



# **2024 Residential Energy Consumption Survey: Household Characteristics Technical Documentation Summary**

May 2026



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## Overview and History

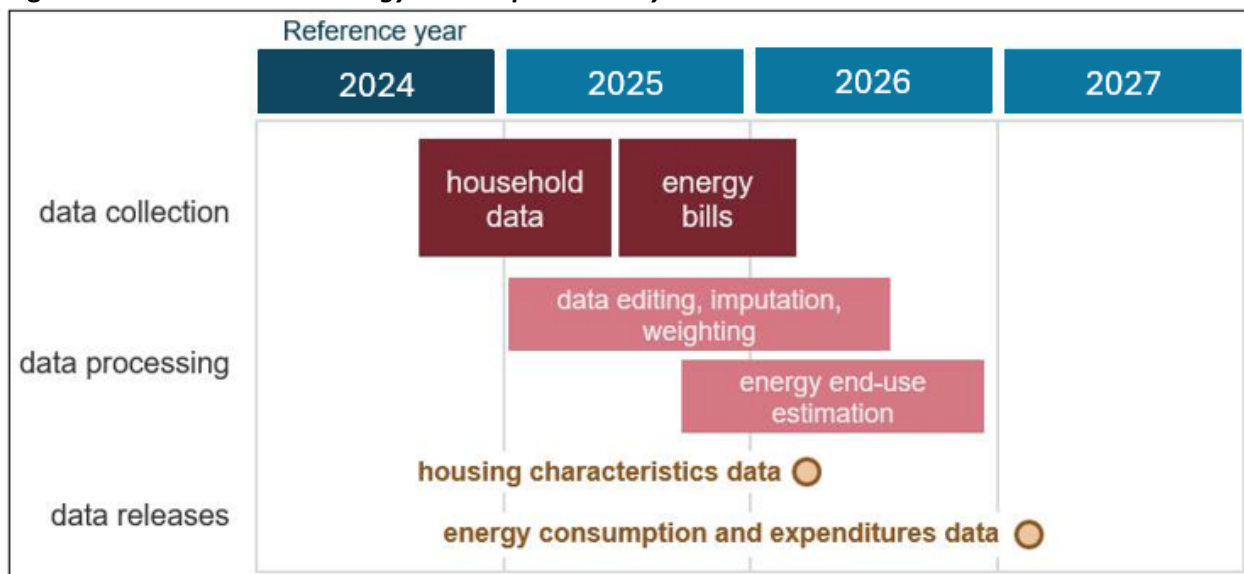
The *Residential Energy Consumption Survey* (RECS) is a periodic study we conduct that provides detailed information about energy usage in U.S. homes. RECS is a multiyear effort consisting of a Household Survey, which collects data directly from primary residences, an Energy Supplier Survey (ESS), which collects data from household energy suppliers, and an additional process for modeling and estimating end-use consumption and expenditures. The 2024 RECS is the 16<sup>th</sup> iteration of the study.

The Household Survey, a voluntary survey, collects data on energy-related characteristics and usage patterns at the national and sub-national (for example, state) levels from a representative sample of Housing Units (HUs). The ESS is a mandatory survey that collects data on how much electricity, natural gas, propane and liquefied petroleum gas (LPG), and fuel oil and kerosene were consumed in the sampled housing units during the reference year. It also collects data on actual dollar amounts spent on these energy sources. We use engineering-based models to produce consumption and expenditure estimates for heating, cooling, refrigeration, and other end uses in all housing units occupied as a primary residence in the United States using the data collected from the Household Survey and ESS. [Figure 1](#) outlines the 2024 RECS timeline.

The scope and purpose of RECS differ slightly from similar EIA products that report residential energy data. RECS samples homes occupied as a primary residence, which excludes secondary homes, vacant homes, military barracks, and common areas in apartment buildings. As a result, RECS estimates do not represent sector-level totals defined in our other products. Rather, they are best suited for comparisons across different characteristics of homes within the residential sector.

We collaborated with IMG-Crown and RTI International to conduct the 2024 RECS Household Survey.

**Figure 1. 2024 Residential Energy Consumption Survey Timeline**



Source: U.S. Energy Information Administration

## Survey Design Elements and Changes

Although the 2024 RECS followed similar methods as the 2020 RECS, we instituted some survey design revisions, content changes, and variable updates for the 2024 RECS:

- We designed the 2024 RECS sample using a 61-stratum design to meet precision requirements for energy consumption for all 50 states and the District of Columbia, plus 10 geographically diverse Metropolitan Statistical Areas (MSAs), with an expected yield of 18,000 to 20,000 completed RECS questionnaires from sampled households. We added precision requirements for 10 MSAs to allow EIA to explore small area estimation, contingent upon availability of resources.
- We added new questions to improve and expand estimates on several different topics including:
  - Tertiary heating equipment and fuel
  - How often people turn heating and cooling equipment on
  - Number of electric vehicles owned or leased
  - Number of solar panels
  - Heat pump/hybrid water heaters
  - Solar thermal backups for water heaters
  - Number of months that a respondent’s pool is heated
  - Inability to pay energy bill in part or in full
- Similar to the 2020 RECS, we collected the Household Survey data in two phases: the first phase, covering 20% of the starting sample, was conducted from October 2024 to January 2025, and the second phase, covering the remaining 80% of the sample, was conducted from January through April 2025. Instead of the Choice+ protocol used in 2020, where both web-survey and paper-survey modes were offered in all mailing invitations, the 2024 RECS implemented a web-first approach to encourage web-based survey completion. The 2024 initial mailing invitation only offered the web mode and then the paper mode was introduced on the second invitation mailing. In addition, the promised incentive was also structured differently. The 2020 RECS consistently offered a higher incentive for web completion compared with paper completion, while the 2024 RECS introduced a delayed, increased incentive model.
- A total of 16,676 respondents completed the Household Survey—93% by web and 7% by paper—representing a shift toward more web surveys than in 2020, particularly for those completed using mobile phones. The shift was influenced by a change in the data collection protocol. The overall unweighted response rate (AAPOR 5.1)<sup>1</sup> was 31.0%, and the overall weighted response rate was 30.7%.
- We conducted quality control checks and edits for all data to validate the sampled addresses of the responding households and to identify and resolve data inconsistencies. This process included identifying outliers for numeric items, identifying and resolving logical inconsistencies, and recoding write-in responses into established response categories.
  - In addition, we are to perform a comprehensive data editing process to reconcile the inconsistencies between respondent-reported characteristics data and the supplier-reported consumption data, mainly to focus on the fuel use variables. Because the reconciliation editing process affects estimates of fuels, space heating, water heating, and air conditioning the most, the estimates of these variables will be released after the process is complete.

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<sup>1</sup> For more information on response rate calculation, see [AAPOR’s Response Rates](#) page.

- To address item nonresponse<sup>2</sup>, we used a hot-deck imputation method for the 2024 RECS. In this method, we match a recipient household that has a missing value for the variable being imputed to a similar donor household that has a response for that variable, and we use that value to replace the missing response. We imputed responses for about 270 Household Survey variables, and the median imputation rate was 2.6%.
- The 2024 RECS weighting process used adjustment methods similar to those in 2020, including adjustments for eligibility, nonresponse, and poststratification. The primary change was in the poststratification step, which used one-year 2024 American Community Survey (ACS) data<sup>3</sup> for occupied housing-unit control totals at the stratum level. Another significant change was to benchmark the housing type at the state level, a more granular approach than the RECS division level used in 2020.
- The 2024 RECS sample used the Jackknife Repeated Replication method for variance estimation. Each RECS estimate has a corresponding relative standard error (RSE). We calculated the RSEs from the estimated variance using replicate weights. RSEs are included as a separate tab in each published Excel table. Estimates greater than zero with a corresponding RSE shown as *P* indicate that the estimate is equal to the control total that was used in poststratification during the weighting adjustment process. The control totals are based on the 2024 ACS one-year estimates.
- We conducted a comprehensive nonresponse bias analysis focusing on key household characteristics and identified no major concerns with the data quality of key 2024 RECS estimates, indicating that the final weighted 2024 RECS estimates are not significantly different from the target population parameters.

## Data Products and Revision Policy

### Data products

We release a variety of RECS products across survey cycles tailored to a wide range of data users. These products are available on the RECS website and include:

- Data tables for housing characteristics, consumption, expenditures, and end use estimates at various geographic levels, including state-level estimates
- *Today in Energy* articles
- Public-Use Microdata File and User Guide
- Webinars
- Topic-specific infographics and articles
- Survey methods documentation

Although we release similar products across survey cycles, we change these products from one cycle to the next to adapt to changes in the residential energy sector and apply new dissemination methods and tools. RECS products from previous cycles are available on each survey cycle's Data page or on the archived Analysis and Projections page.

### Revisions and changes across cycles

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<sup>2</sup> Item nonresponse occurs when respondents do not know or refuse to answer a question in the survey or when we determine a response is invalid and remove it during editing.

<sup>3</sup> For more information on the [ACS one-year data products](#), please refer to the U.S. Census Bureau website.

### *Within-cycle data revisions*

We execute a series of survey data cleaning, editing, imputation, and coding steps to ensure RECS data and estimates meet EIA quality standards. We release preliminary RECS Household Characteristics results at the end of the RECS Household Survey phase. After this release, we perform additional quality control steps to reconcile Household Characteristics data with energy billing data collected as part of the RECS ESS. This additional quality control process may result in further refinement and improved accuracy of estimates, particularly for main-heating fuel and equipment and water-heating fuel.

### *Methodological and content changes across survey cycles*

RECS is a cross-sectional study, with updates to questionnaire content, statistical methods, and dissemination strategies from the previous cycle. We do not currently conduct a longitudinal household energy demand study. Each RECS, however, shares content and design elements across survey cycles. The unit of analysis for every RECS cycle is the occupied, primary housing unit. The sample is designed, using geographic and other stratification methods, using an address-based housing unit frame. Most survey questions are carried forward from one cycle to the next. Although changes in questionnaire wording and survey methods may make some comparisons of estimates between RECS survey cycles invalid, many comparisons are valid and statistically sound.

Major changes to methods or questionnaire content from one cycle to the next are highlighted in Technical Documentation reports, special-topic reports (for example, the end-use modeling changes for 2015), and survey form specifications.

## Frame and Sample Design Overview

The 2024 RECS uses a 61-stratum design, building on the 2020 RECS approach, to meet energy consumption precision requirements for all 50 states, the District of Columbia, and 10 geographically diverse metropolitan statistical areas (MSAs). The target population is all occupied housing units that are used as primary residences within these areas. Vacant homes, seasonal housing units, and group quarters (such as dormitories, nursing homes, prisons, and military barracks) are excluded. Housing units on military installations are included. In addition, we benchmark to occupied housing unit totals from the 2024 one-year ACS. RECS uses the U.S. Census Bureau's definition of a [housing unit](#), which is a single-family home, a unit in a multifamily building, or a mobile home.

## Frame Sources and Coverage

We selected housing units for the 2024 RECS using an Address Based Sample (ABS) design. The frame for this sample is a list of residential addresses, based on the U.S. Postal Service's (USPS) Computerized Delivery Sequence (CDS) file of active mail delivery points. The frame file is enhanced with supplemental data from the Decennial Census, the ACS, and other sources to allow us to stratify the frame for better statistical efficiency and better representation of the population of eligible housing units. The following types of addresses were removed: nonresidential addresses, Post Office Box addresses that are not the only-way-to-get-mail (OWGM),<sup>4</sup> and drop-point addresses that have a frame indication of more than

<sup>4</sup> OWGM Post Office Boxes represent addresses at which a resident's only acceptable form of postal delivery is through a Post Office Box address. See McMichael, J., & Brown, D. (2018). *PO Boxes on Address Based Sampling (ABS) frame: Under- or over-coverage or both?* American Association for Public Opinion Research, Denver, CO.

four units. Overall, the expected population coverage of the RECS ABS frame is about 99.7% of the target population of housing units.

Drop points are addresses that serve multiple housing units (drop units) without a unit identifier. These addresses posed logistical challenges for the 2024 RECS web- and mail-based data collection because the contact protocol included multiple mailings. Because the mailings went to a residential address, not a specific respondent name, subsequent mailings at a drop-point address could be received by respondents from different housing units. Using a frame indicator for number of units, we excluded drop-point addresses with four or more units from the sample frame. These units are a small percentage (about 2.2%) of the overall drop points, and they are more likely to be group quarters that are out of scope for RECS. Nationally, these excluded drop-point addresses led to a loss of around 0.3% in frame addresses. For the drop-point addresses with fewer than four units, we used a sample substitution method.<sup>5</sup> In other words, if a drop-point address was selected, then we selected the nearest non-drop-point multifamily building with the same number of units as the drop-point address. A unit in the substitute building would be randomly selected as a sampling unit.

### Sample allocation and sample selection

Prior to the 2020 RECS, clustered sample designs grouped housing units geographically to make hiring and deploying in-person interviewers efficient and cost effective. With the introduction of an entirely self-administered web and mail design in 2020, an unclustered design became feasible as geographic proximity was no longer necessary for efficient interviewer assignments. In addition, the 2024 RECS allocated samples to 10 MSAs that are distributed across different U.S. regions.<sup>6</sup> The 2024 RECS is a 61-stratum design, which consists of 40 states, the District of Columbia, 10 MSAs and the corresponding 10 non-MSA area strata of the remaining 10 states. Each non-MSA area stratum consists of all the area in the state that is not included in the MSA stratum for that state. [Table 1](#) outlines the energy consumption precision requirements for the geographic domains, where the fuel consumption data are collected from the ESS. To simplify sample allocation, the precision requirements for the 10 states with both MSAs and non-MSAs were set at 5%. Additionally, the precision requirements for propane and fuel oil were relaxed, a decision influenced by challenges in 2020 to achieve desired precisions for these fuels without substantially increasing sample size.

**Table 1. Relative standard error (RSE) requirements for average fuel consumption, 2024 RECS**

Geography	All fuel total <sup>a</sup>	Electricity	Natural gas	Propane	Fuel oil
United States	1%	1%	1%	4%	4%
Midwest, South, and West regions	2%	2%	2%	--	--
Northeast region	2%	2%	2%	--	5%
Census divisions	3%	3%	3%	--	--
50-states and District of Columbia	4%	--	--	--	--

<sup>5</sup> Amaya, A.E (2017). *RTI International's Address-Based Sampling Atlas: Drop points*. Research Triangle Park, NC: RTI Press. RTI Press Publication No. OP-0047-1712.

<sup>6</sup> The 10 MSAs are: Atlanta-Sandy Springs-Roswell in GA; Baltimore-Columbia-Towson in MD; Birmingham in AL; Detroit-Warren-Dearborn in MI; Houston-Pasadena-The Woodlands in TX; Miami-Fort Lauderdale-West Palm Beach in FL; Oklahoma City in OK; Phoenix-Mesa-Chandler in AZ; Riverside-San Bernardino-Ontario in CA; Rochester in NY.

10 MSAs and non-MSAs	5%	--	--	--	--
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Data source: U.S. Energy Information Administration, *2024 Residential Energy Consumption Survey (RECS)*

Note: *All fuel total* includes electricity, natural gas, fuel oil, and propane. -- = not applicable

Similar to 2020 RECS, to achieve these statistical requirements and to improve the precision of other key energy-use metrics, we targeted an estimated 20,000 completed cases during the sample design stage. However, due to the actual response rates being lower than the initial response rates assumed, after data collection and EIA editing, the final number of eligible, completed household cases is 16,676. During the editing process, 62 household cases were excluded, primarily due to multi-family respondents reporting characteristics that pertained to entire buildings or multiple units instead of the single unit that was sampled.

### *Expected completed-household and starting sample size allocation*

When allocating the completed-case sample size, no single formula could optimize and satisfy all the precision requirements simultaneously. Consistent with the 2020 RECS approach, the allocation process was done using a bottom-up approach, by optimally satisfying one requirement at a time.

The first step was to calculate the minimum sample size needed to meet the precision requirement for total energy consumption (in British thermal units) at the stratum level (40 states, the District of Columbia, 10 MSAs and the corresponding 10 non-MSA state areas), then check to see if the requirements at higher geographic levels, such as the division level, regional level, or the national level, were also satisfied. If they were not, then we applied the Neyman allocation to add any required sample to satisfy the precision requirements at each higher geographic level.<sup>7</sup> Once we allocated this initial sample to meet the precision requirement for the average total energy consumption, we then applied the same approach to ensure the precision requirements for each energy fuel source were met to achieve a final minimum sample size.

After the minimum expected number of completes (14,379) was determined, the difference (5,621) between the targeted completes of 20,000 and the minimum sample of 14,379 were allocated to strata in proportion to the number of occupied HUs in each stratum per the 2022 ACS five-year estimates of occupied HU counts. The 2022 ACS data was used because it was the most recent data available at the time the sampling stage was conducted. [Table 2](#) shows the final sample allocation for the expected completed households by stratum. The estimation of the RSEs with the final allocated, completed-case sample size required prior estimation of the means, standard errors, and design effects based on 2020 data.

To achieve the target number of completed households shown in [Table 2](#), an additional sample had to be selected to account for losses due to ineligibility and nonresponse during data collection. The frame address samples required for deployment to achieve the target number of completed households represents the starting sample. We determined the starting sample to be deployed based on the expected number of completed households and the assumed yield rate within each stratum. The yield rate represents the proportion of starting sample households that result in a complete, eligible

<sup>7</sup> Cochran, William G. *Sampling Techniques*, 3rd ed. (New York: John Wiley & Sons, 1977).

questionnaire derived from previous or external data. For the 2024 RECS, the yield rates shown in [Table 2](#) were based on the 2020 RECS data.

The starting samples calculated within each stratum were allocated to two data collection phases, Phase 1 comprising 20% and Phase 2 accounting for the remaining 80%. In addition to the selection of the starting sample (56,775) to meet the target number of complete households, a 15% reserve sample was also selected as a risk mitigation strategy. The intention behind using the reserve sample is that it would only be released, in part or in full, if during data collection, certain strata were projected to fall short of their targets. The 15% reserve sample was allocated to the strata proportional to the minimum sample sizes. Informed by the 2024 Phase 1 submission rates and the 2020 projected rates, the reserve samples in 25 of the 61 strata were incorporated into the Phase 2 data collection.

***Stratification and sample selection***

During the sample selection process, the frame was stratified explicitly by stratum for systematic selection. The strata were 40 states, the District of Columbia, 10 MSAs and the corresponding 10 non-MSA area strata of the remaining 10 states, resulting in the formation of 61 explicit strata. Within each stratum, the variables listed below were sorted as implicit stratification variables. The implicit stratification helps to ensure a representative sample by safeguarding against selecting a sample that is disproportionate to the frame distribution of the variables used for sorting. In essence, it mitigates the risk of a poorly representative sample occurring by chance, thereby enhancing the precision of the estimates. Below is the list of variables used in implicit stratification for 2024 RECS:

- Multifamily dwelling unit indicator (address level, from Computerized Delivery Sequence file)
- Urban or rural classification (census block level)
- Median income (census block group level), grouped into quintiles within each stratum
- Heating degree days (HDD65) (census tract level), grouped into quintiles within each stratum
- Zip code
- Carrier route (for mail delivery)
- Walk sequence (mail delivery sort order within carrier route)
- Zip+4 (for addresses that do not have a walk sequence)

**Table 2. Expected completed cases, assumed yield rate, and allocated starting sample, 2024 RECS**

state_name	state_postal	Stratum	Expected completed		Allocated
			households	Assumed yield rate	starting sample
Alabama	AL	AL MSA	131	32.35%	405
Alabama	AL	AL non-MSA	251	34.50%	727
Alaska	AK	AK	258	34.06%	757
Arizona	AZ	AZ MSA	345	34.72%	994
Arizona	AZ	AZ non-MSA	167	34.85%	479
Arkansas	AR	AR	260	32.92%	790
California	CA	CA MSA	159	32.96%	482
California	CA	CA non-MSA	1019	35.16%	2,898
Colorado	CO	CO	329	39.96%	823
Connecticut	CT	CT	347	34.96%	993

state_name	state_postal	Stratum	Expected completed		Allocated starting sample
			households	Assumed yield rate	
Delaware	DE	DE	181	34.54%	524
District of Columbia	DC	DC	475	36.83%	1,290
Florida	FL	FL MSA	247	27.19%	908
Florida	FL	FL non-MSA	410	31.80%	1,289
Georgia	GA	GA MSA	256	30.14%	849
Georgia	GA	GA non-MSA	178	35.46%	502
Hawaii	HI	HI	274	38.63%	709
Idaho	ID	ID	237	46.00%	515
Illinois	IL	IL	448	32.40%	1,383
Indiana	IN	IN	312	34.93%	893
Iowa	IA	IA	198	41.45%	478
Kansas	KS	KS	201	45.12%	445
Kentucky	KY	KY	387	39.52%	979
Louisiana	LA	LA	323	31.29%	1,032
Maine	ME	ME	229	36.92%	620
Maryland	MD	MD MSA	196	31.40%	624
Maryland	MD	MD non-MSA	244	35.37%	690
Massachusetts	MA	MA	553	32.34%	1,710
Michigan	MI	MI MSA	191	36.36%	525
Michigan	MI	MI non-MSA	197	42.65%	462
Minnesota	MN	MN	286	47.45%	603
Mississippi	MS	MS	256	32.62%	785
Missouri	MO	MO	317	37.80%	839
Montana	MT	MT	317	41.25%	769
Nebraska	NE	NE	255	42.95%	594
Nevada	NV	NV	289	33.67%	858
New Hampshire	NH	NH	277	38.89%	712
New Jersey	NJ	NJ	540	29.73%	1,817
New Mexico	NM	NM	240	33.15%	724
New York	NY	NY MSA	165	42.86%	385
New York	NY	NY non-MSA	1046	27.46%	3,809
North Carolina	NC	NC	395	35.40%	1,116
North Dakota	ND	ND	297	45.10%	659
Ohio	OH	OH	405	33.14%	1,222
Oklahoma	OK	OK MSA	144	34.15%	422
Oklahoma	OK	OK non-MSA	188	33.94%	554
Oregon	OR	OR	341	44.91%	759
Pennsylvania	PA	PA	723	31.72%	2,279
Rhode Island	RI	RI	237	35.24%	673

state_name	state_postal	Stratum	Expected completed		Allocated
			households	Assumed yield rate	starting sample
South Carolina	SC	SC	291	40.29%	722
South Dakota	SD	SD	203	44.63%	455
Tennessee	TN	TN	607	37.77%	1,607
Texas	TX	TX MSA	254	29.13%	872
Texas	TX	TX non-MSA	913	31.44%	2,904
Utah	UT	UT	232	42.82%	542
Vermont	VT	VT	200	44.06%	454
Virginia	VA	VA	401	38.32%	1,047
Washington	WA	WA	399	44.21%	903
West Virginia	WV	WV	219	35.82%	611
Wisconsin	WI	WI	302	47.41%	637
Wyoming	WY	WY	256	38.38%	667
<b>Total</b>			<b>19,998</b>		<b>56,775</b>

## Household Survey

### Questionnaire design

The 2024 RECS Household Survey was designed to be entirely self-administered using either a web or paper questionnaire. Both questionnaires were available in English and Spanish. The 2024 RECS questionnaire specification is available on the [EIA website](#) and consists of the following topical sections:

- Your home
- Appliances
- Electronics
- Space heating
- Air conditioning
- Thermostats and temperatures
- Water heating
- Lighting
- Energy bills
- Other energy uses
- Household characteristics
- Energy assistance
- Energy supplier information

Each time we conduct the RECS, we review the content and lessons learned from the previous cycle and revise the questionnaire appropriately. The content revisions typically include adding or dropping questions to account for household technology changes or to improve response quality. For the 2024 RECS, new questions included information on:

- Tertiary heating equipment and fuel
- Number of electric vehicles owned or leased
- Number of solar panels

- How often people turn heating and cooling equipment on
- Heat pump/hybrid water heaters
- Solar thermal backups for water heaters
- Number of months that a respondent's pool is heated
- Inability to pay energy bill in part or in full

To improve response quality, we updated questions in several sections, including space heating, appliances, electronics, and other energy uses.

## Data collection methods

The RECS Household Survey was voluntary and conducted in two phases: the first phase was fielded from October 2024 to January 2025, and the second phase was fielded from January to April 2025. A total of 16,676 eligible respondents completed the survey: 92.6% (15,446) responded via web questionnaire and 7.4% (1,230) responded via paper questionnaire. Of the respondents that completed the web questionnaire, 55.9% (8,640) used mobile phones, 42.5% (6,568) used a desktop or laptop computer, and 1.5% (238) used tablets. Based on survey timing paradata collected without any data transformation, the web survey took a median of about 35 minutes to complete, which is comparable to the 32 minutes reported in 2020.

### *Contact protocol*

The 2024 RECS HS implemented a different contact protocol design compared to 2020. In 2020, the Choice+ web/mail protocol concurrently offered sampled households both web and paper response options in all contact invitations, as well as with a larger promised incentive for web-based completion. However, the 2024 RECS HS households were initially only offered the web survey mode with a single incentive level. Subsequently, a follow-up invitation containing the paper form offered a higher incentive for web completion and a lower incentive for paper completion, mirroring the 2020 RECS tiered approach but with a delayed rollout of the higher web incentive.

### *Phased approach*

The 2024 RECS was planned as a two-phase, responsive-design approach. Phase 1 consisted of 20% of the initial starting sample. Phase 2 consisted of 80% of the initial sample. A 15% reserve sample was selected and allocated proportionally to each stratum's required minimum sample size during sample design. A partial set of these reserve cases were released to 25 strata in Phase 2.

The phased approach allowed us to mitigate risks and control costs by conducting a series of experiments during Phase 1 and implementing those findings during subsequent phases. Phase 1 included an experiment to test how the addition of a QR code on all letters and reminder cards would affect survey response, respondent representativity, and cost. Phase 1 also included an experiment to test prenotice postcards compared with two different timings of reminder mailings. Based on the experimental results from Phase 1, we selected inclusion of the QR code and a reminder letter following the second invitation for Phase 2.

### *Contact materials*

Phase 1 included the prenotice postcard and reminder mailing experiment, so the contact materials varied. For Phase 2, we sent a sample of addresses seven mailings over approximately 10 weeks. The materials included:

- First invitation—sent to all addresses
- Thank you or reminder postcard—sent to all addresses
- Reminder letter—sent to remaining eligible or open addresses
- Second invitation—sent to remaining eligible or open addresses
- Reminder postcard—sent to remaining eligible or open addresses
- Reminder letter—sent to remaining eligible or open addresses
- Final reminder letter—sent to addresses in four sampling strata with the lowest response rates

### Response rate and nonresponse bias

The overall unweighted response rate for the 2024 RECS Household Survey is 31.0%, and the weighted response rate is 30.7%. The unweighted response rate was calculated using the American Association for Public Opinion Research (AAPOR) formula 3 (AAPOR, 2020):

$$RR = I/(I+R+E)$$

where  $I$  is the number of complete interviews,<sup>8</sup>  $R$  is the number of refusal and eligible incompletes, and  $E$  is the number of eligible cases estimated from cases with unknown eligibility. The  $E$  was determined based on models for 2024 RECS.<sup>9</sup>

The weighted response rate was calculated using the same concept, except we used the corresponding sum of weights in each disposition category.

The overall response rate for 2024 RECS was lower than the 2020 RECS, which had a weighted response rate of 37.9% (unweighted response rate of 38.6%). [Figure 2](#) shows the weighted 2024 RECS response rates for the 50 states and the District of Columbia, demonstrating significant variation across states. The states achieving the highest response rates were South Dakota (40.7%), Idaho (40.1%), and Nebraska (39.9%). Conversely, the states with the lowest response rates were New Jersey (25.5%), New York (25.8%), and Georgia (26.2%).

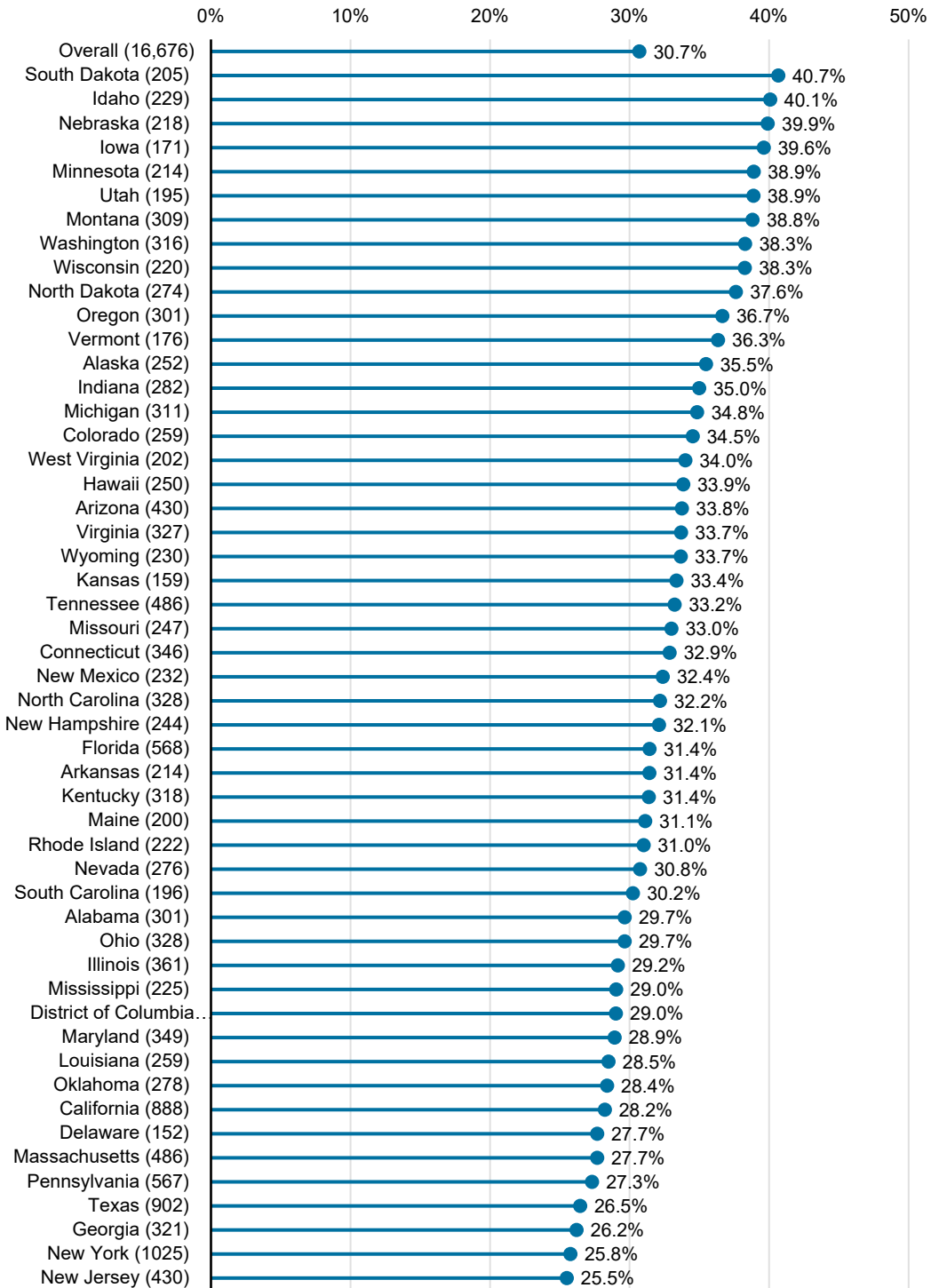
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<sup>8</sup> Completed interviews include interviews where the respondent did not answer all questions in the survey. The respondent must have answered at least 6 out of 10 key RECS questions for the interview to be considered complete. Partially completed interviews that did not meet that definition were defined as eligible incompletes.

<sup>9</sup> See the *Weighting and Sampling Error* section for more details.

**Figure 2. Weighted self-response rate by state, 2024 RECS**

state (number of completed households)



Data source: U.S. Energy Information Administration, *2024 Residential Energy Consumption Survey (RECS)*

We conducted a comprehensive nonresponse bias study to understand how 2024 RECS respondents represented the general population or if any subpopulations were underrepresented in the responding sample. We compared response rates by sample subgroup and compared the estimates of key frame variables between the respondent and nonrespondent groups. Differences in any comparisons could indicate potential nonresponse bias. In addition, we compared demographic variables to the ACS estimates to assess potential differences between the types of households responding to the RECS and the general household population of the United States.

Overall, the nonresponse bias study did not reveal any major bias concerns. The study reached the following conclusions about the Household Survey:

- The frame coverage was high, representing approximately 99.7% of the target population.
- Unit response rates varied across different subgroups, such as housing type, census regions, and urban or rural classification. The largest unit nonresponse biases before weighting adjustment were “percentage of population that speaks English less than very well” and “percentage of housing units that are owner-occupied.” But potential nonresponse bias in these variables and others were reduced by applying weight adjustments, which are described in the Weighting and Sampling Error section.
- No major concerns with item nonresponse were identified. Imputation was a risk mitigation strategy to reduce item nonresponse bias. Among about 270 survey items that went through imputation, four variables had an item nonresponse rate higher than 30%. These were the YEARMAD (year housing unit was built), SQFTEST (respondent-reported square footage), WTRHP (electric water heater is a heat pump water heater), and PVCAPACITY (capacity of PV system in kW).
  - For YEARMAD and SQFTEST, a significant portion of the nonresponse was converted to a range response in the follow-up questions, thereby helping to lessen the bias.
  - The high item nonresponse for the WTRHP variable was the result of respondents reporting “Don’t Know,” particularly among respondents in multi-family building units.
  - The respondent sample size was much smaller for the PVCAPACITY variable, making it difficult to detect statistical significance for the biases.
- Analysis of how well estimates of RECS subgroups represented those groups in the general population found that key 2024 RECS estimates are statistically similar to the 2024 ACS and 2024 American Housing Survey (AHS) estimates. Most of the differences are less than five percentage points. There were a few demographic characteristics showing larger differences, such as respondent education and race, which might indicate some inherent respondent characteristics in the RECS Household Survey, as these differences have been observed across different cycles of the survey.
- When comparing estimates within the 2024 RECS or estimates from previous RECS studies, data users should use the relative standard errors (RSE) to determine if two estimates are statistically different from one another and consider if questionnaire wording has changed.

## Editing and data quality

In addition to the 2024 RECS strategies for data quality improvement, such as adding categorical follow-up questions and explicit *Don’t Know* response options to variables crucial for energy-use modeling, we also implemented web edits for key variables in the Computer-Assisted Web Interviewing (CAWI) instrument, such as FUELHEAT (main space heating fuel type, to be released with consumption data in 2027) and TVCOLOR (number of televisions used).

All completed surveys went through a validation process to ensure that the correct sampled households responded and that key questions were answered. After the validation process, we applied both batch and analyst edits to thoroughly review the data for inconsistent responses, numeric-response outliers, and write-in responses when a respondent chose *other* as a response. If the review indicated that a response was incorrect, it was either changed to a valid response using deductive reasoning, or it was changed to missing and then imputed.

Beginning with the 2015 survey cycle, we introduced an additional quality control step for the RECS Household Survey phase. This step is to reconcile inconsistencies between household characteristics and utility bills reported during the ESS phase. For example, in 2020, we changed a response of *electricity* for main heating fuel on the Household Survey to *natural gas* where ESS data indicated strong winter seasonal use in utility-reported natural gas bills for that household. We also reviewed cases where households reported solar photovoltaic (PV) generation to ensure ESS-provided electricity billing data included both the solar PV generation and the utility-generated consumption. The same strategy of linking the household responses and utility bills to review inconsistencies will be employed for 2024 RECS. These editing steps are to correct some measurement errors in the Household Survey, resulting in more accurate main space-heating fuel, space-heating equipment, and water-heating fuel responses. In addition, these editing steps lead to more consistent linkage between characteristics, annualized consumption and cost, and modeled end-use estimates.

## Item imputation

*Item nonresponse* occurs when respondents do not know or refuse to answer a question in the survey or when we determine a response is invalid and remove it during editing. Item imputation is the process of filling in the missing responses using a statistical model to produce a complete dataset and to reduce the bias associated with item nonresponse.

The 2024 RECS used the hot-deck imputation method, just as for the 2020 RECS. In this method, a recipient case that has a missing value for the variable we are imputing is matched with a similar donor case that has a response for that variable. We use the donor's response for that variable to replace the missing response for the recipient case. After imputation, final editing reviews ensured questionnaire skip patterns were maintained. For the 2024 RECS, we imputed all variables using the Cyclical Tree-Based (CTB)<sup>10</sup> hot-deck method. This method uses classification trees to group recipients and potential donors and uses a weighted, sequential, hot-deck imputation procedure<sup>11</sup> where we use weights to match chosen donors to recipients. The imputation process was carried out in multiple cycles: a base cycle and two additional cycles. In each of the additional cycles, potential predictors for variables were refined by including the imputed/revised values from their preceding cycles.

Consistent with the 2020 RECS, the item nonresponse rates were generally low in 2024. We imputed responses for about 270 Household Survey variables. The average imputation rate was 4.8%, and the median was 2.6%. These rates were very similar to those observed in the 2020 RECS. About 76% of the

<sup>10</sup> Creel, D. V., & Krotki, K. (2006). Creating imputation classes using classification tree methodology. In *Proceedings of the Survey Research Methods Section, American Statistical Association, Joint Statistical Meeting 2006*, pp. 2884–2887.

<sup>11</sup> Cox, B. G. (1980). The weighted sequential hot-deck imputation procedure. In *Proceedings of the Survey Research Methods Section, American Statistical Association*, pp. 721–726.

variables had a less than 5% imputation rate; and 89% of the variables had a less than 10% imputation rate.

## Weighting and Sampling Error

As in 2020, the 2024 RECS used a single-stage probability design to select a sample of households that represents the housing unit population in the United States. To produce population estimates, we weighted the sampled housing units to represent all housing units including those not in the sample. First, we calculated the base sampling weights, which are the reciprocal of the probability of selection for the RECS sample, for each sampled housing unit. We produced the final analysis weights (NWEIGHT) after applying various adjustments. In addition, we computed replicate weights for variance estimation purposes.

The weighting adjustments in 2024 closely mirror those in 2020. The final analysis weights were constructed by applying eligibility, unit nonresponse, and poststratification adjustments to the base or design weights. The eligibility adjustment consisted of two components: first, an adjustment to housing units via a latent-variable technique<sup>12</sup> to predict the probability that a housing unit is occupied or unoccupied; and second, an adjustment to not-primary housing units via a logistic regression model to predict the probability that a housing unit was primary or not-primary. After the eligibility adjustment, we applied the Generalized Exponential Model (GEM)<sup>13</sup> calibration method for the nonresponse and poststratification adjustments.

The last weighting adjustment, poststratification, served to benchmark the 2024 RECS weighted housing unit counts to other external sources presumed to offer a better representation of the full population. Historically, RECS benchmarks to the one-year ACS data products. However, in 2020, the official release of the one-year ACS product was affected by the COVID-19 pandemic, necessitating the use of control totals derived from a combination of estimates from the 2020 Decennial Census and the 2019 one-year ACS. For the 2024 RECS, we were able to use the 2024 one-year ACS data during the weighting process, ensuring more current and consistent benchmarks. [Table 3](#) shows the poststratification comparisons between 2020 and 2024.

A notable methodological difference in control totals between 2020 and 2024 is how housing type was handled: in 2024, housing type was poststratified at the state level, a more granular approach than the division-level poststratification employed in 2020. This state-level poststratification, along with the inclusion of 10 MSAs as strata, introduced methodological challenges. Specifically, poststratifying housing type at the state level required special handling during both the poststratification and replicate weight processes for several states (CT, DC, MA, NE, and PA). This was primarily due to the low sample size of mobile homes in the respondent data, which necessitated combining (collapsing) mobile homes with single-family detached homes to ensure model stability and sufficient sample in these states.

<sup>12</sup> Biemer, P., Murphy, J., & Kott, P. (2016). Estimating mail or web survey eligibility for undeliverable addresses: A latent class analysis approach. In *JSM Proceedings*, pp. 1166–1172. American Statistical Association.

<sup>13</sup> Folsom, R. E., & Singh, A. C. (2000). The generalized exponential model for sampling weight calibration for extreme values, nonresponse, and poststratification. In *Proceedings of the American Statistical Association, Survey Research Methods Section*, pp. 598–603. Alexandria, VA: American Statistical Association.

Similar to 2020, the year-built range variable was poststratified at the division level. The control totals were calculated using estimates from the 2024 one-year ACS “Tenure by Year Structure Built” table and the 2023 one-year ACS Public Use Microdata Sample (PUMS) data to exclude the estimates of boats, RVs, or vans. In addition, the 2020-2024 category was combined with the 2010-2019 category for post-stratification.

**Table 3. Comparison of post-stratification between 2024 RECS and 2020 RECS**

	2024 RECS	2020 RECS
<b>Control totals source</b>	2024 One-Year ACS, 2023 One-Year ACS	2020 Decennial Census, 2019 One-Year ACS
<b>RECS stratum</b>	40 states, DC, 10 MSAs, and 10 non-MSAs	50 states and DC
<b>Housing Unit type</b>	Single detached, single attached, apartment with two to four units, apartment with more than five units, mobile home	Single detached, single attached, apartment with two to four units, apartment with more than five units, mobile home
<b>Year Built Range</b>	Before 1950, 1950–1959, 1960–1969, 1970–1979, 1980–1989, 1990–1999, 2000–2009, 2010 and after	Before 1950, 1950–1959, 1960–1969, 1970–1979, 1980–1989, 1990–1999, 2000–2009, 2010 and after
<b>Two-Way Interaction</b>	State * Housing Unit Type RECS Division* Year Built Range	RECS Division * Housing Unit Type RECS Division* Year Built Range

Data source: U.S. Energy Information Administration, *Residential Energy Consumption Survey* (RECS)

The final analysis weight for each responding household was the number of households in the population that the observation represents. For example, if the analysis weight for a household is 5,000, that household represents itself and 4,999 non-sampled households.

As in 2020, the 2024 RECS also used the Jackknife approach to develop replicate weights for variance estimation, from which the relative standard errors (RSEs) are derived. We employed the delete-a-group Jackknife method (Kott, 2001<sup>14</sup>); it was suited for the stratified design with large and varying numbers of sampled units per stratum. The number of replicate weights was 60 in both 2020 and 2024.

### Relative standard errors

Estimates from a sample survey like RECS are not exact; they are statistical estimates with some associated sampling error—the result of generating estimates based on a sample rather than conducting a census of the entire population. The standard error is a measure of the precision of a particular statistic for a characteristic, based on how variable it is in the population and a given sample size. Standard errors are used with survey statistics to measure sampling error, construct confidence intervals, or perform hypothesis tests. We estimated the standard errors using the Jackknife method with a coefficient of 0.983 (59/60 replicates).

The relative standard error (RSE) measures how large the standard error is relative to the corresponding statistic; the larger the RSE, the less precise the survey statistic. The RSE is expressed as a percentage and is calculated as (standard error/statistic) x 100.

In the public release tables, the following notations are used for RSE values:

- **Q:** Data withheld because either the relative standard error (RSE) was greater than 50% or fewer than 10 households were in the reporting sample.

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- **N:** No households in reporting sample.
- **P:** Estimate is equal to the control total that is used in poststratification and is based on the U.S. Census Bureau's 2024 American Community Survey one-year estimates.

## Weather and Geographic Data

We gather weather and certain geographic indicators from other government agencies to complete the characteristics profile of sampled housing units. The daily average temperature, calculated as the average of the daily minimum and maximum temperature, is available for a number of weather stations within the United States from Climate Data Online (CDO)<sup>15</sup> (part of the National Centers for Environmental Information [NCEI]). Each sampled RECS housing unit was associated with its nearby weather stations, and then we assigned weights to the weather stations based on the horizontal and vertical distances between them and the RECS housing unit. We assigned the resulting weighted daily average temperatures to the RECS housing units, and then we calculated daily heating degree days (HDD) and cooling degree days (CDD) from the weighted temperatures, which are summed to yield annualized HDD and CDD values. We also obtained pre-calculated 30-year HDD65 and CDD65 normals from NCEI for various weather stations within the United States, and we applied the same weighting procedure to their values for each sampled RECS housing unit. [Building America climate regions](#) and [International Energy Conservation Code \(IECC\) climate zones](#) are also assigned to RECS housing units. We based these climate regions assignments on a housing unit's county, but each county's designation is ultimately based on its typically observed values of annual HDD, annual CDD, and average humidity conditions throughout a year.

## Square Footage Data

Square footage data collection, editing, imputation, and data quality are similar to the 2020 RECS. Please refer to the *2020 Residential Energy Consumption Survey (RECS) Square Footage Data Collection and Estimation Methodology* report.

## Confidentiality of Information

The 2018 Confidential Information Protection and Statistical Efficiency Act (CIPSEA) protects the privacy of respondents of federal surveys, including RECS. Any information we collect that could identify respondents or their households is kept confidential and used only for statistical purposes. We use disclosure protection measures before releasing the public-use data files. These measures include removing localized geographic information such as addresses and top-coding certain variables.<sup>16</sup> These disclosure steps mask the data so that the public cannot identify a sampled housing unit or its occupants.

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<sup>15</sup> Formerly known as the National Climatic Data Center (NCDC).

<sup>16</sup> See *How to Use the 2024 RECS Microdata File v1* for a complete list of top-coded variables in microdata release 1.