

2018 Commercial Buildings Energy Consumption Survey (CBECS): Highlights and Methods

*By:
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Outline

- Introduction
- 2018 CBECS highlights
- Survey methods
- Using CBECS data
- Q&A

Introduction

CBECS is...

- The *Commercial Buildings Energy Consumption Survey*
- The *only* independent, statistically representative source of national-level data on the *characteristics* and *energy use* of commercial buildings
- A data collection that produces a snapshot of the commercial building stock and their energy use for a reference year, most recently for 2018
- Required by Congress, conducted periodically since 1979 (2018 was the 11th CBECS)



CBECS is not...

- An energy audit
- A rating system or certification program
- A walk through the building (for example, *ASHRAE Level 1 audit*)
- A database of building energy performance data

What is a *commercial building*?



- Commercial
 - More than 50% of floorspace is devoted to activities that are neither residential, industrial, nor agricultural
- Building
 - A structure intended for human access that is totally enclosed by walls that extend from the foundation to the roof
 - CBECS covers all commercial buildings larger than 1,000 square feet, with a few exclusions.
- Building type
 - Determined by the principal activity or function that occupies the most floorspace in a building



Visit [Building Type Definitions](#) on the CBECS web page to learn more about principal building activities.

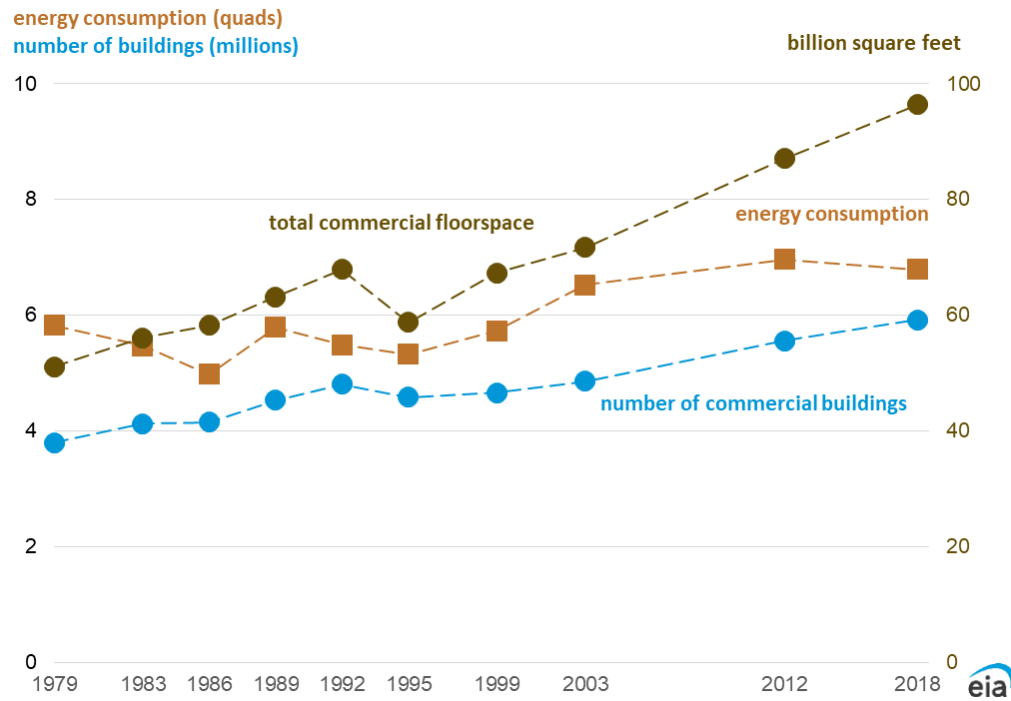
Final 2018 CBECS results refresh our nation's understanding of how commercial buildings use energy

- CBECS data are used to:
 - Forecast or project energy consumption, including our *Annual Energy Outlook*
 - Set energy use targets for benchmarking, including ENERGY STAR
 - Design policies and programs, including building energy codes
 - Conduct academic research
 - Inform business decisions
- The periodic, detailed *snapshots* of U.S. commercial buildings are widely used to re-baseline a variety of analyses.
- Data from 2018 are pre-pandemic; changes that persist will be reflected in the next CBECS.

2018 CBECS Results

Commercial buildings grew larger, outpacing growth in energy consumption

Energy consumption, number, and floorspace of commercial buildings, 1979–2018
quadrillion British thermal units (quads), number of buildings (millions), and billion square feet

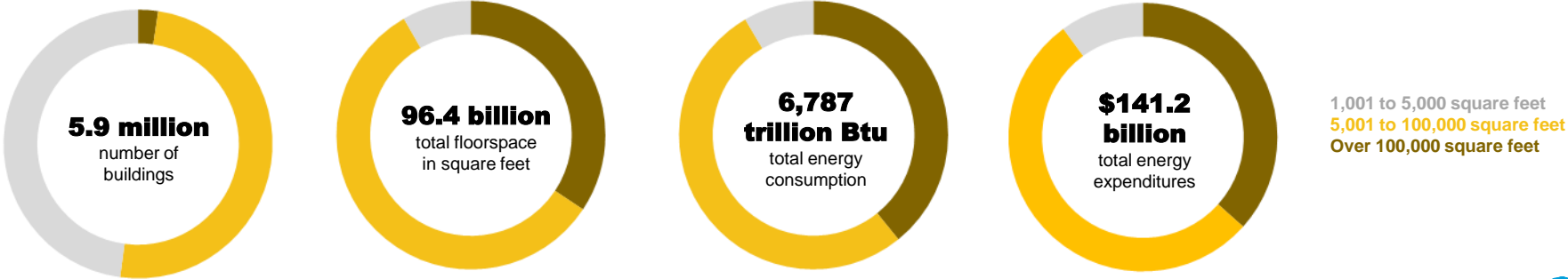


Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

- The estimated 5.9 million U.S. commercial buildings in 2018 had 96 billion square feet of floorspace and consumed 6.8 quadrillion British thermal units (quads) of energy.
- From the first CBECS in 1979 to the 2018 CBECS, commercial floorspace has increased 89% while the number of buildings increased 59%.
- During the same period, consumption of all major fuels increased only 17%.

Larger buildings were fewer in number but accounted for more floorspace, energy consumption, and expenditures than smaller buildings

Number of buildings, square footage, and energy consumption by square footage category, 2018
share of total



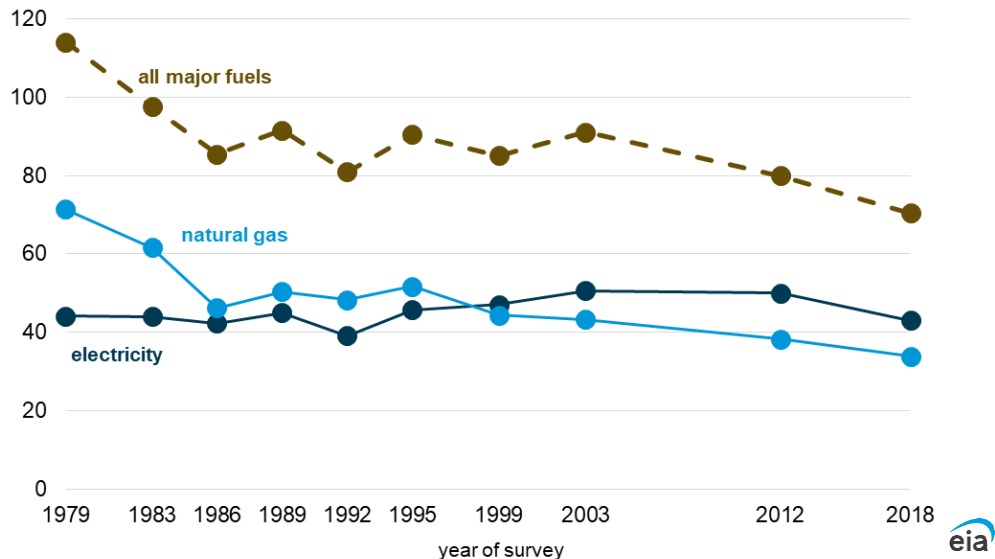
Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*
Note: Btu = British thermal units



- Large buildings (over 100,000 square feet) accounted for more than one-third of total floorspace, energy consumption, and expenditures but were only 2% of commercial buildings.
- Almost half of the commercial buildings were small (1,001 to 5,000 square feet), but used only 8% of the energy consumed.

U.S. commercial buildings continued to consume less energy per square foot of floorspace in 2018

Energy intensity by select fuels, 1979–2018
thousand British thermal units per square foot

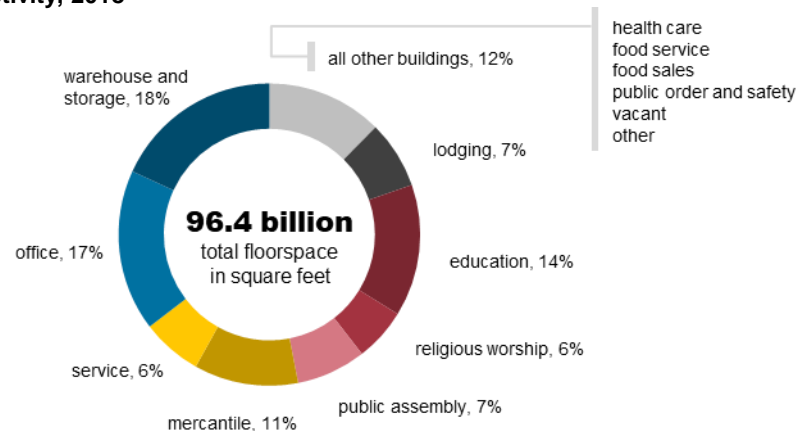
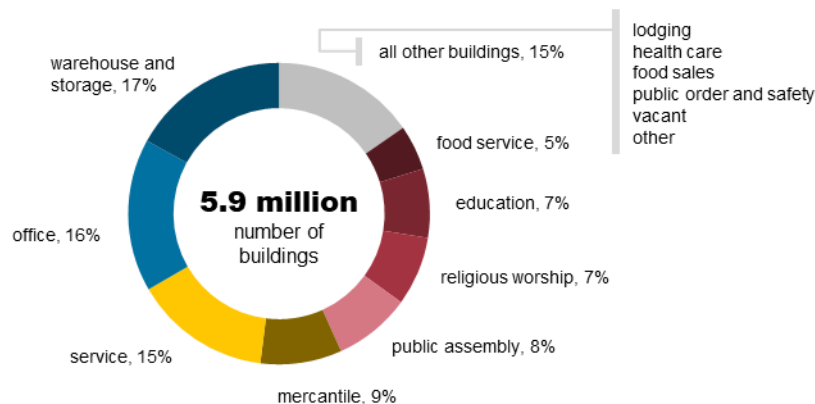


Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

- From 2012 to 2018, the major fuels energy intensity, or energy consumption per square foot, decreased by 12%.
 - Electricity intensity decreased by 14%.
 - Natural gas intensity decreased by 11%.
- Energy efficient building often have lower energy intensities.

Warehouse and storage, office, and service buildings were the most common building types

Percentage of commercial buildings and floorspace by principal building activity, 2018

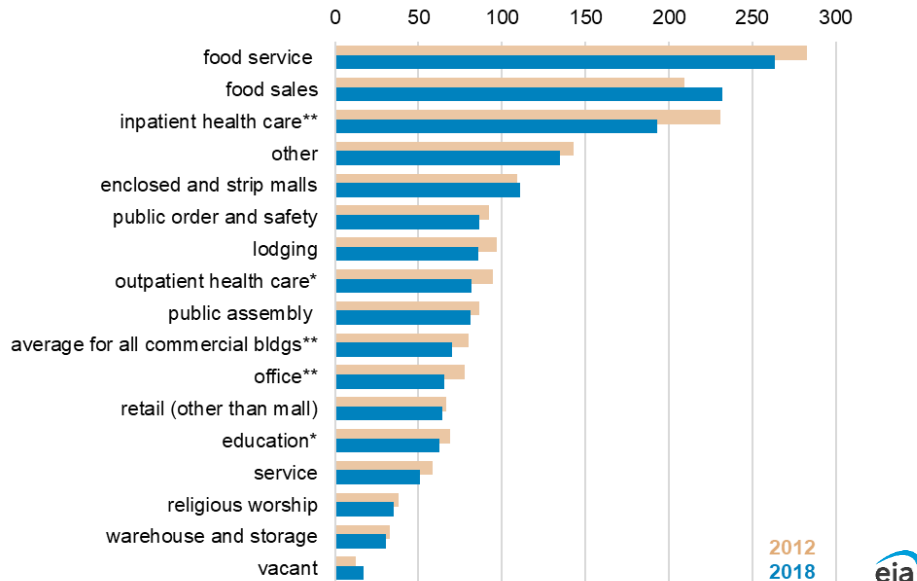


Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

- Warehouse and storage, office, and service buildings together accounted for 48% of all commercial buildings and 42% of total commercial building floorspace.
- The number of warehouse and storage buildings also increased more than 25% from 2012 to 2018, along with service, public assembly, and lodging buildings.

Energy intensity decreased in several building types from 2012 to 2018

Major fuels intensity by principal building activity, 2012–2018
thousand British thermal units per square foot



Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

* Change is statistically significant at the 10% significance level.

** Change is statistically significant at the 5% significance level.

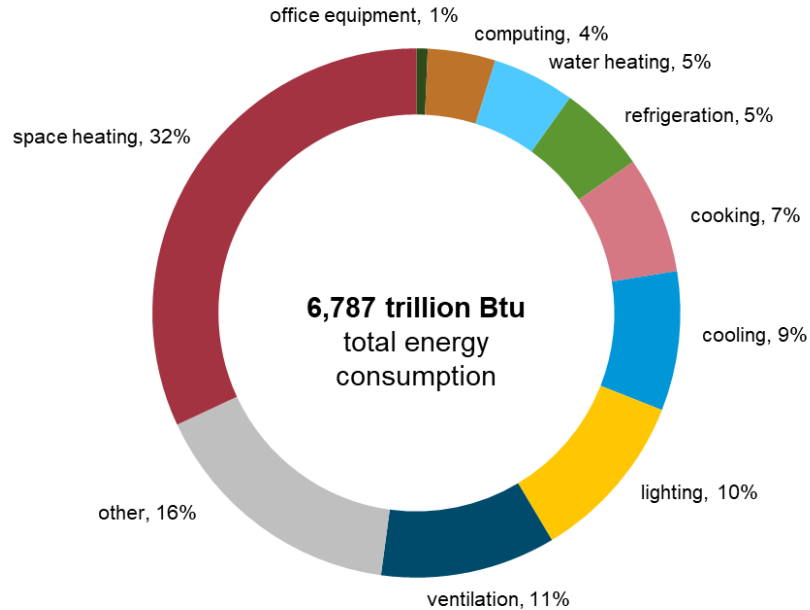
Note: [Building Type Definitions](#) on the CBECS web page provides more information about the principal building activities.

- Inpatient health care buildings had the largest decrease in energy intensity from 2012 to 2018.
- Outpatient health care, office, and education buildings also showed statistically significant decreases in energy intensity.
- None of the building types had a statistically significant increases in energy intensity.

Space heating accounted for close to one-third of end-use consumption in 2018

Major fuels consumption by end use, 2018

share of total



- Space heating was the most common end use in commercial buildings. About 2,167 trillion British thermal units of energy was consumed for space heating.
- Other, ventilation, and lighting each accounted for 10% or more of total energy consumption.

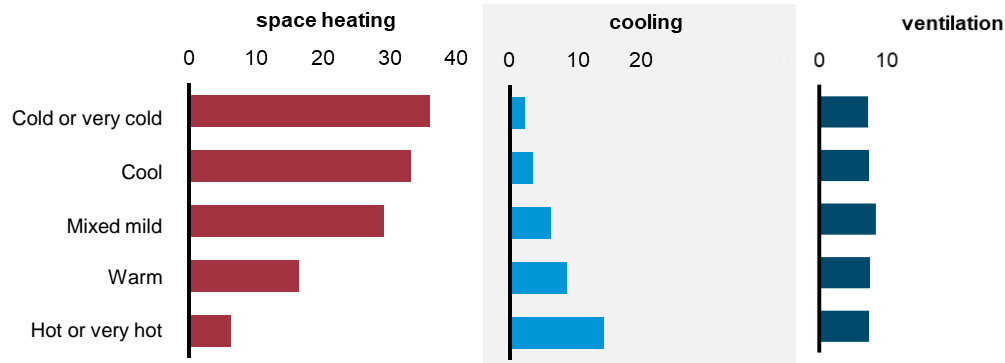


Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

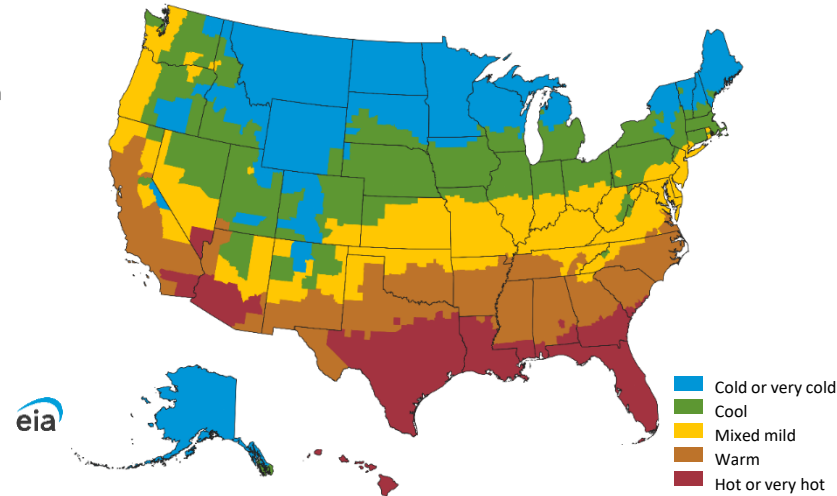
Note: Btu = British thermal units

Energy intensity for heating and cooling commercial buildings varied by climate zone

Major fuels energy intensity by climate zone and space-conditioning end uses, 2018
thousand British thermal units per square foot



Note: Climate affects energy consumption for the end uses selected.
Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*



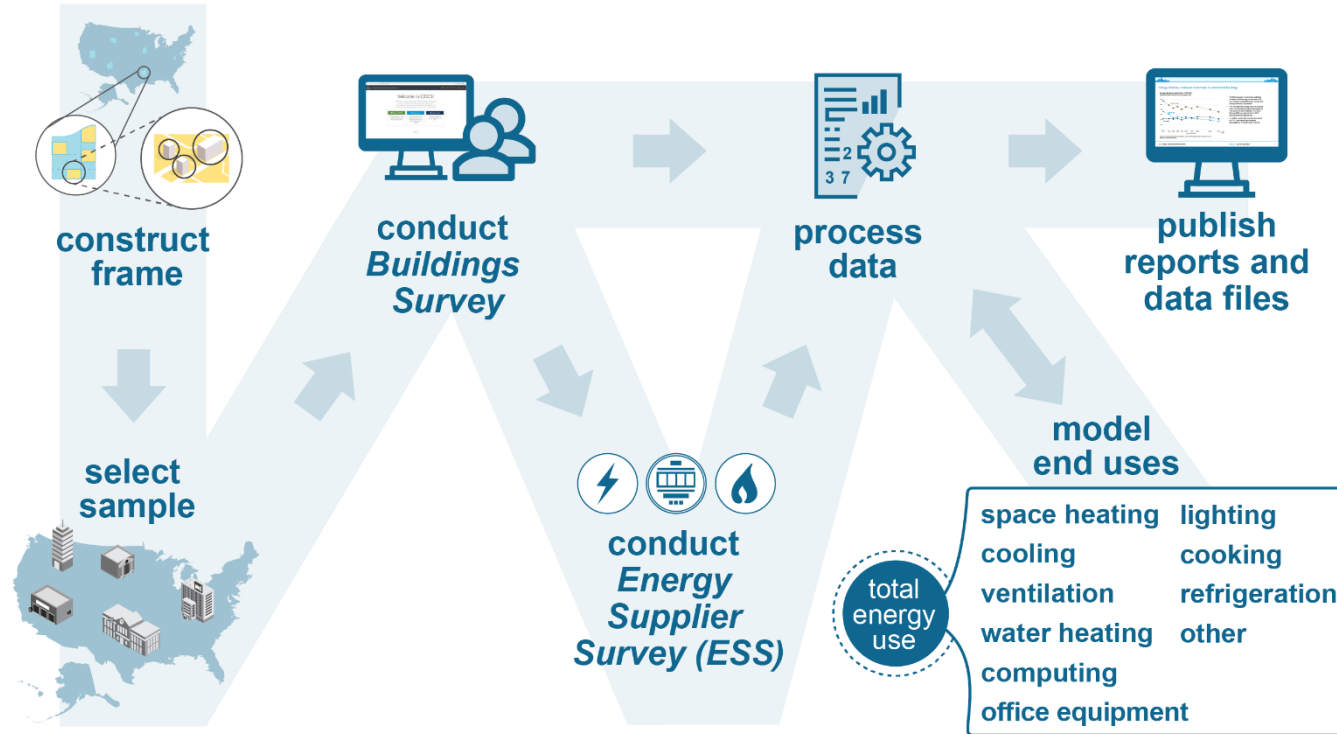
Data source: ANSI/ASHRAE, Standard 169-2021, *Climatic Data for Building Design Standards*

Note: Adapted with permission from Figure A-2, Climate zones for United States counties, ANSI/ASHRAE Standard 169-2021, *Climatic Data for Building Design Standards*, © 2021 ASHRAE.

- Buildings in the coldest climates were nearly five times more energy intensive to heat than buildings in the hottest climates.
- Conversely, cooling energy intensity was higher in warmer climates.

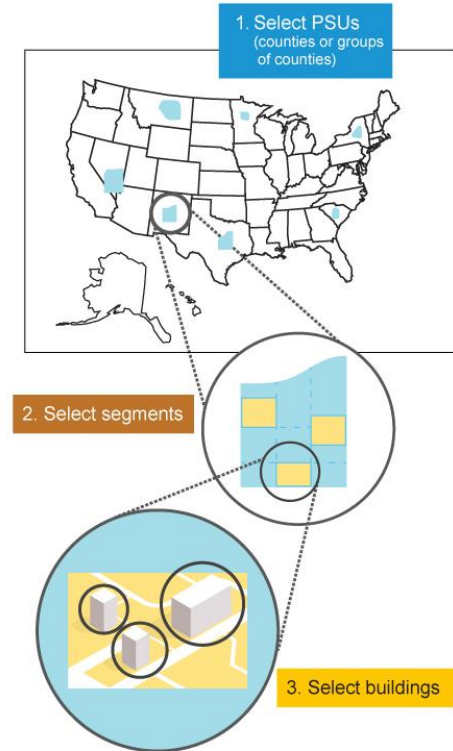
Survey Methodology

Overview of the CBECS survey process



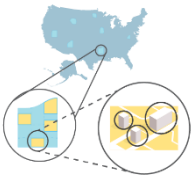
Because no comprehensive list of U.S. buildings exists, EIA builds survey frames

- Area frame
 - Randomly select small, geographic areas
 - Within them, list and stratify all commercial buildings in those areas
 - Randomly select buildings within strata
- List frames
 - Supplemental lists that ensure adequate representation of special buildings
 - Include hospitals, government buildings, college/universities, airports, or other large buildings

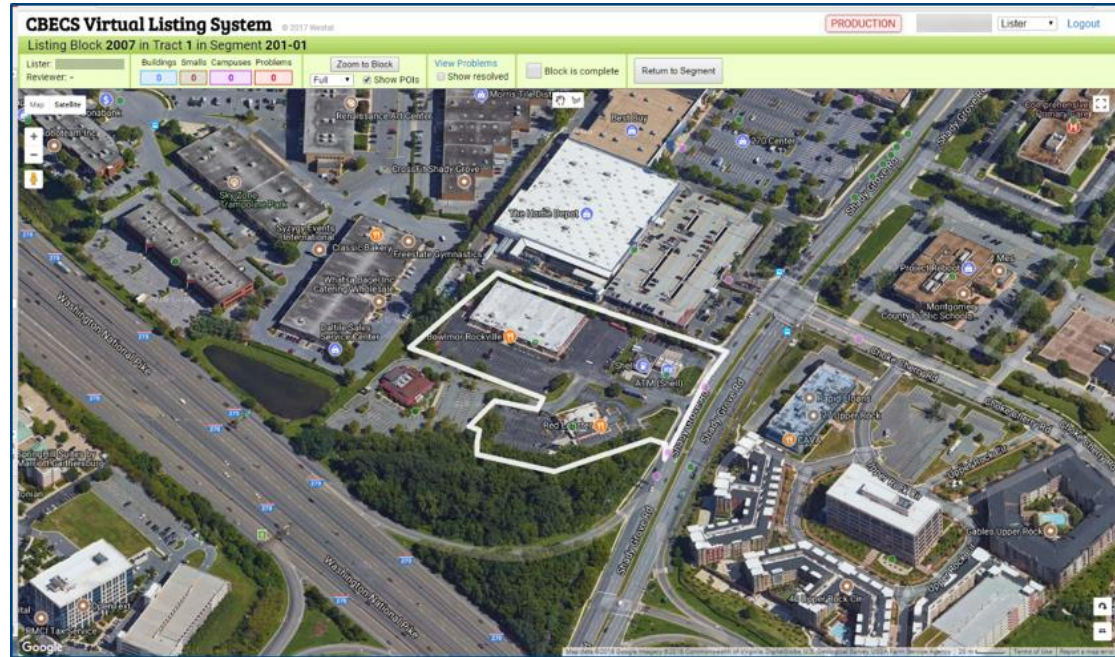


Source: U.S. Energy Information Administration
Note: PSU = primary sampling unit

Virtual listing method added in the 2018 CBECS



- Created area frame using satellite imagery and GIS tools
- Replaced on-the-ground listing in most areas
- Provided many benefits
 - 3% improvement in coverage compared with field listing
 - More than 50% reduction in listing labor hours
 - No travel costs



During the first phase of data collection, building owners and managers completed the *Buildings Survey*



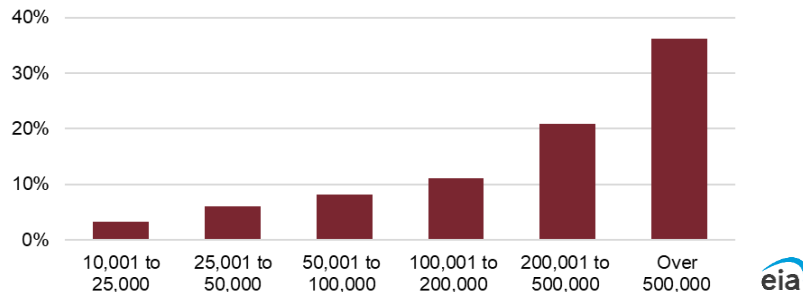
- In-person or telephone interview conducted by a trained interviewer or self-administered web questionnaire
 - New for 2018, 44% of building respondents completed the survey by web
- Respondents included:
 - Building operations, maintenance, and engineering
 - Property managers
 - Company managers and administration
 - Building and business owners
 - Energy and environmental personnel
 - Other people associated with a building
- Data collected for approximately 9 months
- Average completion time for a CBECS questionnaire was 45 minutes
- **Voluntary** survey

Numerous CBECS questionnaire changes were made for 2018 to reflect changes in buildings and data user needs



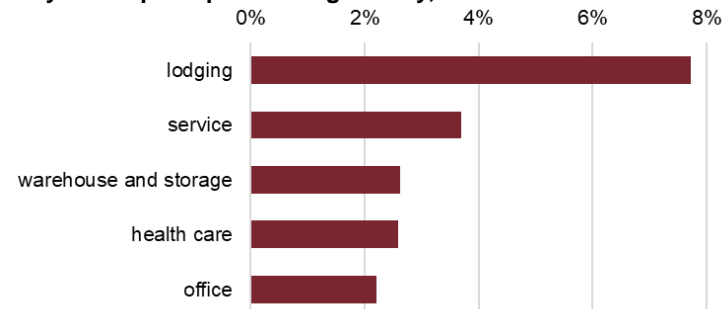
- Questionnaire design process included:
 - Reviewing content from 2012 CBECS
 - Adding and dropping questions based on quality of prior responses and current building technologies
 - Soliciting data user input
 - Pretesting most of the new or substantially revised questions
- For example, we added questions on electric vehicle (EV) charging stations.

Percentage of commercial buildings with EV charging stations by square footage category, 2018



Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

Percentage of commercial buildings with EV charging stations by select principal building activity, 2018



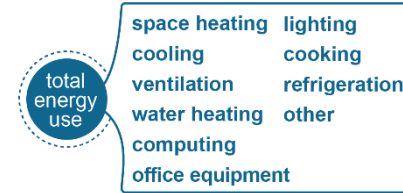
Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*

During the second phase of data collection, energy suppliers completed the *Energy Suppliers Survey (ESS)*

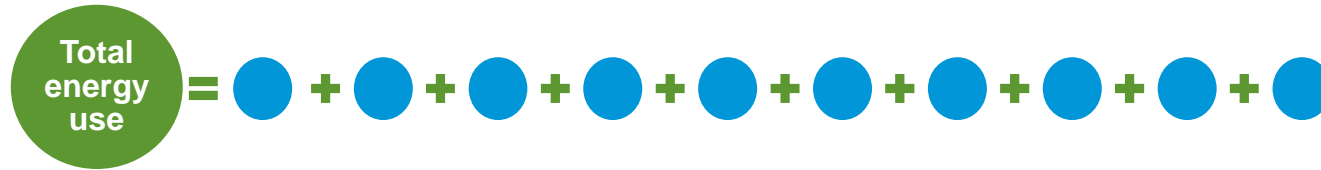


- Follow-up with energy suppliers for buildings that completed the *Buildings Survey*
 - 16 months of energy usage and costs covering calendar year 2018
 - Supplements annual consumption collected in the *Buildings Survey*
- Approximate numbers of unique suppliers contacted:
 - 350 electricity
 - 180 natural gas
 - 110 heating oil
 - 20 district energy
- Suppliers receive building address and energy account number(s) when available
- Data collected for approximately 7 months
- **Mandatory** survey

Modeling used to estimate energy consumption by 10 end uses

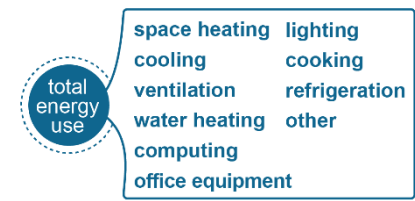


- Engineering-based statistical model fills in for missing energy consumption and disaggregates total energy
- Survey characteristics and energy data used, along with information from other sources (for example, weather, technology efficiencies, etc.)

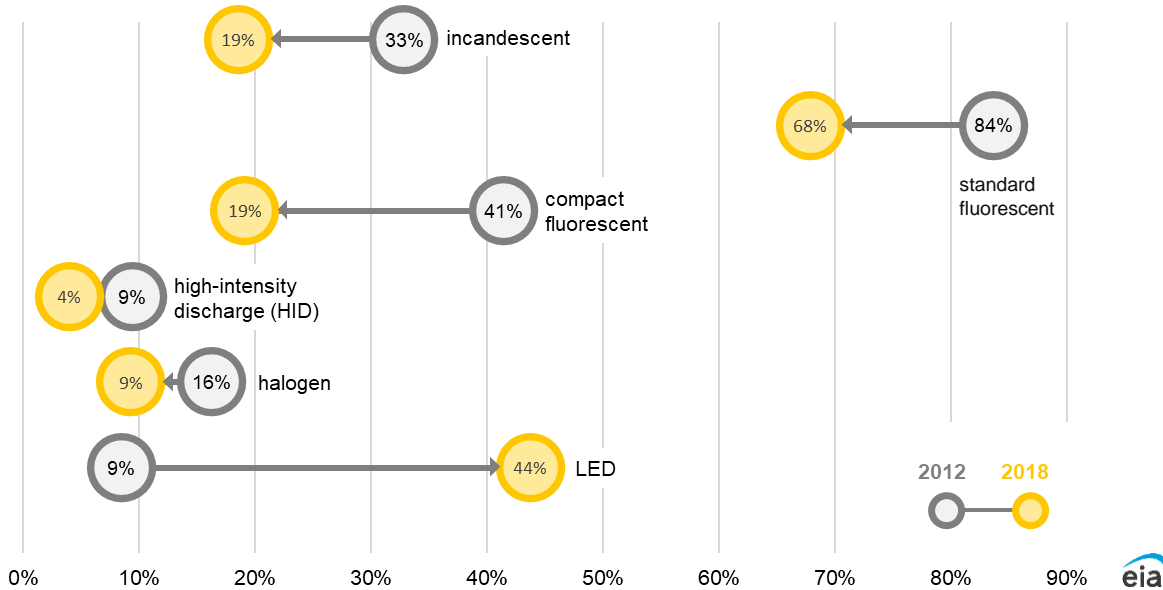


ENERGY SOURCE	Space heating	Space cooling	Ventilation	Water heating	Lighting	Cooking	Refrigeration	Computing	Office equipment	Other
Electricity	X	X	X	X	X	X	X	X	X	X
Natural gas	X			X		X				X
Fuel oil	X			X		X				X
District heat	X			X		X				X

For example, end-use modeling reflected changes in commercial building lighting characteristics



Lighting equipment used in commercial buildings by bulb type, 2018
percentage of buildings



- From 2012 to 2018, only LED lighting equipment use increased
- Aside from LED, all other bulb types decreased in usage

Data source: U.S. Energy Information Administration, *Commercial Buildings Energy Consumption Survey*
Note: More than one bulb type may apply. All changes from 2012 to 2018 were statistically significant at the 5% significance level.

Using CBECS Data

EIA has published all final 2018 CBECS data



- Key products:
 - Data tables with data quality indicators (71 tables)
 - Public use microdata (6,436 buildings)
 - Reports with data highlights
 - *Today in Energy* articles
 - Methodology and research
- Data available for:
 - Building size, age, and structure
 - Building activity
 - Census region and division
 - Ownership and occupancy
 - Weekly operating hours
 - Number of workers
 - Energy sources and their end uses
 - Heating and cooling equipment
 - Other energy-related equipment
 - Annual energy use and cost data, plus end-use estimates for electricity, natural gas, fuel oil, and district heat
- CBECS data provided for statistical purposes
 - Data protected by Confidential Information Protection and Statistical Efficiency Act (CIPSEA)
 - We do not disclose information that could potentially identify a particular responding building

You can use CBECS data several different ways

- Copy charts and slides for your own presentation and reports
 - Over 50 pre-made visualizations
 - Available in PDF and PowerPoint formats
- Use pre-calculated estimates in your own research and analysis
 - Over 70 Excel data tables with estimates and associated relative standard errors (RSEs)
- Create your own estimates with the public use microdata file
 - Data files available in CSV and SAS formats
 - [User's Guide](#) provides instructions and examples for Excel, SAS, and R users
 - Z variables are included to flag whether values were imputed

Tips and tricks for using CBECS data

- Be careful about making inferences from small sample sizes
 - We did not publish estimates with fewer than 20 buildings in the sample
- Don't forget the weights
 - The variable FINALWT shows how many buildings in the country each sampled case represents; tables and reports use this final weight for population-representative statistics
- Use the relative standard errors (RSEs)
 - CBECS sample design allows for calculation of sampling errors for point estimates
 - We published RSEs in Excel data tables and withheld estimates with RSE greater than 50%
 - We recommend use of RSEs to understand the [statistical significance](#) of the difference between two statistics
- Consider how CBECS provides a snapshot in time, not time-series data
 - We summarize key methodology and questionnaire changes between survey cycles
- Cite CBECS and let your audience know how you used our data

Additional CBECS information

- [2018 data tables and microdata](https://www.eia.gov/consumption/commercial/data/2018/)
<https://www.eia.gov/consumption/commercial/data/2018/>
- [2018 building characteristics report](https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf)
https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf
- [2018 consumption and expenditures report](https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS%202018%20CE%20Release%20%20Flipbook.pdf)
<https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS%202018%20CE%20Release%20%20Flipbook.pdf>
- [CBECS methodology](https://www.eia.gov/consumption/commercial/data/2018/index.php?view=methodology)
<https://www.eia.gov/consumption/commercial/data/2018/index.php?view=methodology>
- [CBECS terminology](https://www.eia.gov/consumption/commercial/terminology.php)
<https://www.eia.gov/consumption/commercial/terminology.php>
- [CBECS building type definitions](https://www.eia.gov/consumption/commercial/building-type-definitions.php)
<https://www.eia.gov/consumption/commercial/building-type-definitions.php>
- [Frequently asked questions \(FAQs\)](https://www.eia.gov/consumption/commercial/faq.php)
<https://www.eia.gov/consumption/commercial/faq.php>

For more information

U.S. Energy Information Administration homepage | www.eia.gov

Commercial Buildings Energy Consumption Survey | www.eia.gov/cbecs

Today in Energy | www.eia.gov/todayinenergy

Contact us | eiainfoconsumption&efficiency@eia.gov

Questions?