Functionality	47	For TVs sold in 2009; assumes default is "home"/"standard" preset viewing mode
Advertising Campaign – Change Preset Viewing Modes	555	Maximum savings potential; actual savings likely much lower and would depend on advertising campaign; 2008 installed base
DTV Acceleration Program	10	For 2009; assumes one-year program duration and $50 incentive level

The Energy Star® v3.0 and v4.0 specifications reduce TV energy consumption by creating a market demand for TVs that draw less power in active mode than a specified level as a function of TV screen area. Using EPA's projections for the future market share of v3.0- and v4.0-compliant TVs, we find that the v3.0 and 4.0 specifications are achieve similar energy savings in 2011, about 140 GWh each. This masks an important difference, notably that the market share of v3.0-compliant TVs is much higher than v4.0 compliant

TVs in 2011; much higher UEC savings from the v4.0 specification result in similar total energy savings for the two specifications. In the years after 2011, the AEC savings grow, particularly as the sales of v4.0-compliant units increase.

The "Auto Power-Down" measure reduces energy consumption by switching off TVs after a period of unattended operation, assumed to be three hours (to avoid most situations where the TV would switch off during movie watching). Based on phone survey data for TV usage, we estimate that this feature could reduce the average TV on-time by about 0.5 hours per day. Since 62% of respondents indicated they would enable such a feature, this would yield an attainable average daily reduction of about 0.3 hours. The behavior modification literature suggests that if auto power-down functionality is not enabled as a default option, e.g., as an opt-in option instead, the implementation rate would be much lower, as would the realized energy savings.

The "Forced Menu" measure can save energy by prompting users to select a "home" preset viewing mode (instead of a "bright" mode) when the television is first deployed in a home. The total savings depends on the difference in active-mode between preset viewing modes, the fraction of TVs shipped with the "bright" mode as the default mode, and the fraction of TV owners that would switch to a low-power mode. We estimate that an average new TV in 2009 achieves about a 17 percent reduction in active-mode power draw by switching from "bright" to "home" mode. In addition, data provided by TV manufacturers suggest that approximately 20 percent of LCD TVs and 50 percent of PDPs are shipped in a bright mode. If the "standard/home" is the default forced menu option, we estimate that 80% of users will select and maintain that option, resulting in just under 50 GWh of energy savings if FMF were available in all TVs shipped in 2009.

The "Advertising Campaign" measure seeks to convince viewers to switch their televisions from a "bright" preset viewing mode to a "standard" or "home" viewing mode. Prior to November, 2008, most TVs were shipped in a "bright" mode to enhance in-store appeal, and field data suggest that about 90% of installed TVs remain in this mode. Switching from "bright" to "standard" mode reduces active-mode power draw by approximately 10, 17, and 15 percent for the installed base of CRT, LCD, and PDP technologies, respectively. In contrast to the measures already discussed, the measure applies to all TVs that have low power modes, resulting in a very high maximum energy savings potential.[18] In practice, we expect that many – if not most – owners would not be willing or able to go through the hassle of changing the viewing mode, nor would many be willing to potentially compromise their viewing experience (since consumers rank picture quality as a much more important attribute of TVs than energy efficiency). Consequently, we believe that an advertising campaign alone would not achieve significant participation and resulting energy savings.

Lastly, the "DTV Acceleration Program" measure seeks to reduce energy by providing consumers with a financial incentive to accelerate the replacement of older TVs with newer TVs that consume less energy. In our analysis, we considered a $50 incentive offered to

[18] The energy savings from this measure will decrease over time as pre-November, 2008 TVs are replaced by TVs shipped in default preset viewing modes that draw less power, eliminating the energy savings potential from this measure for those TVs.

replace a CRT from 2002 or earlier with a similarly sized new TV that draws at least 30% less power in active mode than allowed by Energy Star® v3.0. Since many of these older TVs will likely be retired relatively soon anyway, we assessed the incremental sales and energy savings from accelerating that retirement. Clearly, the size of the incentive and the price elasticity of TVs both have a major impact on incremental TV sales driven by the program. Overall, a one-year program with the basic parameters outlined above would increase TV sales in the relevant size range by about 13 percent. Since this measure affects the energy consumption of a relatively small quantity of TVs, we project that it will save significantly less energy than other measures that impact a larger portion of TVs sold or the installed base.

References

Anderson, P.L., R. McLellan, J.P. Overton, and G. Wolfram. 1997."The Universal Tuition Tax Credit: A Proposal to Advance Parental Choice in Education". Mackinac Center Report, Mackinac Center for Public Policy. November.

Appliance Magazine. 2006. "29th Annual Portrait of the US Appliance Industry". Appliance Magazine, September.

Best Buy. 2009. "DOE/EPA Energy Star – April-June 2009: Summary Report".

Bridge. 2009. "2Q09 and Beyond: Some Very Mixed Messages". *The Bridge*. September.

CCAP. 2008. "ccap-electronics080801". Climate Change Action Plan Spreadsheet, Energy Star® Program. 1 August.

CEA. 2009. Television Sales Data, Consumer Electronics Association. August.

CEC. 2008. "2008 Appliance Efficiency Rulemaking: Draft Efficiency Standards for Televisions – Phase I, Part C, Docket #07-AAER-03-C". California Energy Commission Staff Draft Report. December.

Chase, A. 2008a. "Analysis of Standards Options for Televisions – Preliminary CASE Report". Codes and Standards Enhancement (CASE) Initiative for PY2008 Title 20 Standards Development, Prepared for Pacific Gas and Electric Company. 2 April.

Chase, A. 2008b. "Analysis of Standards Options for Televisions – Revised Proposal Version 1.0". Codes and Standards Enhancement (CASE) Initiative for PY2008 Title 20 Standards Development, Prepared for Pacific Gas and Electric Company. 3 July.

CNET. 2009. "Energy Efficiency Guide". Content downloaded on August 28, 2009 from: http://reviews.cnet.com/green-tech/tv-power-efficiency/?tag=contentMain;contentAux .

Comcast. 2009. "Comcast Corporation 2008 Annual Report on Form 10-K". Annual Report Pursuant to Section 13 or 15(d) of the Securities Exchange Act of 1934 for the Fiscal Year Ended December 31, 2008.

CPUC and CEC. 2007. "Reporting and Verification of Greenhouse Gas Emissions in the Electricity Sector." Joint Decision by the California Public Utilities Commission (CPUC) and the California Energy Commission (CEC). CEC-100-2007-007. September.

DOE. 2008. **2008 Buildings Energy Data Book**. Prepared for the Buildings Technologies Program, Energy Efficiency and Renewable Energy, U.S. Department of Energy, by D&R International, Ltd. September.

Ecos Consulting. 2007. "TV Power Consumption Sensitivity Analysis Memo". Memorandum from Ecos Consulting to Brad Meister. 10 October.

EPA. 2008. "TVs Key ENERGY STAR Product Criteria". Available at: http://www.energystar.gov/index.cfm?c=tv_vcr.pr_crit_tv_vcr .

EPA. 2009. "ENERGY STAR® Program Requirements for Televisions: Partner Commitments - Versions 4.0 and 5.0". 3 September. Available at: http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/television/Final_Version%204_5_TV_Program_Requirements.pdf .

GfK. 2008. "Energy Efficiency – Perceptions of Potential TV Buyers". Summary Presentation, August.

Johnson, E. and D. Goldstein. 2003. "Do Defaults Save Lives?". *Science*, no. 302, pp 1338-39.

Kim, G. 2009. "Telco Video Explodes, Satellite Up 3.5%, Cable Flat". *Satellite Technology*. 27 July. Downloaded from: http://satellite.tmcnet.com/topics/satellite/articles/60749-telco-video-explodes-satellite-up-35-cable-flat.htm .

Langille, G. 2009. Personal communication. EchoStar Corp. October.

Lerbinger, O. 2009. Personal Communication. Boston University, Professor Emeritus. August.

Madrian, B.C. and D.F. Shea. 2001. "The Power of Suggestion: Inertia in 401(k) Participation and Savings Behavior." *Quarterly Journal of Economics*, vol. 116, pp. 1149-1225.

Michel, T. and A. Chase. 2009. "Future ENERGY STAR® TV Levels: Perspective from the Business and Consumer Electronics Program". Presentation at the ENERGY STAR® Television Stakeholder Meeting, 24 April.

MTP. 2009. Personal Communication by Bob Harrison, Market Transformation Programme. August.

Novem. 1998. "Analysis of Energy Consumption and Efficiency Potential for TVs in On-Mode". Final Main Report and Annexes, by Novem BV. Contract EC-DGXVII 4.1031/D/97-023. November.

Peters, J.S., K. Seiden, S. Baggett, and L. Morander. 1998. "Changing Consumer Attitudes to Energy Efficiency: Midterm Results from an Advertising Campaign". *Proc. ACEEE Summer Study for Energy Efficiency in Buildings*, Pacific Grove, CA, pp. 8.251-8.261.

Rosen, K.B. and A. Meier. 1999. "Energy Use of Televisions and Videocassette Recorders in the U.S.". Lawrence Berkeley National Laboratory Final Report, LBNL-42393. March.

Roth, K. and K. McKenney. 2007. "Energy Consumption by Consumer Electronics (CE) in U.S. Residences". Final Report by TIAX LLC to the Consumer Electronics Association (CEA), December.

Thaler, R.H. and C.R. Sunstein. 2008. *Nudge: Improving Decisions About Health, Wealth, and Happiness (Revised and Expanded Edition)*. Penguin Books: London, England.

Tutt, T. 2009. "CEC Brightness Settings Proposal". Presentation at the Energy Star® Television Stakeholder Meeting. 24 April.

Weissmann, R. 2009. Personal Communication, Alliance to Save Energy. August.

Winton Sustainable Research Strategies. 2008. "Non-Directive Consumer Group Discussion on Purchasing Major Household Appliances with Reference to TVs and ICT". Final Report Conducted for the Department of the Environment, Water, Heritage and the Arts (Australia). 15 July.