

# Appendix F: Impact of Dynamic Pricing On Low-income Customers

## Quantifying the Benefits of Dynamic Pricing In the Mass Market

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## APPENDIX F: IMPACT OF DYNAMIC PRICING ON LOW-INCOME CUSTOMERS

Dynamic pricing offers electric customers lower prices during most hours of the summer while raising prices significantly for a small percentage of hours when system conditions are critical (typically 2 to 3 percent of all summer hours). The primary attraction of dynamic rates such as critical peak pricing (CPP) or real-time pricing (RTP) is that these rates provide direct incentives to reduce electricity usage when the electrical system is most stressed because they reflect daily peak marginal costs.<sup>1,2</sup>

Some have expressed concern that dynamic pricing may adversely impact low-income customers. In jurisdictions where dynamic prices are under consideration, many utilities are currently pilot testing some type of CPP rate.<sup>3</sup> In this appendix, we summarize the impact of CPP on low-income customers based on empirical results from the California Statewide Pricing Pilot (SPP) of 2003-04.<sup>4</sup> The results show that there is no statistically significant difference in bill-savings across income groups. This means that high-income customers on a dynamic rate do not benefit more than low-income customers, on average. However, taking usage into account, low-income customers in very high usage groups may find it difficult to “save” under a CPP rate. From a policy perspective, alternative dynamic pricing options should be considered for this group of high-usage, low-income customers. Depending on the definition of high usage, this represents about 2.2 percent to 5.7 percent of all households in the U.S. or 4.2 percent to 11 percent of all low-income households. (See Tables F-1 and F-2).<sup>5</sup> One obvious solution is to offer a peak-time rebate (PTR) rather than CPP to this specific group of high-usage, low-income customers. In addition, low-income customers in the low-usage group could be offered a choice between PTR and CPP. In the District of Columbia, as part of its dynamic pricing pilot program, Pepco is currently offering a PTR (also called a critical peak rebate or CPR) to customers that are currently on the Residential Aid Discount (RAD) program.<sup>6</sup>

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<sup>1</sup> Direct load control (DLC) programs are in widespread use today. DLC is problematic in that it offers a fixed financial incentive for an unmeasured load reduction and payments to participants can exceed system benefits. TOU pricing is another strategy for peak reduction. However, under TOU, there is no additional incentive to reduce load when the system is most stressed. Both CPP and RTP correct these shortcomings.

<sup>2</sup> Herter, K., “Residential implementation of critical-peak pricing of electricity.” *Energy Policy* 35 (2007). pp: 2121-2130

<sup>3</sup> Although real time pricing (RTP) is available for residential customers in Illinois, policy makers in most states currently consider RTP to be infeasible and are examining alternative dynamic pricing structures such as CPP and peak-time rebate (PTR).

<sup>4</sup> Charles River Associates, “Impact Evaluation of the California Statewide Pricing Pilot,” March 2005.

<sup>5</sup> Based on the Residential Energy Consumption Survey (RECS) 2001, the percentage of all households that are low income (defined as less than \$40,000) and high usage is about 2.2 percent (defined as 200 percent of average annual kWh) or 5.7 percent (defined as 150 percent of average annual kWh). Based on RECS, average annual usage is 10,654 kWh (833 kWh monthly). Using these definitions of low income and high usage, the percentage of low income customers that are high usage is 4.2 percent (using 200 percent of average annual kWh as the definition of high usage) or 11 percent (using 150 percent of average annual kWh as the definition of high usage). Note that 150 percent of average usage is approximately equal to the top quintile of usage in the U.S. The \$40,000 cutoff for low income is similar to the one used in the CA SPP and is somewhat higher than most definitions of low income.

<sup>6</sup> The Pepco RAD program offers discounts on electricity to low-income customers. For details on the Pepco program, see Smart Meter Pilot Program, Inc., “PowerCentsDC™ Project: Program Description,” April 9, 2007. In general, under a PTR, customers remain on the static rate but receive a rebate for lowering their usage during critical peak hours below what they would have consumed normally during those hours.

Table F-1: Low Income and High Usage (Using 150 Percent of Average Usage)

<b>Low Income and High Usage Breakdown</b>	
<b>High Usage Defined as 150% Greater than Average</b>	
<b>Average Annual Usage (kWh)</b>	10,654
Low Usage: 50% of Average (kWh)	5,327
High Usage: 150% of Average (kWh)	15,981
Low Income Definition	< \$40,000
<b>Total Households</b>	106,989,274
HH Under \$40,000/Over 150%	<b>6,074,485</b>
HH % Under 40/Over 150%	<b>5.68%</b>
Total HH With Low Income	55,492,016
Total HH with High Usage	20,028,174
% Total HH with High Usage	18.72%
% Low Income with High Usage	<b>10.95%</b>

Table F-2: Low Income and High Usage (Using 200 Percent of Average Usage)

<b>Low Income and High Usage Breakdown</b>	
<b>High Usage Defined as 200% Greater than Average</b>	
<b>Average Annual Usage (kWh)</b>	10,654
Low Usage: 50% of Average (kWh)	5,327
High Usage: 200% of Average (kWh)	21,308
Low Income Definition	< \$40,000
<b>Total Households</b>	106,989,274
HH Under \$40,000/Over 200%	<b>2,301,283</b>
HH % Under 40/Over 200%	<b>2.15%</b>
Total HH With Low Income	55,492,016
Total HH with High Usage	9,471,143
% Total HH with High Usage	8.85%
% Low Income with High Usage	<b>4.15%</b>

The California SPP consisted of three tracks: Track A, which included a statistically representative sample of customers; Track B, which focused on low-income customers in areas of San Francisco (located in close proximity to a power plant); and Track C, which focused on customers in San Diego that had smart thermostats.<sup>7</sup> Track A comprised four climate zones while Tracks B and C focused on single climate zones.

In this appendix, we examine the impact of dynamic pricing on low-income customers based on the results of the SPP. First, we summarize the results of a recent study that focused on the final three-month period of the SPP: July 1 to September 30, 2004.<sup>8</sup> These results are indicative of an established program. Second, we provide results for Track B customers only, which represent low-income customers over the entire SPP (15

<sup>7</sup> For the Track B evaluation, see San Francisco Community Power in cooperation with M. Cubed and Charles River Associates, “Statewide Pricing Pilot Track B: Evaluation of Community-Based Enhancement Treatment,” Draft Final Report, March 29, 2005.

<sup>8</sup> Herter, K., “Residential implementation of critical-peak pricing of electricity.” Energy Policy 35 (2007). pp: 2121-2130

months from July 2003- September 2004). Finally, we provide results for Track A customers, which represent the general population of California over the 15-month period. Using Track A, we compare low-income customers to other customers in the same track. As shown below, each of these comparisons shows that low-income customers do respond to dynamic prices. However, as pointed out earlier, there may be very specific groups of customers that should be targeted for PTR rather than CPP.

### **SPP Results: Income and Usage Group Differences**

Some groups have advocated targeting dynamic pricing to the large users of electricity in the residential sector while others have questioned whether dynamic pricing should be offered to low-income customers. Whether these suggestions are sensible depends on the responses of different usage and income groups to dynamic prices and the resulting bill impacts. It is important to recognize that a small percentage of low-income customers are also high-usage customers (about 4.2 percent to 11 percent of low-income customers are high usage depending on the definition of high usage as describe earlier). Based on a sample of 457 customers from the SPP, Herter analyzed the demand responsiveness of low-use (less than or equal to 600 kWh per month) vs. high-use customers (greater than 600 kWh) by three income groups.<sup>9</sup> She found that high-usage customers reduce usage during CPP events while low-usage customers do not show a statistically significant reduction in usage. She also found that, among high users, low- and middle-income customers respond as much as (or more than) high-income customers. Among low users, there were no significant differences across the three income groups.

Herter also examined the bill impacts by usage and income group. Her findings show that, on average, customers save on the CPP rate; low-usage customers save an average of 4 percent on their electricity bills whereas high usage customers save an average of 1.7 percent; across income levels, bill savings are not statistically different. **These findings indicate that targeting dynamic pricing only to high-usage customers would make little sense.**

A second finding of interest is that high-usage customers with incomes under \$50,000 have insignificant bill savings. An examination of the distribution of savings for these customers finds that while some customers did save, others in this group were likely to experience bill increases. This finding suggests that low-income customers with high usage should perhaps be targeted and offered an alternative to CPP such as PTR (representing about 4 percent of low-income customers). **However, low-usage customers are likely to experience bill savings regardless of income group. Therefore, it would make little sense to exclude low-income customers with low usage from dynamic pricing.**<sup>10</sup>

### **SPP Track B (Low-income) Customer Analysis**

The objective of Track B was to examine whether residential customers would be more likely to shift their electricity use off-peak if: (1) they lived close to an electric generating facility, (2) they received information about the connection between electricity generation, especially during the critical peak periods, and associated polluting air emissions, and (3) this information was delivered by a community-based group. Two groups within Track B received community-based information/education and CPP-F price signals, and the third group received only the CPP-F price signals.<sup>11</sup>

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<sup>9</sup> Note that Herter simply divides usage groups into above and below average. Herter defined low income as \$0-\$24,999; middle income: \$25,000-\$49,999; high income: \$50,000 and higher.

<sup>10</sup> See Herter (2007) for the detailed results.

<sup>11</sup> The SPP tested several different rates including two CPP rates and a traditional TOU rate. The CPP-F rate featured a fixed peak period on both critical and non-critical days between 2 p.m. and 7 p.m. weekdays and day-ahead customer

Track B customers were selected from San Francisco’s Bayview, Hunters Point, and Potrero neighborhoods. A control group was selected from Richmond, CA. The control group received price signals but not the enhanced information. The city of Richmond was selected based on its comparability to San Francisco in terms of: climate, energy consumption patterns, demographic characteristics, and environmental hazards and associated environmentally focused community activism.

Demographically, Bayview/Hunters Point and Richmond are similar in their demographics and low median income relative to the San Francisco metropolitan area. The Bayview/Hunters Point population has a median household income of about \$44,000. The Richmond population has a median income of about \$39,000. This is in contrast to the San Francisco metropolitan area with a median income of about \$62,000.

In general, Track B customers showed an ability to shift their usage despite low air conditioning saturation rates and low need for air conditioning given the climate. Examining only Track B low-income customers, Table F-3 shows that peak period consumption decreased on critical peak days. For customers who received information but no price signal, the average daily percentage decrease in consumption during critical peak hours was about 1 percent. For customers who received both information and a price signal, the average daily percentage decrease in consumption during critical peak hours was about 2.6 percent. These results demonstrate that low-income customers do respond to both information/education and price signals.

Table F-3: Change in Critical Peak Period Consumption of Track B (Low-income) Customers in SPP<sup>12</sup>

<b>Impact of information only vs. price and information on consumption</b>	<b>Average Change in Critical Peak Period Consumption (Summer 2003 &amp; 2004)</b>
Track B customers: Information Only	-1.15%
Track B customers: Price & Information	-2.60%

### SPP Track A (General Population) Customer Comparison

The primary objective of Track A was to estimate the average impact of different time-varying rates on energy use for each rate period. Track A customers were selected to represent California’s general population. These customers were split into treatment groups with several different rate structures that included a traditional TOU rate, a variable critical peak pricing (CPP-V) rate, and a fixed critical peak pricing (CPP-F) rate. In addition to getting a different rate or electricity price, customers received educational materials about the environmental and economic benefits of shifting their electricity usage from peak to off-peak periods.

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notification. The CPP-V rate featured a variable length peak period on critical days, which could be called on the day of the critical event. On non-critical days, under both the CPP-F and the CPP-V rates, a TOU rate was in effect. The SPP did not test the PTR.

<sup>12</sup> Average results from Summer 2003 and Summer 2004 in Table 4-2 in San Francisco Community Power in cooperation with M. Cubed and Charles River Associates, “Statewide Pricing Pilot Track B: Evaluation of Community-Based Enhancement Treatment,” Draft Final Report, March 29, 2005

Track A of the SPP provides additional evidence that low-income customers are price responsive. This track covered all four climate zones in the state. Results are available for two categories of low-income customers. First we compare customers with low income. Second, we compare customers on a low-income rate (CARE) that received a 20 percent discount on the electric bill versus non-CARE customers. About 20 percent of residential customers in California are on the CARE rate.

As shown in Table F-4, although high-income households (defined as greater than \$100,000) are somewhat more price-responsive than low-income households (defined as less than \$40,000), low-income customers do exhibit demand response. Low-income customers dropped their load during critical peak hours by 11 percent whereas high-income customers dropped their load by 16 percent.

Table F-4 also shows that customers who did not receive the CARE discount were much more price responsive (dropping their load by about 16 percent) than those who did receive the CARE discount (dropping their load by only 3 percent).<sup>13</sup> Finally, the price responsiveness of all customers was about 13 percent across all zones and about 8 percent in Zone 1 where the climate is similar to that of the low-income customers in Track B.

Table F-4. Track A: SPP Results: Response by Customer Segments

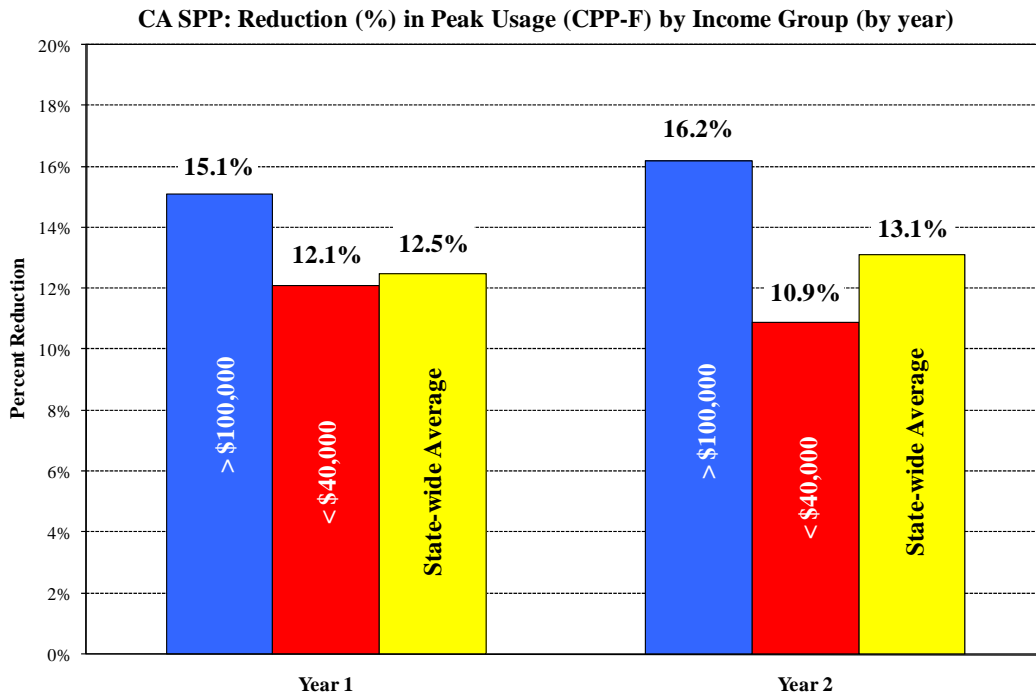
Customer Segment	Customer Sub-Segment	Substitution between peak and off-peak consumption	Price elasticity of daily consumption	Percent reduction in critical-peak consumption
Income	High (\$100,000)	-0.101	-0.045	-16.15
Income	Low (\$40,000)	-0.061	-0.035	-10.92
Care	No	-0.102	-0.029	-15.56
Care	Yes	-0.005	-0.014	-2.87
Average	All Zones	-0.076	-0.041	-13.06
Average	Zone 1	-0.039	-0.041	-7.61

(Source: Impact Evaluation of the California Statewide Pricing Pilot. Final Report. March 2005)

Figures F-1 and F-2 show the percentage reduction in peak period usage under the CPP fixed rate for low income (defined as less than \$40,000) versus high income (defined as greater than \$100,000) for each year of the pilot. As shown in Figure F-1, the low-income percentage reduction in peak usage (11-12 percent) is very similar to the statewide average response (12-13 percent). As expected, low-usage customers (those with usage that is 50 percent of the average) respond less than high-usage customers (defined as those with usage that is 200 percent of the average). Notably, although low usage is below the average in the first year (9.8 percent vs. 12.5 percent peak usage reduction), by the second year of the pilot (which is more likely to represent an ongoing program), low-usage response is much closer to the average response (12.2 percent vs. 13.1 percent reduction).

<sup>13</sup> The CARE results are difficult to interpret. CARE customers may not be as responsive as low-income customers in general because they are accustomed to getting a 20 percent discount on their electric bill.

Figure F-1: CA SPP - Percent Reduction in Peak Period Usage by Income Group<sup>14</sup>

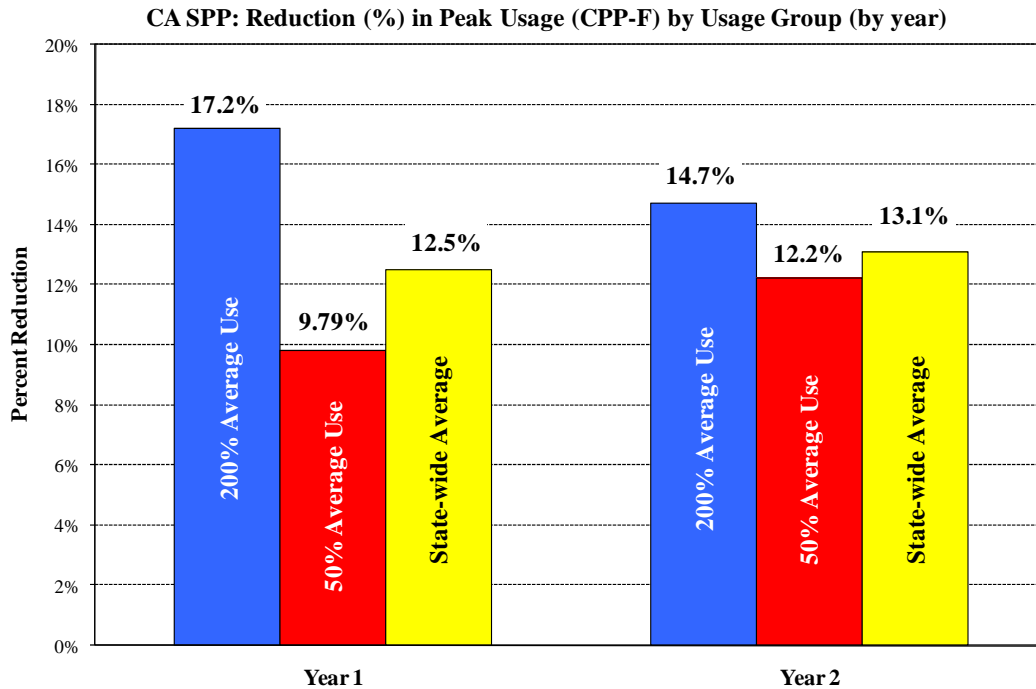


### Summary

The results of the California pricing experiment show that low-income customers do respond to dynamic pricing by lowering usage during high-priced periods. This result holds even in areas with a temperate climate such as San Francisco as demonstrated by the Track B results. However, as demonstrated by the usage and income group analysis of the CPP conducted by Herter, focusing on income group alone is not sufficient and could lead to a faulty policy recommendation; usage must be taken into account. Low-income customers with low usage (which represent about 96 percent of all low-income customers) benefit from CPP in terms of bill savings. However, although low-income customers with high usage (about 4 percent of all low-income customers) may not benefit from CPP, they could benefit from PTR.

<sup>14</sup> Source: California Statewide Pricing Pilot, Summer 2003 Impact Analysis, 2004.

Figure F-2: CA SPP - Percent Reduction in Peak Period Usage by kWh Usage Group



Our major conclusion regarding usage targeting is the following:

- Low-usage customers save an average of 4 percent on their electricity bills whereas high usage customers save an average of 1.7 percent. Therefore, targeting dynamic pricing only to high-usage customers (as a proxy for high income as some have suggested) makes little sense from a policy perspective.

Our major conclusions regarding the effects of dynamic pricing on low-income customers are the following:

- Low usage customers are likely to experience bill savings regardless of income group. Therefore, it would make little sense to exclude low-income customers with low usage (about 96 percent of all low-income customers) from dynamic pricing.
- For the low-income customer with high usage, it may be useful to consider alternative dynamic pricing options such as PTR and information programs (similar to the Pepco pilot in the District of Columbia).

The SPP participant surveys show that about 87 percent of participants believe that dynamic pricing programs should be “probably” or “definitely” offered to all residential customers. Customers cited as a major program benefit becoming educated about the connection between electricity use and bill impacts.

A final concern that has been expressed is the cost of the meter, how fixed costs (such as the cost of a meter) are typically recovered as a flat fee per customer, and how this could have a negative impact for low-income customers. One solution is to consider a “volumetric” per kWh-based cost allocation method for such meters where the cost of the meter per customer per month varies directly with usage.<sup>15</sup>

<sup>15</sup> Roger Levy, Demand Response Research Center. PowerPoint presentation (no title).

In summary, there are many reasons to move forward with dynamic rate options for the vast majority of customers. Most important, customers respond to price signals and, as a result, customers on dynamic rates cost less to serve than those on standard flat or static rates. Second, a large majority of customers that have participated in dynamic rate programs believe that dynamic rates should be offered to all residential customers. Finally, dynamic rates give customers more control over their electric bill. If a small percentage of low-income customers with high usage (about 4 percent to 11 percent of the low-income group depending on the definition of high usage) are disadvantaged by a dynamic rate such as CPP, then one solution is to offer a PTR rate to these customers. However, for the low-income customers in the low-usage category (about 89 percent to 96 percent of the low income group), CPP can be beneficial.