# Section 2. Energy Use in Commercial Buildings

*The purpose of this section is to provide an overview of how energy was used in commercial buildings. Focusing on 1989 buildings, the section shows energy consumption by energy source (electricity, natural gas, fuel oil, and district heat), by energy end use (space heating, cooling, ventilation, water heating, lighting, cooking, refrigeration, office equipment, and other), and by various building characteristics (floorspace, year constructed, weekly operating hours, climate zone, and building activity).*

Key findings of this section include:

- Of all the various end uses, space heating accounted for the largest share of consumption (35 percent), followed by lighting (18 percent), water heating (9 percent), office equipment (7 percent), cooling (5 percent), ventilation (5 percent), cooking (5 percent), and refrigeration (3 percent) (Figure 3).

- Natural gas consumption was dominated by consumption for space heating, accounting for 61 percent of the natural gas consumed (Figure 4).

- Electricity accounted for almost 50 percent of all the energy delivered to commercial sites, while natural gas accounted for 36 percent of site consumption (Figure 5).

- Electricity accounted for over 70 percent of the primary energy consumption (the amount of energy consumed at commercial sites plus the amount of energy lost in producing and transmitting electricity and district heat) at commercial buildings, while natural gas accounted for only 18 percent of primary energy consumption (Figure 5).

- Electricity accounted for over 80 percent of the energy expenditures for commercial buildings, while natural gas accounted for only 13 percent (Figure 5).

- Natural gas space heating and electric lighting were the two largest consumers of site energy (Figure 6).

- Electric lighting accounted for the largest portion of energy expenditures in commercial buildings (Figure 6).

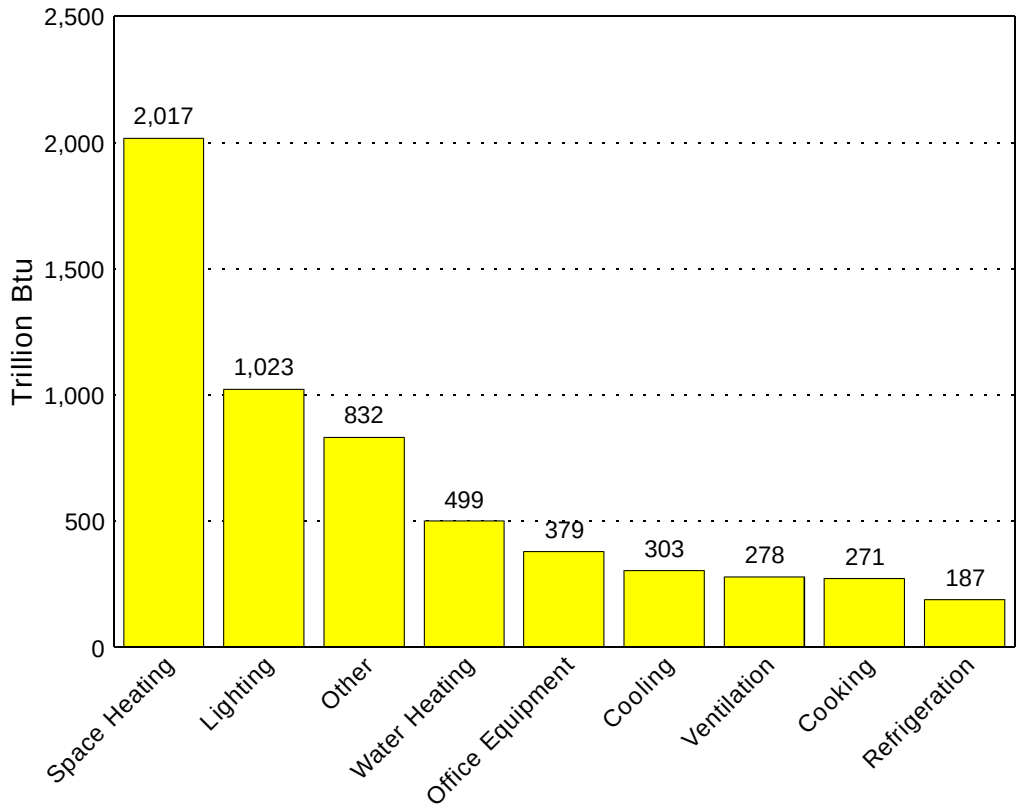
- Defining a building's energy intensity as the ratio of energy consumption to floorspace, the highest intensities were found in buildings constructed in the 1960's. Buildings constructed in the 1980's showed lower intensities (Figure 7).

- Buildings located in the coldest climate had the highest energy intensity because of the demand for space heating. Conversely, the buildings located in the warmest climate, had the lowest energy intensity because of the small demand for space heating, despite their greater need for cooling (Figure 8).

- The different types of commercial buildings had distinctive energy-use profiles (Figure 9).

## Energy Consumption by End Use

**Figure 3. Energy Consumption in U.S. Commercial Buildings, by End Use, 1989**

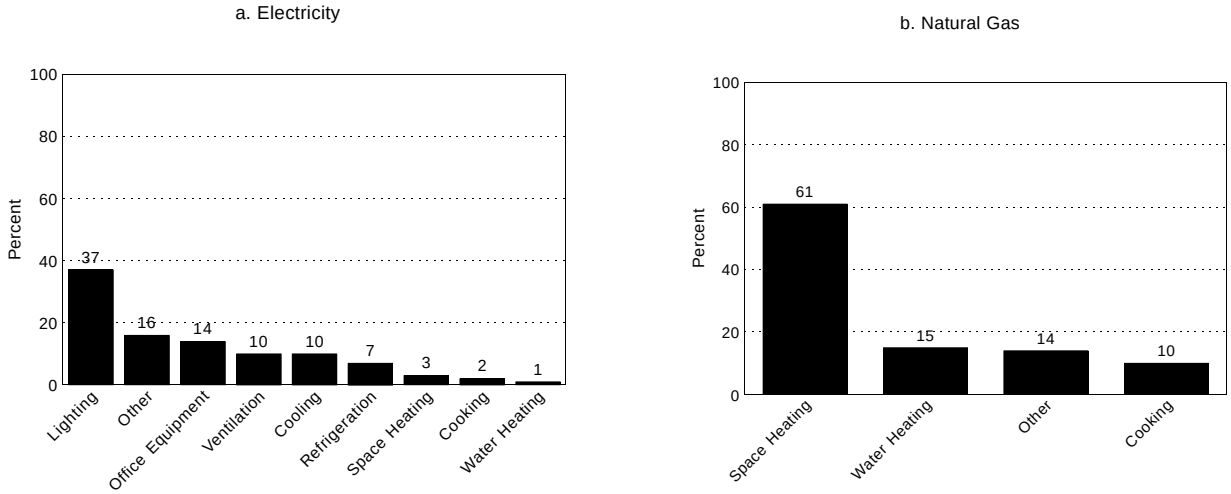



Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- Figure 3 shows that of all the energy used for the various end uses in commercial buildings in 1989, the largest share was for space heating (35 percent), followed by lighting (18 percent), water heating (9 percent), office equipment (7 percent), cooling (5 percent), ventilation (5 percent), cooking (5 percent), and refrigeration (3 percent).

- Several other end uses, which have been grouped in the category called "other," used 14 percent of all energy used in buildings. Included in this category is energy consumed for such uses as elevators, medical and other laboratory equipment, and miscellaneous electrical appliances.

**Figure 4. Shares of Consumption for Electricity and Natural Gas, by End Use, 1989**




Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

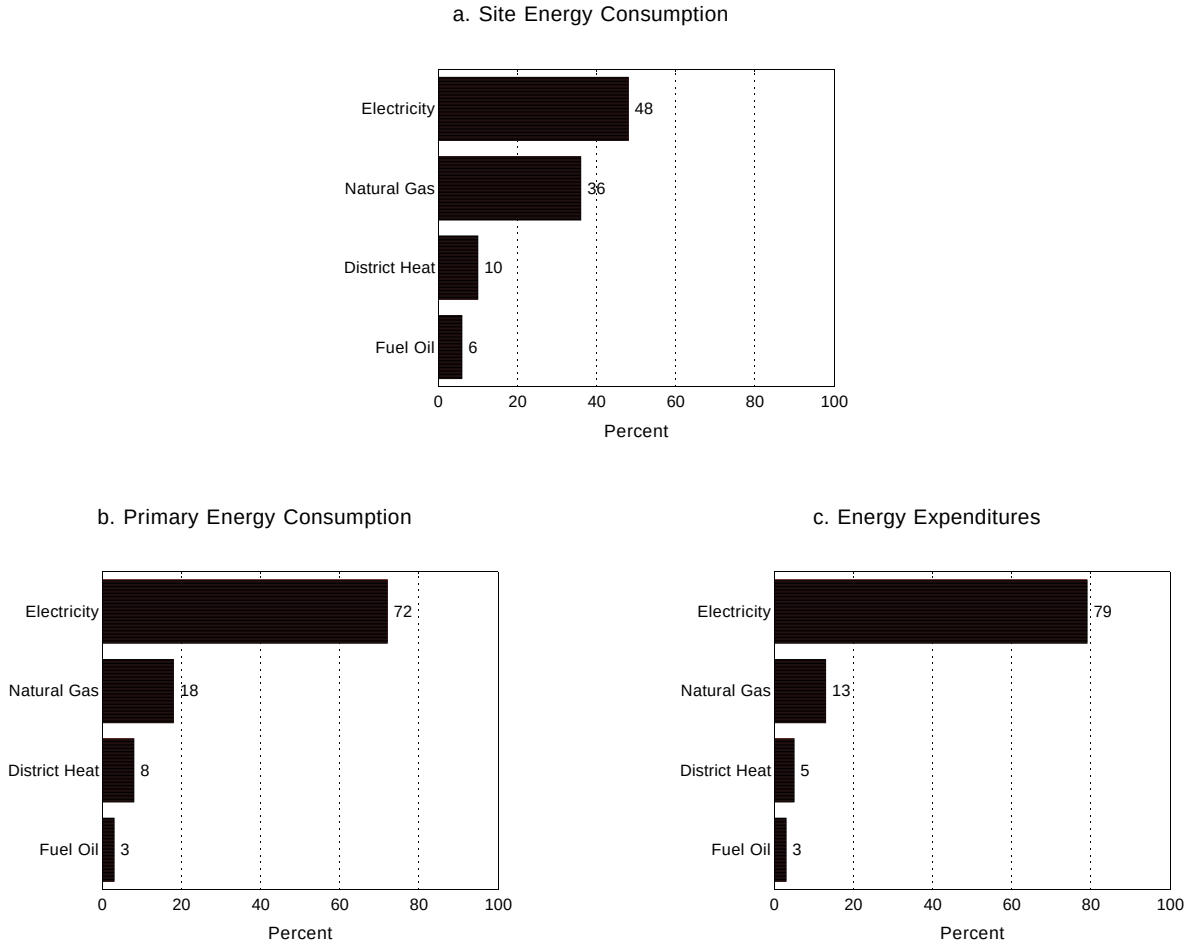
- The two main energy sources consumed in commercial buildings in 1989 were electricity (2.8 quadrillion Btu) and natural gas (2.1 quadrillion Btu) (Figure 1).

- Figure 4 shows that electricity usage was spread among all nine end uses, while natural gas usage was more restricted to end uses involving heating (space heating, water heating, and cooking).

- Lighting was the largest single use of electricity, accounting for 37 percent of the electricity consumed.

- Natural gas consumption was dominated by space heating, accounting for 61 percent of the natural gas consumed.

**Figure 5. Shares of End-Use Site Energy Consumption, Primary Energy Consumption, and Expenditures, by Energy Source, 1989**




Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey.

- Energy consumption can be measured by (1) the amount of energy delivered to a site (site consumption), (2) the amount of energy delivered to a site plus the amount of energy used to produce and transmit the electricity or district heat (primary energy consumption), or (3) the amount of money paid for the energy consumed at a site (energy expenditures).

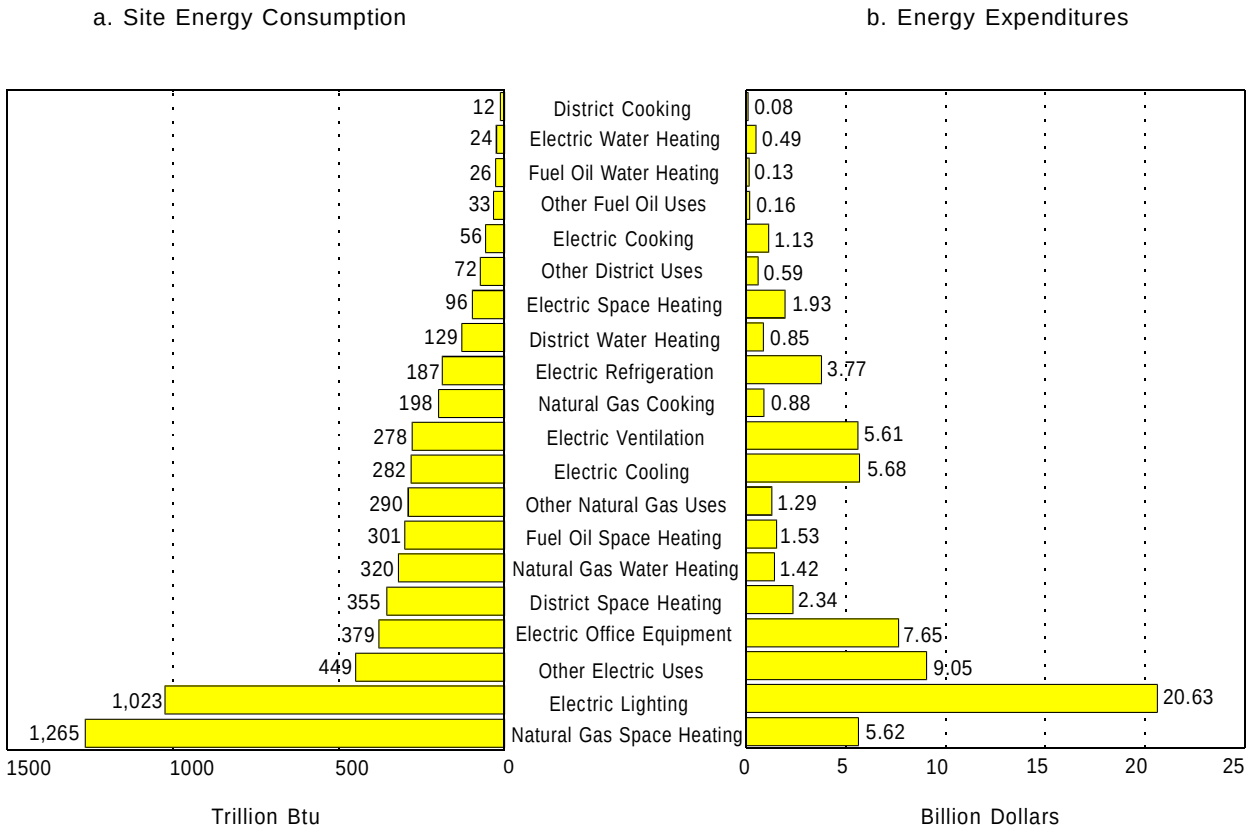
- Figure 5 shows that electricity accounted for almost 50 percent of the site energy consumption, over 70 percent of the primary energy consumption, and almost 80 percent of the energy expenditures in commercial buildings.

- Natural gas, which accounted for 36 percent of site energy consumption, accounted for only 13 percent of energy expenditures, reflecting the lower price of natural gas in 1989 as with prices of other energy sources.

- Electricity, which in 1989 averaged $20.17 per million Btu of site energy (6.9 cents per kilowatthour), was the most expensive energy source. (Natural gas averaged $4.44 per million Btu; fuel oil, $5.10 per million Btu; and district heat, $6.59 per million Btu.)

- At a price of $6.72 per million Btu of primary energy, electricity was still the most expensive energy source, but not by a wide margin. (The primary prices of natural gas and fuel oil were the same as the site prices; the primary price of district heat was $4.40 per million Btu.)

**Figure 6. Energy End Uses Ranked by Site Energy Consumption and by Energy Expenditures, 1989**




Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- Figure 6 shows that rankings of the top energy end uses differed markedly, depending on the criterion used (site consumption or expenditures). Rankings by primary energy were very similar to rankings by expenditures, due to the relatively narrow range of primary prices among the energy sources.

- Natural gas space heating and electric lighting were the two largest consumers of site energy. Each accounted for over 1 quadrillion Btu of energy consumption, out of a total site energy consumption of nearly 6 quadrillion Btu.

- Energy end-use expenditures can be approximated by multiplying the average fuel price by the amount of energy consumed for an end use.

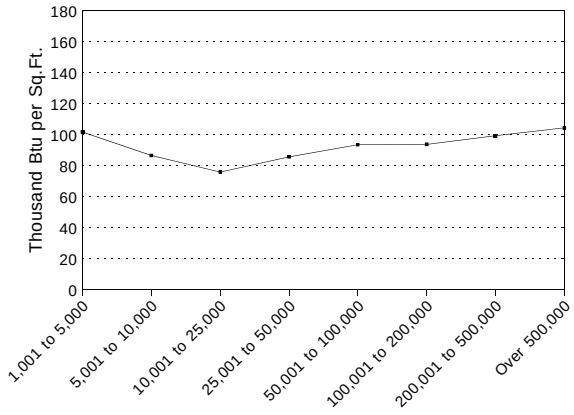
- Electric lighting accounted for the largest portion of energy end-use expenditures in commercial buildings.

- The amount spent on electric lighting was more than double the amount spent on natural gas for all uses, and was considerably more than the amount spent for natural gas, fuel oil, and district heat combined.

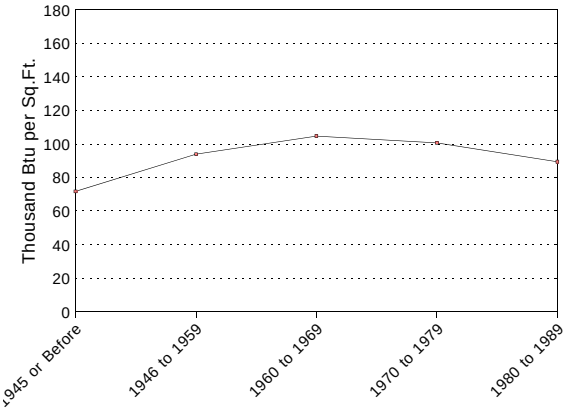
# Major Influences on Energy Intensities

**Figure 7. Energy Intensities for Commercial Buildings, 1989**

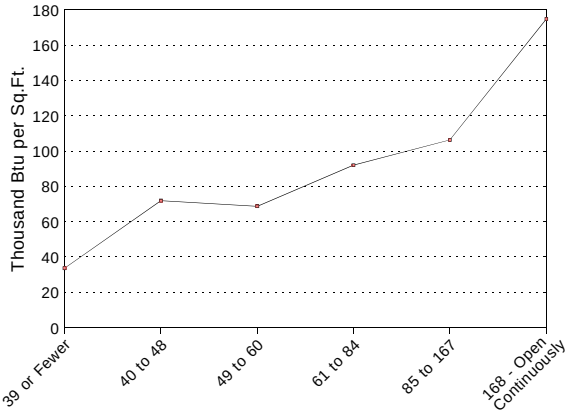
a. Floorspace




b. Year Constructed




c. Weekly Operating Hours




Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey.

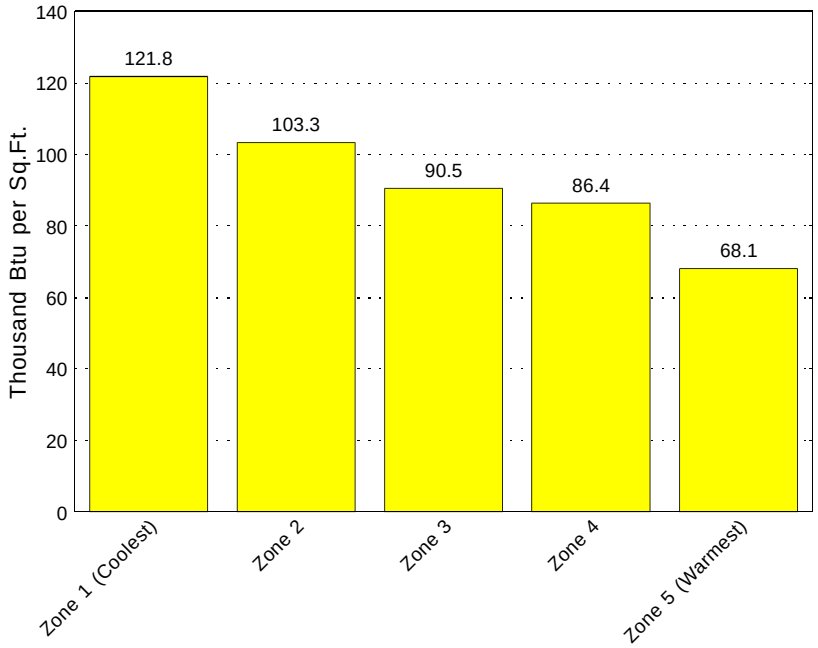
- "Energy intensity" is the ratio of energy consumption to a measure of the demand for energy services (such as building floorspace or weekly operating hours). Energy intensities facilitate the comparison of energy use across different kinds of buildings.

- Figure 7 shows that intensities per square foot were relatively flat across floorspace categories, indicating that the normalization by square footage largely achieved its aim.

- In general, the highest energy intensities were found in buildings constructed in the 1960's. Buildings constructed in the 1980's continued a trend towards lower intensities.

- In general, the longer the weekly operating hours, the higher the building's energy intensity per square foot.

**Figure 8. Energy Intensities for Commercial Buildings, by Climate Zone, 1989**

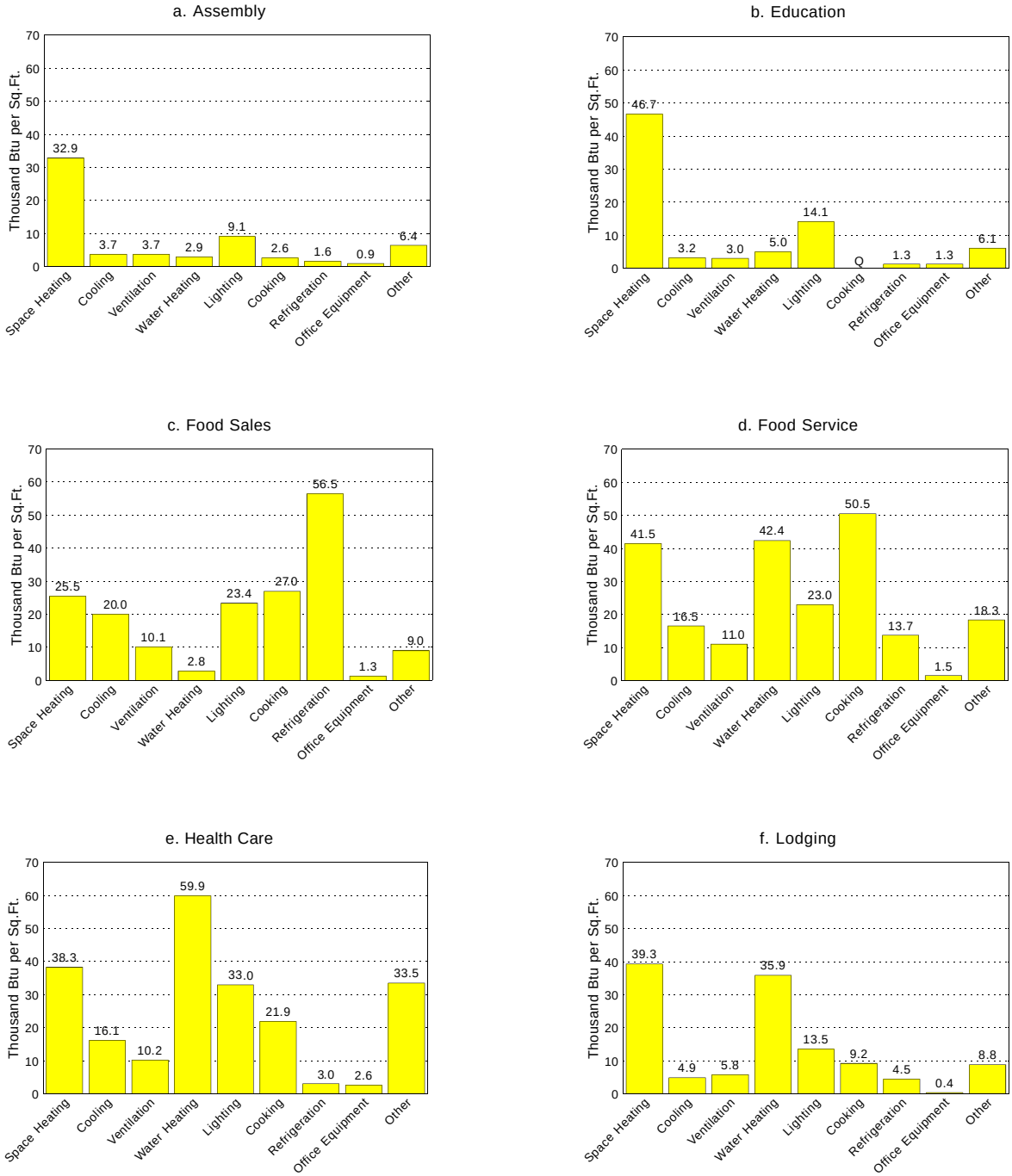


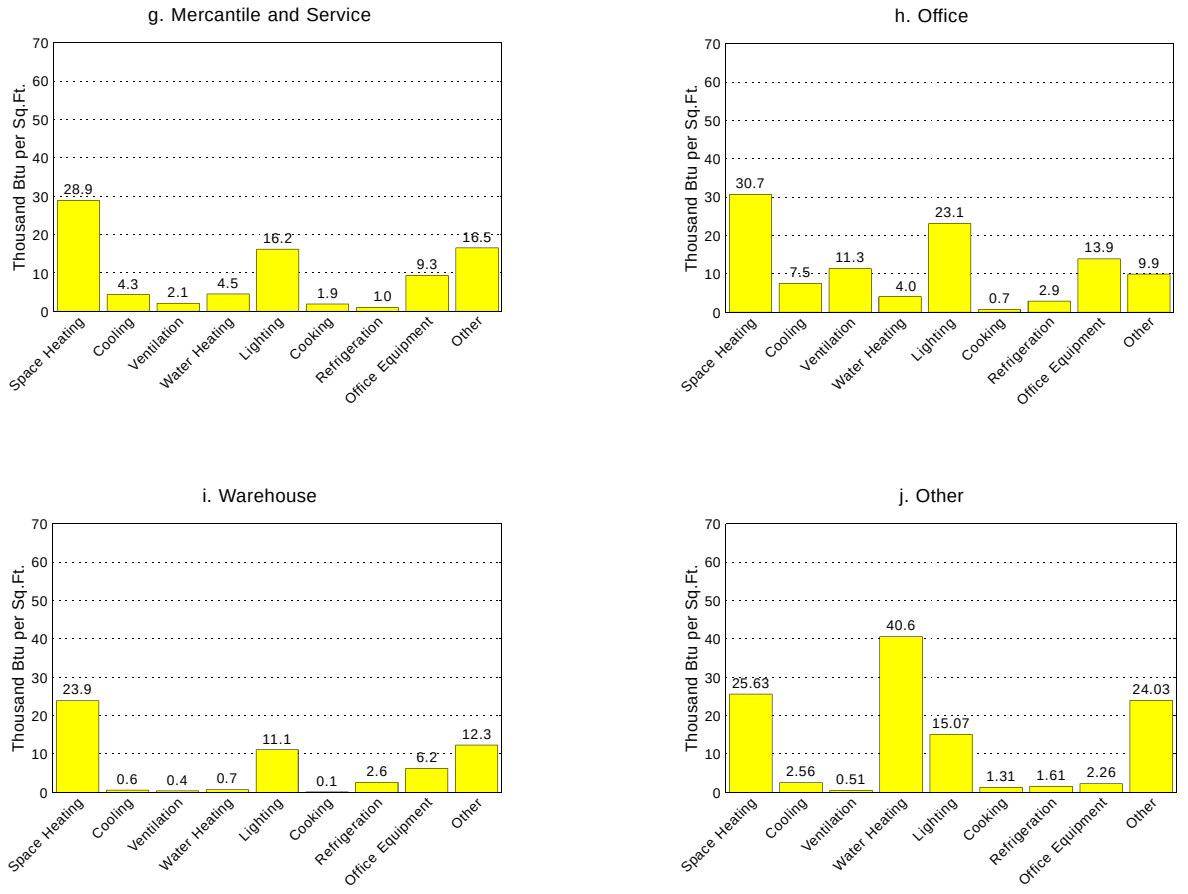

Source: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey.

- Figure 8 shows that the United States can be divided into climate zones according to the average number of heating degree-days (HDD's) and cooling degree-days (CDD's) that have occurred each year over a 45-year period. One HDD occurs when the temperature for the day averages one degree below 65 degrees Fahrenheit. One CDD occurs when the temperature for the day averages one degree above 65 degrees Fahrenheit.

- Zone 1 (the coolest) had the highest end-use intensity because of its greater demand for space heating. Conversely, Zone 5 (the warmest) had the lowest end-use intensity because of its small demand for space heating, even after taking into account the greater cooling load.

**Figure 9. End-Use Intensity Profiles, by Principal Building Activity, 1989**






Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- The ratio of a building's energy consumption for an end use to its floorspace is called an "end-use intensity."
- Figure 9 shows that the different types of commercial buildings had diverse end-use intensity profiles. No two end-use profiles were alike, and some were quite distinct.
- Some end uses, such as heating, cooling, ventilation, and lighting, were found to some degree in all types of buildings. However, other end-uses reflected the activities performed within particular types of buildings.
- Food sales, food service, and health care buildings were similar in having relatively high cooling, ventilation, and cooking intensities.
- Food sales buildings had relatively high refrigeration intensities.
- Food service and health care buildings had relatively high water-heating intensities.
- Office buildings had relatively high intensities for office equipment.
- Buildings in the "other" category, such as laboratories and some mixed commercial-industrial buildings, had a distinctively high intensity for "other" end use.