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# REDUCING ELECTRICITY CONSUMPTION OF RESIDENTS LIVING IN MASS-METERED DORMITORY COMPLEXES

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**ABSTRACT**

Monetary incentives for reduced electricity consumption by residents living in mass-metered university dormitories were provided via a contest and contest-raffle. In the contest, reduced electricity consumption of a group of students was reinforced with group consequences. In the contest-raffle, reduced electricity consumption of a group of students was reinforced with individual consequences. A control condition measured normal fluctuations in electricity use. Electricity consumption by residents in the contest and contest-raffle was consistently lower than consumption by residents in the control condition throughout the treatment period. Also, consumption by male residents was lower than consumption by female residents. Analysis of electricity consumption during a post-treatment baseline period suggested residual effects due to the contest and contest-raffle. Residents' reactions to the contest and contest-raffle were assessed through telephone interviews.

It was suggested that energy conservation programs incorporate elements based on behavioral technology as well as physical technology.

One way in which government, industry, and institutions have approached current energy problems is through the encouragement of energy conservation practices. Persons concerned with energy conservation have generally relied on physical technology as a major resource when developing and implementing conservation programs. Physical technology suggests solutions such as improving home





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insulation materials, encouraging energy efficient building designs, improving the efficiency of automobiles, alteration of lighting patterns, computerized control of energy consumption, and so forth. Concurrent with approaches based on physical technology is a concern with altering the energy consumption attitudes and habits of people. Energy conservation programs developed in this direction are primarily informational campaigns used to increase people's awareness of energy consumption and energy conservation techniques. People are prompted by media advertisements to join car pools, use electricity after peak hours, to buy energy efficient products, and above all not to be "fuelish." To be successful, energy conservation programs should consist of broad-based approaches including both the alteration of physical environments and the alteration of people's energy consuming behavior.

## Effective Energy Conservation

The development of effective energy conservation programs is dependent on the refinement of existing, and development of new, conservation techniques. Research findings concerning conservation techniques based on physical technology are steadily accumulating. Although less publicized, behavioral research regarding conservation is also accumulating. Recent research by behavioral scientists suggests that energy conservation procedures may be developed through an experimental analysis of energy consuming behavior. Through the use of techniques based on reinforcement principles (operant psychology), studies have been conducted with the direct intention of modifying energy consuming behavior.

Winett and Nietzel investigated the effects of conservation information and monetary incentives on electricity and gas consumption in thirty-one homes [1]. Each home was assigned to one of two groups with one group receiving conservation information only, and the other receiving information concerning weekly energy consumption and monetary payments for reduced consumption. The results indicated that the monetary payment condition produced a greater reduction in electricity consumption than the information only condition. The results concerning gas consumption were not significant and quite variable due to weekly temperature fluctuations. Group differences in electricity consumption still appeared at a two week follow-up but not at an eight week check.

Kohlenberg, Phillips, and Proctor studied the effects of providing conservation information, feedback concerning electricity consumption, and monetary incentives on electrical peaking in the residences of three families [2]. Information alone did not alter peaking; and feedback, consisting of a light which came on during periods of excessive peaking, produced moderate changes in peaking. The greatest reduction in peaking occurred when monetary incentives accompanied feedback.

The use of feedback and social commendation to reduce fuel oil consumption was studied by Seaver and Patterson [3]. One hundred-eighty houses were randomly assigned to one of three conditions: feedback on rate of oil use, feedback and commendation for reduced consumption, or a no treatment control. The rate of oil consumption of the feedback and commendation group was significantly lower than the consumption rates of either the feedback group or the no treatment control group. The latter two groups did not significantly differ in oil consumption rate.

Hayes and Cone investigated the effects of information, feedback, and monetary payments on electricity consumption in four units of a university married-student housing complex [4]. As in the previous studies, monetary payments for reduced electricity consumption produced the largest reduction in consumption. Information and feedback were effective but not as much as the monetary payments. Various combinations of monetary payments and information on feedback resulted in reduced consumption rates no greater than for monetary payments alone.

## THE PROBLEM

The conservation procedures mentioned in the studies above involved only a few individuals occupying either single-family residences or a single unit in a multifamily complex. Frequent measurements of energy consumption and opportunities to improve and provide feedback for short consumption periods were available for individual units. In addition, incentives for reduced consumption were easily managed and effective because they were delivered to only a few individuals occupying a single residence. Furthermore, most of these residents received and paid individual utility bills; and thus were already receiving a minimal amount of feedback about energy consumption (receipt of bill), and also experiencing one of the consequences of energy consuming behavior (payment of bill).

The opportunities to monitor energy consumption of, and provide incentives to, persons occupying individual units is not always possible. Many industrial, institutional, and residential settings exist wherein the energy consumption of entire buildings or groups of buildings occupied by a large group of persons is monitored by a single device, such as one electrical meter (e.g., mass-metering). These settings are further characterized by a lack of direct billing or payment of utility bills by individuals occupying and using these settings. As such, these individuals do not experience even the minimal amount of feedback concerning consumption by receiving a utility bill; or directly experience the consequence of paying the bill.

Mass-metering is common in many residential settings, such as apartment complexes and dormitory buildings, and promoting energy conservation in these settings is difficult. To be sure, as the price of energy increases, the rental rates of units in mass-metered residential complexes will also increase. However, there is no guarantee that energy consumption will decrease as a result of rental rate increases. In fact, consumption may even increase for those residents determined to "get their money's worth" by maximizing the use of energy consuming comforts in their living environments (e.g., excessive use of air conditioners or hot water for showers). An alternative to rental rate increases is to change from mass-metered systems to individually metered systems. This alternative may be undesirable in existing complexes because of the high costs involved in converting to new systems. Moreover, no guarantee of energy conservation results from the change; in fact, the net effect may only be a shift in the costs of energy from management to individual residents. With no guarantee of energy conservation efforts resulting from rental rate increases or changes in metering and billing, other ways are needed to deal with the problem of energy consumption in mass-metered residential complexes.

## PURPOSE OF STUDY

In addition to utilizing those techniques based on physical technology (e.g., insulation, altered lighting patterns, etc.) to reduce energy consumption, managers of mass-metered complexes can employ energy conservation procedures which alter the energy consuming behavior of occupants living in the complex. Little information is available concerning efforts to modify the energy consuming behavior of residents in mass-metered residential settings. In one study, The Association of College and University Housing Officers surveyed its member institutions to gather information concerning existing energy conservation practices [5]. In addition to energy conservation guidelines and practices concerning physical alterations to university environments, the ACUHO report includes examples of ways to involve students in energy conservation. These include the preparation and dissemination of memorandums, cartoons, and slogans for the purposes of increasing student awareness of energy use and also to solicit their involvement in conserving energy. In addition, the report suggested the use of energy consumption feedback and contests providing incentives for students to reduce energy use. Some incentives used at a few universities included recreational equipment, special steak dinners, and rental rebates. The contests were apparently successful in reducing energy consumption of student residents. However, the exact effects of information dissemination, feedback, and incentive procedures on energy consumption and awareness is not clear from the report.

The present authors, in a controlled experiment, investigated the effects of conservation information and feedback on electricity consumption of students living in nine mass-metered university dormitories [6]. At the end of a baseline period, residents of three dormitories were mailed a flyer containing the average monthly cost of electricity to the university, ways to reduce electricity consumption, and a request for students to use less electricity. Residents of three other dorms were mailed an identical flyer and weekly feedback sheets containing the amount of electricity consumed in their dormitory, the per cent above or below baseline consumption, and the amount of increased cost or savings to the university. The three remaining dormitories served as controls for measurement of normal weekly fluctuations in electricity use due to variables such as weather, length of day, or vacancies during holiday periods. Per cent changes in electricity consumption from the mean consumption rate during the initial baseline for each dormitory revealed no significant differences among the dormitories during the experimental period and during a second baseline period. These results suggested that conservation information alone and information plus feedback are ineffective in modifying electricity consumption of residents in mass-metered dormitory complexes. These results, however, remain inconclusive until other methods of disseminating information and feedback are researched.

The previous study also suggested that a more potent stimulus is needed to encourage residents living in mass-metered dormitories to reduce electricity use. Based on the research conducted in single-metered residential settings, a monetary incentive was the logical stimulus of choice to be tested in mass-metered residential settings. The use of contest and raffle procedures for providing monetary incentives to residents of student dormitories was suggested by the ACUHO report and also by Geller, *et al.*, [7]. In the Geller, *et al.*, study, monetary incentives and prizes were provided in a contest and a raffle to encourage paper recycling in student dormitories, and were successful in increasing the amount of paper recycled.

The purpose of the present study was to experimentally investigate the effects of a monetary incentive for energy conservation on electricity consumption of students residing in mass-metered university dormitories. The objectives of the study were:

a. to reduce electricity consumption in the dormitories, and
b. to enhance student awareness of energy use in the dormitories.

Monetary incentives were provided via a contest, wherein reduced electricity consumption of a group of students was reinforced with group consequences; and a contest-raffle wherein reduced electricity consumption of a group of students was reinforced with individual consequences.

## Method

### SUBJECTS AND SETTINGS

The subjects were 1,567 undergraduate students of a large university residing in six dormitories during the summer academic term. The dormitories were located within close proximity of each other and situated in one area of the university. Table 1 details the characteristics of the subjects and setting. There were three men dorms and three women dorms. The dorms were similar in construction and room design but varied in the number of floors and number of rooms. In general, two students were assigned to one room. Each dormitory contained several "houses"; each house comprised of students residing in rooms on one or two floors of the dorm. Each house was considered a group or unit with a resident assistant as the group leader.

### METER READING

Most of the electricity consumed in the dorms was through the use of various items in each room (e.g., lights, fans, radio, etc.) and the use of group facilities (e.g., bathroom lights, hall lights, lounge televisions, etc.). The electricity consumption of each dorm was monitored by individual General Electric electrical meters located in the utility room of a main dining hall. The present investigators were experienced in reading electrical meters and read all the

Table 1. Description of Subjects and Settings

| *Treatment* | *Dorm #* | *Sex* | *# Floors* | *# Rooms* | *# Residents* | *# Houses* | *Average # residents per house* | *Mean consumption (KWH) per week (Baseline I)* |
|---|---|---|---|---|---|---|---|---|
| Contest | 1 | M | 6 | 120 | 211 | 3 | 70 | 5733 |
| | 2 | F | 7 | 145 | 245 | 4 | 61 | 6133 |
| Total | | | 13 | 265 | 456 | 7 | | |
| Contest- | 3 | M | 6 | 120 | 203 | 3 | 67 | 4766 |
| Raffle | 4 | F | 5 | 144 | 173 | 3 | 58 | 4900 |
| Total | | | 11 | 264 | 376 | 6 | | |
| Control | 5 | M | 8 | 273 | 503 | 8 | 63 | 11900 |
| | 6 | F | 7 | 144 | 232 | 5 | 47 | 6100 |
| Total | | | 15 | 417 | 735 | 13 | | |

meters throughout this study. After obtaining one reading to serve as an initial reading, the following procedure was used:

a. The six meters were read between 9:30-10:00 a.m. on Thursday of each of nine weeks.
b. Each investigator read the meters and recorded the reading independently.
c. Comparison of the readings was made and disagreements were noted.
d. For disagreements, each investigator re-read the meter simultaneously and mutually agreed on the correct reading.

There were a total of sixty readings (including the initial reading) and nine disagreements; thus, readings between investigators agreed 85 per cent of the time on the independent readings and 100 per cent after disagreements were corrected.

Electricity consumption per week was expressed in kilowatt hours (KWH). Total KWH per week consumed was determined by first substracting the meter reading for the previous week from the reading of the current week, and second, multiplying the difference by 100, the multiplier associated with each meter.

## BASELINE I

KWH consumed per week for each dorm was recorded for three weeks. The average of these readings provided a mean baseline electricity consumption rate. The dorms were paired as closely as possible using the mean baseline electricity consumption rate, the number of students residing in each dormitory, and the number of houses in each dormitory. Subsequently, the dorm-pairs were assigned to one of three treatment conditions: contest, contest-raffle, or control (see Table 1). Since dorms 5 and 6 were not optimally matched, they were assigned to the control treatment. By the flip of a coin, dorms 1 and 2 were assigned to the contest condition, and dorms 3 and 4 to the contest-raffle condition.

## TREATMENT CONDITIONS

*Contest*—On the day following the last baseline recording, residents of dorms 1 and 2 were sent a flyer via campus mail announcing that they were contestants in an energy conservation contest. The flyer also included the rules of the contest and information concerning ways to reduce electricity consumption. Table 2 shows the rules which specified the contest contingencies. Points

Table 2. Rules for Contest and Contest-Raffle

*Rules for Contest*

1. *To win,* you have to reduce the amount of electricity your dorm uses.
2. *Points* are awarded every week for reducing electricity consumption in your dorm. Your dorm will receive *one (1) point for every one per cent* (1%) reduction in electricity consumption.
3. A *"Contest Board"* will be located on the bulletin board on each floor of your dorm. It will indicate the per cent *reduction and number of points* earned for each week of the contest period. This information will be posted each Friday.
4. The dorm with the most points at the end of the contest will be the winner.
5. *Each house* in the winning dorm will receive *$30* to do with as it wishes.
6. The contest *begins July 9* and *ends August 6.*
7. The prizes will be awarded at the end of the contest. You will be notified about the time and place of the awards during the first week in August.
8. In the event of a *tie,* the winning dorm will be determined by a drawing.

*Rules for Contest-Raffle*

1-4. Same as for Contest.

5. *Each house* in the winning dorm will receive $30, which will be *raffled to one member* of the house. The names of the residents in each house will be placed in a container and a drawing will determine the individual winner.

6-8. Same as for Contest.

were awarded every week to each dormitory which reduced electricity consumption; one point for every one per cent reduction (Rule 2). Feedback concerning reduction in electricity use and number of points earned was provided via a "Contest Board" (Rule 3). The "Contest Board" was a yellow poster (15″ X 25″) which specified the per cent reduction in electricity use per week, the number of points earned per week and a cumulative point total at the end of each week for both dorms 1 and 2. In addition, the contest announcement flyer was attached to each Contest Board. The Contest Boards were placed on each floor of dorms 1 and 2 on or near the floor bulletin boards. The dormitory accumulating the most points at the end of the contest was the winner; each house in the winning dorm receiving $30 (Rules 4 and 5). The duration of the contest was four weeks (Rule 6).

The resident assistants in each dormitory received additional announcements and were telephoned at the beginning of the contest to ensure that they received the announcement and to ask for their cooperation during the contest (e.g., answering resident's questions, etc.).

*Contest-raffle*–On the day following the last baseline recording, residents of dorms 3 and 4 were sent a flyer via campus mail announcing that they were contestants in an energy conservation contest-raffle. The information contained on each announcement was identical to that for the contest except for Rule 5 (see Table 2). Each house in the winning dorm would receive $30 which was raffled to one member of the house. All other conditions in the contest-raffle were the same as in the contest.

*Control*–Dorms 5 and 6 served as control dorms for measurement of normal weekly fluctuations in electricity use due to variables such as weather, length of day, or vacancies during holiday periods.

### BASELINE II

Electricity consumption per week was recorded for an additional two weeks after the end of the contest and contest-raffle period. Baseline II was conducted to note any residual effects on electricity consumption following the treatment conditions.

### TELEPHONE INTERVIEWS

During the first week of Baseline II, all of the resident assistants in dorms 1-4 were interviewed by telephone to assess the general reactions of residents to the contest and contest-raffle.

## Results

### ELECTRICITY CONSUMPTION PER WEEK

Figure 1 represents the KWH per week consumed by each dormitory throughout the nine weeks of the study. The horizontal lines represent mean consumption for each dorm during Baseline I, Treatment, and Baseline II periods. During week 3 of Baseline I, electricity consumption was lower than that of weeks 1 and 2. Week 3 included the July 4th three-day weekend, during which many students left campus, therefore lowering consumption for all the dorms. Mean electricity consumption for dorms 1-4 during treatment was lower than mean consumption during Baseline I. The reductions in electricity consumption during the contest and contest-raffle were greater for the male dorms (dorms 2 and 3) than for the female dorms (dorms 2 and 4). (This sex-effect is explained with subsequent data from telephone interviews discussed later on.)

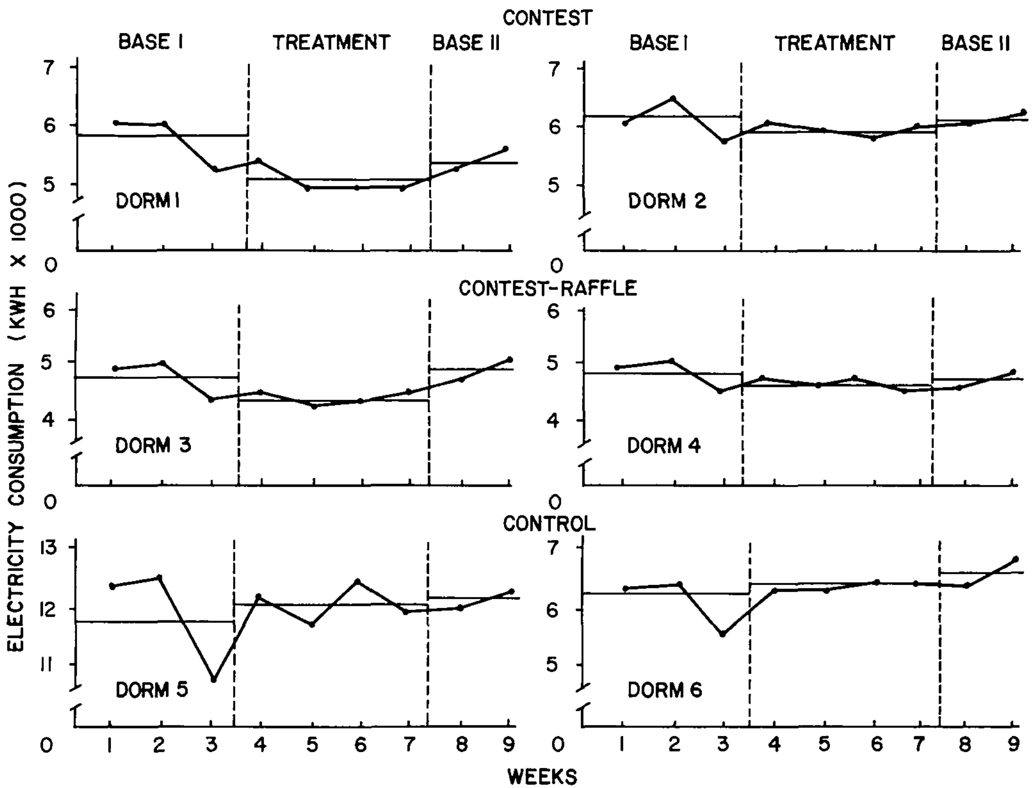


Figure 1. Electricity consumption (KWH) for each dorm during Baseline I, Treatment, and Baseline II periods. Solid horizontal lines represent mean consumption for each period. (Note: Week 3 included the three-day July 4th weekend wherein many residents were absent from the dorms.)

In the control condition (dorms 5 and 6), electricity consumption was at or above mean baseline consumption throughout the treatment period. During Baseline II mean electricity consumption approached the mean consumption of Baseline I for the contest and contest-raffle dorms. Mean electricity consumption of the control dorms remained above mean consumption of Baseline I.

## PER CENT CHANGES IN ELECTRICITY CONSUMPTION

In order to compare the effects of the treatment conditions, the electricity consumption rates in Figure 1 were transformed to per cent change scores. Table 3 shows the per cent changes from Baseline I in electricity consumption for each dorm during the treatment and Baseline II periods. These percentages were computed by the following formula: [Mean Consumption (Base I)—Weekly Consumption/Mean Consumption (Base I)] $\times$ 100.

Per cent changes during the treatment period for the contest and contest-raffle dorms were predominantly negative and indicate decreased electricity consumption. In the contest condition, per cent changes for dorm 1 ranged from -7.6 to -12.8 with a mean of -11.0; for dorm 2, the range was +1.1 to -3.6 with a mean of -1.3. In the contest-raffle condition, per cent changes for dorm 3 ranged from -5.6 to -9.8 with a mean of -7.2; for dorm 4, the range was 0.0 to -4.1 with a mean of -1.5. Reductions in electricity consumption for the female dorms (dorms 2 and 4) in each condition were similar. The only difference between the two conditions was for the male dorms; electricity consumption of dorm 1 of the contest condition was consistently lower than that of dorm 3 of the contest-raffle condition.

Per cent changes for the control dorms were predominantly positive and indicate increased consumption. Per cent changes for dorm 5 ranged from -0.8 to +5.0 with a mean of +1.9; for dorm 6, they ranged from +1.6 to +4.9 with a mean of +3.7.

During Baseline II, the per cent changes for most of the dorms were positive, and increased from week eight to week nine. However, dorm 1 level of consumption remained below that of Baseline I. Dorm 6 consumption increased sharply from week eight to week nine.

## NET PER CENT CHANGES IN ELECTRICITY CONSUMPTION

In order to compare the actual difference between normal electricity consumption level (controls) and consumption of dorms in the contest and contest-raffle conditions, per cent change scores

Table 3. Per cent Changes in Electricity Consumption From the Mean of Baseline I for Each Dorm During Treatment and Baseline II Periods

| | | *Treatment Period (weeks)* | | | | | *Baseline II (weeks)* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Dorm* | *4* | *5* | *6* | *7* | *Mean per cent change* | *8* | *9* | *Mean per cent change* |
| Contest | 1 | -7.6 | -12.8 | -12.8 | -11.0 | -11.0 | -7.6 | - 0.6 | -4.1 |
| | 2 | +1.1 | - 2.2 | - 3.6 | - 0.5 | - 1.3 | +1.1 | + 4.4 | +2.8 |
| Contest-Raffle | 3 | -5.6 | - 9.8 | - 7.7 | - 5.6 | - 7.2 | +0.7 | + 7.0 | +3.9 |
| | 4 | 0.0 | - 2.0 | 0.0 | - 4.1 | - 1.5 | -2.0 | + 2.0 | 0.0 |
| Control | 5 | +3.4 | - 0.8 | + 5.0 | 0.0 | + 1.9 | +0.8 | + 4.2 | +2.5 |
| | 6 | +1.6 | + 3.3 | + 4.9 | + 4.9 | + 3.7 | +4.9 | +13.1 | +9.0 |

were converted to net per cent change scores. Table 4 shows the net per cent changes from Baseline I for the contest and contest-raffle dorms. The per cent changes were averaged for the control dorms for each week during treatment and Baseline II. Net per cent change from Baseline I was then computed by the following formula: Weekly Per Cent Change (Treatment Dorm) –Weekly Per Cent Change (Controls).

Net per cent changes for dorms 1 through 4 in Table 4 are greater than the per cent changes shown in Table 3. These results occurred since normal consumption as represented by the control dorms consistently increased, while consumption in the contest and contest-raffle dorms decreased. The most important effect of this transformation of data was that net per cent changes continued to be negative for dorms 1-4 during Baseline II and indicates possible residual effects on electricity consumption due to the contest and contest-raffle conditions (i.e., conservation behaviors still occurred during Baseline II).

## NUMBER OF POINTS EARNED

Net per cent changes from Baseline I represented the actual reductions in electricity consumption and were used to compute the number of points earned per week by dorms 1 through 4. Points were computed after rounding the net per cent changes to the nearest whole number. Table 5 represents the number of points earned by dorms 1 through 4 during the treatment period. The winner of the contest, dorm 1, earned a total of fifty-six points; and the winner of the contest-raffle, dorm 3, earned a total of forty points. The points earned by the non-winners were seventeen for dorm 2 of the contest and eighteen for dorm 4 of the contest-raffle. The dorms in the contest condition consistently earned more weekly points than the dorms in the contest-raffle condition.

## INCENTIVE PAYMENTS AND SAVINGS

Total incentive payments amounted to $180. Each of the three houses in dorm 1, the winner of the contest, received $30 (total: $90) to spend as they wished. Each of the three houses in dorm 3, the winner of the contest-raffle, received $30 (total: $90) to raffle to one member of each house. Electricity consumption was estimated for dorms 1-4 had there been no treatments. It was assumed that consumption would follow the same trends as for the control dorms during the Treatment and Baseline II periods. The difference between estimated consumption and actual consumption

Table 4. Net Per cent Changes in Electricity Consumption From the Mean of Baseline I for Each Dorm in the Contest and Contest-Raffle During Treatment and Baseline II Periods

| | | *Treatment Period (weeks)* | | | | | *Baseline II (weeks)* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *Dorm* | *4* | *5* | *6* | *7* | *Mean per cent change* | *8* | *9* | *Mean per cent change* |
| Contest | 1 | -10.1 | -14.1 | -17.8 | -13.5 | -13.9 | -10.5 | -9.3 | -9.9 |
| | 2 | - 1.4 | - 3.5 | - 8.6 | - 3.0 | - 4.1 | - 1.8 | -4.3 | -3.1 |
| Contest- | 3 | - 8.1 | -11.0 | -12.7 | - 8.1 | -10.0 | - 2.2 | -1.7 | -2.0 |
| Raffle | 4 | - 2.5 | - 3.3 | - 5.0 | - 6.6 | - 4.4 | - 4.9 | -6.7 | -5.8 |

Table 5. Number of Points Earned by Each Dorm During the Contest and Contest-Raffle

| | *Contest* | | | *Contest-Raffle* | | |
|---|---|---|---|---|---|---|
| | *# Points earned* | | | *# Points earned* | | |
| *Weeks* | *Dorm 1* | *Dorm 2* | *Cumulative Total (Dorms 1 & 2)* | *Dorm 3* | *Dorm 4* | *Cumulative Total (Dorms 3 & 4)* |
| 4 | 10 | 1 | 11 | 8 | 3 | 11 |
| 5 | 14 | 4 | 29 | 11 | 3 | 25 |
| 6 | 18 | 9 | 56 | 13 | 5 | 43 |
| 7 | 14 | 3 | 73 | 8 | 7 | 58 |
| Total | 56 | 17 | | 40 | 18 | |

yielded a savings of 9,227 KWH. At the current rate of 1.62 cents per KWH, a savings of $149.48 was realized.

## TELEPHONE INTERVIEWS

During Baseline II the resident assistants of each house in the contest and contest-raffle dorms were interviewed by telephone to assess reactions to the contest and contest-raffle. The resident assistants, as the leader in each house, have frequent contact with house residents and their responses to questions were considered to represent a group response. The following summarizes responses of the resident assistants to questions in five areas:

*Promotion*—General discussion and promotion of the contest and contest-raffle by the resident assistants in all the dorms was through casual contact with individual house residents. Only three of the resident assistants had formal house meetings to discuss the contest or contest-raffle.

*Conservation procedures*—In general, conservation procedures in all dorms consisted of turning off lights in common areas (halls, study room, bathroom, etc.), individual efforts to cut down use of items in the rooms (fans, stereos, lights, etc.), and efforts to remind each other to reduce electricity use by turning lights off. Hall lights remained out for the winning dorms throughout the contest and contest-raffle. For the non-winning dorms, hall lights remained on most of the time.

*General interest*—Everyone in the winning dorms were interested and enthusiastic throughout the contest period. The non-winners were interested and enthusiastic at the beginning but interest dissipated during the middle and end of the contest and contest-raffle. Common responses were that the other dorm jumped out to such a large lead that it was impossible to catch them, and there was no hope of winning after the first week.

*Positive and negative effects*—The positive effects of the contest and contest-raffle were that residents became highly aware of electricity consumption in the dorms and that conservation of energy is possible. They thought the contest and contest-raffle were good ideas for energy conservation. Some resident assistants reported increased "unity" among house members since the contest and contest-raffle provided subject for common discussion in the house. In the winning dorms (male) there were no negative effects or complaints reported. The non-winning dorms (female) were concerned about threats to safety and security if hall and bathroom lights were turned off; however, no incidents were reported. The female dorms also complained about being "unfairly" matched with male dorms. They stated that women use more grooming devices than men and that the men were capable of altering electrical systems. However, no incidents of tampering with electrical systems were reported.

*Ratings*—The announcement flyer was rated as informative; however the dissemination through the mail was generally considered inadequate based on past resident experiences with announcements in the mail. The "Contest Board, which provided weekly feedback to residents, was considered very informative; and on several occasions, resident assistants thought it was an essential key to success in the contest and contest-raffle. Everyone was pleased with the monetary incentive; however, preference was expressed for each house receiving the award rather than only one individual in a house, as in the contest-raffle.

## Discussion

The results indicate that monetary incentives delivered via a contest and contest-raffle were effective in a) reducing electricity consumption in mass-metered dormitories, and b) enhancing student awareness of energy use and conservation in the dormitories. These results are consistent with reinforcement principles in that the probability of reductions in electricity use was highest when money (a positive reinforcer) was contingent upon reductions in electricity use. No reductions in electricity use was realized when money was not available (e.g., control dorms). In addition, the magnitudes of reductions in electricity use found in this study are comparable to those reported in the ACUHO report.

The initiation and maintenance of reduced electricity consumption was related to the dissemination of information and response feedback. Instructions and/or information concerning reinforcement contingencies is recognized as a key factor in initially prompting specific behaviors, especially in large-scale community settings [8]. In this study, reinforcement contingencies were announced via flyers sent to individual rooms and also flyers attached to the "Contest Board." Responses from the telephone interviews suggested that information dissemination was more effective when posted on the Contest Board than when sent to rooms through the campus mail. Information dissemination was also enhanced by residents assistants' informing residents and answering questions regarding the procedure of the contest and contest-raffle. The procedures used here were for purposes of experimental control; however, other procedures, such as newspaper advertisements, can be used to reach groups of larger sizes when larger energy conservation programs are implemented.

Response feedback was important in maintaining reduced electricity consumption throughout the contest and contest-raffle procedures. Earned points paired with receipt of reinforcers are frequently used to maintain behavior over long periods of time. Earned points serve as an economical and efficient means of providing feedback concerning the state and direction of one's behavior. In addition, the use of points avoids the unwieldly administration of reinforcers in programs which operate over long time durations. The feedback procedure in this study was considered by the resident assistants to be a key factor in informing residents of their progress in reducing electricity use, and generating enthusiasm throughout the contest (at least for the winning dorms).

A question of individual versus group reinforcement arises in relation to the differences in reduced electricity consumption between the contest and contest-raffle procedures. It was initially predicted, based on reinforcement principles, that the contest-raffle procedures would produce greater reductions in electricity consumption than would the contest; since in the contest-raffle, monetary awards were given to one individual per house rather than the house itself. Although the opposite effect occurred, subsequent information from the telephone interview revealed that awards to each house were preferred to individual awards. Furthermore, the resident assistants stated that awards to the house were more motivating than individual awards in that more individuals could share in the awards. In other words, even though an award was given to a group, the probability of individual reinforcement for energy conservation behaviors was higher in the contest than in the contest-raffle procedure.

Some problems related to the "fairness" and "competition" in the contest and contest-raffle deserve mentioning because they directly affected the results of the study. Optimal pairing of dorms for the contest and contest-raffle was difficult since only a few dorms were occupied during the summer term. The resulting male-female dorm pairings, although "fairly" paired based on consumption rates, were perceived by residents of female dorms as "unfair." The females thought they were "beaten from the start" due to the males' ability to alter electrical systems in the dorm, the "fact" that females naturally used more electricity due to hair dryers, etc., and that males need not worry about safety and security as much as females. No reports of tampering with electrical systems were noted, and men do use appliances such as hair dryers, etc. However, threats to safety and security for females do conform to reality in relation to increased incidents of assault and rape in recent years; fortunately, there were no reports of threats to safety and security in the dorms. As such, the males were more willing to turn out hall lights than the females; and therefore, did have a distinct advantage over the females. These effects of competition and perceived "fairness" can be controlled by variations in incentive programs, such as arranging contingencies where individual dorms acquire incentives for individual dorm efforts rather than competing with other dorms.

The energy conservation package of this study, consisting of information, feedback, and monetary incentives, was effective in reducing electricity consumption of residents living in mass-metered dormitory complexes. The task now is to refine and develop energy conservation packages for economical and efficient operation in mass-metered settings. Even though this study was not directly concerned with cost-effectiveness, the incentive payments ($180) were almost totally recovered by the dollar savings from reduced consumption ($149.48). The dollar savings may exceed incentive payments if a dollar value is assigned to the benefits of increased awareness about energy problems and conservation. The energy and cost savings in this study could have increased by increasing the duration of the contest and contest-raffle or by including more dorms. The objective, then, is to efficiently generate maximum energy conservation behavior for the minimum amount of reinforcement. Future energy conservation packages need not be in the form of contests or raffles, but should conform to principles of reinforcement. Information and feedback could be provided through communication devices such as newspapers or radios, or through technological devices, such as in-house meters. A variety of incentives could be used which include rental rebates, recreational equipment, special services, or a share in the money saved through conservation efforts. To maximize awareness of energy problems and energy conservation, the users of mass-metered complexes could become directly involved in operating and managing energy conservation programs. The cooperation received by the resident assistants participating in the contest and contest-raffle suggests that user participation in energy conservation procedures is a viable option.

In conclusion, energy conservation programs should incorporate behavioral technology in addition to physical technology in order to generate maximum reductions in energy consumption. The combination of physical and behavioral interventions is essential to move mass-metered environments from states of energy inefficiency toward states of energy efficiency.

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