FINAL EVALUATION OF AN RCS PROGRAM ALTERNATIVE: THE SANTA MONICA ENERGY FITNESS PROGRAM

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ABSTRACT

From May 1984 through May 1985, the City of Santa Monica operated an innovative home energy audit program designed to test alternative approaches to the federally-mandated Residential Conservation Service (RCS) Program, the program under which virtually major utility companies in the nation have offered their customers energy conservation audits and recommendations since the early 1980's.

The Santa Monica effort, known as the Santa Monica Energy Fitness Program, used new techniques designed to increase participation in the RCS Program by utility customers, particularly by "target groups", as well as improve the energy savings achieved by participants. These "target groups" include senior citizens, low-income residents, and renters of multifamily housing. Two particularly important techniques were the use of a door-to-door canvass as the primary means of offering the program to Santa Monica residents and the completion of a "direct service" home energy audit, which includes the actual on-site installation of energy saving devices in the participant's home.

As a consequence of the Energy Fitness Program's approach, participation in the program ranks among the highest (if not the highest) ever achieved by an RCS Program, the participation of "target groups" is in near-exact proportion to their actual representation within Santa Monica's population, and program costs and energy savings are comparable to, if not an improvement on, those associated with most traditional RCS Programs.

This paper provides a brief summary of the unique elements of the Energy Fitness Program's approach, describes the components of the experimental design by which the Santa Monica effort was completed, and presents the final results of the evaluation performed to measure the Program's effectiveness. The evaluation discussion will particularly focus on program participation and net savings in natural gas, electricity, and water resources achieved by participants.

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I. INTRODUCTION

From May 1984 through May 1985, the City of Santa Monica, California operated an innovative home energy audit program designed to test alternative approaches to the federally-mandated Residential Conservation Service (RCS) Program, the program under which virtually all major utility companies in the nation have offered their customers energy conservation audits and recommendations since the early 1980's.

The Santa Monica effort, known as the Santa Monica Energy Fitness Program, used new techniques designed to increase participation in the RCS Program by utility customers, particularly by "target groups", as well as improve the energy savings achieved by participants. These "target groups" include senior citizens, low-income residents, and renters of multifamily housing. The two most important techniques utilized were a door-to-door canvass as the primary means of offering the program to Santa Monica residents and the completion of a "direct service" home energy audit, which includes the actual on-site installation of energy saving devices in the participant's home.

As a consequence of the Energy Fitness Program's approach, participation in the program ranks among the highest (if not the highest) ever achieved by an RCS Program, the participation of "target groups" is in close proportion to their actual representation within Santa Monica's population, and program costs and energy savings are comparable to, if not an improvement on, those associated with most traditional RCS Programs.

The purpose of this paper is to summarize the unique elements of the Energy Fitness Program's design (Section II) and to present the final results of the evaluation performed to measure the Program's effectiveness, particularly in terms of participation and energy savings (Section III).

II. UNIQUE PROGRAM ELEMENTS

The Santa Monica Energy Fitness Program was approved as an official RCS Program by the California Energy Commission and the California Public Utilities Commission, its auditors were RCS-certified, and the recommendations for conservation measures provided by auditors were sufficient for residents to receive tax credits for completing the recommended measures. However, the services offered by the Energy Fitness Program differed from most traditional RCS Program approaches in four major ways:

1. Every Santa Monica resident was eligible to participate in the program, regardless of the number of units in the building in which they lived, the type of heating system they used, or whether they owned or rented;

2. The Program's home energy audits were delivered through a door-to-door canvass of Santa Monica neighborhoods (with residents receiving at least two notifications prior to the auditors' arrival), rather than solicited through more traditional forms of program promotion;

3. Residents were provided cost, savings, and payback information during the energy audit which had been pre-calculated for "generic" or "standard" housing types in Santa Monica, rather than having measurements and/or calculations performed for each individual residence; and

4. The program's energy auditors provided and installed, free of charge and at the time of the energy audit, up to three of the following types of energy saving devices: water heater insulation jackets, energy efficient showerheads, energy efficient faucet aerators, water heater pipe insulation, and doorsweep weatherstripping.

In essence, these innovative delivery techniques were designed to increase participation in the program by having the broadest possible eligibility requirements and offering the program door-to-door, to shorten the length of the audit without significantly reducing the quality of the recommendations provided by using "generic" cost and savings information, and to improve energy savings and program cost-effectiveness by actually installing energy saving devices at the time of the audit.

III. PROGRAM EVALUATION

There were two primary measures of program performance evaluated and they are reported separately herein. The first measure concerns day-to-day Operating Statistics such as the number of energy audits completed and energy saving devices installed, rates of participation, participation of "target groups", and audit costs. The second measure concerns Energy and Water Savings achieved by a randomly selected sample of audited households above and beyond the savings achieved by a randomly selected sample of "control" or non-audited households.

III.A Operating Statistics

Between May 19, 1984 and May 16, 1985, the period during which the Energy Fitness Program operated, every eligible Santa Monica residence was offered the Program's services at least twice through the door-to-door canvass. Operating results from that period are shown in Table I.

TABLE I. SANTA MONICA ENERGY FITNESS PROGRAM FINAL OPERATING STATISTICS 19 MAY 1984 - 16 MAY 1985.

	PERFORMANCE GOALS	PERFORMANCE ACTUALS
AUDITS COMPLETED	11,760	12,485
DEVICES INSTALLED	22,430	30,154
PARTICIPATION RATE	-	33 - 35%
TOTAL COST PER AUDIT	-	$86.67
	CENSUS DATA EXPECTATIONS (% OF POPULATION)	**12 MONTH PERFORMANCE (% OF AUDITS DELIVERED)**
% MULTIFAMILY	78%	71%
% SENIORS	16%	23%
% RENTERS	78%	75%
% LOW INCOME	19%	11% (minimum)
% HISPANIC, BLACK, OR ASIAN	21%	15%

Under its contract with the Southern California Edison and Southern California Gas companies, the City was required to complete 11,760 home energy audits and install 22,430 energy saving devices during the 12-month operating period. In fact, 12,485 audits were completed and 30,154 devices were installed. In addition, devices were installed in 314 residences which had previously received utility company RCS audits and 242 multifamily building central water heating facilities.

As compared with the traditional RCS Program average annual participation of 5% or less of eligible utility customers, the energy audits of the Energy Fitness Program were accepted by 33-35% of its eligible customers. The lower figure in this range represents the participation rate among all eligible residences which received mailed program announcements. The higher figure excludes customers who had previously received utility company RCS audits as well as residences to which the Energy Fitness Program audit teams could gain no physical access (e.g., those with "no trespassing" signs). (1)

The Program's cost per audit, including all start-up, administrative, publicity, evaluation, and energy saving device expenses, was $86.67. These costs are certainly comparable to historical RCS

Program audit costs which almost never included the installation of energy saving devices. The proportion of per audit costs associated with program administration, energy saving devices, auditor training, the audit and installation itself, program publicity, the production of an Energy Fitness Program Video, and program evaluation are shown in Table II.

TABLE II. COMPOSITION OF AUDIT COSTS.

	ADMIN.	DEVICES	TRAINING	AUDIT	PUBLICITY	VIDEO	EVALUATION	TOTAL
$/AUDIT	7.85	9.02	1.59	54.0	6.04	.62	7.54	$86.67
PERCENT	9.06	10.4	1.83	62.3	6.97	.72	8.70	100%

Moreover, as also shown in Table I, the approach used by the Energy Fitness Program proved effective in reaching typically difficult-to-reach "target groups". Indeed, "target groups" participated in close proportion to their actual representation within Santa Monica's population. For instance, 71% of the program's audits were delivered to multifamily residences, comparable to the percentage of multifamily buildings in Santa Monica of 78%. Twenty-three percent of the audits were delivered to senior citizens, although only 16% percent of the city's population are senior citizens. Also, 11% of the audits were delivered to residents whose self-reported income qualified them as "low- income residents". It is likely, however, that the inclusion of additional low-income residents who chose not to report their income to the audit team would bring the percentage of actual low-income participants much closer to their 19% representation within the community.

III.B Energy and Water Savings

At the very outset of the program, it was not possible to predict with reliable accuracy or confidence what the City's ultimate rate of participation would be or, for that matter, how many audits per day could be completed by program staff. It was important, however, that the order in which streets were canvassed and audited would yield results which were statistically representative of Santa Monica as a whole - independent of participation rates, staff productivity, or the point at which an evaluation was conducted. It would not have been proper, for instance, to offer audits only to streets on which senior citizens were overrepresented relative to census data for the whole city and later claim that an extraordinarily high rate of participation by senior citizens was meaningful or transferable.

Using a complete listing of residential postal addresses in the City, all city blocks were divided randomly into ten equal clusters of about 4200 households each. Each cluster was drawn as a stratified random sample based on various geographic, economic, and demographic characteristics. Not only was each cluster of streets very similar to every other cluster statistically, each cluster, in

fact, represented a "microcosm" of Santa Monica as a whole. By canvassing and auditing one cluster of streets before beginning another, the program was ensured that its operating results (e.g., participation rates, "target group" participation, equipment use rates) were representative and would remain relatively constant throughout the program. The selection of these clusters was also helpful in ensuring that energy savings results were representative as well. Five of the ten street clusters were selected as "test" clusters for the evaluation and one cluster was selected as a "control" cluster and received program information and audits only after the evaluation period was over. (2) The net energy and water savings attributable to the Energy Fitness Program was determined by comparing the energy and water consumption of random samples of households from the test and control clusters before and after the Program's intervention.

Energy and water consumption data were requested from the natural gas, electric, and water utility companies servicing Santa Monica for approximately 500 test and 200 control households randomly selected from the test and control clusters for the period of May 1983 through February 1985. The actual number of households used for the natural gas, electricity, and water savings analyses respectively differed according to the varying availability of the necessary data from each of the different utility companies. As the test households received audits between May and November 1984, at least one year of pre-intervention consumption data and between 3 and 8 months of post-intervention data was available for each household.

III.B1 Energy and Water Consumption Models. In order to properly compare the energy and water consumption of test and control groups to determine the net energy savings attributable to any particular energy program, however, it is essential that the two groups be statistically similar - apples must be compared with apples, not with oranges. However, it is very difficult, if not impossible, for a field experiment such as the Energy Fitness Program to yield precisely identical test and control groups even with random selection; differences will exist. Consequently, it is necessary to make statistical adjustments to the consumption data to make the two groups comparable.

Linear regression techniques were used to construct statistical models which were based on the recognition that energy and water use are a function of the interaction of a variety of variables such as weather, number of residents, number and type of appliances, and the size of the residence. Using actual consumption data, the models determined, across the sample of test and control households, what the effect of any one variable was on energy use independent of all other variables. By examining the actual demographic and household differences between the test and control groups, the models made adjustments to the consumption data to ensure comparability between the two groups. Depending on the utility (i.e., natural gas, electricity, or water) and the availability of data, the models controlled for the following variables: weather (as measured in daily degree days), type of dwelling (single family or multifamily),

type of occupancy (owner or renter), use of high energy consuming appliances (individualized water heater or clothes dryer), use of other appliances (televisions, stoves, refrigerators, freezers), household size, number of occupants, race of occupants, and age of occupants (senior citizen or not). Energy price changes were not included in the models as there were none during the test period. The models used pool pre- and post-intervention attributes, weather, and participants and nonparticipant data.

III.B2 Natural Gas Use by Individual Households. The first statistical model evaluated monthly natural gas consumption by the test and control households during the evaluation period. There were 366 test and 128 control individually metered houses or apartment dwellings included in this analysis. The results of the model are shown in Table III and indicate the effect of each of the variables analyzed in terms of therms of natural gas used per month.

TABLE III. COEFFICIENTS FOR VARIABLES - NATURAL GAS USE IN INDIVIDUAL HOUSEHOLDS.

VARIABLE	COEFFICIENT*	T-VALUE	SIGNIFICANCE
1. Had an Energy Fitness Program Energy Audit	-1.62	3.8	<.001
2. Water Heater (multifamily)	8.09	18.2	<.001
3. Water Heater (single family)	10.51	13.7	<.001
4. Household "Volume"**	.022 Th/DD/Room	21.0	<.001
5. Gas Dryer	7.82	12.3	<.001
6. Winter Months (November - March)	5.53	7.4	<.001
7. Appliance Index (number of TVs, refrigerators, ranges)	2.92 Th/Appliance	14.5	<.001
8. Persons in Household	2.49 Th/Person	13.7	<.001
9. Senior Citizen	1.06	2.3	<.02
10. Renter	-2.15	-3.3	<.001
11. Hispanic, Black, or Asian Household	-0.01	.02	Not Significant

Variance explained: 61%

* Note: all coefficients are in terms of therms (Th)/Month unless otherwise noted.

** Note: an interaction variable for energy use per degree day per room in the household

As might be intuitively obvious, the variables having the largest effect on gas use are the existence of a water heater in the residence (as opposed to a situation in which the water is heated centrally in an apartment building and is billed and paid separately from each resident's gas bill), the existence of a clothes dryer in the residence, the size of the residence, the severity of the weather (which in this model was combined with residence size), and the number of occupants.

More importantly, the results show an average net reduction in gas use for audited homes of 1.62 therms per month or 19.4 therms per year. This represents an average annual savings of 5.4%, as shown in Table V (which also summarizes water and electricity savings). As the analysis completed concerns average effects over all households, it can be projected that the 12,485 households participating in the Energy Fitness Program will save 242,209 therms per year, equivalent to more than $124,000 annually at the average marginal cost of natural gas in Santa Monica in 1985, weighted for the proportion of households in the sample paying lifeline and non-lifeline rates.

Another interesting result of the individual household natural gas model shown in Table III is that energy use increases significantly during heating season or winter months (which in Santa Monica are November - March) independent of the severity of the weather; residents apparently enter a "winter mode" of higher energy use during those months even with the impact of weather mathematically removed.

Statistical tests indicate that the results determined for each variable, with the exceptions of the race and age of the occupant, were significant to the .001 level; that is, the probability that the results achieved were due to random chance was less than 1 in 1000. Additional tests indicated that the relationship between the variables as described in this model (the R-squared value) accounts for 61% of the actual variation in gas consumption among households.

III.B3 Water Use by Multifamily Buildings and Single Family Households. Similar to natural gas and electricity, water use is individually metered in Santa Monica for single family residences. Unlike gas and electricity, however, water use is never individually metered for the units of a multifamily building; there is only one meter for each building as a whole. As a result, the analysis of water savings attributable to the Energy Fitness Program was completed separately for single family residences and multifamily buildings, as shown in Table IV. As a result of this division, a smaller number of variables were included in the water consumption data correction model as demographic and household data were collected only on audited units and controls, not on whole apartment buildings.

There were 368 test and 114 control multifamily buildings used in the first analysis of water savings. Since not every unit of each test multifamily building actually received an audit/installation, data received for each building were weighted according to the

number of units actually audited. Water savings from an additional 70 test and 36 control single family residences were analyzed as well.

TABLE IV. COEFFICIENTS FOR VARIABLES - WATER USE IN MULTIFAMILY BUILDINGS AND INDIVIDUAL HOUSEHOLDS.

VARIABLE	COEFFICIENT*	T-VALUE	SIGNIFICANCE
MULTIFAMILY BUILDINGS			
1. Had an Energy Fitness Program Energy Audit	-1.36**	7.9	<.0001
2. Number of Units	4.27	91.8	<.0001
3. Percent of Units Audited	-.06	3.3	.001
4. Cooling Degree Days	.00	.14	Not Significant
Variance explained: 51%			
SINGLE FAMILY			
1. Had an Energy Fitness Program Energy Audit	-1.80	2.8	<.01
2. Cooling Degree Days	.02	5.8	<.0001
Variance explained: 3%			

* Note: all coefficients are in terms of Hundred Cubic Feet (hcf)/Month unless otherwise noted.

** Note: This coefficient has been weighted to reflect only units audited by the Energy Fitness Program.

The results show an average net reduction in water use of 1.36 hundred cubic feet (hcf) per month or 16.3 hcf per year for each audited multifamily residence and 21.6 hcf for each audited single family residence. This savings represents an average annual net water savings of 16.0% for program participants, as shown in Table V. Furthermore, based on the completion of 12,485 audits (of which 8,897 were multifamily dwelling units and 3,588 were single family dwellings), the projected average annual net water savings for all participating households is 222,433 hundred cubic feet, as also shown in Table V. This savings is equivalent to more than $189,000 per year based on 1985 prices, and takes into consideration varying water rates for buildings of different sizes in Santa Monica and sewer charges, which are set according to water use levels.

Statistical tests indicate that the water savings results for the single family residences were significant to the .01 level and were significant for the multifamily buildings to the .0001 level. The variance explained by the model was 3% for single family residences

and 51% for multifamily residences.

III.B4 Electricity Use by Individual Households. There were 241 test and 90 control individually metered households included in the electricity use analysis and data were corrected for a large number of weather, household characteristic, and demographic variables. The results show no statistically significant changes in electricity consumption for either the test or controls attributable to the Energy Fitness Program.

These results, however, are not surprising. Virtually all of the energy saving measures installed in participating households were designed to reduce energy used for heating water and the water use itself. Furthermore, approximately ninety-seven percent of Santa Monica households use natural gas for both space and water heating. Therefore, for the huge majority of Santa Monica residences, the only electricity savings which could be expected would be from lighting or appliance modifications. Although informally included as part of the audit, lighting and appliance modifications (with the exception of purchasing a new furnace) were not considered "generically cost-effective" in Santa Monica and were not included as formal measures to be evaluated and discussed during the audit as a result of California Energy Commission calculations and rulings.

TABLE V. ENERGY AND WATER SAVINGS.

UTILITY TYPE	# OF CASES	AV. ANNUAL HOUSHOLD NET SAVINGS	AV. ANNUAL % SAVINGS	ANNUAL SAVINGS: ALL PARTICIPANTS	ANNUAL $ SAVINGS: ALL PARTICIPANTS
NAT GAS	366 TEST 128 CONTROL	19.4 THERMS	5.4%	242,209 THERMS	$124,883
WATER	MULTIFAMILY 368 TEST 114 CONTROL	16.3 HCF	16.0%	222,433 HCF	$189,340
	SINGLE FAMILY 70 TEST 36 CONTROL	21.6 HCF			
ELEC.	241 TEST 90 CONTROL	NO STATISTICALLY SIGNIFICANT CHANGE			

III.C Overall Savings and Cost-Effectiveness

Information concerning the Energy Fitness Program's overall savings and cost-effectiveness is shown in Table VI. The total dollar value of the annual natural gas and water savings realized by participants of the Energy Fitness Program, based on 1985 rates, are projected to equal $314,223. This equals a projected average annual savings of $25.17 per audited household. The simple payback for the devices installed by the Energy Fitness Program, which cost $112,000, was less than four months. Moreover, the payback for the Energy Fitness Program as a whole, including all administrative, audit, publicity, evaluation, and equipment expenses - which equaled just under $1.1 million - will be approximately 3.5 years.

TABLE VI. OVERALL SAVINGS AND COST-EFFECTIVENESS.

PROJ. ANNUAL NET SAVINGS PER HOUSEHOLD	TOTAL PROJ. ANNUAL SAVINGS	COST OF DEVICES	PAYBACK OF DEVICES	TOTAL COST OF PROGRAM	PAYBACK OF WHOLE PROGRAM
$25.17	$314,223	$112,000	<4 MOS	$1,100,000	<3.5 YRS

IV. DISCUSSION OF EVALUATION RESULTS

Examination of the impact of the Energy Fitness Program, both in terms of Operating Statistics and Energy and Water Savings, yields six particularly important results and conclusions:

1. The innovative approach of the Energy Fitness Program, particularly the use of the door-to-door canvass and the completion of "direct service" audits, produced several important effects, including participation rates that were among the highest ever achieved by an RCS Program, nearly exact representation of "target" groups, and reasonable audit costs.

2. The natural gas savings of the Energy Fitness Program are comparable with those achieved by RCS Programs in California and many other states.(3) In addition, the water savings of the Energy Fitness Program, which are typically not included in RCS Program evaluations, are also very significant. The savings of the Energy Fitness Program must be viewed somewhat differently from most traditional RCS Programs, however, because the rate of participation is so high. That is, the Energy Fitness Program's approach may not lead to significantly greater measured energy savings per participating household than most traditional RCS Programs; it will, however, generate proportionately more participating households.

3. Using the same approach, energy savings would likely be much greater in less temperate climates than that in Santa Monica. Not only are there generally more cost-effective conservation modifications available to residents in areas with more extreme weather conditions (which might increase participation itself),

the measures which could be installed by program staff could potentially save more energy by focusing on space heating measures as well as the water heating measures completed in the Energy Fitness Program.

4. The key elements of the Energy Fitness Program - the broad eligibility requirements, the door-to-door offer of "generic" audits, and the actual installation of energy saving devices during the audit - are all transferable to other communities and utility company service territories. For transfer to other communities, some elements of the program would need to be localized, such as program advertising, installed devices, and audit calculations. Moreover, the Program's approach could be effective in efforts geared, for instance, only to senior citizens, or low-income residents, or multifamily housing owners and renters, or even small commercial buildings.

5. Future audit programs incorporating a door-to-door canvass and "direct service" audit into their design, however, should endeavor to install as many types of energy saving devices as costs and time allows. The key to a successful conservation program is, in many ways, effective program marketing - getting residents to respond affirmatively to the offer of audits. When a resident does agree to an audit, it is important to make as many hardware modifications as are possible. Regulations preventing the Energy Fitness Program from installing all five of the available devices, even if all five were applicable, for instance, unreasonably limited the program's achievable energy savings.

6. Lastly, the existence of so many variables which affect residential energy consumption and do so in ways that are measurable and statistically significant, indicates that evaluations of energy conservation programs which adjust data only for changes in weather from year to year are capturing only a small portion of the attributable variation in energy use for both test and control groups. Future evaluations should make efforts to control for demographic and household characteristics of the two groups as well.

V. EVALUATION ISSUES

As the Energy Fitness Program was designed to be a demonstration effort, program evaluation was of critical concern from the Program's inception. Several evaluation issues were encountered, including:

- long delays in receiving requested data, in spite of months of coordinated planning;
- limited availability of post-audit data and frequent incompleteness of the data provided;
- concerns that program publicity to the general public be kept to minimum in order to reduce contamination effects on control

households;

- difficulties obtaining phone numbers for test and control households such that pre- and post-interviews (the results of which are not reported herein) could be completed; and

- logistical concerns about auditing one street block and then moving to another block contained in the same cluster of blocks (perhaps on the other side of town), rather than simply moving to the next adjacent street block.

VI. CONCLUSION

The results of the Santa Monica Energy Fitness Program indicate that the modification of traditional RCS Program approaches can lead to notably successful residential energy conservation efforts. The use of innovative techniques, particularly a door-to-door canvass and the installation of energy saving devices during the audit, provides utility customers easier access to program services and increases their motivation to participate by improving the direct benefits of the program. Innovations in program delivery methods and benefits seem to have especially advantageous results among typically difficult-to-reach customers, such as senior citizens, low-income households, and owners and renters of multifamily housing.

Projected savings and audit costs are comparable to those traditionally experienced by most RCS Programs. Indeed, savings must be considered somewhat differently from those traditionally measured due to the higher-than-typical participation rates and audit costs may be considered somewhat lower than usual, as costs associated with the installation of energy saving devices during the audit were included.

Lastly, the expansion and transfer of these methods to other communities or utility company service territories, with modifications geared to appropriately localize the methods, may be one of the most effective means to achieve the participation rates and energy savings for which the designers of the RCS Program originally hoped.

Footnotes:

(1) Security buildings, however, are not excluded from this figure.

(2) Because the Energy Fitness Program was able to canvass every residence in the City during its one year period of operation, part of this selection procedure was rendered moot. The procedure, however, was critical for effective program planning and fine-tuning. Moreover, it was relatively easy to establish using Census data and could be transferred to other programs of this or a similar nature.

(3) Eric Hirst, "Evaluation of Utility Home Energy Audit (RCS) Programs", Proceedings from the ACEEE 1984 Summer Study on Energy Efficiency in Buildings, Volume 6, 1984.