

# Reanalysis of the 2006-08 Upstream Lighting Program

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## Executive Summary

From 2006 to 2008, California residents purchased over 90 million heavily discounted compact fluorescent lamps, through an initiative administered by the state's investor-owned electric utilities and overseen by the California Public Utilities Commission (CPUC) known as the Upstream Lighting Program (ULP). This innovative program provided rebates directly to compact fluorescent light bulb manufacturers, thereby dramatically reducing the price of the bulbs to consumers, while requiring the light bulbs to meet increasingly stringent performance standards. The CPUC's staff evaluation of the 2006-2008 Upstream Lighting Program (ULP Evaluation Report) concluded that the Upstream Lighting Program was a success in that it provided over \$50 million in net benefits to utility customers.

However, California's recent program to promote energy-efficient light bulbs was a far bigger success than the CPUC's staff evaluation indicates. As detailed in this report, errors and biases in estimates for incremental measure costs, net-to-gross ratio (NTGR), and installations in the ULP Evaluation Report resulted in an erroneously large estimate of program costs and an extremely low estimate of program benefits. ***When corrections for these three areas are made, net benefits increase by over \$1 billion. In total, the program provided customers with over \$7 in benefits in energy savings and pollution reductions for every \$1 invested.***

The intent of this report is first and foremost to develop a more accurate and representative estimate of the impacts of the Upstream Lighting Program. Some stakeholders have questioned whether the efficiency programs in California have been successful or whether the state would have achieved the savings even without the programs, based largely on perceptions about the ULP. This analysis highlights that the efficiency programs have been an enormous success for California consumers, and that these savings would *not* have been achieved without the program. It also highlights the need for the CPUC to provide a process to resolve the legitimate technical disputes that experts may have over evaluation results, so that the CPUC can be sure it understands the full impact of the efficiency programs it oversees.

NRDC does not believe that the 2006-08 ULP program should be revived unchanged, nor that the CPUC should re-litigate the utilities' incentives for efficiency during those years. Instead, we believe that lighting programs should continue to evolve over time, as they have done for decades. The purpose of the revised estimates in this report is to provide a truer picture of past program impacts and thereby a better guide to help California take full advantage of future opportunities to achieve cost-effective energy efficiency savings.

## **I. Introduction**

Early in the past decade, the state's three largest private electric utilities working with their regulators developed a strategy to transform California's market for light bulbs. The utilities provided rebates directly to compact fluorescent light bulb manufacturers to dramatically reduce the price of the bulbs to consumers while requiring them to meet increasingly stringent performance standards. This initiative, known as the Upstream Lighting Program (ULP), accounted for 56% of the net expected energy savings from the portfolio of programs administered by these utilities over the 3-year program period from 2006 to 2008.

Based on the California utilities' approved program plans, the program was wildly successful. The California utilities provided upstream rebates on over 90 million efficient light bulbs from 2006 to 2008, with 43 million sold in 2008 alone. In terms of the number of bulbs rebated, the utilities achieved 150% of the stretch goals established by the Commission. Annual statewide sales of CFLs increased ten-fold from 2003 to 2008<sup>1</sup>.

In February 2010, the Energy Division of the California Public Utilities Commission (CPUC) released its evaluation (ULP Evaluation Report) of the impacts of the 2006-2008 ULP program<sup>2</sup>. The goal of the ULP Evaluation Report was to estimate how much electricity was saved and how much peak demand was reduced by the CFLs that received rebates through the program. Surprisingly, this report concluded that the net savings from each bulb was only 25% of what was expected when the CPUC approved the programs. As a result, even though the utilities substantially exceeded their goals, the ULP evaluation proposed to credit the utilities with achieving only a small fraction of the expected energy savings for the ULP. Since the ULP was such a large fraction of the overall portfolio, this made it nearly impossible for the utilities to meet their savings goals for the overall portfolio.

It is important to note that the ULP program was found to be cost-effective even under dramatically reduced estimates of savings in the Evaluation Report. The Energy Division found this program to be clearly cost effective, saving utility customers tens of millions of dollars.

### **Overview of Reanalysis**

This paper offers a reanalysis of just three of the parameters that led to the dramatic reduction in energy savings in the ULP Evaluation Report. Each of the three is described briefly below. A detailed explanation of the three parameters and the impact on energy savings is followed by a summary of the results of the reanalysis.

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<sup>1</sup> The year 2003 is a reasonable starting point both because it immediately preceded the significant expansion of the ULP program to its current status and because it could reasonably be considered the most up-to-date sales data available when the utilities developed and the CPUC reviewed the 2006-08 program plans.

<sup>2</sup> "Final Evaluation Report: Upstream Lighting Program," KEMA, Inc., February 8, 2010  
[http://www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport\\_2.pdf](http://www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport_2.pdf)

- **Incremental measure cost:** According to CPUC policy rules, total program costs from a societal perspective include the net incremental cost to program participants of the efficiency measures that are promoted through the program (i.e. CFLs). In estimating program costs, the ULP Evaluation Report failed to account for the cost savings from the incandescent lamps that participants avoided purchasing. We provide a revised estimate of program costs that accounts for the cost savings from avoided incandescents.
- **Net-to-gross ratio:** According to CPUC policy rules, the calculation of program benefits only includes energy savings from CFL sales beyond what would have occurred in the absence of the program. The ULP Evaluation Report estimated that nearly half of the CFL sales would have occurred in the absence of the program. Based on a corrected analysis of report data and a review of national sales trends, we propose a revised NTGR.
- **Post-2008 installations:** CPUC policy rules credit utilities with savings from measures installed during the program cycle. The ULP evaluation interpreted this rule to include costs but exclude savings from bulbs rebated through the ULP but installed after December 31, 2008. In order to provide an estimate of the full benefits of the ULP, we recalculate total benefits to include savings from bulbs installed in 2009 and 2010.

To determine the impact of these three factors, the Natural Resources Defense Council (NRDC) contracted with the Heschong Mahone Group (HMG) to calculate total costs, total benefits<sup>3</sup>, net benefits, and the benefit-to-cost ratio for the 2006-08 ULP after adjusting for each of the three revised parameter estimates separately and in combination. The results of the reanalysis are described in section V of this report and summarized below in Table 1 and Figure 1. A memo from HMG describing their analysis is included as Attachment A.

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<sup>3</sup> Program benefits represent the cost savings from meeting electricity demand through efficiency rather than increased generation.

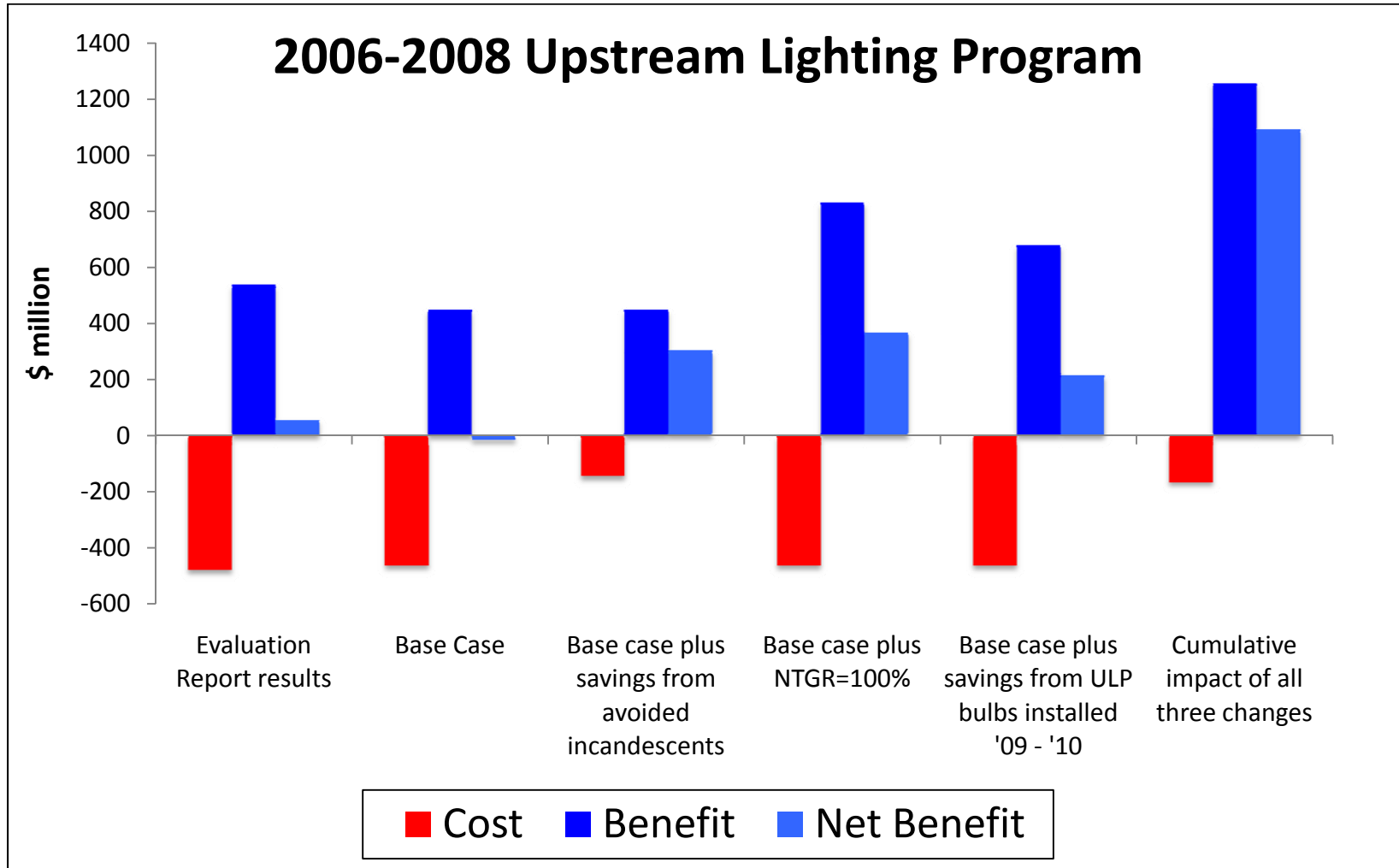
**Table 1: Costs and benefits of 2006-08 ULP using different parameter estimates**

	Cost	Benefit	Net Benefits	Benefit/Cost ratio
	(Million \$)			
Evaluation Report results (1)	-\$481	\$537	\$56	1.1
Base Case (2)	-\$465	\$449	\$-16	1.0
Base case + Cost savings from avoided bulbs	-\$146	\$449	\$303	3.1
Base case + Net-to-Gross Ratio = 100%	-\$465	\$831	\$367	1.8
Base case + Savings from bulbs installed '09 - '10	-\$465	\$680	\$215	1.5
Base case + Cost savings from avoided bulbs Net-to-Gross Ratio = 100% Savings from bulbs installed '09 - '10	-\$167	\$1,258	\$1,092	7.6

(1) Base on reported results for the Upstream Lighting Program (i.e. PGE2000, SCE 2501, SDGE3016) in the 2006-08 Energy Efficiency Evaluation Report.

(2)The Base Case is based on Evaluation Report models and estimates of measure cost, NTGR, and intallation rate. The Base Case is labeled “Scenario A1, NTGR = 54% in the HMG analysis.

Figure 1: Costs and benefits of 2006-08 ULP using different parameter estimates



We attempted to reproduce the results reported by Energy Division staff in the Summary Report on 2006-08 impacts<sup>4</sup> in order to provide a clear basis for comparison to the ULP Evaluation Report. We contacted Energy Division in an effort to properly align our base case with their final evaluation numbers, but were unable to exactly reproduce their results. Our “Base Case” scenario uses the same models and adopts the same values for incremental measure cost, NTGR, and installation rate<sup>5</sup>. However, the benefits we calculate using their parameter values are approximately \$70 million lower than reported by Energy Division. The Benefit-to-Cost ratio for our Base Case is 1.0 compared to the 1.1 reported by Energy Division<sup>6</sup>.

The lifecycle benefits estimated by Energy Division are approximately 20% greater than for our Base Case scenario. Adjusting our analysis to account for the difference would likely result in a proportional increase in total benefits for the other scenarios. In other words, if we were able to precisely replicate the Energy Division results, the total benefits for each of the scenarios would likely increase by approximately 20%.

This reanalysis only includes a revised estimate of ULP impacts based on updates to these three specific parameters. However, the staff Evaluation Report also revised a number of other parameters that further reduced the estimated net benefits of the ULP. Other parameter changes from the original CPUC-approved program plans that also resulted in reduced net benefits were lower hours of use, much greater interactive effects, fewer non-residential installations, and the exclusion of installations outside IOU service territories. Reanalysis of these additional parameters could result in substantial additional increases to the estimated benefits of the ULP.

## **II. Incremental Measure Cost**

The ULP was so successful at stimulating purchases of CFLs in large part because it was able to lower the price of a CFL to less than the cost of the incandescent bulbs that it would replace. As described in the Evaluation Report, the ULP provided rebates directly to lighting manufacturers. The rebate resulted in a lower price to retailers who imposed a lower markup on the wholesale price. A rebate that averaged less than \$1.60 per bulb resulted in a net price reduction at the register for consumers that totaled \$2.70 per bulb. Overall, the net impact of the program was to reduce the retail price of CFLs from \$4.00 to \$1.30<sup>7</sup>.

By reducing the price of a CFL by two-thirds, the ULP addressed a key market barrier to CFL adoption: higher first cost<sup>8</sup>. Customers that would have otherwise been put off by the higher first cost of CFLs, were much more likely to replace their incandescent bulbs.

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<sup>4</sup> “[2006-2008 Energy Efficiency Evaluation Report](#),” Energy Division, CPUC, July 2010

<sup>5</sup> This scenario is labeled “A1, NTGR=54%” in the HMG analysis.

<sup>6</sup> Based on the following programs: PGE 2000, SCE 2501, and SDGE 3016.

<sup>7</sup> To summarize: the average price of a non-rebated bulb was \$4.00; the average price of a rebated bulb was \$1.30; savings at the register was \$2.70 (= \$4.00 minus \$1.30).

<sup>8</sup> The ULP also addressed other market barriers to CFL adoption including product quality, availability, and awareness.

Moreover, by rebating manufacturers directly, rebate dollars were leveraged; every dollar rebated to a manufacturer lowered the cost of a CFL sold in California by \$1.70<sup>9</sup>.

As a result of the price reduction, the program was able to lower the net cost of a CFL to below the cost of the incandescent bulbs a customer would otherwise have to purchase. The staff Evaluation Report cites a CFL lifetime equal to 6.6 incandescents at a cost of 65 cents apiece<sup>10</sup>. The discounted, cumulative cost of those incandescents totals \$3.48<sup>11</sup>, over 2.5 times higher than the retail price of the CFL. In other words, energy savings aside, customers saved money just by purchasing rebated CFLs instead of incandescents.

Customers that would have bought a CFL anyway (i.e. free riders) were able to benefit immediately as well. Rather than purchase the bulb for \$4.00, these customers were able to buy a CFL for only \$1.30. Of course, \$1.57 of the reduced cost of each bulb came from the upstream rebate, which showed up as an increased cost on their utility bill. But the leverage that came from providing the rebate directly to the manufacturer resulted in an additional discount of \$1.13 per bulb.

In accounting for the benefits and costs of energy efficiency programs from a societal perspective, total costs are defined to include the program administrative cost plus the incremental cost of the efficiency measures relative to the less efficient technologies that they replace. However, rather than use the incremental cost of the CFLs, the Energy Division cost-effectiveness analysis simply included the much higher total cost of the CFL rebated through the program.

This error results in a substantial overestimate of total program costs. As described above, the incremental measure cost of CFLs rebated through the 2006-08 ULP was substantially negative. Based entirely on cost data provided in the ULP evaluation, the sale of CFLs through the ULP provided total incremental measure cost savings of \$207 million to CFL purchasers<sup>12</sup>.

The difference between the staff calculation and one that accurately accounts for incremental measure costs is \$319 million<sup>13</sup>. As shown in Figure 1 and Table 1, accurately accounting for incremental measure costs lowers the total cost of the program by nearly two-thirds from \$465 million to \$146 million<sup>14</sup>. The lower total cost also

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<sup>9</sup> The average rebate was \$1.57. The price reduction per dollar of rebate was \$1.70 (= \$2.70 divided by \$1.57).

<sup>10</sup> "Final Evaluation Report: Upstream Lighting Program," pg. 181

<sup>11</sup> Discounted to present value at 8%.

<sup>12</sup> The calculation of net incremental measure cost is different for net participants and free riders. Therefore total incremental cost varies depending on the NTGR. In either case, incremental measure costs are negative, i.e. there are net measure savings. Total incremental cost savings are \$207 million at a 54% NTGR and \$187 million at a 100% NTGR. Incidentally, if all participants were free riders the program would provide no energy savings but \$97 million in savings on lower cost bulbs.

<sup>13</sup> The difference between costs of \$111 million and savings of \$207 million.

<sup>14</sup> The incremental measure cost calculation differs for net participants – who avoid the purchase of a stream of incandescents – and free riders – who avoid the purchase of a more expensive CFL. This figure cited here is based on the 54% NTGR proposed in the ULP Evaluation Report.

results in increased net economic benefits from the program (and from the overall portfolio) by a commensurate \$319 million<sup>15</sup>.

### **III. Net-to-Gross Ratio**

Perhaps the biggest issue arising from the ULP Evaluation Report is the estimate of the fraction of program savings that would have occurred if the program had not been implemented. This estimate is known as the net-to-gross ratio (NTGR). This parameter is difficult to estimate with confidence in any case. In this instance, the estimation of NTGR was particularly challenging.

Estimation of NTGR usually requires an assessment of the market conditions prior to program implementation. However, the ULP evaluation didn't begin to collect market data from participants until 2008, following two years of a massive market intervention. By that time, it had become extremely difficult to collect unbiased data on market conditions in the absence of the program with any confidence.

The NTGR estimation was further complicated by the use of complex modeling approaches whose practical effectiveness had not been tested and a significantly delayed start to the evaluation. The report authors candidly acknowledge concern that "none of the NTGR results derived from the various methods can be considered representative of the 2006-08 program<sup>16</sup>." Ultimately, the authors chose to reject the only NTGR estimates that were defined as representative of the full 2006-2008 program and instead to simply recommend a NTGR estimate of 54% based on the consultant's "best judgment<sup>17</sup>."

In other words, the evaluators estimated that the utility program was only "responsible" for just over half of the savings that were achieved. This NTGR represents a reduction in total net benefits of one third relative to the 80% NTGR assumed in the program applications approved by the CPUC. As described below, a careful evaluation of available evidence shows that a substantially higher estimate of NTGR is justified based on ULP Evaluation Report data and national sales trends.

#### **Evaluation Report Analysis Actually Supports Much Higher NTGR**

One of the ways the ULP evaluation tried to estimate how many bulbs would have been sold in the absence of the program was to ask survey respondents how many bulbs they would have bought at twice the price that they actually paid. Based on their responses, the evaluation developed an estimate of how many bulbs would have been purchased without the price discount from the program. This method of estimating NTGR is called the "stated preference" approach, because it's based on the stated preferences of a sample of purchasers.

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<sup>15</sup> = \$465 million minus \$146 million.

<sup>16</sup> "Final Evaluation Report: Upstream Lighting Program," pg. 82

<sup>17</sup> "Final Evaluation Report: Upstream Lighting Program," pg. 82

This approach to estimating NTGR has been used often in the past, though it has a number of problems that limit its value. For example, survey respondents often do not evaluate their willingness to buy at different hypothetical price points in a purely objective way. People who are approached while walking out of a store may tend to understate their sensitivity to price in order to justify the purchase which they just made. This bias will result in an estimate of purchases in the absence of the program that is skewed to the high side.

Another problem with this approach is that it fails to account for changes in the market due to the program other than price – such as availability and product quality – that affect whether consumers will purchase CFLs. For the ULP, the changes in the CFL market as a result of the program were significant. The ULP was an extremely ambitious program that increased the availability and retail visibility of high-quality bulbs. This survey was not conducted until well into the third year of this three-year effort. By the third year, consumers had much greater familiarity and accessibility to a wide range of high-quality bulbs as well as multiple exposures to information on the cost-savings. All of these factors increased consumers' propensity to purchase bulbs.

By asking only about the price difference, the stated preference survey used for this report fails to credit the program with all of the non-price program-induced changes in CFL markets that made CFLs more appealing to purchasers. Instead, all of those key market changes implicitly count against the program. In order to get a more accurate perspective on the overall impact of the program, the question the survey should have asked purchasers is how many bulbs they would have bought if the bulbs cost twice as much, were of lower quality and harder to find and they didn't know the bulbs cut electricity use and saved lots of money. Clearly their answer would be a lot less than if the only difference was price.

The stated preference analysis imposes yet another downward bias to the NTGR. In response to the question of how many bulbs they would have bought at twice the price, purchasers could select from the responses: "same," "none," or "fewer." While the first two responses are unambiguous, "fewer" requires some interpretation. If "fewer" is assumed to mean "a lot fewer," then the results will be biased towards portraying purchasers as more sensitive to price. If it is assumed to mean "a little fewer," then the results will suggest a relatively lower sensitivity to price.

For the ULP evaluation, the report chose to assume that "fewer" means they would still buy four out of five bulbs if they were twice the price. Absolutely no evidence is used to support the downward bias imposed by this assumption, which results in a NTGR that is about 15% lower than the obvious alternative assumption that fewer means half as many.

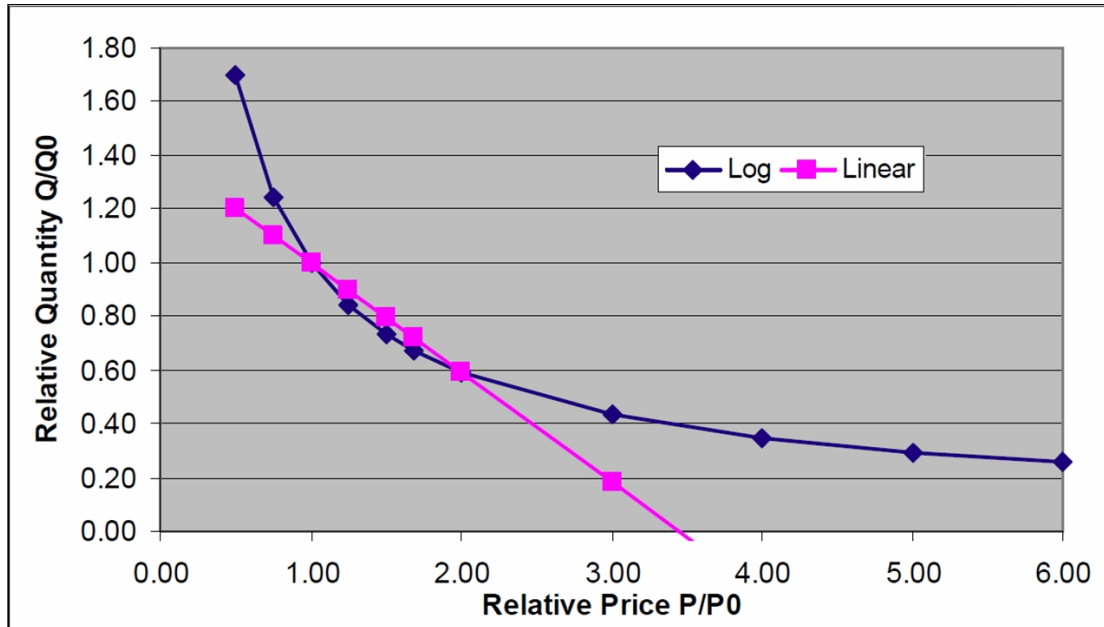
In sum, as employed in this report the stated preference approach ignores the widespread market effects from the program and instead assumes that the only impact of the program is on price. And then, the survey results are interpreted in a way that portrays purchasers as relatively price insensitive. The resulting model of purchaser preferences is clearly biased to underestimate the impact of the program.

Even with all of these inherent biases, the most egregious problem with this analysis is that the authors failed to use the actual reduction in price achieved by the program. The analysis simply provides results based on the hypothetical doubling of price that was used in the survey, as if that were representative of the program's actual impact on prices.

Fortunately, the Evaluation Report provides estimates of the actual impact of the program on prices. As described above, the average program bulb cost \$1.30 compared to an average non-program bulb at \$4.00. Without the program (and ignoring the non-price benefits), bulbs wouldn't have cost twice as much. They would have cost three times as much.

The stated preference model used in the ULP Evaluation Report allows for the calculation of an estimated NTGR taking into account the actual price savings. Figure 2 below portrays the stated preference model developed for the Evaluation Report (Figure 5 in the ULP Evaluation Report)<sup>18</sup>. Two different plausible models of purchaser preference are included, a linear model and a logarithmic model. Based on the assumptions described above, the authors use these models to conclude that at twice the price (i.e. relative price = 2.0), sales would have been 60% of what they were at the program price (i.e. relative quantity = 0.6). This corresponds to a NTGR of 40%, representing the sales that the program was responsible for.

Figure 2: Stated Preference Model



But, as noted above, the average non-program bulb cost three times as much as an average program bulb, corresponding to a relative price of 3.0. Based on the stated preference models, the relative quantity is somewhere between 0.2 and 0.4 at a relative

<sup>18</sup> "Final Evaluation Report: Upstream Lighting Program," pg. 196

price of 3.0. If we pick the midpoint of this range, we conclude that sales without the program would have been only 30% of what they were with the program. That would mean the program is responsible for 70% of the sales or, in other words, that the NTGR is 70%.

As described above, the revealed preference model results are biased to underestimating the NTGR. Therefore, the estimate of a 70% NTGR based on the stated preference models should be seen as substantially lower than the actual value. For instance, simply adopting the interpretation that "fewer" means "half as many" would increase the estimated NTGR from 70% to approximately 80%. Therefore, a straightforward, unbiased review of the stated preference model developed for the ULP Evaluation Report supports a NTGR of at least 80%. Moreover, after accounting for the other downward biases in the analysis, it is clearly consistent with a substantially higher value.

### **Actual Growth in CFL Sales Far Exceeds Historical Trends**

An evaluation of national sales trends also supports a higher NTGR. In 2002, total sales of CFLs in California were around 4.5 million per year. Utility incentive programs are estimated to have been responsible for sales of approximately 2.8 million of these lamps. The remaining 1.7 million was due to consumer demand from early adopters and represents the best estimate of what sales would have been in 2002 without the utility incentive program. Total statewide sales dropped somewhat from 2001 to 2002, but there was a modest uptick in sales of approximately 170,000 in 2003. If we assume this growth was not due to program effects, then the rate of sales growth outside the program from 2002 to 2003 was about 10% per year<sup>19</sup>.

As the utilities prepared to implement the new upstream CFL rebate program, the question facing the utilities and the CPUC was what would happen to sales over the next five years in the absence of a CFL rebate program in the state. The year 2003 is a reasonable starting point both because it immediately preceded the significant expansion of the ULP program to its current status and because it could reasonably be considered the most up-to-date sales data available when the utilities developed and the CPUC reviewed the 2006-08 program plans. Obviously, one plausible forecast is that the 2002 to 2003 growth rate of 10% would be sustained. A growth rate of 10% beginning in 2003 would have resulted in sales of 3 million CFLs in 2008<sup>20</sup>.

There is no way to know what would have happened if the California utilities hadn't run the ULP, but we do know what actually did happen. In 2008, CFL sales in California totaled 52.1 million lamps with rebates provided to customers for 42.6 million of those lamps<sup>21</sup>. If we adopt the estimate that CFL sales would have continued to grow at 10%

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<sup>19</sup> Sales data is from: "California Lamp Report 2003." Itron, July 15, 2004. This calculation assumes a NTGR of 80% for 2002 and 2003. A lower NTGR would result in more sales in the absence of the program, but a lower growth rate. For example, a 60% NTGR would increase the estimate of 2003 sales without the program by 40% but decrease the annual growth rate to 7%.

<sup>20</sup> Assuming a starting point of 1.7 million lamps, sales growth of 10%/year for 5 years results in 2008 sales of 3 million lamps. Similarly, a 37%/year growth rate for 5 years results in 2008 sales of 8.8 million lamps.

<sup>21</sup> "Final Evaluation Report: Upstream Lighting Program."

per year without the program, then a total of 49.1 million lamps were sold as a result of the program (52.1 million minus 3 million). Since rebates were provided for only 42.6 million lamps, the estimated NTGR should be 115% (49.1 million divided by 42.6 million), more than double the 54% rate based on the consultant's "best judgment."<sup>22</sup>

Of course, one might argue that CFLs were actually poised in California in 2003 for even faster sales growth. For example, if sales in other parts of the country grew even faster than 10 percent, that would be an indication that this forecast sales growth rate was too low. In fact, it turns out that the average rate of growth in CFL sales from 2003 to 2008 in the rest of the U.S. was 37% per year<sup>23</sup>. Of course, efficiency programs in other states were also providing incentives to consumers that led to increased sales<sup>24</sup>. In addition, the California programs were run in part through national retailers and likely resulted in additional, unrebated sales outside California, at least in neighboring states. However, for the sake of argument, let's assume that the California ULP and programs in other states had absolutely no effect on sales in other states and that, in the absence of the ULP, California would have enjoyed the same rapid growth in CFL sales of 37% per year. Under this hypothetical scenario, California CFL sales in 2008 would have totaled 8.8 million lamps. That estimate, when compared to actual sales in 2008, results in a NTGR of 102%<sup>25</sup>.

In other words, even if one assumes that the rapid growth in CFL sales in the rest of the US from 2003-08 was not due in any way to the energy efficiency programs implemented over that period and one also assumes that California would have experienced similarly rapid sales growth, then the net benefits of the program are still roughly twice as large as the ULP evaluation concludes.

Let's look at this in a different way. How large would the growth rate in sales have to have been in California without the efficiency programs to justify the estimated NTGR of 54%? In order to justify a NTGR this low, CFL sales would have had to grow from under 1.7 million in 2003 to 29.3 million lamps in 2008 without utility incentives. As shown in Figure 3, the growth rate required to get to this level of sales is 74% per year. In other words, the growth rate in CFL sales in California without a program would have to have been twice as large as the growth rate that actually occurred in the rest of the U.S., during a period in which there were ambitious, well-funded programs in a number of states. As noted earlier, the ULP evaluation provides neither conclusive evidence nor analysis to support this highly implausible result.

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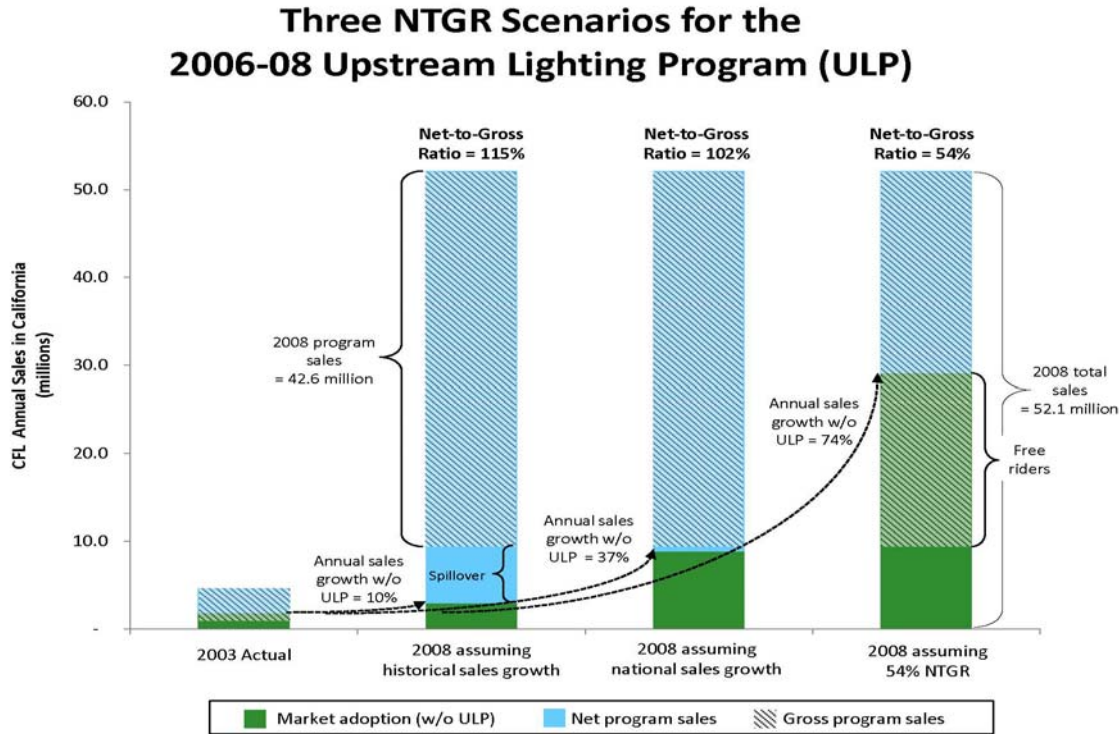
<sup>22</sup> A NTGR of over 100% means that the program resulted in sales of some lamps in addition to those that got rebates. This could happen because of increased customer awareness and acceptance among other factors. A number of states, including New York, Vermont, and Massachusetts currently credit their CFL rebate programs with NTGRs of greater than 100%.

<sup>23</sup> Ecos Consulting analysis of USA Trade Online data

<sup>24</sup> "CFL Market Profile." U.S. DOE. March 2009

<sup>25</sup> Assuming a starting point of 1.7 million lamps, sales growth of 10%/year for 5 years results in 2008 sales of 3 million lamps. Similarly, a 37%/year growth rate for 5 years results in 2008 sales of 8.8 million.

Figure 3: National sales analysis 2003-2008



### 2009 Sales Data Confirms Big Impact of Program on Sales

In 2009, the CPUC directed the utilities to dramatically scale back the ULP effort. In effect, the CPUC implemented a natural experiment that allows us to test whether CFL sales would be sustained and continue to grow in the absence of the program. Recently, the Energy Division staff posted their estimate of bulbs sales in 2009<sup>26</sup>, allowing us to evaluate whether that experiment provides confirmation of the conclusions in the Evaluation Report.

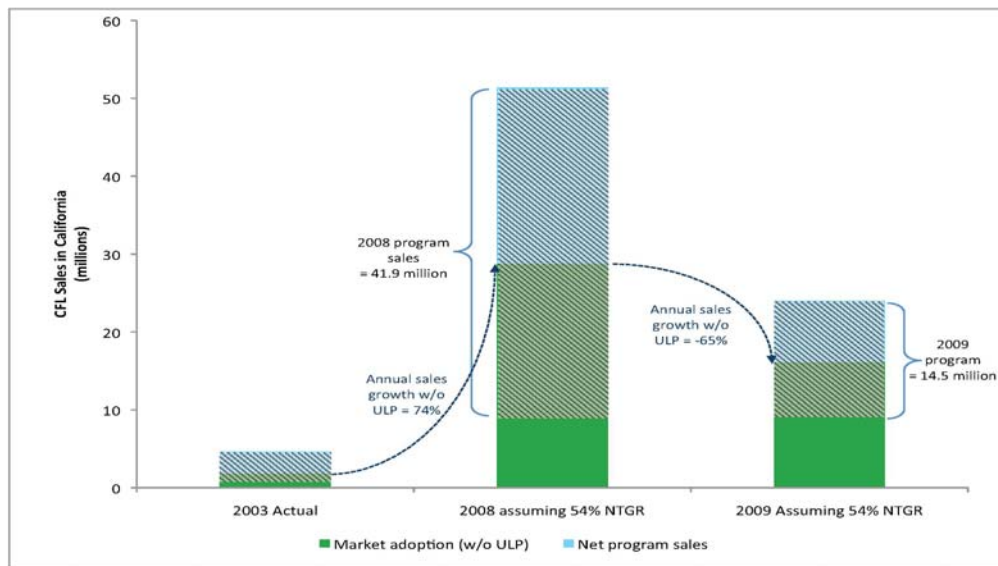
What are the results? According to the Energy Division memo, statewide sales of CFLs in 2009 totaled only 24 million, a reduction of more than 50% from 2008. Sales in 2009 were even 18% lower than the Evaluation Report estimate of what sales would have been without the program in 2008.

As shown in Figure 4 below, the Evaluation Report analysis implicitly assumes that if the utilities had not implemented the ULP, CFL sales in California would have grown by an average of 74% per year from 2003 to 2008 and then plummeted in 2009 by 44%, rather than continuing to grow.

<sup>26</sup> [Energy Efficiency Evaluation Report for the 2009 Bridge Funding Period: Appendix R](#) Energy Division, CPUC, January 2011

This implausible result is dependent on the assumption that the close tracking of sales and program activity is merely coincidental. But as Figure 4 shows, the rapid growth in sales from 2003 to 2008 and the dramatic decline in 2009 exactly parallels program activity. A much more plausible conclusion is that the program was responsible for the dramatic increase in sales between 2003 and 2008 and the steep decline in sales in 2009 was due to the two-thirds cutback in the ULP<sup>27</sup>.

Figure 4: 2009 Sales Analysis



This finding shouldn't really come as a surprise. After all, this program was designed to transform the market by achieving a large increase in the sales of low-cost, high-quality bulbs. To a neutral observer, the 2009 sales data provide strong support for the conclusion that program was in fact responsible for nearly all of the increase in sales.

One possible counter to this conclusion is that the decrease of sales in 2009 was due to the recession rather than the program cutbacks. This does not appear to be the case since the recession resulted in reduced CFL sales in the rest of the U.S. in 2008, but not in California. Total CFL sales in the rest of the U.S. dropped by 28% in 2008. In California, where CFLs were available at very low cost because of the ULP, CFL sales grew by approximately 10% in the same year. California sales didn't drop until 2009, when program spending was slashed.

The drop in sales in 2009 lends further support for the conclusion that the upstream lighting program was responsible for the vast majority of the increase in sales from 2006 to 2008. In contrast the 54% NTGR from the Evaluation Report is flatly inconsistent with the 2009 sales data.

<sup>27</sup> The number of IOU discounted bulbs sold in 2008 and 2009 was 41.9 and 14.5, respectively.

## **Actual Benefits of Lighting Efficiency Program are Likely Twice as Large as Estimated**

To summarize, the estimated NTGR of 54% from the ULP Evaluation Report is based on an implicit assertion that in 2003 sales were somehow poised to grow at the extraordinarily rapid rate of 74% per year for five years running and then plummet by 44%, despite modest at best sales growth from 2001 to 2003. But even if one assumes that sales would have risen at 37% per year based on sales growth in other states, the NTGR in 2008 should be 102%, nearly twice the “best judgment” estimate from the ULP Evaluation Report. The bottom line is that the proposed NTGR of 54%, which is based solely on a consultant's judgment, is unsupported by readily available evidence. National sales data from 2003 to 2008 and the decline in sales in California in 2009 demonstrate that this NTGR estimate is far too low and the ULP was likely responsible for savings at least twice as large as the estimated in the Evaluation Report. This conclusion is supported by the stated preference analysis in the ULP Evaluation Report itself.

### **Impact of NTGR Reanalysis**

Since bulbs that were not installed as a result of the program don't contribute energy savings to the calculation of benefits, crediting the program with a higher share of the increase in sales significantly affects the estimated benefits from the program. Based on the foregoing analysis, we recalculated total benefits using a net-to-gross ratio of 100%. Since total benefits increase while costs are unchanged, net benefits also increase substantially.

As shown in Table 1 and Figure 1 below, based on a NTGR of 54% the estimated total benefits in the Base Case are \$449 million. However, using the more plausible estimate of a 100% NTGR, total program benefits increase to over \$800 million<sup>28</sup>.

### **IV. Post-2008 installations**

The CPUC's efficiency program accounting rules include a recently-adopted provision that requires savings to be accounted for in the year in which an efficiency measure is installed, even if the measure was installed as a result of a prior year's program. This provision resulted in a significant change to the Evaluation Report estimate of the benefits of the ULP because, according to the analysis, many of the bulbs that were brought to market as a result of the 2006-08 ULP program were not installed in light fixtures until 2009 or 2010<sup>29</sup>. This accounting convention lowered the estimated net benefits in the ULP Evaluation Report because the benefits are accounted for in later program cycles even though the costs are attributed to the 2006-08 program. Because the

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<sup>28</sup> These figures only account for the revised NTGR and not for the corrected incremental measure costs or the delayed installations.

<sup>29</sup> The estimate of CFL installations in the ULP Evaluation Report was based on an ad hoc model developed after the proposed analysis failed to produce meaningful results. The significant uncertainty associated with the installation rate evaluation provides further support for the value of the “full-benefit accounting” approach.

convention was adopted recently, savings from previous program cycles were not attributed to the 2006-08 program.

This accounting convention was adopted primarily to address programs where benefits may be delayed and will occur for years after program costs are incurred, such as support for building codes and appliance standards. Including all the costs and benefits together in one balance sheet provides a broader perspective that better reflects the overall benefits of the program. In contrast, the approach adopted in the ULP evaluation complies with CPUC accounting rules, but fails to provide an accurate impression of the ULP total benefits. Because a relatively large fraction of program bulbs were not sold and/or installed until after 2008, this more holistic accounting perspective results in a substantial change to the estimate of total program benefits.

According to ULP Evaluation Report estimates, one third of all bulbs rebated through the 2006-08 ULP were not installed and in use by the end of 2008<sup>30</sup>. However, except for a very small number of bulbs which are in ‘permanent storage,’ all of the 2006-08 ULP bulbs were installed and in use by the end of 2010<sup>31</sup>. In other words, the ULP Evaluation Report includes the costs, but not the benefits, of 28.6 million bulbs that were purchased and installed by utility customers. As shown in Table 1 and Figure 1 including the benefits of these bulbs results in an increase in total benefits of approximately 50%, from \$449 million to \$680 million<sup>32</sup>.

## **V. Results**

As described in this memo, the ULP Evaluation Study adopted estimates for incremental measure costs, NTGR, and installations that resulted in an erroneously large estimate of program costs and an extremely low estimate of program benefits. Even with these biased estimates, the ULP Evaluation Report concluded that the program provided over \$50 million in net benefits to utility customers.

A corrected estimate of incremental measure costs, a full accounting of delayed installations, and an unbiased estimate of NTGR each result in an increase to estimated net benefits of hundreds of millions of dollars. Adjusting both the NTGR and accounting for delayed installations results in a greater increase in benefits than a simple sum of the two changes in isolation. In combination, these three changes result in nearly a tripling of total benefits. As shown in Figure 1 and Table 1, total benefits increase from \$449 million under the Base Case scenario to over \$1.2 billion when all three changes are adopted.

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<sup>30</sup> The ULP evaluation ran into problems in the attempt to estimate the installation rate of CFLs through the program. The evaluation plan proposed to estimate a set of three inter-related models from a survey of users. Unfortunately, as the authors explain, the models did not produce meaningful results and an ad hoc alternative had to be developed late in the study process.

<sup>31</sup> ULP Evaluation Report, p. 124

<sup>32</sup> These figures only account for the benefits of delayed installations and not for the corrected incremental measure costs or the revised NTGR.

As noted earlier, under current CPUC policy program benefits are counted in the program cycle in which measures are installed<sup>33</sup>. Therefore, if one were to re-estimate 2006-08 portfolio net benefits, only the first two of the parameters evaluated in this report would be used. Changing only the estimate of measure costs and NTGR results in an increase in total benefits of \$701 million, relative to the Base Case scenario.

As noted earlier, we attempted to reproduce the results reported by Energy Division staff in the Summary Report on 2006-08 impacts<sup>34</sup>. We were unable to do so. Our “Base Case” scenario adopts the same values recommended in the ULP Evaluation Report for incremental measure cost, NTGR, and total bulbs<sup>35</sup>. However, the net benefits we calculate using these parameter values are approximately \$70 million smaller than reported by Energy Division. Similarly, the Benefit-to-Cost ratio for our Base Case is 1.0 compared to the 1.1 ratio reported by Energy Division.

The intent of this report is first and foremost to develop a more accurate and representative estimate of the impacts of the Upstream Lighting Program. Some stakeholders have questioned whether the efficiency programs in California have been successful or whether the state would have achieved the savings even without the programs, based largely on perceptions about the ULP. This analysis highlights that the efficiency programs have been an enormous success for California consumers, and that these savings would *not* have been achieved without the program. It also highlights the need for the CPUC to provide a process to resolve the legitimate technical disputes that experts may have over evaluation results, so that the CPUC can be sure it understands the full impact of the efficiency programs it oversees.

NRDC does not believe that the 2006-08 ULP program should be revived unchanged, nor that the CPUC should re-litigate the utilities’ incentives for efficiency during those years. Instead, we believe that lighting programs should continue to evolve over time, as they have done for decades. The purpose of the revised estimates in this report is to provide a truer picture of past program impacts and thereby a better guide to help California take full advantage of future opportunities to achieve cost-effective energy efficiency savings.

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<sup>33</sup> Under current CPUC policy, CFLs installed after December 31, 2008 should be excluded from the calculation of net benefits.

<sup>34</sup> “[2006-2008 Energy Efficiency Evaluation Report](#),” Energy Division, CPUC, July 2010

<sup>35</sup> This scenario is labeled “A1, NTGR=54%” in the HMG analysis.



**HESCHONG  
MAHONE  
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# MEMORANDUM

July 13, 2011

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To: Peter Miller (NRDC)  
Cc: Drew Bennett (NRDC)  
From: Marian Goebes, Cynthia Austin, Doug Mahone (HMG)  
Re: **06-08 Upstream Lighting Program (ULP) Estimates**

## UPSTREAM LIGHTING PROGRAM REANALYSIS

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### Introduction

The Natural Resources Defense Council (NRDC) contracted with the Heschong Mahone Group (HMG) to re-analyze the evaluation estimates for the 2006-08 Statewide California Residential Upstream Lighting Program (ULP). The study intent was to analyze how different parameter values would impact program results. HMG estimated costs, benefits, net benefits, and benefit-to cost ratio for the 2006-08 ULP program under several different scenarios. The matrix of results shows the range of program results that could be estimated, depending on the approach taken.

The original 06-08 evaluation was done by a large team of experts, including CPUC staff and independent consultants, who gathered primary data, conducted extensive analysis, and used various sources (e.g., California Evaluations Protocol, Energy Efficient Evaluation Policy Manual) to develop an official impact evaluation. Results were published in the Final Evaluation Report: Upstream Lighting Program, prepared for the CPUC by KEMA Inc. and the Cadmus Group, Inc., February 8, 2010 ("the ULP Report")<sup>1</sup>.

The analysis done here was far smaller in scope, and the results presented are in no way intended to be an alternative to the original impact evaluation.

### Methodology

This analysis re-evaluates the economic impacts of the ULP based on alternative values for three evaluation parameters, 1. Incremental measure costs; 2. net-to-gross ratio (NTGR); and 3. the inclusion of benefits of bulbs installed in 2009 and 2010. For each parameter, the analysis uses the parameter value adopted in the evaluation team's analysis and an alternative parameter value provided by NRDC. The analysis includes a set of six scenarios using all combinations of parameter values. The initial scenario adopts the three parameter values used in the evaluation team's analysis, in an attempt to replicate the staff results as closely as possible. As described

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<sup>1</sup>Available: [www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport\\_2.pdf](http://www.energydataweb.com/cpucFiles/18/FinalUpstreamLightingEvaluationReport_2.pdf)



above, total benefits, total costs, net benefits (benefit minus cost), and benefit-to-cost ratio (equivalent to the Total Resource Cost – TRC) are presented for each scenario.

While the program was intended to serve the residential market, the program provided bulbs in stores and did not impose restrictions on where the bulbs were installed. For analysis, we adopted the same approach as the ULP Report: This analysis is for residential upstream lighting programs, but some of these bulbs were installed in nonresidential areas for PG&E and SCE. This analysis excludes the costs and benefits of nonresidential bulbs for PG&E (which were captured in a nonresidential program, PGE 2080), but includes the costs and benefits of nonresidential bulbs for SCE.<sup>2</sup> No bulbs were assumed to be installed in nonresidential areas for SDG&E.

## Total Costs

### *Incremental Measure Cost*

Total cost equals the utility cost<sup>3</sup> plus the incremental cost to consumers. The CPUC Energy Efficiency Policy Manual (version 4) defines the IMC as, “the additional cost of purchasing and installing a more efficient measure - calculated from the price differential between energy-efficient equipment and standard or baseline measures.”<sup>4</sup> It does not discuss how to calculate the IMC when the efficient measure replaces multiple baseline measures (as is the case with a CFL). There is also confusion over how to count free riders’ incremental costs. The CPUC Energy Efficiency Policy Manual states that the TRC includes “costs participants incur”<sup>5</sup>; it makes no distinction between net participants and free rider participants. The Standard Practice Manual (SPM) states that the TRC include “all equipment costs”, and does not distinguish between free riders and net participants<sup>6</sup>. However, the SPM’s formula for the TRC only includes net participant costs (not total participant costs). Because the free riders’ costs were true costs, they were included here. If a participant is a free rider (i.e., would be purchasing the efficient measure regardless of the program), for this program the incremental cost difference for this participant is negative, thereby lowering the total cost of the program to society.

The estimate of utility costs used for all of the scenarios was taken from the input table in the ERT based on utility E3 submittals. It is similar (~6% lower) from the IOU reports on the EEGA website<sup>7</sup>. The incremental cost to consumers was calculated by multiplying the incremental measure cost per CFL bulb by the number of bulbs purchased by consumers. The number of

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<sup>2</sup> Based on the ULP Report, p. xi, footnote 2, which states that the nonresidential portion was included in another program (PGE2080) for PG&E and included in the residential program for SCE. According to the ULP Report p. 4, no bulbs were assumed to be installed in nonresidential areas for SDG&E.

<sup>3</sup> Utility cost includes rebate costs plus administrative costs.

<sup>4</sup> CPUC, Energy Efficiency Policy Manual, v. 4.0, p.7. 2008

<sup>5</sup> CPUC, Energy Efficiency Policy Manual, v. 4.0, p. 12, 2008

<sup>6</sup> Standard Practice Manual, P. 18

<sup>7</sup> Quarterly and Annual reports from IOUs (PG&E 2008 Annual report; SCE and SDGE 2008 Q4 reports): <http://eeega2006.cpuc.ca.gov/DisplayQuarterlyReport.aspx?ID=9>.



bulbs purchased by consumers was estimated as 86 million, through the following approach. Because some of the rebated bulbs were lost to leakage or lack of verification, the “Bulbs purchased by consumers” is less than the Total Rebated Bulbs.

*Bulbs purchased by consumers = Total Rebated Bulbs x (100% - Leakage Rate) x (Invoice / Verification)*

The IMC is calculated differently for each approach. The approaches are:

- A. IMC is the full cost of a rebated CFL bulb (\$1.30). In this approach, the cost savings of the avoided bulb purchases is not included. This appears to be the approach used in the original evaluation.
- B. This approach includes the cost savings from the purchases that are avoided by purchasing a rebated bulb. Net participants avoid the purchase of a discounted stream of shorter-lived incandescent lamps, while free riders avoid the purchase of an unrebated CFL. For net participants, the IMC is the cost difference between a rebated CFL and the net present value of the equivalent number of incandescents it replaces. For free riders, IMC is the cost difference between a rebated CFL (\$1.30) and a non-rebated CFL (\$4). The total IMC is calculated as a weighted average of the IMC for net participants and free riders based on the net-to-gross ratio (NTGR). Because the cost of the rebated bulb is lower than the cost of the avoided purchase for both free riders and net participants, the IMC for this scenario is negative.

## Total Benefits

### *Net-to-Gross Ratio*

According to the California Energy Efficiency Evaluation Protocols, the net-to-gross ratio (NTGR) is a ratio or percentage of net program impacts divided by gross or total impacts. Net savings are energy savings attributable to the program’s net participants – those that are not free riders. (Free riders would have installed the energy efficient measure, regardless of whether or not there was a program.) Gross savings are the energy savings from program-related actions taken by all program participants, regardless of why they participated. Some regions / states include spillover in the calculation of NTGR. Spillover refers to savings indirectly attributed to the program: from non-participants, or from program participants taking actions to generate other savings beyond those incented by the program. In the 2010 CFL Market Profile memo<sup>8</sup>, (prepared by D&R International for the USDOE), the authors noted that there is variation across the U.S. both in the official NTGR (ranging from 41-160% for the different states) and in the method used to calculate NTGR. For example, several states show a NTGR > 1, which suggests that program spillover is included. However, the California Public Utility Commission has passed a decision that spillover should not be included in the NTGR<sup>9</sup>.

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<sup>8</sup> Energy Star CFL Market Profile. Prepared for the US DOE by D&R International, September 2010. [http://www.drintl.com/Data/Sites/1/downloads/publications/2010\\_cfl\\_market\\_profile.pdf](http://www.drintl.com/Data/Sites/1/downloads/publications/2010_cfl_market_profile.pdf)

<sup>9</sup> CPUC 2007b. California Public Utilities Commission, Interim Opinion On Issues Relating To Future Savings Goals And Program Planning For 2009-2011 Energy Efficiency And Beyond, Decision 07-10-032 October 18, 2007 [http://docs.cpuc.ca.gov/word\\_pdf/FINAL\\_DECISION/74107.pdf](http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/74107.pdf)



Under the California policy framework, NTGR is used to describe the free-ridership that may be occurring within energy efficiency programs. For example, a NTGR = 0.8 suggests that 80% of the program's savings are from net participants, and 20% from free riders. A low NTGR indicates a high percentage of free riders.

In this analysis, two NTGR's were applied:

- ◆ NTGR = 54%, which assumes that almost half of participants were free riders. This was the approach taken by the 2006-08 program evaluators
- ◆ NTGR = 100%, which assumes that there were no free riders.

### *Savings from bulbs installed in 2009 and 2010*

Total benefits is the energy savings from an efficient measure, (compared with its equivalent baseline measure), for its effective useful life (EUL) valued at the avoided cost of electricity. Benefits were calculated using the CPUC's calculator (E3 version 4f2, which was used for the 06 - 08 evaluation), which includes built-in assumptions of the value of avoided electricity, and savings per bulb.<sup>10</sup> The benefit calculation also included the interactive effect – the negative gas savings assumed to result from the increase in heating needs, because a CFL releases less waste heat than an incandescent bulb.<sup>11</sup> We used the 06-08 CPUC Net Evaluated savings to estimate the interactive effect for each utility, using the following approach:

Interactive effect (therm/kWh) = Evaluated gas savings / Evaluated electricity savings

We multiplied this interactive effect by the annual electricity savings to estimate the gas savings (negative) per CFL per year: -0.25, -0.38, and -0.23 for PG&E, SCE, and SDG&E, respectively.

The difference in the approaches was in the treatment of bulbs that were rebated under the 2006-08 program, but installed during 2009 or 2010. The approaches are:

1. Savings is based on the estimated number of rebated bulbs that were installed by December 31, 2008. It excludes the benefits of bulbs that were sold but not installed by December 31, 2008 (29% of the total), and bulbs that were not sold by 2008 (5% of the total). Bulbs that were "leaked" to outside the IOU service territory (5%) and bulb sales that could not be verified (2%) are also excluded.<sup>12</sup> This is the approach adopted in the ULP report (the "adjusted quantity of measures rebated" approach).
2. Savings is based on the estimated number of rebated bulbs that are reasonably expected to be installed eventually in the service territory. This approach includes savings from bulbs that were rebated through the 2006-08 program and installed in

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<sup>10</sup> HMG changed the NTGR in the E3 calculator to the value used by the evaluators - 54%.

<sup>11</sup> Evaluated electricity and gas savings were taken from 06-08 Energy Evaluation Report Appendix A, for PGE 2000, SCE 2501, and SDGE 3016.

<sup>12</sup> Percentages for Leakage, Verification, and Sold through are based on SCE and SDGE values. These factors were aggregated into one number, 14.4%, for PG&E.



2009 or 2010. It excludes bulbs “leaked” to outside the IOU service territory, bulb sales that could not be verified, and bulbs in permanent storage (1%).

In the “CFL memo” released in January 2011, the CPUC’s evaluators recommended that PY 2009 energy savings include savings from bulbs rebated in previous program cycles (e.g., PY2006-08) and installed in program year 2009. Approach 2 would be another method for accounting for energy savings for bulbs rebated in one program cycle, and installed in another cycle. Note that only one of these approaches should be used, to avoid double counting savings.

## Results

The different approaches taken to estimate costs and benefits yield a range of net benefits and benefit-to-cost ratios, shown below.

Approach A1, NTGR=54%, should be the closest to the original evaluation.

Approach	Cost	Benefit	Net Benefits	Benefits / Costs
A1, NTGR=54%	\$464,681,251	\$448,839,297	-\$15,841,954	1.0
A1, NTGR=100%	\$464,681,251	\$831,183,883	\$366,502,632	1.8
B1, NTGR=54%	\$146,120,805	\$448,839,297	\$302,718,492	3.1
B1, NTGR=100%	\$166,662,419	\$831,183,883	\$664,521,464	5.0
A2, NTGR=54%	\$464,681,251	\$679,506,207	\$214,824,956	1.5
A2, NTGR=100%	\$464,681,251	\$1,258,344,828	\$793,663,576	2.7
B2, NTGR=54%	\$146,120,805	\$679,506,207	\$533,385,402	4.7
B2, NTGR=100%	\$166,662,419	\$1,258,344,828	\$1,091,682,408	7.6

*Figure 1- ULP Program costs and benefits*

## Discussion

Results show the large range of results from the different approaches taken, with the benefit-to-cost ratio ranging from 1.0 to 7.6. Major differences and similarities with the results are described below.

### Costs

For costs, there is a major difference in results using Approach A and B. By including the price of the equivalent number of incandescents offset by a CFL for the net participants, and the cost reduction of CFLs for free riders, the benefit-to-cost ratio increases by a factor of 3.

Note that the cost shown in Scenario B with NTGR=100% represents the cost if IMC is calculated as the price difference between one CFL (\$1.30) and the equivalent number of incandescents



that it replaces (net present value of \$3.48).<sup>13</sup> Because one CFL has a much longer lifetime, it replaces approximately 6.5 incandescents, yielding a negative IMC. Thus, Scenarios B1 and B2 reflect results if the IMC represents the equivalent number of incandescents replaced by a rebated CFL.

## Benefits

### *Bulbs installed in 2009 and 2010*

As described above, the evaluation report estimates that 40% of rebated bulbs were installed in 2009 and 2010. (The ULP report also includes trajectories of when program bulbs are installed, and predicts that almost all program bulbs would be installed by the end of 2010<sup>14</sup>). Therefore, inclusion of the savings from these bulbs results in an increase in total benefits of approximately 75% compared to the approach adopted in the evaluation study. Thus, including the energy savings of bulbs that will be installed in the IOU service territories after December 31, 2008, the benefit-to-cost ratio increases by over 50%.

Some of the rebated CFLs installed in 2009 and 2010 replaced bulbs – both CFLs and incandescents - that were working when the consumer purchased the rebated bulb, but which burned out in 2009 or 2010, prompting replacement. Given the 9.4 year life of a CFL (the Effective Useful Life, according to the E3 calculator), if the rebated CFL were replacing a burnt out CFL, the original CFL would have been installed around 2000, when the market penetration of CFLs was lower than present. This suggests that most of the rebated CFLs were replacing incandescents. More importantly, as described by the ULP report<sup>15</sup>, the watts savings does not depend on the prior condition (i.e., what the CFL replaces), but what would have been put in place otherwise.

### *NTGR*

The different NTGR's chosen here also had a major impact on the results. Because the lower NTGR analyzed here was almost half the other NTGR, estimates of total benefits varied by a factor of two.

NTGR is notoriously difficult to determine. The 06-08 evaluation team used various analytical methods, including surveys and interviews with suppliers, participants, and nonparticipants; and regression analysis to compare CFL purchases in California versus other states, to estimate a NTGR of 54%.

The 2010 CFL Market Profile found that 1 in 6.6 (15%) of medium screw-based lamps shipped today is a CFL<sup>16</sup>, and a significant fraction of these bulbs are incented through programs. Note that this does not represent free ridership, as the free ridership would equal the percent of

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<sup>13</sup> Because NTGR=100%, all participants are treated as net participants. Thus, there is no “weighted average” approach used to calculate the IMC, since there are no free riders.

<sup>14</sup> ULP report, p. 124.

<sup>15</sup> ULP report, p. 46.

<sup>16</sup> Energy Star CFL Market Profile, p. 8. See above for full citation.



those CFLs that consumers would purchase regardless of whether there are program incentives. But the low market share of CFL purchases indicates that the market is far from mature, and that consumers are still buying incandescents at > 5x the rate of CFLs.

### Comparison to original evaluation

In this analysis, Scenario A1, NTGR=54% was designed to reproduce the analysis done in the original evaluation. However, the benefit- to-cost ratio found here is lower than the benefit-to-cost ratio found in the original evaluation. The table below shows the benefits (in MWh) and the benefit-to-cost ratio (equivalent to the Total Resources Cost ratio - TRC) – estimated in this analysis and in the CPUC evaluation for comparison.

Program	CPUC Net Evaluated <sup>17</sup>		Scenario A1, NTGR=54%	
	Lifecycle Electricity Savings (MWh)	TRC (Benefit-Cost Ratio)	Lifecycle Electricity savings (MWh)	TRC (Benefit-Cost Ratio)
PG&E Res Mass Market (PGE 2000)	5,367,873	1.00	4,265,498	0.80
SCE Residential Incentive (SCE2501)	4,762,144	1.25	3,868,445	1.27
SDG&E Upstream Lighting (SDGE3016)	527,600	1.09	534,498	1.05

*Figure 2 – Comparison of CPUC Net Evaluated findings with Scenario A1*

One possible reason for the lower electricity savings estimated here for PG&E and SCE is that these were residential umbrella programs, which included components in addition to CFLs. Our estimate of program costs includes all costs (for CFLs and for other measures), but our analysis only includes benefits from the CFLs. Consequently, we underestimated the Benefit-to-Cost Ratio for the upstream lighting portion of these programs. This may also explain the discrepancy between our Benefit-to-Cost ratio and the TRC for PG&E.

This analysis also notes a discrepancy in the number of 06-08 program bulbs reported as installed for PG&E using the methodology described in the ULP Report section Adjustments to Quantity of Measures rebated (p. 36-41) - 27 million<sup>18</sup>, and the bulbs reported as installed for

<sup>17</sup> 2006-2008 Energy Efficiency Evaluation Report, Appendices A-J. Available: <http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/EM+and+V/2006-2008+Energy+Efficiency+Evaluation+Report.htm>

<sup>18</sup> Adjusted quantity of measures rebated equal program bulbs adjusted for leakage, verification, sold through rate, and installation; HMG followed this methodology for Approach 1.



PG&E in ULP Report Table 73 (p. 126) - 31 million<sup>19</sup>. In contrast, the number of bulbs estimated for SCE and SDG&E through the 'Adjusted Quantity of measures rebated' approach were very similar (< 2% different) to the number of installed bulbs reported in Tables 74 and 75, respectively.

## Overall Findings

While guidelines exist on how to conduct impact evaluations for energy efficiency program, there is still latitude on how to apply an evaluation methodology. This analysis shows how a series of policy and evaluation choices, such as:

- ◆ Only counting savings from measures rebated and installed in the same program cycle,
- ◆ Not counting the price of all base measures replaced by an energy efficiency measure, or treating the IMC for free riders the same as net participants,
- ◆ And applying a low NTGR,

produce a much lower benefits-to-cost ratio than what would be calculated using different choices. Through choosing numbers with a downward bias for each step in the process, the underestimated values compound, so that the estimated net benefits are several factors lower than what would be calculated using the approaches described above.

This analysis also illustrates the success of the 2006-08 Statewide California Residential ULP. For all scenarios considered, the benefit-to-cost ratio (equivalent to the Total Resource Cost test) is at least 1. For most scenarios, it is 2-5. For Scenario A1 (most equivalent to the evaluators'), the benefit-to-cost ratio is 1.0. The evaluators found this to be 1.1, indicating that this analysis slightly underestimates the benefit-to-cost ratio.

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<sup>19</sup> The numbers of installed rebated bulbs are very similar if nonresidential bulbs are included in the adjusted quantity of measures rebated, but this seems contrary to ULP Report, p. xi, footnote 2.