# 2. An Overview of RECS

For those who may be unfamiliar with the nature and principal features of the Residential Energy Consumption Survey, this chapter of the *Quality Profile* presents some background information. The first section provides a general overview of RECS, its objectives, and the timing of the periodic surveys. The second section describes the design and methodology of the 1993 RECS. The final section identifies significant changes as the survey design and procedures evolved from the initial survey (known as NIECS, the National Interim Energy Consumption Survey) in 1978 through the 1993 RECS.

# A General Overview of RECS

## Objectives

RECS, the Residential Energy Consumption Survey, is a periodic sample survey that is designed to provide timely information about energy consumption and expenditures of U.S. households and about energy-related characteristics of these households. RECS data are developed for use by the Congress, Government agencies, researchers, and the general public. The data provide major inputs to EIA's National Energy Modeling System, a forecasting system that has been developed for the Department of Energy. In the 1981, 1984, 1987, and 1993 survey years, RECS included a supplemental sample of low-income households to provide information needed by the Administration for Children and Families, Department of Health and Human Services, to provide data needed to administer its Low-Income Home Energy Assistance Program.

## Legal Authority for Survey

RECS is conducted under the authority of the Federal Energy Administration Act of 1974 (Public Law 93-275), as amended, and the Energy Policy Act (EPACT) of 1992. The latter act directs the EIA to conduct a survey of residential energy use at least once every 3 years.

## Data Dissemination

Beginning with the 1980 RECS, the data from each survey have been presented in two major publications, a *Housing Characteristics 1993* report and a *Household Energy Consumption and Expenditures 1993* report. Anonymized data files with information for individual households have been released to researchers and other data users on public-use tapes for all RECS survey years and on diskettes for the 1987 and subsequent surveys. Since August 1995, it has been possible for users to download the data files for the 1987, 1990, and 1993 RECS from the Internet by contacting the EIA home page (http://www.eia.doe.gov).

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## Sources of Data

The information contained in the RECS data files and publications comes from several sources (Figure 2.1). The primary data source is the Household Survey, in which data are collected, mostly via personal interviews, from a sample of several thousand households. For most of these households, a Supplier Survey is undertaken to obtain billing information on energy consumption and costs from the households' suppliers of electricity, natural gas, fuel oil, kerosene, and LPG. For some households occupying rental units in multiunit structures, a Rental Agent Survey is conducted to improve the accuracy of data on the main fuel sources and types of equipment used for space and water heating and air-conditioning.

For every sample household, information on heating and cooling degree-days as measured by a nearby weather station (and humidity, starting in 1990) is obtained from the National Oceanic and Atmospheric Administration (NOAA). Finally, data from the Census Bureau's decennial censuses of population and housing and Current Population Survey are used in the RECS sample design and estimation procedures to improve the reliability and precision of the survey results.

**Figure 2.1. Sources of Information for the RECS System**

| Source | Information Provided (preferred source) | Household Type | Fallback Source |
|---|---|---|---|
| Household survey | Housing-unit and household energy-related characteristics | All housing-units | |
| Supplier survey | Housing-unit consumption and expenditures by fuel type. | Households that pay supplier directly for one or more delivered fuels | Household survey (kerosene only). |
| Rental agent survey | Main fuel source for space and water heating, cooking, air-conditioning | Households in multi-unit structures with one or more fuels included in rent | Household survey |
| NOAA | Weather data for station close to each sample housing-unit. | All housing-units | |
| Census Bureau | 1. Data for formulation of sample strata. 2. Household estimates for benchmarking RECS estimates. | | |

Source: Energy Information Administration, *Consumption and Expenditures* (February 1993).

## Frequency, Reference Periods, and Sample Sizes

The survey has been conducted nine times between 1978 and 1993. As shown in Figure 2.2, it was conducted annually from 1978 to 1982, then 2 years later, in 1984, and subsequently at

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3-year intervals.  Data collection for the Household Survey has started in the autumn of each survey year and has continued through the winter or early spring of the following year.  For the first 8 survey years, through 1990, the "reference month" for households has been November of the survey year.  For the 1993 RECS, July 1993 was chosen as the reference month.  RECS estimates of the number of households are benchmarked to estimates of households for the reference month from the Census Bureau's Current Population Survey.  Through the 1984 survey year, the reference period for consumption and expenditures was the 12-month period starting in April of the survey year and extending through March of the following year.  From survey year 1987 on, the reference period has been the calendar year coinciding with the survey year.

Sample sizes are the numbers of sample units initially assigned to interviewers that turned out to be eligible for the survey and for which acceptable questionnaires were obtained by field or telephone interviews or by mail (Figure 2.2).  The numbers of units initially assigned and the corresponding eligibility and response rates achieved may be found in Chapter 4, Table 4.1.  The larger samples in 1981, 1984, 1987, and 1993 were due in part to the inclusion of supplemental samples of households in low-income areas, as noted above.  The sample for 1993 was also supplemented to provide a larger sample of newly-constructed units, defined as those built in 1987 or later.

**Figure 2.2.  Key Features of RECS, by Survey Year**

| Survey Year | Reference Month[a] for Households | Reference Period for Consumption and Expenditures | Sample Size[b] (Households) |
|---|---|---|---|
| 1978 | November | Apr 78 - Mar 79 | 4,081 |
| 1979 | November | Apr 79 - Mar 80 | 4,033 |
| 1980 | November | Apr 80 - Mar 81 | 6,051 |
| 1981 | November | Apr 81 - Mar 82 | 6,269 |
| 1982 | November | Apr 82 - Mar 83 | 4,724 |
| 1984 | November | Apr 84 - Mar 85 | 5,682 |
| 1987 | November | Jan 87 - Dec 87 | 6,229 |
| 1990 | November | Jan 90 - Dec 90 | 5,095 |
| 1993 | July | Jan 93 - Dec 93 | 7,111 |

[a]Month of survey year for which number of households was estimated.
[b]Number of sample households for which acceptable questionnaires were obtained.
Sources:  Energy Information Administration, *Housing Characteristics* (1980-1993); *Consumption and Expenditures* (1978-1993).

## Overview of the 1993 RECS Design and Procedures

This section summarizes the main features of the 1993 RECS design and procedures.  More detailed information is provided in Appendix A, "How the Survey Was Conducted," in the *Housing Characteristics 1993* report (EIA 1995a), the comparable appendix in the *Household Energy Consumption and Expenditures 1993* report (which includes information about the Supplier Survey, EIA 1995d), and the various procedures manuals developed for the 1993 RECS (for example, Response Analysis Corporation 1995a,b).

## Content

The data collected for households and housing-units in the 1993 RECS can be classified into seven major categories:

1. Energy consumption and expenditure by the household

2. Housing-unit characteristics, equipment, and appliances most directly related to energy use

3. Socioeconomic characteristics of the household occupying the housing-unit

4. Energy sources, uses and suppliers

5. Ownership and use of vehicles

6. Use of energy assistance programs

7. Participation in demand-side management programs of utility companies.

Providing an estimate of energy consumption and expenditure by source for the household and by end use within the household is the primary goal of RECS. Data in the remaining six categories serve several purposes. In addition to being of interest in their own right, variables such as the year the structure was built, the number of rooms in the housing-unit, the area of heated floorspace, and household income can be used as classifiers in presenting and analyzing estimates of energy consumption and expenditures. Socio-economic data for the household and data on housing characteristics, equipment, and facilities are extensively used in the imputation of missing consumption data and in the model-based allocation of the consumption of each fuel to end-use categories. Data on ownership and use of vehicles are used primarily as inputs to the Residential Transportation Energy Consumption Survey and as the basis for selecting a subsample of RECS households for that survey.

Although there has been substantial variation in specific items within each category, data in the first five categories have been collected in all RECS surveys since 1980. Inclusion of questions about the use of energy assistance programs began in the 1981 RECS, coincident with the Congressional authorization of the Low-Income Home Energy Assistance Program (LIHEAP) in that year. Participation in demand-side management programs (activities sponsored by utilities that are intended to influence the timing and amount of electricity use) was the subject of two questions in the 1990 RECS. Detail on this subject was substantially expanded in the 1993 Household Survey questionnaire, and utilities were asked in the 1993 Supplier Survey to report on the programs they offer to residential customers.

In 1992, the EIA conducted a user-needs study to help determine the content of the 1993 RECS (EIA 1993c). Written suggestions were solicited from data users and EIA staff held 15 meetings with different user groups. The findings from that study, as well as specific requirements

mandated by the Energy Policy Act of 1992, led to several changes in content. Important topics covered by questions added to the 1993 RECS questionnaire were:

- Consumer decision-making behavior, such as purchases of new equipment and the influence of energy efficiency considerations on purchase decisions

- Additional building envelope and thermal characteristics, such as exterior wall materials and number and type of windows

- Lighting: Number of lights, location, bulb type, wattage and control mechanisms; i.e., a more detailed lighting supplement was administered to a subsample of households

- Appliance Usage and Equipment: Levels of usage, especially of equipment using hot water, such as washers and dishwashers; identification of some appliances not previously included on the questionnaire

- Emerging Technologies: Awareness and use of several new energy-conserving technologies, such as low-E window glass and halogen light bulbs

- Business use of homes.

In order to accommodate these new questions without undue increase in response burden, several questions that appeared on the 1990 RECS questionnaire were dropped, taking into account expressions of user interest, past experience in the ability of respondents to answer accurately, and demonstrated utility of specific questions for imputation of missing data and estimation of energy consumption by end use. Several questions on space heating, insulation, and other housing characteristics were among those dropped. A more detailed account of these changes is provided in the supporting statement submitted to OMB for clearance of the forms (EIA 1993b).

## Sample Design and Selection

All of the RECS surveys have used a stratified, multistage sample design. Basic principles that guide the sample design are: use of probability sampling at all stages of selection; the ability to produce estimates of acceptable reliability for each of the nine Census divisions and for other subgroups of the target population; and, at the national level, determination of sample sizes at all levels in a way that produces the most reliable estimates possible, given the resources available for the survey. For the 1993 RECS, additional requirements were to oversample newly constructed housing-units and units occupied by households with income below the poverty level, that is, to sample them at rates higher than those used for units not in these categories.

The types of sampling units and the sample selection procedures for each stage of sampling in the 1993 RECS are important (Figure 2.3). The grouping of primary sampling units (PSU's) into strata was carried out within Census divisions, and, within divisions, separately for each of four States with large population (California, Florida, New York, and Texas) and for Alaska and

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Hawaii because of their unique weather conditions.  Of the 116 strata, 31 consisted of a single metropolitan area that had a large enough population to form a stratum by itself.

The 1993 sample was the first one for which 1990 Census data were available for use in stratification of PSU's and secondary sampling units (SSU's) within sample PSU's, and for assigning selection probabilities at each level.  Although a new set of PSU's was selected, for purposes of efficiency this was done in a manner that maximized the overlap with the sample PSU's used in the 1984, 1987, and 1990 surveys.  Of the 116 sample PSU's selected for the 1993 RECS, 94 had been included in the three preceding surveys.

**Figure 2.3.  Sample Design and Selection Procedures for 1993 RECS**

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### DEFINITIONS

**Primary Sampling Units (PSU's):**

Metropolitan areas or groups of counties in non-metropolitan areas.

**Secondary Sampling Units (SSU's):**

One or more Census blocks, with a minimum of 50 housing-units in the most recent census.

**Listing Segment:**

A complete SSU or a selected part of an SSU for which a detailed listing of street addresses is prepared.

**Ultimate Cluster:**

A small group of (potential) housing-unit addresses selected from the listing for a listing segment.

### SAMPLE SELECTION STEPS

1.    Divide the United States into PSU's, each consisting of a metropolitan area or one or more non-metropolitan counties.

2.    Group PSU's to form strata (some strata consist of a single large metropolitan area).

3.    Select one PSU from each stratum.

4.    Select several SSU's from each sample PSU.

5.    (Larger SSU's only)  Divide SSU into listing segments and select one.

6.    Prepare a detailed address listing for each SSU or listing segment.

7.    Select ultimate cluster of addresses from each SSU or listing segment.

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**Figure 2.3.  Sample Design and Selection Procedures for 1993 RECS (Continued)**

### SAMPLING FRAME AND SAMPLE SIZE INFORMATION

| | |
|---|---|
| **PSU's in United States:** | 1,786 |
| **Strata:** | 116 |
| **Sample PSU's:** | 1 per stratum |
| **Sample SSU's in sample PSU's:** | |
| Core sample: | 1,461 |
| Supplement : | 149 |
| Total: | 1,610 |
| Mean per sample PSU: | 13.9 |
| **Listed units assigned to field:** | |
| Total: | 9,869 |
| Mean per sample SSU: | 6.1 |

Source:  Energy Information Administration, *Housing Characteristics* (1993).

The basic criterion for assigning selection probabilities at each stage of sampling was to produce a national self-weighting sample of housing-units, that is, one for which the overall selection probability of each unit, taking all stages of sampling into account, would be the same. However, some departures from this criterion were necessary in order to obtain the desired oversampling of new houses and low-income households, and to ensure that sufficiently reliable estimates could be made for each Census division.

Additional information about the 1993 RECS sample design and selection procedures will be found in Appendix A of the *Housing Characteristics 1993* and the *Household Energy Consumption and Expenditures 1993* reports and in the *Sample Design Procedures Manual* (Response Analysis Corporation 1995a) for the 1993 RECS.  The publication *Sample Design for the Residential Energy Consumption Survey* (EIA 1994) provides information about sample design and selection procedures for all survey years and about how they have changed over the life of the survey.

## Data Collection Procedures

An overview of the timing and collection modes used in collection of data for the 1993 RECS Household, Rental Agent, and Supplier Surveys is important (Figure 2.4).  Data collection began in October 1993 with personal interviewing for the Household Survey.  As shown in Figure 2.4,

there were three waves of personal interviewing. In the first wave, interviewers made a minimum of four attempts (initial attempt plus three callbacks), sometimes several more, on various days of the week and at various times of day, to try to establish contact with all assigned households. In the second wave, a similar effort was made, usually by different interviewers, in an attempt to contact households that had not been available during the first wave and to convince some of those that refused interviews in the first wave to reconsider.

**Figure 2.4. Data Collection Modes and Timing: 1993 RECS**

| Survey and Wave | Collection Mode | Collection Period | | Remarks |
|---|---|---|---|---|
| | | Start | End | |
| Household Survey | | | | |
| Field Wave 1 | Personal interview | Oct 93 | Apr 94 | |
| Field Wave 2 | Personal interview | Jan 94 | Apr 94 | |
| Field Wave 3 | Personal interview | Feb 94 | Apr 94 | Selected sample sites with low response in Waves 1 and 2. |
| Abbreviated Version | Telephone interview | Apr 94 | May 94 | Authorization forms collected by mail. |
| Abbreviated Version | Mail | Apr 94 | May 94 | |
| Rental Agent Survey | Telephone | Jul 94 | Jul 94 | |
| Supplier Survey | Mail, with telephone followup | Mar 94 | Oct 94 | |

Sources: Energy Information Administration, *Housing Characteristics* (1993); *Consumption and Expenditures* (1993).

The third wave was undertaken to try to improve response rates in selected locations that had low completion rates after the second wave.

The telephone and mail phases of data collection for the Household Survey had two goals: (1) to collect, for each household for which a personal interview had not been completed, a limited amount of information about housing-unit and household characteristics and (2) to obtain permission to contact energy suppliers for billing information on their household's consumption and expenditures. Telephone contacts were limited to those households for which telephone numbers were already available or could be obtained from reverse directories. Households responding to telephone interviews were mailed authorization forms for the Supplier Survey to sign and return, and reminder calls were made to those whose forms had not been received.

Results of the telephone phase were:

| | |
|---|---|
| Eligible households | 786 |
| Telephone interviews completed | 197 |
| Authorization forms returned | 74 |
| Interviewed, no authorization form required | 4 |

Only the last two groups were considered to represent completed households; thus, additional interviews were generated for 78 households, or 10 percent of those eligible. A similarly abbreviated mail questionnaire was mailed to most of the remaining nonrespondents. Completed questionnaires were received from 115 (7.5 percent) of the 1,528 households to whom they were sent.

Eligibility for the Rental Agent and Supplier Surveys was determined on the basis of information collected in the Household Survey, so data collection for those surveys could be undertaken only after data collection for the Household Survey was at or close to completion. The Rental Agent Survey was conducted entirely by telephone, in two stages. In the first stage, the survey contractor's telephone interviewers called to verify each rental agent's address, in order to mail an advance letter explaining the nature and purpose of the survey. In the second stage, data for the survey were collected by telephone. The Supplier Survey was conducted by mail. Information about eligibility and completion rates for these surveys is presented in Chapter 4.

The quality of data collected in personal interviews is affected by the qualifications, training, working conditions, and supervision of the interviewing staff. There were 234 interviewers who completed one or more personal interviews in the 1993 RECS. Of these, 35 percent had completed interviews in a prior RECS. Nearly all of the interviewers were trained in 3-day regional training sessions; a small number were trained in a 2-day session or by telephone. At the end of the training, each interviewer took an open book quiz, which was reviewed immediately thereafter.

Field interviewers were paid on an hourly basis for all time spent working on the survey and were reimbursed for their travel expenses. Contractor staff reviewed the first two interviews completed by each interviewer and provided extensive written feedback. Additional telephone training was provided when warranted. A 20-percent sample of the interviews was verified by telephone or mail to ensure that they had been conducted as intended.

Prior to each stage of telephone calls for the Rental Agent Survey, interviewers and their supervisors were briefed at the survey contractor's telephone center by the project manager. The project manager or a trained telephone supervisor monitored the first several calls made by each interviewer and the interviewers were monitored intermittently for the duration of the calling period (EIA 1995b).

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## Data Processing and Imputation

The 1993 RECS data collection operations produced information, mostly in hard-copy format, from six sources: (1) completed Household Survey interview questionnaires, (2) completed Household Survey telephone and mail questionnaires, (3) Housing-Unit Record Sheets, (4) Rental Agent Survey questionnaires, (5) Supplier Survey questionnaires, and (6) weather data from NOAA. In a complex set of operations, data from these six sources were processed, first individually and then in merged files, to produce the final RECS data tapes. A brief overview of these operations is provided here; a more extensive treatment, with emphasis on quality-related aspects, will be found in Chapter 6, Data Processing and Imputation and Chapter 7, Estimation and Sampling Error.

Initial processing of inputs from each of the first five sources involved three major steps: (1) check-in and manual review; (2) data entry; and (3) computer-assisted editing. All data entry operations were 100 percent verified. Telephone calls to respondents were made as needed to resolve inconsistencies identified in the manual reviews. In the computer-assisted edits, problems were resolved first by referring back to the questionnaires and then, when necessary, by calling respondents. The inputs from the sixth source, NOAA, were data files that were manipulated to produce the desired weather information to be associated with each sample household.

Some imputation of missing data, especially for items missing from the Household Survey interview questionnaires, was carried out prior to merging the files with data from other sources. Missing values were imputed for about two-thirds of the Household Survey variables, with "hot deck" imputation being the method most frequently used. Other kinds of imputation required the presence of data from more than one source; for example, imputation of items not included on the telephone and mail questionnaires required that the files of those questionnaires be merged with a set of potential "donor records" from the personal interview data file.

Following is a brief summary of some of the special features of processing relating to each of the six data sources:

- Household Survey Interview Questionnaires. In addition to consistency and range checks, the computer-assisted edits included several "special reports" in which computer listings with identifiers and selected data items were produced for housing- units with certain unusual characteristics. The listings and corresponding questionnaires were reviewed, respondents were contacted when necessary, and all changes were entered on the data file. A few examples of the many topics covered by special reports are: households that did not use any heating fuel; households with incompatible combinations of heating fuel and main equipment; and households that reported presence of a heat pump but no central air-conditioning. An elaborate set of computer runs was used to convert recorded linear measurements to estimates of total and heated areas and to translate from inside to outside measurements where the former had been recorded by the interviewer.

- Household Survey Telephone and Mail Questionnaires. The items not included on the abbreviated telephone and mail versions of the questionnaire were imputed, based on random selections from eligible "donor" households from the set of interview

questionnaires. The donor households were those that matched on a set of variables common to the complete and abbreviated questionnaire versions.

- Housing-Unit Record Sheets. For each assigned field interview, the interviewer completed a Housing-Unit Record Sheet (HURS) with his or her name and ID number, the type of living quarters and occupancy, the date, time, and outcome of each visit, and other particulars. These HURS forms were used, along with the original sample control file and information from other sources, to create the HURS file, which contained basic information about the outcome of data collection for each assigned sample address. HURS file records were also created for additional housing-units identified within sample addresses or by the application of the "half-open interval check" (see Chapter 3, Section 3.2). The HURS file had several uses, including the generation of reports on interview completion rates and interviewer characteristics and the development of weighting factors to adjust for unit nonresponse.

- Rental Agent Survey Questionnaires. The Rental Agent Survey covered households in multiunit structures that had one or more fuels included in their rent payments. Records created from the questionnaires were matched to the Household Survey data files for the same housing-units. Responses for items common to both surveys, such as year of construction and main heating fuels and equipment, were compared and changes were made to the Household Survey data whenever it was judged that the rental agent was more knowledgeable than the household respondent.

- Supplier Survey Questionnaires. For most households, the Supplier Survey is the preferred source of RECS information on household consumption and expenditures. After data entry, data from this source underwent a complex series of processing steps. A separate data file was created for each of the five fuels covered: electricity, natural gas, fuel oil, kerosene, and LPG. A series of edits was performed on the data that had been reported by month or another billing period, and the edited data were used to arrive at annualized estimates for all respondents who had adequate monthly data. These estimates were compared with model-based estimates based on household characteristics, and large differences were investigated. Similar model-based estimates were used to develop estimates of total consumption and expenditure by fuel for households not eligible for the Supplier Survey and those for which usable data were not obtained in the Supplier Survey. Finally, total consumption and expenditure of each fuel was allocated to end-use categories on the basis of a nonlinear regression model.

- Weather Data. Temperature data from all official U.S. weather stations were purchased on data tapes from NOAA. Based on analyses of proximity factors and the quality of the weather data, a specific weather station was associated with each RECS SSU. Temperature data for the selected SSU's were used to calculate heating and cooling degree-day estimates. The estimates for each SSU were added to the household and billing data files for all households located in that SSU. As one step in processing the Supplier Survey data, monthly estimates of degree-days were used to develop annual estimates for housing-units for which only part-year data were reported. For humidity,

the data were keyed from a NOAA publication and linked with RECS sample households at the PSU level.

## Estimation

As in earlier surveys, the estimation procedures used in the 1993 RECS had four goals:

1.  To reflect the overall selection probability of each sample housing-unit by the application of appropriate weights

2.  To minimize bias resulting from unit nonresponse by the application of weight adjustments to groups of sample households with similar characteristics

3.  To minimize sampling variance by the use of ratio estimates based on data available for all PSU's, whether or not included in the sample

4.  To minimize bias resulting from undercoverage by benchmarking the RECS estimates of number of households to more precise estimates derived from the Census Bureau's Current Population Survey.

The overall weight developed for each sample housing-unit reflects the joint effects of sample weighting (Item 1 above), nonresponse adjustment (Item 2), and ratio estimation to reduce sampling variance and bias (Items 3 and 4).

Sampling errors for most estimates included in the published reports from RECS are estimated by the use of a balanced half-sample replication method. The results for individual data cells are used to develop generalized variance factors that are presented in the publications. Estimation procedures and sampling errors are discussed in greater detail in Chapter 7.

## Data Dissemination

The *Housing Characteristics 1993* report for the 1993 RECS was released in June 1995 and the *Household Energy Consumption and Expenditures 1993* report was released in October 1995. Preparation of public-use data files with housing-unit data from all sources requires various deletions and other changes to ensure that the identity of individual housing-units and households cannot be determined by users. For example, all geographic identifiers other than Census region and division are removed. These anonymized public-use files are made available on magnetic tape for use with main frame computers and on diskettes for use with personal computers. The public-use files for the 1993 RECS were sent to the National Technical Information Service for distribution in August 1995 and, as noted in Chapter 1, were also made available for downloading via Internet at that time.

## Cost of the Survey

The total cost of the 1993 RECS was approximately $3,965,000 over a 3-year period.  This includes $475,000 provided by the Administration for Children and Families to support the collection of data used in the administration of the Low-Income Home Energy Assistance Program.  The 1993 RECS was the first to use the sampling frame redesigned with the use of 1990 Census data.  The cost of the redesign attributed to RECS was $556,000.  The sampling frame is updated once every 10 years and the latest update will be used for at least two additional RECS.

The total cost of the 1990 RECS, exclusive of any cost arising from the redesign of the sample after the 1980 Census, was $2,115,000.  The percentage breakdown of the total cost by major survey activities was:

| Activity | Percent of Total |
|---|---|
| Planning and administration | 5.2 |
| Sample selection, including field listings and updates | 18.3 |
| Interviewer training | 10.4 |
| Household Survey data collection | 28.4 |
| Household Survey data processing | 18.9 |
| Rental Agent Survey data collection and editing | 1.1 |
| Supplier Survey data collection | 5.9 |
| Supplier Survey data processing | 8.5 |
| Documentation | 3.3 |
| | |
| Total | 100.0 |

# Evolution of the RECS Design:  1978-1993

Many of the basic design features of the 1993 RECS were present in the 1978 National Interim Energy Consumption Survey (NIECS), which was the first in the series of national sample surveys of residential energy consumption.  Features that have remained constant throughout the nine surveys conducted between 1978 and 1993 include:

- Collection of data on household consumption of major fuels as a primary goal

- Collection and integration of data from multiple sources:  households, rental agents, energy suppliers and weather stations

- Use of a national multistage probability sample of several thousand households

- Primary reliance on personal interviews to collect data from households

- Use of regression methodology to estimate consumption of each major fuel by end use within each household.

Within this broad framework, however, there have been many changes in specific features of the survey design and methodology. Changes have occurred because experience, experimentation, and research have suggested improvements; because the needs and interests of data users have changed; because there have been changes in the data available for use in sample design and estimation; and because the level of resources available for the surveys has varied from year to year. This section identifies important changes that have occurred in the 15-year evolution of RECS. Their impacts on the quality of RECS data are discussed in the chapters that follow.

## Frequency and Timing of the Surveys

- Surveys were conducted annually from 1978 through 1982. The next RECS was conducted in 1984 and, since then, surveys have been undertaken at 3-year intervals, in 1987, 1990, and 1993. (As noted above, the Energy Policy Act of 1992 requires EIA to conduct a survey of residential energy use at least once every 3 years.)

- From 1978 through 1984, consumption data were collected for the 1-year period from April of the survey year through March of the following year. Starting with the 1987 survey, however, the consumption data have been collected for the survey calendar year.

## Survey Content

- Although the broad topics of RECS have remained fairly constant, there have been many changes in specific items. Several of these changes reflect efforts to improve the performance of the regression models used to estimate total consumption of each fuel for households with no data from the Supplier Survey and to allocate consumption for each fuel to specific end uses. Some items used in one or more surveys have been dropped because respondents have found them difficult to answer. Examples are questions on the location and thickness of insulation.

- Several items have been added or deleted in response to changes in energy policies and programs and the emergence of new energy technologies. Questions on participation of low-income households in government programs to help cover the costs of home energy and weatherization improvements were added in 1981 and have been a regular feature since then. Questions about use of income tax credits for expenditures on home energy conservation improvements were asked in the 1982 and 1984 RECS but were then dropped when this provision of tax law expired. Questions about participation in demand-side management programs (utility-sponsored activities

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designed to affect the amount and timing of customer electricity use) have become more detailed as these programs have expanded in scope and coverage.

- As described in the previous section, a comprehensive 1992 study of RECS user needs led to inclusion of several new items in the 1993 RECS Household Survey questionnaire and the elimination of some items covered in earlier surveys.

## Sample Design

- The sample for the 1980 survey was the first one specifically designed for the purpose of a residential energy consumption survey. Coverage of the target population was expanded to include Alaska and Hawaii and residential housing-units on military bases.

- The samples for the 1984 and 1993 RECS were redesigned in order to take advantage of the availability of new data from the 1980 and 1990 Censuses, respectively. In each instance, the new census data were used in the definition, stratification and selection of PSU's and SSU's and to improve the precision of the survey estimates.

- The sample used in 1978 and 1979 was designed to produce data for the four Census regions. The 1980 sample was designed to produce statistically reliable data for nine Census divisions and 10 Federal regions. The requirement for the ten Federal regions was dropped in the 1984 redesign.

- The 1980 and subsequent redesigns have provided for the possibility of including a longitudinal component in successive surveys--that is, a subsample of the housing-units included in each survey could also be included in the next survey. Longitudinal components were included in the samples for the 1982, 1984, 1987, and 1990 surveys but not in the 1993 survey. In each instance, the sample for one-half of the sample SSU's consisted of housing-units from the previous survey, plus a sample of newly constructed units. Inclusion of longitudinal components has two advantages: it increases the precision of estimates of change between successive surveys and it provides a basis for longitudinal analyses, at the housing-unit level, of changes in consumption and household characteristics.

- The core sample for each RECS has been close to a self-weighting sample (the same overall selection probability of selection for each sample housing-unit), with adjustments to obtain the required minimum precision for each Census division. Supplemental samples of housing-units occupied by low-income households were provided for in the 1981, 1984, 1987, and 1993 designs. Because of an interest in changing trends in the energy efficiency of new houses, the 1993 sample design also provided for oversampling of new housing-units, defined as those completed in 1987 or later.

## Data Collection Procedures

- Each Household Survey from 1978 through 1990 included a multiwave effort to obtain personal interviews for the greatest possible number of sample households, followed by the use of abbreviated mail questionnaires to seek limited information from the remaining households. In the 1993 RECS, a telephone followup procedure, also using an abbreviated version of the questionnaire, was inserted between the personal interview and mail phases.

- In the 1978 survey, Household Survey respondents were asked to estimate their total floor space, and there were also questions about the number of rooms and the size of the largest room. In 1979, the question on total floor space was dropped. From 1980 on, interviewers used tape measures to determine the physical dimensions of sample housing-units.

- Because of increasing interest in knowing the rated efficiency of major appliances, in the 1990 RECS interviewers attempted to obtain relevant information from the nameplates of central air-conditioning units. This procedure had only limited success and was not repeated in the 1993 RECS.

- Small cash incentive payments were used in connection with the Household Survey interviews in 1978 and 1979 and dropped thereafter. Cash incentives were used with the mail questionnaires through the 1982 survey. No incentives were used in the 1984 RECS; from 1987 on, a small token incentive, such as a key chain, has been sent out with the mail questionnaires.

- Interviewers for the Household Survey were trained by mail for the 1978 and 1979 surveys. In 1980, interviewers received in-person training in small group sessions at several locations throughout the country. For the 1981, 1982, and 1984 RECS, the 1980 training procedure was used for new interviewers, but training for those with prior RECS experience consisted of self-study materials and practice interviews. For the 1987 RECS, most of the interviewers received in-person training at five different locations. For the 1990 RECS there was no in-person training; all interviewers received their training via self-study materials, instructional videotapes, and completion of practice interviews, with evaluation by contractor staff. Interviewer training for the 1993 RECS reverted to the 1987 in-person model, with training at four different locations.

## Data Processing

- Data entry operations were 100-percent verified in the 1978, 1979, and 1980 surveys. From 1981 through 1984, key questionnaire items were verified 100 percent and the remaining items were checked for a 25-percent sample of households. The cost of correcting data entry errors in subsequent stages of processing proved to be substantial, so 100-percent verification of data entry for all items has been used since the 1987 RECS.

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- Procedures for associating weather data acquired from NOAA with individual sample housing-units have evolved over the life of the survey. A major change occurred in the 1987 RECS, when degree-day information for each housing-unit in an SSU was taken from the individual weather station nearest (in terms of distance and other factors) to the SSU, provided usable data were available for that station. Prior to 1987, degree-day data had been based on clusters of weather stations within a NOAA weather division.

## Estimation Procedures

- For each RECS, part of the estimation procedure has been to benchmark the survey estimates of the number of households in various subgroups to agree with independent estimates derived from the Census Bureau's Current Population Survey (CPS). Initially, this ratio estimation procedure was carried out separately for 12 cells based on Census region and location type (central city, suburban, rural). Early analyses showed that RECS estimates of one-person households were low, so in the 1982 RECS a preliminary step was added in which the estimates were benchmarked to CPS estimates for three categories: single-person households with male householders, single-person households with female householders, and all other households. In the 1993 RECS, a further benchmark adjustment was introduced to ensure agreement of RECS and CPS household estimates for the nine Census divisions and for four large States: California, Florida, New York, and Texas.

- For all surveys through 1990, the CPS-based estimates used as benchmarks for the RECS estimates of households were developed for November of the survey year, representing the approximate midpoint of the data collection period for the Household Survey. In the 1993 RECS, the benchmark month was changed to July of the survey year, to coincide with the midpoint of the reference period for energy consumption.

- Measured total consumption of each fuel is allocated to end-use categories by use of a model-based estimation procedure that relates end-use consumption to a variety of housing and household characteristics for which information is obtained in the survey. The allocation model has been gradually refined in successive surveys. A major shift occurred in the 1984 RECS, when a nonlinear regression model replaced the linear model used in the earlier surveys (Carroll 1987). The number of separate end-use categories estimated for electricity was increased in 1990 and again in 1993.

## Data Dissemination

- Starting with the 1980 RECS, there have been two major publications of the results from each survey, the first covering *Housing Characteristics 1993* and the second covering *Household Energy Consumption and Expenditures 1993*. In 1984, for the first time, estimates of energy consumption by end use were included in the regional supplement to the *Household Energy Consumption and Expenditures 1993* report.

Prior to then, the end-use data had been released in various special publications (EIA 1983c, EIA 1984c, Thompson 1987).

- Public-use data tapes (i.e., tapes with anonymized data for individual sample households) have been released for all surveys. Starting with the 1987 RECS, public-use data sets have also been released on diskettes for use on personal computers. In August 1995, public-use data sets for the 1987, 1990, and 1993 surveys were made available for downloading via the Internet.