

Final Report

**Analysis of the Load Impacts  
and Economic Benefits  
of the TOU Rate Option**

*Prepared for:*  
Pacific Power

*March 31, 2005*

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# Executive Summary

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In 2002, Pacific Power (Pacific, the Company) filed a time-of-use (TOU) rate schedule for residential, small commercial, and irrigation customers with the Oregon Public Utility Commission in compliance with the requirements of OAR 860-038-0220 and pursuant to the recommendations of the State Portfolio Advisory Committee. The rate structure was later modified in 2004 with Commission approval.

In January 2005, PacifiCorp retained Quantec, LLC, a Portland-based energy consultancy, to evaluate the load impacts and economic performance of the TOU rate option. The principal objective of this assessment was to empirically investigate the actual load impacts and potential changes in energy use, and to determine the economic implications from the participant and total resource cost perspectives. This document reports the methods and conclusions of that assessment.

The analytic method of this assessment relied on a “quasi-experimental” research design, involving a comparison of load patterns between participants in the TOU rate and a sample of customers from Pacific’s residential and small commercial load research group. Due to the small number of participants, the irrigation sector was not analyzed separately. In addition, billing data were reviewed and analyzed to assess the potential impacts of the TOU rate structure on consumption.

The main findings of this evaluation are:

- In early 2002, PacifiCorp informed all eligible customers about the TOU rate through a direct mail informational brochure. Additional statewide program promotion has occurred since then. PacifiCorp also has conducted targeted program promotions during 2004 and 2005.
- The 2004 TOU rate structure update was designed to overlay rate differentials onto PacifiCorp’s basic rate structures. The 2004 rate structure revision also was significant in the increase in costs for the summer on-peak period. This appears to have led to a small load response from participants.
- The largest load impact of TOU rates tend to occur during the winter morning peak hours. TOU customer loads were, on average, 0.22 kW (9%) and 0.37 kW (17%) lower than those of the control group during the winter morning for the residential and commercial customers, respectively. Load impacts during the summer peak period tended to be smaller in magnitude, averaging at 0.1 kW and 0.23 kW for residential and commercial customers. Net reductions in demand remained the same under both rate structures.

- Participation in the pre-2004 TOU rate option also resulted in net reduction of 792 kWh/year and 1,128 kWh/year for the residential and commercial customers, respectively. Net energy savings dropped to 336 kWh/year in the residential sector and 516 kWh/year under the revised rate structure. It appears that the revised rate structure might have induced a larger shift in load rather than on-peak usage curtailment.
- Under the original rate structure, the average annual electricity bills for TOU participants were nearly \$27 and \$77 lower for the residential and commercial customers, respectively, than they would have been under the standard rate schedule. Average bill savings dropped to approximately \$5 per year for residential and \$10 per year for commercial participants under the revised TOU rate schedule.
- Actual energy use reduction was more pronounced in the pre-2004 period. It is possible that the change in rate structure and increase in summer on-peak rates led to more shifting of demand with less of a focus on conservation. This may have been encouraged by the new “credit” approach to the off-peak period
- The economic performance of the Program was analyzed for the current participants assuming a seven-year horizon with an annual future drop in enrollment of 14%. The results of this analysis suggest that the Program’s expenses are unlikely to be justified by its benefits from a total resource cost perspective. The Program as a whole (using previous impacts and assuming post-2004 impacts in the future) can be expected to yield a 0.23 benefit/cost ratio.
- The relationship between customer loads and the TOU rate structure was analyzed to assess the elasticity of loads with respect to the TOU rate structure. The results show that load responses in both commercial and residential sectors appear to be relatively inelastic with respect to rates, especially during the summer months. Estimated elasticity values also suggest that loads in both sectors were less responsive to price under the revised rate schedule.

Interest in the TOU rate has been generally low. Program records indicate a relatively steady rise in enrollment from March 2002 through March 2003, to 1,600 participants. Yet, by the end of 2003, the number of participants had declined to 1,400. In 2004, more customers dropped out (244) than enrolled (166) in the program, thereby reducing the net number of enrollees by the year’s end.

## Conclusions and Recommendations

TOU offerings provide several important benefits to participants and the utility system as a whole. Well-designed TOU pricing options are effective



means of conveying to customers the actual marginal costs of electric services; they can help the utility better manage its load, and improve the efficiency of the distribution system. The additional data storage and management costs notwithstanding, TOU programs also provide the opportunity to collect usage data with higher resolution. This evaluation focused primarily on the capacity and energy savings of Pacific's TOU option.

The results of this evaluation show that the Program does not meet the total-resource-cost criterion for cost effectiveness. This is principally due to the confluence of two factors: relatively low load impacts and low participation rates in both residential and commercial sectors, which are exacerbated by the concomitant effects of attrition during 2004.

Actual load impacts appear to be lower than those experienced in similar programs offered by other regional utilities, e.g. Portland general Electric and Puget Sound Energy. Indeed, once the potential effects of free-ridership, which were not analyzed in this evaluation, are taken into account, the impacts might prove to be even smaller. However, it is important to note that, due to the small sample sizes for both participant and the control group, these estimates carry large margins of error and therefore are not as reliable as one might ideally expect. Therefore, in our view, findings concerning the load impacts of the Program are to be considered as indicative rather than conclusive. It is recommended that these estimates be revisited with larger samples for both groups.

Low participation, coupled with a high dropout rate, is an important confounding factor in the Program's economic performance. There is clearly a need to seek means that can help increase participation and retain participants once they enroll in the Program.

PacifiCorp has made a considerable effort in promoting the Program through traditional outreach and marketing efforts, including comprehensive Oregon Portfolio Options mailings to all eligible customers occurring in early as well as late 2002. Ongoing promotions also have occurred since program inception, and a third major Oregon Portfolio Option mailing is underway during March and April 2005. In response to OPUC Order 03-393 (July 2003) that PacifiCorp "will target any marketing of the TOU option to high-usage customers," the Company conducted targeted promotions during the fall of 2004 and late winter of 2005. Neither of those promotions produced substantive customer interest in the Program.

Alternative, more aggressive, and better-targeted marketing strategies with a stronger emphasis on customer education might yet be called for if participation rates are to improve. In our view, while customer benefits through bill reduction are important motivators for participation in TOU offers, an increased awareness concerning the system-wide benefits may help heighten customers' interest in the Program.

The results of this study have shown that participants had lower bill savings and, on average, increased their off-peak usage under the revised rate structure. This is likely to be a result of misconception among participants regarding the rate structure. Representation of off-peak discount may have been misconstrued as an actual “credit” for off-peak usage, rather than a discount against average rates. Existence of the mandated 10% cost “guarantee” throughout enrollees’ initial 12-month participation in the program also may be a factor that has impacted observed participant behavior.

Offering complementary services that can help participants modify their electricity use patterns may further enhance marketing and educational efforts. These may include, among others, low-cost energy efficiency measures, technical advice, and rebates for measures that allow reducing peak energy usage through customer-controlled devices, e.g., timers and programmable thermostats. Addition of other services, such as direct load control, may also increase and help improve the reliability of load impacts. However, since, by definition, peak loads tend to be lower among TOU participants, arguably, non-participating customers may offer greater savings opportunities for direct load control.

# I. Introduction

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## Overview

The Oregon Senate Bill 1149, enacted in July 1999, requires investor-owned electric utilities to provide a portfolio of product and pricing options for their residential and small non-residential customers. Small non-residential customers are defined as those with a maximum monthly demand of 30 kW or less. A “market-based” time-varying rate option is among those required by the Bill.<sup>1</sup>

In 2002, Pacific Power (Pacific) filed a residential time-of-use (TOU) rate schedule with the Oregon Public Utility Commission in compliance with the requirements of OAR 860-038-0220 and pursuant to the recommendations of the State Portfolio Advisory Committee (PAC).<sup>2</sup> The purpose of this filing was to offer residential and small non-residential customers an alternative, “market-based” pricing option to complement the company’s standard rate under Rate Schedules 4, 23 and 41 (residential, small commercial, and small agricultural).

The initial TOU program was designed as a three-part rate structure. Three periods were defined (peak, mid-peak, and off-peak), and a standard cost per kWh was instituted for each. In addition, there was a 10% cap on the amount above the standard rate that a customer would pay. Table 1.1 outlines the TOU rate schedule from March 2002; Table 1.2 outlines the daily periods by season.

---

<sup>1</sup> In order to provide the customers with additional rate flexibility, Pacific also offered the option to participate in the Seasonal Flux program. Approximately 1,350 residential and commercial customers (90% residential/10% commercial) enrolled in this program. In January 2004, the Seasonal Flux program was discontinued at the direction of the Oregon Public Utility Commission. Fewer than 40 Seasonal Flux customers elected to transfer to the Time of Use program, though that option was clearly communicated to them, when the Seasonal Flux program was discontinued.

<sup>2</sup> The committee was established by the Oregon Public Utility Commission (OPUC), comprised of representatives of investor-owned utilities, OPUC staff, Oregon Office of Energy staff, and public interest groups.

**Table I.1: March 2002 Time of Use, Cents/kWh**

	Season	On Peak	Mid Peak	Off Peak
Residential (Sch. 4)	Summer	6.02	3.30	1.51
	Winter	6.02	2.61	1.51
Commercial (Sch. 23)	Summer	6.88	3.77	1.72
	Winter	6.88	2.98	1.72
Agricultural (Sch. 41)	Summer	6.52	3.58	1.63
	Winter	6.52	2.83	1.63

**Table I.2: Definitions of Daily Periods**

Season	On Peak	Mid Peak*	Off Peak
<b>Winter</b> (November - March)	Weekdays: 6 a.m. - 10 a.m., 5 p.m. to 8 p.m.	Weekdays: 10 a.m. - 5 p.m., 8 p.m. to 10 p.m. Saturday: 6 a.m. to 10 p.m.	Weekdays and Saturday: 10 p.m.-6 a.m. Sunday & Holidays: All day
<b>Summer</b> (April- October)	Weekdays: 4 p.m. to 8 p.m.	Weekdays: 6 a.m. - 4 p.m., 8 p.m. to 10 p.m. Saturday: 6 a.m. to 10 p.m.	Weekdays and Saturday: 10 p.m.-6 a.m. Sunday & Holidays: All day

\* Beginning on January 1, 2004, midpeak hours were combined into offpeak.

In 2004, the TOU rate structure was revised to a two-part tariff – removing the mid-peak period and assigning all mid-peak hours to off-peak. Also, rather than retaining a separate Energy Charge rate schedule, the TOU customers were provided a credit for off-peak hours and an additional charge for on-peak hours. Therefore, the standard Schedules 4, 23, and 41 (including block usage structures) were utilized for all customers, and TOU participants received a credit or charge on their bill as a result of their participation in the TOU program.

Tables I.3 through I.5 below outline the actual post-2004 rate. For the pre-2004 period, the March 2002 rate schedule is shown using the same credit/charge approach: standard rates were subtracted from the TOU rate schedule to display the pre- and post-2004 rates on a consistent basis.

The 2004 TOU program change for all sectors included a significant increase in the summer on-peak period prices as compared to the pre-2004 TOU rate structure.

**Table I.3: Residential: Difference between Time of Use and Standard Rates (Schedule 4), Cents/kWh**

	Season	On Peak	Mid Peak	Off Peak
<b>Pre 2004</b> (March 2002)	Summer	3.05	0.33	-1.46
	Winter	3.05	-0.35	-1.45
<b>Post 2004</b>	Summer	6.12	-1.13	
	Winter	3.32	-1.13	

**Table I.4: Commercial: Difference between Time of Use and Standard Rates (Schedule 23), Cents/kWh**

	Season	On Peak	Mid Peak	Off Peak
<b>Pre 2004</b> (March 2002)	Summer	2.86	-0.24	-2.29
	Winter	2.86	-1.03	-2.29
<b>Post 2004</b>	Summer	9.35	-1.44	
	Winter	4.37	-1.44	

**Table I.5: Agricultural: Difference between Time of Use and Standard Rates (Schedule 41), Cents/kWh**

	Season	On Peak	Mid Peak	Off Peak
<b>Pre 2004</b> (March 2002)	Summer	3.28	0.33	-1.62
	Winter	3.28	-0.42	-1.62
<b>Post 2004</b>	Summer	8.00	-1.23	
	Winter	3.74	-1.23	

In January 2005, PacifiCorp engaged the services of Quantec, LLC, a Portland-based energy consultancy, to evaluate the load impacts and economic performance of the TOU rate option. The principal objective of this assessment was to empirically investigate the actual load impacts and potential changes in energy use, and to determine the economic implications of these from the participant and total resource cost perspectives. This document reports the methods and conclusions of that assessment, as well as recommendations for potential TOU program enhancements.

In this study, pre-2004 is referenced for all rate structures before January 2004 (therefore coinciding with calendar years 2002-2003). Additionally, the agricultural customers were combined with small commercial for impact analyses.

## TOU Participants

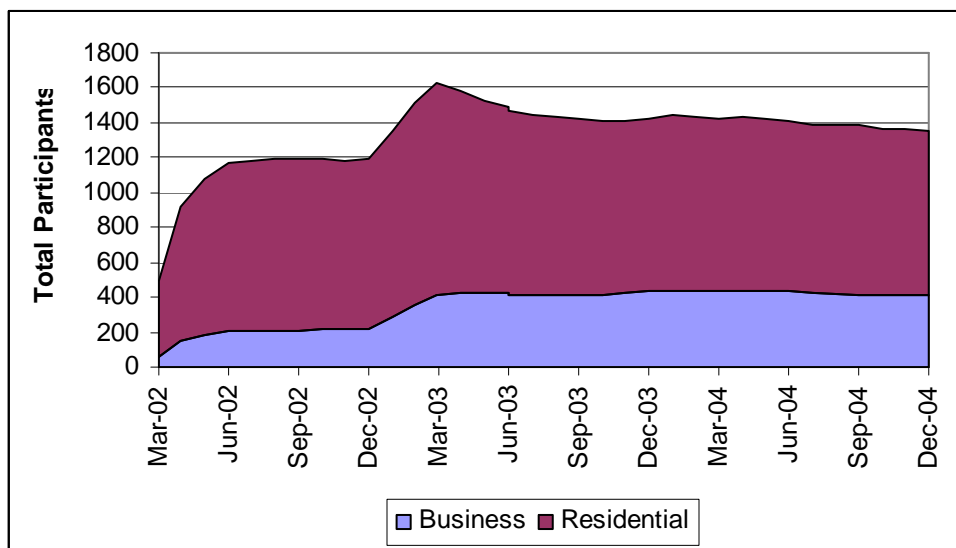
In early 2002, PacifiCorp informed all eligible customers about the TOU rate through a direct mail informational brochure. A second major informational mailing to all eligible customers occurred in late 2002. Additional promotions also have been conducted since program inception and a third major Oregon Portfolio Options informational brochure mailing is underway during March and April 2005.

In response to OPUC Order 03-393 (July 2003) that PacifiCorp “will target any marketing of the TOU option to high-usage customers,” PacifiCorp also conducted targeted TOU promotions during the fall of 2004 and late winter of 2005. Neither of those promotions produced substantive customer response:

- During the fall of 2004, PacifiCorp conducted a targeted promotion to customers in six communities. That promotion utilized newspaper and radio advertising through a six-week period. Nine customers enrolled in the TOU program in those communities during and shortly after the promotion period.
- During the late winter of 2005 PacifiCorp conducted a targeted, direct mail promotion to approximately 500 holders of Time of Use-eligible irrigation accounts in five communities. Four of the targeted irrigators responded by enrolling in the Time of Use program during the promotion period.

The total enrollment in the TOU Program rose steadily from March 2002 through March 2003, to 1,600 participants. Yet, by the end of 2003, the number declined to 1,400 participants, where it has stayed relatively stable, as shown by Figure I.1.

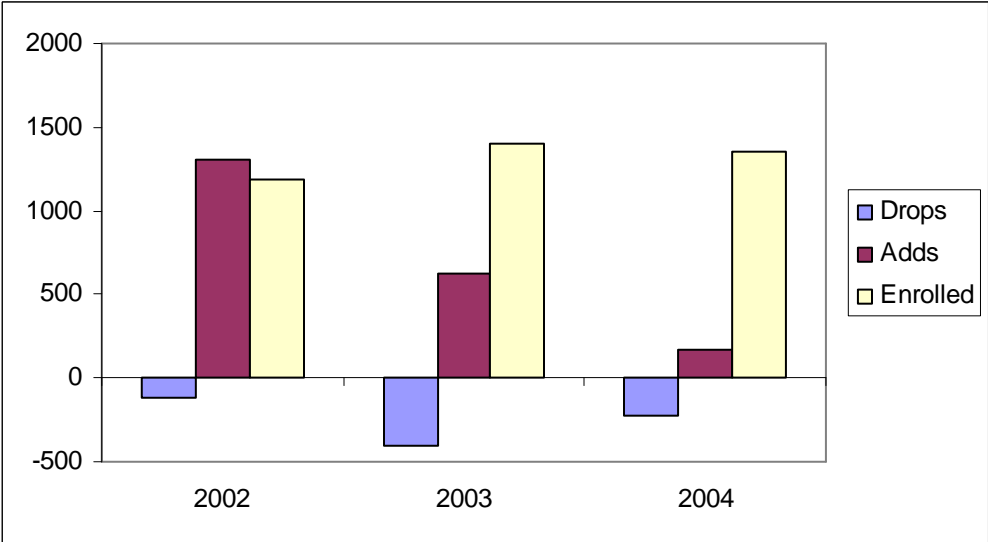
**Figure I.1: Participation Total Enrollment**



Although total participation appears to have reached a plateau, the figure above does not display the actual numbers of new participants and dropouts. These figures are particularly important due to the additional burden of stranded meter and installation costs that can have a significant effect on the economic performance of the Program as a whole.

In 2003, the new participants and those who dropped-out were nearly equal, leaving the total participants relatively consistent (Figure I.2). In 2004, more customers dropped out (244) than enrolled (168), thereby reducing total participation.

**Figure I.2: Participation Adds and Drops**



### Data and Methodology

The data used in this study were based on already available information and were comprised of the following:

- Hourly interval load data from October 2002 through December 2004, for TOU participants and a control group from the general load research sample
- Monthly consumption histories for TOU participants from 2001 to 2005
- Weather data, including heating and cooling degree-days (HDD, CDD) obtained from local NOAA weather stations

- TOU program expenses including administration, promotion, meter hardware and installation, and communications
- Economic assumptions including cost of capital, rates, and avoided capacity and energy costs

To calculate the Program’s cost effectiveness, its impacts on demand (kW), energy (kWh), and monthly bills were calculated. In addition, the elasticity of load response with respect to changes in rates was analyzed to determine the effectiveness of the rate structure in inducing reductions in peak demand.

### Demand Impacts

The analytic approach in this assessment was based on a “quasi-experimental” research design, which involves a comparison of load and consumption patterns between customers who had subscribed to the TOU rate (the treatment group) and a sample of standard rate residential customers comprising PacifiCorp’s load research sample (the comparison group).

Interval data for the sample of TOU participants and the control group were used to create profiles of weekdays, and estimates of average demand impacts were calculated by season and peak period. Table I.6 outlines the sample size attrition for interval data of participants and the control group.

**Table I.6: Interval Data Sample by Sector**

	Sample Initial/Analysis	Commercial		Residential	
		TOU Participants	Control Group	TOU Participants	Control Group
Winter 2003	Initial (# of sites)	43	75	54	59
	Bad/Incomplete Load Data (# of sites dropped)	-4	-5	-2	-5
	Consumption outlier (# of sites dropped)	-6	-39**	-3	-3
	Final Analysis (# of sites)	33	31	49	49
Winter 2004	Initial (# of sites)	43	75	54	59
	Bad/Incomplete Load Data (# of sites dropped)	-5	-4	-5	-4
	Consumption outlier (# of sites dropped)	-7	-42**	-2	-8
	Final Analysis (# of sites)	31	29	47	47
Summer 2003	Initial (# of sites)	43	75	54	59
	Bad/Incomplete Load Data (# of sites dropped)	-5	-8	-4	-6
	Consumption outlier (# of sites dropped)	-2	-41**	0	-3
	Final Analysis (# of sites)	36	26	50	50
Summer 2004	Initial (# of sites)	43	75	54	59
	Bad/Incomplete Load Data (# of sites dropped)	-6	-5	-23*	-4
	Consumption outlier (# of sites dropped)	-1	-42**	-3	-27
	Final Analysis (# of sites)	36	28	28	28

\* Some participants were missing 2004 data after February 2004.

\*\* All of the nonparticipants dropped had usages above the maximum participant usage in the period. These nonparticipants were dropped in the matching process, and participants were matched to the nonparticipant average.



## Energy Impacts

Energy savings were calculated using the subset of the participants who had sufficient billing data in both the 2002-2003 and the 2004-present periods. Bills were normalized for weather, and energy savings were calculated on a per-kWh basis for the two rate periods. Table I.7 outlines the number of participants used in the analysis of energy impacts.

**Table I.7: Energy Savings Sample by Sector**

Analysis Periods	Residential	Commercial	Total
Pre (2001)	325	95	420*
Post (2002-2003)	325	95	420*
Post (2004)	325	95	420*

\* In order to compare the impacts for the different rates, only customers who had complete billing data for the pre period (2001), 2002-2003 rate period, and the post 2004 period were used in the analysis. Also, in each of the three periods, they had to have 12 months of bills. Customers with changes of consumption from pre to the post periods by more than 50% were dropped.

## Rate Structure Impacts

The Program's impact on customers' bills due to the rate structure were calculated as the difference between what that customer would have paid if they were on the standard rate versus what they paid on the TOU rate. Table I.8 details the sample of TOU participants utilized in the billing analysis by sector. Please note that participant samples for pre-2004 and post-2004 are not mutually exclusive as many of the participants were active in the Program during both time periods.

**Table I.8: Bill Savings Sample by Sector**

	Residential	Commercial	Total
Pre-2004	1,410	458	1,868
Post-2004	1,100	443	1,543

## Cost Effectiveness

The economic analysis of load impacts relied on a conventional benefit/cost analytic framework, comparing the value of the TOU rate's load impacts and costs from the perspectives of the customer and total resource costs.



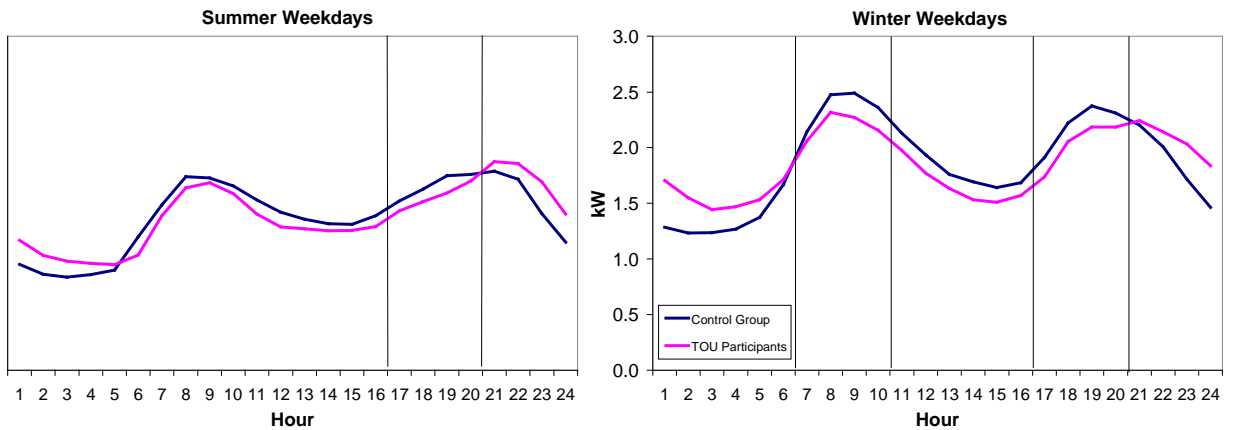
## II. Load Impacts

### Demand Impacts

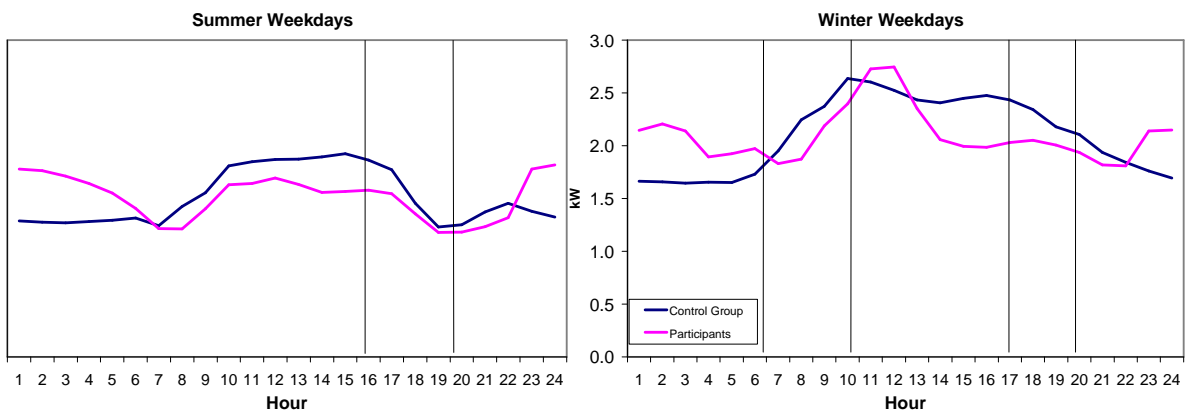
The analysis of the load impacts of the TOU rates was based on a comparison of hourly load profiles between the TOU and load research (control) groups from October 2002 to December 2004.

Differences in daily consumption patterns between the two groups are illustrated in Figures II.1 through II.4. These figures are shown for commercial and residential sectors, by rate structure (i.e., pre-2004 and post-2004). In all cases, relative to the control group, demand levels for participants are lower during peak periods and higher in the off-peak periods.

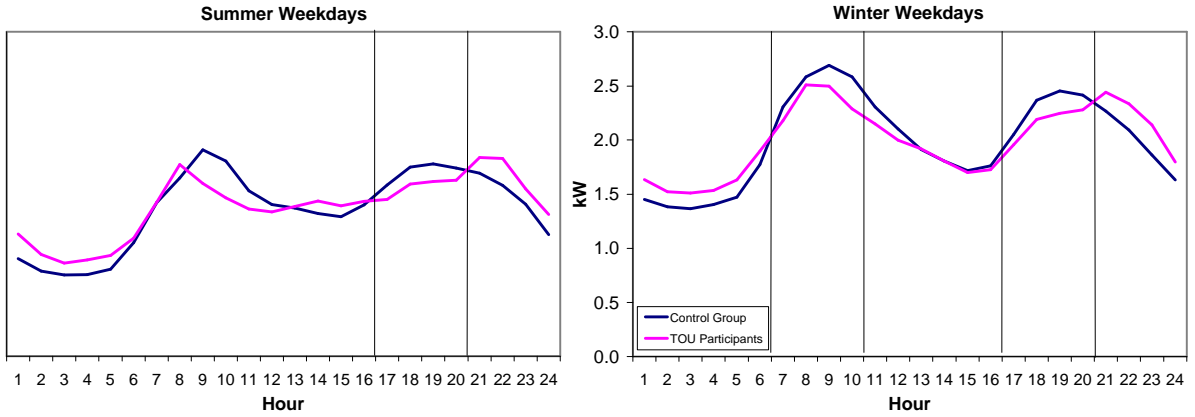
**Figure II.1: Residential – Pre-2004 Rate**



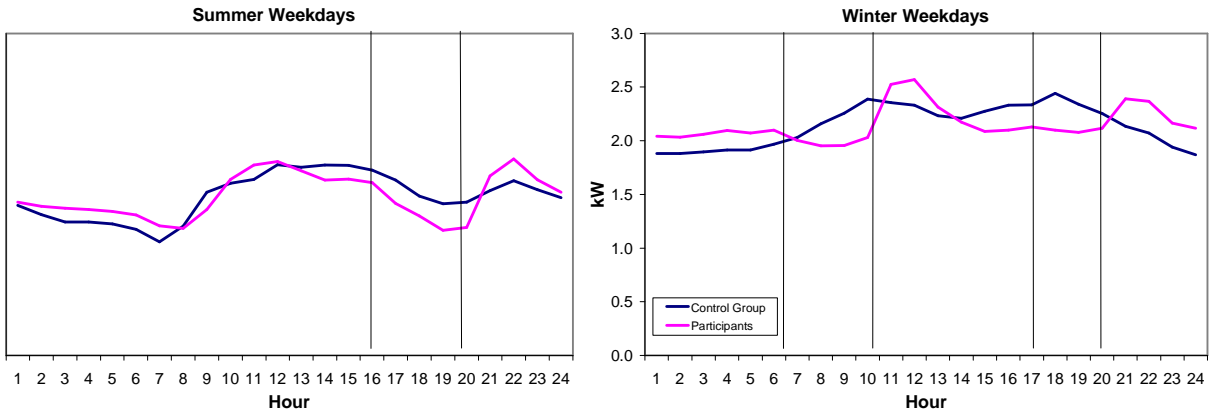
**Figure II.2: Commercial – Pre-2004 Rate**



**Figure II.3: Residential – Post-2004 Rate**



**Figure II.4: Commercial – Post-2004 Rate**



The data in Figures II.1 through II.4 are summarized in Table II.1. Actual load impacts of the TOU rates were analyzed with respect to “average” and “maximum” impacts during seasonal peak periods.

**Table II.1 Maximum Hour Reduction for TOU Participants**

	Residential		Commercial	
	2003 Max	2004 Max	2003 Max	2004 Max
Winter Morning	7-8 a.m.	9-10 a.m.	9-10 a.m.	9-10 a.m.
Winter Evening	5-6 p.m.	5-6 p.m.	6-7 p.m.	6-7 p.m.
Summer	4-5 p.m.	6-7 p.m.	6-7 p.m.	6-7 p.m.

The results of this analysis, as shown in Tables II.2 and II.3, indicate that TOU participants demand less than the control group during the winter morning hours.

In the residential sector, the average kW reduction in both winter periods is approximately 0.17 kW and is relatively consistent across years. It appears that there was a slight reaction to the increase in the summer peak rate in 2004, as demand reduction increased from 0.10 kW to 0.14 kW in the summer period.

**Table II.2: Residential Summary of Load Impacts**

Seasonal Peak Period	Pre-2004				Post-2004			
	Mean Reduction		Maximum Average Reduction		Mean Reduction		Maximum Average Reduction	
	Avg. kW	%	Avg. kW	%	Avg. kW	%	Avg. kW	%
Winter Morning	0.17	7%	0.22	9%	0.17	7%	0.30	12%
Winter Evening	0.16	7%	0.19	8%	0.17	7%	0.21	8%
Summer	0.10	6%	0.16	7%	0.14	8%	0.16	9%

Before 2004, the commercial sector’s TOU customer loads were, on average, 0.23 kW and 0.21 kW lower than that of the control group during the winter morning and evening peak periods, respectively. These figures did not change significantly in 2004, but there was a noteworthy response by this sector to the summer-peak rate, as demand savings rose from 0.11 kW to 0.22 during summer peak hours. This appears to be due to the relatively punitive nature of the commercial summer-on peak rate, which tripled from the pre-2004 structure.

**Table II.3: Commercial: Summary of Load Impacts**

Seasonal Peak Period	Pre-2004				Post-2004			
	Mean Reduction		Maximum Average Reduction		Mean Reduction		Maximum Average Reduction	
	Avg. kW	%	Avg. kW	%	Avg. kW	%	Avg. kW	%
Winter Morning	0.23	10%	0.37	17%	0.22	10%	0.36	15%
Winter Evening	0.21	9%	0.29	12%	0.25	10%	0.34	14%
Summer	0.11	7%	0.23	13%	0.22	15%	0.25	18%

## Energy Impacts

Net potential energy impacts of the TOU option were examined by analyzing change in the average total consumption of the TOU participants during the pre- and post-participation periods, using weather normalization.

Using weather-normalized billing data for those participants with sufficient pre-participation information, changes in energy consumption were calculated. The results, as reported in Tables III.4 and III.5, show that

residential customers saved 792 kWh before 2004 and 336 kWh after. Commercial customers saved 1,128 kWh/year before 2004 and 516 kWh after the 2004 TOU rate revision.

**Table II.4: Residential: Energy Savings (kWh)**

	Monthly	Annual	As % Pre-Consumption
Pre 2004	66	792	4%
Post 2004	28	336	2%

**Table II.5: Commercial: Energy Savings (kWh)**

	Monthly	Annual	As % Pre-Consumption
Pre 2004	94	1,128	6%
Post 2004	43	516	3%

The results of this analysis indicate that, in addition to the primary effect of encouraging inter-temporal shifts in consumption, subscription to TOU rates is likely to result in modest net reductions in consumption. In other words, the curtailed consumption during the high-price peak periods is not completely compensated by higher consumption during off-peak periods.

Based on the results of this analysis, it appears that under the original, less severe rate structure (i.e., pre-2004), customers tend to reduce demand during peak periods – rather than shift consumption to off-peak. Under the revised rate structure, with a larger peak-to-off-peak rate differential, customers tend to shift more of their usage to off-peak. In addition, it is likely that the “credit” component of the revised rate structure might have encouraged an increase in consumption during off-peak periods.

## Customer Bill Impacts

To measure the potential savings to participants resulting from the TOU rate schedule, the annual energy charges were calculated separately under the TOU and basic rate schedules. It is important to note that the estimated changes in bills do not necessarily imply a change in consumption patterns and may at least partially reflect the customers’ pre-existing consumption patterns.

The results, as shown in Table III.6, indicate that the bill savings, compared to a standard rate tariff, for commercial participants was nearly \$80 before 2004, but only \$20 after the 2004 rate structure change. Residential customers saved nearly \$23 annually before 2004, and \$6.50 after. This decrease in bill

savings, while significantly reducing the Program’s benefits to participants, may also be construed as more revenue neutral.

**Table II.6: Annual Bill Impacts of TOU Rate Schedule, including \$1.50 Monthly Meter Charge**

	Residential		Commercial	
	Bills Savings	% Bill Savings	Bills Savings	% Bill Savings
<b>Pre-2004</b>				
Summer	\$5.89	1.2%	\$47.17	7.9%
Winter	\$20.68	4.1%	\$30.23	7.9%
<b>Post-2004</b>				
Summer	\$(2.25)	-0.4%	\$2.61	0.4%
Winter	\$7.04	1.2%	\$12.07	2.7%

### Elasticity of Price Response

Customers’ response to TOU prices are expected to be a function of the rate schedule, that is, the degree to that prices vary from one period to the next as well as the change in 2004 rate structure. This relationship was analyzed by estimating price elasticity of demand with respect to the rate structure using a conventional demand model with the following specification:

$$kW_{tdLR} - kW_{tdTOU} = \alpha + \beta(P_{tLR} - P_{tTOU}) + \varepsilon_{td}$$

This relationship simply states that the difference in average hourly load between the comparison group and the TOU participants in any period t (peak, mid-peak, off-peak) on day d ( $kW_{td}$ ) is a function of the differences between the standard and TOU rates for that period. The estimated parameter  $\beta$  is then used to calculate price elasticity.<sup>3</sup>

The relationship specified above was estimated for residential and commercial customers during winter and summer periods in separate models using ordinary least squares (OLS) estimation approach. The results are shown in Table II.7. The elasticity values indicate percent change in load that can be expected to result from a one percent (1%) change in the difference between the TOU rate and the standard rate. An elasticity of less than unity (one) indicates an inelastic response. As can be seen, load responses in both commercial and residential sectors appear to be relatively inelastic with respect to rates, especially during the summer months. Estimated elasticity values also suggest that loads in both sectors were less responsive to price under the revised rate schedule.

<sup>3</sup> Seasonal elasticity at the mean is then calculated as:  $\beta * (\text{mean price} / \text{mean kW reduction})$ .

**Table II.7: Price Elasticity of Load Response**

	Costing Period	% Elasticity at the Mean	
		Pre 2004	Post 2004
Residential	Summer	-0.37%	-0.19%
	Winter	-0.33%	-0.26%
Commercial	Summer	-0.30%	-0.10%
	Winter	-0.29%	-0.23%

These findings appear reasonable and consistent with the empirical evidence of the observed shifts in consumption derived from the load data. The estimates are also in line with findings of several other studies of TOU price schedules offered elsewhere in the country. For example, a study conducted in 1994 estimated average elasticity estimates of -0.16% and -0.35% for the peak and off-peak periods.<sup>4</sup>

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<sup>4</sup> Train, Kenneth and Gil Mehrez, Optional Time-of-Use Rates for Electricity, University of California Energy Research group, January, 1994. Also see Geott, Andy, Load Impact Analysis of Pacific Gas and Electric Company's Time-of-Use Pricing Experiment, Cambridge Systematics, May 1988.



### III. Economic Impacts

The economic performance of the TOU rate option was analyzed from the perspectives of the participants and total resource cost annually and in terms of a seven-year roll out. The technical and economic assumptions used in this analysis are shown in Table III.1

**Table III.1: Assumptions for Benefit/Cost Analysis**

Basic Economic Assumptions	
Discount Rate (PacifiCorp) Cost of Capital	9.1%
Line Loss	8.0%
Annual Avoided Capacity Costs (\$/kW/yr)	\$45.00
Avoided Energy Costs (\$/kWh)	\$0.042
Average Standard Residential Rate	\$0.069
Average Standard Commercial Rate	\$0.077
Post 2005- Drop-Out Rate	14%*

\* 14% is derived with the assumption that the maximum Program participation is seven years, thus the annual drop out rate is one-seventh.

### The Participant Perspective

From the participants’ point of view, benefits that accrue from participation in the TOU option are reductions in monthly billing associated with the rate structure and potential reductions in energy consumption due to the fact that avoided energy use during peak periods is not always entirely compensated by increased off-peak usage (partial shift). Annual meter charges of \$18 are the only participant costs included in the analysis. In all cases, benefits to participants exceed costs, but benefits are sharply reduced from the pre- to the post-2004 period as both energy savings and rate schedule benefits fell. (See Table III.2.)

**Table III.2: Summary of Participant Benefits and Costs**

Benefits	Commercial		Residential	
	Pre-2004	Post-2004	Pre-2004	Post-2004
<b>Benefits</b>				
Rate Schedule Benefits	\$79.8	\$19.7	\$22.7	\$6.4
Energy Savings	\$98.9	\$80.1	\$70.7	\$39.6
<b>Total Benefits</b>	<b>\$178.7</b>	<b>\$99.8</b>	<b>\$93.4</b>	<b>\$46.0</b>
<b>Costs</b>				
Meter Charge	\$18.0	\$18.0	\$18.0	\$18.0

## Total Resource-Cost Perspective

The overall benefits and costs of the Program were analyzed to determine the programmatic performance of the rate option over a nine-year planning horizon (2002-2010) from a total resource cost point of view. This analysis focused on existing participants only, assuming no additional enrollments in 2005. Moreover, it is assumed that 14% of the 2004 participants (or 193) of the current participants opt-out of the Program, so that no participant will remain in the Program for more than seven years. The choice of a seven-year tenure was based on the assumption that residential customers, on average, tend to relocate every seven years.

Total Program expenses are estimated as shown in Table III.3 below. Meter hardware costs are estimated at \$180 per participants. Internal labor costs for Program administration were estimated as a portion of FTE costs for the program manager and a marketing staff. Communications and advertising were estimated as 25% of those costs allocated by the Company to SB1149 programs. Moreover, the analysis incorporated load research expenses attributable to the TOU program for samples of 94 residential and 65 commercial sites. Initial per-unit costs were estimated at \$835 for residential<sup>5</sup> and \$960 for commercial<sup>6</sup> load research sample points. Both require \$190 per year of ongoing costs.<sup>7</sup> Post-2005 annual Program administrative costs were assumed at \$15,000 per year until 2010 to account for ongoing customer service for existing participants.

**Table III.3: Approximate TOU Program Costs**

	2002	2003	2004
Meter Hardware	\$234,720	\$112,320	\$30,240
Load Research	\$171,036	\$30,146	\$30,146
Internal Labor Costs	\$15,000	\$15,000	\$15,000
Communications and Advertising	\$131,984	\$110,208	\$65,756
	<b>\$552,740</b>	<b>\$267,674</b>	<b>\$141,143</b>

Annual and cumulative Program costs and benefits over the nine-year planning horizon are reported in Table III.4. The primary benefits of the Program included in this analysis consist of avoided capacity and energy benefits, including avoided line losses. Based on the per-unit values of the avoided capacity and energy costs, the cumulative benefits resulting from the TOU rate option are estimated at approximately \$0.26 million in 2003 dollars.

<sup>5</sup> Assumes \$140 for meter hardware, \$650 for cell phone package and \$45 of labor.

<sup>6</sup> Assumes \$250 for meter hardware, \$650 for cell phone package and \$60 of labor.

<sup>7</sup> Assumes \$15.80 per site per month in cell phone data uplink charges.

Based on these figures and discounted Program costs of approximately \$1.1 million, the Program can be expected to yield a benefit/cost ratio of 0.23.

**Table IV.4: Overall Program Benefits and Costs  
(2004 Dollars)**

Year	Participants	Program Impacts		Program Benefits			Program Costs
	Total	kW	KWh	kW	kWh	Total	
2002	1,191	215	1,120,453	\$9,696	\$47,137	\$67,685	\$632,746
2003	1,407	255	1,323,659	\$11,454	\$55,686	\$73,270	\$292,113
2004	1,351	264	570,178	\$11,883	\$23,987	\$35,870	\$141,143
2005	1,158	226	488,724	\$10,185	\$20,561	\$28,174	\$13,745
2006	965	189	407,270	\$8,488	\$17,134	\$21,514	\$12,595
2007	772	151	325,816	\$6,790	\$13,707	\$15,771	\$11,541
2008	579	113	244,362	\$5,093	\$10,280	\$10,839	\$10,576
2009	386	75	162,908	\$3,395	\$6,854	\$6,621	\$9,691
2010	193	38	81,454	\$1,698	\$3,427	\$3,034	\$8,880
<b>Total</b>						<b>\$262,778</b>	<b>\$1,133,030</b>

Given the relatively large magnitude of fixed costs associated with the Program, its performance in the long run is expected to depend largely on the number of participants. Under the current assumptions concerning the Program's fixed costs, in particular communications and administrative expenses, and assuming no additional expenses for load research, this analysis shows that approximately 10,000 customers would need to be enrolled in the Program in order for it to break even.

## Conclusions and Recommendations

TOU offerings provide several important benefits to participants and the utility system as a whole. Well-designed TOU pricing options are effective means of conveying to customers the actual marginal costs of electric services; they can help the utility better manage its load, and improve the efficiency of the distribution system. The additional data storage and management costs notwithstanding, TOU programs also provide the opportunity to collect usage data with higher resolution. This evaluation focused primarily on the capacity and energy savings of Pacific's TOU option.

The results of this evaluation show that the Program does not meet the total-resource-cost criterion for cost effectiveness. This is principally due to the confluence of two factors: relatively low load impacts and low participation rates in both residential and commercial sectors, which are exacerbated by the concomitant effects of attrition during 2004.

Actual load impacts appear to be lower than those experienced in similar programs offered by other regional utilities, e.g. Portland general Electric and

Puget Sound Energy. Indeed, once the potential effects of free-ridership, which were not analyzed in this evaluation, are taken into account, the impacts might prove to be even smaller. However, it is important to note that, due to the small sample sizes for both participant and the control group, these estimates carry large margins of error and therefore are not as reliable as one might ideally expect. Therefore, in our view, findings concerning the load impacts of the Program are to be considered as indicative rather than conclusive. It is recommended that these estimates be revisited with larger samples for both groups.

Low participation, coupled with a high dropout rate, is an important confounding factor in the Program's economic performance. There is clearly a need to seek means that can help increase participation and retain participants once they enroll in the Program.

PacifiCorp has made a considerable effort in promoting the Program through traditional outreach and marketing efforts, including comprehensive Oregon Portfolio Options mailings to all eligible customers occurring in early as well as late 2002. Ongoing promotions also have occurred since program inception, and a third major Oregon Portfolio Option mailing is underway during March and April 2005. In response to OPUC Order 03-393 (July 2003) that PacifiCorp "will target any marketing of the TOU option to high-usage customers," the Company conducted targeted promotions during the fall of 2004 and late winter of 2005. Neither of those promotions produced substantive customer interest in the Program.

Alternative, more aggressive, and better-targeted marketing strategies with a stronger emphasis on customer education might yet be called for if participation rates are to improve. In our view, while customer benefits through bill reduction are important motivators for participation in TOU offers, an increased awareness concerning the system-wide benefits may help heighten customers' interest in the Program.

The results of this study have shown that participants had lower bill savings and, on average, increased their off-peak usage under the revised rate structure. This is likely to be a result of misconception among participants regarding the rate structure. Representation of off-peak discount may have been misconstrued as an actual "credit" for off-peak usage, rather than a discount against average rates. Existence of the mandated 10% cost "guarantee" throughout enrollees' initial 12-month participation in the program also may be a factor that has impacted observed participant behavior.

Offering complementary services that can help participants modify their electricity use patterns may further enhance marketing and educational efforts. These may include, among others, low-cost energy efficiency measures, technical advice, and rebates for measures that allow reducing peak energy usage through customer-controlled devices, e.g., timers and programmable

thermostats. Addition of other services, such as direct load control, may also increase and help improve the reliability of load impacts. However, since, by definition, peak loads tend to be lower among TOU participants, arguably, non-participating customers may offer greater savings opportunities for direct load control.