A RAND NOTE

HOUSEHOLD ENERGY CONSERVATION: STRATEGIES FOR BEHAVIORAL RESEARCH

Sandra H. Berry and John D. Winkler

October 1982

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Prepared for

The U.S. Department of Energy

Rand
SANTA MONICA, CA. 90406

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PREFACE

This study, undertaken for the Office of Policy, Planning, and Analysis of the U.S. Department of Energy, examines energy consumption and conservation, covering a multiyear Rand program on long-term issues important in formulating national energy policy. The goals of this program are to help policymakers assess (a) marketplace incentives to pursue an efficient use of energy, and (b) the appropriateness of government action to encourage or require conservation of energy.

We address three major questions in this program: How rapidly are consumers responding to rising energy prices? Are there differences between the behavior of owner-occupants and tenants? What are the implications of this analysis for public information programs such as energy labeling, and building and appliance standards?

This Note focuses on the third question: consumer information. It presents a critical review of research on consumer attitudes toward energy conservation and on behavioral mechanisms that might encourage conservation. It also describes the potential application of this research in two subject areas: utility report card billing and major conservation purchase decisions such as energy-efficient appliance purchases or household retrofits.

This Note was funded under Contract DE-AC01-80PE70269.

SUMMARY

This Note reviews research in the behavioral and social sciences on household energy conservation. Our goals were to describe the research and the savings in energy that have been achieved, and indicate how they were achieved. In addition, we suggest areas for future research that will extend or enhance the findings reported here.

Research on household energy conservation has established the importance of household members' behavior in the day-to-day management of the energy in their homes (e.g., setting the thermostat), and in the decisions they make about changing their homes to conserve energy (e.g., insulating). Both kinds of behavior can significantly affect levels of energy consumption. Conservation efforts have been primarily directed at the day-to-day behaviors, although the longer-term decisions can result in greater and longer lasting savings.

Our review of the literature showed that the methods used to induce conservation behavior fell into three categories. Based on differing assumptions about what promotes conservation behavior, these categories can be described as attitudinal, cognitive, and motivational: They concentrate on changing attitudes, improving knowledge, and motivating people to conserve energy. Experiments carried out over the past 10 years that use these methods (singly or in combination) are described in this document.

The results of these experiments conclude that:

- All interventions to promote energy conservation have achieved some success.
- Changing attitudes about energy conservation may be useful (or even necessary), but they are not sufficient to change behavior.
- Attempts to change specific attitudes are more effective than general messages, although neither is as effective as cognitive or motivational techniques.
- Feedback about energy use is an effective form of cognitive intervention in promoting conservation behavior.
- Providing motivation, especially in the form of rebates, appears to be a highly effective technique for promoting conservation behavior.
- Combining techniques enhances the effects.

We suggest two kinds of additional research that would build on existing knowledge. First, methodological work is needed to measure attitudes and the results of conservation behavior, particularly energy consumption behavior. Second, applications of the findings of these experiments should be studied. For example, written feedback can be provided with utility bills; methods for making most effective use of this technique should be developed. Another promising application is encouraging better consumer decisions in areas that have long-term energy conservation effects, such as appliance purchase and retrofit of dwellings. Better communication and motivational techniques can enhance existing energy conservation programs.

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CONTENTS

PREFACE iii

SUMMARY v

ACKNOWLEDGMENTS vii

Section

I. INTRODUCTION 1

Variation in Household Energy Use 1
Household Conservation Behavior 4
Strategies for Inducing Conservation Behavior 6

II. INDUCING CONSERVATION BY CHANGING ATTITUDES 8

Role of Attitudes in Predicting Behavior 10
Changing General Attitudes 16
Targeted Appeals 18

III. INDUCING CONSERVATION BY PROVIDING INFORMATION 20

Facts About Energy Consumption 20
Individual Consumption Levels 22

IV. INDUCING CONSERVATION BY INCREASING MOTIVATION 26

Material Incentives 26
Social Incentives 29

V. COMPARING AND COMBINING STRATEGIES 32

VI. CONCLUSIONS 35

Methodological Development 36
Applications 37

REFERENCES 41

I. INTRODUCTION

In this study, we review the contributions of behavioral and social scientists in understanding and encouraging household energy conservation. In the sections that follow, we will describe their research, examine energy savings that behavioral or social interventions have achieved, and discuss the reasons for these results. Finally, we will point to aspects of energy conservation that would benefit from further behavioral or social research.

VARIATION IN HOUSEHOLD ENERGY USE

Most behavioral and social research in energy use has focused on residential energy consumption. The household sector accounts for about one-third of the energy used in the United States, with about 53 percent of household energy consumed in the home, rather than for transportation (Committee on Measurement of Energy Consumption, 1977, cited in Stern and Gardner, 1981). Households vary greatly in the amount of energy they use. For example, in 1976, 22 percent of the households served by the Los Angeles Department of Water and Power used 150 kilowatt hours (KWH) of electricity or less per month with 5 percent using over 1000 KWH per month (Acton, Manning, and Mitchell, 1978).

Many of the differences in household energy consumption have little to do with household behavior. Those differences are accounted for by climate, features of the housing unit, and characteristics of the household. Climate influences energy consumption because half of the energy consumed in households is used for space heating (Stanford Research Institute, 1972, cited in Fritzsche, 1981). Features of the

housing unit that affect energy consumption include its size, building shell efficiency, and efficiency of the heating system. The fuel used for water heating and the presence of major appliances such as air conditioners, washers, dryers, and dishwashers also have an important effect on household consumption (Newman and Day, 1975). Household size affects energy consumption directly because larger households require more food, hot water, and clean clothes; indirectly since they tend to live in larger housing units. In general, larger households consume more energy than smaller ones, although household characteristics such as the stage of the family life-cycle or the age of its members also affect energy consumption.[1]

Finally, household income has a large effect on household energy consumption. Newman and Day (1975) found that households with more income consumed more energy than households with less, regardless of any other condition (including climate, size of house, family size, and age). Naturally, this is tied in with other factors associated with higher income, such as the presence of more appliances or appliances that consume more energy.

However, significant differences in energy consumption occur between households even when these factors are accounted for. Evidence on this point comes from research done at Twin Rivers, New Jersey, a community of townhouses built in the early 1970s. These townhouses all had similar floor plans and identical insulation, heating, air conditioning, and appliances. Their occupants were primarily couples in

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[1] For example, Fritzsche (1981) found that households of equal size, but at different stages of the life-cycle, consumed different amounts of energy. Energy consumption increased with each stage of the life-cycle through the child-raising years, and then declined at a slower rate than it grew as family members left home.

their thirties, with a college degree or some college education, and small children.[2]

The homogeneity of the housing stock and the households allowed researchers to focus on the variation in energy consumption attributable to the behavior of residents. Sonderegger (1977) reported that the highest consumers of energy at Twin Rivers typically used at least twice as much energy as the lowest users, both in winter and summer.[3] Sonderegger's (1977) research provides other evidence on the resident's contribution to energy consumption. Comparisons among 205 townhouses in which the same household resided over two winters in some cases and changed in others indicated that energy consumption levels of new occupants were nearly unrelated to those of previous occupants of the same unit. An estimated 70 percent of the variation in consumption observed in dwellings that changed occupants appeared to be due to household behavior, not housing features. Finally, further evidence of the resident's effect on consumption is provided by studies of Twin Rivers houses that received retrofits. The rank-ordering of the households' consumption levels prior to retrofit remained about the same after the retrofit, although the level of consumption for all households was lower (Socolow, 1977).

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[2] Based on these characteristics, the household incomes are probably quite similar, although such data were not provided.

[3] Ellis and Gaskell (1978), based on a review of similar research in the U.K., have concluded that the resident's contribution to variance in household consumption is smaller than 50 percent but still substantial.

HOUSEHOLD CONSERVATION BEHAVIOR

Results of the Twin Rivers study show that some differences in consumption patterns of households are attributable to the energy-consuming activities of household residents. Presumably, people can to some degree choose to consume or conserve energy. The range of consumption choices for consumers is broad and includes a number of conservation measures. These measures, in turn, are differentiated by their potential for saving energy. Although the greatest potential for reducing energy use lies in promoting behaviors that save the most energy, those behaviors tend to be more difficult to effect than others that save less.

Table 1 lists a range of possible conservation behaviors, categorized by the frequency with which they must be performed to be effective. The behaviors are also classified by cost: those that are likely to require an outlay of about $100 or more (E) versus those that involve a small expenditure, if any (I). Potential savings from each behavior are shown in terms of the potential system savings (e.g., heating and cooling system; major appliances; water heating; refrigerator and freezer; and lighting and small appliances). The savings shown in Table 1 are not additive, although potential savings from combining several of these measures can be large. Sinden (1977) reported achieving an estimated 67 percent reduction in energy use for space heating from a combination of measures in a Twin Rivers townhouse.

Based on Table 1, it appears that the most dramatic savings can be realized from the one-time changes to heating and air conditioning systems. These changes are usually classified as expensive, but once

Table 1

COMPARISON OF POTENTIAL SAVINGS AND COST OF CONSERVATION MEASURES

Conservation Measure	System Savings (%)	Cost[a]
One-Time Changes		
Passive solar heating	19-23	E
Evaporative cooler	15-24	E
Clock thermostat	15-24	E
Ceiling insulation	19-23	E
Whole house fan	12-23	E
Wall insulation	9-22	E
Thermal windows	6-13	E
Duct insulation	5-11	I
Floor insulation	3-8	E
Use of plantings for shade	up to 8	I
Solar hot water system	40-75	E
Heat-pump hot water heater	40-50	E
Water flow restrictors	up to 17	I
Water heater insulation	3-9	I
Reducing hot water temperature	up to 7	I
Removing second refrigerators and freezers	up to 17	I
Periodic Measures		
Insulating windows in winter	up to 11	I
Caulking and weather stripping	3-8	I
Maintaining heater or furnace	up to 5	I
Selecting energy-efficient appliances	10-25	E
Reducing wattage of bulbs or changing to fluorescent	30-38	I
Frequent Practices or Habits		
Setting temperature back at night	5-20	I
Reduced heat setting, higher air conditioning setting	5-20	I
Reducing energy use when house is unoccupied	5-12	I
Closing off unused rooms	up to 10	I
Using fireplaces efficiently	2-8	I
Maintaining and operating appliances efficiently	5-10	I

SOURCE: Southern California Edison Company.

[a]E=approximate cost is $100 or more, I=cost is less than $100 or zero.

made, they require little or no further effort to obtain the energy savings. With the exception of selecting energy-efficient appliances, most periodic practices (such as weather stripping) are inexpensive but produce correspondingly smaller reductions in consumption. Most of the frequent measures (such as low thermostat settings) can result in substantial energy savings at low cost, but must be established and maintained to result in substantial savings over time.

STRATEGIES FOR INDUCING CONSERVATION BEHAVIOR

Table 1 suggests that conservation can be enhanced if consumers are induced to perform relatively inexpensive activities more frequently or to undertake the more costly infrequent measures. Evidence suggests that large potential savings exist for both types of activities, but especially for the latter. For example, Beck, Doctors, and Hammond (1980) reported that 60 to 90 percent of the consumers they interviewed in Pittsburgh regularly undertook some of the frequent measures in Table 1, but that only 55 percent repaired weatherstripping before each winter, and 13 to 40 percent had undertaken the appropriate one-time changes.

With large numbers of consumers--and large potential energy savings--waiting to be reached, behavioral and social scientists have examined possible strategies for influencing consumers to engage in energy-conserving behaviors. However, most research has not considered specific energy behaviors in detail, but instead has considered conservation as a general set of behaviors (Stern and Gardner, 1981).

Behavioral science research has placed more emphasis on identifying and modifying the underlying mechanisms that influence a household's energy-consuming behaviors.

Most of this research has evolved from one of three assumptions:

1. People would conserve energy if they had more positive attitudes.
2. People would conserve energy if they had more information about energy consumption and conservation.
3. People would conserve energy if they were motivated to do so.

These assumptions, respectively, rely on general categories of behavior that are attitudinal, cognitive, and motivational (although these explanations are not strictly independent). Each category calls for specific experimental intervention, and each has achieved varying success in reducing energy use. We review this research in terms of these three categories: Section II discusses work on inducing conservation by changing attitudes; Section III, by improving knowledge; and Section IV, by increasing motivation. Section V compares the effectiveness of those inducements and Section VI presents general conclusions about the existing research and suggests promising research directions.

II. INDUCING CONSERVATION BY CHANGING ATTITUDES

Inducing people to conserve energy by changing their attitudes assumes that attitudes can stimulate conservation behavior. The widespread acceptance of this assumption is demonstrated by the considerable amount of research on public attitudes toward energy conservation. At its simplest level, the research consists of opinion polls that reflect the severity of the "energy crisis" and behavioral adaptations to energy shortage. These polls have been conducted since 1973, and consistently report that about 75 percent of the population view the energy situation as "serious," but not as the most important problem facing the U.S. However, about 15 to 30 percent still think that no real shortage exists. This is a reverse of poll results in 1973, when the majority felt that the crisis was contrived (Milstein, 1976; Root, 1978; Farhar, Weis, Unseld and Burns, 1979). Belief in the existence of a genuine energy shortage is now found among younger people, those with higher levels of education, and those who have personally experienced actual energy shortages (Murray, Minor, Bradburn, Cotterman, Frankel, and Pisarski, 1974; Farhar et al., 1979). That belief does not appear to be strongly linked to political orientation, sex, race, or other attitudes (Farhar et al., 1979). The direction of the relationship with income is ambiguous (Ellis and Gaskell, 1978).

Most people (85 percent) report that they do act to conserve energy, but they most frequently report actions that are least difficult and least significant in reducing overall consumption, such as turning off lights and televisions when not in use, running washer, dryer, and

dishwasher with full loads, and so on (Milstein, 1976; Root, 1978; Farhar et al., 1979). Overall, evidence from cross sectional studies shows that increasing belief in an energy shortage is not matched with evidence of increasing serious conservation practices by U.S. consumers (Ellis and Gaskell, 1978).[1]

Survey results suggest several reasons for this mismatch. Murray et al. reported in 1974 that the energy problem was simply deferred, possibly because people expected that the problem would be solved in four or five years. Farhar et al. (1979) found that lack of technical knowledge kept people from adopting conservation practices. Similarly, Kempton and Montgomery (1981) suggested that many people have strong misconceptions about the amount of electricity used for various household purposes. Milstein (1976) reported the results of focus-group interviews with consumers;[2] he found that consumers placed a high value on comfort and convenience, were more concerned with the present than the future, and were inclined toward conspicuous consumption. People were cynical about the origins of energy problems and the solutions proposed by both government and industry. Finally, concerns with the equity of sacrifices to conserve energy brought up in the focus groups have also been important in consumer surveys (Farhar et al., 1979).

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[1] A major problem with these studies is reliance on self-reported behavior, which is discussed later.

[2] Focus groups are small group discussions with members of the population of interest (e.g., consumers). They are useful in identifying issues that may be important in response to a particular problem.

ROLE OF ATTITUDES IN PREDICTING BEHAVIOR

Because of the intuitive appeal of the expected link between conservation attitudes and behavior, and because of distrust of verbal reports of conservation behaviors, a number of studies have examined more closely the relationships between attitudes toward energy conservation, conservation behavior, measures of consumption, and respondent characteristics. Table 2 summarizes the findings of nine surveys that have examined correlations between energy conservation behavior, income, and other demographic characteristics, and consumer attitudes. These studies were conducted in the United States between 1973 and 1980, a period of intense interest in energy issues.[3] They vary considerably in focus and approach to measurement and analysis; most use a regression approach, but one is experimental (Olsen and Cluett, 1979).

These studies report mixed results on the relationship between income and conservation behavior. Murray et al. (1974) and Marsden and McKinney (1980) found that higher levels of household income are associated with conservation behavior. Beck (1980) found that income was associated with conservation behavior through homeownership. Burnette and Carner (1979) and Cunningham and Lopreato (1977) found that lower income was associated with conservation behavior. Becker, Seligman, Fazio, and Darley (1981) found no association between income and conservation behavior.

[3] Similar surveys have been carried out in Canada and in Western Europe. For these results, see Heslop, Moran, and Cousineau (1981); Ritchie, Claxton, and McDougall (1981); and Verhallen and Raaij (1981).

Table 2

SUMMARY OF U.S. SURVEY RESULTS ON LINKS BETWEEN CONSERVATION ATTITUDES AND BEHAVIOR

STUDY	DESCRIPTION OF SURVEY (Year, location, sample)	DEPENDENT VARIABLE(S)	INDEPENDENT VARIABLE(S)	FINDINGS
Murray, et al., 1974	1973, national, weekly samples, total = 600+/-	-change in usage -conservation practices	-demographic -income -attitudes	-no association with attitudes -change and practices associated positively with income
Sears, et al., 1978	1974, Los Angeles n=1069	-change in usage	-attitudes	-conservation associated with belief in severity of crisis and excessive public consumption as cause
Cunningham and Lopreato, 1977	1975, southwest cities, n=2403	-change in usage	-demographic -income -attitudes	-pro-conservation attitudes associated with high-SES -conservation associated with low SES
Beck, 1980	1978, Pittsburgh, n=779	-conservation practices	-demographic -income -attitudes -knowledge	-conservation associated with homeownership, knowledge, concern with the energy situation, and anti-materialism, younger age
Marsden and McKinney, 1980	1978, North Carolina, n=604	-change in usage	-demographic -income -attitudes -knowledge	-conservation associated with higher education, higher income, younger age, homeownership, pro-conservation attitudes, conservation knowledge
Olsen and Cluett, 1979	1978, Seattle n=368	-change in consumption (predicted minus actual fuel use)	-experimental workshop program	-conservation behavior induced by workshops, but no change in attitudes (possibly due to ceiling effect)
Burnette and Carner, 1979	1978, California n=499	-consumption of electricity and gas	-demographic -income -attitudes	-lower usage associated with lower demographic backgrounds and attitudes toward conservation
Seligman, et al., 1978	1979, New Jersey n=56,69	-consumption of electricity (summer)	-attitudes	-factors affecting usage were perceived importance of temperature to comfort and health, perception of conservation effort vs. savings, importance of individual actions
Becker, et al., 1981	1980, New Jersey n=207	-consumption of gas (winter)	-attitudes	-factors affecting usage were importance of temperature to comfort and health, and belief in technology; no significant association with beliefs in legitimacy of crisis, individual's role, or family fiances

These conflicting findings might be partially explained by differences in constructing scales for conservation activities. Scales that contain items requiring expensive practices and changes to the dwelling's physical structure (e.g., installing insulation) might indicate more conservation behavior by high-income consumers. But this is not the case. Beck (1980) found that homeowners were more likely to engage in major conservation efforts than renters, but that as a group they were also slightly more likely to engage in any conservation effort. Cunningham and Lopreato (1977), on the other hand, found that low-income consumers were more likely to practice energy conservation.

Ellis and Gaskell (1978) suggest that the confusion occurs mainly among the highest income groups. Affluent consumers have more opportunities to conserve because they consume at high levels and can afford to make investments in energy-saving devices, but may have less incentive to do so because they are less affected by high energy prices. This is surprising, however, because when people who report taking actions to conserve energy were asked <u>why</u> they conserve, the most frequent response was that they were trying to save money (Milstein, 1976).

A second conclusion reached in these studies is that although the evidence on the association of attitudes about energy shortages and actual conservation behavior is also unclear, the evidence does not suggest a total <u>lack</u> of relation between these constructs. Others who have reviewed this research reached similar conclusions. Olsen, for example (1981), found no significant relationship between general energy attitudes and reported conservation behaviors, but suggested that

anticipation of direct personal consequences from shortages might have some effect. Cook and Berrenberg (1981), Cunningham and Lopreato (1977), Marsden and McKinney (1980), and Shippee (1980) have concluded either that there is a moderate link between conservation attitudes and behavior or that the evidence is mixed. Our examination of the nine studies included in Table 2 indicates a positive relation between expressing beliefs in the energy shortage and the need for conservation, and engaging in conservation behaviors. This is particularly evident in the surveys conducted in 1978, compared with earlier studies and one more recent study.

Only three of the nine surveys (Murray et al., 1974; Cunningham and Lopreato, 1977; Becker et al., 1981) found no significant correlation between attitudinal variables and conservation. Olsen and Cluett (1979) measured attitudes before and after involving consumers in experimental energy conservation workshops. While the workshops appeared to bring about an actual conservation of energy, no attitude change was observed. However, nearly all of the consumers expressed pro-conservation attitudes before the workshop, so there was little room for attitude change.

The other five studies showed a significant relation between attitudinal variables and conservation behavior. The first of the studies, Sears et al. (1978), found that although the major predictor of engaging in conservation behavior was its perceived personal effect, believing that the crisis was severe and blaming it on excessive public consumption were fairly consistently related to engaging in conservation practices. Beck (1980) found a significant relation between conservation practices and unwillingness to blame shortages on others

(Arabs, cold winter, oil companies), deriving satisfaction from conservation behaviors, and concern about the energy situation. In addition, those who reported financial hardship were more likely to conserve. Marsden and McKinney (1980) found that those who reported that the need to save energy was serious and that conservation would help a great deal were significantly more likely to adopt conservation practices. Burnette and Carner (1979) also found that lower consumption was related to pro-conservation attitudes. Finally, Seligman, Kriss, Darley, Fazio, Becker, and Pryor (1979) found that four factors explained 55 percent of the variance in summer electricity consumption in Twin Rivers townhouses. These were the importance of coolness of indoor temperature on comfort and health, the perceived difficulty of conservation behavior, the judged importance of individual conservation efforts, and the perceived legitimacy of the energy crisis.

These studies suggest that conservation practices are associated with beliefs that an energy shortage exists, that individual efforts are useful, and that they do not involve much difficulty on the part of the consumer. They also suggest that the association between attitudes and behavior is strongest when the attitude measured comes closer to actual behavior than a general disposition (the perceived importance of coolness of indoor temperature to health compared with the perceived seriousness of the energy crisis). However, the relation between conservation attitudes and behavior is often obscured by methodological inconsistencies between studies or by contextual features of particular studies, as we discuss below.

One reason for inconsistency between studies is the newness of the research area and lack of established paradigm, which produce a number

of methodological inconsistencies. First, dependent variables differ sharply between studies. The main distinction is between self-reported conservation behavior and direct measures of energy consumption. For the first category, some studies define conservation in terms of changed behavior (e.g., lowering the thermostat) and some in terms of a specific behavior that indicates a conservation practice (e.g., keeping the daytime temperature at 68 degrees).

Those differences are not a matter of carelessness; there are good reasons for using each measure, depending on the research question. Using direct measures of consumption is most accurate because it avoids response errors associated with self-reports.[4] However, measuring total household consumption of gas or electricity does not allow examination of the effects of individual conservation practices because they are frequently confounded with the very large effects of structural characteristics. Measuring reported changes in behavior is useful for identifying response to a particular event (e.g., a fuel shortage), but these responses may be overstated, or this method may fail to identify long-standing conservation practices, thus underestimating total conservation behavior. Measuring conservation practices, on the other hand, identifies all the relevant behaviors, but cannot be used to measure the effect of a particular event unless it can be compared with some earlier measure. An additional problem with using the reported behaviors as a dependent variable is that they are frequently combined

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[4] Beck (1980) had interviewers verify self-reports of conservation behavior and found that consumers did inflate their actual conservation practices, but that the inflation was uncorrelated with most of the explanatory variables and was unlikely to introduce serious bias. Hirst, Maier, and Patton (1981) found that higher levels of reported conservation behavior were not matched by lower levels of actual energy consumption.

into a simple additive scale composed of variables that apply differently across subgroups (e.g., renters and owners) of the population and are of unequal importance in conserving energy.

Another methodological complication is that independent variables also differ considerably, reflecting research interests of the authors, and a general lack of agreement about important variables. For example, specific demographic factors may or may not be considered and are usually measured differently across studies. Specific attitudinal dimensions may or may not be included and are nearly always measured differently across studies. The lack of replication means that no standard measures have been developed.

Finally, there is a reasonable expectation and some evidence that the correlation between variables changes over time. Cunningham and Lopreato (1977) suggest that conservation practices were initiated in the post-1973 energy crisis period by more affluent and educated consumers as a public-spirited response to the crisis, but that the initiative has since passed to lower-income consumers, because of greater economic pressure on them and increases in their knowledge about possible conservation measures. Thus, results may vary according to the historical context of an individual study.

CHANGING GENERAL ATTITUDES

Based at least on the seemingly obvious belief that the attitudes one holds about energy use must be related to actual energy behavior, researchers have attempted to change general predispositions and feelings about energy conservation to stimulate conservation behavior. The idea has been to induce pro-conservation attitudes by persuading the public that there is an energy crisis, that energy waste will lead to

negative consequences (conversely, that energy conservation will lead to positive consequences), and that particular energy-saving recommendations should be followed (Cook and Berrenberg, 1981). Most appeals also attempt to demonstrate the value of individual action.

A major vehicle for inducing attitude change has been persuasive mass communication. Appeals have been based on a rich tradition of research in the use of persuasion to promote attitude change in the social sciences. Unfortunately, like researchers in these disciplines, those who use mass communication to preach the gospel of energy conservation are learning that general persuasive appeals do not produce widespread or lasting behavior change (Klapper, 1960; Larson, 1964; McGuire, 1969).

For example, Heberlein (1975) conducted an experiment on the effect of written appeals on the electricity consumption of residents of 96 apartment units in six buildings in Madison, Wisconsin, during the winter of 1973. Letters from the "Committee for Rational Use of Electricity" presented arguments that energy conservation was desirable based on the cost of electricity, the consequences to others of overuse of electricity, and the personal responsibility of the consumer for those consequences. Average daily use of electricity over a 30-day period, based on meter readings, did not differ for residents who received these appeals, compared to a control group of apartment dwellers who did not receive them.

Others have reviewed this literature more extensively and reached similar conclusions about generalized persuasive appeals (Olsen, 1978; Tuso and Geller, 1976). One possible explanation is that mass appeals could influence people's opinions or intentions, but lead to little

change in actual behavior. Another is that mass appeals did not affect attitudes at all (most of these studies did not measure attitudes before and after the appeal). Further study on the nature of the relation between energy attitudes and energy behavior would help us understand when attitudes will produce a desired behavior and therefore guide the implementation of more effective mass communication campaigns.

TARGETED APPEALS

Other research has found more positive effects of persuasive appeals, based on principles of targeted communication. The principle behind this approach is that appeals will be most effective when they are simple, very specific, and aimed at particular target audiences.

Several experiments based on this approach were conducted by Craig and McCann (1977; 1978a; 1978b). Their first two experiments demonstrated that conventionally derived appeals were ineffective in changing energy use among a large number of Consolidated Edison residential consumers, although they did affect customer interest in receiving further information and their stated intentions to conserve. Changes in actual energy consumption, however, were affected only by the specificity of the conservation recommendations. In this study (1978b), 2400 Consolidated Edison residential consumers received appeals that differed along a number of dimensions, including whether the message described how to improve ventilation to save on air conditioning versus a simple exhortation that there are "easy ways" to conserve. In the month following receipt of the message, customers who received the specific recommendation used 18.3 KWH less electricity on the average than did customers who received the general exhortation.

Although the savings does not represent a large amount of electricity, these results suggest that attempts to influence consumers through mass appeals can be more successful when careful thought is given to adapting those appeals to consumers' circumstances and needs. Additionally, evidence suggests that audience characteristics will determine the acceptance of the message (McGuire, 1969). Vertinsky (1979) provides an excellent analysis of message-media-audience issues in communications about energy conservation, and describes a number of promising mass media strategies. Her review indicates that considerable research is still needed on the optimal communications "mix," particularly in identifying segments of consumers as targets for particular messages. Consumer reaction must be examined in fine detail, because evidence indicates that consumer preferences for a type of appeal may bear little relation to its actual effectiveness. McDougall (1980), for example, found that consumers say they dislike specific messages more than general messages, but as we have seen, specific messages may be more effective in reducing energy consumption. Research on these issues is currently under way (Burby, Didow, and Marsden, 1981).

III. INDUCING CONSERVATION BY PROVIDING INFORMATION

Another approach to changing energy consumption patterns is based on the premise that people would consume less energy if they had greater knowledge about energy conservation and consumption. Research shows that there is little accurate public knowledge of the facts about energy conservation and consumption (Farhar et al., 1979). Misperceptions, however, abound, such as "bigger" appliances are less energy efficient than "smaller" appliances (Baird and Brier, 1981) or switching a light on and off is more wasteful that leaving it on (Rappeport and Labaw, 1975), as well as widespread public ignorance about how utility bills are calculated, meters read, and so on. The correlation between knowledge and behavior is supported by learning theory in psychology, which shows that knowledge of the results of one's behavior greatly facilitates further learning and performance (Ammons, 1956; Locke, Cartledge, and Koeppel, 1968).

FACTS ABOUT ENERGY CONSUMPTION

Unlike attitudinal research, research based on public knowledge about energy conservation is concerned not with an individual's feelings about energy conservation, but on a knowledge-based approach that emphasizes the cognitive determinants of behavior. The results of the two kinds of research are distinguishable: One produces books on how to retrofit a house and pamphlets on how to read a gas meter; the other produces exhortations based on appeals to patriotism, social approval, and the like.

However, as might be expected from the above discussion, the effects of a public information campaign differ only slightly from those of a campaign of public persuasion. Unfortunately, even though numerous pamphlets full of facts about energy are widely disseminated, little evidence exists to show that this strategy significantly reduces energy use (Cook and Berrenberg, 1981; Milstein, 1976; Shippee, 1980; Stern and Gardner, 1981).[1] Several studies have provided consumers with information on how to interpret an electricity bill or on the energy consumption costs of household appliances. However, when compared to a control group that received no information, it was found that these interventions either did not produce energy savings or they produced less energy savings than interventions such as consumption feedback or rebates (Winett, Kagel, Battalio, and Winkler, 1978; Hayes and Cone, 1977).

Therefore, simple dissemination of information appears to be a weak intervention. A "targeted" approach might make this strategy more effective. Evidence suggests that short, specific, highly visible messages or "prompts" (e.g., "Conserve electricity--turn lights out after 5 p.m.") can reduce unnecessary electrical consumption (Winett, 1977). However, Geller (1981) reported poor results in a 1977-78 demonstration. Volunteer subjects attended three-hour workshops on energy conservation. Pre- and post-workshop questionnaires demonstrated significant differences in attitudes and knowledge about subjects discussed in the workshop, but a follow-up home visit six weeks later

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[1] We were not able to examine the actual materials used in these studies. The quality and type of information provided may affect the response.

showed that few actually adopted conservation techniques. Thus, although targeted information campaigns may be more effective than general information campaigns, research that further refines how to direct specific types of information to certain categories of consumers (e.g., those who express interest in learning about conservation) might improve its potential effectiveness.

INDIVIDUAL CONSUMPTION LEVELS

Another method of instilling knowledge of energy conservation is to encourage an understanding of one's own level of energy consumption through feedback. Feedback tells people their rate of energy consumption, permitting them to change that consumption when they are exceeding a desired level. Much behavioral research has examined the value of feedback in modifying energy use, and has compared the effectiveness of different forms of feedback. That research has been summarized extensively elsewhere, so we will only briefly describe the results of those studies in the remainder of this section.[2]

Research that has provided consumers with feedback and individual consumption levels has demonstrated that potential energy savings are impressive. For example, Seligman and Darley (1977), in one of the Twin Rivers studies, provided homeowners with feedback about their electricity use, based on meter readings taken four times a week during one summer month. Since air conditioning represents the largest use of electricity during the summer, they found they could reliably predict electricity consumption from outdoor temperature. Feedback was provided

[2] For detailed reviews of individual studies that have examined the effects of consumption feedback on household energy use, see Ellis and Gaskell, 1978; Carlyle and Geller, 1978; Shippee, 1980; or Winett, 1979.

in the form of percentage scores of actual consumption to predicted consumption. Compared to a control group that received no consumption information, households that received feedback reduced their electricity use 10.5 percent.

Winett, Neale, Williams, Yokley, and Kauder (1978) provided consumption feedback to other residents during five to six weeks of the summer. Daily feedback was provided as the number of KWH used the previous day and its percentage increase or decrease relative to predicted use, calculated from baseline observations and adjusted for temperature. Winett et al. (1978) found consistent reductions in electrical consumption of between 7 and 20 percent in feedback groups relative to comparison groups, with the biggest and most reliable differences occurring in the largest, centrally air-conditioned structures with the highest average levels of consumption occurring during baseline. Bittle, Valesano, and Thaler (1979) found smaller decreases with similar feedback on electricity use.

While the Seligman and Darley (1977) and Winett et al. (1978) studies address potential electrical savings from adjusting air conditioning use, another study by Winett and his colleagues examined potential savings in all-electric households during a heating season (Winett, Neale, and Grier, 1979). Households were randomly assigned to one of four conditions. Some families received daily feedback about their average KWH use; some volunteered to participate but received no feedback; and an additional group of nonvolunteers was surreptitiously monitored.[3]

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[3] A practical matter in conducting experiments on energy conservation is obtaining the consent of households to participate. Energy savings might be overestimated if people who cooperate in conservation studies have predispositions to conserve. Winett, Neale, and Grier (1979) used "nonvolunteer participants" to compare their

Another group of households was also recruited and taught to read their electrical meters and monitor their own performance--to see whether households could be taught to provide their own feedback. Results indicated that compared to the no-feedback comparison groups, both the feedback and the self-monitoring group used significantly less electricity; the feedback group used 14 percent less during the experiment and the self-monitoring group used 8 percent less. The feedback and self-monitoring groups did not differ during the feedback phase, but a follow-up study showed that the feedback group's conservation activities persisted, while the self-monitoring group's did not.

Those studies indicate possible reductions in energy use in the range of 7 to 20 percent when households have information about their rates of electricity consumption. However, it is premature to conclude that feedback works. Other studies have failed to find beneficial effects of feedback (Katzev, Cooper, and Fisher, 1981), have established restrictions for feedback to be effective (Becker, Seligman, and Darley, 1979), or have found that simple consumption feedback is less effective than feedback augmented with other techniques (e.g., Becker and Seligman, 1978; Seaver and Patterson, 1976).

These studies indicate that before the technique of feedback can work, several important issues need to be addressed. For example, studies that have successfully reduced energy use have personally delivered feedback from four to seven times a week. This method is

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energy use before and during their study with the volunteers who received no feedback. They found no differences in energy consumption for "volunteer" versus "nonvolunteer" status before or during the study (see also Hayes and Cone, 1977).

impractical on a widespread basis and may produce experimental bias. A solution to this problem may be found, but for a device such as an in-house meter to be effective, more basic knowledge is needed on the best metric and method for indicating feedback to consumers.

To illustrate, an instantaneous digital readout of electricity costs in cents per hour (as provided by an instrument known as the "Fitch monitor") does not produce statistically reliable decreases in household electrical consumption, compared to equivalent non-equipped households (Becker, Seligman, and Darley, 1979, Study 7; McClelland and Cook, 1979). Becker et al. (1979, Study 6) point out that there are limits to the range of acceptable variability of feedback. They conclude that consumers will ignore feedback if it "jumps around" too much, making it difficult for them to assess the relation between their conservation behaviors and the feedback.

The results of those studies point to two dimensions of feedback that need further analysis--its optimal unit of measurement and its frequency. Additional issues in feedback research include the comparison baseline: whether feedback should be presented respective to one's past use (introducing problems of adjusting for weather, previous adaptation, and so forth) versus comparison to similar households (introducing problems of determining comparability). Current knowledge is also equivocal about feedback's effectiveness with nonelectrical energy systems, for households at different levels of general energy consumption, and over prolonged time intervals (Cook and Berrenberg, 1981; Shippee, 1980; Winett and Neale, 1979).

IV. INDUCING CONSERVATION BY INCREASING MOTIVATION

Research interventions that we refer to as "motivational" evoke behavior that satisfies a person's needs. Motivation can be elicited by incentives or disincentives that reward or punish particular behavior, causing behavior patterns to be strengthened or weakened. These incentives or disincentives may appeal to extrinsic needs by way of material costs or rewards, or to intrinsic needs through social approval or disapproval, for example. Psychological theory and research, however, has long maintained that greater behavior change will result from positive, rather than negative, reinforcement (e.g., Menninger, 1966; Skinner, 1971). The effects of positive incentives have been examined in experiments on energy consumption.

MATERIAL INCENTIVES

Many economic studies show that people curtail their demand for energy in response to increased prices that act as disincentives to consumption. In contrast, much behavioral research has examined how material incentives, such as rebates and rewards for energy conservation, influence energy consumption. The results of these studies have demonstrated that impressive energy savings can result when consumers are provided with positive incentives to conserve.

Winett and Nietzel (1975), for example, compared family use of electricity and natural gas in two randomly assigned conditions. Both groups of families were given an eight-page manual that detailed methods for conserving electricity and natural gas. Some families were offered monetary incentives to reduce their use of electricity and gas according

to a graduated schedule--$2 for each weekly 5 to 10 percent reduction from baseline; $3 for each 10 to 20 percent reduction; $5 for each weekly reduction of more than 20 percent.

Electrical and gas consumption was read from meters during the four-week study period; consumption was checked again two weeks and two months later. Results showed that families who were offered incentives reduced their electrical consumption 15 percent more during the experimental phase than did families given only information, and they were still using significantly less electricity two weeks (but not two months) after the experiment ended.

Other studies assessing consumer responses to rebate programs demonstrate that large energy savings are possible. In two studies, Winett and his colleagues offered large rebates to consumers and succeeded in reducing their use of electricity nearly 30 percent in the spring (Winett, Kaiser, and Haberkorn, 1977) and from 10 to 12 percent in the summer (Winett et al., 1978). However, these rebate schedules represent changes of several hundred percent relative to the price of electricity. Rebates of this size are obviously impractical; however, these studies do indicate that further experimentation on the effects of rebates is warranted. Also, if large one-time rebates had a "shock" effect, causing newly adopted conservation behavior to persist, they might prove cost-effective in the long run.

Hutton and McNeill (1981) found that incentives were useful in stimulating adoption of energy-solving "tips" among households. In this case, the incentive was a low-flow shower device, which came with an informational booklet. Although there was no real control group in this study, acceptance and use of the incentive was associated with higher self-reported adherence to the booklet's "tips."

Another area for research on the effects of rebates and positive incentives for energy consumption has been in the use of master-metered settings, such as are found in apartment buildings, where tenants are generally not accountable for their energy consumption. In many cases, retrofitting these apartments with individual meters is too costly; therefore, eliciting conservation behavior is particularly suitable to a behavioral approach. Several successful attempts to influence energy consumption have been made in dwellings equipped with master-metered settings by using material incentives, demonstrating that notable improvements in energy consumption are possible.

Walker (1979) offered tenants in a 176-unit, all-electric master-metered apartment complex a $5 cash award for conforming to several energy-conserving criteria (for example, setting the air conditioner thermostat to 74 degrees). Tenants were informed that there would be infrequent, random visits to apartments when the tenants were at home. Compared to a similar apartment complex where such incentives were not offered, the experimental complex reduced its energy consumption 8.6 percent in autumn and 2.2 percent in winter.

Another set of studies was conducted by McClelland and her colleagues in master-metered settings, using group incentives. Two programs were conducted in university dormitories (McClelland and Belstein, 1979). The first used persuasive communication, information, feedback, and group meetings and achieved a 16 percent reduction of electricity use from baseline, corrected for temperature, over a 10-week period. Because the savings in energy proved substantial, the second also included a monetary incentive designed to rebate some of the dollar

savings to dormitory residents. This program achieved an additional reduction of 10 percent.

Another experiment investigated whether an "energy contest" could lead residents of master-metered apartments to reduce their energy consumption (McClelland and Cook, 1980b). An earlier study conducted during the summer indicated that dormitory residents competing for incentives achieved net changes of 4 to 14 percent in electricity consumption in each dorm (Newsom and Makranczy, 1978). McClelland and Cook (1980b) experimented with this method among groups of gas-heated apartments during the winter, bringing about reductions in natural gas use of about 7 percent.

The use of material incentives in master-metered settings is limited in scope and scale. However, one of the most interesting results of such studies indicates that conservation behavior persists significantly (McClelland and Belstein, 1979; Newsom and Makranczy, 1977). Residents may "gear up" for an individual or group incentive program by making a number of semi-permanent physical changes, such as using lower wattage light bulbs. Thus, offering residents in master-metered settings an incentive to make changes in their energy-consuming behavior may bring about long-lasting benefits. Since these benefits accrue for those who pay the utility bills, it would be in their interest to promote such programs in large apartment complexes or dormitories.

SOCIAL INCENTIVES

Unlike material incentives, social incentives appeal to people's intrinsic needs, such as gaining approval or maintaining self-esteem. One example of research conducted on this premise is provided in the

work of Pallak and his colleagues (Pallak and Cummings, 1976; Pallak, Cook, and Sullivan, 1980), who conducted several studies based on the notion of commitment. This idea argues that people will strive to maintain consistency between their public verbal pronouncements and their outward behavior.

For example, Pallak and Cummings (1976) discussed a variety of conservation strategies with homeowners and elicited their participation in one of two conditions. In the first, homeowners agreed to have their names appear in the local newspaper as residents who were trying to conserve energy. In the second, homeowners told the interviewer they would try to conserve, but they were not publicly identified. There was also a control group of homeowners who made no commitment, but agreed to provide access to their utility records. These conditions were examined in two studies--one in winter that determined consumption of natural gas; the other in summer that determined consumption of electricity.

Results were encouraging. In the first study, at the end of one month, differences in homeowner rates of gas consumption were 12 percent between the public commitment and control conditions, 3 percent between the private commitment and control conditions, and 9 percent between the public and private commitment conditions. In the second study, differences in the rates of electrical consumption were 24 percent between the public commitment and control condition, 4 percent between the private commitment and control condition, and 20 percent between the private and public commitment conditions. Follow-up studies indicated that these statistically significant differences persisted during the year following the studies (Pallak, Cook, and Sullivan, 1980).

A second example of a behavioral intervention based on principles of social incentives is described by Seaver and Patterson (1976). This study compared the effect on fuel oil consumption of feedback and social commendation for saving energy versus a feedback condition and a no-intervention control group during a winter's heating season. These researchers assumed that information about energy use, combined with social reinforcement for conserving energy, would promote conservation activities.

The feedback group was provided with a monthly statement of fuel oil use, compared to the same period a year earlier, adjusted for weather differences. Other households received feedback, and if they reduced their fuel oil consumption, they received a decal that said, "We Are Saving Oil." Fuel oil use was monitored for the delivery period that followed. Results indicated that households that received feedback plus commendation used the least fuel oil, followed by households that received consumption feedback, followed by the comparison group. The feedback plus commendation group differed significantly from the other groups, but the other groups did not differ from each other. In interpreting the failure of the feedback effort, it is important to note that consumers received feedback only once a month, and the comparison was to their use one year earlier.

V. COMPARING AND COMBINING STRATEGIES

As we have seen, impressive energy savings have resulted from techniques that originated with principles of behavioral science. Besides experimenting with individual approaches, some studies have compared the effectiveness of one type of technique compared to another. Others have examined combinations of techniques, compared to single techniques or other combinations of techniques. On a simple level, the conclusions drawn from these studies can be summarized as follows: (a) the most effective interventions are rebates, followed by feedback, followed by targeted information, followed by changing attitudes; and (b) combinations of these techniques can be extremely potent mechanisms for inducing energy conservation.

Hayes and Cone (1977), for example, performed an experiment during the winter with four volunteer families. The experiment was designed to compare the effectiveness of rebates, consumption feedback, and information on electrical consumption. They used a "multiple baseline, withdrawal" design that examined comparative effects of the different techniques on the same household over time. They found that a graduated rebate schedule produced a 33 percent reduction of electrical use from baseline, on average. Smaller rebates also produced considerable savings; feedback produced smaller savings, with information alone having little effect. Hayes and Cone (1977) also examined combinations of these effects. They found that payments combined with either information or feedback brought about reductions in electrical use of 21 to 43 percent from baseline, on average. These results are intriguing;

however, they must be viewed with caution because of the small, highly selective number of subjects, and the fact that the study confounded treatments with order and time of year.[1]

Experiments by Winett and his colleagues, discussed earlier, also offer comparisons between various techniques. Winett, Kaiser, and Haberkorn (1977) found that high rebates were more effective in reducing electrical consumption than feedback, and that small rebates were a little more effective than feedback alone. Winett et al. (1978) found that high rebates were more effective than low rebates, feedback, and information, respectively.

At the same time, Winett et al. (1978) also found that rebates of any size, combined with feedback and information, resulted in much larger electrical savings than information alone. This result indicates that there might be some synergistic effect in combining techniques to enhance energy conservation.

Another study that demonstrates the potency of combining different techniques was conducted as part of the Twin Rivers effort and demonstrates the effectiveness of an informational and motivational intervention (Becker, 1979). Consumption feedback was one variable in the study; some families received it and others did not. Another variable was goal-setting, which is said to have a motivational effect

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[1] The use of small numbers of subjects in multiple baseline designs is a method adapted from behavioral studies of operant conditioning in animals. Several of the early behavioral studies of energy consumption followed this procedure. They demonstrate energy savings of a huge order of magnitude. Palmer, Lloyd, and Lloyd (1977) obtained average decreases in consumption of 35 percent for feedback and prompts, for example. However, these studies have methodological problems: They did not use formal, statistical hypotheses tests; experimental conditions are confounded with the order in which they are administered; studies rarely adjust for changes in climate over the course of the study.

on performance (Locke, Cartledge, and Koeppel, 1968). Some families agreed to pursue a difficult goal (reduce electrical consumption 20 percent); other families agreed to pursue an easy goal (reduce consumption 2 percent). These variables were crossed to create four conditions--feedback, difficult goal; feedback, easy goal; no feedback, difficult goal; no feedback, easy goal. There was also a control group whose energy consumption was monitored, but who received no feedback and set no goals. Results indicated that the 20 percent feedback group consumed the least electricity; their average daily consumption was 13 percent less than the control group. In fact, they were the only group whose consumption was significantly different from the control group.[2]

Still another example is provided by Becker and Seligman (1978), who provided consumers with consumption feedback and a signaling device that indicated the opportunity to conserve. The signaling device indicated to consumers when the outside temperature was less than the indoor temperature, permitting savings in electrical air conditioning. Results showed a significant 15.7 percent decrease in energy use for households with the device that received consumption feedback. Thus, informational feedback combined with a prompt to conserve energy produced results with the use of these behaviorally oriented interventions.

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[2] The 2 percent feedback group used 5 percent less electricity than the control group; the no-feedback groups used approximately the same amount of electricity as the control group.

VI. CONCLUSIONS

The work described here pursued three main approaches to encouraging residential conservation behavior--attitudinal, cognitive, and motivational. All three of those approaches used experimental techniques to measure their success in promoting conservation.

The major findings of this research are:

- Changing attitudes about energy conservation may be useful (or even necessary) but is not sufficient to change behavior.
- Targeted communication designed to change attitudes is more effective than general messages, although neither is as effective as cognitive or motivational techniques.
- Feedback about energy use is an effective form of cognitive intervention in promoting conservation behavior.
- Motivation, especially in the form of rebates, is a highly effective technique for promoting conservation behavior.
- Combining techniques enhances the effects.

Based on our review of this research, we suggest two areas for additional work. First, the research already conducted has revealed methodological problems that should be considered in the design of other techniques. Second, this research has also revealed promising strategies that should be further explored.

METHODOLOGICAL DEVELOPMENT

As mentioned throughout this review, the measures used in much of the research are not well-established. Most have been developed in an ad hoc fashion to accommodate highly specific research interests. While this work provides a base of experience, it is now time to devote attention to developing and testing measures in several areas. The most obvious areas include attitudes toward conservation and conservation practices. Further, because self-reported conservation practices are frequently used as a dependent variable, consideration of specific practices is needed, and more work that links specific conservation practices to actual effects on energy consumption should be pursued. This, in turn, requires more sensitive measures of energy consumption, possibly through new technological developments.[1]

In addition to better measures, experiments that test the effects of strategies for promoting conservation should clearly spell out how the intervention should work and should provide tests not only of the end result, but also of the process. For example, does feedback work by changing attitudes, providing motivation, or simply by providing the option to monitor energy use? How do consumers reduce their energy use in response to these interventions? What energy use practices do they adopt or change? Can their response be guided toward more effective adjustments? This question leads, naturally, into additional work that will test the effectiveness of combining techniques for inducing energy conservation.

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[1] An example of this might be meters that provide measures of consumption for specific appliances.

APPLICATIONS

The second major area of research should be the practical application of promising strategies to current policy problems. This involves changing the scale of the research, making it more generalizable to policies that could be implemented on a large scale, as well as to problems that offer a greater payoff in energy savings.

For example, it is not currently feasible to provide the type of large-scale feedback tested in most experiments that we reviewed. But it is feasible to translate the strategy of feedback into providing useful consumption information to be included in regular utility bills. Experiments testing this proposition and exploring the questions of the proper metric (dollars, kilowatts, etc.) and form of comparison (previous use, other households' use, etc.) are a logical extension of the promising results on feedback.[2] It would also be useful to explore how this strategy could be combined with others, such as providing information or rebates, to enhance its effects. All demonstrations of these ideas, some now in progress, should include an evaluation component.

Another policy area concerns conservation activities that are more costly or difficult to implement but that offer large and continuing energy savings. As discussed earlier, higher-cost, lower-frequency conservation behaviors are under-practiced and under-researched. One possible research problem, for example, is that of purchase decisions for major appliances. Some programs that test promotion of the general

[2] For example, Kempton and Montgomery (1981) point out that dollars are a widely used "folk measure" of the effects of energy conservation practices, and that energy price changes may reduce observed results.

concept of life-cycle cost through mass media campaigns have already been carried out. Hutton (1982) reported small improvements in knowledge and awareness of concepts, but little behavior change. It would be fruitful to test the role of policies such as energy-consumption labeling to promote purchases of energy-efficient appliances. This involves testing the effects of both cognitive and motivational aspects of the purchase decision and using them to promote conservation decisions.

A second major purchase decision with great conservation potential is the retrofit of existing dwellings. As we discussed, major energy savings can be realized through changes to a dwelling's physical structure (Hirst and Talwar, 1981). Because of this potential, utilities are now required to provide audits for their customers, and a number of financial incentives for retrofits are available. Most research on promoting conservation will be important in solving this problem. For example, the roles of attitudes and knowledge are crucial in understanding consumer decisions. Also, financial incentives are a motivational intervention that is receiving little formal testing.

Pease (forthcoming) assembled information on the evaluations of the Residential Conservation Service programs that have been conducted using consumption as a dependent variable. While the results of the programs in terms of fuel savings were mixed, the evaluations revealed problems with a basic assumption: that market forces alone are sufficient to promote conservation investments. Consumers, it was found, have little understanding of the economics of conservation investments. Their expectations about costs of investments and acceptable payback periods were inaccurate and unrealistic. This suggests that while economic

incentives can motivate change, more research is needed on how to communicate economic concepts in an effective manner to consumers, and on how to help consumers channel that motivation into effective actions that will promote conservation.

In summary, early behavioral research on promoting energy conservation has yielded promising results. Based on this demonstrated potential, it is time to refine the quality of the research and examine its usefulness on a greater variety of energy policy problems.

REFERENCES

Acton, J. Paul, W. G. Manning, Jr., and B. M. Mitchell, Lessons To Be Learned from the Los Angeles Rate Experiment in Electricity, The Rand Corporation, R-2113-DWP, July 1978.

Ammons, R. B., "Effects of Knowledge on Performance: A Survey and Tentative Theoretical Formulation," Journal of General Psychology, Vol. 54, 1956, pp. 279-299.

Baird, J. C., and J. M. Brier, "Perceptual Awareness of Energy Requirements of Familiar Objects," Journal of Applied Psychology, Vol. 66, 1981, pp. 90-96.

Beck, P. A., S. J. Doctors, and P. Y. Hammond, Individual Energy Conservation Behaviors, Oelgeschlager, Gunn, and Hain Publishers, Cambridge, Massachusetts, 1980.

Beck, P. A., "Correlates of Energy Conservation," Public Policy, Vol. 28, 1980, pp. 451-471.

Becker, L., "Joint Effect of Feedback and Goal Setting on Performance: A Field Study of Residential Energy Conservation," Journal of Applied Psychology, Vol. 63, August 1978, pp. 428-433.

Becker, L., and C. Seligman, "Reducing Air Conditioning Waste by Signalling It Is Cool Outside," Personality and Social Psychology Bulletin, Vol. 4, 1978.

Becker, L., C. Seligman, and J. M. Darley, Psychological Strategies to Reduce Energy Consumption: Project Summary Report, Report PU/CEES 90, Center for Energy and Environmental Studies, Princeton University, June 1979.

Becker, L. J., C. Seligman, R. H. Fazio, and J. M. Darley, "Relating Attitudes to Residential Energy Use," Environment and Behavior, Vol. 13, No. 5, September 1981, pp. 590-609.

Bittle, R. G., et al., "The Effects of Daily Cost Feedback on Residential Energy Consumption," Behavior Modification, Vol. 3, No. 2, April 1979, pp. 187-202.

Burby, R. J., et al., "Promoting Load Management Programs in North Carolina: Efficient Strategies for Meeting Market Penetration Goals in the Residential Sector," Research proposal submitted by University of North Carolina at Chapel Hill, December 1981.

Burnette, P., and D. C. Carner, "California's Residential Energy Commission Profiles," in R. A. Fazzolare and C. B. Smith (eds.), Changing Energy Use Futures, Vol. 2, Pergamon Press, New York, 1979.

Carlyle, J., and E. S. Geller, Behavioral Approaches to Reducing Residential Energy Consumption: A Critical Review, Department of Psychology, Virginia Polytechnic Institute and State University, Blacksburg, 1978.

Cook, S. W., and J. L. Berrenberg, "Approaches to Encouraging Conservation Behavior: A Review and Conceptual Framework," Journal of Social Issues, Vol. 37, 1981, pp. 73-107.

Craig, C. S., and J. M. McCann, "Communicating Energy Conservation Information to Consumers: A Field Experiment," in B. A. Greenberg and D. A. Bellinger (eds.), Contemporary Marketing Thought, American Marketing Association, Chicago, 1977, pp. 432-436.

Craig, C. S., and J. M. McCann, "Assessing Communication Effects on Energy Conservation," Journal of Consumer Research, Vol. 5, 1978a, pp. 82-88.

Craig, C. S., and J. M. McCann, "The Impact of Persuasive Communications on Energy Conservation," Energy Systems and Policy, Vol. 2, No. 4, 1978b, pp. 433-447.

Cunningham, W., and S. C. Lopreato, Energy Use and Conservation Incentives, Praeger Publishers, New York, 1977.

Ellis, P., and G. Gaskell, A Review of Social Research on the Individual Energy Consumer, London School of Economics and Political Science, September 1978.

Farhar, B. C., P. Weis, C. T. Unseld, and B. A. Burns, Public Opinion about Energy: A Literature Review, Solar Energy Research Institute, SERI-TR-53-155, Golden, Colorado, 1979.

Fritzsche, D. J., "An Analysis of Energy Consumption Patterns by Stage of Family Life Cycle," Journal of Marketing Research, Vol. 18, May 1981, pp. 227-232.

Hayes, S. L., and J. D. Cone, "Reducing Residential Electrical Energy Use: Payments, Information, and Feedback," Journal of Applied Behavior Analysis, Vol. 10, 1977, pp. 425-435.

Heslop, Louise A., Lori Moran, and Amy Cousineau, "'Consciousness' in Energy Conservation Behavior: An Exploratory Study," Journal of Consumer Research, Vol. 8, December 1981, pp. 299-305.

Heberlein, T. A., "Conservation Information: The Energy Crisis and Electricity Conservation in an Apartment Complex," Energy Systems and Policy, Vol. 1, 1975, pp. 105-117.

Hirst, E., et al., "Evaluating Telephone Energy Conservation Information Centers in Minnesota," Journal of Environmental Systems, Vol. 10, No. 3, 1981, pp. 229-247.

Hirst, E., and R. Talwar, "Reducing Energy Consumption in Low-Income Homes: Evaluation of the Weatherization Program in Minnesota," Evaluation Review, Vol. 5, No. 5, October 1981, pp. 671-685.

Hutton, Bruce, "Advertising and the Department of Energy's Campaign for Energy Conservation," Journal of Advertising, Vol. 11, 1982, pp. 27-39.

Katzev, R., L. Cooper, and P. Fisher, "The Effect of Feedback and Social Reinforcement on Residential Electricity Consumption," Journal of Environmental Systems, Vol. 10, 1981, pp. 215-228.

Kempton, W., and L. Montgomery, "Folk Quantification of Energy," Michigan Agricultural Experiment Station, Journal Article No. 9987, October 1981.

Klapper, J. T., The Effects of Mass Communication, The Free Press, Glencoe, Illinois, 1960.

Larson, O. N., "Social Effects of Mass Communication," in R. E. L. Farris (ed.), Handbook of Modern Sociology, Rand McNally, Chicago, 1964.

Locke, E. A., N. Cartledge, and J. Koeppel, "Motivational Effects of Knowledge of Results: A Goal-Setting Phenomenon?" Psychological Bulletin, Vol. 70, 1968, pp. 474-485.

Marsden, M. E., and M. W. McKinney, "Household Behavior in Energy Conservation," in Raymond J. Burby and Mary Ellen Marsden (eds.), Energy and Housing, Oelgeschlager, Gunn, and Hain Publishers, Cambridge, Massachusetts, 1980.

McClelland, L., and L. Belstein, "Promoting Energy Conservation in University Dormitories by Physical, Policy, and Resident Behavior Changes," Journal of Environmental Systems, Vol. 9, 1979, pp. 29-38.

McClelland, L., and S. W. Cook, "Energy Conservation Effects of Continuous In-Home Feedback in All-Electric Homes," Journal of Environmental Systems, Vol. 9, 1979, pp. 169-173.

McClelland, L., and S. W. Cook, "Energy Conservation in University Buildings: Encouraging and Evaluating Reductions in Occupants' Energy Use," Evaluation Review, Vol. 4, 1980a, pp. 110-133.

McClelland, L., and S. W. Cook, "Promoting Energy Conservation in Master-Metered Apartments Through Group Financial Incentives," Journal of Applied Social Psychology, Vol. 10, 1980b, pp. 10-31.

McDougall, G. H., "Consumer Reaction to Energy Conservation Messages: An Experimental Design," Proceedings of the American Marketing Association, 1980.

McGuire, W. J., "The Nature of Attitudes and Attitude Change," in G. Lindzey and E. Aronson (eds.), Handbook of Social Psychology, Vol. 3, Addison-Wesley Publishers, Reading, Massachusetts, 1969, pp. 136-314.

Menninger, K., The Crime of Punishment, Viking Press, New York, 1966.

Milstein, J. S., Attitudes, Knowledge, and Consumer Behavior of American Consumers Regarding Energy Conservation with Some Implications for Governmental Action, U.S. Department of Energy, DOE/TIC-10713, October 1976.

Murray, J. R., M. J. Minor, N. M. Bradburn, R. F. Cotterman, M. Frankel, and A. E. Pisarski, "Evolution of Public Response to Energy Crisis," Science, Vol. 184, April 1974, pp. 257-263.

Newman, D. K., and D. Day, The American Energy Consumer, Ballinger Publishing Company, Cambridge, Massachusetts, 1975.

Newsom, T. J., and U. J. Makranczy, "Reducing Electricity Consumption of Residents Living in Mass Metered Dormitory Complexes," Journal of Environmental Systems, Vol. 1, 1977, pp. 215-236.

Olsen, M. E., "Consumers' Attitudes Toward Energy Conservation," Journal of Social Issues, Vol. 37, 1981, pp. 108-131.

Olsen, M. E., "Public Acceptance of Energy Conservation," in S. Warkov (ed.), Energy Policy in the United States: Social and Behavioral Dimensions, Praeger Publishers, New York, 1978, pp. 91-109.

Olsen, Marvin E., and C. Cluett, Evaluation of the Seattle City Light Neighborhood Energy Conservation Program, Battelle Human Affairs Research Center, Seattle, 1979.

Pallak, M. S., D. A. Cook, and J. J. Sullivan, "Commitment and Energy Conservation," in L. Bickman (ed.), Applied Social Psychology Annual, Vol. 1, Sage Publications, Beverly Hills, 1980.

Pallak, M., and W. Cummings, "Commitment and Voluntary Energy Conservation," Personality and Social Psychology Bulletin, Vol. 2, Winter 1976, pp. 27-30.

Palmer, M. H., M. E. Lloyd, and K. E. Lloyd, "An Experimental Analysis of Electricity Conservation Procedures," Journal of Applied Behavior Analysis, Vol. 10, 1977, pp. 665-672.

Pease, S. R., An Appraisal of Utility Residential Energy Conservation Program Evaluations, The Rand Corporation, N-1925-DOE, forthcoming.

Rappeport, M., and P. Labaw, Consumer Behavior and Attitudes Toward Energy-Related Issues: Highlight Report, Opinion Research Corporation, March 1975, p. 34.

Ritchie, J., R. Brent, John D. Claxton, and Gordon H. G. McDougall, "Consumer Energy Conservation Options--Professional and Consumer Perspectives," Consumer and Corporate Affairs, Ottawa, Canada, 1981.

Root, T., "Energy and Utilities: A Detailed Look at More Than 100 Public Opinion Polls," Electric Perspectives, Vol. 78, 1978, pp. 1-3.

Sears, D. O., T. R. Tyler, J. Citrin, and D. R. Kinder, "Political System Response to the Energy Crisis," American Journal of Political Science, Vol. 22, 1978, pp. 56-82.

Seaver, W. B., and A. H. Patterson, "Decreasing Fuel Oil Consumption Through Feedback and Social Commendation," Journal of Applied Behavior Analysis, Vol. 9, No. 2, 1976, pp. 145-152.

Seligman, C., and J. M. Darley, "Feedback as a Means of Decreasing Residential Energy Consumption," Journal of Applied Psychology, Vol. 62, 1977, pp. 363-368.

Seligman, C., M. Kriss, J. M. Darley, R. H. Fazio, L. J. Becker, and J. B. Pryor, "Predicting Residential Energy Consumption from Homeowners' Attitudes," Journal of Applied Social Psychology, Vol. 9, 1979, pp. 70-90.

Shippee, G., "Energy Consumption and Conservation Psychology: A Review and Conceptual Analysis," Environmental Management, Vol. 4, 1980, pp. 297-314.

Sinden, F. W., "A Two-Thirds Reduction in the Space Heat Requirement of a Twin Rivers Townhouse," Energy and Buildings, Vol. 1, 1977, pp. 243-260.

Skinner, B. F., Beyond Freedom and Dignity, Alfred A. Knopf, New York, 1971.

Socolow, R. H., "The Twin Rivers Program on Energy Conservation in Housing: Highlights and Conclusions," Energy and Buildings, Vol. 1, 1977-78, pp. 207-242.

Sonderegger, R. C., "Movers and Stayers: The Resident's Contribution to Variation across Houses in Energy Consumption for Space Heating," Energy and Buildings, Vol. 1, 1977-78, pp. 313-324.

Stern, P. C., and G. Gardner, "Psychological Research and Energy Policy," American Psychologist, Vol. 36, 1981, pp. 329-342.

Tuso, M. A., and E. S. Geller, "Behavioral Analysis Applied for Ecological Rebalance: A Review," Journal of Applied Behavior Analysis, Vol. 9, 1976, p. 526.

Verhallen, Theo M. M., and W. Fred Raaij, "Household Behavior and Energy Use," in John D. Claxton, C. Dennis Anderson, J. R. Brent Ritchie, and Gordon H. G. McDougall (eds.), Consumers and Energy Conservation, Praeger Publishers, New York, 1981, pp. 32-45.

Vertinsky, P., "The Use of Mass Communication Strategies to Promote Life-Style Change," in P. Nemetz (ed.), Energy Policy: The Global Challenge, Institute for Research on Public Policy, Montreal, Canada, 1979, pp. 383-410.

Walker, J. M., "Energy Demand Behavior in a Master-Metered Apartment Complex: An Experimental Analysis," Journal of Applied Psychology, Vol. 64, 1979, pp. 190-196.

Winett, R. A., "Prompting Turning-Out Lights in Unoccupied Rooms," Journal of Environmental Systems, Vol. 6, 1977, pp. 237-241.

Winett, R. A., "An Emerging Approach to Energy Conservation," in D. Glenwick and L. Jason (eds.), Behavioral Community Psychology: Progress and Prospects, Praeger Publishers, New York, 1979.

Winett, R. A., J. H. Kagel, R. C. Battalio, and R. Winkler, "The Effects of Monetary Rebates, Feedback, and Information on Residential Electricity Conservation," Journal of Applied Psychology, Vol. 63, 1978, pp. 73-80.

Winett, R. A., S. Kaiser, and G. Haberkorn, "The Effects of Monetary Rebates and Daily Feedback on Electricity Consumption," Journal of Environmental Systems, Vol. 5, 1977, pp. 327-338.

Winett, R. A., and M. Neale, "Psychological Framework for Energy Conservation in Buildings: Strategies, Outcomes, Directions," Energy and Buildings, Vol. 2, 1979b, pp. 101-116.

Winett, R. A., M. Neale, and H. C. Grier, "The Effects of Self-Monitoring and Feedback on Residential Electricity Consumption: Winter," Journal of Applied Behavior Analysis, Vol. 12, 1979a, pp. 173-184.

Winett, R. A., M. S. Neale, K. W. Williams, W. Yokley, and H. Kauder, "Effects of Feedback on Residential Electricity Consumption: Three Replications," Journal of Environmental Systems, Vol. 8, No. 3, 1978, pp. 217-233.

Winett, R. A., and M. Nietzel, "Behavioral Ecology: Contingent Management of Residential Use," American Journal of Community Psychology, Vol. 3, 1975, pp. 123-133.