EVALUATION OF HL&P'S ENERGY MANAGER PILOT PROGRAM

FINAL REPORT

Submitted to

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EXECUTIVE SUMMARY

Exhibit 1
HL&P's Energy Manager Pilot Program
Major Conclusions

Conclusions
Most participants reduced consumption during the high and critical price periods.
The average annual bill savings was over $150.
During the summer months, the critical signal can provide impacts ranging from 0.33 to 1.18 kW. Demand impacts can range from 1.24 to 1.81 kW.
The Variable Energy Price component of Energy Manager can provide bill savings to customers without the TranstexT technology.
Participants tended to use the temporary system override option rather than reprogramming the thermostat setpoints.

PARTICIPANTS IN HL&P'S ENERGY MANAGER (EM) PILOT PROGRAM RESPOND TO THE PRICE SIGNALS BY REDUCING LOAD DURING HIGH AND CRITICAL PRICE PERIODS. BY REDUCING LOAD DURING THESE PERIODS AND CONSUMPTION OVERALL, AND BY SHIFTING CONSUMPTION TOWARDS LOWER RATE INTERVALS, PARTICIPANTS CAN EXPECT TO SAVE, ON AVERAGE, MORE THAN $280 ANNUALLY.

- Participants generally respond to the variable energy prices (VEP) by increasing consumption when prices decrease, and decreasing consumption when prices increase.
- Average annual bill savings were over $280, comparing program participants' bills with those of the control group. The bill savings result from both an overall decrease in consumption as well as a shift in consumption towards lower-rate periods[1].
  - The average all-electric participant saved $275 annually.
  - The average mixed fuel participant saved $291 annually.
- Comparison of the control group shows that access to the VEP rate can provide bill savings to customers without the TranstexT technology. That is to say, the VEP rates are not revenue-neutral. A detailed analysis of the bill savings for both groups follows on pages two and three.
- Differences between the 1996 and 1997 results can be expected to arise from three sources, whose effects were analyzed separately:
  - Differences in weather between the two years
  - Differences in the number of critical signals sent in each year
  - Learning on the part of the test group members – that is, more familiarity with the TranstexT system and an enhanced ability to use it to save money on energy bills.

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[1] The calculation of these savings differs from that used in the analysis of the 1996 program. Here, a comparison is made between the actual bills of the test and control groups (the bold, italicized figures in Exhibit 2). The savings in the previous year's analysis refers to a comparison between the test group's actual bill and the test group's hypothetical bill calculated at the Standard Rate (the figures in the top row of the tables in Exhibit 2). Comparing actual bills demonstrates the dual effects of VEP pricing and the energy consumption behavior changes induced by the program.

- The control group served as an attractive measure for weather differences – inter-year differences should only reflect changes in weather. Any significant differences between test and control groups in the sign or magnitude of the change from 1996 and 1997 may be considered to stem from sources other than weather differences. No strong systematic differences emerged between the test and control groups' inter-year comparisons, suggesting that changes in weather are largely responsible for changes in energy use between years for the test group.

- The reduction in the number and frequency of critical signals sent in 1997 relative to 1996 produced only minimal revenue effects.

  - The critical signal was sent less frequently, and for fewer hours, in 1997 than in 1996. Since the critical signal corresponds to a rate of $0.38/kWh – considerably higher than any of the VEP or standard rates – we would expect to see a difference between the 1997 and 1996 bills that reflects this relative infrequency of its occurrence.

  - Calculations of the costs incurred and forgone during these periods indicate that the average yearly bill in 1996 included $53.05 which was attributable to the critical signal. For 1997 the figure was $38.96. Thus the difference in the number of critical signal hours between the two years resulted in a difference of $14.09 between average yearly bills, or a savings of only 0.8%.

- Comparisons of average monthly bills across years and between groups suggest that the learning effect is minimal. This is not surprising considering that, as will be noted below, program participants appear not to have made important changes in their thermostat settings in the past year.

  - Since the participants' objective in using the TranstexT system emphasizes bill savings more than reduction in energy use, a reasonable test for learning is a comparison of monthly bills between years. Inter-year differences between average monthly bills were calculated for both groups. If program participants had learned to use the system to greater effect in 1997, they would be expected to show greater decreases and/or lesser increases in average monthly bills than would their control group counterparts.

  - Most average monthly bills increased from 1996 to 1997. A few of these increases, notably those for July and December, were smaller for the test group than for the control group. However, the differences

between the test and control groups' increases are not substantial; they are on the order of $5 to $13, representing in total less than 2% of average yearly bills.

Exhibit 2

Comparison of Average Annual Bills under VEP and Standard Rates: 1996 and 1997

1996 Figures

Mixed Fuel

	VEP	Standard Rate	Savings
Test	***$1,772***	$1,934	$162
Control	$2,011	***$2,046***	$35
Savings	$239	$112	--

All-Electric

	VEP	Standard Rate	Savings
Test	***$1,610***	$1,743	$133
Control	$1,749	***$1,843***	$9[illegible]
Savings	$139	$100	--

1997 Figures

Mixed Fuel

	VEP	Standard Rate	Savings
Test	***$1,726***	$1,890	$164
Control	$1,967	***$2,017***	$51
Savings	$241	$127	--

All-Electric

	VEP	Standard Rate	Savings
Test	***$1,623***	$1,774	$150
Control	$1,796	***$1,898***	$102
Savings	$173	$125	--

AS IN THE 1996 PROGRAM, BOTH SEGMENTS SAVE MONEY UNDER THE VEP RATE RELATIVE TO THE STANDARD RATE. THE TEST GROUP'S SAVINGS RESULT FROM SHIFTING CONSUMPTION TO LOWER-RATE PERIODS AND REDUCING OVERALL CONSUMPTION. THE POTENTIAL SAVINGS FOR THE CONTROL GROUP ARE THE RESULT OF THE VEP RATES ALONE, AND INDICATE THAT THESE RATES ARE NOT REVENUE-NEUTRAL.

- The total effect of the program is the combined effect of the VEP rates and TranstexT system. This is obtained by comparing each group's actual bill – the test group's bill under the VEP rates and the control group's bill under the standard rates, as is done in Exhibits 16 and 17. This comparison reveals an overall average savings of $275 for the all-electric segment and $291 for the mixed fuel segment.

- The mixed fuel segment's average annual bills are larger than those for the all-electric segment. This rather incongruous result is explained by the stratification scheme. Since the high-usage segment is based on high *annual* consumption, households with non-electric heat must consume a larger percentage of their total energy during the summer months in order to be included in the high-usage segment.

- Exhibit 2 demonstrates the effects of the VEP rates and the TranstexT system separately. For both segments, bills calculated for the control group using VEP rates are less than the actual bills, indicating that the control group stands to benefit from VEP pricing even without changing its power consumption patterns – that is, the VEP rates are not revenue-neutral.

- By comparing each column one can see the effect of the TranstexT system by itself. For each segment, the test group enjoys bill savings relative to the control group, regardless of the rate system employed for comparison. The test group has both shifted its consumption to lower-rate periods and reduced overall consumption. These changes can be seen more clearly in Exhibits 8, 9, 14, and 15.

- For the mixed fuel segment, average annual bills for 1997 closely approximate the corresponding figures for 1996. Comparisons between the test and control groups and between rate schedules yield very similar savings figures for the two years. For the all-electric segment average annual bills and savings for 1997 slightly exceed those for 1996.

Exhibit 3
HL&P's Energy Manager Pilot Program
Recommendations

Recommendations
The mixed fuel segment should be targeted if demand reduction is the program's goal. If the program's goal is customer retention then both segments can be targeted.
Increasing rates can reduce EM's impact on revenues.
The high period should be shifted to a later interval to reduce revenue impact while increasing or maintaining current demand impact.
Investigate whether a program like EM requires a TranstexT like thermostat, or whether a simple programmable thermostat would be sufficient.

WE RECOMMEND SHIFTING THE HIGH PERIOD TO A LATER INTERVAL IN ORDER TO REDUCE THE REVENUE IMPACT AND INCREASE THE DEMAND IMPACT.

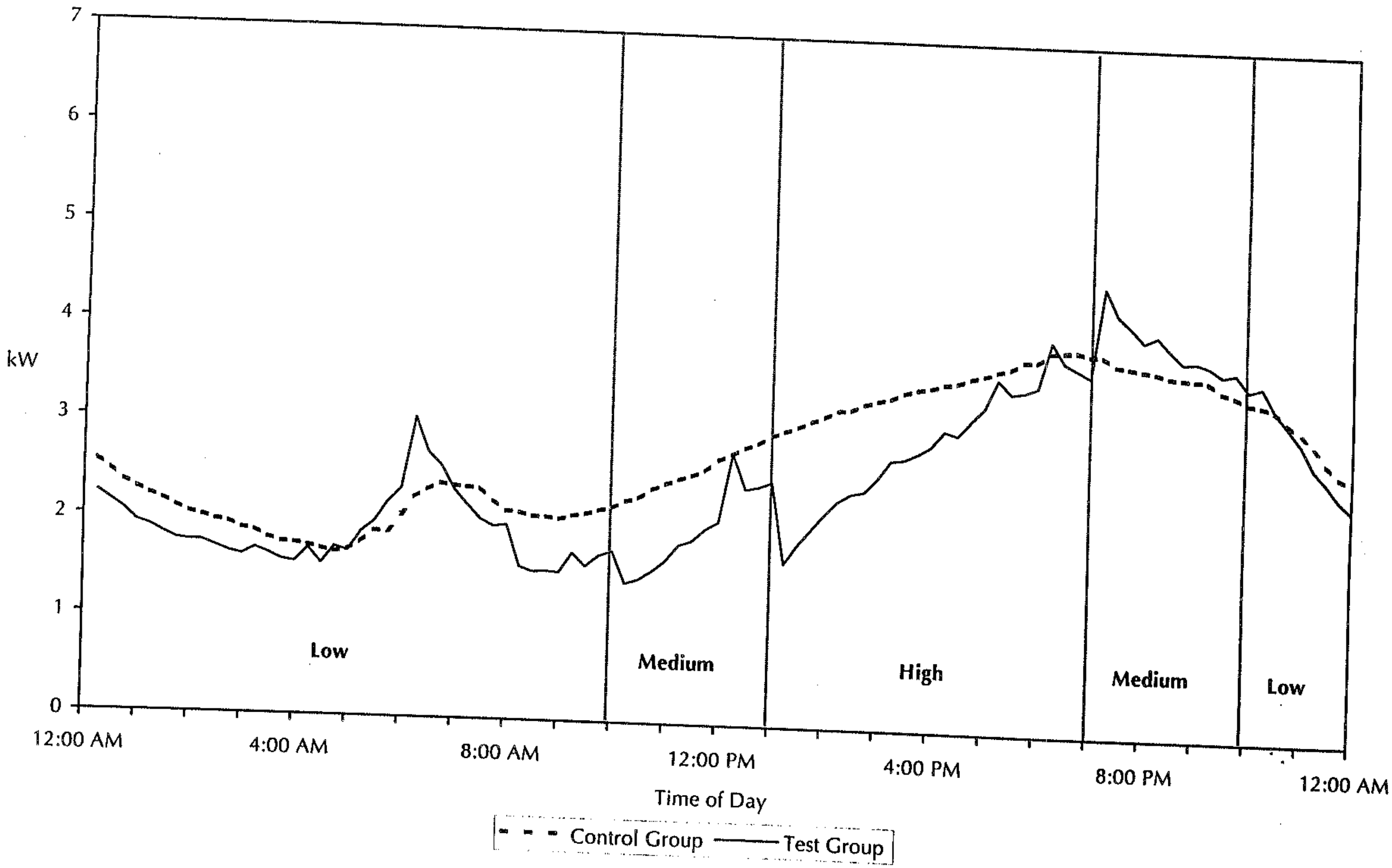
- If the goal of EM is demand reduction then the program should be targeted at the mixed fuel segment. The demand impact for the mixed fuel segment is 2.00 kW compared with the 1.34 kW impact of the all-electric segment. If the goal of EM is customer retention, then both segments should be targeted -- both segments receive bill savings in excess of $260 in comparison with their respective control groups.

- At present, the end of the daily HIGH period creates a spike in demand that is coincident with the period of peak residential demand. Moving this period from 1:00 PM – 7:00 PM to 3:00 PM – 8:00 PM would shift this spike to 8:00 PM, when overall residential peak has already begun to decline. A shift of the HIGH period would also increase revenues from the program participants and help to reduce the program's adverse impact on revenue.

- An investigation into demand elasticities is recommended in order to determine the appropriate parameters for a shift in the HIGH period and/or a change in VEP rates. Achieving the desired revenue and demand impacts discussed above is predicated on precise information about price response.

- Given that the default thermostat temperature and time settings greatly affect the summer load shape, it is imperative that consideration be given to appropriate settings. This is particularly true since the summer default settings are altered by only a degree or two, on average.

Exhibit 4
Average Summer Weekday Load Profile
All-Electric Segment



THE SHIFTS IN DEMAND AND ENERGY CONSUMPTION INDUCED BY THE EM PROGRAM ARE EASILY SUMMARIZED BY COMPARING AVERAGE LOAD PROFILES FOR THE CONTROL AND TEST GROUPS. THE DISCRETE DEMAND SHIFTS DEMONSTRATED BY THE TEST GROUP INDICATE THAT ACCESS TO THE TRANSTEXT SYSTEM ALLOWS CONSIDERABLE CONTROL OVER ELECTRICITY CONSUMPTION.

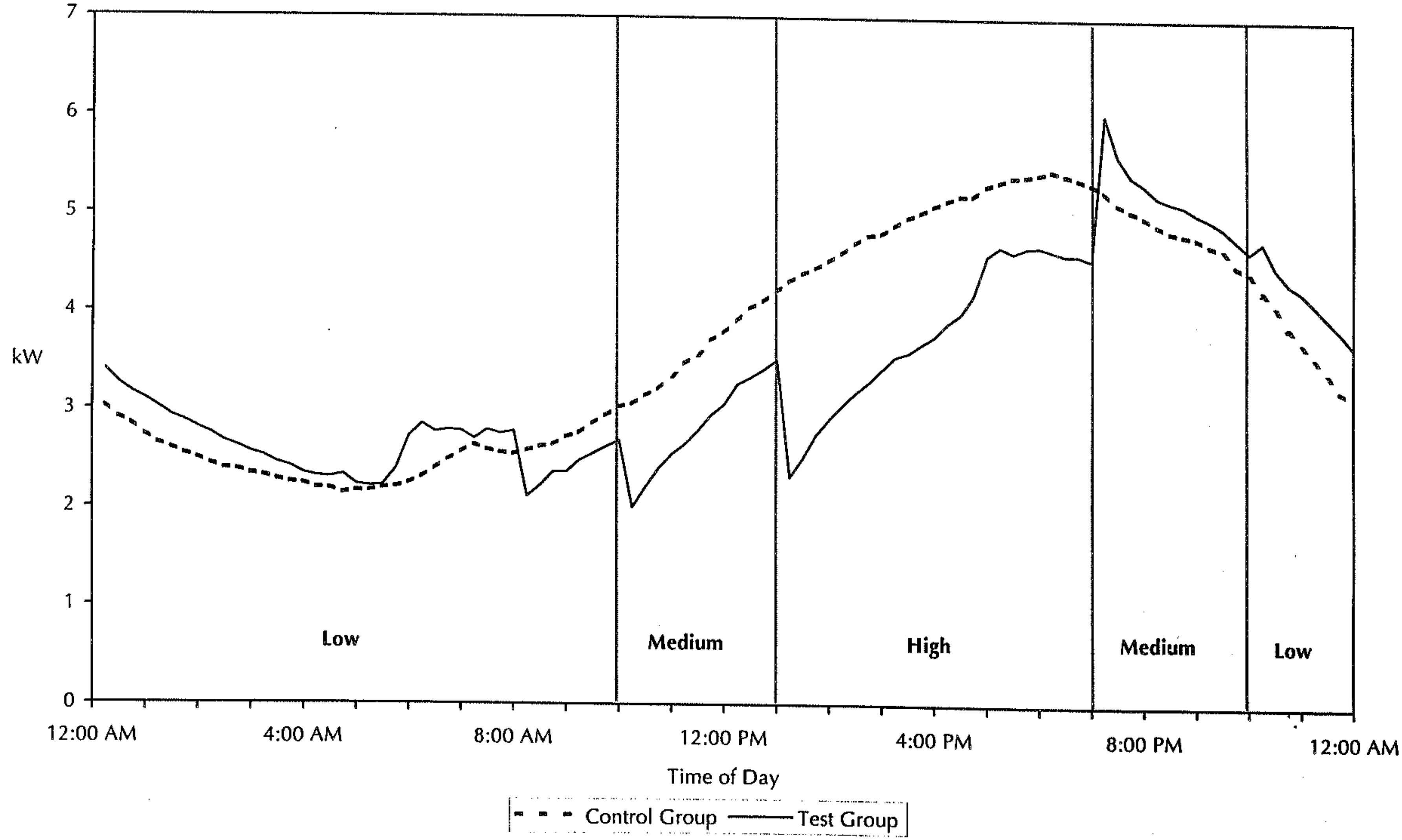
- During summer, the shifts from one rate tier to another induce corresponding increases or decreases in demand. In Exhibit 4, for example, a distinct decrease in demand at 10:00 AM corresponds to the change from the LOW to the MEDIUM rate tier. Similarly, a decrease in demand at 1:00 PM is brought on by the change from the MEDIUM to the HIGH level.

- The change from the MEDIUM to the HIGH rate tier, which represents a 185 percent increase from $0.065/kWh to $0.185/kWh, reduces demand by an average of 0.82 kW. This downward shift keeps the test group's profile below that of the control group for almost the entire HIGH rate period. The result is a positive demand impact for most of that interval. At 7:00 PM, when the rate reverts to the MEDIUM tier, average demand shifts back up by 0.92 kW.

- Within the LOW rate period, shifts in demand can be explained by water heater activity. Thermostat default settings for water heater operation cause heaters to switch on at 6:00 AM and off at 8:00 AM. Correspondingly, a 6:00 AM demand spike and a leveling-off of demand at 8:00 AM are induced. This observed shift may be enhanced by the change in thermostat day settings; at 6:00 AM the setting switches from NIGHT to MORNING, representing a decrease in the average thermostat setting until 8:00 AM, when the setting shifts back up.

- The load profiles for 1997 are very similar to those for 1996, indicating that neither the test nor the control group participants have changed their energy consumption behavior drastically between years. In particular, the strikingly similar shape of the test group's load profiles for both years suggests that the majority of program participants have not changed their thermostat settings significantly in the last year.

Exhibit 5
Average Summer Weekday Load Profile
Mixed Fuel Segment



RELATIVE TO THE ALL-ELECTRIC SEGMENT, THE MIXED FUEL SEGMENT GENERALLY DEMONSTRATES LARGER DEMAND IMPACTS. FURTHERMORE, SHIFTING OF DEMAND TO LOWER-RATE TIERS IS MORE CLEARLY SEEN IN THIS SEGMENT'S RESULTS.

- During the change from the MEDIUM to the HIGH rate tier, the demand impact for the mixed fuel segment reached 1.20 kW, as compared with 0.82 kW for the all-electric segment. At the end of the HIGH rate tier, demand increases an average of 1.48 kW, as compared with 0.92 for the all-electric segment. Because of the stratification scheme used for the pilot, mixed fuel participants are greater users of cooling than the all-electric participants. Curtailment of these greater-volume cooling households results in larger average impacts for the mixed fuel segment.

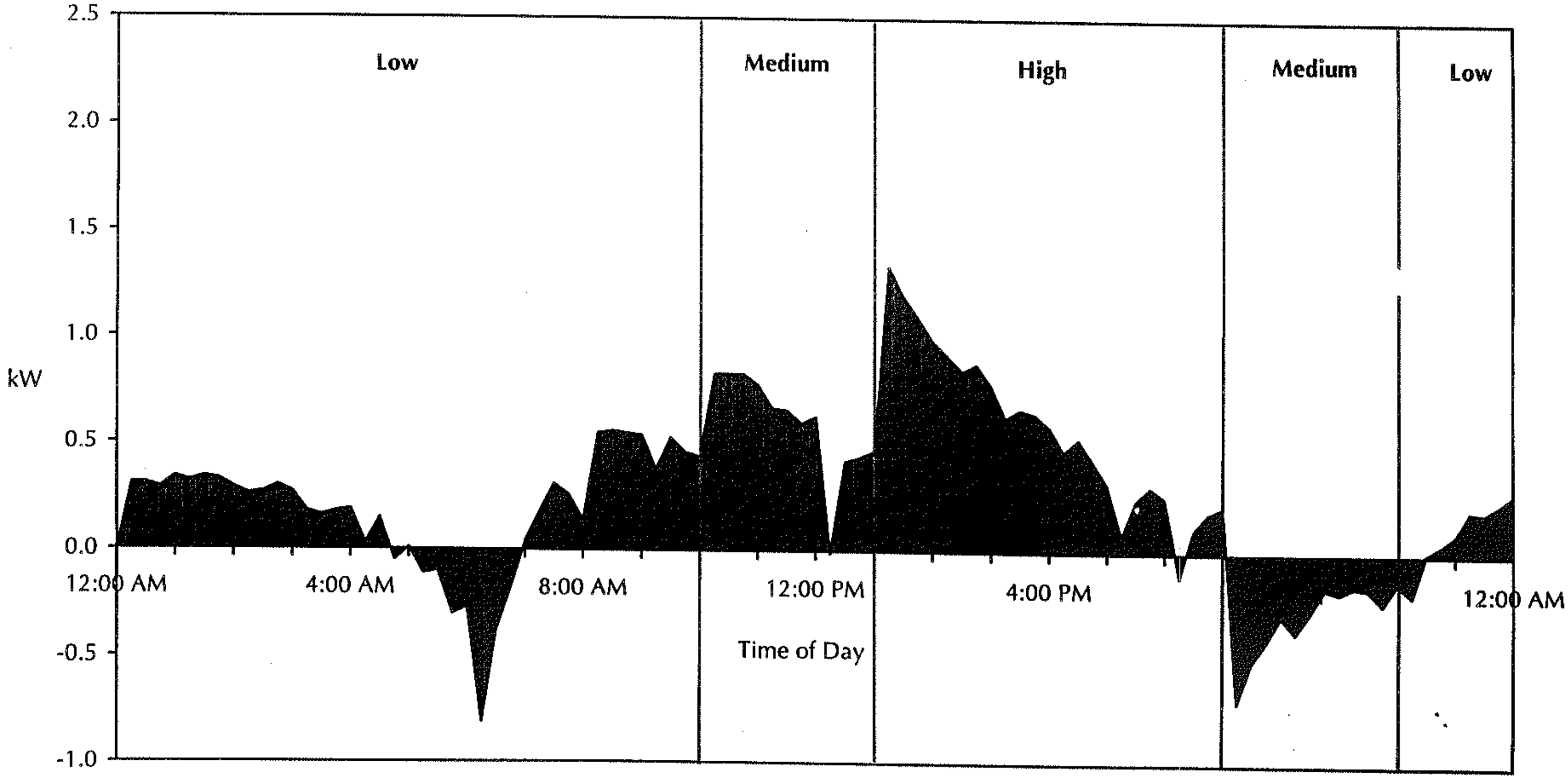
- Within the LOW rate period, observed shifts in demand may be caused by changes in thermostat day settings. At 6:00 AM, the setting changes from NIGHT to MORNING, representing a decrease in the average thermostat setting. At 8:00 AM, the day period changes again from MORNING to DAY, causing an increase in the average thermostat setting. We observe an increase in demand from 6:00 AM to 8:00 AM.

- The demand impacts created by the HIGH price are not constant over the duration of the price period. A leveling-off of demand at 5:00 PM cannot be explained by changes in thermostat day settings nor by water heater activity.

- The mixed fuel segment's results clearly show the test group's tendency to shift consumption away from higher-rate intervals. During summer weekdays, the test group's average demand lies below that of the control group for the entire HIGH rate period and the first MEDIUM rate period. Correspondingly, the test group's demand is higher than that of the control group for all but two hours of the LOW rate intervals.

- The load profiles for both the test and control groups are very similar across 1996 and 1997, indicating that no significant change took place in the energy consumption habits of either group between years. More specifically, the test group participants appear not to have made major changes in their thermostat settings.

Exhibit 6
Average Summer Weekday Demand Impacts
All-Electric Segment



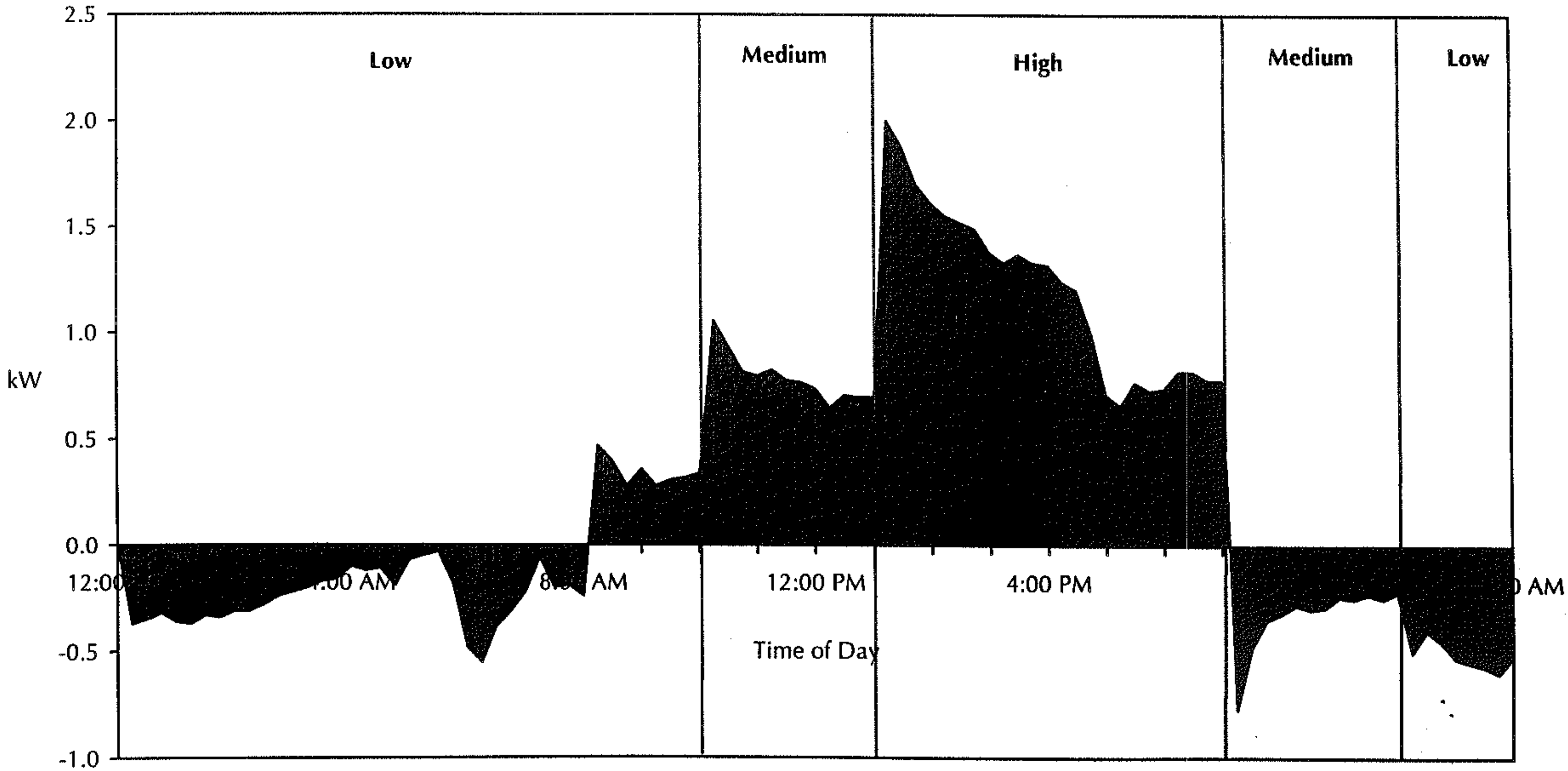
DURING SUMMER WEEKDAYS, THE AVERAGE DEMAND IMPACT FOR THE ALL-ELECTRIC SEGMENT MAY BE AS MUCH AS 1.34 KW DURING THE HIGH RATE PERIOD. NEGATIVE IMPACTS ARE OBSERVED DURING THE MORNING LOW AND EVENING MEDIUM RATE PERIODS.

- Exhibit 6 compares the difference in demand between the all-electric control and test groups. A positive impact means a decrease in demand for the test group relative to the control group. Negative values mean an increase in demand for the test group relative to the control group.

- The largest impact observed corresponds to the beginning of the HIGH rate period at 1:00 PM. The impact diminishes until the end of the HIGH rate period, at which point the test group's demand increases in response to a decrease in price. At this point a negative impact of –0.70 is observed.

- Generally, if the test group is responding to the VEP, one would expect demand to increase as relative prices drop and to decrease when relative prices increase. The responses are fairly consistent except for the morning LOW period, during the interval 8:00 AM to 10:00 AM. Given that rates do not change during this period, the decrease in demand cannot be attributed to price. Alternatively, the drop in demand may be the result of preprogrammed thermostat settings. For the average household, 8:00 AM corresponds to a shift in the thermostat day periods from MORNING to DAY – a two-degree increase in the average preprogrammed thermostat setting. In addition, on average, water heaters are turned off between 8:00 AM and 10:00 AM.

Exhibit 7
Average Summer Weekday Demand Impacts
Mixed Fuel Segment



DURING SUMMER WEEKDAYS, THE MIXED FUEL SEGMENT'S AVERAGE DEMAND IMPACT EXCEEDS THAT OF THE ALL-ELECTRIC SEGMENT. DEMAND IMPACT REACHES 2.00 KW DURING THE HIGH RATE PERIOD.

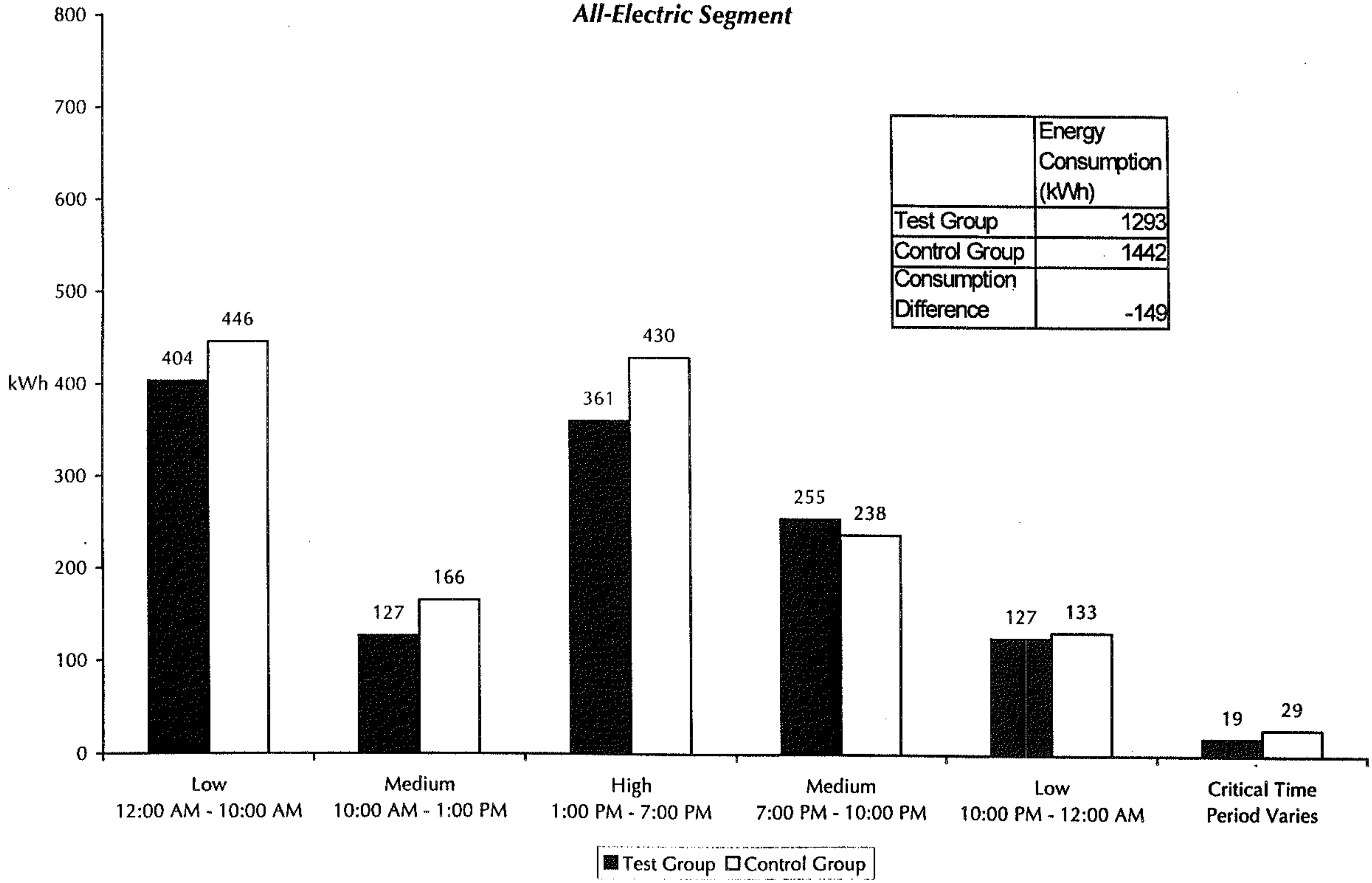
- Exhibit 7 reports the difference in demand between the mixed fuel control and test groups. As stated in the discussion of Exhibit 5, the mixed fuel group's greater cooling volume results in a greater demand impact in response to price changes. During summer weekdays the mixed fuel group records an impact of 2.00 kW at the onset of the HIGH rate period.

- Demand impact is positive throughout the entire HIGH rate period and the first MEDIUM rate period, while it is negative throughout all but two hours of the LOW rate periods. This demand pattern indicates the test group's willingness to shift consumption in response to prices. Examples of "shiftable" activities include running pool pumps, dishwashers, and washing machines.

- In addition to shifting consumption, participants are choosing to reduce overall consumption, as is evident in the much larger positive impact (load reduction) relative to the negative impact.

- Demand tends to follow the price signals for all periods except the evening LOW period. This is not surprising since demand during this period is likely to be less price-sensitive given the late hour at which it occurs.

Exhibit 8
Average Monthly Energy Consumption (kWh)
By Price Period for Summer Weekdays
All-Electric Segment

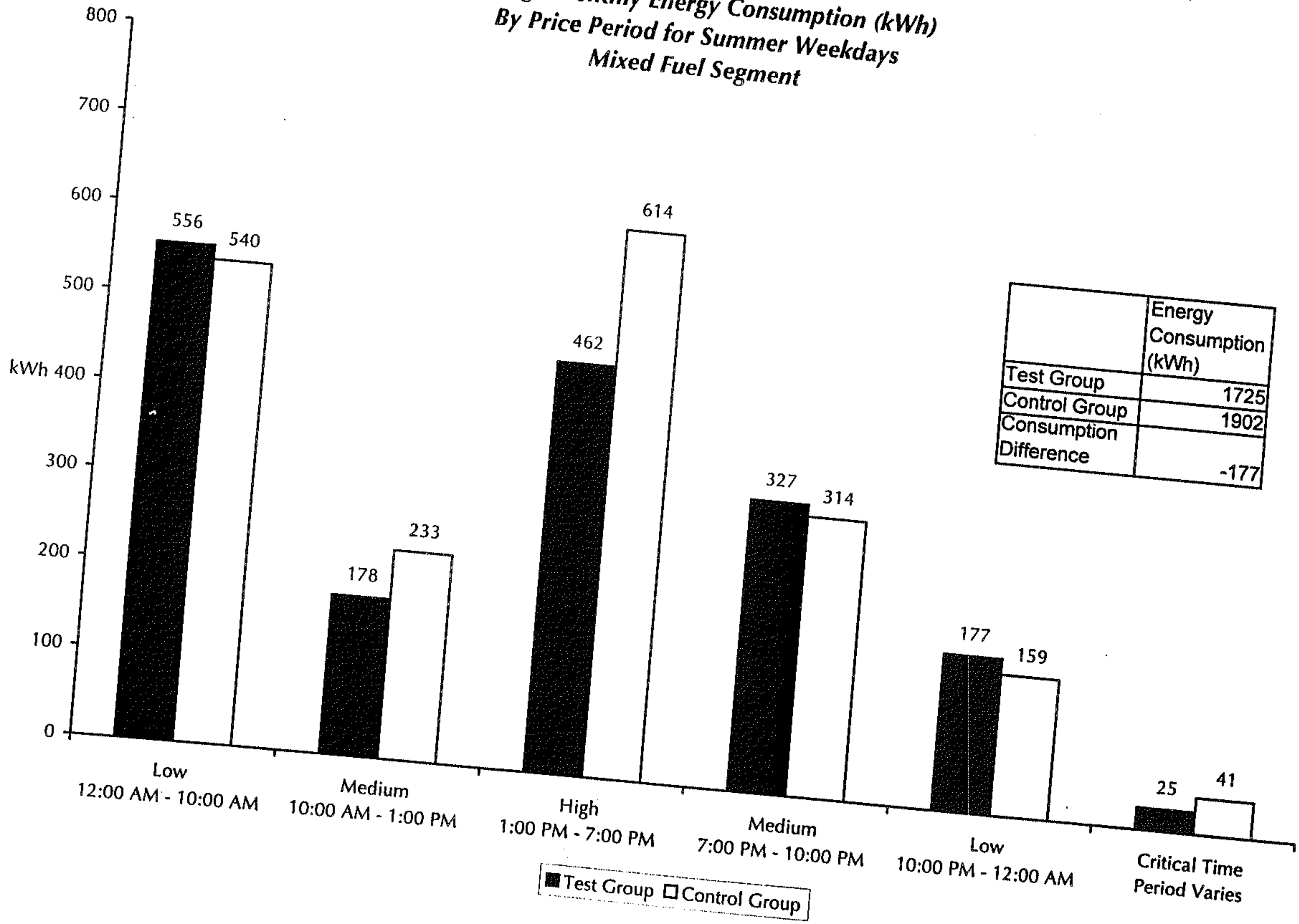


	Energy Consumption (kWh)
Test Group	1293
Control Group	1442
Consumption Difference	-149

THE EM PROGRAM HAS HAD THE EFFECT OF GENERALLY REDUCING OVERALL ENERGY CONSUMPTION AND OCCASIONALLY CAUSING A SHIFT IN DEMAND FROM HIGH PRICE PERIODS TO LOW PRICE PERIODS. BY COMPARING THE DAILY CONSUMPTION PATTERNS OF THE TEST AND CONTROL GROUPS, ONE CAN SEE HOW THE PROGRAM HAS AFFECTED ENERGY USAGE DURING EACH VEP PERIOD.

- Focusing on the all-electric segment, Exhibit 8 presents a comparison of average monthly energy consumption during each price period. Consumption is not grouped by price alone because the response to specific prices varies by time of day. For example, energy consumption decreases during the MEDIUM price period from 10:00 AM to 1:00 PM, but increases slightly during the period from 7:00 PM to 10:00 PM.
- The most dramatic shift in energy consumption occurs during the HIGH price period. Consumption during the six-hour period from 1:00 PM to 7:00 PM decreases by 16 percent.
- The all-electric segment does not increase consumption in response to the LOW prices available during the late evening and early morning. Although the differences in consumption are small, the test group actually consumed less energy than did the control group during the time periods when the lowest VEP rate prevailed.
- As noted above, the response to the MEDIUM rate differs by time of day. Consumption decreases during the morning hours, and increases at night. The decrease in morning consumption likely reflects the effect of the preprogrammed thermostat settings. Average preprogrammed thermostat settings during the morning MEDIUM period are 80°F, compared to the 77°F that is observed during the evening MEDIUM period.
- Energy consumption during critical signal periods is less in 1997 than in 1996, reflecting the relative infrequency of critical signals sent in 1997.

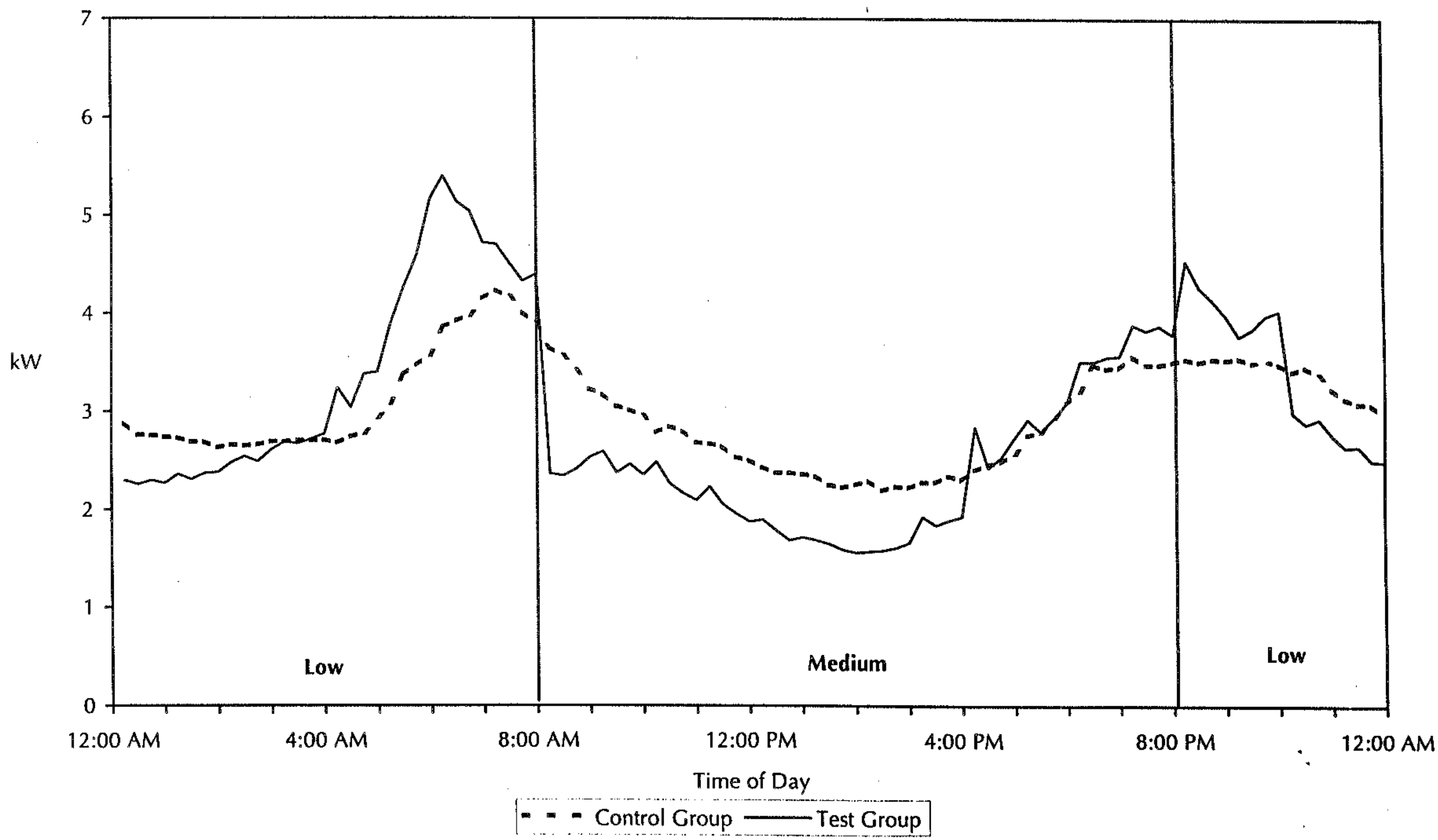
Exhibit 9
Average Monthly Energy Consumption (kWh)
By Price Period for Summer Weekdays
Mixed Fuel Segment



THE ENERGY USAGE PATTERNS OF THE MIXED FUEL PROGRAM PARTICIPANTS REVEAL A STRONGER RESPONSE THAN IS OBSERVED FOR THE ALL-ELECTRIC SEGMENT. CONSUMPTION DECREASES DRAMATICALLY DURING THE HIGHER PRICED PERIODS, AND INCREASES WHEN THE LOWEST PRICES ARE IN EFFECT.

- In response to the HIGH price ($0.185/kWh), the mixed fuel segment decreases consumption by nearly 25 percent. This reduction in consumption corresponds to the period from 1:00 PM to 7:00 PM.
- As stated above, the sample stratification scheme grouped heavier users of cooling into the mixed fuel segment. Not surprisingly, then, the mixed fuel segment shows significantly higher levels of consumption during summer weekdays than does the all-electric segment.
- Although the differences are modest, the mixed fuel group's energy consumption increases during both LOW price periods, relative to control group consumption.
- The mixed fuel and all-electric participants respond in a very similar manner to the VEP MEDIUM rates. During the morning hours, the mixed fuel participants reduce consumption. Again, this is likely the result of the change in thermostat day periods (which represent a two-degree increase in the average thermostat setting) and the change in price. In the evening, when the MEDIUM period follows a six-hour period when the HIGH rate has been in effect, the mixed fuel segment responds with a small increase in consumption.
- Energy consumption by the mixed fuel segment during critical signal periods is less in 1997 than in 1996, reflecting the relative infrequency of critical signals sent in 1997.

Exhibit 10
Average Winter Weekday Load Profile
All-Electric Segment

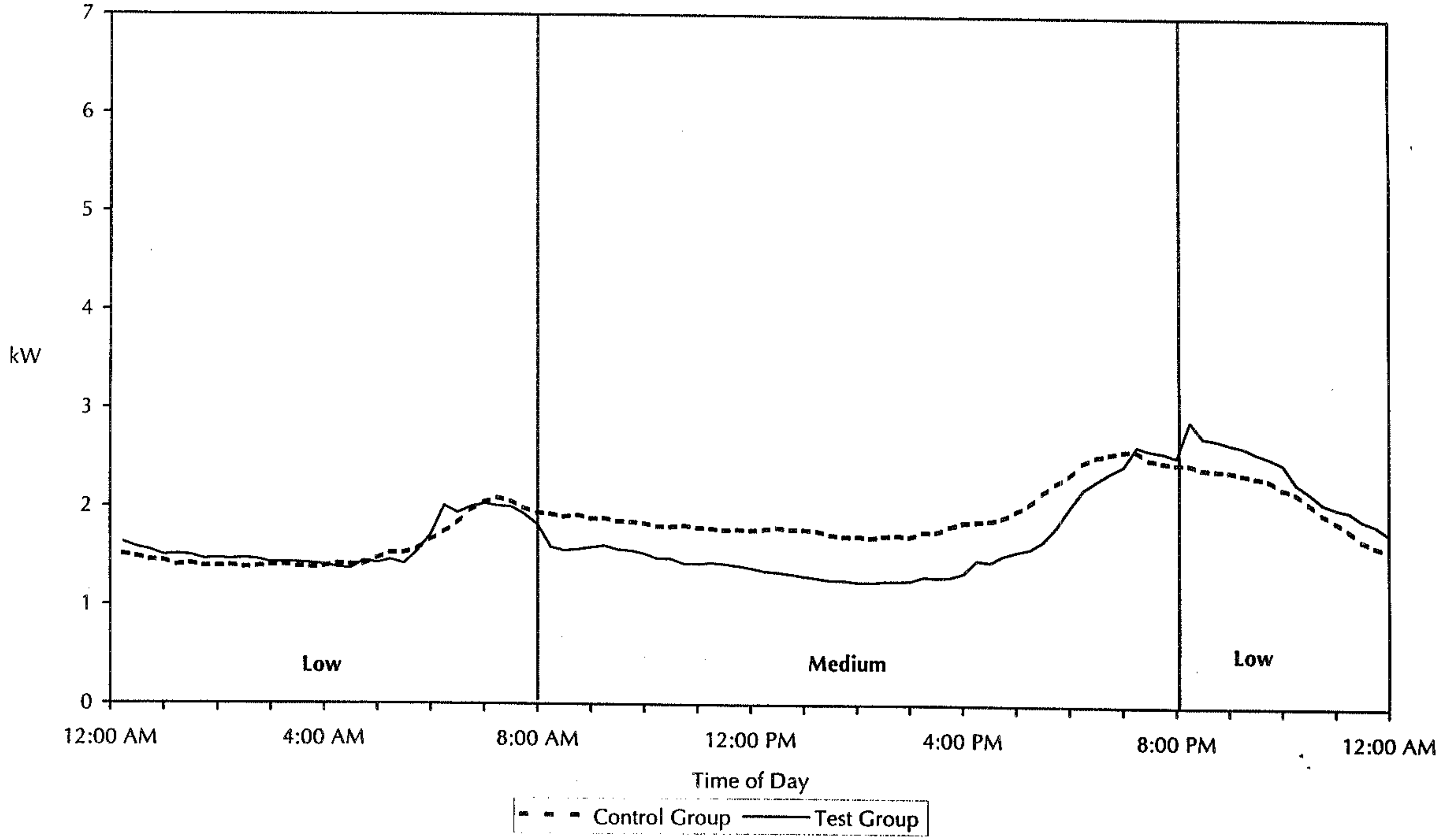


AVERAGE WINTER WEEKDAY DEMAND FOR THE ALL-ELECTRIC SEGMENT DECREASES SUBSTANTIALLY AS PRICES SHIFT FROM THE LOW TO THE MEDIUM PRICE PERIOD.

- Average winter weekday load follows the price changes in an expected pattern, decreasing during the MEDIUM price periods and increasing during the LOW price periods.
- The dramatic drop in demand at 8:00 AM is due, in part, to the rate change which occurs at this hour. However, 8:00 AM also corresponds to a seven-degree decrease in the average thermostat setting as the day period changes from MORNING to DAY. In addition, the preprogrammed appliance schedule shuts water heaters off between 8:00 AM and 10:00 AM, increasing the demand impact.
- Relative to the summer load profile, winter offers only limited demand reduction. This is due primarily to the mild winter weather and the relatively small difference in relative prices, $0.05/kWh vs. $0.065/kWh for the LOW and MEDIUM periods, respectively.
- The drop in load after 10:00 PM is likely the result of another shift in the thermostat day periods, from EVENING to NIGHT. This change in thermostat periods corresponds to a three-degree change in the average preprogrammed thermostat setting.
- The 1997 load profile differs little from that of 1996, revealing no substantial changes in demand patterns for the test or control groups.

COMPARISON OF THE TWO FUEL TYPES REVEALS THAT THE ALL-ELECTRIC SEGMENT CONSUMES SUBSTANTIALLY MORE ENERGY DURING THE WINTER MONTHS. MOST OF THE MIXED FUEL SEGMENT'S PARTICIPANTS USE NON-ELECTRICAL FUEL SOURCES FOR HEATING, SO THIS PORTION OF WINTER ENERGY USE DOES NOT REGISTER IN THE LOAD DATA.

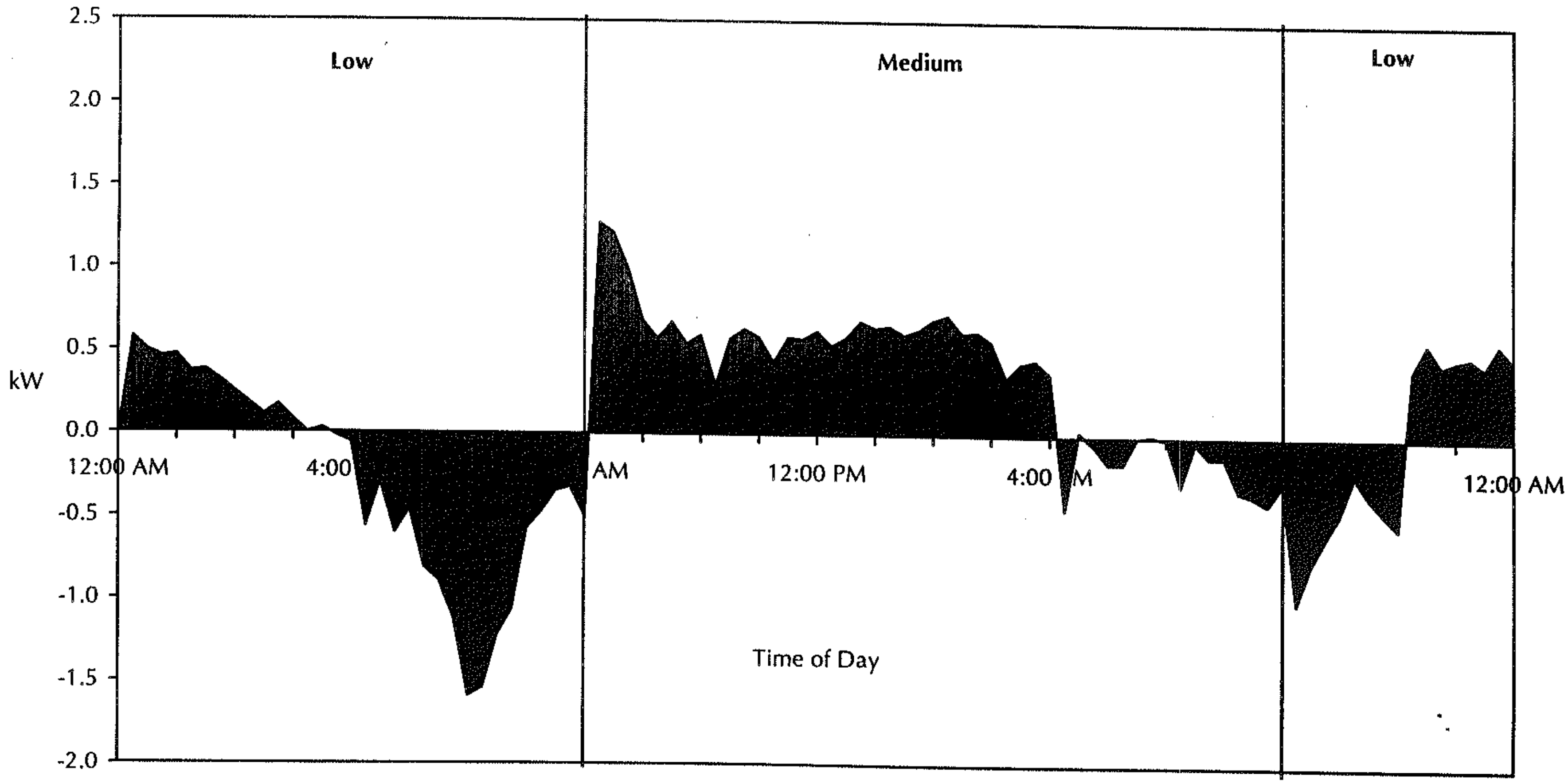
Exhibit 11
Average Winter Weekday Load Profile
Mixed Fuel Segment



THE LACK OF HEATING LOAD FOR THE MIXED FUEL SEGMENT IS REVEALED BY THE RELATIVELY FLAT LOAD PROFILE. THE IMPACT IS EXPECTEDLY SMALL.

- The mixed fuel segment consumes little energy during the winter. It follows that average impact is quite small -- less than 0.51 kW at its maximum.
- Because mixed fuel participants are unlikely to have electric heat, the role of the thermostat is greatly reduced as well.
- No discernible differences emerge between the 1996 and 1997 load profiles for the mixed fuel segment during winter, since winter energy use is not weather-sensitive for this segment.

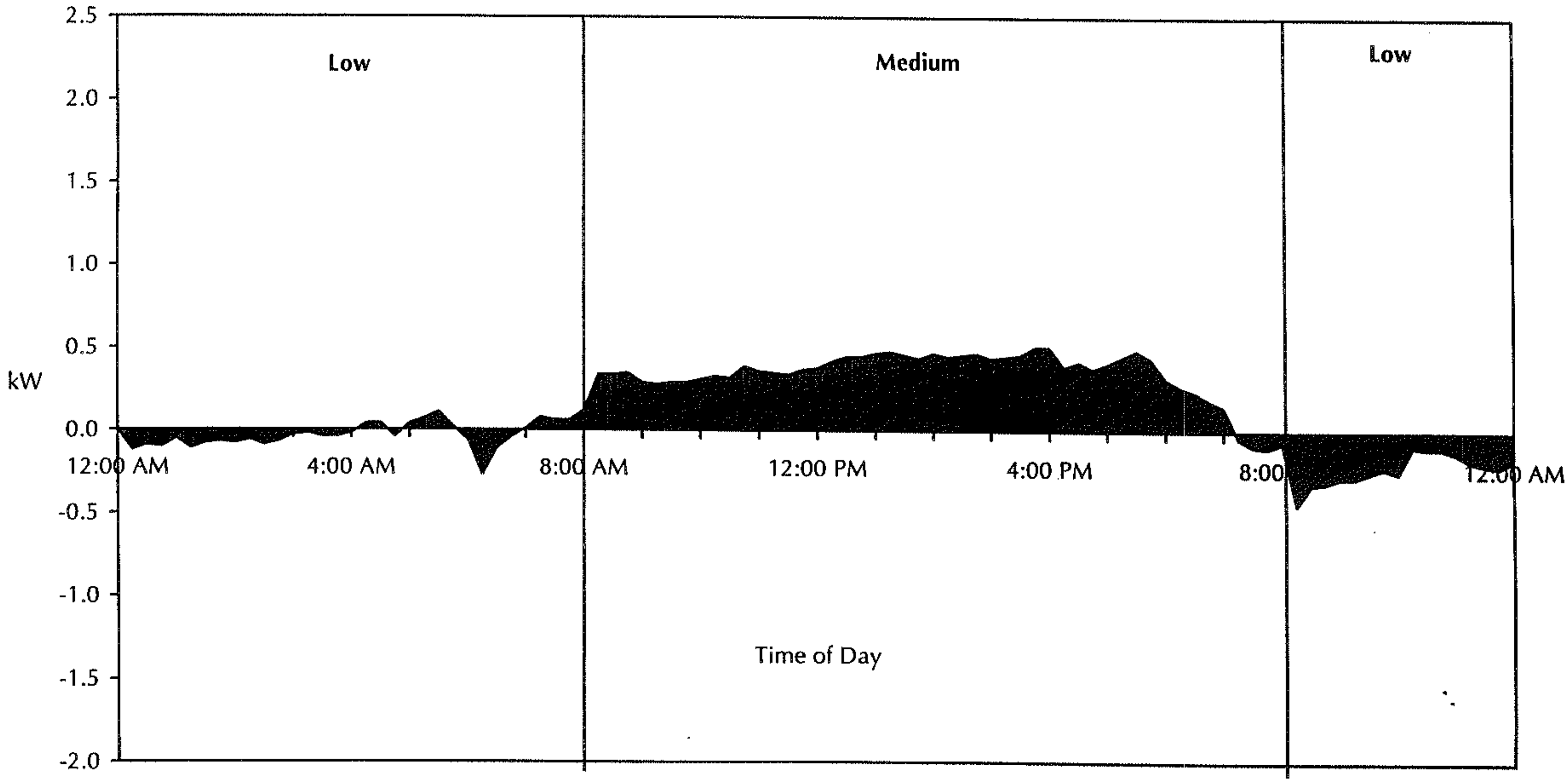
Exhibit 12
Average Winter Weekday Demand Impacts
All-Electric Segment



THE AVERAGE WINTER WEEKDAY DEMAND IMPACTS FOR THE ALL-ELECTRIC SEGMENT CORRESPOND CLOSELY TO RATE CHANGES.

- Demand impacts were calculated exactly as were the summer impacts; that is, the test group demand was subtracted from the control group demand. Positive values imply a decrease in test group demand relative to the control group and therefore a positive impact. Negative values imply an increase in test group demand relative to the control group.
- The positive portion of the impact for winter weekdays is concentrated during the MEDIUM rate interval from 8:00 AM to 8:00 PM. As stated in the discussion of Exhibit 10, the positive impact beginning at 10:00 PM is attributable to the change in thermostat day periods at that time, from EVENING to NIGHT, corresponding to a three-degree change in the preprogrammed thermostat setting.
- A sharp decrease in demand at 8:00 AM, as discussed above, results in positive impacts as high as 1.28 kW. Negative impacts occur chiefly in the LOW rate intervals, reaching –1.59 kW at 6:00 AM.

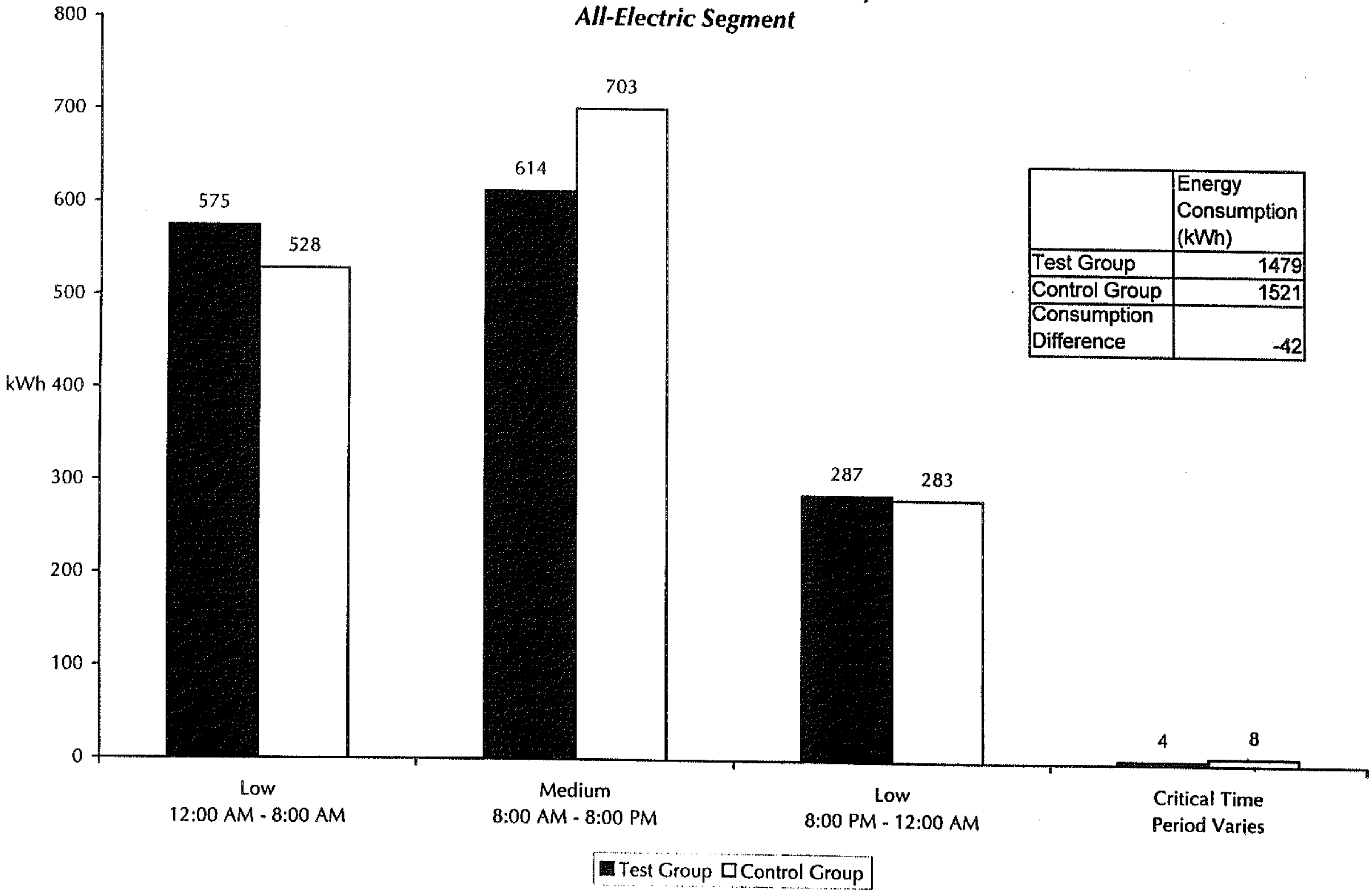
Exhibit 13
Average Winter Weekday Demand Impacts
Mixed Fuel Segment



BECAUSE MIXED FUEL PARTICIPANTS ARE LIKELY TO HEAT WITH A NON-ELECTRIC FUEL SOURCE, THE WINTER WEEKDAY IMPACTS ARE PREDICTABLY SMALL.

- The mixed fuel segment registers comparatively small demand impacts. Average demand impacts do not exceed 0.51 kW.
- Nevertheless, the impact pattern adheres to expectations – impacts become positive at the change from the LOW to the MEDIUM rate period and become negative again with in increase in demand at the onset of the evening LOW rate period.

Exhibit 14
Average Monthly Energy Consumption (kWh)
By Price Period for Winter Weekdays
All-Electric Segment

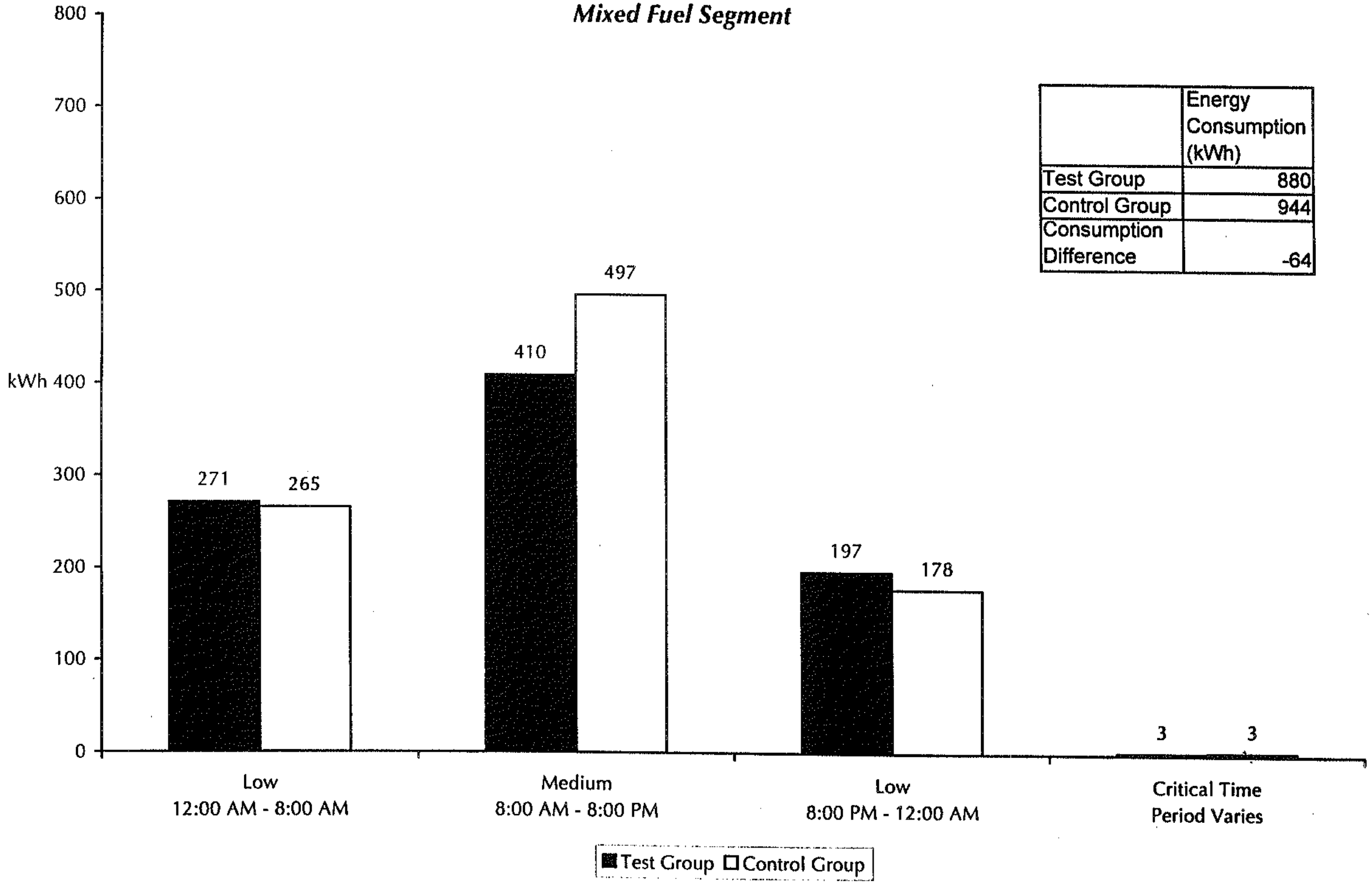


	Energy Consumption (kWh)
Test Group	1479
Control Group	1521
Consumption Difference	-42

DURING WINTER, THE ENERGY CONSUMPTION PATTERN OF THE ALL-ELECTRIC SEGMENT IS CLOSELY LINKED TO CHANGES IN PRICE. ENERGY CONSUMPTION DECREASES WHEN THE MEDIUM AND CRITICAL PRICES ARE IN EFFECT AND INCREASES WHEN THE LOW PRICES PREVAIL.

- The shifts in energy consumption summarized in Exhibit 14 correspond directly to preprogrammed thermostat settings selected for each thermostat day period. Preprogrammed thermostat settings selected for the MEDIUM periods are, on average, two degrees cooler than the corresponding settings for the LOW price periods.
- Participants' thermostats, including those of participants who deviated from the default settings, were set at approximately 64 degrees for the period from 8:00 AM to 5:00 PM. Analysis of the average load profile confirms that their settings produced significant energy savings during these hours. Although programmed thermostat settings are adjusted upward by some participants, these adjustments averaged less than two degrees and had only a minimal effect on average daytime energy consumption.
- Overall, winter weekday energy consumption for the test group was slightly lower than for the control group. Average monthly weekday energy consumption differed by 42 kWh.
- Consumption figures for winter, 1997 are only slightly higher than the corresponding figures from 1996, while the consumption shifting patterns are almost identical, suggesting little change has occurred in the test group's behavior. Consumption during critical time periods is much lower for 1997, reflecting that fewer critical signals were sent that year than in 1996.

Exhibit 15
Average Monthly Energy Consumption (kWh)
By Price Period for Winter Weekdays
Mixed Fuel Segment

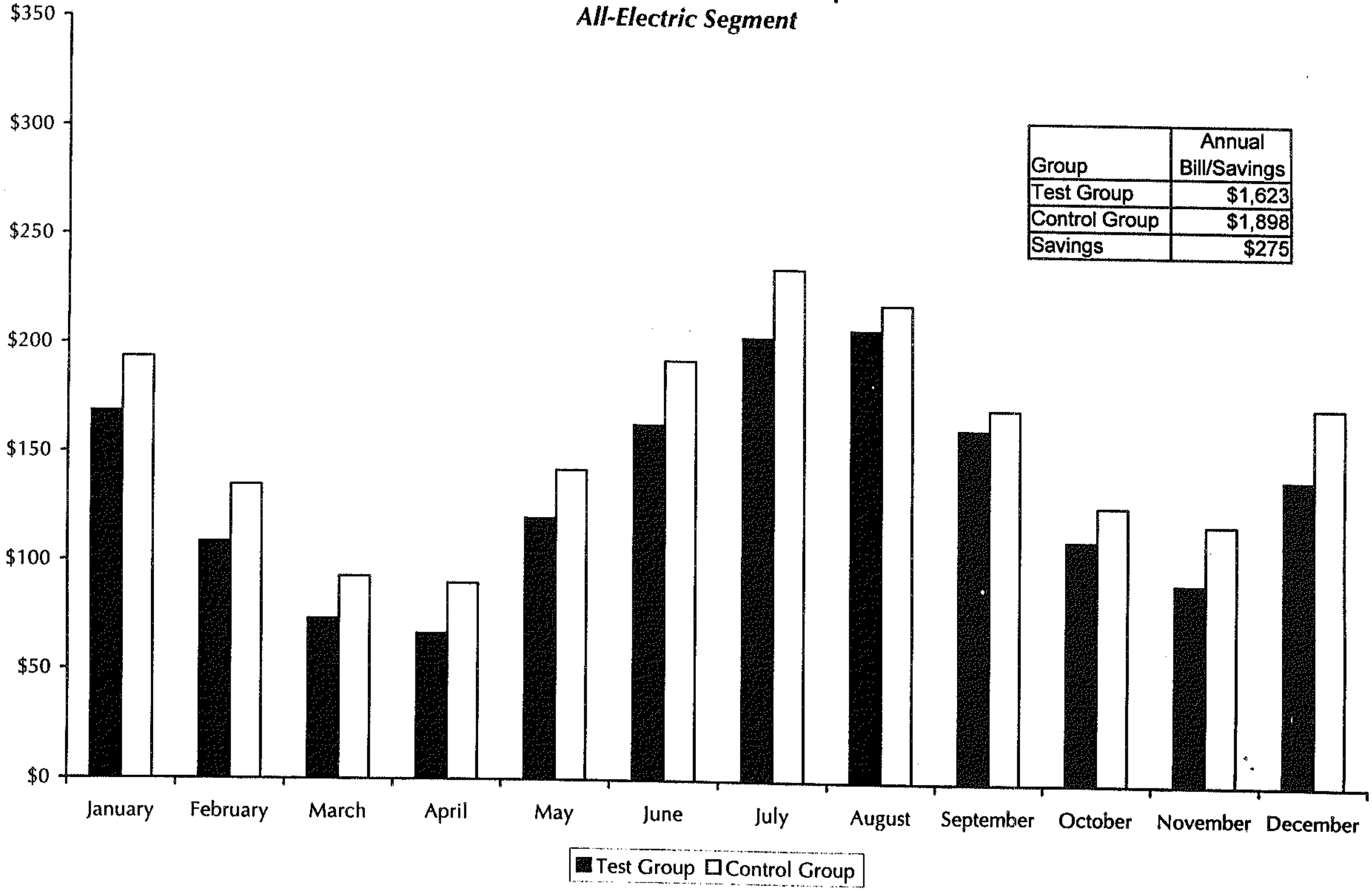


	Energy Consumption (kWh)
Test Group	880
Control Group	944
Consumption Difference	-64

THE WINTER ENERGY CONSUMPTION PATTERNS OF THE MIXED FUEL SEGMENT CLOSELY MATCH THOSE OF THE ALL-ELECTRIC SEGMENT. TOTAL ENERGY CONSUMPTION IS LOWER, BUT BOTH THE MIXED FUEL AND ALL-ELECTRIC PARTICIPANTS RESPOND TO THE VEP IN A SIMILAR MANNER.

- Exhibit 15 focuses on weekday consumption, but similar responses are observed on weekends as well. Energy consumption decreases significantly during the MEDIUM price periods, and increases during both the late evening and overnight LOW periods.
- The decrease in consumption during the MEDIUM period is larger than the increases occurring during the LOW periods. As a result, total energy consumption is lower by 64 kWh for the test group than for the control group.
- Winter weekday energy consumption was slightly lower in 1997 than in 1996, although the difference between test and control group consumption was slightly higher (64 kWh as compared with 53 kWh from 1996). This difference is spread evenly over the decreases in energy use during the MEDIUM rate and critical signal intervals and the increases during the LOW rate intervals.

Exhibit 16
Comparison of Average Monthly Bills
Test Group vs. Control Group
All-Electric Segment



Group	Annual Bill/Savings
Test Group	$1,623
Control Group	$1,898
Savings	$275

ALTHOUGH THE EM PROGRAM PARTICIPANTS GENERALLY REDUCED THEIR MONTHLY BILLS, THE LEVEL OF SAVINGS DIFFERED FROM MONTH TO MONTH. FURTHER DETAIL ABOUT THE PATTERN OF PARTICIPANTS' BILL SAVINGS CAN BE REVEALED BY ANALYZING SAVINGS ON A MONTH-BY-MONTH BASIS. THIS APPROACH HIGHLIGHTS HOW MONTHLY BILLS DIFFER OVER THE COURSE OF THE YEAR AND INDICATE WHEN PARTICIPANTS CAN EXPECT THE LARGEST SAVINGS.

- Exhibit 16 provides a direct comparison of the average monthly bills of the all-electric participants with those of the corresponding control sample. These bill estimates do not include the standard facilities charge, but do reflect HL&P's regular fuel charge. A description of the bill estimation approach is included in Appendix A.

- Within the all-electric segment, test group households have a lower average bill than control group households during every month of the year. Savings are larger during the winter, but some bill savings can be expected throughout the year.

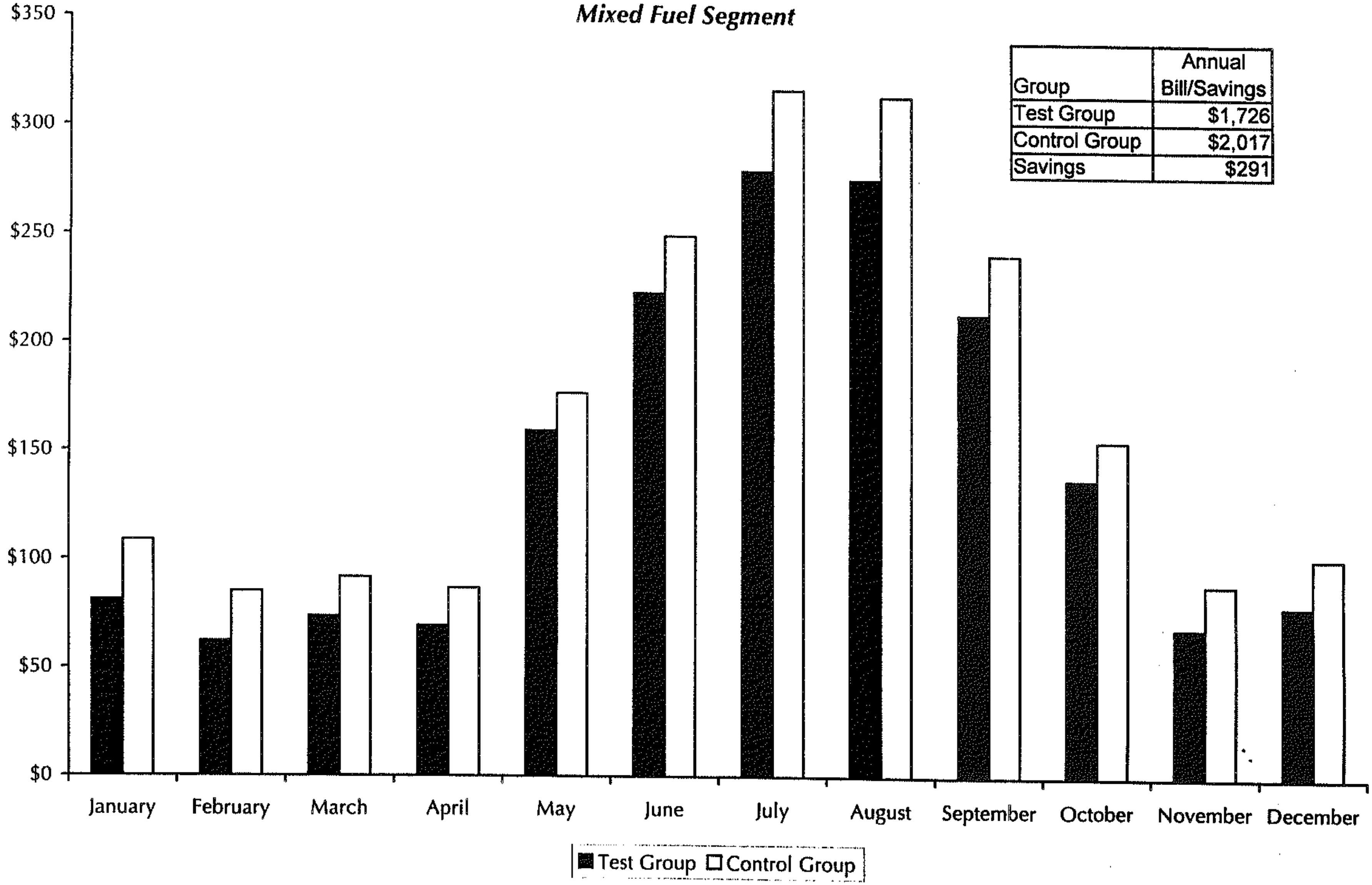
- The VEP rate imposed during the winter and shoulder months, November through April, did not include a HIGH price period, and the CRITICAL price was rarely employed. As a result, we would expect to see the greatest savings during these months. In general, this is true, but substantial savings are also observed during the months of June and July.

- As stated in the discussion of Exhibit 8, all-electric segment participants shifted considerable portions of summer consumption away from the HIGH price period, and the CRITICAL signal rate was less of a factor in 1997 than in 1996. The all-electric participants also reduced their overall summer energy consumption.

- Over the course of the entire year, savings for the all-electric test group averaged $275, as compared with $233 in 1996.

HIGH USAGE ALL-ELECTRIC PARTICIPANTS EXPERIENCED BILL SAVINGS THROUGHOUT THE YEAR AND ACHIEVED AN AVERAGE ANNUAL SAVINGS OF $275.

Exhibit 17
Comparison of Average Monthly Bills
Test Group vs. Control Group
Mixed Fuel Segment



Group	Annual Bill/Savings
Test Group	$1,726
Control Group	$2,017
Savings	$291

A COMPARISON OF MONTHLY BILLS FOR THE MIXED FUEL SEGMENT CONFIRMS THAT THIS SEGMENT EXPERIENCES SIGNIFICANTLY HIGHER BILLS IN SUMMER THAN IN WINTER. AVERAGE SAVINGS ARE LARGER DURING THE PERIODS OF HIGH CONSUMPTION; HOWEVER, SOME SAVINGS ARE OBSERVED DURING EVERY MONTH.

- Mixed fuel customers, both those in the EM program and those in the control group, experience large fluctuations in their monthly bills. During winter, bills average less than $100, while during the hotter months of the summer, average monthly bills exceed $250.
- Although absolute bill savings are largest during summer, the percentage savings remain relatively consistent over the course of the year. When compared to the control group, the mixed fuel EM participants save an average of 14 percent per month.
- Annual bill savings were larger for the mixed fuel participants. Annual savings averaged $291 for this group, compared to the $275 saved by the all-electric participants.
- Average monthly bills for the mixed fuel group in 1997 were slightly lower than those for 1996, but annual bill savings relative to the control group were higher; on average, test group participants saved $291 in 1997, as compared with $274 in 1996.

WHEN COMPARED TO THE CONTROL GROUP, MIXED FUEL PARTICIPANTS EXPERIENCE NOTABLE BILL SAVINGS THROUGHOUT THE YEAR. DURING SUMMER, THESE SAVINGS ARE CONSIDERABLY HIGHER THAN THOSE OBSERVED AMONG THE ALL-ELECTRIC PROGRAM PARTICIPANTS.

APPENDIX A
BILL ESTIMATION APPROACH

Exhibit A
Approach for Monthly Bill Estimation

The following is the normalization approach used to estimate average bills for a weekday good, good 0. This approach was necessary to limit the bias associated with missing data.

(1) $g_{id} = \sum_{J^0} x_{ijd}$

where g_{id} equals good 0 for individual *i* on day *d* and x_{ijd} equals *weekday* demand for individual *i* at interval *j* for a day *d*. J^0 represents the total number of intervals *j* in good 0.

(2) $\bar{g}_{im} = \frac{\sum_{N_d} g_{id}}{N_d}$

where $\bar{g}_{im}$ equals the average daily consumption of good 0 by individual *i* for month *m*. N_d represents the number of days in month *m* with non-missing values for good 0.

These calculations are also carried out for weekend consumption, yielding a weekday $\bar{g}_{im}$ and a weekend $\bar{g}_{im}$.

(3) $G_{im} = [(weekday\bar{g}_{im} * 5/7) + (weekend\bar{g}_{im} * 2/7)] * 31$

where G_{im} equals normalized consumption of good 0 for individual *i* during month *m*. (Of course, the sum in brackets is variously multiplied by 31, 30, or 28, depending on the month.)

(4) $B_{im} = \sum_{a=1}^{6} G_{aim} * r_a$

where B_{im} is the normalized bill for individual *i* during month *m*. Subscript *a* indexes goods 1 through 6 and r_a is the billing rate, including the fuel charge, for good *a*.

Now, individual monthly bills can be averaged over all individuals to get overall mean monthly bills.

(5) $\overline{B}_m = \frac{\sum_{N_I} B_{im}}{N_I}$

where $\overline{B}_m$ is the average normalized bill for month m. N_I is the number of individuals without missing data for monthly bills B_{im}.

APPENDIX B
EVALUATION OF HL&P'S ENERGY MANAGER PILOT PROGRAM: 1996