Collecting Energy-Related Consumer Behavior Information in the Real World

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ABSTRACT

This paper deals with the dynamic tension between the detailed information researchers want to know and what can be effectively collected during an interview with a nontechnical respondent. The Energy Information Administration (EIA) has conducted 10 cycles of the Residential Energy Consumption Survey (RECS) from 1978 through 1997. The RECS collects information both on the energy-related physical characteristics of housing units and on the demographic characteristics of the occupants. Data are collected via a computer-assisted personal interview with the householder at the housing unit site. The interviewers are professional field workers who are adept at conducting personal interviews, but are not necessarily energy experts. In addition, the respondents typically have limited knowledge of energy terms, issues, and heating and cooling equipment. Over the 10 survey cycles of RECS, attempts have been made to collect data items concerning consumer behavior requested by researchers and modelers. This paper will talk about the results of these efforts to obtain the best consumer behavior data in the real world of imperfect interviewers and unknowledgeable respondents.

Background about RECS

The Energy Information Administration (EIA) has conducted 10 cycles of the Residential Energy Consumption Survey (RECS) from 1978 through 1997. It is currently conducted every four years. The RECS collects information both on the energy-related physical characteristics of housing units and on the demographic characteristics of the occupants during an interview with the householder at the housing unit site. Up through 1993, data were collected via a paper and pencil interview, starting with the 1997 RECS, data were collected via a computer-assisted personal interview. The RECS is a nationwide multistage probability sample of between 5,000 and 7,000 households (depending on funding per survey cycle) chosen to represent all households in the United States.

The RECS is conducted in two major stages: The Household Survey and the Energy Supplier Survey. The Household Survey collects information concerning the housing unit and its occupants through an on-site personal interview. The Energy Supplier Survey collects actual energy consumption and expenditures for the housing unit from billing records provided by the supplier of energy (electricity, natural gas, fuel oil and/or propane) to the household. Therefore, RECS provides a unique opportunity to ask about energy usage within the household and then look at the actual energy usage to see if they correlate.

Introduction

Energy modelers, energy conservation advocates, and other researchers often request that more detailed and technical information questions be added to the Residential Energy Consumption Survey. The RECS has tried to accommodate many of these requests, within resource constraints. Specifically, this includes collection of air conditioner nameplate data in the 1990 RECS and a New Homes Supplement in the 1993 RECS. This paper will briefly describe these efforts and the relationship between what the respondents reported and the apparent quality of that data. Based on these studies, it was found that to be meaningful to RECS respondents, questions had to be tied to behaviors that were easily remembered and repetitive over the report period. Relating the answers to these behavioral questions with household demographics and actual energy usage for the housing unit provides a better indication of household usage and energy-efficiency knowledge.

User-Needs Study for the 1993 RECS

One of the ways EIA identifies what questions to ask on the RECS is through user-needs studies. The last full scale users' needs study for the RECS was performed prior to the 1993 RECS. (EIA 1993b). This was an in-depth examination of what uses organizations were making of RECS data and what future needs they might have. Current RECS data users were identified and then requests for written input were sent to them. In addition, representatives from industry, manufacturers, State agencies, Department of Energy, and other Federal agencies were given the opportunity to express their data needs and suggest changes for the RECS.

While EIA did attempt to accommodate the needs of its RECS users whenever possible, there were a number of constraints faced in satisfying customer needs.

The first constraint was the limit on the length of the personal interview with the household respondent. In 1993, that limit was 60 minutes to avoid respondent fatigue and encourage cooperation.[1] Because the interview was already about that length, in order to add questions, other questions had to be cut. To make room for new questions, EIA drew up a list of "Expendable" questions. A question was considered expendable if it did not contribute significantly to allocating energy consumption to an end use such as space heating, water heating, air conditioning, or refrigerators. Some other questions were dropped because they were funded on a "one time" basis; others were methodological questions which had served their purpose, or simply priorities had changed.

Perhaps the greatest factor impeding RECS' ability to meet user needs is cost. Many suggested changes are rejected simply because they are too expensive to implement. For instance, the most common requests are to increase the sample size and field the RECS more often. EIA would like to do both of these. However, current financial constraints make these changes impossible. Some questions are also rejected due to lack of funding. Some groups, such as the Administration for Children and Families (ACF), DOE's Office of Minority Economic Impact, DOE's Office of Energy Efficiency and Renewable Energy, and the

[1]In the 1997 RECS, we further limited the average time for a household interview to 40 minutes, necessitating even more questionnaire cuts.

Environmental Protection Agency have provided funding for specific questions to be asked on the RECS. The ACF has also funded additional sample cases in low-income areas.

The 1993 User-Needs Study helped focus attention on areas felt to be critical and to prioritize data needs. The resultant "wish list" could not be implemented in full, but high priority data items were added and lesser priority items were dropped from the RECS Household Questionnaire.

The next section of the paper will illustrate how RECS has attempted to accommodate the priorities of data users in collecting data about energy-efficient equipment and household knowledge about this equipment. Various question techniques have been used, some more successful than others. Examples will be drawn from the 1990 RECS air conditioner nameplate data collection, 1993 RECS questions about new home insulation, and 1997 RECS behavioral activity questions. The examples will illustrate the increasing reliance on questions about behavior to extrapolate energy usage and equipment.

Air-Conditioner Nameplate Data Collection in the 1990 RECS

Short of measuring the actual efficiency of major home appliances via metering, the only means of getting a measure of the rated efficiency of the equipment is from nameplate information affixed to the equipment. In the 1990 RECS, the viability of collecting central air-conditioner (CAC) nameplate data during the RECS interview was tested (EIA 1993a, 150-151). Interviewers recorded data on the make and model directly from the air-conditioning unit's nameplate during their on-site interview at the housing unit. Air conditioners were chosen for this test (as opposed to furnaces) because CAC units were located outside and were thus more readily accessible to the interviewers than heating equipment.

In the 1990 RECS, 1,820 (35.7 percent) of the responding housing units had central air conditioning. Collection of nameplate data was not attempted for multiunit dwellings or for the households responding to the mail questionnaire (a total of 483 units). Nameplate data were obtained for the remaining 73.5 percent of the centrally air-conditioned, single-family households (1,337 cases). An attempt was then made to match the reported nameplate data with information in the *Air-Conditioning and Refrigeration Institute Directory* to assign a Seasonal Energy Efficiency Ratio (SEER) rating. The SEER is a measure of the cooling output divided by the power consumption. A SEER was assigned to a total of 331 units, using both computer and extensive manual matching. For the remaining units, there were several reasons why SEER's could not be obtained: 1) the air-conditioner nameplate data obtained was incomplete (597 cases); 2) a match could not be found for the air-conditioning nameplate data reported (283 cases); and 3) SEER's were not available for air-conditioning units manufactured before 1980 (126 cases). Results of attempts to assign SEER's for single-family housing units or mobile homes with central air conditioning or heat pumps are summarized in Table 1 below.

Table 1. SEER Collection Results from the 1990 RECS

SEER Code Result	Number of Cases [2]	Percent	Cumulative Percent
Valid SEER Located	331	18.2	18.2
No Match on Make	574	31.5	49.7
No Model Year	23	1.3	51.0
No Match on Model	283	15.5	66.5
No SEER available	126	6.9	73.5
Total Nameplate Data Obtained	1,337	73.5	--
Mail Questionnaire	99	5.4	78.9
Multifamily Unit	384	21.1	100
Total Nameplate Data Not Obtained	483	26.5	--
Total CAC Units	1,820	100.0	100

There are two ways of computing the match rate and assessing the success of this effort. The first is to note that SEER's for 331 of the total 1,820 cases that had central air conditioning were obtained. Thus, a match rate of 18.2 percent was achieved. The second is to take into account that no attempt was made to collect air conditioner nameplate data from the 483 multifamily dwellings and mail-in questionnaire housing units with CAC. Thus, SEER's for 331 of 1,337 possible cases were obtained, achieving a match rate of 25 percent. But even a match rate of one in four is low given the additional data collection time, processing and SEER lookup costs.

1993 RECS New Homes Supplement–Asking about Equipment

Another way to find out about energy-efficient equipment is to ask the household respondent. To help answer users' questions about households' energy efficiency awareness, the 1993 RECS included a series of questions to household respondents owning single-family

[2]The following results, and throughout this entire paper, reflect the unweighted household or respondent counts.

homes built between 1988 and 1993 (EIA 1995, 5-6). Of the 7,111 RECS respondents in 1993, 775 cases fulfilled the criteria for newly-built single-family houses.

The questions were designed to measure the energy-efficiency awareness levels of occupants of new single-family homes. It was thought that the energy-efficiency awareness of respondents might be attributed to sales brochures and publicity about newer single-family homes. Our supposition was that builders give new buyers information about the new homes, including energy-efficiency information. The new homeowners were asked about the efficiency of central air-conditioning and heating equipment, the capacity of the air-conditioning equipment, and the R-value of roof or ceiling insulation. EIA found that many occupants of new homes had little information on the energy-related characteristics of their homes.

An example of the technical questions asked of respondents is this one about the respondent's knowledge of insulation. The question was "What is the R-value of the insulation in the roof or ceiling, or perhaps you know the inches of insulation?"

As shown in Table 2, about 40 percent of the respondents did not know the R-value of their ceiling or roof insulation. Half of the respondents reported an R-value (or inches) of insulation and the answers provided ranged from 3 to 114.[3] Of these, only 26 percent of the homeowners reported that the ceiling insulation of their homes had R-values of 30 to 38 or higher, which are the recommended R-values for most homes. Fifteen cases reported R-values (or inches) that were 50 or greater–almost certainly an erroneous figure. About a third (32 percent) reported having insulation with a lower than recommended R-value or none at all.

Table 2. Responses to Roof or Ceiling Insulation Question in the New Homes Supplement, 1993 RECS

Response	Number of Cases	Percentage
Estimated R-value obtained	260	33.5
Estimated inches obtained	130	16.8
Reported no insulation	12	1.6
Did not know	306	39.5
No answer/missing*	67	8.6
Total	775	100.0

*No answer was recorded for this question. The reasons for this could be 1) the interviewer erroneously did not ask the question, 2) a respondent did not reply or, 3) the interviewer did not record the response.

[3]Respondents provided an estimate of the R-value or inches of insulation. For comparison purposes, the R-values were converted to inches.

Therefore, even in the "best case" new, owner-occupied, single family homes, we obtained estimates of R-values (or inches) in only 390 out of 775 cases (approximately 50 percent) and some of the values were inaccurate. We surmise that the percent of cases where accurate R-values are obtainable should be even lower for older homes, renters, apartment units, and for wall insulation, which often cannot be seen.

The new homeowners were also asked about central air conditioner capacity and heating and cooling equipment efficiency. Results were similar to the insulation question–respondents do not seem to be aware of, nor can they accurately report about, the energy efficiency of their equipment.

Equipment Usage Questions–Trying a New Behavioral Tack

Neither directly obtaining equipment nameplate data nor asking respondents about their equipment were effective means of collecting information about energy-efficient equipment in the home. Therefore, EIA tried another tack–asking respondents about their behavior, which in turn affected their energy usage. Respondents were asked if they had certain equipment or appliances and if so, then they were asked a follow-on question indicating usage. For example, if they had a dishwasher, how many times was it used per week. These usage indicators are also good predictors for use in the regression equations for energy end uses modeling. We could track the accuracy of these predictions by matching the household usage characteristics with the actual consumption for that household as obtained from the billing records of the energy supplier to that household. Behavioral questions have been introduced into RECS over the last several cycles. Table 3 contains some representative usage questions from the most recent RECS fielded in 1997 (EIA 1999, 251-275).

Table 3. Representative Usage Questions, 1997 RECS

Question Text	Energy Usage
Q: Which of the categories shown best describes, on average, how often hot meals are usually cooked in your home? Answers range from three or more times a day, down to less than once a week.	Cooking
Q: [for a second refrigerator] During the past 12 months, how many months was this refrigerator turned on?	2nd Refrigerator usage
Q: Altogether, how many hours a week is/are your personal computer(s) turned on? Answers range from less than two hours per week up to turned on all the time.	Computer Usage
Q: Because bathing and showering affect how much energy a household uses to heat water, can you give me an estimate of how many baths and showers are taken by all the members of your household during a typical week? Answers are broad ranges: fewer than 10, 10-20, more than 20.	Hot Water Usage
Q: [asked separately about both central and window air-conditioning units] Which of the statements shown best describes the way your household used the air-conditioning system last summer? A: Not used at all Turned on only a few days or nights when really needed Turned on quite a bit Turned on just about all summer	Air-Conditioner Usage
Q: Overall, would you say that your home is... Well insulated Adequately insulated, or Poorly insulated?	Insulation Levels
Q: About how much of the basement would you say is warm enough to sit, work, or play in during the winter months?	Heated area of housing unit

Asking a perception question, such as the insulation question in Table 3, is also a good predictor of the amount of insulation and much easier for a respondent to reply to than "what is the R-value." The insulation perception question was asked of all respondents in the 1993 RECS. Comparing the answers from the same respondents in Table 2 (those in new homes) with

their answers to a similar insulation question as cited in Table 3, shows that the perception question provided more information, as shown in Table 4 below.

Table 4. Comparison of Insulation Question Responses, 1993 RECS

	Respondent-Indicated Insulation Quality					
Table2 Response	**Well**	**Adequately**	**Poorly**	**None**	**Don't Know**	**Total**
"No insulation"	8	1	2	1	0	12
"Don't Know"	187	102	16	0	1	306
Gave an R-value or inches*:						390
5-17 inches	96	43	13	0	0	151
25-50 inches	192	45	2	0	0	239
*Respondents provided an estimate of the R-value or inches of insulation. For comparison purposes, the R-values were converted to inches.						

It is interesting to note that of the 306 respondents who could not answer the R-value question, all but one could give an indication of how well they thought the house was insulated. It also looks like 75 percent of the respondents who answered they had no insulation to the R-value question, actually felt their homes to be well or adequately insulated. The seemingly conflicting answers may have been due to the fact that they did not understand the R-value question.

Therefore, the perception and actual usage questions are easier for respondents to understand and to provide answers. These answers, along with the list of equipment and appliances present in the household, provide good predictors of energy usage and can be used as input to the regression equations for energy end uses.

Conclusions

Energy analysts and modelers would like to have detailed information on energy-efficient equipment in households. However, household respondents often are not cognizant of the energy-related characteristics of their housing units. The results from the New Homes Supplement included in the 1993 RECS, indicated that even new home buyers do not know much about the insulation and heating and cooling equipment within their homes. The results were disappointing in that we had hoped that these new buyers might remember the information from builders' information, sales brochures, or even warranties provided with the house. Based on the results from this study, it seems unlikely that the usual household respondent can provide technical information about the heating and cooling systems within their homes.

Even collecting information directly from the equipment nameplates, and not depending upon the respondent's knowledge, is not effective. As we found out in the 1990 RECS, nameplate data collected directly from the air conditioner could be matched to industry records to obtain SEER's for only one-fourth of the cases.

Therefore, our results indicate that detailed technical data cannot be collected during an interview conducted by a nontechnically trained field interviewer with a household respondent. Sending out a trained energy auditor to the household might be the more effective, albeit also more expensive, way to gather detailed energy information.

Instead, RECS collects equipment, insulation and usage questions in a way that respondents find easier to answer. For example, concerning insulation, the question, "Overall, would you say that your home is well insulated, adequately insulated, or poorly insulated?" has been found to correlate with the actual level of insulation. Respondents can relate how they feel inside their home in the winter with whether the insulation is adequate. For hot water usage, we ask about the number of showers/baths taken, the number of laundry loads run, and the number of times the dishwasher is used. By tying in usage with common activities, respondents can better answer questions from which usage and equipment can be extrapolated.

In the 2001 RECS, we plan on continuing to ask behavioral questions to obtain usage estimates. We will continue with the method of asking if respondents have any of a comprehensive list of equipment and appliances, and then for their energy-intensive equipment, asking for some indicator of usage. For researchers, these figures are less precise than metering data or detailed energy audits, but they are willing to give up some of the precision in order to have regional and national level estimates.

References

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