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Commercial Buildings Characteristics 1992

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Executive Summary

Commercial Buildings Characteristics 1992 presents statistics about the number, type, and size of commercial buildings in the United States as well as their energy-related characteristics. These data are collected in the Commercial Buildings Energy Consumption Survey (CBECS), a national survey of buildings in the commercial sector. The 1992 CBECS is the fifth in a series conducted since 1979 by the Energy Information Administration. Approximately 6,600 commercial buildings were surveyed, representing the characteristics and energy consumption of 4.8 million commercial buildings and 67.9 billion square feet of commercial floorspace nationwide. Overall, the amount of commercial floorspace in the United States increased an average of 2.4 percent annually between 1989 and 1992, while the number of commercial buildings increased an average of 2.0 percent annually.

Key Findings

- **Energy Conservation:** Overall, a building's size, as measured by floorspace, was the overwhelming determinant in whether it practiced energy management or had some type of conservation feature related to the building shell, the heating, ventilation, and air-conditioning (HVAC) system or the lighting system. Larger buildings were more likely to have either conservation features or practice energy management or both.

  Building age was important for specific types of energy conservation such as the use of energy management and control systems (EMCS) or lighting features; newer buildings were more likely to have taken these measures. Building age, however, was less relevant for conservation efforts related to the building shell, such as insulation and window treatments, since older buildings can be retrofitted with these features relatively easily.

- **Demand-Side Management (DSM):** Knowledge of utility-sponsored DSM programs appears to be a key factor in whether a building participates in a program. While only 13 percent of the CBECS respondents reported an awareness of utility-sponsored DSM programs, approximately one-third of those who were aware took part in them. However, it should be noted that only 7 percent of all buildings participated in a DSM program. This suggests that there is a large potential for energy savings in the commercial buildings sector through DSM programs.

- **New Office Buildings:** Newer office buildings took advantage of the more energy-efficient lighting and HVAC systems in their construction. Analysis of office buildings constructed after 1986 indicates that these buildings were three times more likely to use compact fluorescent bulbs than office buildings constructed in 1986 or earlier. Newer office buildings also reported the use of variable air-volume (VAV) systems on their heating or cooling units at five times the rate of older office buildings. There was no statistically significant difference between newer and older office buildings in the use of high-intensity discharge (HID) lights or in regularly scheduled HVAC maintenance and repair programs. Approximately 70 percent of all office buildings had regularly scheduled HVAC maintenance and repair programs.

- **Government-Owned Buildings:** The 1992 CBECS shows that Government-owned buildings were more likely to practice energy management than non-government-owned buildings. Approximately 59 percent of government-owned buildings utilized one or more of the following energy management practices: EMCS, DSM, energy audits, or building energy managers.

- **Main Heating Fuel:** As a main heating fuel, natural gas made inroads in newer buildings. The 1992 CBECS data show that the largest percentage of commercial floorspace in buildings constructed in the 1980's was primarily heated with electricity; however, the largest percentage of floorspace in buildings constructed between 1990 and 1992 was primarily heated with natural gas.
- **Energy-Using Equipment:** In 1992, more buildings reported the use of packaged cooling units and heat pumps, with a dramatic increase in the use of heat pumps in the West Census Region.

Table ES1 provides national and Census regional-level commercial building counts and square footage for the 1986, 1989, and 1992 CBECS.

Table ES1. Number and Square Footage of Commercial Buildings by Census Region, 1986, 1989, 1992

Census Regions	1986 CBECS	1989 CBECS	1992 CBECS
Number of Buildings (thousand)			
Total	**4,154**	**4,528**	**4,806**
Northeast	663	783	771
Midwest	1,096	1,046	1,202
South	1,570	1,847	1,963
West	825	851	870
Floorspace (million square feet)			
Total	**58,229**	**63,184**	**67,876**
Northeast	11,830	13,569	13,400
Midwest	16,034	15,955	17,280
South	19,427	22,040	24,577
West	10,937	11,620	12,619

Source: Energy Information Administration, Office of Energy Markets and End Use, 1986, 1989, and 1992 Commercial Buildings Energy Consumption Surveys.

Introduction

Commercial Buildings Characteristics 1992 contains detailed tables of the physical and operating characteristics that affect energy use in the U.S. commercial building stock as of 1992. This report, the first of two publications based on data from the 1992 Commercial Buildings Energy Consumption Survey (CBECS), contains estimates of the number of buildings and square footage by various energy-related characteristics. Estimates of the actual energy consumption and expenditures for electricity, natural gas, fuel oil, and district heat will be reported separately in *Commercial Buildings Energy Consumption and Expenditures 1992* to be published at a later date. The CBECS is the only source of national-level data on both commercial building characteristics and related energy consumption and expenditures. Detailed analysis of 1992 commercial building characteristics, along with an analysis of the energy consumption and expenditures data, will be reported separately following the release of the *Commercial Buildings Energy Consumption and Expenditures 1992* report. A special report covering buildings in the 1980's will include additional analysis of 1992 commercial buildings characteristics.[1]

This report is prepared by the Energy End Use and Integrated Statistics Division, Office of Energy Markets and End Use, Energy Information Administration (EIA). The EIA is mandated by Congress to be the agency that collects, analyzes, and disseminates impartial, comprehensive data about energy including the volume consumed, its customers, and the purposes for which it is used. To comply with this Congressional mandate, the EIA collects energy data from a variety of supplier and consumer sources, in surveys covering a range of topics.[2]

Background

The CBECS provides basic national-level statistical information on the consumption of energy, expenditures for energy, and energy-related characteristics in commercial buildings. EIA conducts this national sample survey of commercial buildings and their energy suppliers on a triennial basis. Previous surveys were conducted in 1979, 1983, and 1986 under the name Nonresidential Buildings Energy Consumption Survey (NBECS). In 1989, the survey name was changed to Commercial Buildings Energy Consumption Survey (CBECS). For consistency, all the surveys will be referred to as CBECS in this report.

EIA also conducts energy consumption surveys in the residential, residential transportation, and manufacturing sectors. See Appendix I, "Related EIA Publications in Energy Consumption," for a listing of publications from the CBECS and from other EIA consumption surveys.

[1]The report, *Buildings and Energy in the 1980's,* is planned for early 1995.

[2]These surveys can be divided into two broad groups. The first group, supply surveys, are directed to the suppliers and marketers of specific energy sources, and measure the quantities of specific fuels produced and/or supplied to the market. The results of the supply surveys are combined and published in the *Monthly Energy Review* and other EIA publications. The second group, energy consumption surveys, gathers information directly from the end users of energy on the types of energy used, along with energy-related characteristics. The CBECS belongs to the consumption survey group because it collects information directly from the end user -- commercial buildings. Although there are some elements in common, the supply survey data and the consumption survey data collections have substantially different approaches, capabilities, and objectives. Care must be taken in comparing CBECS data in relation to supply survey data. For a summary of the differences in the commercial sector, see Energy Information Administration, *Energy Consumption by End-Use Sector, A Comparison of Measures by Consumption and Supply Surveys*, DOE/EIA-0533 (Washington, DC, April 1990) and Energy Information Administration, *Commercial Buildings Energy Consumption and Expenditures 1992* (forthcoming).

The data for the 1992 commercial building stock were collected on the 1992 CBECS Forms EIA-871A through G. The data included in this report are based on Form EIA-871A, the 1992 Building Questionnaire. Form EIA-871A was used to collect information on building characteristics during a personal interview with building managers, owners, or tenants. All data in this report are aggregated; individual building name and address information is confidential.

A longitudinal component was incorporated into the 1992 CBECS by revisiting many of the same buildings that were sampled for the 1986 CBECS. Longitudinal analysis of the 1986/1992 CBECS data will be conducted separately.

This report provides descriptions of the 1992 commercial building stock at the national and Census region levels in terms of the following characteristics:

- Building Size
- Principal Building Activity
- Building Structure
- Building Use
- Energy Sources and Energy End Uses
- Energy-Related Equipment
- Energy Conservation and Energy Management Features.

These data are published to provide meaningful, objective, and accurate energy information for a wide audience including Congress, Federal and State agencies, industry, and the general public.

The EIA gratefully acknowledges the cooperation of the respondents for providing the information used to produce the estimates in this report.

Organization of this Report

The section of the report, "At A Glance" provides several pages of text, graphs, and charts showing some of the more interesting survey results.

The appendices are provided for more statistically oriented readers, and readers who want to know the supporting detailed information on the survey. Information about the sample design and data collection procedures is provided in Appendix B, "How the Survey Was Conducted." Adjustments to collected data and factors affecting data quality are discussed in Appendix C, "Nonsampling and Sampling Errors." Appendix D, "Comparisons of CBECS, 1983 to 1992," provides a comparison of the type of data items that have been collected in each CBECS beginning with 1983. A detailed description of the principal building activities is contained in Appendix E, "Types of Buildings." Appendix F, "U.S. Climate Zones and Census Regions and Divisions Maps," contains maps showing the climate zones by which the data are reported and the Census regions and divisions used in this report. All estimates in this report are based on data collected on Form EIA-871A, "Building Questionnaire." This form is found in Appendix G, "Survey Forms." Appendix H provides metric conversion factors. A list of related energy-consumption publications in Appendix I, "Related EIA Publications on Energy Consumption," is for readers interested in earlier CBECS publications, or reports on energy consumption in the other sectors. A glossary of terms is also included to assist users in understanding the statistical and engineering terminology used in this publication.

Appendix A, "Detailed Tables," of this report provides extensive crosstabulations of commercial buildings' characteristics in the United States. The tables are divided into the following seven main categories:

Location - Includes Census region, Census division, metropolitan statistical area, and climate zone tables

Structure - Includes tables pertaining to building size, year constructed, number of floors, and building shell materials

Building Use - Includes tables relating to number of workers, operating hours, ownership and occupancy, vacancy rates, multibuilding facilities, and energy-related space functions

Energy Sources - Includes total energy sources, and energy sources used for heating, cooling, cooking, heating water, and other energy end uses

End-Use Percentages - Includes tables for percent of building space that is heated, cooled, and lit

Equipment - Includes tables relating to heating, cooling, refrigeration, water heating and lighting equipment and

Conservation Features - Includes tables on building shell conservation features, energy management practices, reduced equipment use in off hours, and participation in lighting and heating, ventilation, and air-conditioning (HVAC) related demand-side management (DSM) programs.

The organization of the detailed tables and the procedures for calculating Relative Standard Errors (RSE's) are explained in Appendix A. Also in Appendix A, a Quick-Reference Guide by topic is provided for the 70 detailed tables.

New or expanded tables include more detail on the following:

- Building shape
- Energy-related space functions
- Occupancy characteristics
- Energy-using equipment: refrigerators, freezers, water heaters, and personal computers or terminals
- Demand-Side Management programs
- Energy management features
- Lighting conservation features
- Characterization of multibuilding facilities such as school campuses and hospital complexes

All information in this report is based on the 1992 CBECS data, which can be reproduced using the 1992 CBECS Public-Use Data files.

Statistics Reported

Commercial Buildings

For purposes of the CBECS, a commercial building is a roofed and walled structure whose principal activity is nonresidential, nonagricultural, and nonindustrial. The CBECS population is restricted to buildings larger than 1,000 square feet (roughly twice the size of a two-car garage).

Principal Building Activity

The principal building activity is the activity that occupies the most floorspace in the building. Data were collected for 21 building types. Beginning with the 1992 CBECS, the building type "assembly" was divided into two separate categories, "public assembly" and "religious worship." Data for building types are provided separately in the detailed tables. However, in some instances, the CBECS sample was too small to permit reliable estimates for breakdowns within the 21 categories. Therefore, several types of building activities have been combined in most tables and figures. Inpatient and outpatient health care facilities have been combined into a single health care building type; refrigerated and nonrefrigerated warehouses form a single warehouse category. Skilled nursing buildings have been included in "lodging." The "other" category includes laboratory buildings, with the exception of those laboratory buildings used in academic or technical classroom instruction.

Energy Sources

The CBECS identifies all energy sources delivered into the building. For certain types of minor energy sources (most notably coal, and such renewable sources as wood, photovoltaic cells (PVC's), and solar thermal panels), there were too few buildings in the sample to permit separate reporting. Therefore, in most of the tables in this report, coal, wood, PVC's and solar thermal panels are grouped with "other" under the category "energy sources." District steam and district hot water are combined into "district heat."

Main and Secondary Fuels

Main and secondary space-heating fuels are distinguished in certain tables but are combined in other tables as "space heating." In previous surveys, very few buildings reported having a secondary water-heating fuel. In 1992, secondary water-heating fuel was not collected.

Number of Workers/Operating Hours

The 1992 CBECS obtained information on two very important contributing factors to energy consumption --the number of occupants in the building, and the number of hours the building is in use. Specifically, the 1992 CBECS asked for the total number of workers across all shifts as well as the number of workers for the main shift. For comparability with the 1989 CBECS report, only the number of workers during the main shift are included in the 1992 CBECS report. Information was obtained about the regular operating hours and the additional ("shoulder") hours when most of the heating and/or cooling and lighting equipment were in use. Data about both the regular operating hours and the additional hours are included in the detailed tables.

Survey Estimates

The statistics published in this report are based on a random sample from the population of all commercial buildings in the United States as of fall 1992. As a result, all the numbers are estimates rather than exact measures for the population. As described in Appendix C, the accuracy of each estimate is indicated by the RSE. No estimates were published that were based on data from fewer than 20 sampled buildings or that had an RSE greater than 50 percent. With the exception of Table A1 estimates for median statistics, RSE's can be calculated for all the estimates in the detailed tables using row/column RSE factors.[3] Overall, the RSE's for the 1992 CBECS are comparable to those for the corresponding aggregates from the 1989 survey, indicating a continuing high accuracy of the survey estimates.

[3]See Appendix A "Detailed Tables" for information on how to use the Row/Column factors to calculate an approximate RSE.

HIGHLIGHTS ON COMMERCIAL BUILDINGS FROM THE 1992 CBECS

This section provides several short synopses of some interesting highlights from the 1992 CBECS. As a result of numerous requests from CBECS data users to expedite the release of the CBECS data, extensive analysis of the data was not conducted at this time.

The following are included in this section:

Where Commercial Buildings are Located is an overview of the number of commercial buildings and floorspace in the four Census regions and nine Census divisions.

Commercial Buildings in 1992 includes information about building size, vintage, and principal building activity.

Conservation and Energy Management describes the types of buildings most likely to report the use of energy conservation features or practice energy management. This section also includes brief descriptions of the types of buildings that participated in DSM programs and the types of energy management and conservation practices found in office buildings and government-owned buildings.

Energy Sources and End Uses briefly discusses primary space-heating trends and the use of renewables and special technology in commercial buildings.

End-Use Equipment includes information about the use of packaged cooling units, heat pumps, commercial lighting, water heating and refrigeration equipment.

Where Commercial Buildings Are Located

Geographic location affects energy-use patterns because of the regional variations in climate, building materials, and energy sources.[4] In 1992, there were 4.8 million commercial buildings in the United States with 67.9 billion square feet. The Northeast had the largest buildings and the South had the smallest buildings (Table 1). The South contained the largest proportion of both buildings (41 percent) and floorspace (36 percent). The Midwest had the second highest proportion of both buildings (25 percent) and floorspace (25 percent) (Figure 1).

Table 1. Number of Buildings and Floorspace by Census Regions and Divisions, 1992

Census Regions and Divisions	Number of Buildings (thousand)	Total Floorspace (million square feet)	Mean Floorspace per Building (thousand square feet)
Total	4,806	67,876	14.1
Northeast	771	13,400	17.4
New England	186	3,265	17.6
Middle Atlantic	585	10,135	17.3
Midwest	1,202	17,280	14.4
East North Central	749	10,712	14.3
West North Central	453	6,568	14.5
South	1,963	24,577	12.5
South Atlantic	755	10,586	14.0
East South Central	454	5,375	11.8
West South Central	754	8,616	11.4
West	871	12,619	14.5
Mountain	297	3,645	12.3
Pacific	574	8,974	15.6

Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1992 Commercial Buildings Energy Consumption Survey.

Figure 1. Percent of Buildings and Floorspace by Census Region, 1992

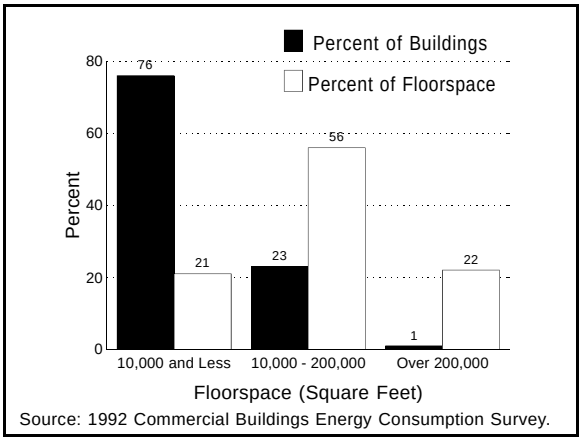
[4]Detailed information on the location of 1992 commercial buildings is found in Appendix A, "Detailed Tables," Tables A1 through A7.

Commercial Buildings in 1992

Commercial buildings, in general, are diverse structures with equally complex operations. To depict commercial building use, two measures are employed: building counts and floorspace. These two measures provide different views of commercial building use, which allow the analysis to focus on the characteristics of building use as they relate to either the commercial building stock or the amount of building floorspace.

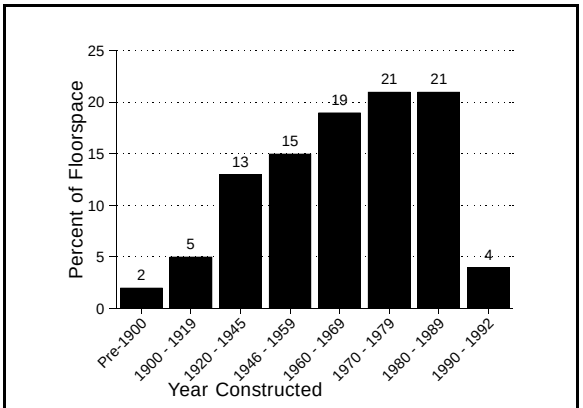
Energy use in commercial buildings is affected by the physical characteristics of the buildings, as well as the efficiency of the equipment and the occupants' energy-related behavior. Since 1979, the CBECS has consistently collected data about the size, vintage, and principal building activity. Figures 2 through 5 show the size, vintage, and principal building activity.[5]

Figure 2: Commercial Building Size, Percent of Buildings and Floorspace, 1992



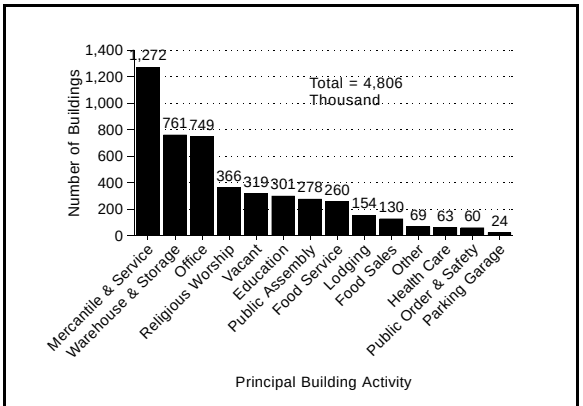
Source: 1992 Commercial Buildings Energy Consumption Survey.

Figure 3: Commercial Building Vintage, 1992



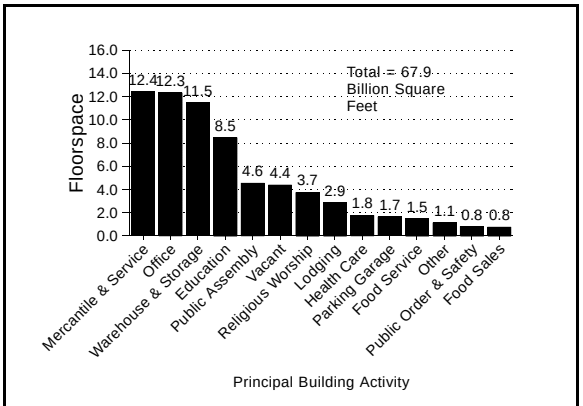
Source: 1992 Commercial Buildings Energy Consumption Survey.

Figure 4. Principal Building Activity, Number of Buildings, 1992



Source: 1992 Commercial Buildings Energy Consumption Survey.

Figure 5. Principal Building Activity, Floorspace, 1992



Source: 1992 Commercial Buildings Energy Consumption Survey.

[5]Detailed information on the structure of 1992 commercial buildings is found in Appendix A, "Detailed Tables," Tables A8 through A28.

Commercial Building Activity Accounts for 67.9 Billion Square Feet of Floorspace in 1992

In 1992, commercial buildings accounted for approximately 67.9 billion square feet of floorspace in 4.8 million buildings. Comparable figures for the 1989 CBECS were 63.2 billion square feet in 4.5 million buildings. This translates into an annualized increase between 1989 and 1992 of 2.0 percent in the number of buildings and 2.4 percent in commercial floorspace. The mercantile and service category showed the greatest number of buildings, with roughly 1.3 million buildings, or nearly 26 percent. In addition, mercantile and service buildings accounted for the most floorspace, representing 18.3 percent (12.4 billion square feet) of all commercial activity. Office buildings represented the second largest amount of floorspace, with over 12.3 billion square feet, or approximately 18.1 percent. Interestingly, office and mercantile and service buildings comprised nearly equal amounts of total floorspace, but the average floorspace per office building was over 40 percent higher than the average floorspace per mercantile and service building (Table 2). The percentage of buildings classified as vacant was relatively unchanged between the 1989 and 1992 CBECS data collection, accounting for 6.6 percent of all commercial buildings and similar floorspace coverage.[6]

Table 2. Floorspace by Selected Principal Building Activity, 1992

Principal Building Activity	Percent of Floorspace	Mean Floorspace per Building (thousand square feet)
Mercantile & Service	18.3	9.7
Office	18.1	16.4
Warehouse & Storage	16.9	15.1
Education	12.5	28.2
Other	34.2	--
Total	100.0	--

Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1992 Commercial Buildings Energy Consumption Survey, Table A1.

[6]"Other" includes all buildings not identified as mercantile and service, office, warehouse and storage, or education.

Conservation and Energy Management

More than any other building characteristic, a building's size, measured in floorspace, appeared to be the overwhelming determinant in whether a building had conservation features or practiced energy management. In general, the larger the building, the more likely it was to have conservation features (Box 1) or to practice energy management (Box 2).[7]

Energy Conservation Features

Almost all of the respondents to the CBECS (91 percent of all buildings; 95 percent of the floorspace) reported the presence of an energy conservation feature related to either the building shell, heating, ventilation and air-conditioning (HVAC) systems, or lighting. Building shell conservation features were the most common type.

Although it may seem that new buildings would have been more likely than old buildings to have features related to building shell conservation, the presence of these features was not related to the age of the building. This lack of correlation is probably due to the fact that old buildings are often retrofitted with insulation, storm windows or other energy-saving measures related to the shell (Table A57).

Box 1. Energy Conservation Features

Building Shell Conservation Features
- Roof or Ceiling Insulation
- Wall Insulation
- Storm Windows or Multiple Glazing
- Tinted Glass
- Shadings or Awnings
- Windows Which Open and Close

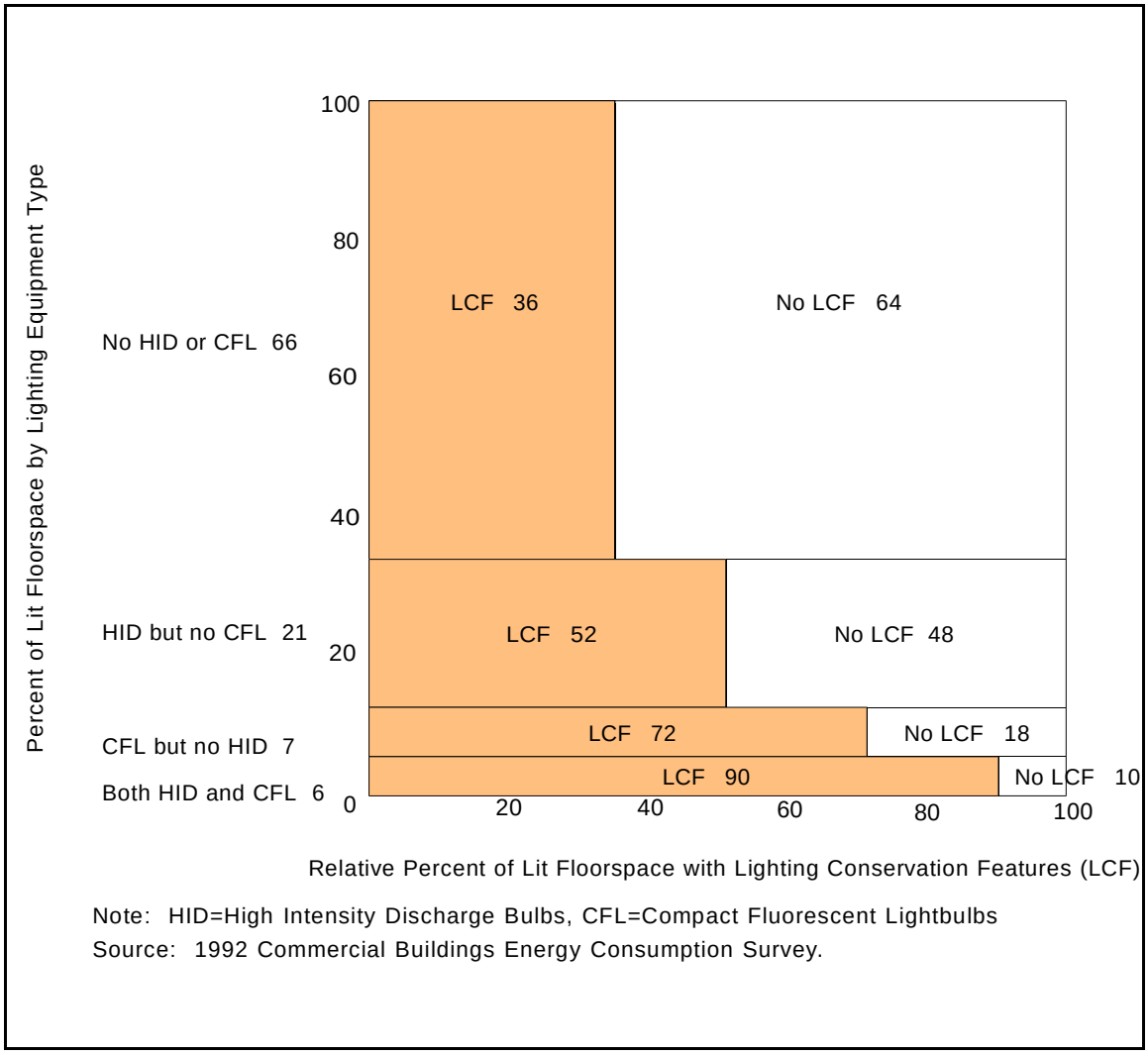
HVAC Conservation Features
- Variable Air-Volume System
- Economizer Cycle
- Regular Maintenance of HVAC System

Lighting Conservation Features
- Specular Reflectors
- Daylighting Controls
- Occupancy Sensors
- Timed Clocks or Switches
- Dimmer Switches
- Other Lighting Conservation Equipment

[7]Detailed information on conservation and energy management practices in 1992 commercial buildings is found in Appendix A, "Detailed Tables," Tables A57 through A67.

HVAC and lighting conservation features were not equally prevalent across all types of buildings, but instead were related to the specific characteristics of the building. HVAC conservation features were more likely to be found in education, health care, lodging, office and public order and safety buildings, in part because these types of buildings tended to be larger. Lighting conservation features were more often found in recently constructed buildings and in buildings that used high-intensity discharge (HID) lighting or compact fluorescent lightbulbs (CFL). Only 6 percent of lit floorspace was in buildings that had both HID and compact fluorescent bulbs, but nearly all (90 percent) of these buildings had some lighting conservation feature. The majority of the total lit floorspace was in buildings with no HID or compact fluorescent lighting (66 percent); of these buildings, however, those with lighting conservation features comprised only 36 percent of the floorspace (Figure 6).

Figure 6. Presence of Lighting Conservation Features by Types of Lighting Equipment, 1992



Note: HID=High Intensity Discharge Bulbs, CFL=Compact Fluorescent Lightbulbs
Source: 1992 Commercial Buildings Energy Consumption Survey.

Energy Management Practices

Box 2. Energy Management Practices

- DSM program participation
- Energy audits performed
- Building energy managers employed
- Energy Management and Control System used

Energy management practices were less common than energy conservation features. Buildings that practiced energy management made up only 41 percent of commercial floorspace.

Energy Managment and Control System (EMCS): An EMCS is a computerized system used to manage a building's use of energy for HVAC, lighting, or other equipment. Unlike building shell conservation features, for which age was not a determining factor in the presence of the feature, EMCS's were more common in new construction. Buildings with an EMCS made up only 15 percent of the floorspace of buildings constructed before 1970. This figure increased to 24 percent of the floorspace for buildings built from 1970 to 1979 and to 30 percent for those built from 1980 to 1989. For buildings that were built between 1990 and 1992, the percent of floorspace in buildings with an EMCS was an impressive 49 percent (Table 3).

Table 3. Vintage of Buildings with Energy Management and Control Systems

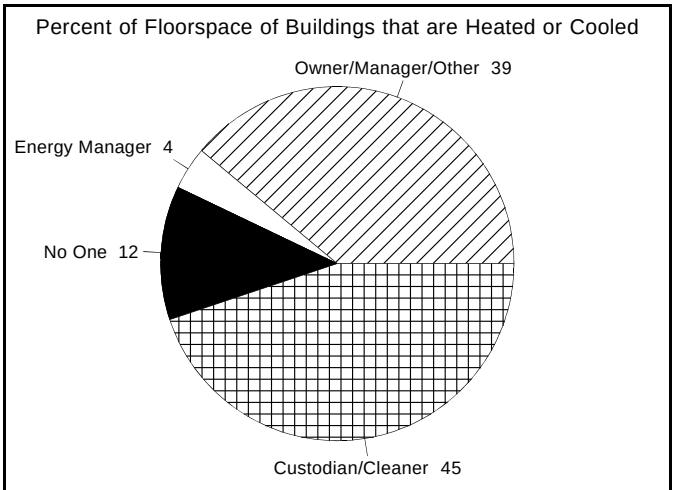
	All Buildings		Buildings with EMCS Control of Any System			
Year Built	Number of Buildings (thousand)	Floorspace (million square feet)	Number of Buildings (thousand)	Percent of Buildings	Floorspace (million square feet)	Percent of Floorspace
All Buildings	4,806	67,876	236	5	14,320	21
Before 1970	2,811	37,074	106	4	5,431	15
1970-79	982	14,014	52	5	3,313	24
1980-89	884	14,287	58	7	4,342	30
1990-92	128	2,502	19	15	1,236	49

Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1992 Commercial Buildings Energy Consumption Survey.

Energy Audits: Buildings that had an energy audit performed since 1987 comprised only 22 percent of commercial floorspace. The older the building, the more likely it was to have had an energy audit. Additionally, energy audits were more likely to occur in buildings located in the Northeast, those which are government owned, and those which use district heat (Table A61).

Energy Managers: People who are responsible for the day-to-day operation and maintenance of the heating and/or cooling equipment, building energy managers, were employed in buildings comprising only 4 percent of heated or cooled commercial floorspace (7 percent of all commercial floorspace is not heated or cooled). These energy managers were most likely to be found in health care buildings; 12 percent of the floorspace in health care buildings was in ones with a building energy manager (Table A61). In most other commercial buildings, this responsibility was taken on by a custodian, cleaning contractor, owner, manager, or other, usually a tenant or an organizational volunteer (Figure 7).

Figure 7. Person Responsible for the Heating and/or Cooling Equipment, 1992

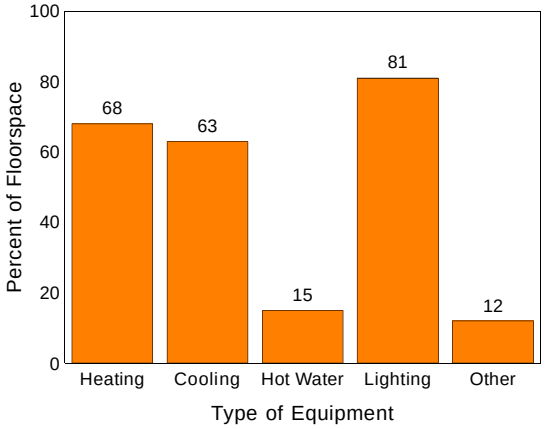


Source: 1992 Commercial Buildings Energy Consumption Survey.

Reduction in Equipment Use When Closed

Lighting was more likely to be reduced when a building was closed than were heating, cooling or water heating. Figure 8 shows the percentage of floorspace in buildings where equipment use was reduced during off hours, by the specific type of equipment (Table A63).

Figure 8. Types of Equipment that Were Used Less When the Building Was Closed, 1992



Source: 1992 Commercial Buildings Energy Consumption Survey, Table A63.

Demand-Side Management (DSM)

Only 7 percent of all buildings, 17 percent of the floorspace, participated in DSM programs in 1992 (Tables A60 and A61).[1] Specifically, 4 percent of all buildings were in programs sponsored by their electric or gas utility and 3 percent participated in in-house, third-party, or other-sponsored DSM programs.

Figure 9 displays the DSM participation rates for various types of buildings. For example, 31 percent of all the buildings over 200,000 square feet participated in DSM. The highest participation rates were in buildings that were: large (both in floorspace and in number of workers), used for education or health care, located in the Northeast, or government owned (Table A60).

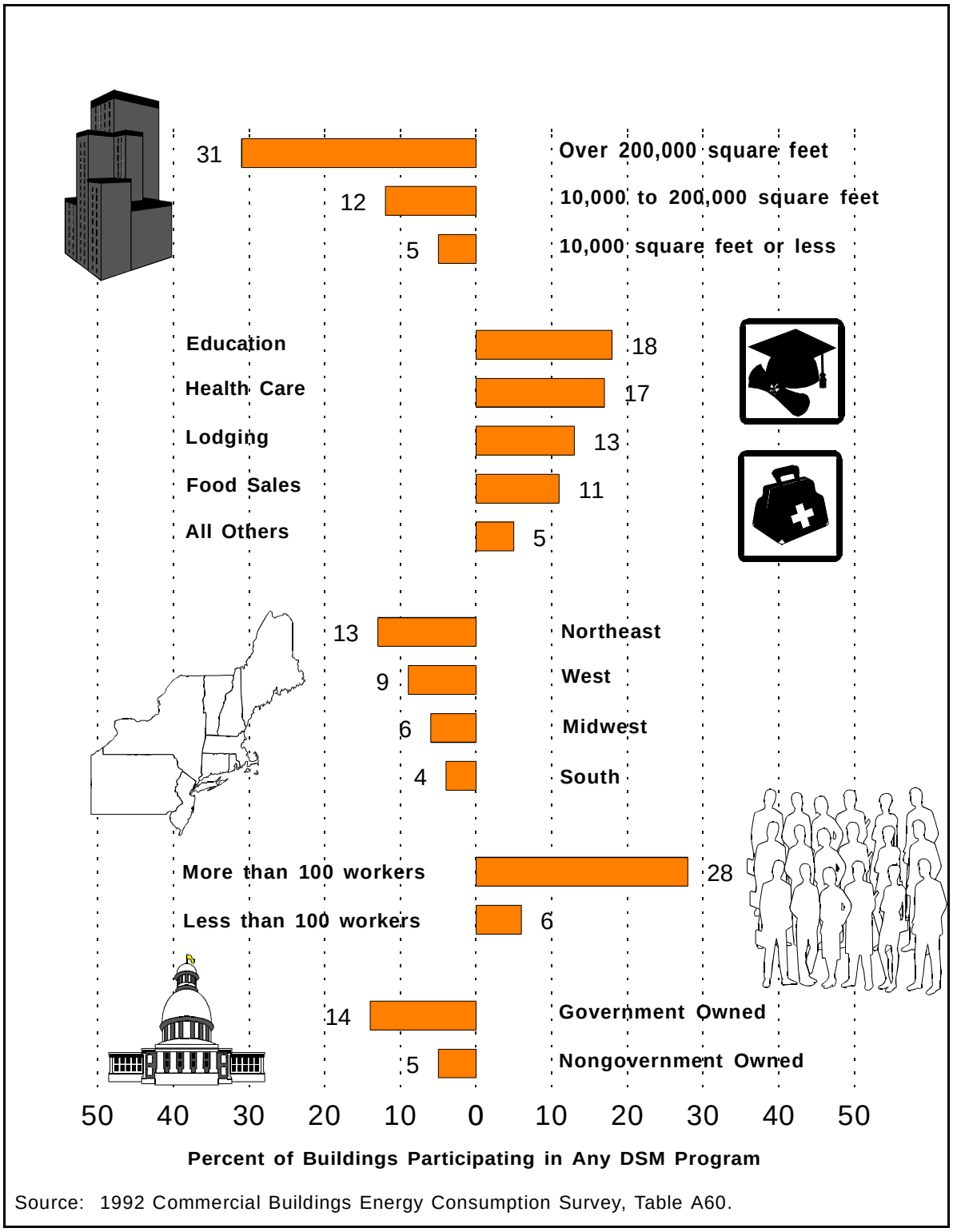
The 1990 Residential Energy Consumption Survey indicated that substantial energy savings could be found in the residential sector by targeting potential DSM participants.[2] Similarly, the 1992 CBECS data suggests that a large potential also exists in the commercial sector for DSM programs. While only 13 percent of the CBECS respondents were aware of DSM programs offered by their utility, of this group, 32 percent actually took part in a utility-sponsored DSM program.

Lighting DSM programs were more often utility-sponsored (65 percent of buildings participating in lighting programs were in ones sponsored by an electric or gas utility) rather than in-house, third party, or other-sponsored (39 percent). Conversely, HVAC programs were more often in-house, third party, or other-sponsored (60 percent) rather than utility-sponsored (42 percent). Some of these buildings were in programs with more than one sponsor. An in-house sponsor is the building's owner or management; a third-party sponsor is an energy service company (ESCO) that advises on the best type of energy-efficient equipment to be installed for a particular building.

[1]The CBECS includes in-house demand-side management programs and programs with a third party or other sponsor as well as utility-sponsored programs. Cases in which the respondent did not know whether the building participated in DSM programs were not imputed.

[2]For information about energy use in the residential sector, see *Household Energy Consumption and Expenditures 1990* DOE/EIA-0321(90), pp 37-47.

Figure 9. Types of Buildings Most Likely to Participate in DSM, 1992



Source: 1992 Commercial Buildings Energy Consumption Survey, Table A60.

Conservation in Office Buildings and Government-Owned Buildings

Profile of Office Buildings

The characteristics of office buildings are of increasing interest to energy analysts since office buildings consume slightly over one-fifth of all energy used in commercial buildings. An oversample of office buildings was included in the 1992 CBECS to better understand the potential for energy savings in these buildings. In 1992, office buildings comprised 16 percent (749 thousand buildings) of the building stock and 18 percent of the commercial floorspace (12,319 million square feet). Of these, 57 thousand (7.6 percent) were buildings constructed after 1986. Below is a profile of selected energy-related characteristics for office buildings in the 1992 commercial building stock.

Box 3. Conservation in Office Buildings

Office Buildings - 749 thousand
Office Buildings Constructed after 1986 - 57 thousand

Floorspace: Of the 57 thousand office buildings constructed after 1986, 47 percent were over 10,000 square feet compared to 24 percent of the 692 thousand office buildings constructed in 1986 or earlier.

Lighting: Newer office buildings were more likely to use energy-saving lighting equipment.

	Percent of Office Buildings Constructed after 1986	Percent of Office Buildings Constructed 1986 or Earlier
Compact Fluorescent Bulbs	19	6
High-Intensity Discharge Lights	11	5
Specular Reflectors	26	13
Manual Dimmer Switches	21	8

HVAC: Newer office buildings had more HVAC conservation features.

	Percent of Office Buildings Constructed After 1986	Percent of Office Buildings Constructed 1986 or Earlier
Variable Air-Volume System	40	8
Economizer Cycle	35	11
Regular HVAC Maintenance	74	69

Profile of Government-Owned Buildings

With the signing of the Energy Policy Act of 1992 (EPACT),[10] the CBECS is uniquely placed to determine and illustrate this legislation's impact on the commercial buildings market. This section highlights some findings for government-owned (Federal, State, and local) commercial buildings (Tables A21, A22 and A23).

Box 4. Effects of EPACT on Government-Owned Buildings

EPACT affects federally owned commercial buildings:

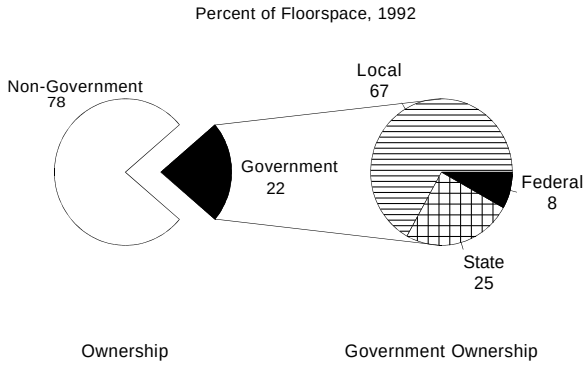
- By mandating a 20 percent reduction, by the year 2000, of energy consumption per square foot in federal buildings;
- By requiring that by the year 2005 federal buildings install energy conservation features that will pay for themselves from energy savings within 10 years (i.e., a 10-year payback); and,
- By introducing financial incentives to federal buildings for energy improvement programs.

EPACT also creates, for local-owned and State-owned commercial buildings, an Energy Incentive Fund which provides up to $1 million to States that demonstrate a commitment to improving the energy-efficiency of buildings.

[10]The Energy Policy Act of 1992, Title I - Energy Efficiency, Subtitle E - State and Local Assistance, Section 141 and Subtitle F - Federal Agency Energy Management, Section 152.

Government-owned buildings represented approximately 22 percent of the commercial floorspace in 1992, or 15.1 billion square feet in approximately 0.6 million government-owned buildings. Of these government-owned buildings, 8 percent of the floorspace was in buildings owned by the Federal government, 25 percent was in State-owned buildings, and 67 percent was in buildings owned by local governments (Figure 10). Education was the primary activity of government-owned buildings, representing 46 percent of all government buildings.

Figure 10. Ownership of Commercial Buildings, 1992

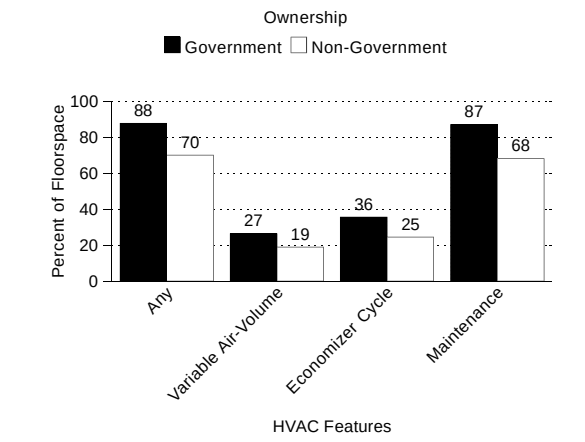


Source: 1992 Commercial Buildings Energy Consumption Survey, Table A21.

Government-Owned Buildings Take Advantage of Energy-Efficient Technologies and Energy Management Practices

Commercial buildings consume large amounts of energy for HVAC purposes.[11] In 1992, as measured in floorspace, approximately 88 percent of all government buildings contained HVAC conservation features compared to 70 percent of non government buildings (Figure 11).

Figure 11. HVAC Conservation Features by Building Ownership, 1992



Source: 1992 Commercial Buildings Energy Consumption Survey, Table 36.

In 1992, government-owned buildings indicated a higher usage of energy management practices than non-government buildings. The 1992 CBECS included four energy management practices: EMCS, DSM, energy audits, and building energy managers. According to the CBECS, in 59 percent of government-owned floorspace energy management practices were used, compared to 36 percent of non government-owned floorspace.[12] Of the 15.1 billion square feet of government-owned floorspace: EMCS controlled 32 percent; 28 percent of the floorspace showed DSM activity; and 30 percent indicated the performance of energy audits. Although 5 percent of government-owned floorspace had a building energy manager, there was not a statistically significant difference between government-owned and non government-owned buildings.

[11]End-use consumption estimates are not currently available. End-use intensities (EUI) will be published at a later date.

[12]Estimates of any energy management practices were calculated from public use diskettes of Commercial Buildings Energy Consumption Survey.

Energy Sources and Energy End Uses

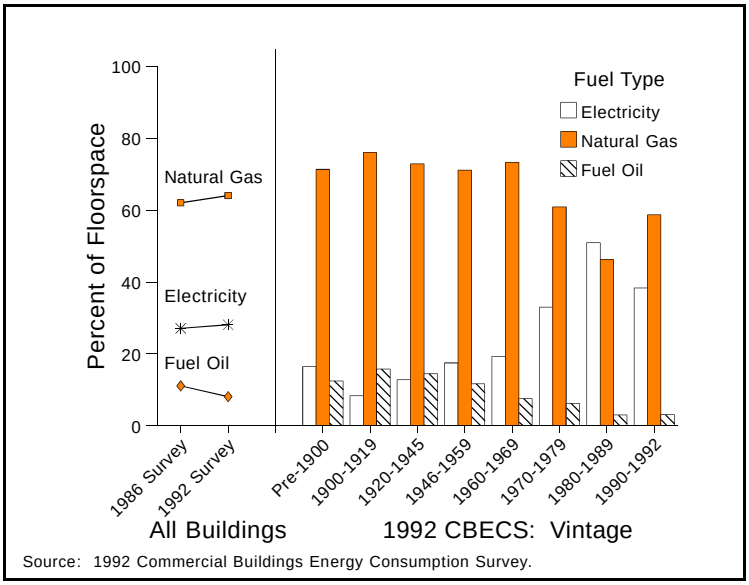
The CBECS collects and provides data about the types of energy sources and how each is ultimately used in commercial buildings.[1] Expanded tables of energy sources, Tables A69 and A70, provide information about energy sources used specifically for each energy end use.

Primary Space-Heating Trends

As has been the case in previous CBECS, the 1992 CBECS showed that across the entire commercial building stock, natural gas was the primary space-heating fuel for the largest percentage of commercial floorspace (Figure 12).[2] Electricity was the primary space-heating fuel for the second largest percentage of floorspace, and fuel oil accounted for the third largest percentage.

Figure 12 also shows the primary space-heating fuel distribution by building vintage. Data from buildings constructed in the 1980's show an interruption in the long-standing dominance of the use of natural gas as the primary space-heating fuel. In buildings constructed during the 1980's, the largest percentage of floorspace was heated with electricity.

Figure 12. Primary Space-Heating Fuel by Building Construction Year, 1986 and 1992



Source: 1992 Commercial Buildings Energy Consumption Survey.

Renewable Energy and Special Technology

In response to users' requests for more information about special energy technologies and the use of renewable energy, questions about the use of solar, geothermal, and thermal energy storage, along with questions about the use of waste incineration, wind generation, and well water for cooling, were added to the 1992 CBECS .[3]

Buildings with some special energy technology and/or a renewable energy source were found in each Census region. Wood was by far the most widely used renewable fuel; it was used in about 2.2 percent of commercial buildings. Buildings reporting wood as an energy source tended to be under 10,000 square feet and usually reported having one to four workers. These buildings also tended to be used for mercantile and service activities or as nonrefrigerated warehouses. Thirty-six percent of buildings that used wood were constructed between 1920 and 1945; over 60 percent of wood-using buildings were located in the Midwest or the South Regions.

[1]Detailed information on energy sources and end uses in 1992 commercial buildings is found in Appendix A, "Detailed Tables," Tables A29 through A46.

[2]The 1992 CBECS resampled buildings that were sampled in the 1986 CBECS. For further information, see Appendix B, "How the Survey Was Conducted."

[3]*Users-Needs Study for the 1992 Commercial Buildings Energy Consumption Survey*, DOE/EIA-0555(92)/4, Energy Information Administration (Washington, D.C.: Government Printing Office, September 1992).

The most widely reported special technologies were passive solar features, thermal energy storage (TES) or pump storage, and well water used for cooling. Buildings in the West Census Region reported using passive solar technologies and TES more frequently than buildings in the other regions. Buildings built between 1970 and 1986 were the most likely to use passive solar technology, while those built between 1920 and 1945 were most likely to use TES. Both of these construction periods accounted for high percentages of buildings using well water for cooling; 42 percent of all cases using well water for cooling were located in the South. In all regions, buildings that most frequently reported using any of these special technologies were office buildings, mercantile and service buildings, and education buildings.

Box 5. Special Energy-Related Technologies

Widely Reported:
- Passive Solar Features
- Thermal Energy Storage (TES)
- Well Water for Cooling

Reported:
- Photovoltaic Cells
- Solar Thermal Panels
- Geothermal Energy
- Waste Incineration
- Wind Generation

For certain renewable energy types and technologies, there were too few buildings in the sample to permit separate reporting or to be statistically significant. These technologies include: photovoltaic cells (PVC), solar thermal panels, geothermal energy, waste incineration, and wind generation.

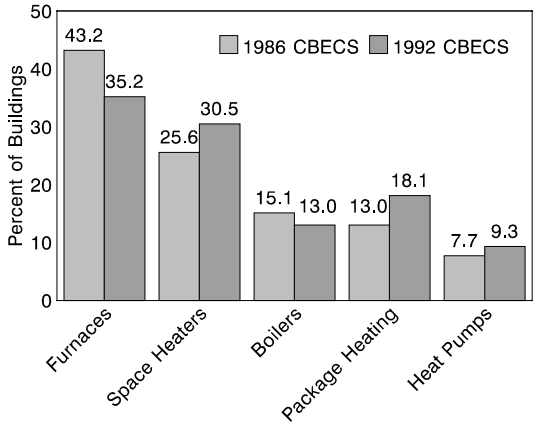
End-Use Equipment

A large portion of the energy used in commercial buildings is devoted to heating, cooling, ventilation, and lighting. The 1986 and 1992 CBECS included questions on the types of equipment that provide these energy services in order to provide a profile of the main energy using equipment in the U.S. commercial building stock. In addition, the 1992 CBECS included questions about commercial refrigeration equipment, water heating equipment, and the presence of personal computers and terminals.[16]

Increased Use of Packaged Cooling Units and Heat Pumps

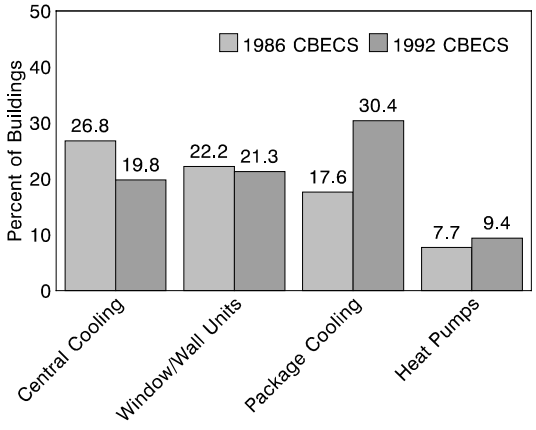
Among cooling equipment types, an increase in the percentage of buildings using packaged cooling systems represents the largest difference between the 1986 and 1992 CBECS.[17] Heat pumps also showed a slight increase, while all other types of cooling equipment showed a decline. The increase in heat pumps, however, may be overstated; the figures for 1986 include only air-source heat pumps, while the 1992 figures include both air- and water-source heat pumps (see Figures 13 and 14).

Figure 13. Percent of Buildings Using Heating Equipment in 1986 and 1992 CBECS



Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1986 and 1992 Commercial Buildings Energy Consumption Surveys.

Figure 14. Percent of Buildings Using Cooling Equipment in 1986 and 1992 CBECS



Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1986 and 1992 Commercial Buildings Energy Consumption Surveys.

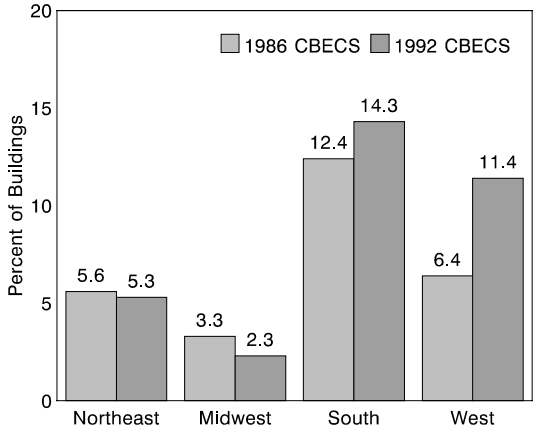
While the percentage of buildings using heat pumps had increased slightly nationwide between 1986 and 1992, there was, in fact, a quite dramatic increase in the West. This region, which already showed the second largest percentage of buildings using heat pumps in 1986, increased its lead over the Northeast and Midwest, where the percentages showed slight declines.

[16]Detailed information on end-use equipment in 1992 commercial buildings is found in Appendix A, "Detailed Tables," Tables A47 through A56.

[17]Because the 1986 CBECS questionnaire included a category of "Central Cooling," under which respondents could have mistakenly included packaged cooling units, it is possible that packaged cooling units are underrepresented in the 1986 data. However, the increase is of such a magnitude that it could not be accounted for simply by mistaken responses.

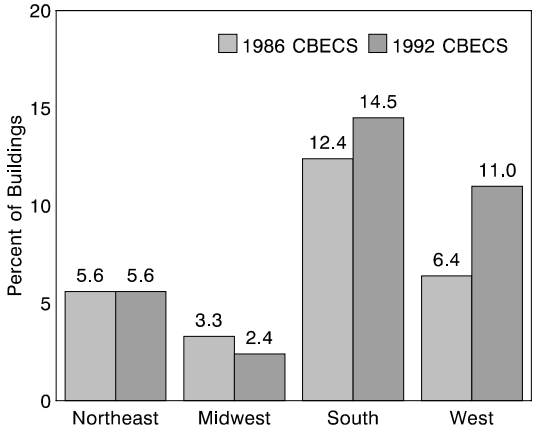
In 1992, unlike 1986, the respondents were given a chance to indicate whether their heat pump was used for heating or cooling or both. By definition, a heat pump can be used for both heating and cooling, but in most regions the use of heat pumps for cooling was higher than their use for heating (Figures 15 and 16). There are any number of reasons why an individual might decide to use a heat pump for heating only or cooling only, rather than both, and the most probable explanations vary by region. In the Northeast and the Midwest, the colder climate may lead a building manager to believe that a heat pump would not be adequate to heat their building, or would not be economical, causing him to use some other heating equipment. In the South, the warmer climate may make it unnecessary to heat a building at all, and a heat pump would be used only for cooling. Only in the West was the use of heat pumps for heating greater than the use of heat pumps for cooling. Presumably, the climate in some parts of this region is cool enough to require a moderate amount of heating in the winter, but no cooling in the summer.

Figure 15. Percent of Buildings Using Heat Pumps for Heating, by Region, 1986 and 1992 CBECS



Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1986 and 1992 Commercial Buildings Energy Consumption Surveys.

Figure 16. Percent of Buildings Using Heat Pumps for Cooling, by Region, 1986 and 1992 CBECS

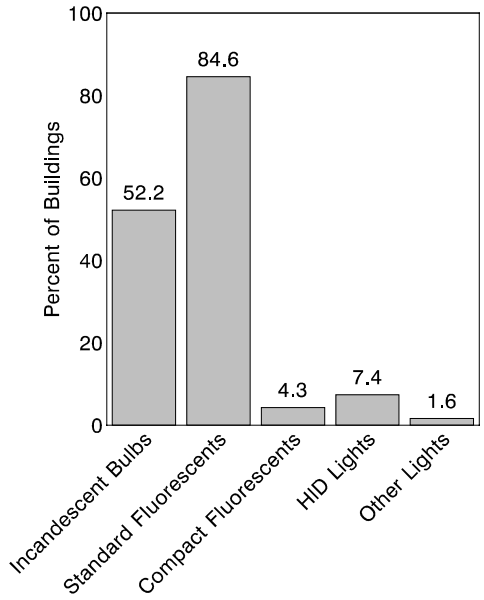


Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1986 and 1992 Commercial Buildings Energy Consumption Surveys.

Fluorescent Lamps Are the Predominant Commercial Lighting Source

The 1992 CBECS data reveal that fluorescent lamps were by far the most common lighting type in commercial buildings. These were followed by incandescent bulbs, with compact fluorescent lights and high-intensity discharge (HID) lights lagging far behind these two types. These data suggest that there is an unrealized potential for replacing incandescent bulbs with more energy-efficient equipment (Figure 17).

Figure 17. Percent of Buildings Using Lighting Equipment, 1992



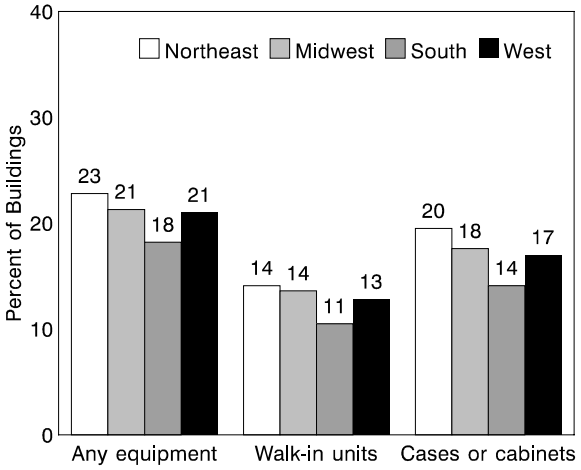
Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1992 Commercial Buildings Energy Consumption Survey.

Use of Water-Heating and Refrigeration Equipment Largely Uniform Among Regions

For the first time in 1992, detailed data on different types of commercial refrigeration equipment and different types of water-heating equipment were collected. Among the different Census regions, there was little or no variation, although the South appeared to have slightly fewer buildings with refrigeration equipment. In addition, the relative proportions of the different equipment types remained almost constant among the Census regions (Figure 18). As for the water-heating equipment, by far the most common types were the single-centralized tank, and the distributed-residential type tank. No other types were represented in more than 2 percent of commercial buildings.

- A centralized tank with its own heat source was present in 36 percent of commercial buildings
- Residential-type water-heating tanks, distributed about the building, were present in 30 percent of commercial buildings
- Other types of water-heating equipment (e.g., those drawing heat from the space-heating equipment, or instantaneous point-of-use heaters) were each present in less than 2 percent of commercial buildings.

Figure 18. Percent of Buildings Using Refrigeration Equipment, by Region, 1992



Source: Energy Information Administration, Office of Energy Markets and End Use, Form EIA-871A, 1992 Commercial Buildings Energy Consumption Survey.

There is little diversity in the types of water heating equipment used in commercial buildings, with the vast majority of buildings having one of only two types. This also applies to the other forms of energy-using equipment, with two or three types predominating among the various types of heating, cooling, and lighting equipment used in commercial buildings.