Section 3. Space-Conditioning Intensities

The purpose of this section is to provide information on how energy was used for space conditioning--heating, cooling, and ventilation--in commercial buildings. For heating, it shows the percent of energy supplied by each energy source and compares space-heating intensities for natural gas and electricity, by the year the building was constructed, and by principal building activity. It also gives the heating intensities in buildings where natural gas was the main heating fuel, by year constructed, floorspace, weekly operating hours, and climate zone. In addition, it shows heating intensities in buildings where electricity was the main heating source, by year constructed and floorspace. This section also shows electric cooling and ventilation intensities in commercial buildings, by year constructed, floorspace, principal building activity, and climate zone.

Key findings of this section include:

- Natural gas was the dominant energy source for space heating in commercial buildings in 1989, providing 63 percent of all the energy consumed for space heating (Figure 10).

- Natural gas provided a much higher percentage than electricity (whether measured by site or primary energy) of the space-heating energy consumed in buildings constructed during the 1980's, even though the amount of floorspace heated by the two energy sources was roughly equal (Figure 11).

- Natural gas space-heating intensities were higher than electricity intensities (site or primary). Possible explanations for the lower electricity intensities include the relatively higher prices of electricity (which may encourage more conservation measures, such as insulation) and the relatively younger age of electric space-heating equipment (Figure 12).

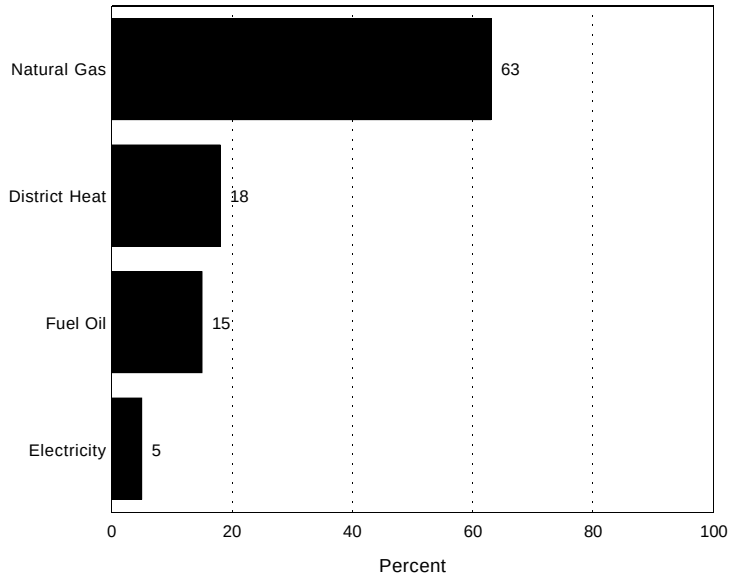
- Education and food service buildings had relatively high natural gas space-heating intensities, either per square foot or per heated square foot-hour-HDD. Health care buildings had the lowest intensities per square foot-hour-HDD (Figure 13).

- Buildings constructed in the 1970's had the highest cooling intensities, defined as the ratio of energy used for cooling to the product of the cooled square footage, the annual building operating hours, and the average daily CDD's (Figure 17).

- Larger buildings had the highest ventilation intensities, defined as the ratio of energy used for ventilation to the product of the square footage and the annual building hours. More energy is required to circulate air through the relatively large interior spaces of the larger buildings (Figure 18).

Space Heating

Figure 10. Percent of Energy Supplied for Space Heating, by Energy Source, 1989



Note: Because of rounding, data may not sum to total.

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.

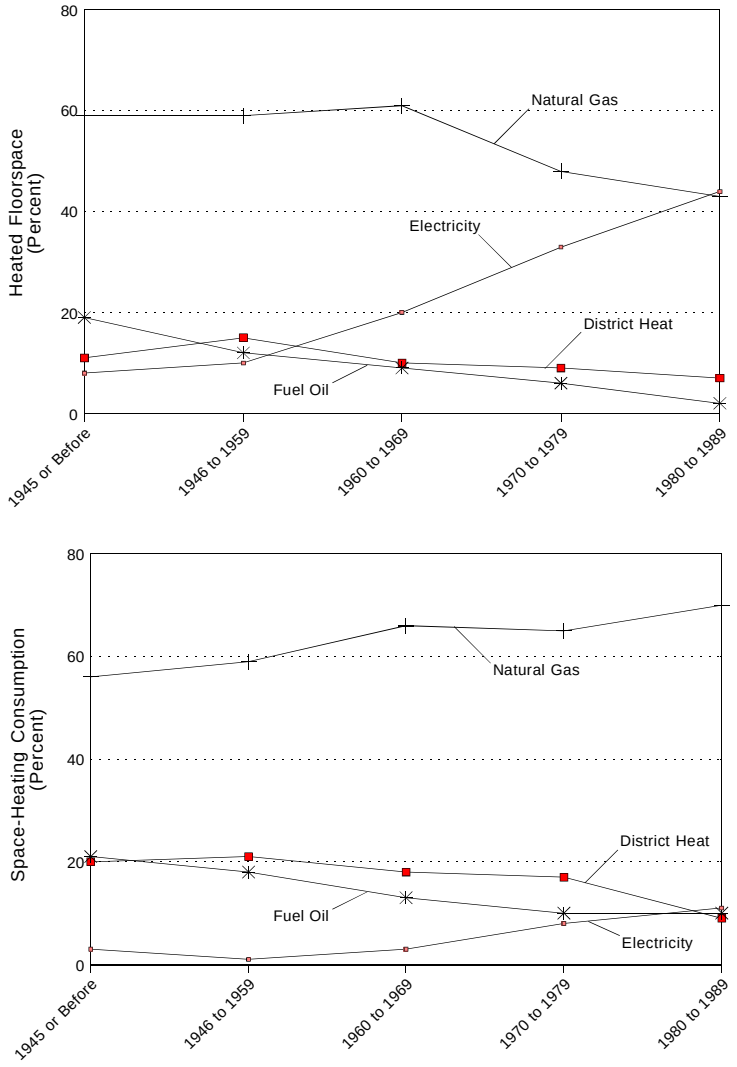
- Figure 10 shows that natural gas was the dominant energy source for space heating in commercial buildings in 1989, providing 63 percent of all the energy consumed for space heating.

- District heat and fuel oil lagged far behind at 18 percent and 15 percent, respectively, with electricity trailing at 5 percent.

- Buildings using natural gas as the main space-heating fuel consumed 1.2 quadrillion Btu for space heating, 21 percent of all energy delivered to commercial buildings in 1989.

- Electricity, like fuel oil, was widely used both for main space heating and for secondary (supplemental or backup) space heating. In 1989, 75 trillion Btu of electricity were used for main space heating, while the rest (21 trillion Btu) was used for secondary space heating.

Figure 11. Percent of Heated Floorspace Served by Each Main Space-Heating Energy Source and Percent of Space-Heating Consumption, by Year Constructed, 1989



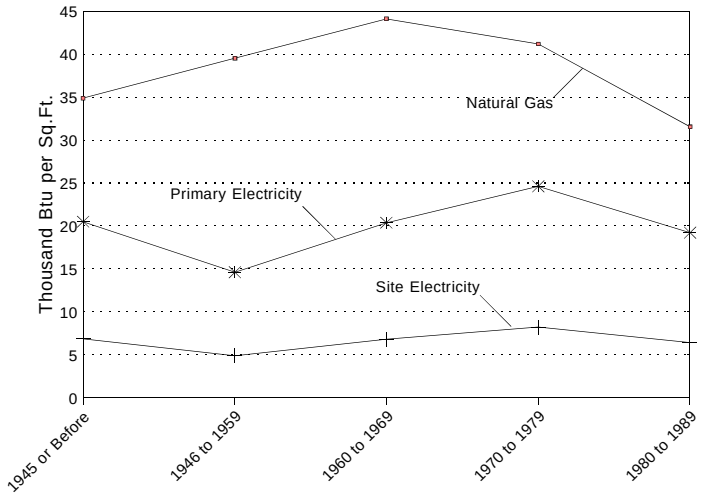
Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- Figure 11 shows that natural gas provided a much higher percentage than electricity of the space-heating energy used in buildings constructed during the 1980's, even though the amount of floorspace heated by the two energy sources was roughly equal.

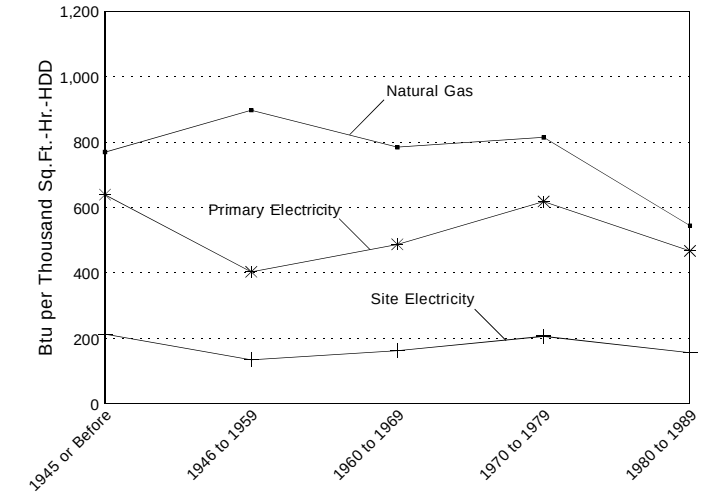
- The bulk of new construction during the 1980's occurred in warmer climates. In warmer climates, where space-heating demands were relatively lower, electricity tended to be the main heating energy source. Natural gas continued to be used in climates with higher space-heating demands.

Figure 12. Comparison of Main Space-Heating Intensities for Natural Gas and Electricity, by Year Constructed, 1989

a. Intensity per Square Foot



b. Intensity per Square Foot-Operating Hour-HDD



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.

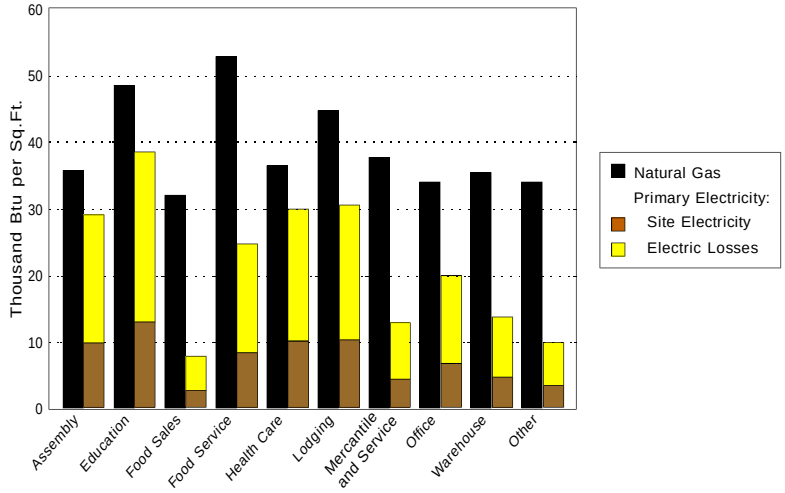
- Figure 12 shows that no matter which measurement is used--energy consumption per square foot or energy consumption per square foot-operating hour-HDD--natural gas space-heating intensities were higher than site electricity intensities.

- Even after converting site electricity to primary energy, the electricity space-heating intensities would still be lower than those for natural gas. However, the gap between primary electricity and natural gas space-heating intensities was narrower in newer buildings, especially when differences in weather (HDD's) and operating hours are taken into account.

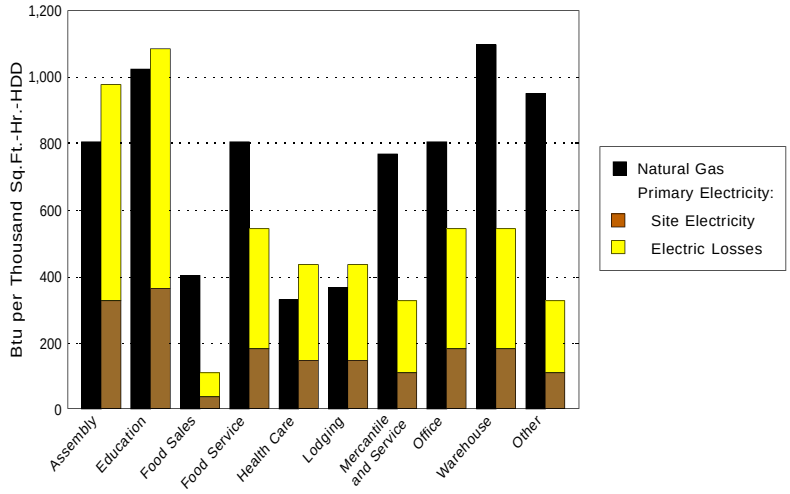
- Possible explanations for the lower electricity intensities include the relatively higher prices of electricity (which may encourage more conservation measures, such as insulation) and the relatively younger age of electric space-heating equipment.

Figure 13. Comparison of Main Space-Heating Intensities for Natural Gas and Electricity, by Principal Building Activity, 1989

a. Intensity per Square Foot



b. Intensity per Square Foot-Operating Hour-HDD



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.

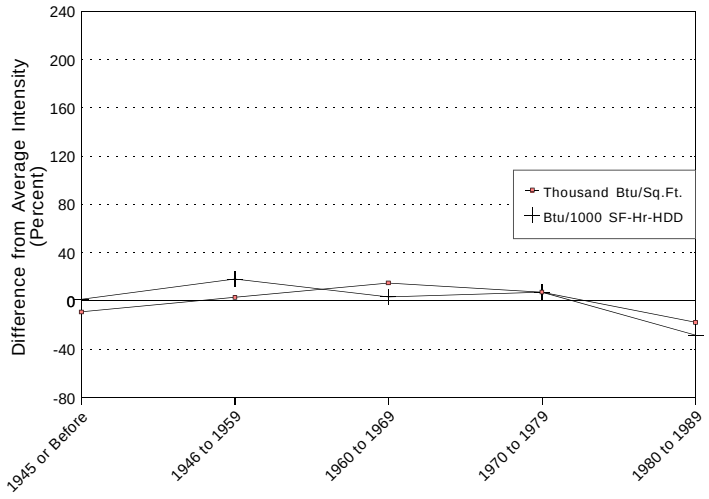
- Figure 13 shows that natural gas space-heating intensities were higher than site electricity space-heating intensities in all types of buildings. However, electricity intensities were somewhat higher than natural gas intensities for assembly, education, health care, and lodging buildings when electric losses were included.

- Education and food service buildings had relatively high natural gas space-heating intensities, either per square foot or per heated square foot-hour-HDD.

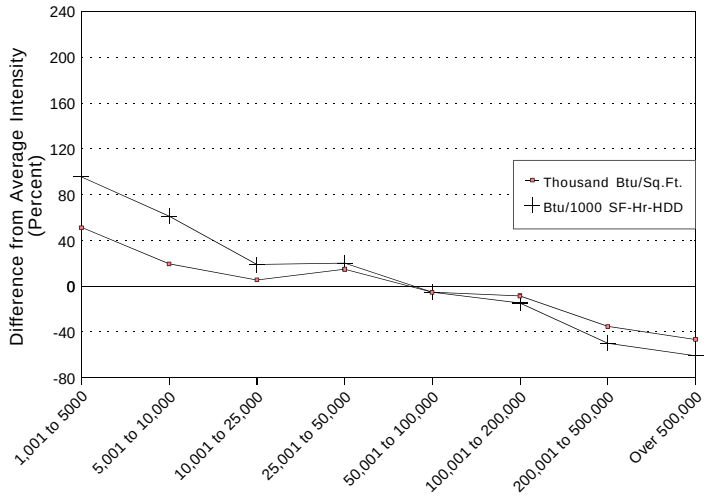
- Natural gas intensities per square foot were about the same in health care buildings as in warehouses. However, health care buildings had the lowest intensities per heated square foot-hour-HDD, while warehouses had the highest. Warehouses consume energy more intensively to meet a much smaller demand (particularly in terms of operating hours and proportion of floorspace heated) than do health care buildings.

Figure 14. Heating Intensities in Buildings Where Natural Gas Was Main Heating Fuel, by Year Constructed and by Floorspace, 1989

a. Year Constructed



b. Floorspace



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.

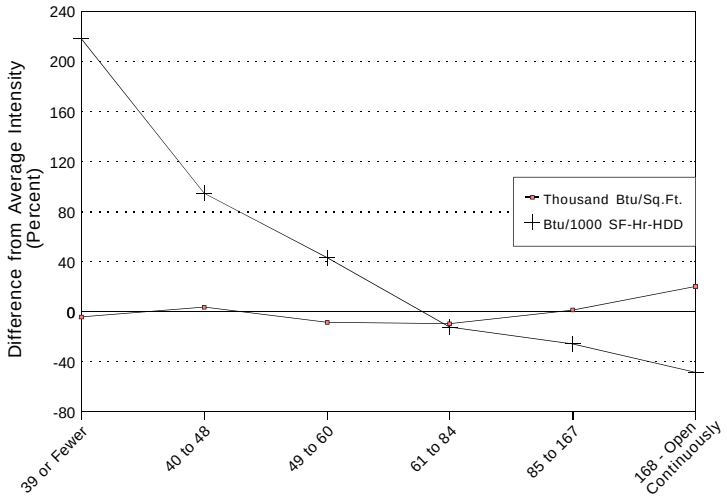
- Figure 14 shows that buildings constructed in the 1960's, when energy was plentiful and cheap, continued to have high natural gas heating intensities in 1989.

- In buildings constructed after the energy crisis of the early 1970's, heating intensities fell steadily until the mid-1980's.

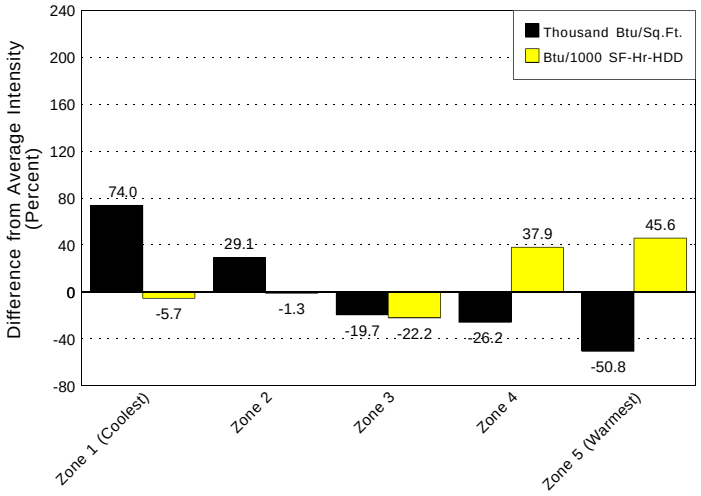
- The larger a building's floorspace, the lower was its heating intensity. This phenomenon is probably due to the fact that since the ratio of exterior surface to total floorspace was smaller in larger buildings, building interiors required less heating to maintain a comfortable temperature.

Figure 15. Heating Intensities in Buildings Where Natural Gas Was Main Heating Fuel, by Weekly Operating Hours and by Climate Zone, 1989

a. Weekly Operating Hours



b. Climate Zone



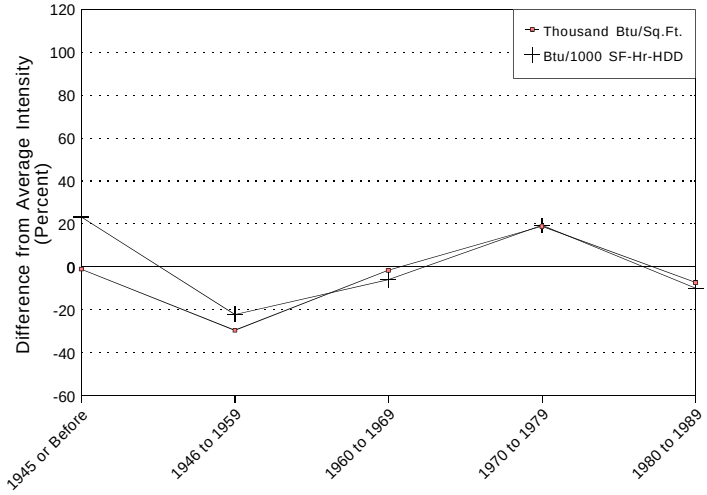
Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- Figure 15 shows that the fewer the number of operating hours, the higher the space-heating intensity (square foot-hour-HDD). This could indicate that heating systems in buildings with shorter weekly schedules tended to operate during off-hours.

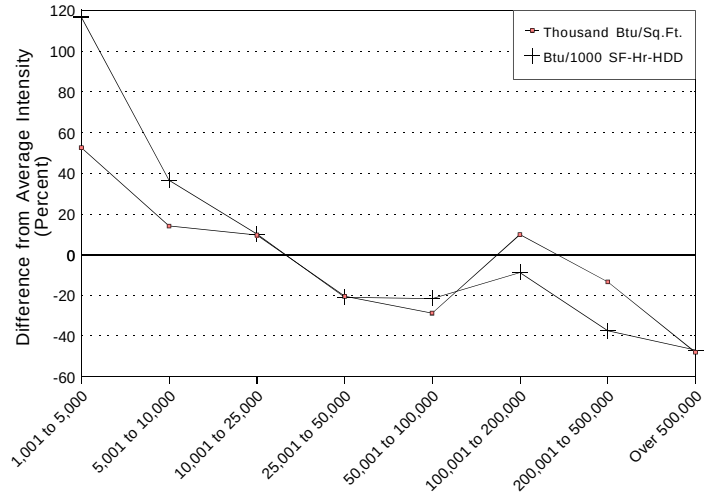
- Heating intensity per square foot declined from the coolest to the warmest climate zone. However, intensity per square foot-HDD was relatively constant in the coolest three zones and increased in the warmest two zones, where heating demand was lowest. Buildings in warmer areas consumed relatively more energy in cooler weather than did buildings in colder climates, due either to differences in equipment efficiencies or to differences in the occupants' demands for space heating.

Figure 16. Heating Intensities in Buildings Where Electricity Was Main Heating Fuel, by Year Constructed and by Floorspace, 1989

a. Year Constructed



b. Floorspace

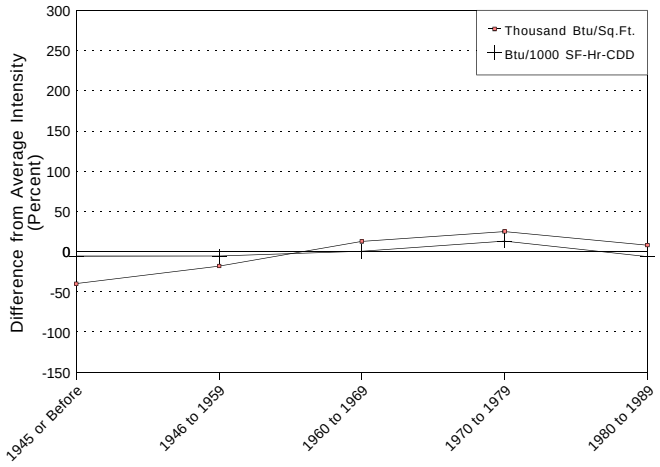


Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

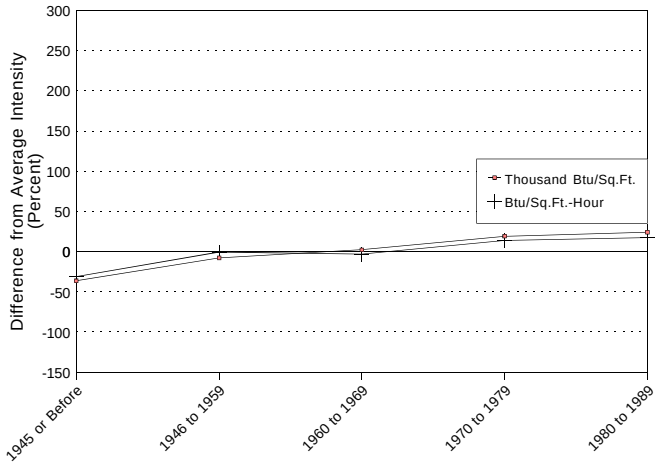
- Figure 16 shows that electricity heating intensities were highest for buildings constructed during the 1970's.
- Electricity heating intensities declined sharply for building constructed during the 1980's.
- As was the case for natural gas, electricity heating intensities declined as building size increased.

Figure 17. Electric Cooling and Ventilation Intensities, by Year Constructed, 1989

a. Cooling



b. Ventilation

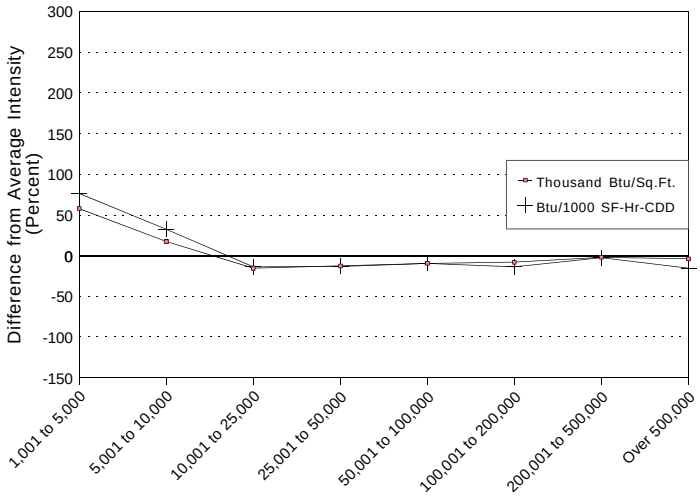


Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

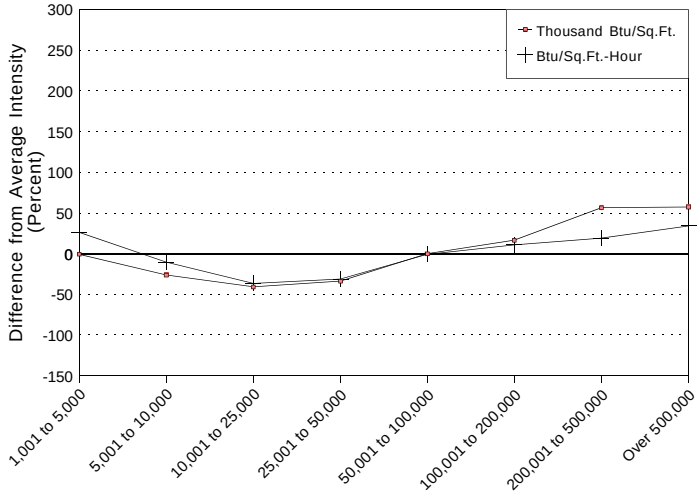
- Cooling intensities are defined as the ratio of energy used for cooling to the product of the cooled square footage, the annual building operating hours, and the average daily CDD's.
- Figure 17 shows that the oldest buildings had the lowest cooling intensities.
- Cooling intensities increased to a peak for buildings constructed in the 1970's.
- Ventilation intensities are defined as the ratio of energy used for ventilation to the product of the square footage and the annual building operating hours.
- The oldest buildings had the lowest ventilation intensities.
- Buildings constructed during the 1980's had the highest ventilation intensities.

Figure 18. Electric Cooling and Ventilation Intensities, by Floorspace, 1989

a. Cooling



b. Ventilation



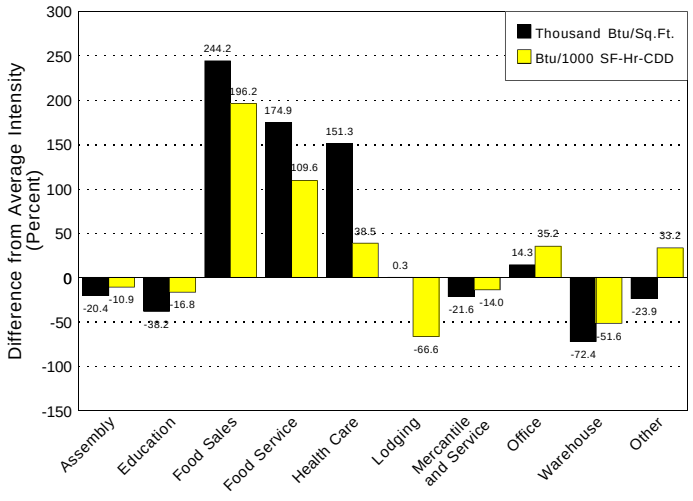
Sources: Energy Information Administration, Office of Energy Markets and End Use, Forms EIA-871A through F of the 1989 Commercial Buildings Energy Consumption Survey and statistically adjusted engineering end-use estimates.

- Figure 18 shows that cooling intensities, like space-heating intensities, were higher for the smallest buildings. As with space heating, the larger buildings had proportionately less exposed exterior surface area, relative to their total floorspace.

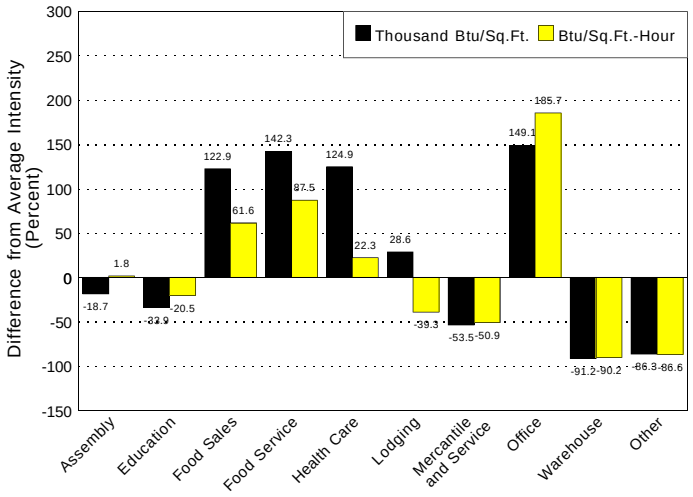
- Ventilation intensities were high for the smallest buildings (as was true for heating and cooling intensities), but were the highest for the larger buildings. More ventilation was required in larger buildings, particularly in buildings such as offices and hospitals.

Figure 19. Electric Cooling and Ventilation Intensities, by Principal Building Activity, 1989

a. Cooling



b. Ventilation



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.

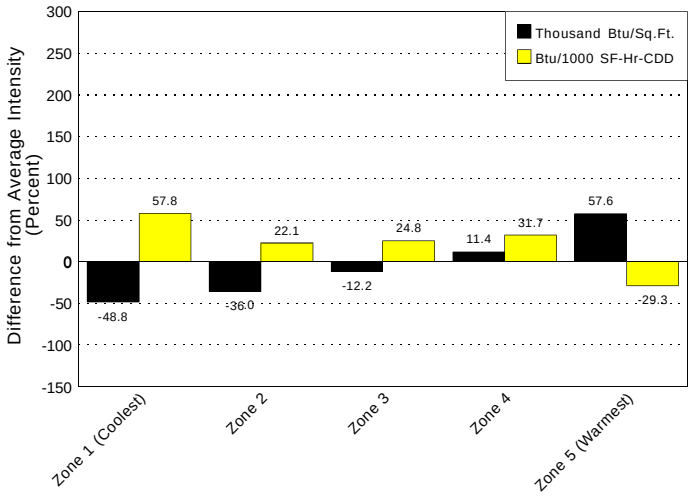
- Figure 19 shows that cooling intensities in food sales, food service, and health care buildings were relatively high.

- High ventilation intensities were associated with high cooling intensities in food sales, food service, and health care buildings.

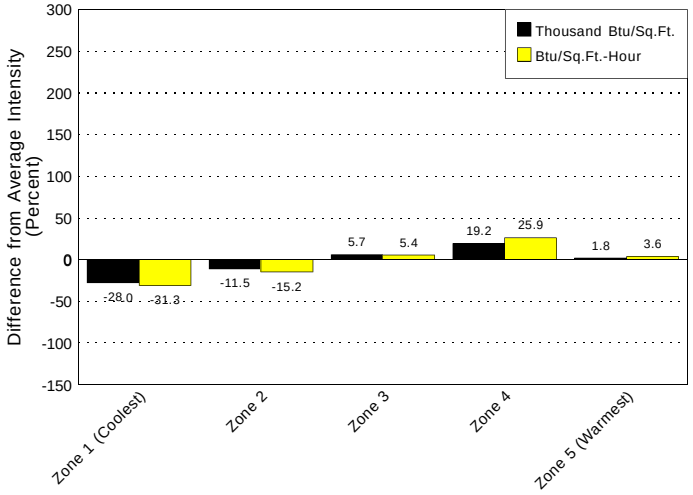
- The highest ventilation intensities were found among office buildings, which included a substantial number of larger buildings and had the highest occupant densities (workers per thousand square feet).

Figure 20. Electric Cooling and Ventilation Intensities, by Climate Zone, 1989

a. Cooling



b. Ventilation



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 20 shows that cooling intensities per square foot increased from the coolest to the warmest climate. However, intensities per square foot-hour-CDD were the lowest in the warmest climate zone, where the cooling demand was greatest. Buildings in cooler areas consumed relatively more energy for cooling in warmer weather than did buildings in warmer climates, due either to differences in equipment efficiencies or to differences in the occupants' demands for cooling.

- Ventilation intensities were lowest in the coolest climate zone. However, climate zone was not as important for ventilation intensity as it was for cooling intensity.