

# Understanding Customer Decisions Associated with Default Dynamic Pricing

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## ABSTRACT

In May 2008, San Diego Gas & Electric (SDG&E) placed roughly 1,800 non-residential, interval-metered customers on a default critical peak pricing tariff. Customers were given 45 days to migrate to the otherwise applicable tariff, which was a TOU rate. If they did not move within that period of time, they were to remain on the tariff for at least 12 months. This paper compares the characteristics of customers who stayed on the rate with those who left, and examines some of the drivers of those decisions. It is based on analysis of decisions that were made during the first program year, when customers were provided with bill protection. By the time of the AESP conference, new data and models will be available showing subsequent decisions that were made after the bill protection period ended.

## Introduction

In May 2008, SDG&E implemented a default CPP tariff that applies to all non-residential, bundled service customers with peak demands exceeding 20 kW who have interval meters. Once SDG&E has completed full deployment of advanced meters, this tariff will apply to all customers with peak demands greater than 20 kW.<sup>1</sup> Customers defaulted onto the CPP rate will have the option of selecting an alternative, non-dynamic tariff, which will be a TOU rate with a peak demand charge, as described below. At the time the default CPP tariff was implemented, 1,767 customers were defaulted onto the rate.<sup>2</sup> Table 1 shows the breakdown of customers who were defaulted onto the rate by size. Twenty three percent of the customers defaulted onto the rate had peak demands below 200 kW. The average annual maximum demand across the entire customer population was 474 kW.

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<sup>1</sup> All customers in California with peak demands exceeding 200 kW have had interval meters installed since roughly 2002. In SDG&E's service territory, many customers below 200 kW are also interval metered, as participants in any of SDG&E's DR programs require interval metering. Within the next few years, SDG&E will have completed its advanced metering deployment, and all customers in the service territory will have interval meters.

<sup>2</sup> Customers participating in one of SDG&E's day-ahead demand response programs were not eligible for the rate.

**Table 1:** SDG&E Customers Transferred to CPP-D Tariff in May 2008

Size Category	Number of Customers	Percent of Customers	Average of Max. Summer On-Peak Demand (kW)
100 kW or less	175	10%	48
100 to 200 kW	225	13%	157
200 to 500 kW	871	49%	315
500 kW and up	386	22%	1,003
Unclassified	110	6%	400
<b>Total</b>	<b>1,767</b>		<b>474</b>

SDG&E was the first utility in California to implement default CPP pricing for non-residential customers. PG&E has been directed to implement a similar pricing plan over the next two years and SCE is likely to follow shortly thereafter.

### Overview of Tariff Options

SDG&E's CPP-D tariff applies to commodity service only. It consists of a three-period rate where, during the summer, the peak-period is from 11 am to 6 pm on weekdays, the semi-peak period is from 6 a.m. to 11 a.m. and 6 p.m. to 10 p.m. on weekdays, and the off-peak period is from 10 p.m. to 6 a.m. on weekdays and all day on weekends and holidays. Under CPP-D, prices vary across rate periods on all weekdays, but are higher during the peak period on CPP event days than on normal weekdays. The maximum number of event days that can be called under the CPP-D tariff is 18 and customers are notified by 3 p.m. the day before an event occurs. Prices and rate periods vary seasonally<sup>3</sup> and the summer period is from May 1 to September 30. In its November 15, 2008 rate design window application, SDG&E filed to be able to call CPP events year round.

SDG&E's non-commodity service also has prices that vary by time of day according to the same rate periods. The non-commodity portion of the tariff has monthly charges as well as non-coincident demand charges and charges for maximum demand during the peak rate period.

At the same time that the new CPP-D tariff was introduced, SDG&E modified its Otherwise Applicable Tariff (OAT) for commodity service for 20 kW and above customers. Prior to May 2008, there was no demand charge for commodity service, but the new OAT implemented in May 2008 has a demand charge. Thus, when considering whether or not to stay on the default CPP-D tariff, the OAT that customers had to consider was not their prior tariff, with no commodity demand charges, but rather a new tariff that has demand charges for the commodity and also has different prices for energy by rate period compared with the prior tariff. Table 2 compares the prices associated with the prior OAT, the new OAT and the CPP-D tariffs for commodity service. Prices for the non-commodity portion of service do not vary across the three tariffs depicted in Table 2.

Another feature of the CPP-D tariff is the opportunity to insure against bill volatility by reserving a level of generation capacity that would protect that portion of load from the high energy prices during the peak period on critical event days. Customers electing to protect a portion of their load pay a Capacity Reservation Charge (CRC) each month. The CRC price, shown in the first column of Table 2, is \$6.20/kW. If a customer does not proactively select a portion of their load to be protected by the CRC option, the CRC amount is set to 50% of their CPP Maximum Demand, defined as the maximum on-peak demand recorded during the most recent full summer billing period. If a CPP Maximum Demand

<sup>3</sup> The complete tariff can be found at <http://www.sdge.com/business/esc/documents/cppTariff.pdf>.

cannot be determined for a customer, the default CRC level is set to zero.

**Table 2:** Commodity-Related Charges for CPP-D and the Otherwise Applicable Tariff

*Pre-default*

Charge Description	DEFAULT Critical Peak Pricing	OPT-OUT Commodity Pricing	<del>CURRENT</del> Commodity Pricing
<b>New</b> Summer Energy Rates (\$ per kWh)			
CPP Event Period – Above Capacity Reservation	\$1.06781	NA	NA
On-Peak	\$0.10360	\$0.10821	\$0.14033
Semi-Peak	\$0.08307	\$0.08768	\$0.08283
Off-Peak	\$0.06139	\$0.06600	\$0.05807
Winter Energy Rates (\$ per kWh)			
On-Peak	\$0.10170	\$0.10631	\$0.14033
Semi-Peak	\$0.09313	\$0.09774	\$0.08283
Off-Peak	\$0.06822	\$0.07283	\$0.05807
<b>New/Optional</b> Capacity Reservation Charge (\$ per kW/Month – Year Round) Self-Selected kW	\$ 6.20	NA	NA
<b>New</b> On-Peak Demand Charge (\$ per kW) Maximum Summer On-Peak Demand	NA	\$ 6.43	NA
On-Peak Demand (\$ per kW) Maximum Winter On-Peak Demand	NA	\$.21	NA

The new OAT has lower peak prices than the prior tariff but a demand charge has been added where there was not one in the previous tariff

T&D charges were the same for CPP-D and the opt out tariff

### Transition Process and Results

Customers were defaulted onto the CPP-D tariff starting in early May and were given 45 days to opt-out and to select their CRC amount. If a customer did not opt-out of the rate, they were obligated to stay on the rate for 12 months. Customers will continue on this rate unless they notify SDG&E on the anniversary of their enrollment date that they wish to leave or unless they become ineligible, for example, by enrolling in one of SDG&E’s demand response programs.

Customers who stay on the rate are given bill protection for the first 12 months of service following the default date. At the end of the 12-month period, SDG&E will calculate each customer’s bill based on the OAT and compare that amount with the amount billed under the CPP-D tariff. If the bill amount under CPP-D is greater than the amount under OAT, SDG&E will refund the difference. In all cases, at the end of the bill protection period, SDG&E will send a report summarizing the analysis and will give each customer 45 days from receipt of the report to opt-out of the rate. Otherwise, they will continue on the rate without bill protection.

At the time of notification of the new tariff, customers who were registered online were provided with access to a bill analysis tool that they could use to determine what their bills would be under the CPP-D and OAT tariffs, based on their prior usage patterns, capacity reservation level selection, assumptions about the number of CPP event days, and load reductions they might make during high price periods. The billing analysis tool was also available to all customers through their assigned account representatives. Customers registered online also had access to their interval data and load shape information through SDG&E’s kWickview online energy monitoring tool.

Table 3 shows the number and average demand for customers who were defaulted onto the CPP-D tariff (last set of columns), as well as for those who stayed on the rate (first set of columns), and those

who opted out to the OAT option. Table 4 contains similar information for the CRC selection for customers who stayed on the CPP-D tariff.

**Table 3: CPP-D Opt-Out Decisions**

Industry type	Default CPP Tariff			Opt-Out TOU Tariff		Total	
	# of Cust.	% of Customers	Average of Max. Summer On-Peak Demand (kW)	# of Cust.	Average of Max. Summer On-Peak Demand (kW)	# of Cust.	Average of Max. Summer On-Peak Demand (kW)
1 Ag, Mining & Construction	23	74%	604	8	274	31	509
2 Manufacturing	190	77%	502	57	531	247	508
3a Wholesale, Transport	153	90%	554	17	512	170	549
3b Water Districts	110	81%	570	26	463	136	552
4 Retail Stores	119	73%	383	45	475	164	407
5a Offices, Finance & Services	315	73%	531	114	462	429	512
5b Hotels and Apartments	95	52%	393	89	495	184	442
6 Schools	133	77%	391	40	374	173	388
7 Institutional, Government	175	78%	380	50	488	225	402
8 Other	7	88%	248	1	271	8	252
Total	1,320	75%	476	447	471	1,767	475

**Table 4: CPP-D Capacity Reservation Charge Decisions**

Industry Types	Default CRC Level (50%)		Selected CRC Levels		Aggregate CRC Levels	
	# of Cust.	% of Cust.	# of Cust.	Ave. CRC Level	# of Cust.	Ave. CRC Level
1 Ag, Mining & Construction	14	61%	9	6%	23	26%
2 Manufacturing	93	49%	97	10%	190	26%
3a Wholesale, Transport	45	29%	108	2%	153	16%
3b Water Districts	15	14%	95	26%	110	29%
4 Retail Stores	67	56%	52	8%	119	29%
5a Offices, Finance & Services	167	53%	148	9%	315	26%
5b Hotels and Apartments	58	61%	37	12%	95	32%
6 Schools	123	93%	10	25%	133	48%
7 Institutional, Government	50	29%	125	5%	175	14%
8 Other	5	71%	2	0%	7	47%
Total	637	48%	683	10%	1,320	26%

Overall, 75 percent of all customers and the same percent of demand stayed on the default CPP-D rate. The percent of customers who stayed on the default tariff exceeded 70 percent for all business types except hotels and apartment buildings, where it was only 52 percent. Wholesale and transportation customers had the highest stay rate, at 90 percent of all accounts.

As seen in Table 4, of the 1,320 service accounts that stayed on the CPP-D tariff, a little less than half (48 percent) accepted the default CRC amount of 50 percent. Of the 683 customers who did not accept the default amount, 513 (or 75 percent) set the reservation amount at zero, and 41 (6 percent) set their CRC amount at 50 percent (that is, they indicated they wanted a value of 50 percent rather than defaulting onto the 50 percent reservation amount).

## Opt-Out Model Development and Validation

The default CPP-D tariff implemented by SDG&E is, to our knowledge, the first of its kind in the country and certainly the first default dynamic tariff in California among the three major investor owned utilities. However, both SCE and PG&E will soon implement default dynamic pricing. The choices made by SDG&E's customers may provide some guidance on predicting the choices that customers might make in response to similar pricing strategies implemented elsewhere. They may also be useful in helping SDG&E to predict the choices that additional non-residential customers are likely to make as they are defaulted onto the CPP-D tariff when their interval meters are installed over the next several years.

In order to extrapolate to other service territories, or to additional customers within SDG&E's service territory, it is necessary to control for differences in population characteristics between customers that already made their choice and future customers who will be offered an identical or similar choice. This can be done through choice modeling. A choice model estimates the likelihood that a customer will choose between two or more options as a function of customer characteristics, the characteristics of the choices available, or both. This section documents the choice models that were developed and that can be used by others to predict the percent of customers who are likely to stay on a similar rate or make an alternative selection.

Importantly, the models discussed below can control for differences in customer characteristics such as load shapes and industry type, and one of the models can adjust for the impact of differences between SDG&E's default and opt-out tariffs and those that might be relevant in other jurisdictions. However, none of the models can control for differences in the default process due to the lack of variation across these factors in the estimating sample. Specifically, choices made by SDG&E's customers may have been influenced by the first year bill protection provision of the default tariff. If so, the models presented here may under predict the opt-out rates for utilities that do not offer that option, since bill protection may increase the likelihood that customers will stay on the default tariff at least through the first 12 months. By the time of the AESP conference, we expect to be able to present preliminary results from subsequent analysis of data covering the post-bill protection period.

Choice models based on individual customer data were estimated for both the decision of whether or not to stay on the default rate and whether or not to accept the default CRC reservation amount. Three probit models were estimated for each decision, with the main difference between them having to do with variables used to represent how customers might determine the likelihood of whether or not they would be better or worse off on the default rate. Two of the models assume that customers use heuristics<sup>4</sup> to make their choice while the third model assumes that customers base their choice on a comparison of bills under the two rate options available.

- **Percent CPP Load Model:** The key variable in this model equals the total kWh during the peak period on the top 9 system load days divided by annual kWh. This is meant to represent the percent of a customer's load that could be subject to high CPP prices. Calculating this value requires that customers have access to interval data. All SDG&E customers did have access to interval data but it took some effort to retrieve it and there was no information available indicating whether customers accessed these data.
- **Percent Peak Load Model:** The key variable in this model is the percent of annual load that falls in the peak period on all summer days. All customers who were defaulted onto the CPP-D

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<sup>4</sup> It should be noted that use of the word "heuristics" is not meant to imply that these models are any less formal or necessarily have less predictive power than the bill analysis model. This term means that customers may use rules of thumb rather than careful bill comparisons to make decisions.

tariff were already on TOU rates. As such, this variable could be calculated by a customer from information on their monthly bills.

- **Bill Comparison Model:** The key variable in this model is the difference in a customer's bill on the CPP-D and OAT tariffs, divided by the OAT bill amount, assuming no change in energy use. This variable indicates whether or not a customer is a structural winner and the magnitude of that structural win or loss. This value was calculated based on the assumption that, on average, there will be 9 event days.

Clearly, all of the key variables in the three models are highly correlated, as the magnitude of structural wins and losses is largely a function of the percent load that is subject to high prices. An important advantage to the bill comparison model is that it can be used to reflect the impact of default and opt-out tariffs that differ from those that were used to estimate the model. However, if most customers rely on heuristic decision making, unless the alternative rates are extremely different from those underlying the estimating sample, the heuristic models may provide predictions that are at least as accurate as the bill comparison model. In fact, the heuristic model based on the percent of annual consumption during expected CPP hours actually predicts better for the estimating sample than does the bill comparison model. However, it is impossible to know which model has the highest external validity (*i.e.*, predicts best for alternative rate options) until choice data become available for some alternative options, and predicted and actual choices are compared. Until then, we recommend using the bill comparison model as it may have more perceived external credibility (as distinct from external validity) among certain stakeholder groups because it can reflect differences in tariff values whereas the other two models can not.

The remainder of this discussion is focused on the bill comparison model, which contains the following variables:

- A continuous variable indicating the magnitude of a customer's structural benefit or loss under the assumption that there will be 9 event days.<sup>5</sup> Specifically, the variable is calculated as the difference in a customer's bill on the CPP-D and opt-out TOU tariffs, divided by the opt-out TOU bill amount, assuming no change in energy use;
- The coefficient of variation of the monthly bill amounts based on the OAT;
- A binary variable indicating whether a customer has high or low variation of monthly bills based on the OAT;
- The interaction between the second and third variables;
- Whether or not a customer had access to their interval data through SDG&E's My Account web tool, which provides access to interval data; and
- Business type.

Several additional variables were tested but were not statistically significant in the bill comparison model, including the age of the account, load factor, customer size (annual kWh), volatility of demand during CPP-like days, and climate zone.

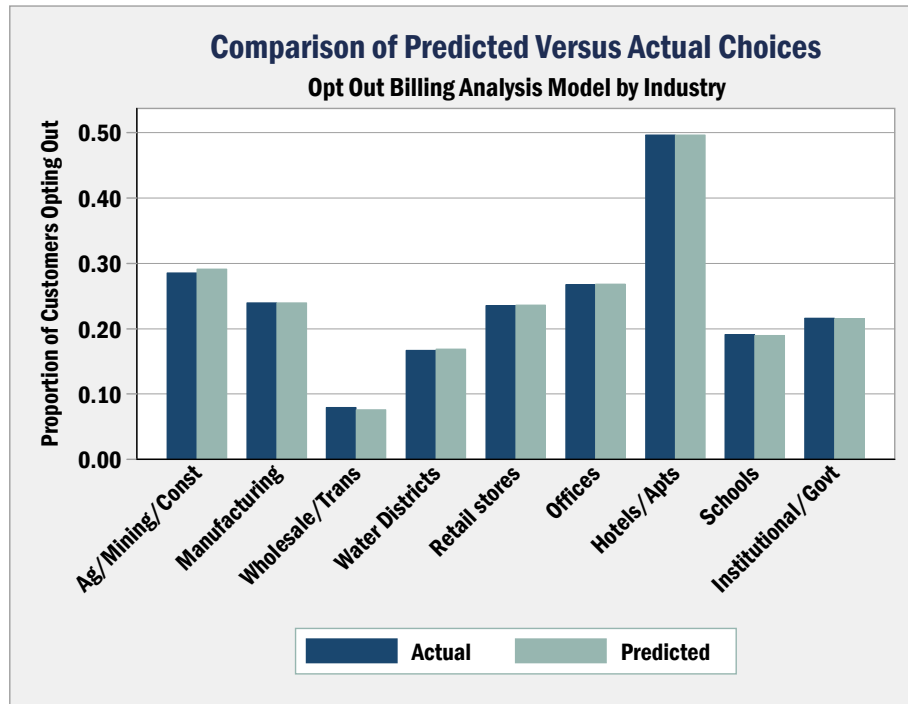
In addition to the variables mentioned above, we also tested binary variables representing each individual customer service representative who were assigned to an account. Collectively, these variables nearly doubled the explanatory power of the model and there was wide variation across account representatives in the percent of their assigned accounts that stayed on the default rate after controlling for load shapes, industry mix, and size. However, we did not have access to any information about the activities that account representatives engaged in with customers, so it was not possible to assess whether certain activities that other utilities might engage in with customers would influence customer choice. Put another way, the version of the model that includes account representative

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<sup>5</sup> The percent of customers who are structural winners will vary significantly with the number of assumed event days.

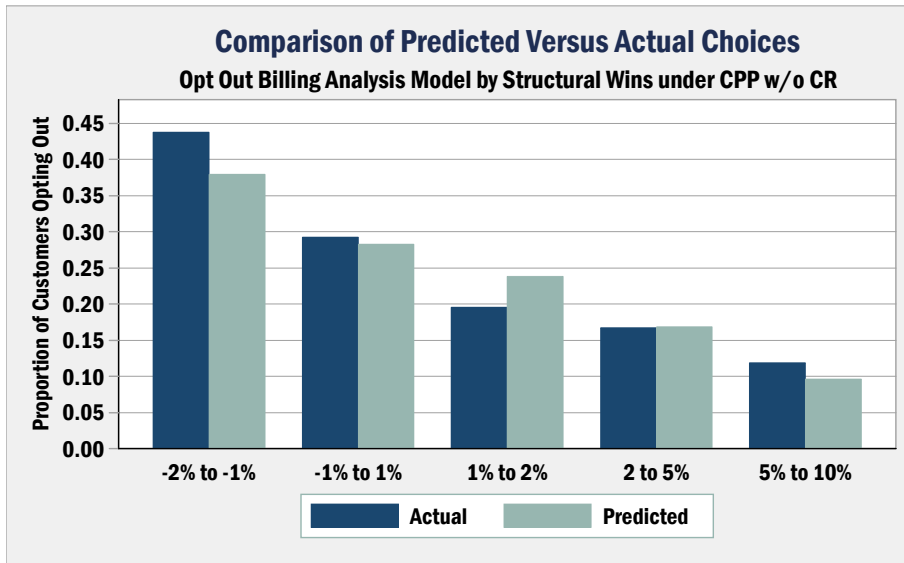
variables cannot be used by other utilities to predict what choices would be made by their customers based on variation in account representative activity. As such, we excluded these variables from the three choice models.

Figures 1 through 4 compare predicted and actual values for the percent of customers by type who opt-out of the default tariff. As seen in Figure 2, the model does an extremely good job of predicting the percent of customers who leave the default rate for each business type. The figure also shows clearly the variation in opt-out rates across business segments and the much higher opt-out rate for hotels and apartments.



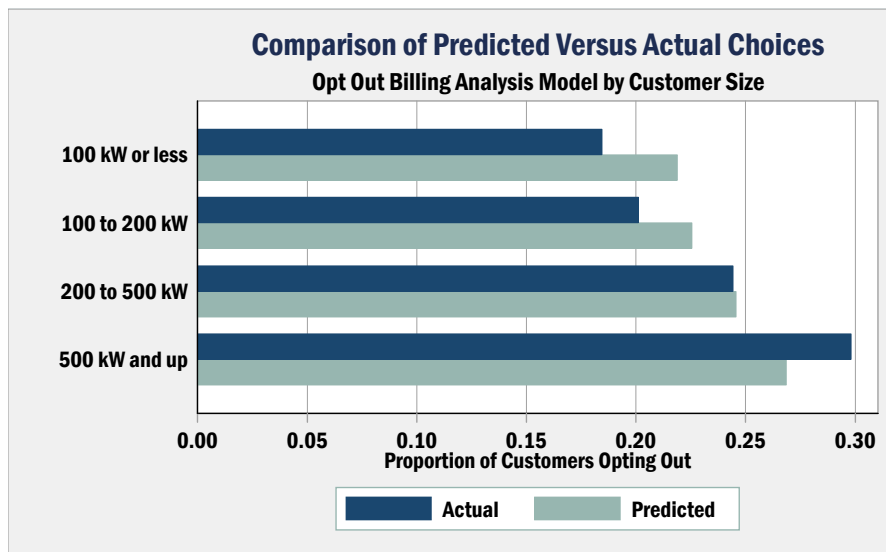
**Figure 1:** Opt Out Billing Analysis – Accuracy by Industry

Figure 2 compares predicted and actual opt-out values for customers who are structural winners and losers. As indicated, structural losers have a much higher probability of choosing the OAT option than do structural winners, and the opt-out rate varies with the magnitude of the predicted structural wins and losses.



**Figure 2:** Opt Out Billing Analysis – Accuracy by Percent Bill Change

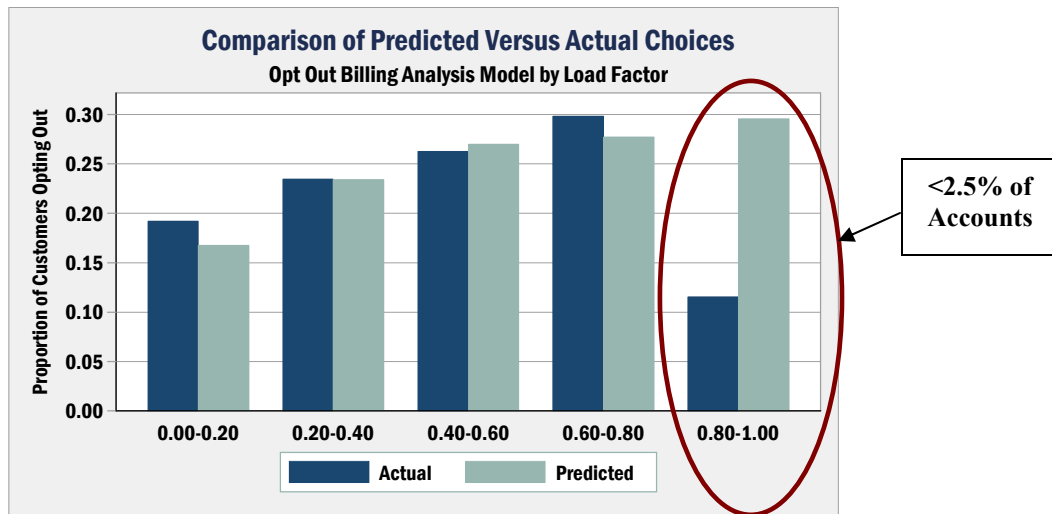
Even though customer size was not included in the model because it was not statistically significant, size may be correlated with other explanatory variables and a comparison of predicted and actual choices by size may still be of interest. Figure 3 shows the predicted and actual values by customer size. The model under predicts for large customers and over predicts for smaller customers, but the differences between predicted and actual values are not large (roughly 5 percentage points for the smallest customer segment and approximately 3 percentage points for the largest customer segment).



**Figure 3:** Opt Out Billing Analysis – Accuracy by Customer Size

The final validation comparison examines differences across customer segments distinguished by load factor. Once again, the difference between predicted and actual choices is not large except for the small number of very high-load factor customers in the sample.





**Figure 4:** Opt Out Billing Analysis – Accuracy by Load Factor

### CRC Choice Model Development and Validation

A probit model was also estimated to predict the probability that a customer will select the default CRC amount of 50 percent of their CPP Maximum Demand, or will select an alternative reservation amount. Customers only pay CPP prices for the average hourly demand in excess of the capacity reservation amount during CPP events. Recall from earlier discussion that roughly half of the customers that stayed on the CPP-D tariff accepted the default reservation amount and the other half selected an alternative value. The majority of those who did not take the default value chose zero as their reservation load quantity.

The explanatory variables used in the probit model to predict the probability that the default reservation quantity would be accepted are:

- The ratio of the difference between the bill on the CPP-D tariff and on the OAT, divided by the OAT bill amount, assuming 9 event days and a zero reservation amount for CRC (e.g., the percent of structural wins and losses);
- The prior variable interacted with whether or not a customer has access to My Account;
- The maximum summer, on-peak demand (kW);
- The maximum summer on-peak kW interacted with a binary variable (>350 kW) to account for non-linearities in the relationship;
- The percent of hours during the CPP period in which the load exceeds the capacity reservation amount;
- The volatility of the load during the peak period on the highest 9 system load days (coefficient of variation);
- The natural log of annual Mwh;
- Binary variables representing each business type.

Figures 5 and 6 compare actual and predicted values for different business categories and for structural winners and losers. As seen, the model predicts well for customers segmented according to these variables. As seen in Figure 5, nearly all schools took the default CRC options, whereas most transportation companies, water districts and institutional customers chose a custom CRC amount. As

seen in Figure 6, structural winners were much less likely to take the default CRC option than were structural losers.

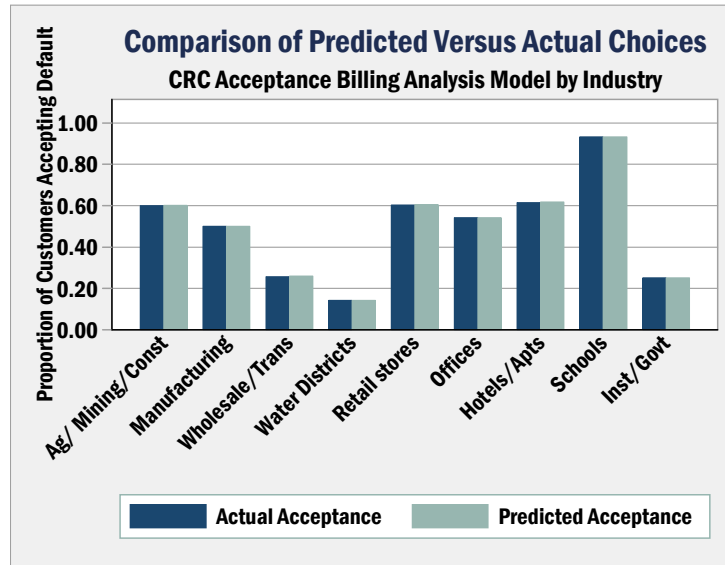


Figure 5: CRC Acceptance Model – Accuracy by Industry

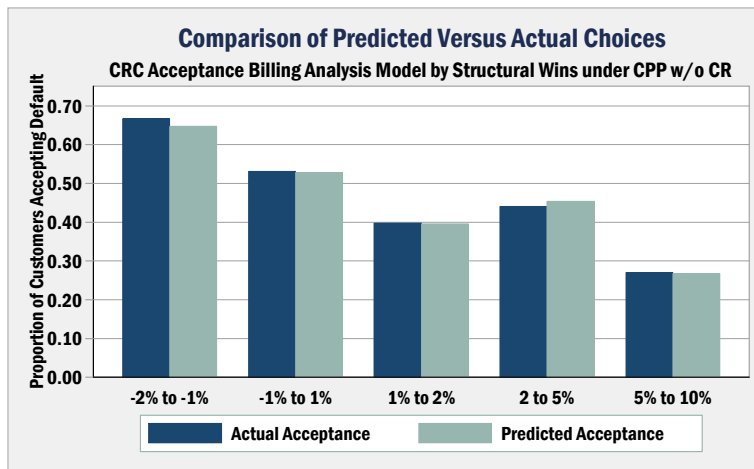


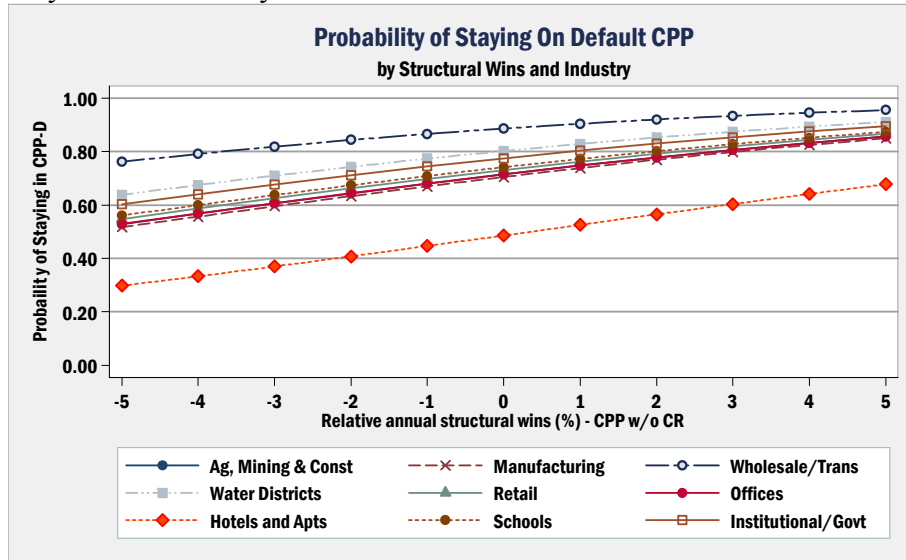
Figure 6: CRC Acceptance Model – Accuracy by Bill Impacts

### Predicting Opt-Out Rates

As seen in the prior sections, the probit models documented here do a good job of predicting whether customers are likely to stay on a default dynamic rate and to accept default CRC reservation amounts if that feature is offered. The models can be used to predict initial choices assuming that customers are defaulted onto a dynamic rate with first year bill protection. The key explanatory variables are business type and variables representing energy use, bill amounts and bill volatility under the tariff options offered.

Figure 7 shows the effect of two of the primary explanatory variables, the percent of structural wins/losses and industry type, on the likelihood of staying on default CPP, while holding other factors constant. For example, a hotel with 2 percent structural losses has a 40 percent probability of staying

on default CPP while a hotel with 2 percent structural wins has close to a 60 percent probability of staying on default CPP. In addition, the figure shows that wholesale and transportation customers are nearly twice as likely as hotels to stay on default CPP rates.



**Figure 7:** Probability of Staying on CPP-D – by Bill Change

Another key explanatory variable affecting opt-out rates was registration for the online account that provided access to billing tools. Customers that registered online had a 26 percent higher likelihood (or roughly 5 percentage points higher) of opting out of the CPP-D tariff than did customers that had not registered online. Finally, variables that reflect monthly bill volatility for the CPP and OAT tariffs were tested. A variable representing price volatility of bills under the CPP tariff was not statistically significant, although it consistently indicated that the more volatility in monthly bills (assuming no change in behavior), the higher the likelihood of opting out of CPP-D.

## References

- [CAEC 2008b] CA Energy Consulting, *Impact Evaluation of California Statewide Critical-Peak Pricing Rate and Demand Bidding Program for Commercial and Industrial Customers – Program-year 2007*, CALMAC Study ID SEC0258.01, prepared for Southern California Edison and the Demand Response Measurement and Evaluation Committee (CRMEC), August 2008.
- [CAEC 2008a] CA Energy Consulting, *Program-year 2006 Evaluation of Statewide Large Commercial and Industrial Day-Ahead Demand Response Programs*, prepared for Southern California Edison and the Working Group 2 Measurement and Evaluation Committee, June 2008.
- [Quantum 2004] Quantum Consulting and Summit Blue Consulting, *Working Group 2 Demand Response Program Evaluation – Program Year 2004 Final Report*, Prepared for the Working Group 2 Measurement and Evaluation Committee, 2004.
- [Quantum 2006] Quantum Consulting and Summit Blue Consulting, *Evaluation of 2005 Statewide Large Nonresidential Day-ahead and Reliability Demand Response Programs*, Prepared for Southern California Edison and the Working Group 2 Measurement and Evaluation Committee, 2006.