Future Energy: Opportunities and Challenges

Part III. Energy Demand

Chapter 16. Commercial Energy Use

Future Energy:
Opportunities and Challenges

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16
Commercial Energy Use

The Main Points

- **Slightly over one-sixth of the energy produced in America is used by commercial buildings.**
- **Over 75 percent of the primary energy produced to serve commercial buildings is used to generate and deliver electricity.**
- **Delivered electricity and natural gas collectively supply around 90 percent of delivered energy for commercial buildings.**
- **Building owners and tenants have conflicting interests over energy requirements.**
- **Commercial energy use follows economic conditions.**

16.1 Introduction

Commercial buildings use slightly more than one-sixth of U.S. energy. Commercial buildings and residential buildings together account for the largest share of U.S. energy consumption (around 38 Quads). Commercial sector energy use involves many of the same energy supplies as the residential sector, but the relative contributions of the various energy supplies are different. Furthermore, unlike the residential sector, the commercial sector encompasses many different types of enterprise, each with its own energy use pattern.

The commercial sector, as defined by the U.S. Department of Energy, includes all buildings that are not used for residential or industrial purposes. Even though the designation is “Commercial Buildings,” it includes buildings used for non-commercial purposes such as government buildings, schools, and churches.

The Energy Information Administration reports detailed information about commercial energy use[1]. The Energy Information Administration’s reporting of energy use in commercial buildings differs from its reporting for other energy sectors due to different data collection procedures. For example, the Commercial Building Energy Consumption Survey (CBECS)[2] provides the most complete itemization of energy use by different types of commercial buildings, but its accounting covers only about three-fourths of energy consumption in the commercial sector. In spite of this sampling approach, the CBECS is the source of much of the information in other government reports and the information presented in this chapter.

Note: At the time of this writing (early 2012), the future of CBECS faces uncertainties. Publication of the 2007 survey was withheld because of concerns about the statistical significance of the data[3]. In 2011, work on the CBECS was suspended by the Energy Information Administration because of a budget reduction[4], but there is congressional interest for restoring funding[5]. The government will certainly continue to publish energy data for the commercial sector, but these issues may complicate future access to current data by interested readers.

Since the technologies for reducing energy requirements and for producing local energy in residences are largely applicable to commercial buildings and are described in Chapter 15, they are not repeated here.

16.2 Commercial Energy Use

Commercial energy consumption is the smallest among the four energy use sectors. For example, in 2010, the commercial sector used about 18.34 Quads of primary energy, or about 18.8 percent of the total U.S. primary energy consumption of 97.77 Quads[1]. The delivered energy was 8.49 Quads out of a total U.S. delivered energy consumption of 70.46 Quads, or 12 percent.

Figures 16-1 and 16-2 show the sources of delivered energy and primary energy. As with residences, electrical energy is the dominant primary energy used in the commercial sector. Table 16-1 shows the uses of electricity in commercial buildings.

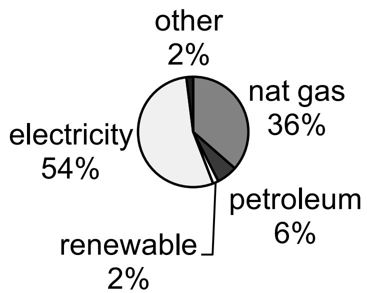

Figure 16-1. Commercial Delivered Energy (2010)

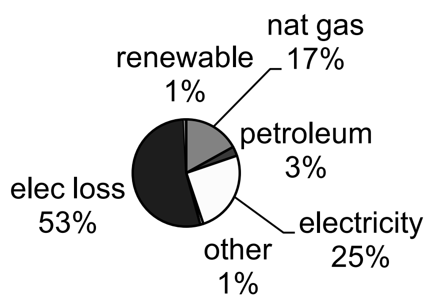

Figure 16-2. Commercial Primary Energy (2010)

Table 16-1. Commercial Electricity Use (2010)[1]

Use	Delivered Energy Quads	Primary Energy Quads
Lighting	1.02	3.20
Space Cooling	0.58	1.82
Space Heating	0.18	0.55
Electronics	0.26	0.82
Ventilation	0.51	1.60
Water Heating	0.09	0.29
Refrigeration	0.39	1.23
Computers	0.21	0.66
Cooking	0.02	0.07
Other	0.65	2.03
Adjustments	0.69	2.15
Total	**4.60**	**14.42**
Note: Adjustments account for discrepancies in the data.		

The uses of commercial energy are as shown in Figure 16-3. Space heating and lighting dominate delivered energy consumption. Space heating is the largest user of delivered energy, and lighting is the largest user of primary energy. Thus, energy-efficient design of heating systems and measures to minimize heat losses is the major focus for reducing delivered energy use, and efficient lighting is the major focus for reducing primary energy use.

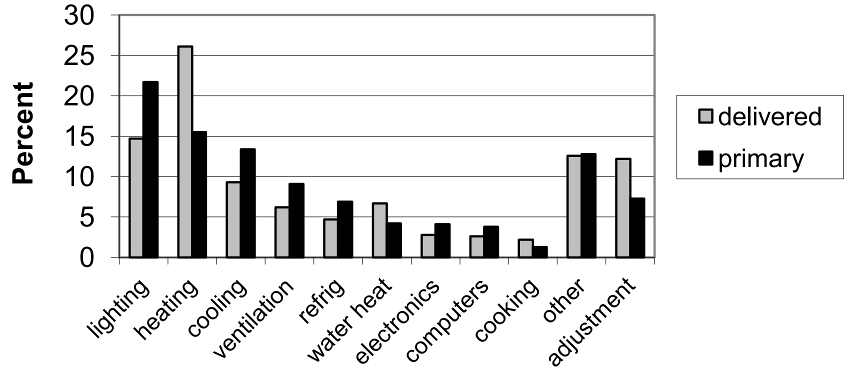

Figure 16-3. Commercial Energy End Uses (2008)

Figure 16-4 shows energy use in the various sub-sectors of the commercial sector. Mercantile and office uses dominate.

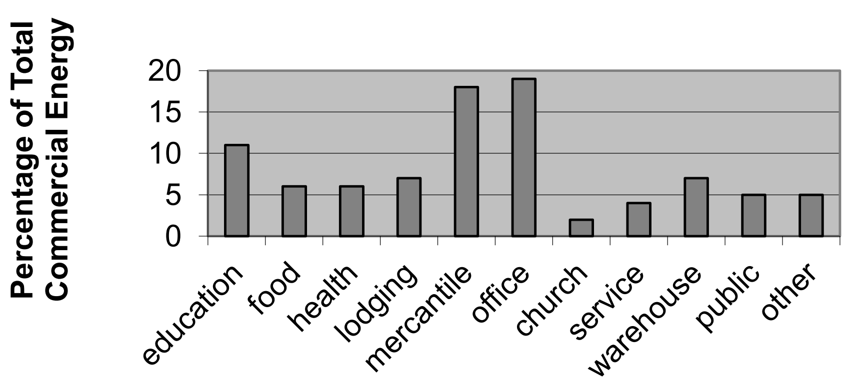

Figure 16-4. Commercial Energy Use by Sector

16.3 Capital Investment Incentives and Barriers

Investments being considered to minimize energy consumption in new or existing commercial buildings are subject to cost-benefit analysis. This analysis may be intuitive and subjective or rigorous and quantitative. In the past, only those involved in building or remodeling large buildings or groups of buildings had the in-house resources and capability to perform a rigorous, quantitative cost-benefit analysis. However, new software to aid in investment decisions is free, easy to use, and readily available[6].

The stakeholders who may be involved in investment cost-benefit analysis and/or decisions are investors, builders, architects, engineers, and occupants.

Investment decisions depend on some or all of the following considerations:

- Incentives and regulations
- Interest rates on borrowed money
- Payback time for return on investment

Federal and state governments provide incentives for undertaking measures that are in the common good. Tax credits, tax deductions, and subsidies may be provided by governments to encourage business investments that reduce energy use, resource depletion, the trade deficit, and environmental degradation. In addition, governments sometimes include domestic job creation as part of the rationale for investment incentives.

The incentives offered by governments change often. This is especially true when the dominant political party changes and when a consensus develops among the citizens that change is necessary.

Governments also influence building energy use by regulations. In the past, building codes served to ensure that buildings were safe, harmonious with other local construction, and durable enough to protect the new owners when the building changes owners. More recently, codes are being strengthened to ensure that buildings also minimize energy use.

There is no summary of incentives and regulations presented here. They are constantly changing, and they differ greatly from state to state. Those planning to construct or remodel commercial buildings are advised to check the latest information (such as is available in Reference 7) or to hire a qualified consultant. The government and various energy efficiency advocacy groups provide web sites with useful, free information. A web search for "codes and regulations for building energy" readily identifies these web sites.

Widespread adoption of energy-saving measures also faces barriers that inhibit implementation. Some of the more important barriers are as follows:

- Separation of building owner from energy expenditures. Often an investor builds a building for rent or lease to a tenant who will be responsible for energy expenditures. The owner is motivated to minimize initial cost, even if this action will result in higher ongoing energy consumption. The tenant often has little control over the design of the building and the consequent energy consumption required for the building.

- Ignorance. Failure to know what is possible, and how much energy-saving measures will cost, can inhibit the making of wise long-term decisions. The ease with which useful information is now available should reduce this problem.

- Apathy. It is tempting to do things in old, familiar ways. Implementing improved measures usually requires learning and decision-making.

- Shortsightedness. It is sometimes difficult to take the long view, especially in times of major political and economic uncertainty.

16.4 Reducing Commercial Energy Consumption

Energy conservation and efficiency measures for commercial buildings are basically the same as for residential buildings and industrial facilities. The idea is to reduce energy losses in the building itself and to use energy-efficient equipment. However, there are some different considerations for commercial buildings.

There is less opportunity for optimizing commercial building orientation to achieve solar heating than for residences. Also, window placement to influence energy transfer into or out of a building is often impossible in commercial buildings. Nevertheless, several energy-reducing measures are uniquely suitable for commercial buildings.

Many commercial buildings have large unshaded roof areas that are well suited for solar energy collectors for heating building air or water or for producing photoelectricity. Skylights, possibly with retractable shades, can augment building lighting. Geothermal heat pumps may be more cost-effective for commercial buildings than for residences, because the necessary excavation and subsurface installation of components is facilitated by the presence of heavy earth-moving equipment typically found at construction sites for commercial buildings.

16.5 Trends

In the early years of the twenty-first century, there are three dominant trends in commercial energy use:

- Energy intensity, as measured by energy used per square foot of commercial floor space, is decreasing.
- Total commercial energy consumption grew slowly until the economic downturn that began in 2008. Increased floor space offset decreases in energy intensity.
- Electrical energy continues to dominate commercial consumption.

16.6 Possibilities

As with residential buildings, one must ask about possibilities for energy saving measures in commercial buildings.

Efforts are under way to develop and implement zero energy building technology for the commercial sector. The Department of Energy, through its Building Technologies program[8], has set a goal for commercial building energy use. The target is to have cost-effective zero energy commercial building technology available by 2025. As with residential buildings, a commercial building can achieve zero energy status by reducing energy consumption to some low point and then producing the balance of needed energy locally with renewable (most often solar) energy systems.

Leadership in Energy and Environmental Design (LEED)[9,10] certification, mentioned in Chapter 15, applies to commercial buildings as well as to residences. Certification indicates the building meets criteria for minimizing energy use and environmental impact. LEED certification is available in many countries and has been applied to over 5 billion square feet of commercial building space.

Several important studies[11,12,13] provide estimates of the potential energy savings in commercial buildings. The U.S. has over 70 billion square feet of commercial building space,[8] and the average delivered energy use is around 110 BTU per square foot per year. The National Renewable Energy Laboratory[11]estimates energy reductions achievable with the application of several different levels of energy-saving measures. The estimate for bringing all commercial buildings into compliance with existing codes is a reduction in energy use to around 79 percent of current use. Application of all available current technologies would reduce energy use to around 45 percent of current use. The estimated additional benefit possible with the use of rooftop photovoltaic systems is a reduction to 13.6 percent of current energy use. These impressive improvements are only estimates, but they provide a feel for what is possible.

16.7 Commentary

Reducing energy use in buildings is a major opportunity and a major challenge. Buildings (residential plus commercial) account for the largest share of U.S. energy consumption, and reductions in use are technically feasible. But there is inherent inertia. Buildings last for decades. Owners will be reluctant to invest in improvements in existing buildings so long as the buildings continue to serve their purpose, and improvements fail to provide quick paybacks on investments. Development of cost-effective energy-reducing technologies for new buildings is predicted for the near future. Such a revolution in building technology will gradually reduce energy consumption as new buildings replace older buildings.

The bottom line is that optimism is justified, but improvements will be slow.

References

1. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Buildings Energy Data Book" at http://buildingsdatabook.eren.doe.gov.

2. Energy Information Administration "Commercial Building Energy Consumption Survey" at http://www.eia.doe.gov/emeu/cbecs.

3. Energy Information Administration press release "2007 Commercial Buildings Energy Consumption Survey (CBECS) will not be released at http://www.srmnetwork.com/wp-content/EIA_CBECS_2007_Release_05-06-11.pdf.

4. Energy Information Administration press release "Immediate Reductions in EIA's Energy Data and Analysis Programs Necessitated by 2011 Funding Cut" at http://eia.gov/pressroom/releases/press362.cfm.

5. Howard, B. U.S. Green Building Council report "Senate Panel Signals Support for Commercial Building Energy Consumption Survey" at http://livabilitylaw/archives/2817.

6. "Quick List of ENERGY STAR Resources for Buildings" at http://ww.energystar.gov/ia/business/challenge/get_started/QuickListBusiness.pdf - 2010-06-02.

7. "Database of State Incentives for Renewable Energy" at http://www.mrsolar.com/content/dsire.php.

8. Crawley, D. *Statement before the Subcommittee on Economic Development, Public Buildings and Emergency Management*, Committee on Transportation and Infrastructure, U.S. House of Representatives, July 16, 2009. at http://republicans.transportation.house.gov/Media/file/TestimonyEDPB/2009-07-16-Crawley.pdf.

9. U.S. Green Building Council "LEED" at http://www.usgbc.org/LEED.

10. Wikipedia "Leadership in Energy and Environmental Design" at http://en.wikipedia.org/wiki/Leadership_in_Energy_and_Environmental_Design.

11. Griffith, B. et al, "Assessment of the Technical Potential for Achieving Net Zero-Energy Buildings in the Commercial Sector" *National Renewable Energy Laboratory Report NREL/TP-550-41957* December 2007.

12. American Physical Society report "Energy Future" at http://www.aps.org/energyefficiencyreport/report/index.cfm.

13. Grenade, H.C., et al. "Unlocking Energy Efficiency for the U.S. Economy" McKinsey and Company Report July 2009 at http://www.mckinsey.com/Client_Service/Electric_Power_and_Natural_Gas/Latest_thinking/Unlocking_energy_efficiency_in_the_US_economy.

Exercises

16-1. Discuss the relative possibilities for on-site energy production in residential buildings and commercial buildings.

16-2. Discuss similarities and differences between residential energy consumption and commercial energy consumption.

16-3. A local discount store has a roof surface area of 40,000 square feet. If the average annual solar radiation absorption rate is 1300 BTU/hour-square foot, how much electric power can be generated with rooftop photovoltaic systems with a conversion efficiency of 20 percent? How much is this electricity worth in a location where electricity costs 11 cents per kilowatt-hour?

16-4. As this book was being written, the U.S. and the world were experiencing a serious economic recession. Use the Internet to find out what has happened to commercial energy use in recent years. Discuss and interpret your findings.