

AN EXPERIMENTAL ANALYSIS OF ELECTRICITY  
CONSERVATION PROCEDURES

An abstract of a Thesis by  
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The problem. To determine if behavioral procedures would be effective in lowering overall daily electricity consumption with residential consumers.

Procedure. Electricity meters were read each night for 106 days at the homes of four experimental families. Each family experienced one or more of the following conditions. Feedback: Daily reports of electricity consumption were provided to experimental families. Monetary feedback: As well as daily reports of electricity consumption, projected monthly electricity bills were provided daily. Daily prompts: A card prompting electricity conservation was provided each day. Prompts and feedback: Both feedback and prompts were provided simultaneously. Government prompt: A personal letter from the Director of the Iowa Office of Energy was sent to the experimental families urging a reduction in electricity consumption.

Findings. Either prompting or feedback techniques were effective in lowering total daily electricity consumption in three of four suburban families.

Conclusions. Additional research is necessary to assess the relative effectiveness of various prompting and feedback techniques.

Recommendations. Behavioral research should be used as a resource in energy conservation programs.

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Presented to  
The School of Graduate Studies  
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by  
Michael H. Palmer  
May 1975

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## Chapter 1

### INTRODUCTION

Environmental problems have been the subject of recent behavioral analyses, e.g. littering (Burgess, Clark & Hendee, 1971; Kohlenberg & Philips, 1973), bus riding (Everett, Hayward & Meyers, 1974), destructive lawn walking (Hayes & Cone, 1974), and using returnable bottles (Geller, Farris & Post, 1973). The energy shortage is an environmental problem which has recently become critical. The electrical energy shortage is a result of both the limited capacity of electrical plants to meet daily peaks in electricity consumption and the limited supply of primary energy sources from which electricity is manufactured.

Behavioral procedures have been successfully used to delay the use of some electrical appliances until non-peak times of the day (Kohlenberg, Philips & Proctor, 1974). With decreased peaking, more electrical demands can be met without increasing plant capacity. To conserve primary energy sources, however, overall electrical reduction is necessary. The present study is an experimental analysis of procedures designed to reduce total daily electricity consumption of residential consumers.

## Chapter 2

### METHOD

#### Subjects

Four families living in a suburb of Des Moines, Iowa were selected from 253 families who were identified by the utility company as having outdoor gas, water, and electric meters. Of these, every tenth family was identified as a potential subject family. Thirteen of these families were excluded because they used electric heat, or because they did not have school age children. The remaining 12 families were notified by letter that they might be invited to participate in an energy conservation program. The first four families which were subsequently contacted accepted the invitation and became the experimental families. Each family included two adults and at least two school age children enrolled in a public school at either the elementary or secondary level. Families 1 and 3 had college aged children who were home at various times during the experiment.

#### Pre-experimental Instructions

Families were told that their outside gas, water, and electric meters would be monitored on a daily basis, and that messages would occasionally be taped to the inside of their storm doors. An adult in each family was asked to make sure

that all members of the family read and initialed the messages on the day they were received. In addition, they were requested to save the messages in a 3-by-5 index card file which was provided for that purpose.

### Procedure

Data were collected from February 2, 1974 through May 19, 1974 for a total of 106 days. Meters were read at each home between 10:00 p.m. and 10:30 p.m. each night. Electric meters were read to the nearest half-kilowatt hour. The units dial of the meter was read as a whole number only when the hand of the dial covered any part of a number. When the white background of the meter could be perceived between the hand of the units dial and the last number which the hand passed, a half-kilowatt hour was recorded. The difference between each night's reading and the preceding night's reading defined the electricity consumption for that day.

### Reliability

Once each week, a second observer read the electric meters independently of but at the same time as the first observer. In all cases agreement was 100%.

### Baselines

During baseline conditions, daily measures of electricity consumption were taken for each family.



### Experimental Conditions

Feedback condition. Each night, a card showing the consumption of electricity for that day compared to the mean daily consumption for the previous baseline period was taped to the inside of the front storm door of the families' home. The difference in kilowatt hours was also indicated.

Monetary feedback condition. In addition to the information provided in the feedback condition, the expected monthly bill projected from the mean baseline consumption (calculated by multiplying the mean baseline consumption by 30 and determining the monthly cost from the power company's rate table) was compared with the expected monthly bill projected from that day's consumption (calculated by multiplying that day's consumption by 30 and determining cost as above). The difference between the two projections was identified as the amount of money that would be saved or wasted if that day's consumption were maintained for 30 days.

Daily prompt condition. Each night, one of a series of 8 typewritten prompts (see Appendix C) was taped to the inside of the storm doors.

Prompt plus feedback condition. Each night, one of the prompts from the prompt series was typed on the back of the feedback card.

Government prompt condition. A personal letter was mailed to the families from the Director of the Iowa Office of Energy. The letter discussed the instability of

electricity supplies and included a plea for a 20% reduction of electricity consumption. Although the letter was sent only once, this condition was assumed to be in effect from the day that the letter was received until the onset of the next condition.

## Chapter 3

### RESULTS

Figures 1 and 2 show each family's daily electricity consumption during each condition and the median consumption for the last ten days of each condition. Medians were calculated for the entire condition when conditions lasted less than ten days. Figure abscissas were plotted in seven day units indicating Sundays of consecutive weeks.

Family 1: During the last ten days of the initial baseline condition, median consumption was 29 KWH per day. After the introduction of monetary feedback, consumption was reduced to 23 KWH per day. Although consumption did not return to its original level during the second baseline condition, when monetary feedback was reintroduced, the median decreased further to 14 KWH and the daily consumption pattern became less variable than in any of the preceding conditions. When monetary feedback was no longer available, consumption increased to 18 KWH per day and variability increased.

Family 2: The daily consumption pattern of family 2 was extremely variable throughout all conditions. Family 2 consumed approximately 33 KWH per day during the initial baseline condition. Consumption decreased to 29 KWH per day when the monetary feedback condition was introduced and returned to its original level when monetary feedback was

subsequently withdrawn. When government and daily prompts were introduced, consumption decreased again to 27 KWH. Consumption increased to 34 KWH per day when prompts were discontinued. Day to day variability did not decrease as it had with Family 1.

Family 3: Family 3 consumed approximately 22 KWH of electricity per day during baseline. After the government prompt, consumption decreased to 18 KWH and remained at approximately that level when daily prompts were added. Consumption decreased further to 14 KWH per day with prompts and feedback; increased to 19 KWH per day when these were no longer available; and decreased again to 14 KWH per day when prompts and feedback were reintroduced.

Family 4: During the last ten days of baseline, Family 4 consumed approximately 29 KWH of electricity per day. Consumption decreased after the government prompt, during the daily prompts, and the second baseline condition. Consumption did not change appreciably when feedback was introduced.

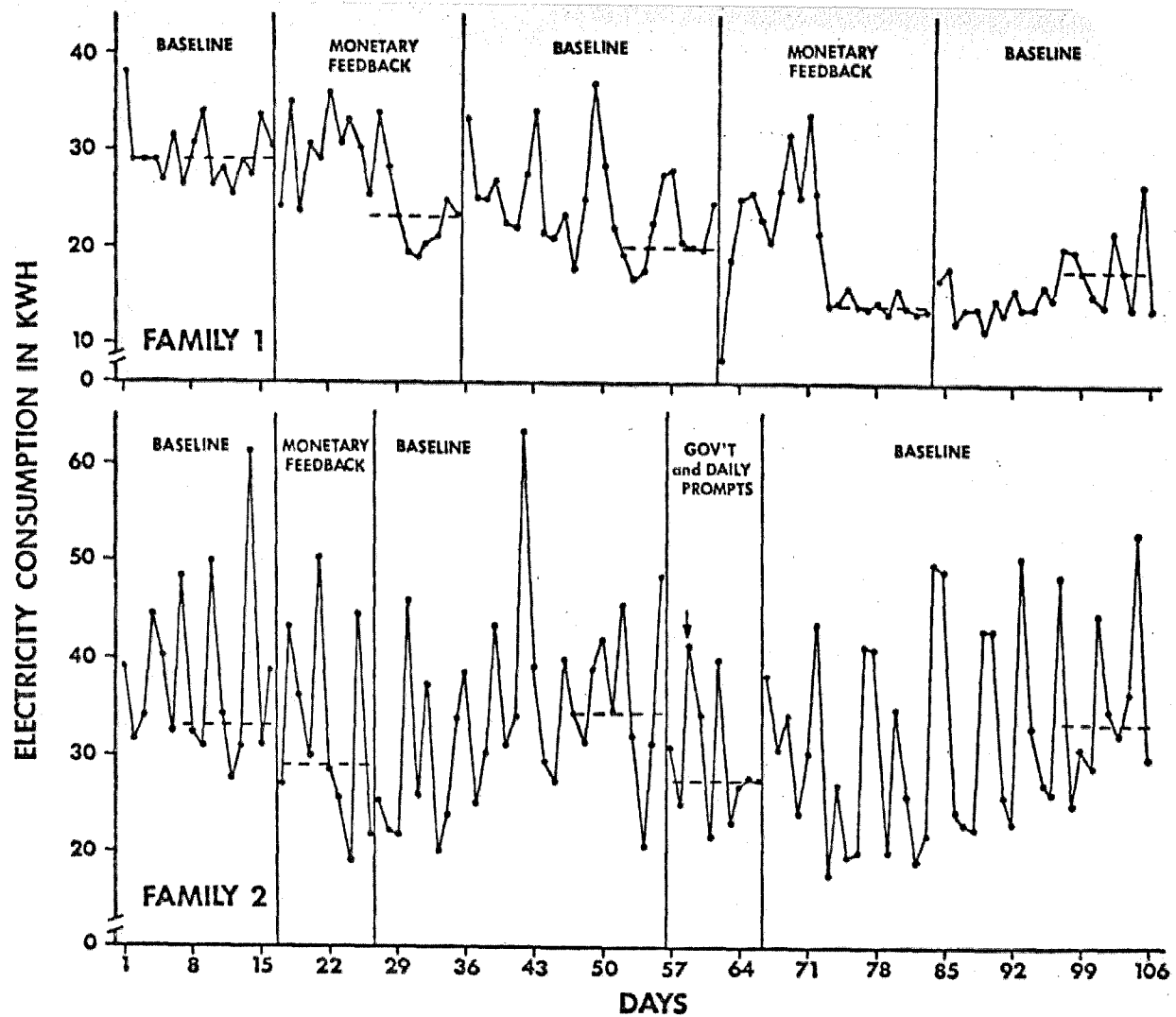


Figure 1. Daily electricity consumption for Families 1 and 2 for all days of baseline and experimental conditions. Dotted lines indicate median consumption for the last ten days of each condition. Numbered days are Sundays. For Family 2, the arrow indicates the first daily prompt. ∞

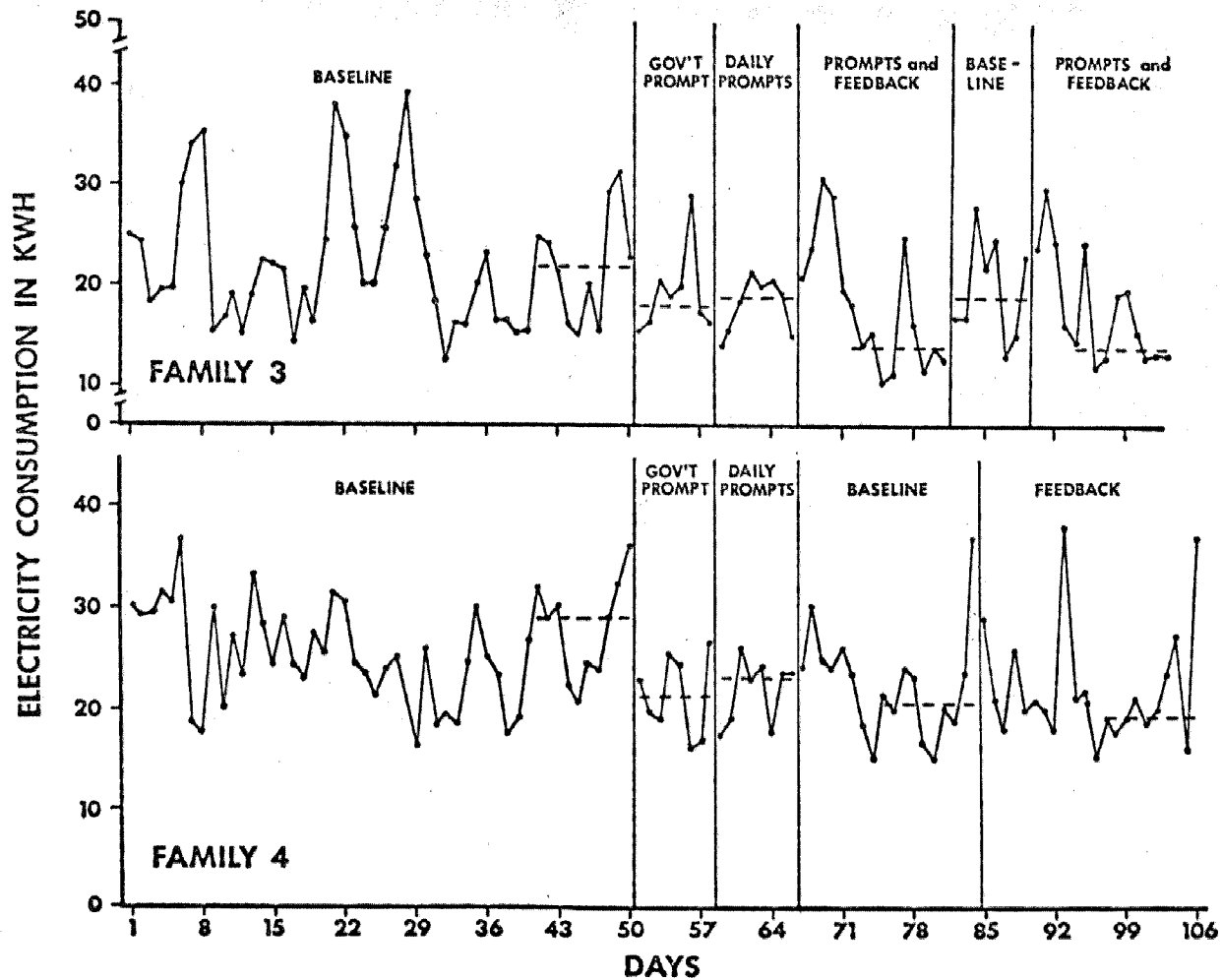


Figure 2. Daily electricity consumption for Families 3 and 4 for all days of baseline and experimental conditions. Dotted lines indicate median consumption for the last ten days of each condition or for the entire condition if that condition lasted less than ten days. Numbered days are Sundays.

## Chapter 4

### DISCUSSION

This study demonstrated that either prompting or feedback techniques were effective in reducing daily electricity consumption in three of four suburban families. Since data were collected from February through May, some decreases in consumption may have been related to changes in temperature and daylight hours. However, since the median consumption of three of the families increased toward baseline levels during the month of May, seasonal changes should not substantially affect the interpretation of these data.

The patterns of electricity consumption varied greatly among families. The range of day to day variability in Family 4 was about 23 KWH (38 KWH - 15 KWH) while the range for Family 2 was 46 KWH (63 KWH - 17 KWH). High consumption days for Family 2 were frequently on weekends and on Wednesdays. Family 2 attributed this to clothes washing (Family 2 was the only family which used an electric hot water heater).

In general, relatively long periods of time were required to demonstrate experimental effects. One possible reason for this is that experimental conditions were applied to behavioral outcomes (daily electricity consumption) rather than to specific behaviors. Families had to learn the relevant behaviors by trial and error. For example,

Family 2 may have learned to wash greater amounts of clothes less often. Reductions in electricity consumption may have occurred more quickly if behaviors, rather than outcomes, had been consequated.

Previously, wives have been reported to be largely responsible for changes in appliance use resulting in reductions of electrical peaking (Kohlenberg et al., 1974). In a follow-up interview, Families 1, 2, and 3, in the present study reported that the wives' behavior was most affected. Family 4 reported that no one took an interest in the study. Family 4 was the only family that was inconsistent in initialling the 3-by-5 card messages.

Since electricity consumption decreases when families have daily knowledge of consumption and cost, a simpler means of providing this knowledge might be devised. Decorative electric meters indicating both consumption and cost (as gasoline pumps do) could be installed in conspicuous locations in kitchens or living rooms.

A considerable savings in both electrical power and money was obtained by the families. For example, the projected monthly bill for Family 1 during the last ten days of the second monetary feedback condition was about \$13.18 as compared with the second baseline projection of \$21.89, a savings of \$8.71 and about 315 KWH. If all of the 77,303 residential consumers in the Des Moines metropolitan area saved this amount, the resulting savings would be about



\$673,309.13 and about 24,350,445 KWH per month.

The local power company seems to encourage high rates of electrical power consumption since the rate charged per KWH decreases with increased usage. Large reductions in electricity consumption therefore result in a proportionately smaller money savings. If conservation of electrical power is desired, it would be more efficient to reverse these billing procedures, i.e. to charge increasingly more for greater consumption levels.

The conditions in this study were effective during relatively brief experimental periods. Long term effectiveness cannot be determined from these data. Additional research is needed to assess the relative effectiveness of prompts and feedback, to identify family variables which may effect outcome, and to evaluate the practicality of behavioral procedures for large scale energy conservation programs.

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APPENDIX A

Sample feedback  
information.

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Card # \_\_\_\_\_  
Today's consumption of electricity at your house was  
\_\_\_\_\_ Kilowatt-hours. This is enough electricity to  
burn \_\_\_\_\_ 100-watt light bulbs for 10 hours. This is  
\_\_\_\_\_ KWH (less more) than your previous consumption.

## APPENDIX C

Daily prompt series.

1. Midwesterners may be asked to share their electricity supplies with people on the east coast. To prepare for this possibility, conserve electricity now.
2. Kill-a-Watt. Conserve electricity!
3. The primary sources of energy from which our electricity is manufactured are unstable in supply. Conserve electricity.
4. Save a lot.....Save a watt! Conserve electricity.
5. Protect our environment, conserve electricity.
6. Watt if? Watt if? Watt if? Watt if?.....  
Be positive, conserve electricity.
7. Energy is precious, conserve electricity.
8. Save money! Conserve electricity.