THE EFFECTIVENESS OF AN ENERGY SPECIALIST AND EXTENSION AGENTS IN PROMOTING SUMMER ENERGY CONSERVATION BY HOME VISITS*

RICHARD A. WINETT

SUSIE Q. LOVE

Virginia Polytechnic Institute and State University

CHARLOTTE KIDD

Virginia Cooperative Extension Service

ABSTRACT

This summer project focused on lower-income consumers (N = 52 households) living in Section Eight, all-electric apartments that were dispersed around the city of Roanoke, Virginia. It extended prior work by attempting to develop and evaluate a simple way to promote energy savings for apartment dwellers. The effectiveness of extension agents and a trained energy specialist in delivering the interventions by home visits was compared. The results indicated that relative to prior baseline use and control groups, the technician and extension groups reduced electricity use by about 21 per cent; on warm days use was reduced by about 24 per cent, while on cooler days, electricity was reduced by about 9 per cent. The technician and extension groups performed about the same, although the technician group showed a somewhat more consistent and enduring response.

Numerous studies have shown that psychologically-based strategies can reduce residential energy consumption at least in the short-run [1, 2]. Most effective of these strategies are behavioral consequence procedures such as monetary rebates contingent on reduced consumption and frequent feedback on energy

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use. However, these strategies have infrequently been implemented on a large-scale because of cost, logistical, and political considerations [2]. Antecedent strategies such as providing information by brochures, booklets, by telephone "hotlines" or through workshops, have at most promoted only very marginal energy savings [1–4]. This is unfortunate since these antecedent strategies are generally low-cost, and politically and publically acceptable. However, recently the first author has argued that most field-tested antecedent strategies have been poorly designed from the perspective of efficacious informational, educational, or communication strategies [5]. For example, when conservation strategies have been explicitly demonstrated in videotape programs which incorporated facets of behavioral modeling [6] and communications strategies [7], significant reductions in electricity were found [8].

At the same time that more effective persuasion and behavior influence procedures are being developed, it is equally important to devise and promote simple low-cost, no-cost conservation plans. Recent research has shown that energy savings from thermostat setbacks, hot-water heater thermostat lowering, and some passive solar strategies can be substantial, and considerably more than had been expected in the past [8–10]. An important conservation tactic involves persuading consumers to adopt these no-cost, low-cost approaches, and wherever, and whenever, feasible to *substitute* low energy consuming appliances or practices for high energy consuming practices. For example, in a project conducted in the summer, consumers were asked to close all windows, shades, blinds, and doors in the morning; use window fans in the evening for cooling, and only use air conditioning (set between 78°-80° F) on extremely hot days. Data showed that consumers adopted facets of this overall plan, were able to maintain a comfortable temperature in their homes ($\overline{x}$ = 77°F), but reduced electricity used for cooling by 35 per cent [8].

Within this framework, the current study had a number of objectives, including:

1. To further develop other effective antecedent strategies that could be used by energy or extension services. In this project, home visits were used in a manner similar to aspects of the "house-doctor" model advocated by others [11]. The house-doctor is seen as a technician-level energy specialist who can demonstrate conservation behaviors, implement simple retrofits, and recommend other more costly retrofits. The house visits in this project were used to focus on two high energy consuming targets – air conditioning and heating of hot water.
2. To replicate the feasibility of substituting window fans and the practices enumerated above for air conditioning while maintaining comfort in typical residential low-rise apartment buildings.
3. To ascertain if these startegies could work with a low-income population. The first author has argued that aside from weatherization, conservation programs focusing on changes in practices should not be targeted to

low-income groups since their consumption is quite low, i.e., the potential cost-benefit compared to middle and upper income groups is minimal [12]. However, lower income groups may be highly motivated to change since their income expended for energy ("budget share") is quite high [13].

Thus, the feasibility and effectiveness of home visits with low income people stressing simple low-cost, no-cost strategies focusing on air conditioning and water heating were investigated in this field study.

METHOD

Participants and Setting

The participants were thirty-nine families living in Section Eight housing in Roanoke, Virginia. Under Section-Eight guidelines, families received income subsidies for housing and utilities based on current income and local utility rates and weather. People under this plan were eligible to live in any dwelling that met subsidy and structural criteria. In practice, while people on this plan were scattered across the city, they tended to be concentrated in a number of low-rise apartment complexes built approximately ten years ago. All the apartments were similar in that they were all-electric, had similar appliances (refrigerator, stove, diswasher, thirty-gallon water tank with fiberglass insulation), and were centrally air conditioned. The air conditioning in all apartments was controlled by one thermostat located in a hallway near the front door.

Participant families were provided a utility subsidy that each month was reflected in a reduced rental payment. The subsidy accounted for number of rooms and number of exposed walls and amounted to a mean of about $47, or about thirty kWh per day under the prevailing rates at the time of the study. The subsidy remained constant across months, and although it was deducted from the rental fee, all participants had to pay each month's utility bill in full.

Recruitment and Assignment to Groups

Families in Section-Eight housing were sent a letter from the City Redevelopment Housing Authority indicating that the Virginia Tech Extension Service was initiating an experimental program on energy conservation. The note said that participants would be shown conservation strategies and receive a window fan on loan for the summer. Following door-to-door recruitment strategies described elsewhere [14], forty-one families agreed to participate (of seventy families contacted) with thirty-nine families eventually participating.[1,2]

[1] Three families moved between the time of recruitment and the baseline period.

[2] Data for three households were only available for the first half of the intervention period, but were included in the analyses. One household was from the technician group, and two were from the nonvolunteer control group.

Participants were assigned to three different groups following a stratified random assignment procedure based on baseline kWh consumption. The groups were also balanced for the floor where the apartments were located.

The three groups were:

1. *Energy-technician (N = 14)* – This group received home visits and instruction from author two. It was felt that her greater focus and commitment to the project could yield larger energy savings that may not be replicable by an extension service with many other commitments. Such a finding would suggest a more specialized house-doctor.
2. *Energy-extension (N = 13)* – This group received home visits and instruction from extension agents who were *trained* by author two, with that training lasting about one hour. Three different agents performed the visits, were familiar with participant families, but had no prior training in energy conservation, and were involved in many other activities during the project. Each agent visited three or four families.
3. *Control group (N = 12)* – Participants in this group received no visits or training. After being informed that they were in the control group, the families received no additional contact.

In addition, a group of *nonvolunteer* households (N = 13) who lived in the same apartment complexes as the volunteers was used to assess the effects of volunteering for a project and representatives of the volunteer families. This group also provided a greater number of households to correct data for weather variation (described below), but aside from the initial decline by the families to participate in the project, there was no further contact between project staff and this group.

Table 1 shows the mean, range, and standard deviation for the kWh per day, per household, of the four groups.

Table 1. Mean, Range, and Standard Deviation for kWh Per Day, Per Household for the Groups at Baseline

Group	*n*	*Mean*	*Range*	*S. D.*
Technician	14	27.2	6.1 – 42.2	9.5
Extension	13	25.3	12.9 – 41.5	9.9
Volunteer Control	12	23.0	6.3 – 54.0	12.8
Nonvolunteer Control	12	26.6	16.8 – 41.6	8.6

Home Visits Procedures

The home visits focused on hot water heating and air conditioning. The procedures in the first home visit for hot water involved:

1. turning down the hot water heater thermostat to 130°F (the mean setting prior to the visits was 150°F);
2. providing a family with a set of written rules for turning the hot water heater off and on; identifying for the family the hot water circuit breaker and posting the hot water heater rules written on a 3" X 5" slip in the kitchen (the hot water heater and circuit breaker were located in a pantry in the kitchen); and
3. the rules were turning off the hot water when arising, turning on the hot water thirty minutes before evening use and leaving the hot water on through the night; and, noting that more savings could be accrued by turning off the hot water after use in the evening.

The procedures and rules for air conditioning were :

1. *morning and afternoon* – on days hotter than 80°F outside, close all windows, shades and drapes; when less than about 80°F, leave the above open; use air conditioning only if hotter than about 90°F outside and set the thermostat between 78°-80°F; close down apartment as above when air conditioning was on;
2. *fans* – each family was provided with one twenty-inch window fan on loan for the summer (the wholesale cost of each is about $12-$15); and
3. *night* – place fan in a window with air blowing in (the configuration of the apartments were more suitable for spot cooling); place fan first in the room of persons going to sleep first, and then move to other rooms, and turn off the fan in the morning and put on the floor – safety instructions were also provided with the fan and participants were told not to use the fans and air conditioning at the same time.

Hot water and air conditioning rules were also given to families during the first visit on 8" X 14" sheets. The first visit took approximately fifteen minutes per household and at least one adult (generally, a woman) was present. The second visit took about five minutes; was conducted about two weeks after the first visit with the same adult(s) as visit one, was used to review the rules, spot and discuss any problem in following the rules, and encourage the participants' efforts.

Thus, the procedures focused on changing the hot water heater setting and limiting the time the hot water was on; only using air conditioning when it was extremely hot and setting the air conditioning thermostat between 78°-80°F; clsoing down the home in the morning, and using a window fan at night for spot cooling. Changes in the hot water heating setting, providing the fan, and rules and instructions were given in two brief home visits by an energy specialist or an extension agent.

Design and Dependent Measures

The study included a two and a half week baseline period (June and July), followed by the visits (mid-July), with no additional contact until the concluding visit for an interview (mid-September).

The major dependent measure was electricity consumption based on bi-weekly meter readings. In addition, a procedure used previously [14] was used to account for vacations, absences, etc., and was based on a weather correction system. That is, a reading for a period (kWh consumption for a household) was dropped from the data when: (kWh mean for a household for a time period ÷ baseline kWh mean for a household) ÷ (overall sample kWh mean for a time period ÷ overall sample kWh mean for the baseline) $< .50$. However, individual household data was dropped on only 2.5 per cent of occasions.

The second dependent measure consisted of a short structured interview given at the end of the data recording period to ascertain how and when participants followed procedures and problems encountered.

RESULTS

Inspection and analysis of the data indicated no differences prior to intervention on mean kWh use per household between the technician group ($\bar{x}$ = 27.2) and extension group ($\bar{x}$ = 25.3), or between the volunteer ($\bar{x}$ = 23.0) and nonvolunteer ($\bar{x}$ = 26.6) control groups. These groups were combined to form an experimental (N = 27; $\bar{x}$ = 26.3), and control group (N = 24; $\bar{x}$ = 24.8). Electricity data were analyzed with a 2 X 2 time by group analysis of variance using household mean kWh use for the baseline and intervention phases. The analysis indicated no significant effect by group, $F(1, 49) = .31$, ns; or time, $F(1, 49) = .03$, ns; but a significant group by time interaction, $F(1, 49) = 14.8$, $p < .001$. The Duncan's test indicated that the experimental group significantly ($p < .05$) *decreased* kWh consumption ($\bar{x}$ = 26.3 to $\bar{x}$ = 23.6), while the control group significantly ($p < .01$) *increased* kWh consumption ($\bar{x}$ = 24.8 to $\bar{x}$ = 28.2). Between group comparisons indicated no significant differences at baseline, but for the intervention period the control group ($\bar{x}$ = 28.1) had a higher mean kWh use ($p < .01$) than the experimental group ($\bar{x}$ = 23.6).

Weather bureau temperature data indicated a higher mean high temperature during intervention (84.5°F) than during baseline (80.7°F). Thus, as expected, the control group increased electricity use during the intervention phase, but the experimental group was able to decrease use despite higher temperatures. In addition, analysis with the original four groups showed that the two experimental groups (technician = 89% of baseline use; extension = 93%) and the two control groups (volunteer = 120%; nonvolunteer = 109%) performed about the same. This point is discussed further in a later section.

A rough estimate of percentage reduction for the experimental groups is: intervention kWh use ÷ baseline kWh use = 23.6 ÷ 26.3 = .90; divided by the

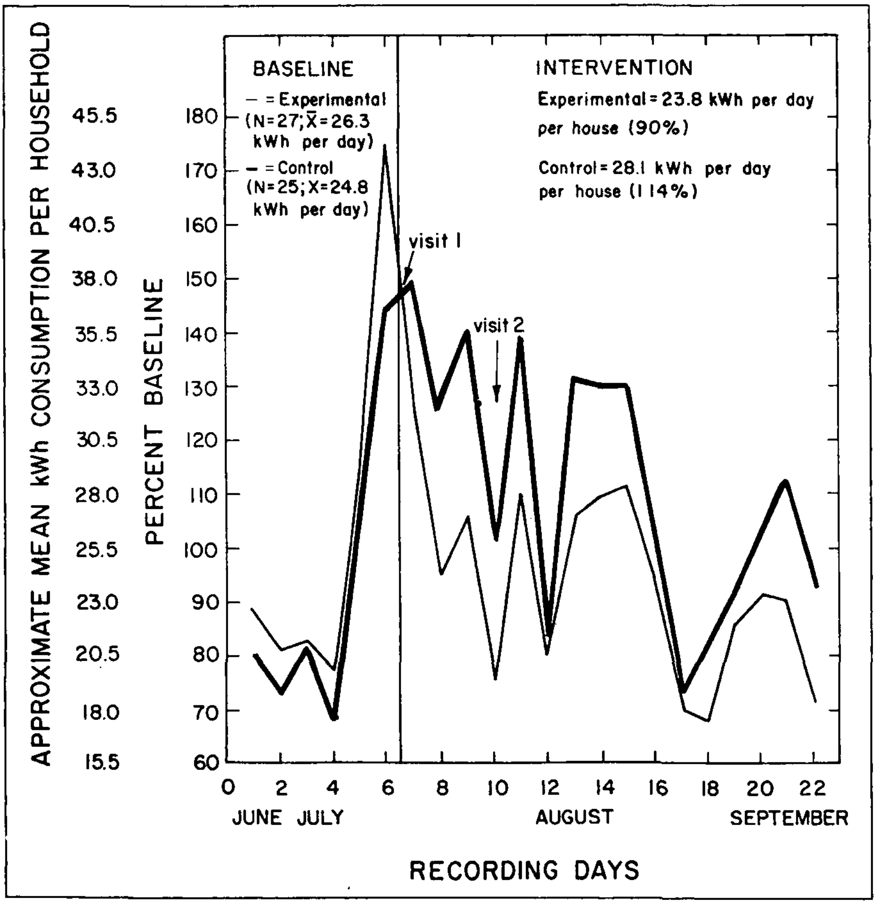

Figure 1. Mean kWh use per household per day across phases of the study represented as per cent baseline and approximate kWh use.

control group's performance, 28.2 ÷ 24.8 = 1.14; .90 ÷ 1.14 = .79, or a 21 per cent reduction.

Figure 1 shows the approximate mean kWh consumption per household and per cent of baseline mean for the intervention and control groups from late June (baseline) through to mid-September. Electricity consumption closely follows the weather (high temperature), i.e., for air conditioning. Unfortunately, for purposes of fully testing the program, the mean high August temperature was unseasonably cool (84.7°F compared, for example, to 90°F the prior year). Nevertheless, the figure generally shows that large differences between groups occurred for very warm periods. For recording periods when the control groups used more than 100 per cent of baseline (ten periods), the mean difference between groups was 24.2 per cent. For the other six cooler periods, the difference was 9.3 per cent. In addition, most very warm weather occurred between or shortly after the home visits somewhat obscuring the longer-term outcomes of the intervention.

Individual and Interview Data

An analysis of individual household data indicated that 59 per cent (sixteen of twenty-seven) households in the intervention groups compared to only 4 per cent (one of twenty-five) in the control groups reduced kWh consumption compared to the baseline period by $\geq$ 6 per cent.

An analysis of the technician and extension groups suggested stronger and more enduring responsiveness in the technician group. For example, ten of fourteen (71%) technician group households, but only six of thirteen (46%) extension households reduced consumption by $\geq$ 6 per cent. Then, too, during the last month of the project, the technician group performed better than the extension group by about 10 per cent.

A further inspection of the data indicated that on cooler days the technician group was consistently superior to the extension group. This finding suggests that the technician group was more diligent in turning the hot water on and off than the extension group.

Structured home interviews conducted in mid-September focused on strategies participants followed and the convenience-inconvenience, or comfort-discomfort that resulted from following the designated strategies. These interviews indicated that almost all participants adopted at least one or more strategy (closing down home; water heater on and off; etc.), with most participants adopting the strategies to their own situation. For example, some participants reported using air conditioning during the afternoon, but the fan only at night. Inspection of the interview data indicated that following more strategies was associated with greater electricity savings. As suggested by the electricity data, there was attendency for the technician group to report following more strategies than the extension group. All but two participants reported that the use of the fan made their home "comfortable" for sleep and that turning the hot water on and off was "not inconvenient" and still resulted in ample hot water for household functions.

DISCUSSION

The results of the present study showed that brief home visits, focusing on high energy consumption practices, and using simple low-cost retrofits and no-cost changes in practices were effective in reducing the energy consumption of low-income residents. The electricity data and self-report data indicate that greater energy savings were accruable from use of the window fan used to spot cool and partly replace air conditioning, while lesser, though still meaningful savings were found from changes in hot water heating settings and practices. Participants also apparently found that the fan was usually a good substitute for air conditioning and reported "comfort" with its use. Although the summer for testing this program was cool, the results essentially replicate prior work done during a very hot summer with middle-class residents [8]. The results from the prior study suggest that savings would have been *much greater* in the present study during a warmer summer.

The savings from the hot water manipulations were somewhat less than expected [9] and were probably attributable to:

1. the water heaters being well insulated, and that
2. during warm weather and high interior temperatures, the interventions will probably yield less savings.

This last point needs to be verified in a winter study. However, it is important to note that whatever savings are accruable from turning the thermostats from a baseline mean of about 150°F to 130°F are *permanent* (assuming settings are not turned up again, which participants reported not doing) regardless of new occupancy of the apartment.

The finding of minimal differences between the groups served by the energy technician (author two) and the three extension agents suggest that the general procedures were easy to communicate to staff and participants. It may, however, be expected that as procedures become more complex that a trained technician may be more successful than extension agents or similar personnel. It is also not clear how many home visits are optimal, and, of course, home visits are a major expense. These points need to be further assessed. However, the general approach and findings are supportive of the more comprehensive "house-doctor" model that has been advocated for several years, but not implemented on a wide scale [2], and also consistent with the argument that better developed, more focused, antecedent strategies can be effectively used to modify resource consumption [5]. It is also important to note that in this project a much more active approach compared to, for example, Residential Conservation Services programs was used. Rather than have residents respond to an ad, and then call a utility or extension service, the residents' involvement was directly solicited. This is still an entirely voluntary procedure, but consistent with research evidence showing that an active and direct approach is often necessary for effective program dissemination and implementation [15].

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Direct reprint requests to:

Richard Winett
Associate Professor, Psychology Department
Virginia Polytechnic Institute and
State University
Blacksburg, Virginia 24061