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A Review of the 2011 and 2013 Digital Television Energy Efficiency Regulations Developed and Adopted by the California Energy Commission

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Abstract

In 2009, the California Energy Commission (CEC) adopted standards for power consumption of televisions. The California Public Resources Code (CPRC) requires that proposed regulations must "not result in any added total costs to the consumer over the designed life of the appliances." To comply, the CEC issued a report alleging consumers would save $8.1 billion from reduced energy consumption. We find that the CEC study is critically flawed and that contrary to their conclusions, California consumers are likely to be economically harmed by the regulations. Inasmuch as the regulations took effect in 2011 and are cited as a model for the nation, our results have important legal, economic, policy and regulatory implications for California and the nation.

Keywords: public policy analysis, California Energy Commission, digital television, economic impact

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I. Introduction

In California, the consumption of energy by certain appliances and equipment is regulated, in part, by the state's Appliance Efficiency Regulations (AER).[1] These regulations are designed by the California Energy Commission (CEC) and impose standards of power consumption (e.g., watts used) for consumer appliances (e.g., refrigerators), subject to Section 25402(c) of the California Public Resources Code (CPRC) which states that standards must be "feasible" and "attainable" and must "not result in any added total costs to the consumer over the designed life of the appliances concerned."[2] In other words, the total cost to consumers of the regulations, over the life of the regulated appliance, must be nonpositive (i.e., the present value of consumer savings from reduced energy consumption must be greater than the increased price paid by the consumer for the compliant appliance). Put another way, the regulation must be consumer net-neutral.

In April 2008, the CEC's Efficiency Committee issued a Scoping Order to establish the scope of Phase I of the 2008 Appliance Efficiency Rulemaking regarding possible amendments to the Appliance Efficiency Regulations (Title 20, California Code of Regulations, Section 1601 through Section 1608).[3] Later the same month, Part C of Phase I was separately established to explicitly include televisions as part of the possible amendments. The CEC subsequently issued a Staff Draft Report in December 2008 proposing draft efficiency standards and, following a period of public and stakeholder comment, issued its final recommendation for proposed television regulations in September 2009.[4] The proposals covered television standby power consumption (i.e., when the TV is turned off) and active mode power consumption standards as well as labeling and performance requirements.

On December 3, 2009 the CEC issued its final order adopting the proposed regulations which took effect at the beginning of 2011.[5]

The CEC stated that the proposed regulations would result in overall energy cost savings to California consumers of approximately $8.1 billion (net present value) plus the savings gained by the state (and consequently taxpayers) from avoiding the construction of an approximately $615 million natural gas plant.[6]

The proposed CEC regulations were cited by the CEC Chairman,[7] CEC Commissioners,[8] and stakeholder utilities (e.g., Pacific Gas & Electric Company [PG&E])[9] as making California "a leader in clean investment and green jobs" and a model for the rest of the country. As a result, the analysis of the CEC's decision-making and assumptions underlying its new regulation has important policy and regulatory implications not only for California but for the rest of the United States.

We find that the regulations are economically misguided and that the study conducted by PG&E, upon which the CEC based its conclusions, is compromised by simple, yet important, mathematical errors and a reliance on unfounded assumptions. We ultimately conclude that the regulations will likely violate the restriction that said regulations must at least be consumer net-neutral if not net-positive.[10]

II. The Evidence and Reasons Proffered for the Regulations Are Misleading

In its 2009 Staff Draft Report, the CEC justified the need for television energy efficiency regulations by claiming television viewing and related but separate devices currently represent 10% of residential electricity usage,[11] which is increasing.[12]

One of the primary motivating factors behind the CEC's regulatory efforts is the fact (asserted in the PG&E report) that the total number of TVs in use is increasing and therefore power consumption is increasing.[13] We do not dispute the increased number of televisions in use. However, in evaluating the resulting increase on power consumption, one should consider the benefits of the *replacement effect* (i.e., gains caused by the replacement of inefficient CRT televisions with predominantly LCD technology).[14] In a working paper released in early 2011, researchers from the Ernest Orlando Lawrence Berkeley National Laboratory stated "electricity consumption is expected to slightly decrease in the short term, because of a large-scale technological transition (e.g., CRT to LCD, and CCFL-LCD to LED-LCD) and rapid improvements in TV energy efficiency, in spite of the projected increase in penetration of TVs in households . . . as well as the projected increase in the average screen size of TVs purchased."[15]

A simple modeling exercise is presented numerically in Table 1, which details the evolution of the replacement effect and estimates its magnitude from 2009 through 2018.[16] Table 1 demonstrates that while energy costs and consumption are

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Table 1.

		2009	2010	2011	2012	2013
Average energy consumption (cost factors)	Television size (in)[1]	35.8	36.8	37.6	38.3	39.0
	Television Area (in^2)[2]	547.6	578.7	604.1	626.8	650.3
	Energy Costs ($kWh)[3]	0.1592	0.1499	0.1478	0.1454	0.1443
	Hours per Year[4]	3,030	3,071	3,112	3,155	3,198
	Cost Multiplier[5]	0.4824	0.4602	0.4599	0.4586	0.4614
Stock of Television Units[6]	Television type					
	CRT	27,583,333	27,166,667	26,130,048	24,460,667	22,722,722
	DLP	6,472,222	8,916,667	9,953,897	11,534,942	13,169,680
	LCD	2,166,667	2,833,333	3,212,596	3,698,663	4,201,187
	PDP	2,194,444	2,666,667	3,035,293	3,399,535	3,775,906
	TOTAL	38,416,667	41,583,333	42,331,833	43,093,806	43,869,495
Total Estimated Energy Cost[7]	CRT	3,552,267,081	3,522,118,828	3,531,116,739	3,417,473,406	3,311,507,850
	DLP	222,299,606	308,704,627	359,537,841	431,089,326	513,781,975
	LCD	160,284,695	211,277,358	249,932,191	297,722,224	353,012,738
	PDP	191,328, 846	234,358,078	278,306,028	322,509,051	373,934,387
	TOTAL	$4,126,180,228	$4,276,458,890	$4,418,892,800	$4,468,794,007	$4,552,236,950
	PRESENT VALUE[8]	$4,126,180,228	$4,151,901,835	$4,165,230,276	$4,089,579,563	$4,044,603,569

[1] The Revised PG&E CASE Study cited the "Average Screen Size for North American TV Shipments" that explicitly forecasts the average screen sizes for 2009-2012 as noted in the exhibit. The growth rate of these forecasts asymptotically approaches approximately 2%, therefore we estimated growth for the years 2013-2018 as the last projected growth rate of 1.86%. See Revised PG&E CASE Study, p. 13, box 3.

[2] Television Area = [Television Size]*[Area:Size Multiplier]*[Television Size]. [Area:Size Multiplier] is derived by assuming an aspect ratio of 16:9 and applying the Pythagorean Theorem. This results in a multiplier of (16/9)*(81/337).

[3] Energy Information Administration 2009 Annual Energy Outlook (Early Release) estimates of the cost per kilowatt hour in the End-Use Residential sector of California for 2009-2018. See Table 84. Electric Power Projections for EMM Region, Western Electricity Coordinating Council / California.

Table 1. cont.

		2014	2015	2016	2017	2018
Average energy consumption (cost factors)	Television size (in)[1]	39.7	40.5	41.2	42.0	42.8
	Television Area (in^2)[2]	674.8	700.1	726.4	753.6	781.9
	Energy Costs ($kWh)[3]	0.1435	0.1431	0.1427	0.1433	0.1430
	Hours per Year[4]	3,241	3,285	3,330	3,375	3,421
	Cost Multiplier[5]	0.4650	0.4702	0.4752	0.4836	0.4894
Stock of Television Units[6]	Television type					
	CRT	20,914,286	19,033,383	17,077,993	15,046,041	12,935,405
	DLP	14,859,530	16,605,949	18,410,424	20,274,480	22,199,677
	LCD	4,720,604	5,257,359	5,811,908	6,384,717	6,976,264
	PDP	4,164,725	4,566,318	4,981,020	5,409,171	5,851,122
	TOTAL	44,659,146	45,463,010	46,281,345	47,114,409	47,962,468
Total Estimated Energy Cost[7]	CRT	3,184,231,672	3,038,472,900	2,856,745,349	2,655,832,584	2,395,822,717
	DLP	606,061,469	710,646,645	826,112,388	960,613,087	1,104,361,691
	LCD	414,690,303	484,587,674	561,705,617	651,561,067	747,484,675
	PDP	431,189,839	496,051,531	567,367,162	650,579,033	738,880,807
	TOTAL	$4,636,173,283	$4,729,758,750	$4,811,930,515	$4,918,585,771	$4,986,549,890
	PRESENT VALUE[8]	$3999,203,799	$3,961,098,491	$3,912,539,855	$3,882,777,028	$3,821,775,273

[4] Nielsen Media Research estimated the average total number of daily viewing hours and minutes for U.S. households in 2008 to be 8:18. This total was then multiplied by 365 days for a 2009 year estimate. The calculated geometric mean for the growth in years 1998-2008 of 1.36% acts as the yearly growth rate. This rate should be interpreted as a conservative estimate because the increase in the 2007-2008 period was only 0.81%. See Nielsen Media Research, "Americans Can't Get Enough Of Their Screen Time", November 24, 2008, table 3.

[5] Cost Multiplier = [Energy Cost ($/kwH)]*[Hours Per Year]/[1,000].

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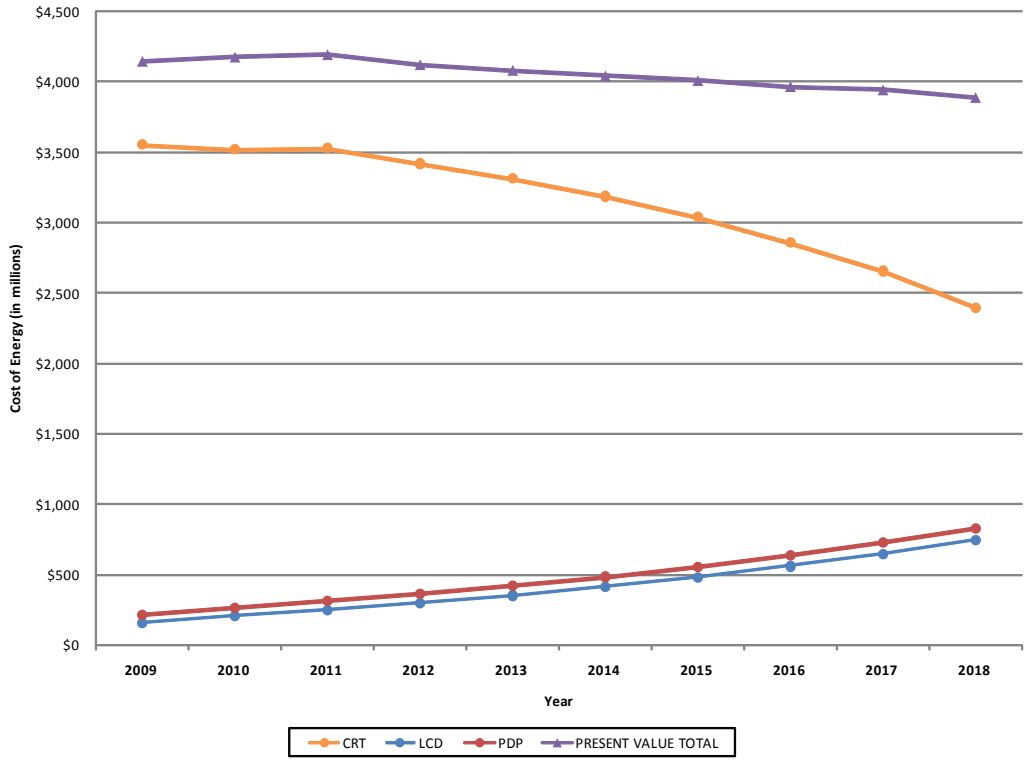
Table 1. cont.

[6] The stock of televisions is forecasted in the PG&E Emerging Technologies Program December 2006 Report, Consumer Electronics: Market Trends, Energy Consumption, and Program Recommendations 2005-2010, p. 40, table 4.2-8. The 2009 and 2010 estimates of market stock are directly from the 2005-2010 table. The exact figures and assumption (e.g., PGE&E accounts for 36% of the California population) were applied in the PG&E CASE Study, p. 13, table 4. We utilize 2005-2010 PG&E projections and forecast 2011-2018 based on the following simple linear regressions: CRT STOCK PROPORTION(t) = -0.05 + 0.96*[YEAR #(t)] , DLP STOCK PROPORTION(t) = 0.03 + 0.01*[YEAR #(t)] , LCD STOCK PROPORTION(t) = 0.01 + 0.01*[YEAR #(t)], PDP STOCK PROPORTION(t) = 0.01 + 0.02*[YEAR #(t)]. The proportion in units is calculated by taking the total stock of the year and multiplying by the proportion for that television type of the year.

[7] TOTAL ESTIMATED ENERGY COST(t) = [STOCK(t)]*[Cost Multiplier(t)]*[Energy Consumption by Television Type(t)]. CRT power consumption is calculated with the assumption that LCD televisions are 70% more energy efficient than CRT televisions. See Business and Climate, “Put yourself in the picture over energy efficient TV screens”, March 30, 2007, p.8. The average energy usage for Energy Star Qualified converter boxes (DTAs), 6.26 watts, was added to the energy consumption of CRT televisions to account for the transition to Digital Television. See Energy Star: Digital-to-Analog Converter Boxes (DTAs) Qualified Product List, February 1, 2009. DLP, LCD, PDP power consumption is calculated using the average television area for each year multiplied by the average watt per square inch used by each specific technology (0.13, 0.28, 0.33 respectively). See CNET’S Quick Guide, “The basics of TV power consumption”, February 6, 2009.

[8] The discount rate of 3% assumed in the CEC Staff Draft Report is conservatively applied to calculate the Present Value. See CEC Staff Draft Report, p. 7.

Figure 1: Total Estimated Energy Cost of Televisions by Type



increasing due to consumers watching more television on larger screens, the offset due to relatively more efficient technology keeps energy costs to consumers constant over time. This is also displayed graphically in Figure 1 below. These results demonstrate that the CEC's claims that larger screen sizes necessitate energy control and regulation are dubious at best.

A. The CEC Distorts Energy Consumption Forecasts

The CEC made the following statement at its public hearing of October 13, 2009:

> The residential consumption due to new televisions, digital televisions, rapidly increased from 3 to 4 percent in the 1990s to 8-10 percent in 2008. And it is continuously growing.

> Without regulations, the residential energy consumption may grow up to 16-18 percent by 2023.[17]

An increase in residential consumption from 10% to 16% over 15 years would require a growth rate of 3.2% which is not supported by any analysis, evidence, or data found in the CEC docket, PG&E reports, or energy literature. In fact, a white paper released in 2008 co-authored by PG&E cites the U.S. Energy Information Administration (EIA) Annual Energy Outlook (AEO) from 2008 as its source for stating that televisions comprised 6.5% of residential consumption in 2005 and will comprise only 9.4% of residential electricity in 2030.[18] This is based on the 2008 AEO's estimated 2005-2030 growth rate of 1.8% .

Additionally, supporters of the CEC's position, such as the Environmental Defense Fund, have similarly asserted false or misleading energy consumption growth rates:

> TVs account for 10 percent of household electricity and their energy consumption rate is increasing 8 percent annually.[19]

Granted, the CEC is presented with differing data and opinions; however, the AEO is a nationally recognized source for energy statistics and has been relied on heavily by PG&E in the past, and also in PG&E's support for these regulations.

III. CEC'S Savings Estimate of $8.1 Billion Is Predicated on Math and Logic Errors and Flawed Assumptions—Expected "Savings" Are Likely Negative

The CEC based its estimated present value of overall energy savings in large part on the analysis contained in the PG&E Revised CASE Study; see Exhibit 1.[20] The Revised CASE Study was misinterpreted and then incorrectly utilized by CEC in its present value computation.

A. CEC Incorrectly Uses 6.5 TWh As Its Annual Energy Savings Estimate

The CASE study reports annual incremental energy savings, which accumulate to 6.5 TWh/yr *after* complete stock turnover in 2022.[21] In other words, annual savings are 6.5 TWh/yr only in the final year of the study—2022. The CEC misinterpreted this finding and concluded that annual cost savings for *each* year between 2011 and 2022 are 6.5 TWh/yr. The correct application of the CASE study 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

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**

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).

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regulation. Simply correcting this error reduces the estimated $8.1 billion in savings to $3.5 billion; see Exhibit 2.

That the CEC misinterpreted and misapplied the CASE report is an incontrovertible fact. Although this error was pointed out during the review process,[22] at no point during the regulatory proceedings did the CEC acknowledge this error or amend its analysis accordingly. In its final response to industry, the CEC reiterated: "The Energy Commission estimated from information in the record that the statewide benefit from the efficiency standards for televisions will result in an energy savings of 6,515 GWh/yr that will result in a direct energy cost savings to consumers of 8.1 billion dollars" and concluded by saying "[t]here is no mathematical error in the analysis. CEA and its allies have not identified any error."[23] Indeed, its press release announcing the approved regulations was issued on November 18, 2009 with the subtitle "*First in the Nation Standard Will Save Consumers $8.1 Billion Over 10 Years.*"[24]

B. CEC Used an Unreasonable Discount Rate to Estimate the Net Present Value of Energy Cost Savings

One of the fundamental tenants of financial economics is the concept of present value which, in simple terms, allows for the comparison of the worth of a dollar today with a dollar tomorrow.[25] In principle, a dollar today is worth more than a dollar tomorrow because the dollar today can be invested in order to generate a return. In other words, future dollars must be discounted at an appropriate discount rate to account for this lost opportunity to invest and earn a return. In this case, where consumers are allegedly saving money from reduced future electricity expenditures, the appropriate discount rate is the consumers' opportunity cost (e.g., the amount that the consumer could earn with his dollar today or more conservatively the costs that could be avoided by paying down debt). This discount rate is often referred to as the *cost of capital,* which incorporates both the concepts of opportunity cost and risk.

Our position that the consumer's cost of capital is the appropriate discount rate is consistent with the United States Department of Energy's position:

> The life-cycle costs (LCC) and payback period (PBP) analyses determine the economic impact of potential standards on individual consumers. . . . The LCC calculation considers the total installed cost of equipment manufactured to comply with potential energy efficiency standards (equipment purchase price plus installation cost), the operating expenses of such equipment (energy and maintenance costs), the lifetime of the equipment, and uses the discount rate that reflects the **consumer cost of capital** to put the LCC in current year dollars.[26]

The CEC assumes without any exposition or analysis that the consumer cost of capital is 3%. We have conducted a thorough review of the records in this pro-

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.

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ceeding/rulemaking and, to the best of our knowledge; the following chronology represents the full extent of the "analysis" conducted by the CEC in arriving at their 3% discount rate. First, PG&E commissioned a report from Energy Solutions, resulting in the CASE Report dated July 8, 2008.[27] This report sets forth the basic model which serves as the foundation of the CEC's analysis. It contains no analysis of discounting. Next, using the CASE report as the basis of its analysis the CEC issues its Staff Draft Report, which states: "The present value of a kWh over a 10 year design life is calculated to be $1.244 using $0.14 per kilowatt hour with a 3 percent discount rate."[28] No explanation or justification is given for assuming a 3% discount rate.

The estimation of the average California consumer cost of capital is beyond the scope of this paper. However, a conservative approximation can be readily derived. First, one can safely assume that California consumers generally carry some level of debt (e.g., mortgage, credit card, automobile financing).[29] Any dollar invested today in order to earn a return in the future could instead be used to reduce the consumer's total debt (e.g., by paying down a credit card or student loan) and hence reduce the consumer's interest payments. Consumer borrowing rates for the purposes of purchasing a television can be assumed to be bounded by 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 14.67%.[30] Consumer finance rates offered by retailers for electronic purchases are approximately 25%.[31] On April 15, 2011, Bank of America showed automobile interest rates ranging between 2.99% and 6.05%.[32]

Second, assuming that some fortunate consumers may have no debt to reduce, one must then consider the opportunity cost of investing the dollar today in either debt or equity instruments. The equity premium (the return required above the risk free rate in order to induce investors to invest in equities) is approximately 6%.[33]Given that 30-year constant maturity U.S. treasuries currently yield approximately 4%, the opportunity cost of investing in the market can be taken as approximately 10%.[34]

A weighted combination of these various rates (giving due consideration to, among other things, individual debt differences, investment preferences, and risk aversion) averaged over all purchasers of televisions in California would result in the California consumer cost of capital. The weightings are unknown, but given these data points, there seems little doubt that the appropriate discount rate to apply is *at least* 10%.

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

C. The CEC Ignores That Competition, Not Regulation, Is Driving the Production and Adoption of More Efficient TV 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 and existing voluntary programs such as ENERGY STAR.[35] 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 TV energy efficiency are made between that baseline and 2022.[36] PG&E itself recognizes this limitation and states repeatedly that their analysis "*does not account for natural market adoption of higher efficiency models*."[37] The CEC analysis similarly fails to account for this significant limitation.

The evidence shows that, absent regulation, the energy efficiency of TVs has improved remarkably over time.[38] Figure 2 shows the improvement in power consumption for LCD TV power consumption for the industry as well as announced targets for Sharp, one of the largest producers of flat panel televisions.[39] These improvements in energy efficiency have been generated as a result of the competitive nature of the consumer electronics industry, not as a result of regulation.[40] Simply comparing ENERGY STAR data over time reveals a time-weighted 29.3% power reduction from December 2007 to October 2009.[41]

The television industry itself believes that the average energy efficiency (across all TVs, not just ENERGY STAR compliant models) will continue to improve. The historical evidence shows that, on average, LCD energy efficiency is improving by approximately 15% a year and is expected to continue at this rate for the next few years.[42] In our discussions with the various manufacturers, we were informed that a 10% annual improvement through 2022 for LCD TVs could readily be expected. Moreover, Panasonic states that the energy efficiency of their plasma TV technology has improved by approximately 30% between 2008 and 2010.[43] Similarly, another manufacturer indicates that from December 2007 to October 2009 the energy efficiency of TVs improved by 22% annually.[44]

It is virtually certain that future efficiencies would continue to be obtained in the absence of government regulation. Consequently, one must measure the cost savings of the regulations against the expected energy efficiency of unregulated televisions in 2010, 2011, 2012 . . . 2022, not simply against the efficiency of 2006-2008 TVs (as the CEC has done).

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

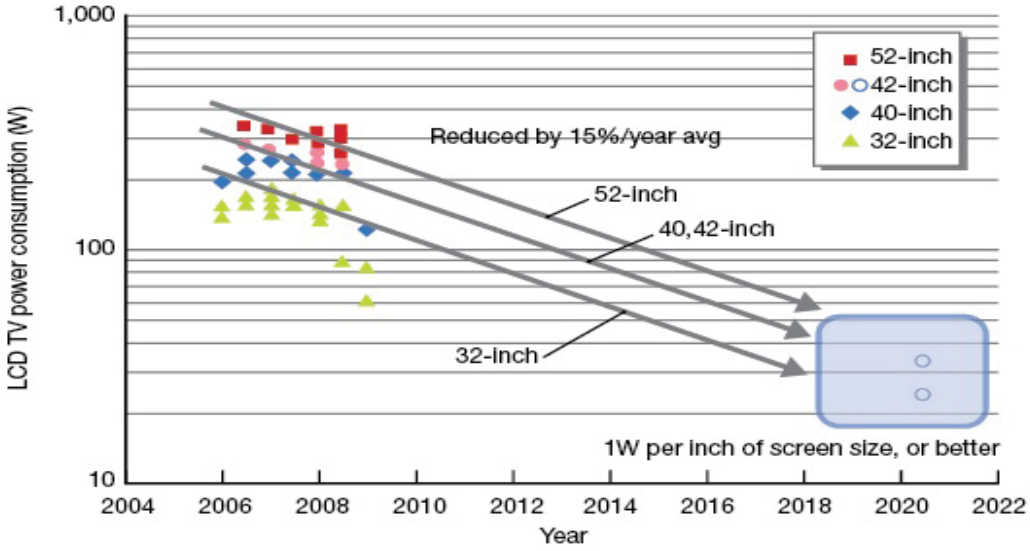
Year	1st year Incremental Savings from Tier 1 and 2 (TWh)[2]	Actual Cumulative Incremental Savings from Tier 1 and 2 (TWh)	Annual Energy Prices ($/kWh)[3]	Corrected Energy Savings ($M)	Present Value (@10%) of Cumulative Incremental Savings from Tier 1 and 2 ($M)
a	**b**	**c(t) = b(t) + c(t-1)**	**d**	**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

[2] See Exhibit 1: Column J.

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

Figure 2: Historical and Estimated Energy Efficiency Improvements



In arguendo, assuming an annual efficiency gain of 17% between 2008 and 2010 and just 1% for both LCD and plasma televisions annually thereafter reduces the 6.5 TWh/yr cumulative incremental savings in 2022 to 1.7 TWh/yr. Following PG&E's own model this decreases the previously estimated $2.4 billion savings to $548 million. See Exhibit 4 for a complete analysis of these figures.

D. CEC Assumes Zero Cost of Compliance with the Regulations; a Cost of Compliance Greater Than $17 Eliminates Any Potential Savings

The fourth major flaw in the CEC analysis is the assertion that the cost of compliance—that is the increased television purchase price to consumers of the regulation, setting aside energy efficiencies—is zero. The CEC's support for this claim is simply that compliant models currently exist, that in some cases these models are less costly than non-compliant models, and that one TV manufacturer (Vizio) supported the regulation.[45] These points fall far short of conclusive evidence that the cost of compliance is zero.

First, simple reliance on fundamental economic theory indicates that the cost of compliance is unlikely to be zero. *Ceteris paribus*, if manufacturers could satisfy demand (in terms of customer-demanded price and feature combinations) with models that are simultaneously more energy efficient and no more expensive to the consumer, they would already be doing so for competitive reasons because the

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**

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).
See Exhibit 7: Column L.
See Exhibit 8: Column L.
Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.

economic gains (i.e., the consumer savings from lower power consumption) would be divided between the supplier and the consumer resulting in economic improvement for both parties.

Second, and perhaps more importantly, it is our opinion that the absence of easily accessible data does not equate to a waiver of the CEC's obligation to comply with the CPRC and promulgate only consumer net-neutral regulations. In concept the necessary data can be readily assembled; one need only collect the technical specifications for all televisions sold in California and build a database that includes power consumption as well as other important features and elements such as price, size, warranty, contrast ratio, etc. This data is available to the CEC; a quick search of televisions on Best Buy's website indicates that power consumption is provided for every television sold through that retailer.[46] Similarly, the technical specifications were available at retailers such as Amazon and Costco as well. Admittedly, the building of such a database is a resource consuming project but that does not make it undoable. With such a database, one could readily determine which televisions (and potentially even which manufacturers) would be removed from the market and thus the extent that competition would be reduced.Ultimately, if the increased cost of a compliant television is $17, the estimated $548 million in savings is eliminated. Any price increases above $17 would immediately cause the regulations to be consumer net-negative; see Exhibit 5. Given that a relatively small increase would result in the regulations being net-negative to consumers it is our opinion that the CEC should have addressed the cost issue in a more systematic and scientific way (e.g., by building the necessary database).

IV. Conclusion

In summary, on December 3, 2009 the CEC issued its final order adopting proposed regulations on TV energy consumption. These regulations took effect at the beginning of 2011. In that final order, the CEC asserted that the regulations will result in overall energy cost savings to California consumers of approximately $8.1 billion (net present value) plus the savings gained by the state (and consequently taxpayers) from avoiding the construction of an approximately $615 million natural gas plant, and that the overall cost impact on California consumers would satisfy the net-neutral requirement of the CPRC.[47]

We believe that the CEC analysis supporting its assertion is deeply flawed and: (1) includes mathematical and logic errors; (2) uses an inappropriate discount rate in computing net present value of the savings; (3) ignores competition driven technological improvements; and (4) substitutes assumption for analysis when asserting a zero cost of compliance.

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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**

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).
See Exhibit 7: Column L.
See Exhibit 8: Column L.
Annual Energy Prices were not explicitly given by the CEC. See Exhibit 6.
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.

We find that once the errors in the CEC analysis are corrected, a mere $17 increased selling price for compliant televisions would violate the net-neutral requirement of the CPRC. As a matter of economic theory, we do not believe the cost of compliance to be zero. More importantly, the CEC has the ability to acquire the necessary data to perform the needed analysis and has simply chosen not to do so.

To the extent that other states consider adopting similar regulations, their respective legislative bodies and regulatory agencies should be aware of the flaws and shortcomings of the CEC analyses proffered in support of the now-effective California regulation.[48]

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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.

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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.

Notes

[1] California's Appliance Efficiency Regulations were established in 1976 and are updated periodically to reflect new energy efficiency technologies. The current Appliance Efficiency Regulations, (California Code of Regulations, Title 20, Sections 1601 through 1608), dated August 2009, contain amendments that were adopted by the California Energy Commission on December 3, 2008, and replaced all previous versions. The official version of these regulations is published by the Office of Administrative Law.

The Appliance Efficiency Regulations include standards for both federally-regulated appliances and nonfederally regulated appliances. Twenty-three categories of appliances are included in the scope of these regulations. The standards within these regulations apply to appliances that are sold or offered for sale in California, except those sold wholesale in California for final retail sale outside the state and those designed and sold exclusively for use in recreational vehicles or other mobile equipment. Source: 2009 Appliance Efficiency Regulations, California Energy Commission, August 29, CEC-400-2009-013.

[2] California Public Resources Code Section 25402.

[3] <http://www.energy.ca.gov/appliances/2008rulemaking/notices/2008-04-02_COMMITTEE_SCOPING_ORDER.PDF>.

[4] 2009 Appliance Efficiency Rulemaking, Phase I, Part C - Docket #09-AAER-1C.

[5] State of California Energy Resources Conservation and Development Commission (Appliance Efficiency Regulations). Docket No. Docket No. 08-AAER-1 C. Order Number 09-1118-13. Order Adopting Regulations and Directing Additional Rulemaking Activities.

[6] 2009 Appliance Efficiency Rulemaking, Phase I, Part C - Docket #09-AAER-1C. Page *v*.

[7] "…Energy efficiency standards are one of the most important responsibilities of the Energy Commission and, in part, in large part, through our standards, the energy use of per capita energy use of Californians has remained constant for the past 30 years, where it has gone up 40 percent on average in the rest of the country." CEC Chairman Karen Douglas. Proposed Amendments To Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009. Page 9.

[8] "I would like to quote our governor, Arnold Schwarzenegger, who just last month said, and I quote, 'Being a leader in clean energy standards has made California a leader in clean energy investment and green jobs. In the last three years, more than $6 Billion . . . ,' and that is Billion with a "B," '. . . $6 Billion in venture capital has been pumped into California's economy, making us the national leader in a number of clean businesses.' So this is not the original purpose of our energy efficiency standards, but we think it is a very large additional benefit. . . ." Julia Levin, CEC commissioner. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, page 9.

[9] "California will lead not only the nation but the entire world by adopting these standards." Alex Chase (Energy Solutions, PG&E). Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, page 55.

[10] In 2008, we were engaged by the Consumer Electronics Associations (CEA) to conduct an analysis of the economic impact of the television efficiency standards proposed by the CEC, and some of the analysis presented in this paper are a result of that work

[11] "Currently the total energy used by television viewing, and the associated peripherals commonly connected to them, is estimated to represent about 10 percent of residential electricity use. The Energy Commission has found to be a significant amount of energy use statewide." 2009 Staff Draft Report, page 11. This statistic is sourced from "Cable and Satellite Set-Top Boxes," a 2005 white paper that included a hypothetical example of a household with one plasma HDTV, one ana-

log CRT TV, two DVD/VCRs, one HD set top box, and one digital set top box, all of which would require approximately 1,200 kWh/year. After rounding down to 1,000 kWh/year, it is claimed this "amount translates to approximately 10 percent of residential electricity use and is greater than the average annual energy used to light the entire home." Page 2, <http://www.nrdc.org/air/energy/energyeff/stb.pdf>. This claim quoted by the CEC was made without citation to supporting facts.

[12] "PG&E submitted to the Energy Commission in July, 2008, their revised Codes and Standards Enhancement (CASE) Initiative study related to televisions. This study showed a continuous increase in household television energy use." 2009 Staff Draft Report, page 11.

[13] "PG&E's analysis indicates that energy consumption of digital flat screen TVs is, in addition to other factors, proportional to screen size. The demand for larger screen size TVs is continuously growing; consequently, energy consumption is also on the rise." See CEC Staff Draft Report, page 2.

[14] LCD televisions compose approximately 90% of the market of new television purchases and LCD televisions are 70% more energy efficient than CRT televisions. See Business and Climate, "Put yourself in the picture over energy efficient TV screens," March 30, 2007, page 8. LCD televisions have become more efficient since 2007, the current stocks of CRT TVs in use is relatively even more inefficient. This point is conceded but not quantified by PG&E: "The market is rapidly shifting; the formerly ubiquitous cathode ray tube TV with an analog signal will soon be surpassed by new types of digital televisions." See PG&E in the Codes and Standards Enhancement ("CASE") Initiative "Analysis of Standards Options for Televisions". April 1, 2008.

[15] "TV Energy Consumption Trends and Energy-Efficiency Improvement Options" Park, Phadke, Shah, Letschert. Environmental Energy Technologies division Internal Energy Studies Group. May 13, 2011. <http://ies.lbl.gov/drupal.files/ies.lbl.gov.sandbox/SEAD_TVAnalysis_Draft_Working_Document.pdf>.

[16] Table 1 aggregates data from a number of different sources; these sources are cited in the footnotes to the table.

[17] Harinder Singh, Project Manager for Television Rulemaking. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, page 16.

[18] "The Television and Set-top Box category is expected to increase from 6.5% of overall residential electricity in 2005 to 9.4% in 2030." *Consumer Electronics Efficiency Programs: The Next Big Challenge.* Alex Chase and Ted Pope, Energy Solutions. David Canny, Pacific Gas and Electric Company, <http://eec.ucdavis.edu/ACEEE/2008/data/papers/9_277.pdf>.

[19] Lauren Navarro, Environmental Defense Fund. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, page 115.

[20] See PG&E Revised CASE study. July 3, 2008, page 17, Table 8.

[21] See PG&E Revised CASE study. July 3, 2008, page 14, Table 3.

[22]"First of all, there is a mathematical calculation error in their analysis. If you fix that error, the $8.1 billion number drops to $4.9 billion, and that is without changing anything in their model other than fixing an arithmetic error." C. Paul Wazzan. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, page 16.

[23] Supplemental Response to Consumer Electronics Association's comments. DOCKET 09-AAER-1C. DATE NOV 02 2009, RECD. NOV 02 2009.

[24] <http://www.energy.ca.gov/releases/2009_releases/2009-11-18_tv_regulations.html>.

[25] See, e.g., Brealey, Richard A. and Stewart C. Myers, *Principles of Corporate Finance*, McGraw-Hill Irwin, New York, N.Y., 2003.

[26]Department of Energy, Office of Energy Efficiency and Renewable Energy, 10 CFR Part 430, [Docket No. EE–RM/STD–00–550]. RIN 1904–AB08. Federal Register /Vol. 69, No. 145 /Thursday, July 29, 2004 / Proposed Rules, p 45377.

[27] PGE Revised Television Proposal.pdf Jul 08 2008.

[28] CEC Staff Draft Report, December 2008 CEC-400-2008-028-SD, PHAS E 1, PART C DOCKET # 07-AAER- 03 –C.

[29] Total U.S. revolving debt (98% of which is made up of credit card debt): $852.6 billion, as of March 2010 (Source: Federal Reserve's G.19 report on consumer credit, March 2010). Total U.S. consumer debt: $2.45 trillion, as of March 2010 (Source: Federal Reserve's G.19 report on consumer credit, May 2010). Average credit card debt per household with credit card debt: $16,007 (calculated by dividing the total revolving debt in the U.S. ($852.6 billion as of March 2010 data, as listed in the Federal Reserve's May 2010 report on consumer credit) by the estimated number of households carrying credit card debt (54 million). Average total debt in 2009 (including credit cards, mortgage, home equity, student loans and more) for U.S. households with credit card debt: $54,000. Average total debt in 2009 (including credit cards, mortgage, home equity, student loans and more) for all U.S. households: $16,046. Total U.S. consumer debt (which includes credit card debt and noncredit-card debt but not mortgage debt) was $2.45 trillion at the end of 2009 (Source: Federal Reserve's G.19 report, March 2010). Total U.S. consumer revolving debt fell to $866 billion at the end of 2009, down from $958 billion at the end of 2008. About 98 percent of that debt was credit card debt. (Source: Federal Reserve's G.19 report, March 2010). Source:< http://www.creditcards.com/credit-card-news/credit-card-industry-facts-personal-debt-statistics-1276.php#ixzz1JcXPKExm>. Note that slightly more than half of Americans— 51%—said that in the past 12 months, they carried over a balance and was charged interest on a credit card. (Source: "Financial Capability in the United States," FINRA Investor Education Foundation, December 2009).

[30] Average APR on credit card with a balance on it: 14.67%, as of February, 2010. (Source: Federal Reserve's G.19 report on consumer credit, May 2010).

[31] See, e.g., Best Buy's credit card program states: "HSBC Deferred Interest Info Variable APRs as of 04/01/2011: Plan A: For Accounts generated on or after 06/29/10: Variable Standard Rate APR: 25.24%. Variable Penalty Rate APR: 29.99%. For Accounts generated before 06/29/10: Variable Standard Rate is 24.24%. Variable Penalty Rate is 29.24%. Plan B: Variable Standard APR: 27.99%. Variable Penalty APR: 29.99%." Best Buy website accessed on 4/15/11. <http://www.bestbuy.com/site/null/null/pcmcat163300050048.c?id=pcmcat163300050048>.

[32] Bank of America website accessed 4/15/11. <http://www.bankofamerica.com/vehicle_and_personal_loans/index.cfm?template=auto_loans&cm_mmc=eLend-Auto-_-BAC-Homepage-_-AutoLoans-_-TextLink>.

[33] See, e.g., Fernandez, Pablo and Del Campo Baonza, Javier, Market Risk Premium Used in 2010 by Professors: A Survey with 1,500 Answers (May 13, 2010). Available at SSRN: <http://ssrn.com/abstract=1606563>.

[34] Thirty-year constant maturity yield is 4.07%, Federal Reserve Statistical Release, H.15 Daily update. 4:15 p.m. Eastern Time, July 29, 2010.

[35] "In 1992, the U.S. Environmental Protection Agency (EPA) introduced ENERGY STAR as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions. Computers and monitors were the first labeled products. Through 1995, EPA expanded the label to additional office equipment products and residential heating and cooling equipment. In 1996, EPA partnered with the U.S. Department of Energy for particular product categories. The ENERGY STAR label is now on major appliances, office equipment, lighting, home electronics, and more. EPA has also extended the label to cover new homes and commercial and industrial buildings." <http://www.energystar.gov/index.cfm?c=about.ab_history>.

[36] See PG&E Revised CASE study. July 3, 2008, page 16, Table 7.

[37] See e.g., PG&E Revised CASE study. July 3, 2008, page 16, Table 7, fn 5.

[38] See e.g., King, Ponoum, Power Consumption Trends in Digital TVs Produced Since 2003, TIAX, February 2011.

[39] See, e.g., Tanaka, Naoki, Lower Energy Consumption Top Priority with LCD TVs, *Nikkei Electronics Asia*, Jul 14, 2009.

[40] See, e.g., Tanaka, Naoki, Lower Energy Consumption Top Priority with LCD TVs, *Nikkei Electronics Asia*, Jul 14, 2009. "At the International Consumer Electronics Show (CES), the largest digital consumer electronics show in the world held in Las Vegas in Jan 2009, Sony Corp of Japan announced the VE5 Series of LCD TVs offering a reduction of about 40% in power consumption. Sony stated that the outstanding thrust of the line is that it is "eco-friendly." Panasonic Corp of Japan announced new panels, the NeoPDPeco and NeoLCDeco, both featuring low power consumption as the key point and slated for commercial release in TVs before the end of 2009. Taken together with other developments such as the announcement of an LCD TV by Sharp Corp of Japan achieving about 30% lower power consumption, these events reveal that energy conservation is becoming a major new competitive factor."

[41]"If you compare ENERGY STAR data from December 2007 to now, October 2009, you will find that there is a 29.3% average power savings weighted across all sizes. That translates into a 41.4% energy improvement over that time period." Bill Belt, CEA. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, pages 95-97.

[42] See, e.g., Tanaka, Naoki, Lower Energy Consumption Top Priority with LCD TVs, *Nikkei Electronics Asia*, Jul 14, 2009.

[43] David Katzmaier and Matthew Moskovciak, "The Basics of TV Power," CNET, April 21, 2010. <http://reviews.cnet.com/green-tech/tv-power-efficiency/?tag=allEfficiency%20guidesTab;allEfficiency%20guidesDropDown>.

[44] Per confidential discussions with the manufacturer.

[45] "There is the Sylvania model and Envisions, and then there is a Vizio model, they are the same way, the cost in the Vizio model is a $40.00 difference here, and lifetime energy savings cost is $150.00. So that all indicates that the cost-effectiveness of the televisions, the energy efficient televisions are made available to the consumers and it is not costing any extra money." Harinder Singh, Project Manager for Television Rulemaking. Proposed Amendments to Appliance Efficiency Regulations California Code of Regulations Title 20 Sections 1601 through 1607 Public Hearing Transcript October 13, 2009, pages 38-39.

[46] <www.best.buy.com> accessed on May 23, 2011. The Panasonic Viera 50" Class / 1080p / 600Hz / Plasma HDTV, Model: TC-P50S30 | SKU: 2120201, indicated power consumption of 106 watts in on-mode and 0.2 watts in stand-by mode.

[47] The avoided construction cost of the approximately $615 million natural gas plant was not asserted in the CEC's final press release nor corroborated through analysis. It was therefore not included in this analysis although it could be easily incorporated at a later date.

[48] The CEC indicates that "Massachusetts has held hearings, and Washington is gathering information on new standards that match California's proposed standards." Supplemental Slides to Legislative Hearing Presentation, Legislative Hearing, October 21, 2009, Chairman Karen Douglas California Energy Commission. More recently, the Connecticut Legislature passed a bill directing a state agency to conduct a review of the California regulation (Senate Bill 1243, June 2011), <http://www.cga.ct.gov/2011/ba/2011SB-01243-R01-BA.htm>.