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PROMOTING ENERGY CONSERVATION IN UNIVERSITY DORMITORIES BY PHYSICAL, POLICY AND RESIDENT BEHAVIOR CHANGES*

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ABSTRACT

Two successive energy conservation programs were implemented in four University of Colorado dormitories. Program I included persuasive communications, information, feedback, and group meetings. Program II included in addition a monetary incentive for conservation. The first program reduced electricity consumption to 84 per cent of baseline; the second, to 90 per cent of the *revised* (i.e., lowered) baseline. Consumption did not rise to baseline levels following either program. Interviews with dormitory students and staff suggest that both everyday resident actions (e.g., turning off lights) and physical-policy changes (light bulb removal, closure of unused rooms) were important in reducing consumption. Reasons for the behavioral and physical-policy changes and implications for conservation programs and conservation research are discussed.

Colleges, universities, and other educational institutions use large amounts of energy: the Educational Facilities Laboratories estimate energy costs in the 1977-78 academic year at $200 per student [1]. Although much of this energy use is amenable to reduction by technological modifications to heating, cooling, air circulation, and lighting systems, energy use under direct control of building residents is often more difficult to reduce.

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Dormitories are a particularly likely target for energy conservation programs. They are used intensively by their residents, and unlike most campus buildings are occupied twenty-four hours daily. The high resident turnover from year to year makes ongoing conservation programs more feasible than in buildings housing stable faculty-staff populations. Finally, dormitory residents often have an enthusiasm for conservation and a group spirit not found among older faculty and staff.

Dormitory energy conservation programs at other institutions (e.g., at Stanford [2], Dartmouth [3], Oklahoma State [4]) have typically included both permanent physical changes (e.g., to lighting systems) and publicity and competitions to increase conservation awareness by residents. Unfortunately, their effects have not been evaluated rigorously. An exception is a contest among four Pennsylvania State dormitories [5] in which electricity consumption in the four-week test period averaged 86 to 96 per cent of baseline levels.

This paper describes two successive electricity conservation programs implemented in four University of Colorado dormitories. The first, conducted between February and May 1977, included persuasive communications, group meetings, feedback on energy use, and conservation information. The second, mid-October to December 1977, included in addition a monetary incentive for conservation. Both programs reduced electricity consumption, which was monitored weekly before, during, between, and after the programs from September 1976 to May 1978. The types of resident and staff actions which led to the electricity savings are also discussed.

SETTING AND BACKGROUND

The Kittredge Residence Complex is a group of four dormitories, plus a commons building with cafeteria, set at a corner of the University of Colorado campus. The four dormitories, completed in 1963, are three and four story brick structures with tile roofs. Two-person rooms of various shapes and sizes are arrayed along outside walls; baths, laundry rooms, storage and stairwells are located in interior cores. Each dormitory houses about 250 students of all classes. In the 1976-77 school year two housed males, two females; in 1977-78 two housed both sexes and two one sex. The conservation programs were implemented in Kittredge jointly by administrative staff and an elected student government board, with direction and advice from Institute of Behavioral Science staff.

Two additional dormitories on campus, Libby and Nichols, were monitored from January 1977 (when their electric meters were installed) to May 1978. These each house about 420 male and female students; they are four stories, brick, traditionally styled with long wings of identical rooms. Only the first conservation program was implemented in these dormitories; they served as controls during the second program.

In both sets of dormitories electricity is used primarily for lighting and appliances. In Kittredge, air circulation equipment (for heat only; there is no air conditioning) is also electric; because more heated air is circulated in colder weather, more electricity is used then. In Libby and Nichols there is no electrical air circulation equipment, but power for the cafeteria kitchens is provided through the dormitory meters.

Although there are some differences in electricity consumption among the four dormitories in the Kittredge complex and between Libby and Nichols, the differences are minor and transitory. They are probably functions of differing initial energy waste levels and of random variations in activities, rather than indicative of basic differences in patterns of energy use. Consumption data have therefore been combined across the four Kittredge buildings and for Libby and Nichols; only the combined data are presented below. Because the number of residents in each building declines slightly over the academic year, all consumption data are presented as kwh (kilowatt-hours) per occupant per day.

Electricity consumption was monitored for fourteen weeks preceding the first conservation program in Kittredge, for three weeks in Libby and Nichols (there were no meters prior). These data were used to estimate the relationship between weekly consumption and weather in Kittredge. Of many weather measures tried, the best is percentage of days over 70°F. (21°C.). The regression equation relating consumption and weather is kwh/occupant/day = 4.57 - .58 (per cent $> 70°$), where percentage over 70° ranges from 0 to 99 (R^2 = .80, df = 12, standard deviation of the residuals as a per cent of the mean = 1.9%). All consumption data presented below for Kittredge have been "corrected" by the above equation to a basis of no days over 70° so that data from warm and cold weather periods can be compared directly. Although a similar correction equation could not be derived for Libby and Nichols because only three baseline weeks were available, the differing (non-electrical) nature of heat distribution in those buildings made the necessity of such correction unlikely. This supposition was supported by examination of data collected later.

PROGRAM ONE

The first conservation program began in early February 1977, about four weeks into the spring semester. Although the programs varied slightly across the six dormitories, all involved:

1. an appeal for conservation from the Chancellor and from dormitory administration;
2. information on how to save electricity (tailored for dormitories);
3. reminder posters and light switch labels;
4. discussions at floor meetings required of all residents; and
5. monthly letters to residents reporting how actual electricity consumption compared with expected levels.

Student government representatives from many floors and wings also held group or individual discussions with residents about opportunities for conservation.

During ten weeks of the program, electricity consumption per occupant per day (corrected for weather in Kittredge) dropped to 84.2 per cent of baseline levels in Kittredge (4.57 to 3.85, $F(1,23) = 384.43$, $p < .001$) and to 87.8 per cent of baseline in Libby and Nichols (4.19 to 3.68, $F(1,12) = 74.08$, $p < .001$). Total savings over the ten weeks were almost 50,000 kwh worth $985 (at then-current cost of 2¢/kwh) in Kittredge, 29,000 kwh worth $580 in Libby and Nichols. Consumption levels for the entire two year period are shown in Figure 1. Interviews were conducted with dormitory staff and with student government representatives at the end of the term to ascertain what changes led to the reduction; these are discussed after all consumption data have been presented.

Monitoring of consumption was resumed in early September 1977, at the beginning of the fall semester. There was no active conservation program in either Kittredge or Libby-Nichols during the first half of the semester. In this period consumption remained at program levels in Kittredge (3.81 in fall 1977 vs. 3.85 the previous spring; $F(1,14) = .85$, $p > .35$) and rose slightly in Libby-Nichols (3.78 vs. 3.68, $F(1,14) = 2.06$, $p = .15$). Resident turnover in each dormitory between spring and fall terms was over 50 per cent.

PROGRAM TWO

When the results of the first program were presented to dormitory administrators in early fall 1977, the Kittredge staff expressed interest in continuing their conservation efforts. They were especially interested in obtaining some portion of the financial savings resulting from conservation for use in the dormitory complex. Institute of Behavioral Science staff agreed to continue monitoring consumption and to help with the design of an appropriate program incorporating a financial incentive.[1] Details of the program's design as well as all publicity and implementation were the responsibility of the student government board.

The program finally decided upon by the board was an "energy challenge": in each of three two-week periods between October 17 and December 5 (Thanksgiving week excluded) a monetary prize of $85-335 was offered. The amount earned depended upon per-resident electricity consumption (corrected for weather) as follows:

average kwh/occupant/day:	3.41-3.60	3.21-3.40	3.20 or below
prize for two weeks:	$85	$215	$335

[1] Money for the incentive came from a grant to the Institute of Behavioral Science from the Fleischmann Foundation. Without the Foundation's help the program would not have been possible.

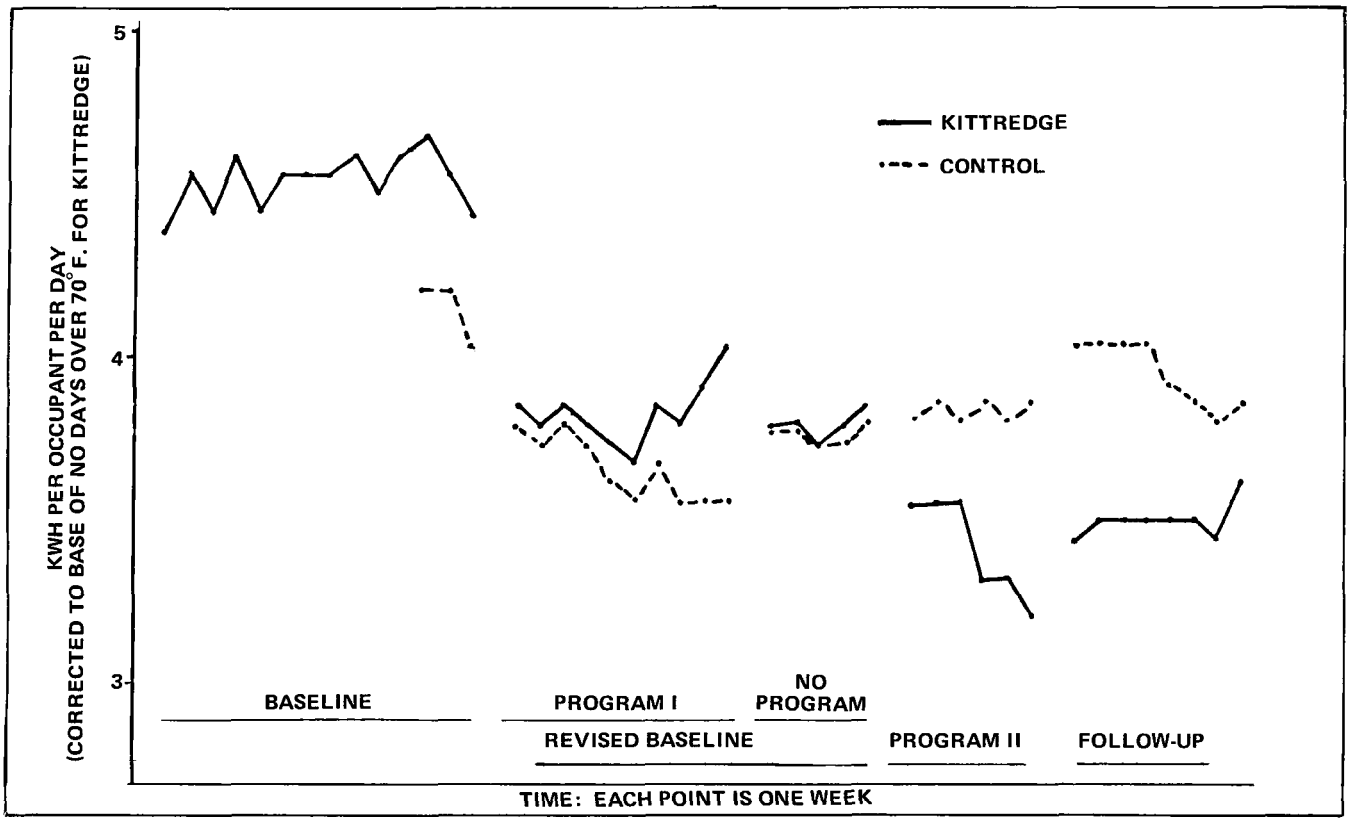

Figure 1. Electricity consumption for Kittredge and control dorms, September 1976-May 1978. (Academic holiday weeks deleted)

The cutoff levels of 3.6, 3.4, and 3.2 kwh/resident/day represent savings of 6.2, 11.4, and 16.6 per cent from the revised baseline (spring and early fall 1977). In each successive two-week period consumption had to be at least as low as in the prior period for an award to be made.

The challenge program was publicized by a letter to each resident, discussions in floor meetings, articles in the weekly dormitory newsletter, a large (1.5 x 3m) plot of weekly consumption in the mail room, and a poster in the dining room soliciting ideas for disposition of award monies. Awards were made to the student government board in the name of all residents; the board determined their final disposition.

Average consumption levels for the three two-week periods were 3.57, 3.44, and 3.28, allowing a total award of $385 (two prizes of $85 and one of $215). The overall average of 3.44 kwh/resident/day is 89.6 per cent of the revised baseline level of 3.84 ($F(1,20) = 38.78$, $p < .001$). Total savings for Kittredge in the six weeks (compared to the revised baseline) were about 17,000 kwh worth $350. By contrast, in Libby and Nichols, now control dormitories, consumption in the challenge period was 3.8 per cent higher than in the revised baseline (3.83 vs. 3.69, $F(1,20) = 4.57$, $p < .05$).[2]

The challenge program ended December 5, 1977, with awarding of the last prize. Monitoring of consumption continued throughout eight weeks of the spring term. During this period consumption in Kittredge remained very close to challenge-period levels while that in the controls rose significantly: Kittredge 3.50 vs. 3.44 ($F(1,13) = .95$, $p = .4$), controls 3.96 vs. 3.83 ($F(1,13) = 6.97$, $p < .02$). See Figure 1 for a plot of all consumption results.

Early in spring term 1978, thirty-five randomly-selected Kittredge residents were interviewed by telephone about their knowledge of and involvement in the challenge program. All but five of the thirty-five were aware that there had been such a program; twenty-three of these thirty reported that they had become involved in it, mostly by turning off lights in their rooms. All but two of the thirty who knew that there had been a program also knew that it had included monetary prizes for conservation. However, knowledge of how much money had been available and how much had been earned was minimal: only three residents answered both questions correctly (that is, within $100 of the correct response), and twenty of twenty-eight would not even guess at one or both figures. Despite this lack of information, comments about the program were almost uniformly positive, pointing to its effectiveness in increasing awareness of and involvement in energy conservation.

[2] An analysis of covariance with the control dormitories as covariate (the usual method of analysis) was not performed because (weather-corrected) consumption in Kittredge and in the controls during the revised baseline period are not significantly related ($r = -.18$, $p > .5$).

DISCUSSION

The results on electricity consumption presented above speak to the success of the two energy conservation programs. Why and how the reductions in consumption were achieved cannot be determined from these results but must be inferred from the interviews with staff and students at the end of the first program, the survey of Kittredge residents following the challenge program, systematic observations of energy waste made during the first year, and the nature of the ongoing contacts between dormitory staff and the Institute of Behavioral Science. All sources suggest that two somewhat independent types of changes – physical-policy changes and changes in the everyday activities of residents – contributed to the reductions in consumption. As is discussed below, the two types of changes differ not only in the nature of their effects but also in their causes.

Physical-Policy Changes

Dormitory staff implemented a number of physical changes (e.g., removal of alternate light bulbs in hallways; reduction of wattage in lounge areas) and policy changes designed to conserve energy. Examples of policy changes include directing security personnel to turn out bathroom lights on their 2 a.m. rounds and locking underused study areas to concentrate use in other locations. Many such changes were reported by dormitory staff, even during the challenge program when opportunities were fewer because most obvious changes had already been made. Physical and policy changes are by their nature long-lasting, continuing in effect with little maintenance from those who implement them. That this type of change contributed substantially to the energy savings that occurred is indicated by the maintenance of reduced levels of electricity consumption following both the first and second conservation programs. In particular, the high level of resident turnover in Kittredge and the controls between the end of the first program and the following fall makes physical and policy changes (rather than changes in everyday resident behavior) implemented during the program the probable primary contributor to the reduced consumption levels observed in both these periods.

Interviews with dormitory staff and weekly contacts during the programs point to three factors prompting the physical and policy changes. First, directives to the staff from the university's central dormitory administration emphasized that physical modifications conserving energy could and should be made. Second, residents made many suggestions for changes to the staff; some of these resulted from discussions about conservation opportunities held in floor meetings. Third, the availability of the monetary prizes in the challenge program clearly motivated high-level staff and student government officials to search systematically and carefully for opportunities for change. Both staff and student officials showed much more interest in and attention to the challenge

program and associated conservation efforts than to the first conservation program.

Changes in Resident Actions

A substantial amount of electricity use in dormitories cannot be reduced by physical and policy changes. Changes in the everyday behaviors of individual residents —turning off room lights and equipment when not in use, keeping windows closed in cold weather, turning off bathroom lights when the room will be empty – must occur if this portion of use is to be reduced. Such changes are not usually enduring, lasting only as long as individual residents remember and care to carry them out.

Changes in resident behaviors were indicated in two ways. First, the residents interviewed said that they and others changed; this is weak evidence indeed. Second, systematic observations of lighting waste controlled directly by residents (lights on in empty baths, laundry rooms, and lounges) were made four times weekly during the first year in each dormitory. These observations show substantial and significant drops in lighting waste in all dormitories from the baseline to initial program periods. For example, the percentage of empty lounges observed with lights on in Kittredge fell from 34.8 in the baseline to 12.6 during the program ($\chi^2(1) = 49.89$, $p < .001$).

Interviews with residents and their comments on the survey following the challenge programs indicate three factors promoting energy-conserving actions by residents. First, a general atmosphere of concern about energy waste was created by memos from administration and student government and by discussions in floor meetings. Second, the group meetings and the awareness of a common goal suggested to residents that certain energy-saving actions were socially acceptable and even desirable. A prime example is leaving a (windowless) bathroom dark for the next user. Finally, information about the importance of every resident's contribution to overall savings and information about exactly how to save also promoted change. Many residents did not know prior to the programs that it is always most efficient to turn off an unused fluorescent light no matter how short a time it will be off; this information led directly to behavior changes by some residents.

Whether or not the monetary incentives for conservation in the challenge program motivated changes in resident behavior is difficult to determine. Only one resident surveyed mentioned the money as important, and one commented that the program would have been better without the prizes. The low level of knowledge about the magnitude of the monies available and earned indicates that the size of the awards was probably not a factor in promoting changes in resident activities. Furthermore, there is no relationship between knowledge of how much money was available and (self-reported) involvement in the program. Of the twenty-three residents who reported involvement, five knew that $1000

could be earned in six weeks; of the seven residents who reported no involvement (but did know there was a program), two knew ($\chi^2(1) = .02$).

CONCLUSIONS

The work reported here represents the first time that separate successive conservation programs in the same institutional setting have been evaluated. Of the results discussed above, four seem of special significance.

1. Electricity consumption did not return to baseline levels following termination of the programs, and the second program produced almost as great a reduction in energy use as did the first. (Consumption in Kittredge was 89.6 per cent of the revised baseline during the challenge, 84.2 per cent of baseline during the first program.) Thus in institutions short-term programs repeated at periodic intervals may be as effective (or even more effective) as continuous programs. Whether this is true in institutional settings without high occupant turnover remains to be tested.
2. The effect of the monetary incentives offered through the challenge program was not as anticipated. Whereas the program was intended to interest and motivate residents, staff and student officials seemed most affected by the promise of prizes for conservation. Of course, the indirect effect on residents of the interest and involvement by staff cannot be calculated.
3. Institutional settings can probably achieve as large or larger reductions in energy consumption through physical and policy changes as through changes in the everyday actions of occupants. Conservation programs should therefore be aimed at least in part at encouraging the identification and follow-up of opportunities for physical and policy changes. This does not mean that occupants play an unimportant role, for it is they who are often most creative at identifying such opportunities. In addition, changes suggested by occupants are more likely to be accepted by them.
4. There is more than one way to save a kilowatt. A light bulb can be removed, turned out by someone appointed to do so, or turned out by the last one to leave the room, all with more or less the same effect. Whereas this is certainly true in institutional settings, it is generally true of residential settings also, where physical modifications and mechanical "policy-implementing devices" (e.g., automatic set-back thermostats) play a large role in conservation. Research on conservation programs must determine the mechanisms through which any energy consumption reductions occur as well as their size and statistical significance; this is essential for predicting a given program's effectiveness in new settings. As the U.S. energy crisis worsens, more and more settings will have already made obvious physical and policy changes, and knowledge of precisely

how various conservation methods act to reduce consumption will become more critical.

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