U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Energy Efficiency Trends in Residential and Commercial Buildings

August 2010

McGraw_Hill CONSTRUCTION

Prepared by McGraw-Hill Construction for the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy

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Notes and definitions:

- Commercial buildings are defined as buildings with more than 50% of floorspace used for commercial or industrial activities, including (but not limited to) stores, offices, schools, churches, libraries, museums, stadiums, hospitals, clinics and warehouses.
- As defined by the U.S. Department of Energy's Energy Information Administration (EIA), commercial energy use is mostly, but not exclusively, attributed to commercial buildings. EIA commercial data also include sewage treatment, irrigation pumping, highway lighting and certain industrial facilities.
- Data from public sources available to evaluate residential energy performance are more robust than those available to evaluate commercial energy performance. That disparity may be evident in sections of this report.
- All the market opinion data in chapter four are pulled from the McGraw-Hill Construction research database and do not reflect the opinion of the U.S. Department of Energy or Pacific Northwest National Laboratory, nor does analysis incorporated into the narrative.

Introduction

The building industry is critical to the U.S. economy and to people's lives. Today, construction of commercial and residential buildings contributes approximately 6.5% to U.S. Gross Domestic Product (GDP), second only to healthcare, and it generates jobs for designers, engineers, contractors, home builders and tradespeople as well as jobs at firms that manufacture, develop, assemble and deliver products and services to the creation of those buildings.

Over time, buildings have changed to meet the needs of society, including changes in design and construction strategies, materials and product development and needed skill sets. For example, skyscrapers emerged on the landscape a century ago, and those supertall buildings have only gotten bigger and more pervasive over the last fifteen years (see page 9). The advent of these types of buildings enabled growth with a contained footprint and denser urban populations.

Homes have changed as well—with home sizes linearly increasing to where the average size home of 2,200 square feet in 2008 is 1.3 times larger than homes in the 1980s.

Today, there is more attention on the role of buildings in U.S. energy consumption, with attention on the energy, carbon and environmental footprint of commercial and residential buildings. However, firms and homeowners are also facing the realities of the economic recession. Driven by the need to maximize economic resources, such as time and budget, they are looking for ways to also reduce expenses in the long-run. At the same time, there is a growing acknowledgement of the need to conserve natural resources—such as clean air, water, energy and land. Transformative technologies and innovative practices are one of the key aspects of helping the U.S. adapt to these changing needs.

Report Overview

This report overviews trends in the construction industry, including profiles of buildings and the resulting impacts on energy consumption. It begins with an executive summary of the key findings found in the body of the report, so some of the data and charts are replicated in this section. Its intent is to provide in a concise place key data points and conclusions.

The remainder of the report provides a specific profile of the construction industry and patterns of energy use followed by sections providing product and market insights and information on policy efforts, such as taxes and regulations, which are intended to influence building energy use. Information on voluntary programs is also offered.

Report Data

This report is built off a 2008 version covering similar trends. Much of the data presented is pulled from proprietary resources and based solely around data that can be tracked and measured over time. Therefore, data from government surveys that have been discontinued are not included in this report even if they were contained in the *Energy Efficiency Trends in Residential and Commercial Buildings Report* issued by the U.S. Department of Energy (DOE) in 2008.

Specifically, the buildings start data are pulled from McGraw-Hill Construction's proprietary data sources and are representative of all U.S. commercial buildings. Used by the U.S. Census Bureau to help calculate GDP contribution from construction, this data collection is real-time and not based on surveys. Data presented in chapters 3 and 6 are derived from McGraw-Hill Construction's approximately 60,000 project plans and specifications of current buildings. These specifications only cover the commercial buildings sector, and trends offered reflect that. For comparison, DOE's 2003 Commercial Buildings Energy Consumption Survey (CBECS) is built off a representative sample of 6,380 building cases eligible for survey. The data are based on 5,215 responding building cases (82% response rate). The 2003 survey is the most recent available. For more information, visit http://www.eia.doe.gov/emeu/cbecs/2003sample.html.

While this report was sponsored by the Building Technologies Program within the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy and managed by the Pacific Northwest National Laboratory, it is not a description of DOE's programs nor an attempt to advocate any position related to energy use or industry activity. Its intent is to document apparent trends related to energy efficiency in the U.S. buildings substantiated by data and analysis.

Executive Summary

Impact and Changing Trends in Construction

Construction is critical to the U.S. economy, with residential construction serving as an indicator of changes in economic patterns. In the recent downturn there has been a shift in construction to more emphasis on renovation projects altering existing building space Figure i) as less capital is available for new projects.

Furthermore, only a small percentage of the total building stock is new every year. For example, in 2008, new commercial construction accounted for only 1.8% of total building floor area. Therefore, while attention to efficiency and other green priorities in new building construction is important to impact efficiency gains in long-term building stock, both short-term and long-term efficiency goals require a focus on improving efficiency in existing buildings.

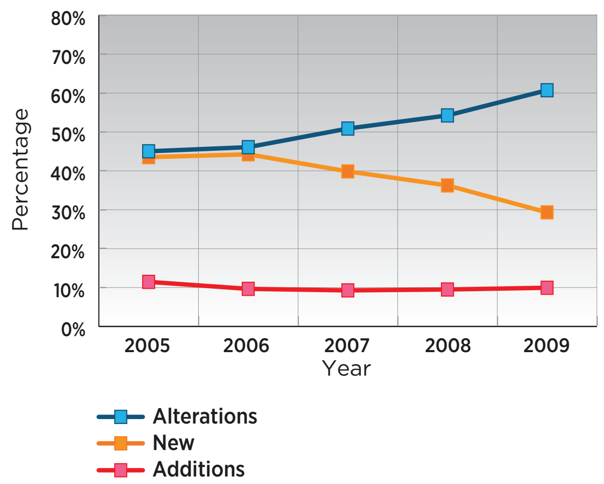
McGraw-Hill Construction market estimates of the share of new and existing building construction that is green shows increases over time. From 2005 to 2008, the share of green new commercial buildings increased from 2% in 2005 to 10% in 2008. For existing building projects, the 2009 share estimated to be green was 8% and energy-efficient, nearly two-thirds.

Energy Use in Buildings

Buildings account for 40% of all energy use in the U.S. In fact, the construction industry consumes more energy than the industrial or transportation sectors. (Figure ii)

The U.S. is responsible for 20% of the world's carbon dioxide emissions, with U.S. buildings' energy use responsible for 8%.

Figure i: Commercial Construction Based on Projects Started



Source: McGraw-Hill Construction, Construction Starts Database, 2005–2009

Market Drivers

Large corporate owners are starting to see the business advantages of investing in green buildings and energy efficiency in their building portfolios. As a result, the influence government policies are having in motivating this sector is decreasing over time.

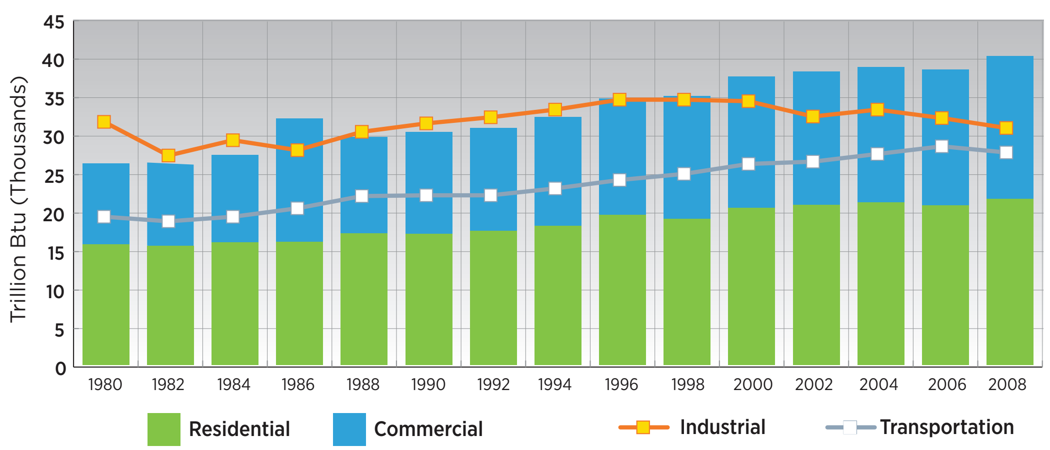
Despite being only one component of a green building, energy efficiency is driving the market that way—both for residential and commercial buildings.

Voluntary Programs and Policies

ENERGY STAR and the LEED Green Building Certification Program by the U.S. Green Building Council are the best known green building programs nationally. There is increasing inclusion of these terms in project plans and specifications.

Policies oriented toward green building have also been increasing. By the end of 2009, 35 states and Washington, DC had instituted green building policies, as did 253 city and local governments—an increase of 66% over 2008.

Figure ii: Growth in Building Energy Use Relative to Other Sectors



Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2009 Buildings Energy Data Book <http://buildingsdatabook.eren.doe.gov/>

Chapter 1
Drivers of Energy Use in Buildings

The services demanded of buildings—for lighting, heating, cooling, water heating, electronic entertainment, computing and cooking—require significant energy use, approximately 40 quadrillion Btus per year,[1] costing the U.S. population over $392 billion in 2006 alone.[2] These same demands lead to the nation's commercial buildings and homes accounting for 40% of all U.S. energy use—more energy than either the transportation or industry sectors—and corresponding to approximately 40% of U.S. carbon dioxide emissions.

The way a building and its systems are constructed helps determine how efficiently the building consumes energy. Therefore, understanding the building design and construction industry and tracking its trends provides insight into strategies for turning U.S. energy consumption patterns around.

Though the recent economic recession has impacted the construction industry, it has not changed the types of buildings being built or the energy needed for those buildings. The biggest impact of the recession may be a stronger awareness and prioritization of the need to improve the performance of the existing building stock as new construction activity slows.

Energy use today is driven by the following factors, explored in this section:

- **Population growth:** An increasing population drives not just housing, but other service needs such as schools, public buildings and retail.
- **Economic changes:** Growth can mean booms in construction, but recession can still encourage changes to the existing built environment.
- **Building size:** In both the commercial and residential sectors in the U.S., the size of those buildings is growing (see Figure 7 on page 9 and Figure 13 on page 12), which will require more energy to heat and cool these larger spaces. The size of buildings can change the efficiency required for systems to reduce their overall energy consumption.
- **Service demands/Plug loads:** With shifts to electronic forms of communication, pervasiveness of computers and home electronics, larger servers for information services and the use of complex new technologies in schools, hospitals and office buildings, the demand for energy services is growing.
- **Efficiency of energy use:** Efficiency gains include more efficient technologies that use electricity, such as appliances, lighting and other building systems, as well as ways of operating and maintaining buildings to achieve maximum efficiency.

Technology advancements that will help buildings be more efficient over time and provide access to new energy sources will allow buildings to shift away from reliance on coal and natural gas. However, there are a number of factors that can improve the efficiency of buildings without significant investment or research, including more widespread use of integrated design practices, energy use reduction strategies targeted to the specific needs in geographic regions, an increase in effective policies at all levels of government, and better operation and maintenance of existing buildings.

[1] Buildings Energy Databook, 2009, Table 1.1.1, U.S. Department of Energy <http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.1.1>.
[2] Buildings Energy Databook, 2009, Table 1.2.3, U.S. Department of Energy <http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=1.2.3>.

All Buildings

Construction Value Over Time—New Building and Renovation

Construction of commercial and residential buildings is the second largest contributor to Gross Domestic Product (GDP), behind only healthcare, suggesting the critical importance of construction on the U.S. economy. In 2005, both commercial and residential buildings contributed 6.5% to GDP and accounted for approximately $800 billion.

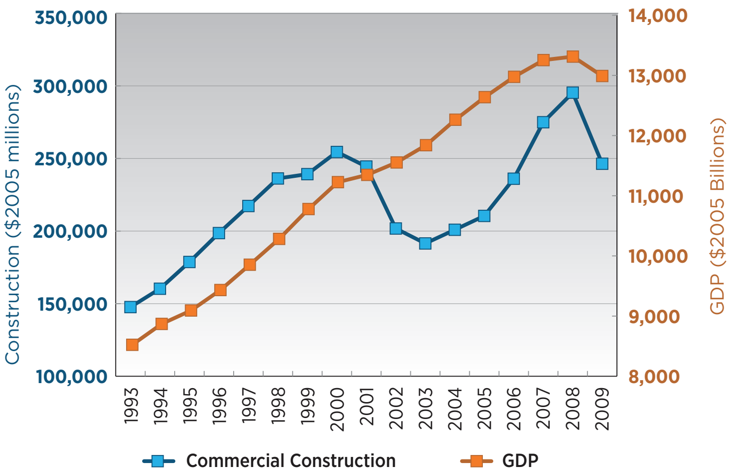
COMMERCIAL CONSTRUCTION

Though there has been a decrease in new commercial construction activity since the economic downturn in 2007, the share of GDP from these buildings has remained strong (Figure 1).

Further, as the economy has slowed, the focus on renovation work has increased. In 2009, the number of major renovation/alteration projects comprised 60.7% of all construction activity occurring in the U.S., an increase in share of 12% from 2008 (from 54.2% of projects in 2008). (Figure 2)

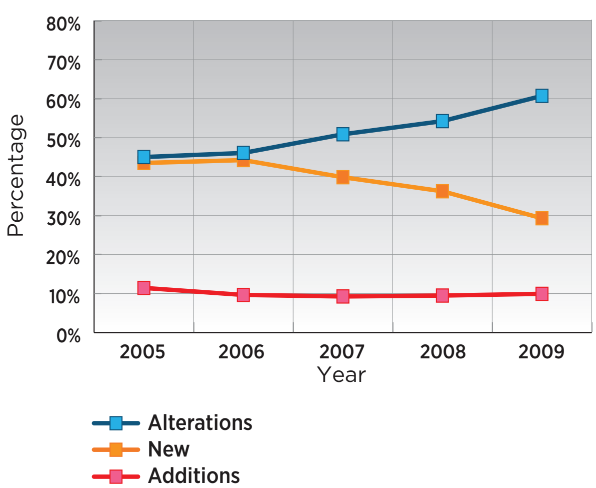
Though renovation work is still lower in value than new projects, the share of activity from renovation/alteration grew to comprise 25.3% of all construction value in 2009, up 28% from 2008. New construction still comprises the highest share of construction by value. However, that share dropped from 65% in 2008 to 58% in 2009. (Figure 3)

Figure 1
Value of Private Commercial Building Construction



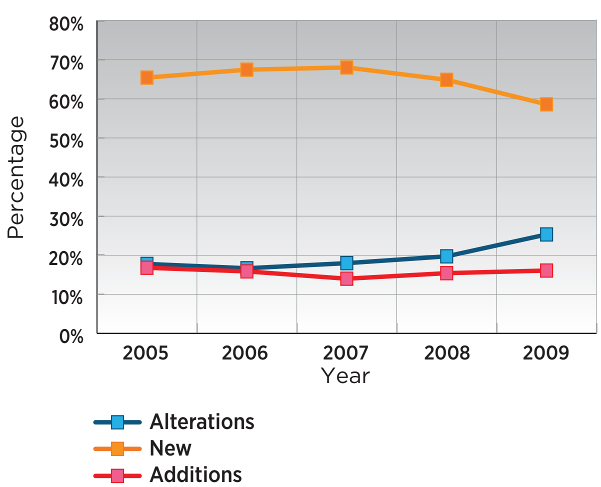
Source: U.S. Department of Commerce, Bureau of the Census, Value of Construction Put in Place, 1993-2009 (Construction Value); U.S. Department of Commerce, Bureau of Economic Analysis http://www.bea.gov/national/index.htm#gdp (GDP). 2005 GDP deflator U.S. Department of Commerce, Bureau of Economic Analysis

Figure 2
Commercial Construction Based on Projects Started



Source: McGraw-Hill Construction, Construction Starts Database, 2005–2009

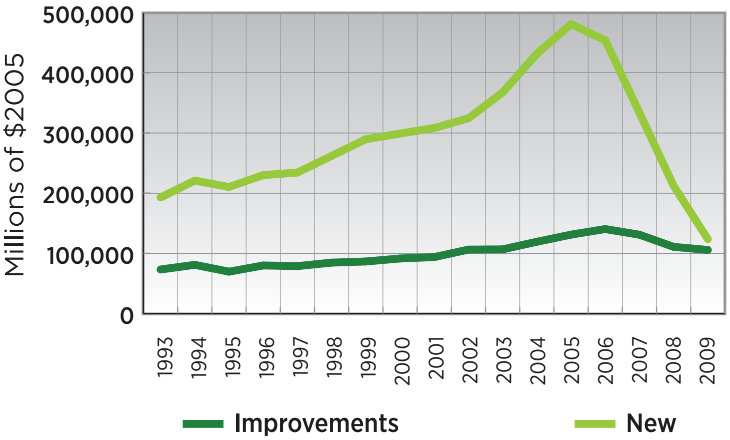
Figure 3
Commercial Construction Based on Value Started



Source: McGraw-Hill Construction, Construction Starts Database, 2005–2009

* Note: Alterations, or renovation projects, are ones that modify existing space but do not add square footage. Additions are projects that add square footage to an existing building but do not modify the existing space.

Figure 4
Residential Construction Value

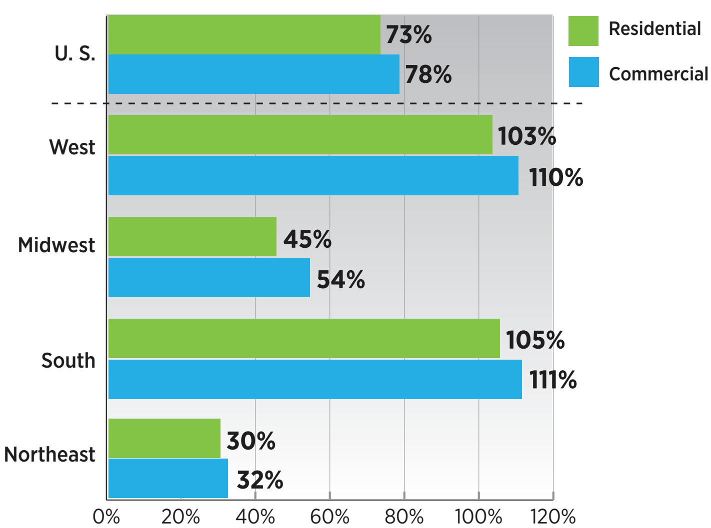


Source: U.S. Department of Commerce, Bureau of the Census, Value of Construction Put in Place, 1993-2009

RESIDENTIAL CONSTRUCTION

The economic downturn caused a severe decline in new home construction, starting in 2007. Home improvement activity also declined 24.7% from its height in 2006, going from $140 million in 2006 to $106 million in 2009. However, even with this decline, home improvement activity is still higher than it was prior to the recession. Home improvements tracked here do not include maintenance or repair work, but they do include efficiency upgrades.

Figure 5
Percent Growth in Square Footage of Building Inventory over 30 Years (1978–2008)



Source: McGraw-Hill Construction, Building Stock Database, 1978-2008

The regions include the following states:

- West: CA, WA, OR, NV, HI, AZ, NM, UT, CO, WY, ID, MT, AK
- Midwest: IL, IN, MI, OH, WI, IA, KS, MN, MO, NE, ND, SD
- South: AL, KY, MS, TN, DC, FL, GA, MD, NC, SC, VA, WV, AR, LA, OK, TX
- Northeast: NJ, NY, PA, CT, ME, MA, NH, RI, VT

Square Footage Growth Over Time by Region

Over the last 30 years, the volume of building area has grown dramatically in the South and West, with the volume of both residential and commercial space more than doubling.

The North Central region saw less than a 50% increase over the same time, while Northeast growth lagged at less than one half the rates of the South and West.

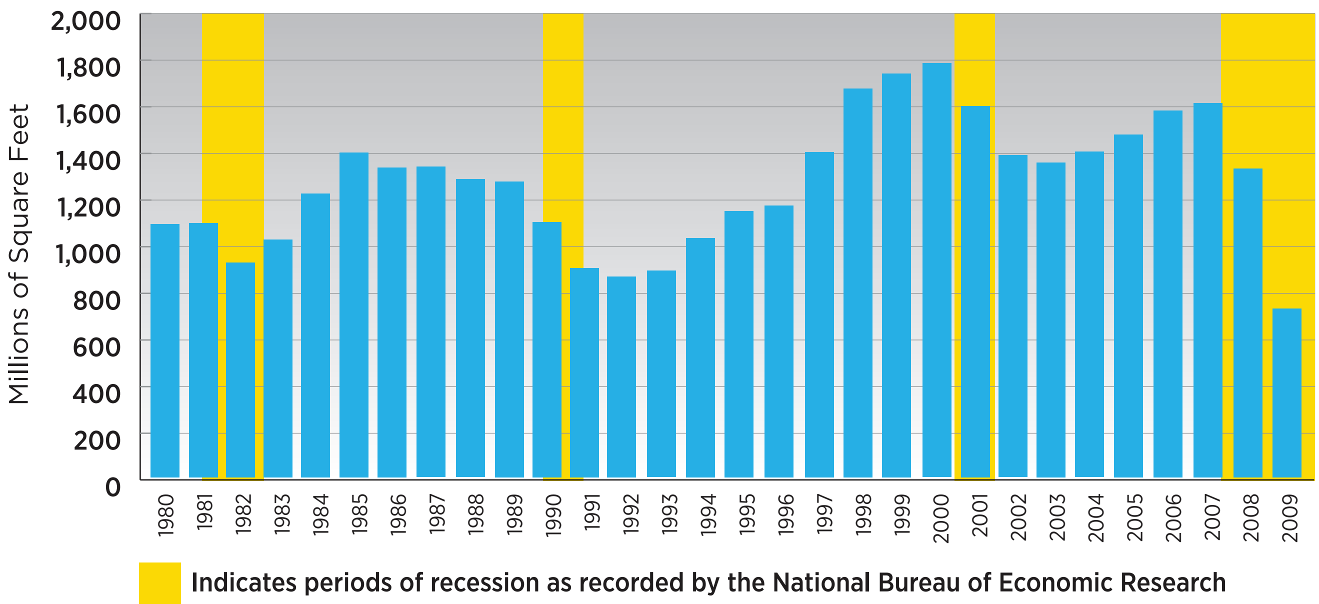
Commercial Building Trends

Commercial Square Footage Over Time

New commercial construction generally cycles slightly behind the overall economy. For both of the brief recessions in the early 1990s and 2000s, construction continued to dip a year or two after the recession ended. This pattern suggests that commercial construction will not recover from the current recession until after the economy improves.

During the boom years of the late 1990s and the mid-2000s, new construction often equalled 1.5 billion square feet or more per year. The current recession continues to depress new commercial construction, with levels falling to less than half of those at peak times. However, even in peak years, the square footage added to overall building stock from new construction was only 2%.[3]

Figure 6
Total Square Footage Started in Commercial Buildings



Source: McGraw-Hill Construction, Construction Starts Database, 1978-2008

[3] Building Stock Database, McGraw-Hill Construction, through 2009.

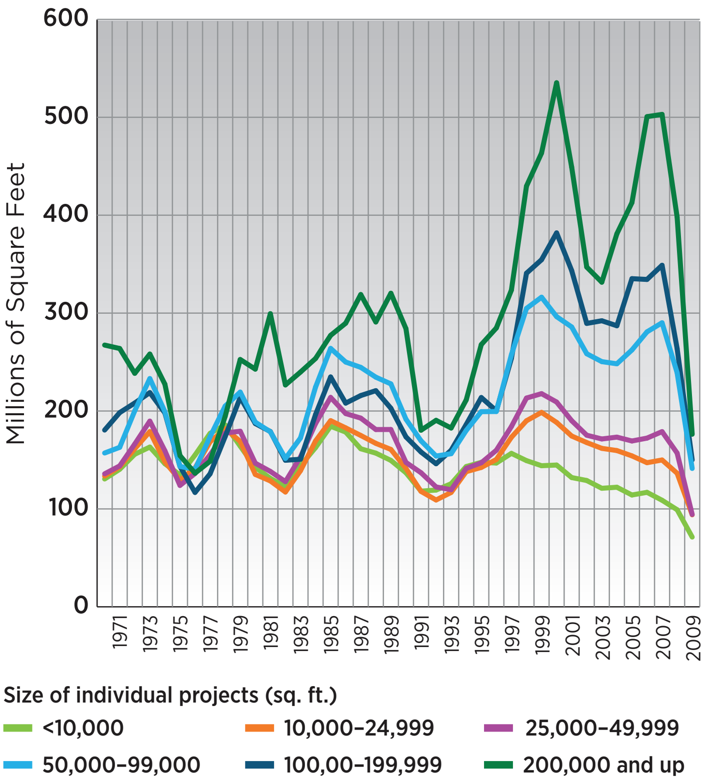
Large Project Growth Over Time

The volume of new commercial construction coming from large projects has grown over time, particularly since the mid-1990s. (Figure 7)

However, the number of these projects has been decreasing over time and is low compared to the number of smaller projects occurring. (Figure 8) This suggests that the buildings in these project size ranges are becoming larger.

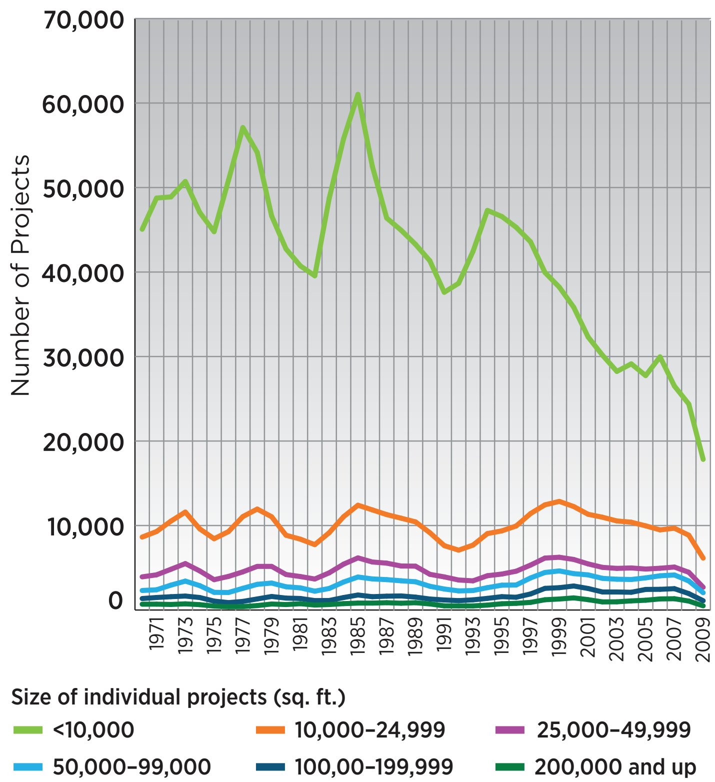
These big projects (over 50,000 square feet) are also seeing more volatile cycles, booming in good times and crashing in bad times, with the largest projects (over 200,000 square feet) seeing the most volatility. (Figure 7)

Figure 7
New Commercial Construction Started by Size of Projects



Source: McGraw-Hill Construction, Construction Starts Database, 1978-2009

Figure 8
New Commercial Construction Started by Number of Projects



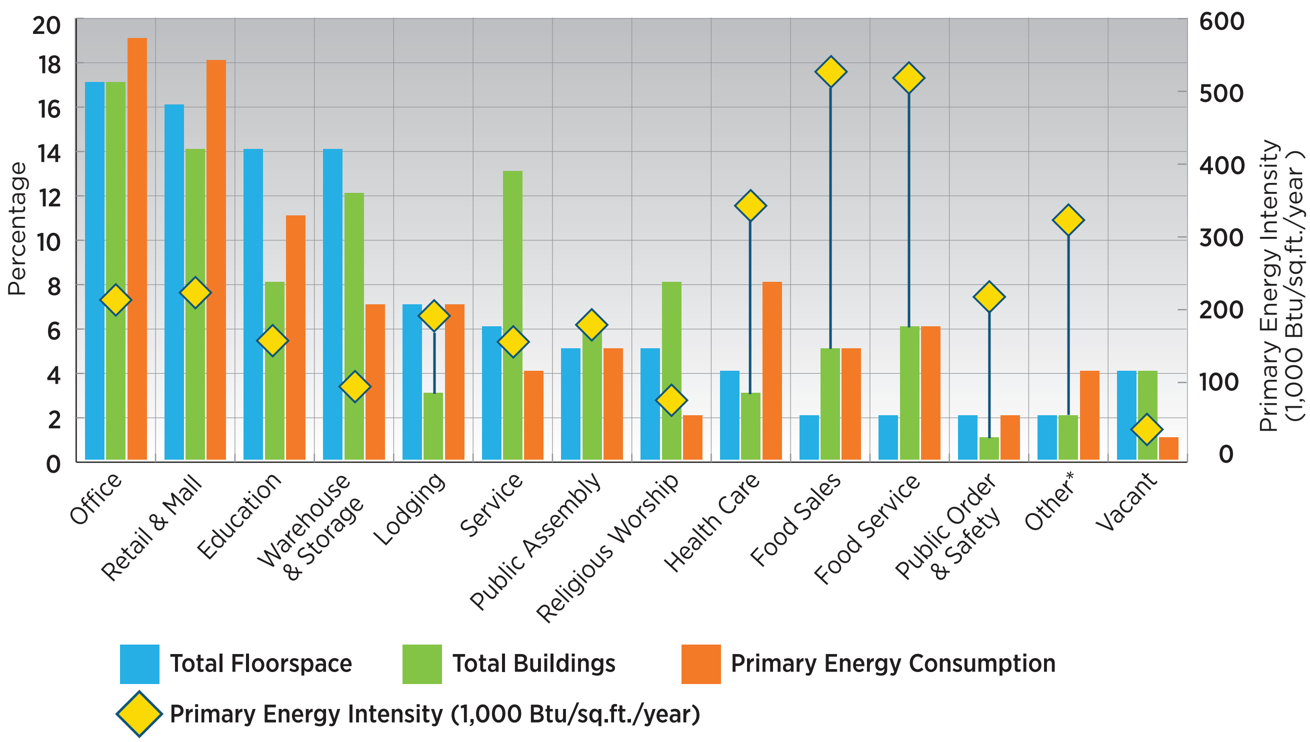
Source: McGraw-Hill Construction, Construction Starts Database, 1978-2009

Commercial Building Composition and Energy Use by Sector

Commercial building types can be characterized by number of buildings, floorspace and energy use. In terms of square footage, the building types with the largest share are office (17%), retail (16%), education (14%) and warehouses (14%). The building types with the largest number of projects are office (17%), retail (14%), service (13%) and warehouses (12%).

For the most part, share of energy use by building type is consistent with the total floor area of the project, with the largest energy users being office (19%), retail (18%) and education (11%). Healthcare buildings are the exception. Comprising the fourth largest share of commercial building primary energy consumption, healthcare buildings, including hospitals, have a much higher primary energy intensity with only 4% of the total commercial floorspace and 3% of the total number of buildings. Food sales, food service and public order buildings all also have high primary energy intensities. By comparison, the buildings with the lowest energy use per square foot are religious worship, lodging and warehouses.

Figure 9
Commercial Building Types and Energy Consumption: Floorspace, Number of Buildings, Primary Energy Consumption and Primary Energy Intensity by Square Foot



Source: 2009 Buildings Energy Data Book, U.S. Department of Energy, October 2009, Table 3.1.10 and Table 3.2.2 <http://buildingsdatabook.eren.doe.gov>.

* Other buildings refer to buildings that are industrial or agricultural with some retail space; buildings having several different commercial activities that, together, comprise 50 percent or more of the floorspace, but whose largest single activity is agricultural, industrial/ manufacturing, or residential; and all other miscellaneous buildings that do not fit into any other category.

Residential Buildings

Housing Units Continue to Increase

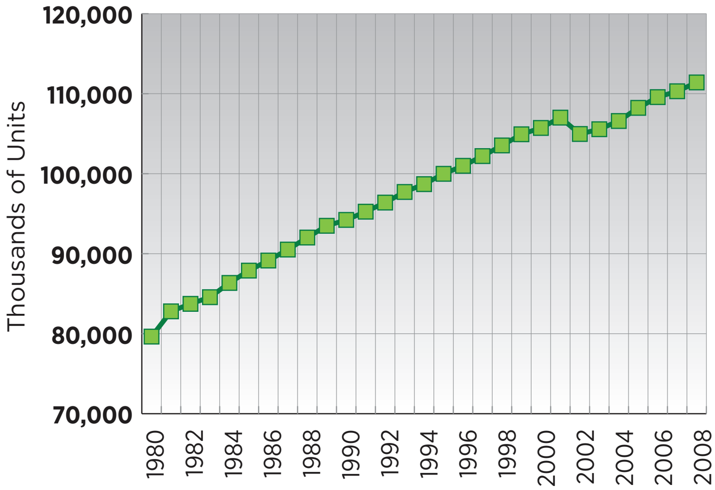
The total number of housing units in the U.S. has steadily grown over the last 30 years. (Figure 10) Based on historical record, an increase in the number of homes has correlated with an increase in energy use, including for heating, cooling and appliances. Figure 14 on page 14 shows that the share of energy used in homes has increased over time. The increase in use of home appliances and electronics, however, could be offset by efficiency gains per unit.

New Housing Starts Over Time

New residential construction has cycled with the overall economy, with a downturn in new activity a precursor of each recession period. (Figure 11) The boom years of the 2000s saw between 1.5 and 2 million new homes annually. Unlike commercial construction, the growth in new home starts corresponds with recovery from recessions. Mortgage interest rate declines may in part account for those immediate recovery rates.

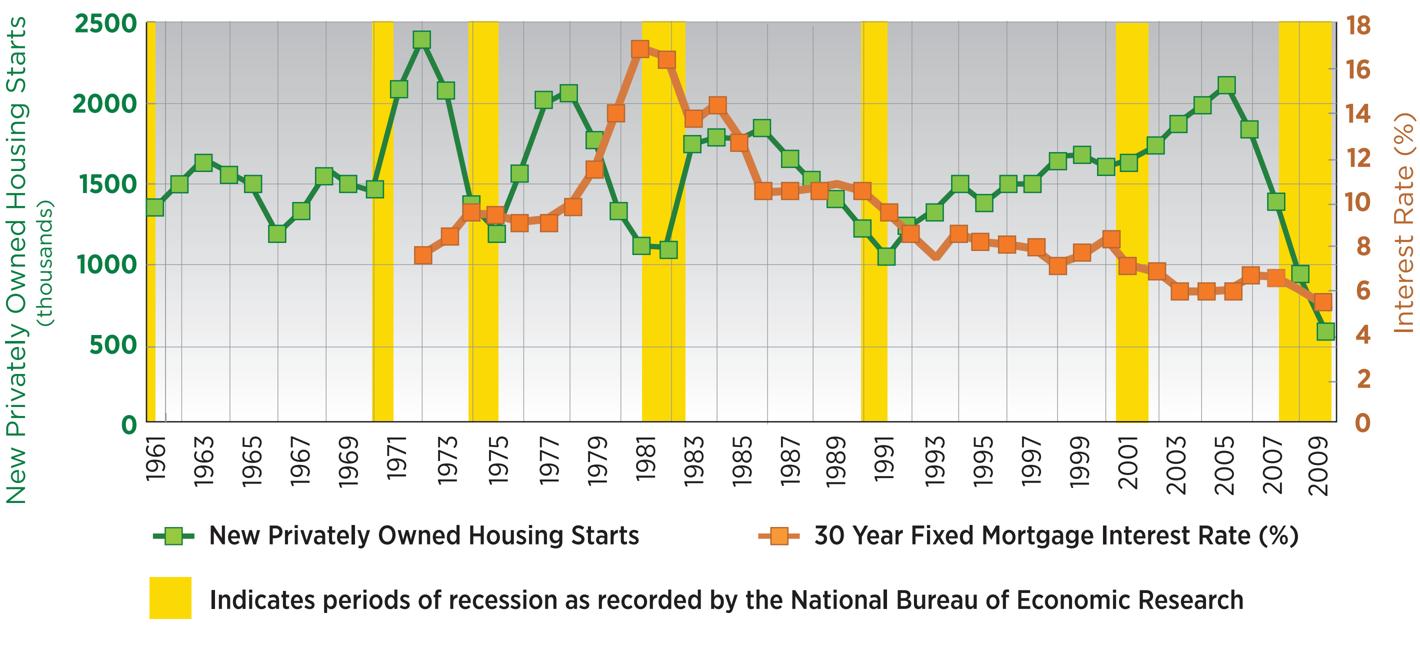
These data points reinforce the traditional perception that the housing market is an indicator of where the economy is headed, with the economic depression of 2008–2009 being accompanied by housing starts at historic lows.

Figure 10
Occupied Housing Units



Source: U.S. Department of Commerce, Bureau of the Census, Housing Vacancy Survey, 1980-2008 <http://www.census.gov/hhes/www/housing/hvs/hvs.html>

Figure 11
Cyclicality in Housing Starts

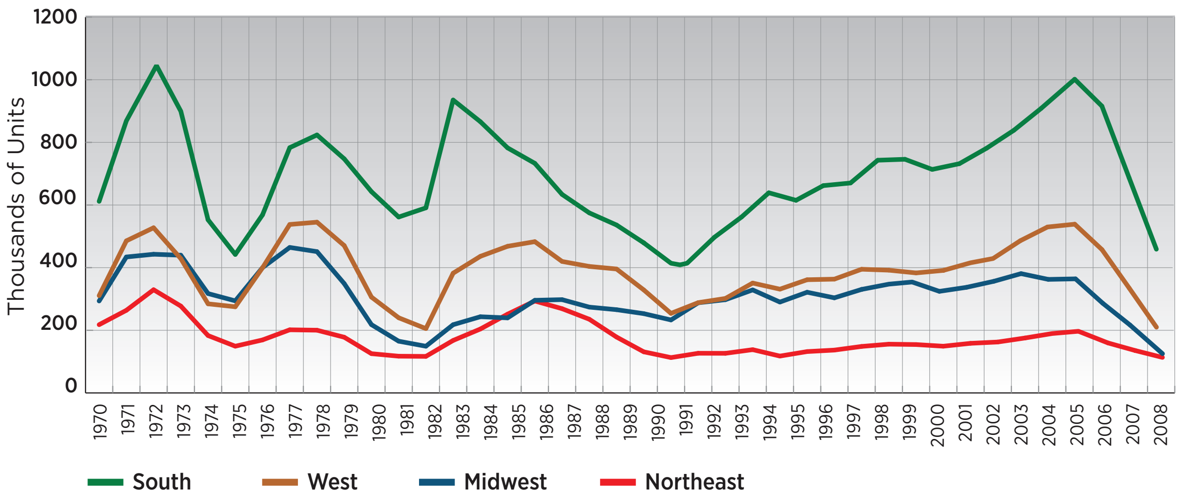


Source: U.S. Department of Census, 1961-2009 <http://www.census.gov/const/starts_cust.xls>; Primary Mortgage Market Survey® data provided by Freddie Mac <http://www.federalreserve.gov/releases/H15/data/Annual/H15_MORTG_NA.txt>

REGIONAL CHANGES IN HOUSING STARTS

The decrease in overall housing starts with the economic downturn also is reflected regionally. However, despite the downturn, the South still has the largest number of housing starts, reflecting the population shift to the Sunbelt and coastal states.

Figure 12
U.S. Housing Starts by Region (1970–2008)



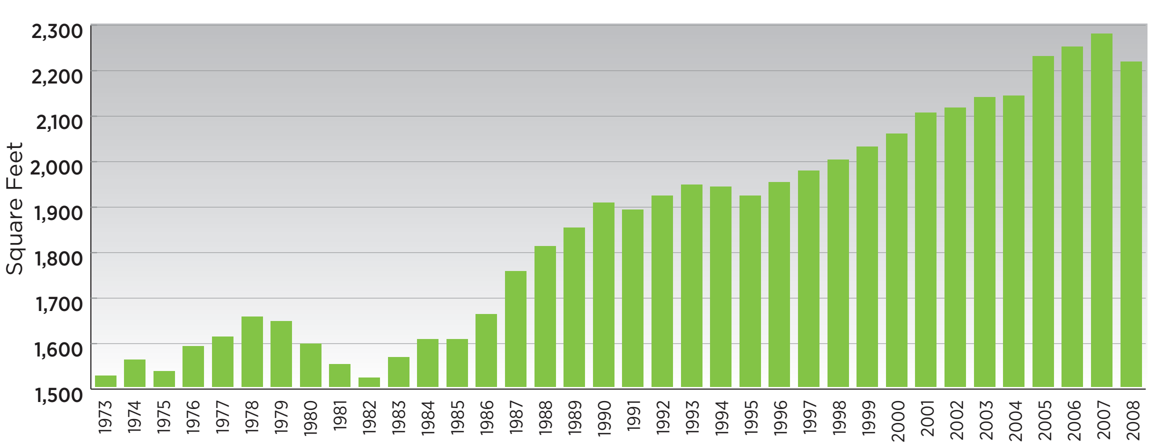
Source: U.S. Department of Commerce, Bureau of the Census, 1970-2008 <http://www.census.gov/const/startsan.pdf>

The regions include the following states:
- South: AL, KY, MS, TN, DC, FL, GA, MD, NC, SC, VA, WV, AR, LA, OK, TX
- West: CA, WA, OR, NV, HI, AZ, NM, UT, CO, WY, ID, MT, AK
- Midwest: IL, IN, MI, OH, WI, IA, KS, MN, MO, NE, ND, SD
- Northeast: NJ, NY, PA, CT, ME, MA, NH, RI, VT

AVERAGE HOUSE SIZE GREW THROUGH 2007

After years of increasing house sizes, the recessionary market in 2008 experienced the first decline in the median size of a single-family home. Further data are needed to determine if this 3% decline marks a long-term trend toward smaller homes or just a short-term response to the recession. However, even with this recent drop in size, homes are still significantly larger than in the 1990s or early 2000s, equating to an increase in space per person.

Figure 13
U.S. Median Single Family House Size of Completed Projects



Source: U.S. Department of Commerce, Bureau of the Census, 1973-2008 <http://www.census.gov/const/C25Ann/sftotalmedavgsqft.pdf>

Chapter 2

Profiles of Building Sector Energy Use

Overall growth in U.S. construction has driven an increase in electricity consumption. Electricity is the largest energy source for buildings, and that predominance has grown over time. Natural gas is the second largest energy source and petroleum (primarily heating oil) a distant third. Buildings' demand for electricity was the principal force behind the 58% growth in net electricity generation between 1985 and 2006.

69.4% of U.S. electricity is generated by burning coal, petroleum or natural gas, another 20.7% by nuclear power stations and 9.% from renewable sources, including large hydropower.[4] Conversion from one fuel form to another entails losses, as does the transmission and distribution of electricity over power lines. Those losses are roughly twice the size of actual purchases, making electricity the largest primary source of energy for buildings, at about 72% in 2005.

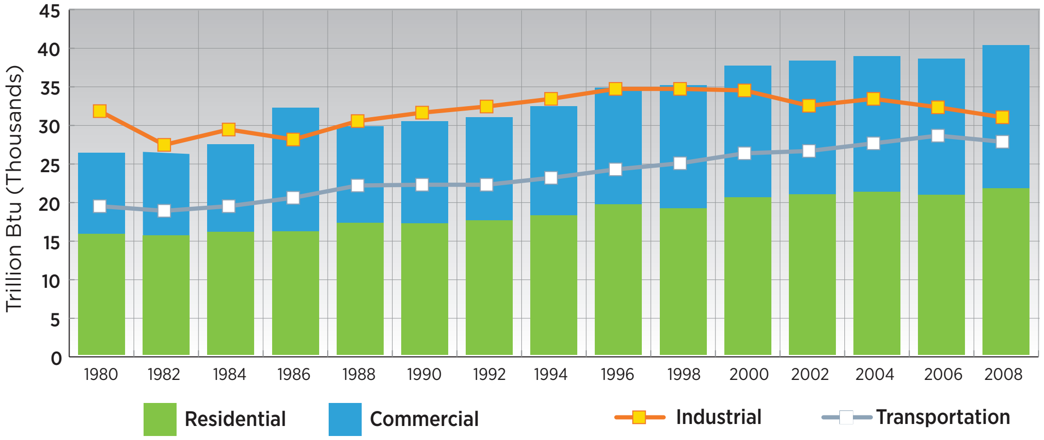
Given the size of the construction market and its growth over time (see Chapter I), it is important to put buildings into context with regard to other sectors using energy and electricity, as well as their role in overall greenhouse gas emissions.

[4] Buildings Energy Data Book, 2009, Table 6.1.2, U.S. Department of Energy <http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=6.1.2>.

Growth in Building Energy Use Versus Other Non-Building Sectors

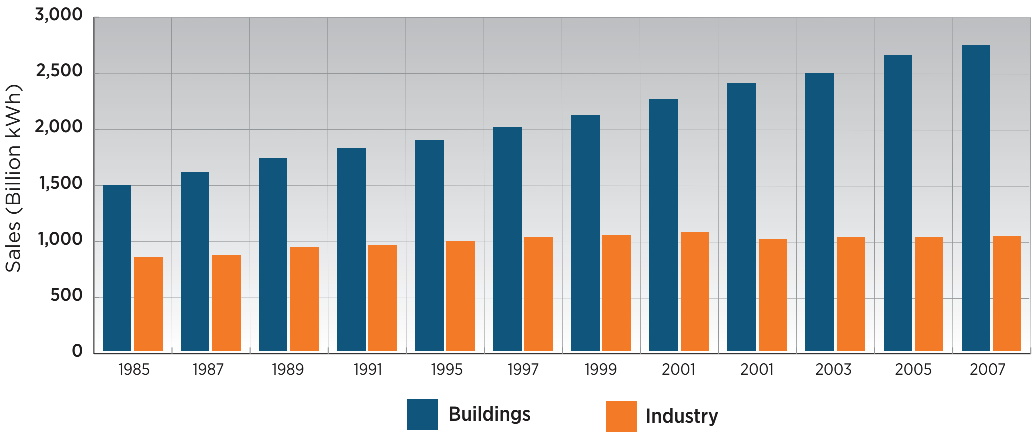
Buildings account for 40% of all energy use in the U.S. in primary energy terms. In fact, buildings consume more energy than the industrial or transportation sectors, surpassing industrial in 1998 as the number one consumer of energy. Unlike those two sectors, the building sector also has continued to increase its energy use, even during the ongoing economic downturn that began in 2007. Residential consumption currently exceeds that of commercial buildings, but the share of energy use from commercial buildings has grown at a faster rate in recent years. (Figure 14)

Figure 14
Growth in Building Energy Use Relative to Other Sectors



Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2009 Buildings Energy Data Book <http://buildingsdatabook.eren.doe.gov/>

Figure 15
Growth in Electricity Sales in Buildings Relative to Industry



Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2009 Buildings Energy Data Book <http://buildingsdatabook.eren.doe.gov/>

Electricity Consumed by Buildings Versus Industry Average

Electricity use in buildings has increased dramatically relative to industry's use, which has remained flat over the last 20 plus years. Despite brief periods of recession, electricity use by the building sector has steadily increased. (Figure 15)

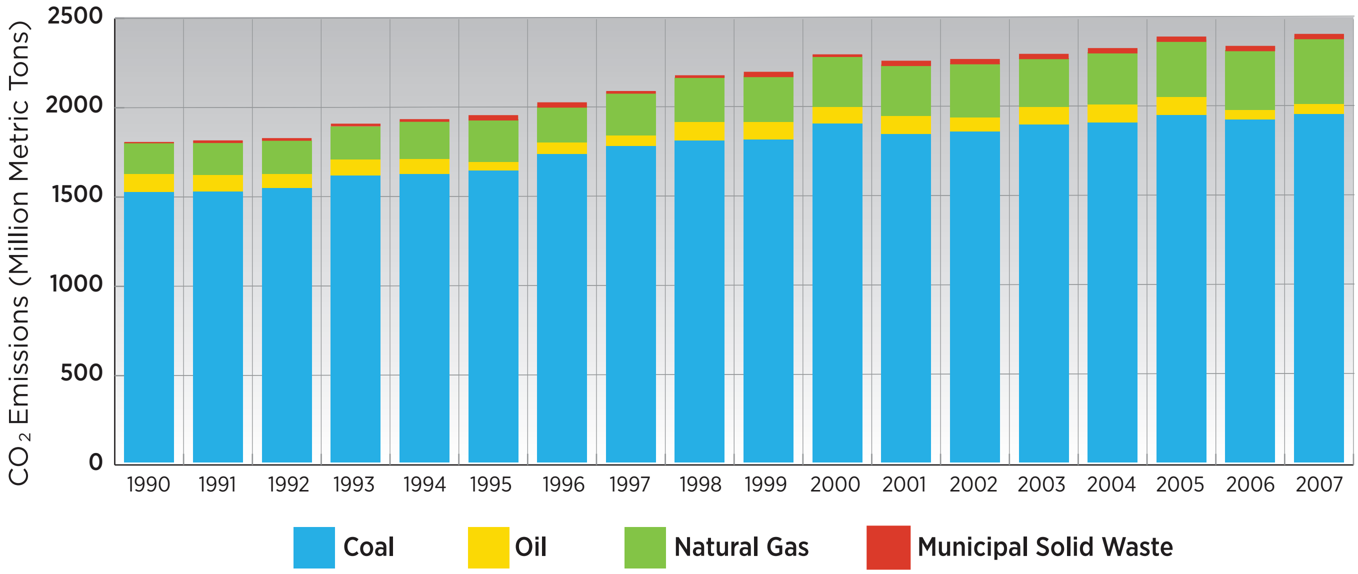
This increasing energy consumption places a higher demand on power plants and utilities, requiring the need for more generation and thus, more coal, uranium and natural gas to meet that need. Coal-fired plants account for 39% of that increase, natural gas-fired 31% and nuclear plants 28% (much of which is due to increased plant capacity, which rose to 90% in 2006, up from only 58% in 1985).

69.4% of U.S. electricity is generated by burning coal, petroleum or natural gas, another 20.7% by nuclear power stations and 9.% from renewable sources, including large hydropower. Conversion from one fuel form to another entails losses, as does the transmission and distribution of electricity over power lines. Those losses are roughly twice the size of actual purchases, making electricity the largest primary source of energy for buildings, at about 72% in 2005.

Most CO_2 Emissions from Electricity Use Are Attributable to Coal-Fired Generation

The increased need for electricity has created growing carbon dioxide emissions. The U.S. is responsible for 20% of the world's carbon dioxide emissions, with U.S. buildings' energy use responsible for 8%.[5] The majority of carbon dioxide emissions are still attributable to coal. Contributions from geothermal and municipal solid waste have remained insignificant, with little change over the last 20 years.

Figure 16
Contributors to Electricity-Related CO_2 Emissions



*Due to its comparatively small contribution to electricity CO_2 emissions, geothermal energy is not included in this chart.

Source: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2009 Buildings Energy Data Book <http://buildingsdatabook.eren.doe.gov/>

[5] U.S. Department of Energy, Energy Information Administration, <http://www.eia.doe.gov/oiaf/1605/ggrpt/#global>.

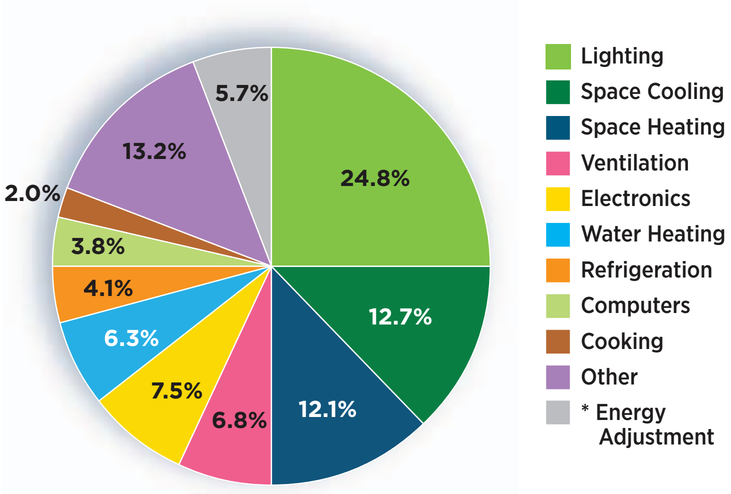
Energy Use in Commercial Buildings

The way energy is used in a commercial buildings has a large effect on energy efficiency strategies. The most important energy end-use across the stock of commercial buildings is lighting, which accounts for one-quarter of total primary energy use.

Heating and cooling are next in importance, each with about one-seventh of the total. Equal in magnitude—though not well-defined by the U.S. DOE Energy Information Administration—is an aggregate category of miscellaneous "other uses," such as service station equipment, ATM machines, medical equipment and telecommunications equipment. Ventilation uses another 7% of energy, making HVAC as a whole the largest user of energy in commercial buildings at nearly 32%.

Water heating and office equipment (not counting personal computers) use similar amounts of energy (6%–7.5%), and refrigeration, computer use and cooking consuming the least.

Figure 17
Commercial Primary Energy End-Use Splits, 2006



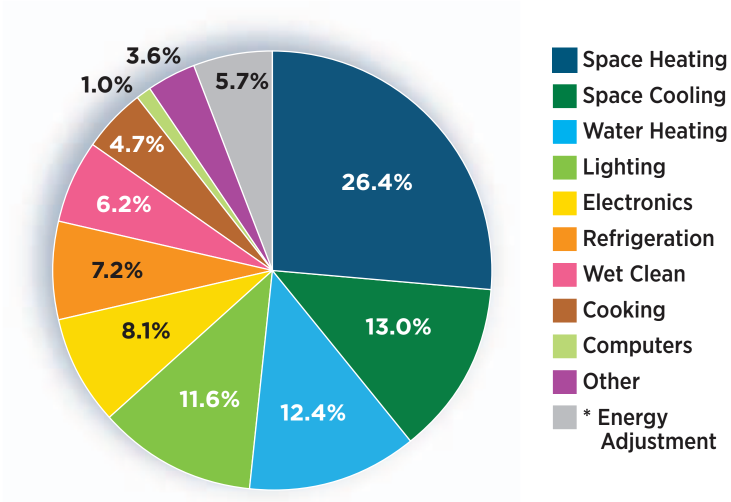
Source: 2009 Buildings Energy Data Book, U.S. Department of Energy, Table 3.1.4 <http://buildingsdatabook.eere.energy.gov/docs/xls_pdf/3.1.4.pdf>

* Energy adjustment U.S. Department of Energy, Energy Information Administration uses to adjust for discrepencies between data sources. Energy attributed to the commercial buildings sector, but not directly to any specific end-use.

Energy Use in Residential Buildings

Space heating comprises the largest energy use in a home, at one quarter—almost twice any other end use. Space cooling, water heating and lighting all use roughly the same percentage of energy in a home (12%–13%), followed by another set of uses —electronics, refrigeration and wet cleaning—sharing similar levels of use from 6% to 8%.

Figure 18
Residential Primary Energy End-Use Splits, 2006



Source: 2009 Buildings Energy Data Book, U.S. Department of Energy, Table 2.1.5 <http://buildingsdatabook.eere.energy.gov/docs/xls_pdf/2.1.5.pdf>

* Energy adjustment U.S. Department of Energy, Energy Information Administration uses to adjust for discrepencies between data sources. Energy attributed to the residential buildings sector, but not directly to any specific end-use.

Chapter 3

Patterns of Energy-Efficient Building Product Adoption in Commercial Building Design

The kinds of products and systems selected for building design can significantly influence how those buildings use energy and where the opportunities for reduction lie. The more aware the design and construction community is of alternative design practices and technologies that lead to more efficient buildings, the easier it will be to lessen the overall use of energy.

Given the importance of lighting and space cooling and the availability of McGraw-Hill Construction specifications data for these two end uses, these product types are the focus of the investigation in this section.

The specification searches draw from McGraw-Hill Construction's proprietary database of approximately 60,000 actual project plans and specifications. These searches provide insight into trends regarding how well known and adopted specific product types are in the design of new and major renovation commercial building projects. The analysis by building type and geography reveal nuances of where the largest awareness is by designers and specifiers today. However, the specification data do not indicate specific market share of a product.

Searches of specifications measure incidence of the product or search term in the specification, not actual installation rates. Therefore, the number of products in a building cannot be determined based on specification rate. For example, whether there is one elevator in a building or multiple elevators, the specification rate for that building would show up as one count for the specification rate of elevators regardless of number.

Key findings:

- **Ballasts:** Though there is little variation in the specification of ballasts among different building types, offices and living spaces, such as apartments and dormitories, have the highest level of specification of magnetic ballasts—which have been demonstrated to be less efficient than fluorescent lights with electronic ballasts.
- **LED lighting:** LED lighting is evolving quickly, and many industry experts expect costs of these fixtures to go down considerably in the next 15 years. Dormitories and education buildings see the highest specification rates at over 13%.
- **Solar panels and photovoltaic cells:** Though low, tracking the specification of these products over time will show where this market growth is occurring as well as the impact of various incentives offered by utilities and by government agencies at the federal, state and local levels.

McGraw-Hill Construction Specification Database

Each year McGraw-Hill Construction (MHC) collects and digitizes approximately 60,000 project plans and specifications, approximately 10% of construction projects at pre-start stages. The specifications are written by the project designers and contain the specific types of products that have been approved for use during construction, as well as legal requirements and other information about the building not included on the drawings. The frequency of appearance of a product, term or requirement in the specifications can demonstrate its level of adoption by the design and construction professions.

MHC's digitized project plans and specifications are for new and major renovation/alteration commercial projects. Actual installation rates are not available through the specifications and only reflect what has been recommended in the specification.

MHC does not capture every project in its specifications database as compared to MHC's Dodge project data that reflect all commercial activity in the U.S.

Lighting

Ballasts

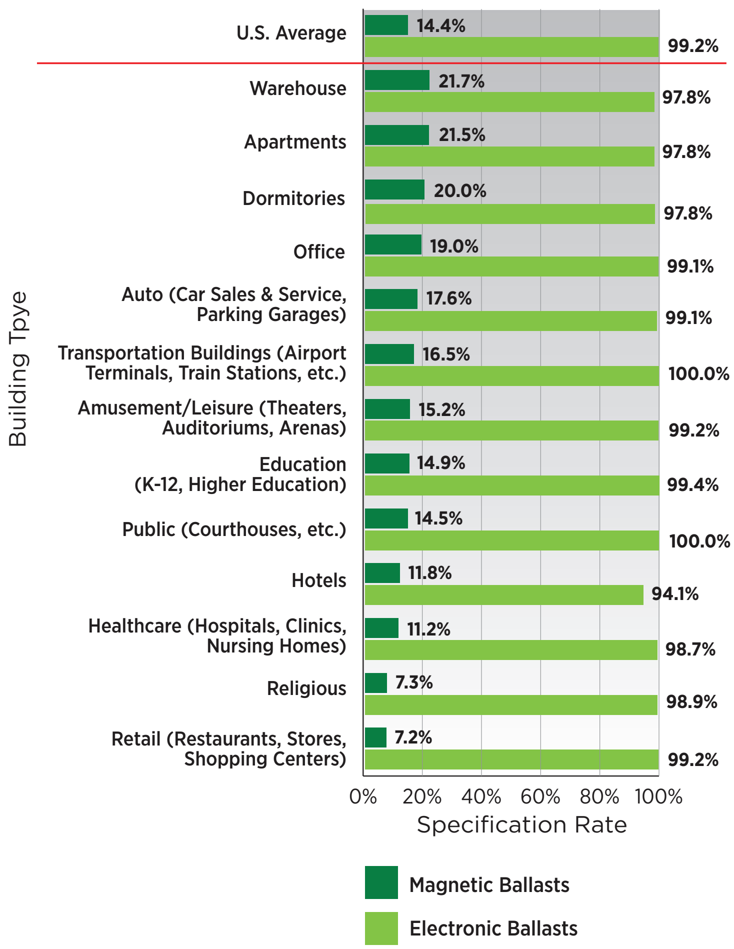
Fluorescent lights with electronic ballasts have been demonstrated to be 13%–36% more efficient than those with magnetic ballasts.[6] In addition, the University of Michigan Department of Occupational Safety and Environmental Health reports that using fixtures with electronic ballasts can result in 5%–10% air conditioning cost reduction, due to the reduced amount of heat generated by the operation of the lights.[7] Electronic ballasts also eliminate the hum associated with fluorescent lighting and offer a better light color.[8]

While electronic ballasts are still more expensive than traditional fluorescent ballasts, the energy savings associated with properly installed fixtures can offer a relatively short payback of the investment.

Given the benefits of electronic ballasts, it would be consistent for them to be specified on most projects involving fluorescent lights. However, 14.4% still include magnetic ballasts in their design. Since the specifications do not provide clarity on whether the majority of these buildings are using magnetic ballast lighting for their primary energy consumption, there may still be opportunity for significant improvement in lighting energy efficiency.

Though there is little variation among building types, offices and living spaces, such as apartments and dormitories, have the highest level of specification of magnetic ballasts.

Figure 19
Florescent Ballast Specification Rates by Building Type Electronic Versus Magnetic Ballasts (January–May 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, January-May 2010

[6] "Fluorescent Lamp Ballast Analytical Spreadsheets: Lifecycle Costs Spreadsheet," *Appliance and Commercial Equipment Standards*. U.S. Department of Energy. <http://www1.eere.energy.gov/buildings/appliance_standards/residential/gs_fluorescent_tools.html>.
[7] "Energy Conservation: Ballast Retrofits," *P2000 Manual*. University of Michigan Pollution Prevention Program <http://www.p2000.umich.edu/energy_conservation/ec2.htm>.
[8] *Electronic Ballasts: Non Dimming Electronic Ballasts for 4-foot and 8-foot Fluorescent Lamps*, Specifier Reports, Vol 8, No1, May 2000. National Lighting Product Information Program.(NLPIP) <http://www.lrc.rpi.edu/programs/NLPIP/PDF/VIEW/SREB2.pdf>.

LED Lighting

Light emitting diodes (LEDs) are an emerging technology in energy-efficient lighting. They have potential to lead to significant energy savings as well as other benefits, such as longer operating life, lower operating costs, compact size and shorter startup time as compared to conventional light sources (incandescent, neon).[9]

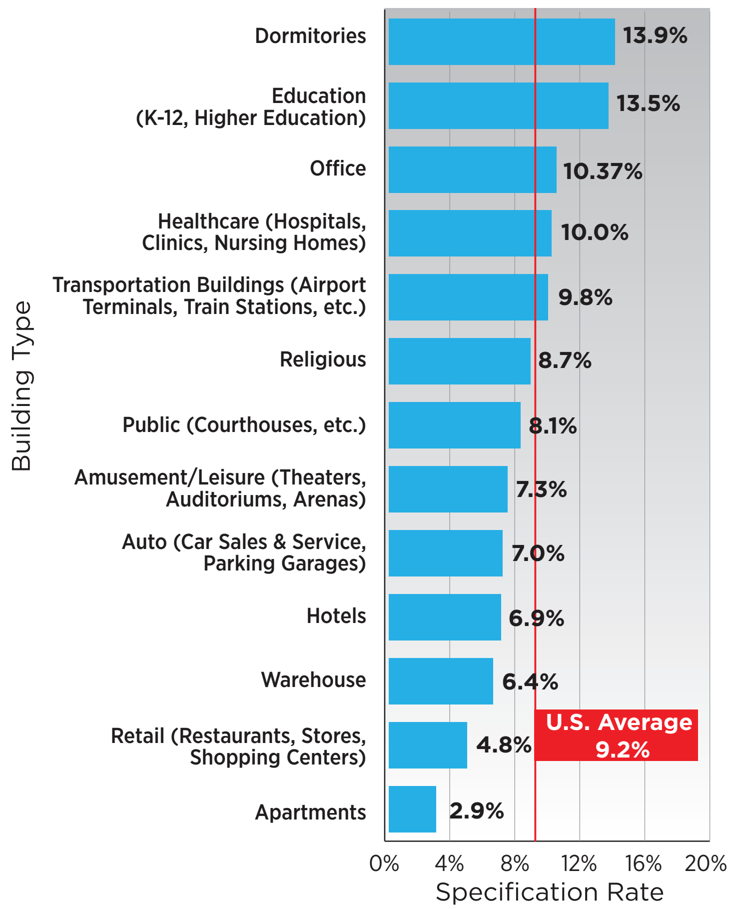
Currently, the price of LEDs could be an obstacle to its use in certain sectors. However, LED technology is evolving quickly, and many industry experts expect the cost of these fixtures to go down significantly in the next 15 years.[10] The U.S. Department of Energy's Solid State Lighting (SSL) Research & Development (R&D) Program is investing in activities to improve efficiency, lifetime and quality of light while decreasing the cost of these light sources.

LEDs are suitable for applications like adjustable task lighting and outdoor lighting as well as in elevators and spaces with occupancy sensors. Tracking specification rates over time may show how the design community is influenced as the technology develops and whether these applications correlate with building type.

The LED lighting specification rates shown in Figure 20 include LEDs for interior lighting and emergency lighting, which may account for an average specification rate of 9% for an emerging technology.

Dormitories and educational buildings see the highest specification rates for LEDs, both over 13%. The other building types that have a higher specification rate than the average are healthcare, office and transportation. Like education-related buildings, many healthcare buildings, such as hospitals, and office buildings—such as government-owned offices—are largely occupied by their owners, who may be more likely to support the investment in long-term efficiency gains or willing to pilot a new technology.

Figure 20
LED Lighting Specification Rates by Building Type (January–March 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, January-March 2010

9 "Multi-Year Program Plan Solid-State Lighting Research and Development: Multi-Year Program Plan," prepared for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program by Bardsley Consulting, Navigant Consulting, Inc., Radcliffe Advisors, Inc., SB Consulting, and Solid State Lighting Services, Inc., March 2010 <http://www1.eere.energy.gov/buildings/ssl/projects.html#2008portfolio>.

10 "LED Basics" U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy <http://www1.eere.energy.gov/buildings/ssl/basics.html>.

Heating and Cooling

Space heating and cooling account for 40% of residential primary energy use (see Figure 18 on page 16). In commercial buildings, space heating, ventilation and air conditioning/cooling (HVAC) activity account for nearly one third of their primary energy use. This represents an opportunity for energy savings using proven technologies and design concepts.

Often more than one HVAC system may be specified for a single building. As a result, the specification rate for a building type is more than 100%.

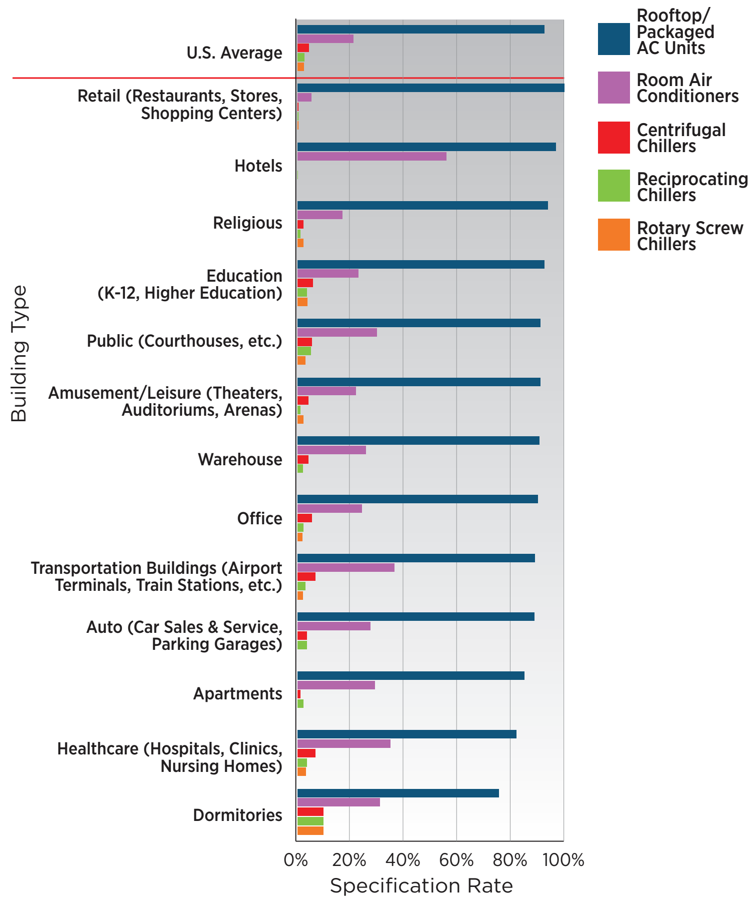
Cooling Equipment

Rooftop units and packaged AC units are the most frequently specified type of cooling equipment in all commercial building types.

Rooftop units and packaged systems tend to be the most commonly employed in smaller buildings, especially those that are 20,000 square feet or less. Rooftop units and packaged systems also are typically less expensive to install and maintain. Buildings over 100,000 square feet tend to use one or more custom designed, central systems based on how their space is used.[11]

Hotels are the only major category with room air conditioners specified in over 50% of projects, although specification rates for room air conditioners are relatively high in most other project types compared to other kinds of cooling systems.

Figure 21
HVAC Systems Aggregated Specification Rates by Building Type (January–June 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, January-June 2010

[11] "High Performing HVAC Systems," *Online Guide to Energy-Efficient Commercial Equipment.* American Council for an Energy-Efficient Economy. <http://www.aceee.org/ogeece/ch3_index.htm>.

Central Air Conditioning Systems—Chillers

Central air conditioning systems have a specification rate of less than 10% in any building type, which corresponds to the fact that the majority of commercial building projects are significantly less than 100,000 square feet (see Figure 8 on page 9). However, because of their use on large volume projects, such as hospitals and large office buildings, the impact of chillers on energy use is much larger than their specification rate implies.

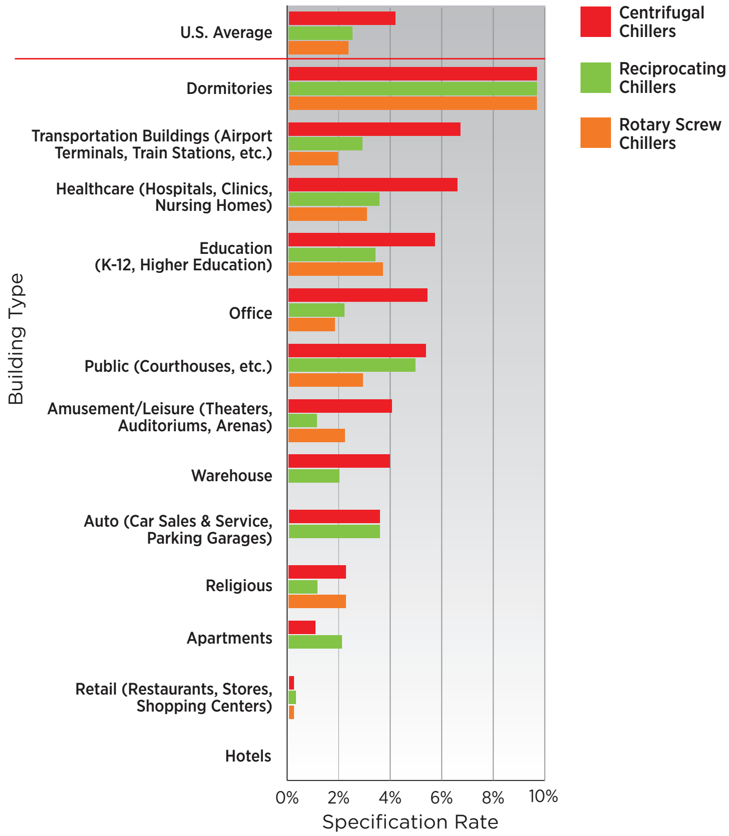
Three common types of chillers used in central air conditioning systems in commercial buildings are rotary-screw chillers, reciprocating chillers and centrifugal chillers. According to the Applications Team at the Lawrence Berkeley National Laboratory, the following characteristics apply to the three types of chillers.

- **Reciprocating chillers** serve the smallest loads efficiently.
- **Rotary-screw chillers** provide the highest level of flexibility.
- **Centrifugal chillers** provide the most efficiency when fully loaded.[12]

The specification rates (Figure 22) follow these characteristics.

- Building types that tend to be large or complex, such as hospitals, public buildings, offices and educational buildings, most frequently specify centrifugal chillers.
- Buildings with a wide range of uses like educational buildings and hospitals also have a relatively high specification rate for rotary-screw chillers.
- Buildings that are often publicly owned, such as public buildings, education buildings and dormitories, have the highest specification rate for reciprocating chillers.
- Dormitories have the highest specification rate for all types of central system air conditioning, with each type of chiller specified at the same frequency.

Figure 22
Central Air Conditioning Product Specification Rates by Building Type (January–June 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, January-June 2010

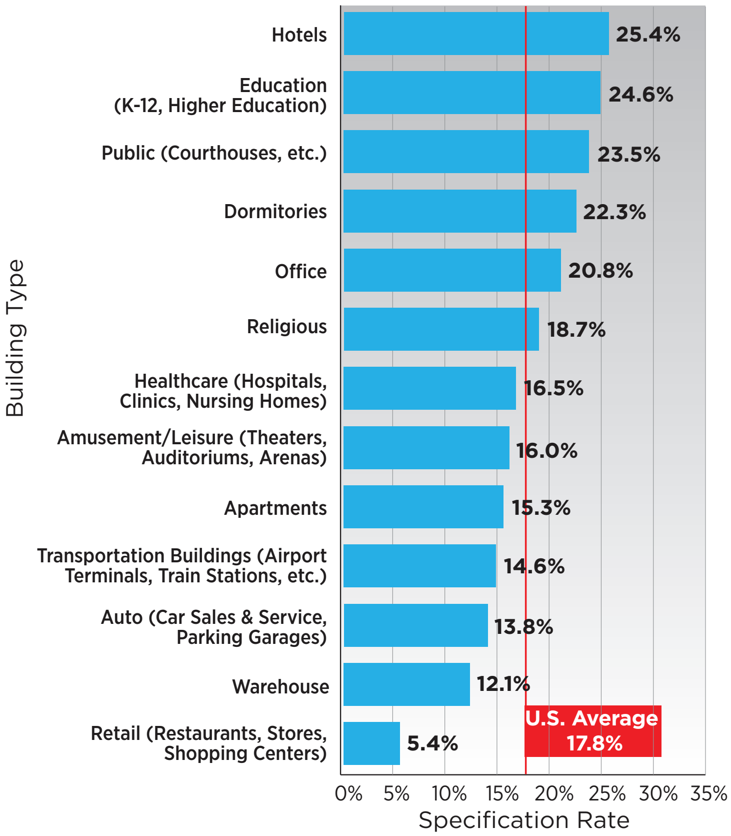
[12] "Chillers," *Design Guide for Energy-Efficient Research Laboratories—Version 4.0*. Lawrence Berkeley National Laboratory, Center for Building Science Applications Team, prepared July 1996, updated August 2003 <http://ateam.lbl.gov/Design-Guide/DGHtm/chillers.htm>.

Split Systems and Variable Refrigerant Flow Split Systems

Variable refrigerant flow (VRF) systems are ductless commercial HVAC systems that provide a high level of design flexibility, quiet operations, the ability for individual controls over temperature and some energy-efficiency savings.[13] They were first introduced in Japan in 1982 and since have gained attention in other markets.[14] The VRF systems typically include a centralized monitoring application. Because they can have individual zone controls, locations needing little or no cooling can be adjusted, thus lowering energy consumption. In buildings that require simultaneous heating and cooling, VRF can lead to a high coefficient of performance.[15]

Building types that benefit most from VRF systems include those having varying loads and different zones, such as schools, hotels, hospitals and office buildings.[16] Buildings less likely to benefit include stadiums and warehouses. This is consistent with the building types that are specifying VRF systems.

Figure 23
Split Systems and Variable Refrigerant Flow Split Systems Specification Rates by Building Type (January–December 2009)



Source: McGraw-Hill Construction Analytics, SpecShare, January-December 2009

[13] Roth, Kurt W; Detlef Westphalen; John Dieckmann; Sephir D. Hamilton; William Goetzler, "Energy Consumption of Commercial Building HVAC Systems Volume III: Energy savings Potential," TIAX, LLC, prepared for the U.S. Department of Energy, Building Technologies Program, July 2002 <http://apps1.eere.energy.gov/buildings/publications/pdfs/commercial_initiative/hvac_volume3_final_report.pdf>.
[14] Ibid.
[15] Ibid.
[16] Ibid.

Green/Vegetated Roofing

Green roofs reduce energy use by absorbing heat and insulating buildings. Specific energy savings from green roofs depend on the local climate and individual building and roof characteristics,[17] but many studies indicate that green roofs reduce building energy use by reducing the demand for cooling in the summer and heating in the winter.[18] One study conducted in Canada found that heat gain was reduced by 95% in the summer and heat loss was reduced by 26% in the winter. The benefits from heat loss reductions allow green roofs to provide energy cost savings in the winter as well as the summer. They also offer additional environmental and social benefits over traditional roofing materials, namely management of stormwater runoff—and the resulting energy use savings from reduced need for water pumping—and creation of green spaces fostering wildlife and habitat.[19]

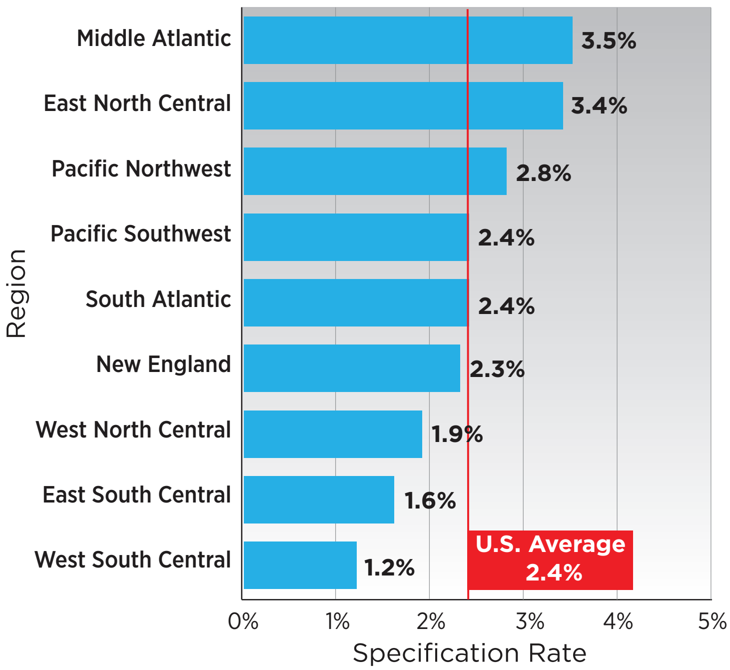
Currently, with such minimal penetration, building types and climate zones do not seem to correlate with specification rates of green roofs. However, there are some differences by region. Those specifying green roofs at a considerably higher rate than the national average include:

- Middle Atlantic
- East North Central
- Pacific Northwest

Policies encouraging green roofs may have an influence on these higher specification rates:

- **Middle Atlantic:** Green roof subsidy program in Washington, DC, and tax credits for the use of a green roofs in New York City and Philadelphia
- **East North Central:** Green roofs grant program launched by the City of Chicago in 2005
- **Pacific Northwest:** Floor area ratio bonuses in Seattle, WA and Portland, OR, which increase the amount of floor area a developer can add to a building without additional permitting if the project includes a green roof.

Figure 24
Vegetated Roof Specification Rates by Region (January–December 2009)



Source: McGraw-Hill Construction Analytics, SpecShare, January-December 2009

The regions include the following states:
- Middle Atlantic: NJ, NY, PA
- East North Central: IL, IN, MI, OH, WI
- Pacific Northwest: AK, ID, MT, OR, WA, WY
- Pacific Southwest: AZ, CA, CO, HI, NV, NM, UT
- South Atlantic: DE, DC, FL, GA, MD, NC, SC, VA, WV
- New England: CT, ME, MA, NH, RI, VT
- West North Central: IA, KS, MN, MO, NE, ND, SD
- East South Central: AL, KY, MS, TN
- West South Central: AR, LA, OK, TX

[17] "Reducing Urban Heat Islands: Compendium of Strategies, Green Roofs" Draft from the U.S. EPA, October 2008 <http://www.epa.gov/heatisland/resources/pdf/GreenRoofsCompendium.pdf>.
[18] Liu, K.L., and B. Baskaran. "Thermal Performance of Green Roofs through Field Evaluation." Presented at "Greening Rooftops for Sustainable Communities," the First North American Green Roofs Infrastructure Conference, Awards, and Trade Show, Chicago, IL, May 29-30, 2003. National Research Council, Institute for Research in Construction referenced in "Green Roofs. Federal Technology Alert: A New Technology Demonstration Publication," U.S. Department of Energy, Federal Energy Management Program <http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf>.
[19] "Green Roofs. Federal Technology Alert: A New Technology Demonstration Publication," U.S. Department of Energy, Federal Energy Management Program <http://www1.eere.energy.gov/femp/pdfs/fta_green_roofs.pdf>, and *DDC Cool and Green Roofing Manual*, June 2007, New York City Department of Design and Construction <http://www.nyc.gov/html/ddc/downloads/pdf/cool_green_roof_man.pdf>.

Renewables—Solar Panels and Photovoltaic Cells

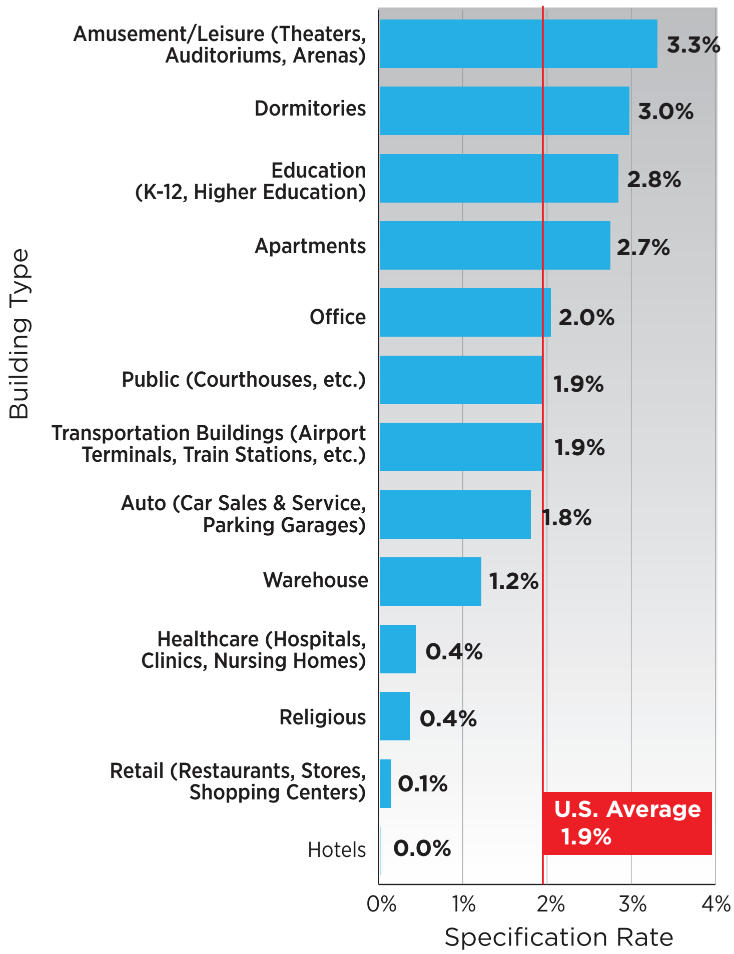
Although the specification rate of solar panels and photovoltaic cells (1.89%) is low in commercial construction, there are some sectors that are specifying solar energy product use at significantly higher rates than average, most notably dormitories and education projects, as well as amusement projects (e.g., stadiums, theaters) and apartment buildings.

The use of these technologies is consistent with the features of the buildings themselves and with policies encouraging renewables. Amusement projects tend to have more space in which to install panels, while dormitories and apartments can easily utilize the hot water generated by solar panels. Further, there are a number of incentives in place to encourage use of renewables in schools and office buildings.

Big box stores, such as Walmart, Target and Home Depot, may present opportunities for solar with large roof areas over one-story buildings. However, the specification rates are significantly lower than average. This rate may be diluted by the smaller stores and restaurants that comprise a large number of projects in this sector.

Tracking the specification of these products over time will show where this market grows as well as the impact of various incentives by utilities and at the federal, state and local levels.

Figure 25
Solar and Photovoltaic System Specification Rates by Building Type (October 2009–March 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, October 2009-March 2010

Chapter 4

Industry Research Findings Driving Energy-Efficient Buildings

The U.S. built environment comprises more than 77.9 billion square feet of commercial buildings[20]—approximately 5.3 million buildings[21]—and 114 million homes.[22] Only a small percentage of the total building stock is new every year. For example, in 2008, new commercial construction accounted for only 1.8% of total building floor area.[23] While attention to efficiency and other green priorities in new building construction is important to impact efficiency gains in long-term building stock, both short-term and long-term efficiency goals require a focus on improving efficiency in existing buildings.

Different players in the industry are motivated to shift to more efficient buildings, whether they are involved in commercial or home construction, new or renovation projects. Understanding the market drivers is critical to achieve energy reduction goals.

Since 2005, McGraw-Hill Construction has regularly surveyed a representative sample of construction industry players (owners, architects, engineers and contractors) to gauge the industry on various topics related to green building and energy performance of new and existing buildings—both commercial and residential. Those study results feed the collective MHC proprietary market research database. Results in this section are primarily derived from that data.

What is Green Building?

McGraw-Hill Construction uses the following definition of green building, which encompasses more than just energy efficiency.

To be considered a green building, a project must be energy efficient, water efficient, have improved indoor air quality and include aspects of the building that use resources efficiently through materials selection.

Therefore, a building that focuses solely on one aspect of environmental performance (e.g., energy) is not considered a green building. Neither is a building that has only one or two products that lead to improved environmental performance.

Buildings certified under recognized green building standards (e.g., LEED Green Building Certification program, Green Globes) are typically more narrowly defined green buildings given their specific requirements for responsible site management and other aspects of construction. These buildings are a subset within McGraw-Hill Construction's definition.

[20] Annual Energy Outlook 2010, U.S. Department of Energy, Energy Information Administration <http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_5.xls>.
[21] Calculated based on the total square footage from Annual Energy Outlook 2010, U.S. Department of Energy, Energy Information Administration <http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_5.xls> divided by the average size of a commercial building from Commercial Buildings Energy Consumption Survey, 2003, U.S. Department of Energy, Energy Information Administration, table a1 <http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003pdf/a1.pdf>.
[22] U.S. Department of Commerce, Census Bureau
[23] McGraw-Hill Construction, Buildings Stock Database

Corporate Drivers to Energy-Efficient Building Portfolios

Corporate America Sees Strong Value in Greening Portfolios

Corporate leaders report an increased level of green building since 2006.[24] However, the motivations behind green building have overall remained quite consistent over time.

The only major change is the decrease in the relative influence of government regulation, as green building is an increasingly common building practice and becoming increasingly motivated by business benefits. (Figure 26)

Corporate leaders—chief executive officers (CEOs), chief operating officers and chief financial officers—believe that the difficulty in creating proper benchmarks and measuring against those benchmarks is one of their biggest challenges to increasing their commitment to improving the energy and environmental performance of their buildings.[25] (Figure 27) Other industry players—architects, engineers and contractors—believe the first costs of green building is their largest hindrance.[26] This suggests a shift in leadership and policy trends, with the emphasis by big private owners on proving results more than on immediate first costs.

Sustainable Practices in Corporations Are Being Driven by Energy Cost Savings and Competitive Advantage

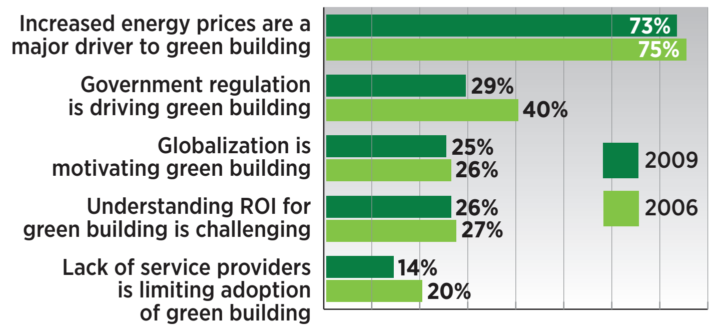
There is a correlation between how corporate executives view sustainability policies overall and how much they commit to energy-efficient and green buildings.

Energy and cost savings are the most important drivers promoting corporate sustainability.

When asked to rank their number one driver, energy and cost savings remain the top driver for all corporate leaders. However, nearly one fifth of all CEOs believe competitive advantage is driving them toward more sustainable practices (Figure 28). Forced ranking also dropped technology changes down from second position to third.

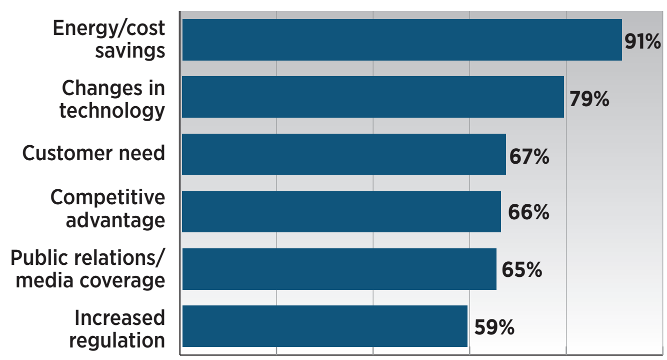
[24] *The Greening of Corporate America SmartMarket Report*, 2007, McGraw-Hill Construction; *The Greening of Corporate America Report 2009,* McGraw-Hill Construction/Siemens.
[25] *The Greening of Corporate America Report 2009*, McGraw-Hill Construction/Siemens.
[26] *Commercial and Institutional Green Building SmartMarket Report,* McGraw-Hill Construction, 2008.

Figure 26
Motivations Behind Green Building in Corporate America



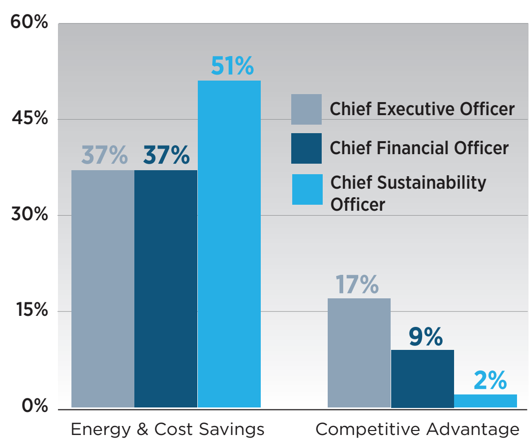
Source: *2009 Greening of Corporate America Report*, Siemens/McGraw-Hill Construction, 2009

Figure 27
Drivers Promoting Sustainability
(selected by more than 50% of respondents)



Source: *2009 Greening of Corporate America Report*, Siemens/McGraw-Hill Construction, 2009

Figure 28
Most Important Key Driver in Promoting Corporate Sustainability (by Position in Firm)



Source: *2009 Greening of Corporate America Report*, Siemens/McGraw-Hill Construction, 2009

Green and Energy-Efficient Building Market Opportunity

Energy-Efficiency Improvements Are a Well-Established Part of Commercial Renovation and Retrofit Practice

In 2009, the overall value of the major retrofit and alteration market (projects over $1 million) was approximately $41 billion. Renovation/alteration projects that include energy-efficiency improvements made up approximately two-thirds of that activity,[27] demonstrating a strong established market for energy efficiency, but one with room for growth.

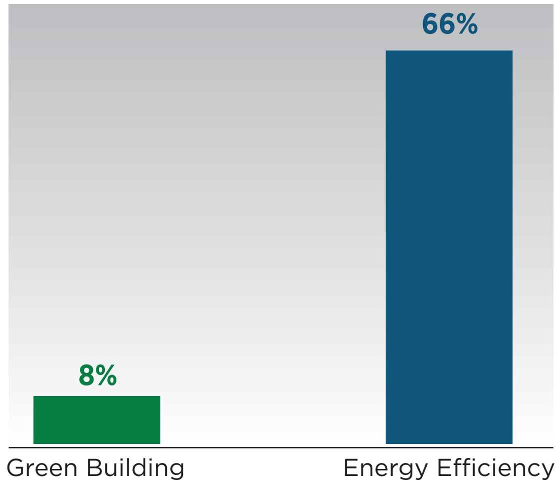
Green building, which encompasses more than energy efficiency (see definition of green building on page 25), comprised 8% of the total commercial renovation and alteration work in 2009. This smaller number reflects the broader acceptance of energy efficiency standards in renovation work compared to the more varied and stringent green building requirements.[28]

New Green Building Market Has Grown Dramatically Over Time

In both commercial and residential new construction, the share that is green grew significantly between 2005 and 2008—from $10 billion in 2005 to $45 billion in 2008. Despite a dramatic downturn in the residential market, the residential share that was green also grew from 2% to 8% of the market from 2005 to 2008.[29]

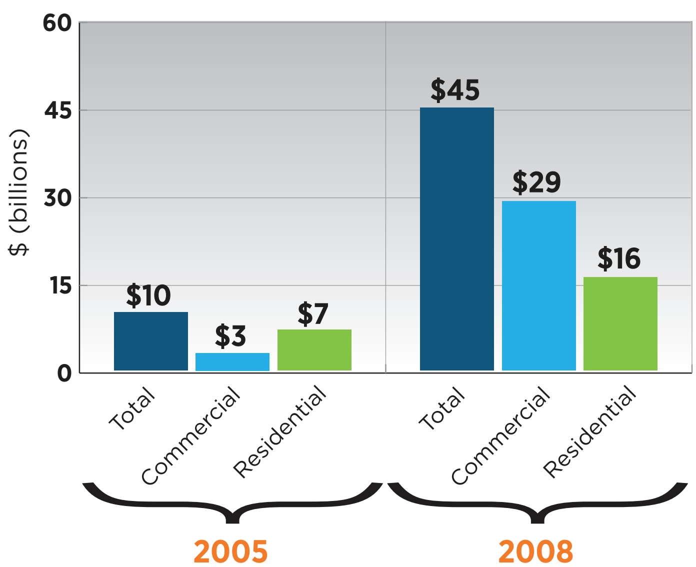
This market growth has implications for energy efficiency, which is one of the fundamental aspects of a green building. As green building becomes standard construction practice, energy efficiency will become a core aspect of buildings—both residential and commercial.

Figure 29
Energy-Efficient and Green Building Market Share of 2009 Commercial Retrofit and Renovation Construction Activity



Source: *Green Buidling Retrofit & Renovation SmartMarket Report*, McGraw-Hill Construction, 2009

Figure 30
Green Building Market Size (2005–2008)



Source: *Green Outlook 2009*, McGraw-Hill Construction, 2008

[27] Note: Even if a project includes an energy-efficient feature, that does not suggest that the entire value of that retrofit/renovation project can be attributed to energy efficiency practices.
[28] See page 25 for definition of a green building.
[29] *Green Building Outlook 2009*, McGraw-Hill Construction, 2008.

Commercial Building Trends

Improved Energy Performance Is the Major Driver and a Highly Valued Aspect of Green Commercial Buildings

The same factors influence owners of new green buildings and owners of existing buildings considering a green renovation/retrofit, but not always to the same degree.

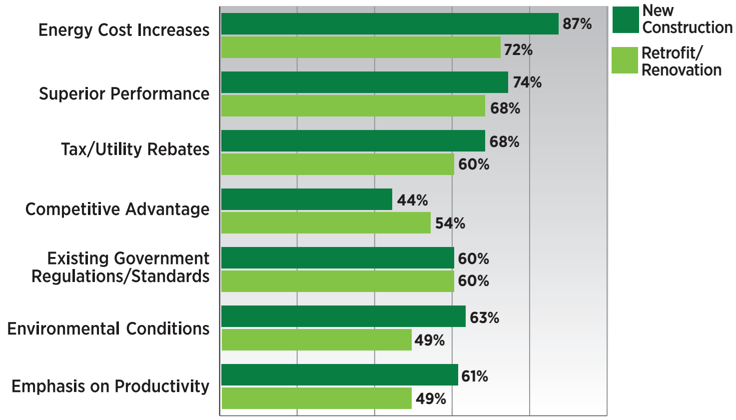
- **Energy cost increases:** Though a green building is focused on more than just energy efficiency, the most important driver moving an owner toward green building is the price of energy—both for new and existing buildings.
- **Performance:** Superior performance, such as through energy and water savings or increased occupant well-being and satisfaction, is also an important driver for owners to invest in green buildings. This bodes well for specific energy and water-efficient technologies and practices since they are the easier aspects of green buildings to measure.
- **Government influence:** Government mandates (regulations) are equally influential for owners of new buildings and existing buildings, while incentives (rebates) are slightly more influential at influencing new green building construction.

Selection of Green Products for Commercial Retrofit and Renovation Projects Corresponds to Overall Emphasis on Building Energy Performance

There are a variety of products and practices that owners report having included in their green retrofit and renovation projects, including energy efficient technologies.

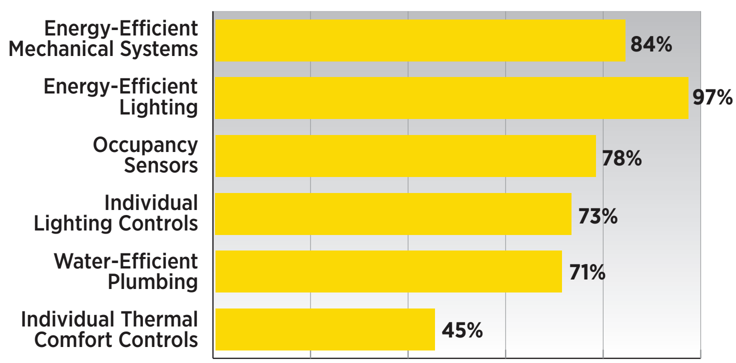
Most owners who engage in green retrofits and renovations install energy-efficient lighting and mechanical systems. Though there are a variety of other products and practices beyond energy efficiency used in these projects—which defines them as green renovation or retrofit projects—nearly all of them are improving lighting. There are a number of reasons likely, including the higher financial return on investment, availability of technology and practices familiar to designers and contractors.

Figure 31
Building Owners: Triggers for Greening Buildings (new and existing)



Source: *Commercial & Institutional Green Building SmartMarket Report*, McGraw-Hill Construction, 2008; *Green Building Retrofit & Renovation SmartMarket Report*, McGraw-Hill Construction, 2009

Figure 32
Popular Products for Building Owners Conducting Retrofit/Renovation of Existing Buildings



Source: *Green Building Retrofit & Renovation SmartMarket Report*, McGraw-Hill Construction, 2009

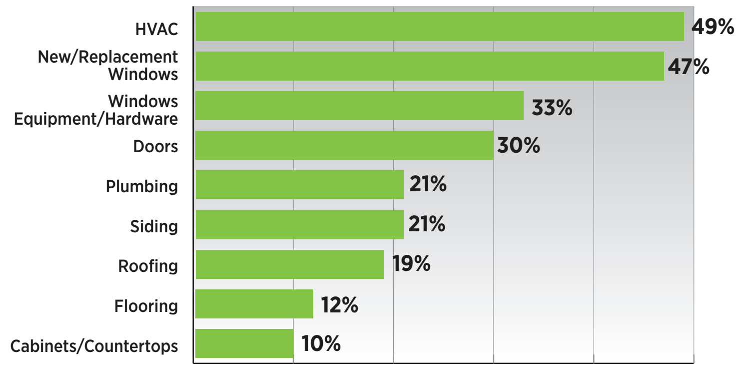
Residential Building Trends

Green Homeowners Are as Concerned About Energy Efficiency as Green Commercial Building Owners

Homeowners engaged in green remodeling are as energy conscious as consumers buying new green homes or commercial building owners. Again, though energy efficiency is not the sole environmentally beneficial aspect of their green homes, it is a core factor, as is homeowner comfort.

- Efficient HVAC systems are the most common feature reported to be used in green home remodeling. Despite potential higher first costs, HVAC systems have a number of factors behind their increased use, including their need for replacement, cost savings from energy savings and improved comfort.
- Building envelope improvements that increase energy efficiency—new windows, window equipment and doors—are another prominent feature. These products also have cost, environmental and comfort benefits. The prevalence of these products may suggest a positive influence from government rebates and tax incentives.
- Water efficiency is also important in plumbing upgrades or repairs, with more than one fifth reporting this aspect of their projects.

Figure 33
Features Most Often Replaced in Green Home Remodeling (according to Homeowners)



Source: *The Green Home Consumer SmartMarket Report*, McGraw-Hill Construction, 2008

Home Builders Recognize Importance of Energy Efficiency to Green Homeowners

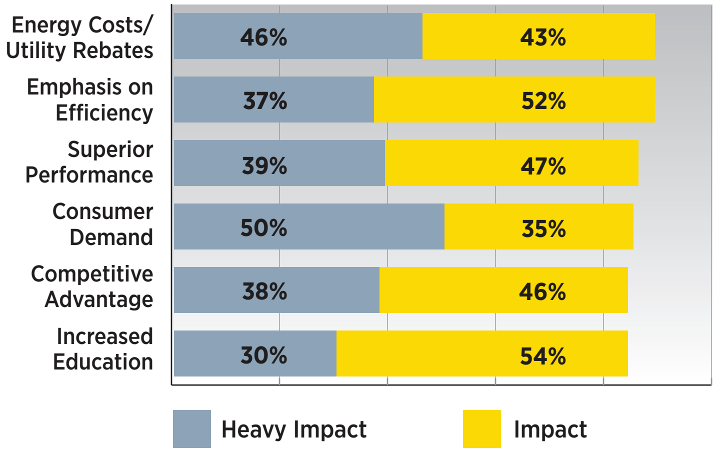
Home builders recognize green homeowner concerns as the main drivers for the market. When measuring obstacles to green market growth, home builders are also concerned about the costs of projects, but there are a number of factors driving them toward green home building activity.

- **Energy costs:** In 2008, home builders reported two factors as having the greatest impact on the potential growth of the green home building market: energy costs/utility rebates and a greater emphasis on efficiency.
- **Consumer demand:** When asked to rank factors having the *most influence*, half the home builders noted the influence of consumer demand on the green housing market. This was particularly true of larger builders versus small, custom builders.

Nearly all home builders surveyed report using some feature with a high level of energy efficiency in the green homes they construct.

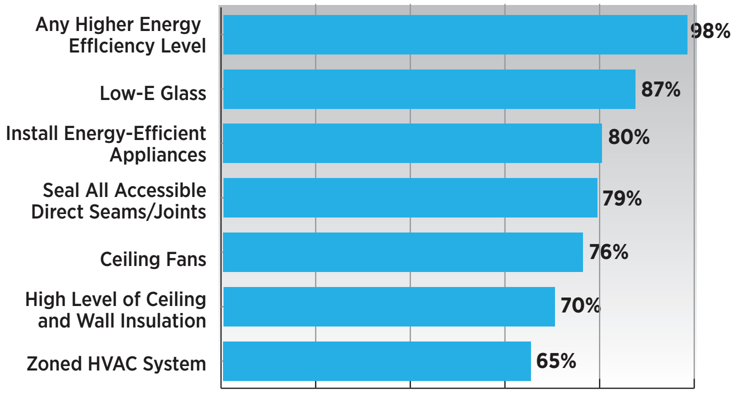
- Low-E glass was very common, with 87% reporting its use.
- Energy-efficient appliances with the ENERGY STAR label were reported used by 80% of builders, though this may refer to only one type of appliance.
- Features that improve building envelope and HVAC were also important, being used by over 60% of builders.

Figure 34
Triggers Impacting Green Home Building Market Growth (according to Home Builders)



Source: *The Green Home Builder SmartMarket Report*, McGraw-Hill Construction, 2008

Figure 35
Most Highly Used Energy-Efficient Building Features (according to Home Builders)



Source: *The Green Home Builder SmartMarket Report*, McGraw-Hill Construction, 2008

Chapter 5

Energy Efficiency Standards, Codes and Incentives

The U.S. Department of Energy (DOE), by law, must set conservation standards for equipment and appliances at the maximum level of energy efficiency that is technologically feasible and economically justified. In setting these standards, DOE works to maximize consumer benefits while minimizing negative impacts on manufacturers and other stakeholders. By establishing these standards, DOE can ensure consistent, national energy efficiency requirements for selected appliances and equipment.

Another strategy for improving building performance is to enact strict energy codes for new construction and major renovations. Building codes are often based on a national model code, such as ASHRAE Standard 90.1 or the IECC, though they are likely to be modified at the state or local level as they are adopted. They are also enforced at the local level and not updated uniformly, leaving a patchwork of old and new codes across the nation. Still, the overall trend has been an increase both in overall adoption and in the stringency of the codes adopted.

Schedule for Issuing New Energy Efficiency Standards

In 1987, federal legislation first began requiring DOE to establish and amend energy conservation standards for certain covered products. Each standard adopted by DOE is designed to achieve the maximum improvement in energy efficiency that is technologically feasible and economically justified.

The Energy Policy Act of 2005 (EPAct 2005) and the Energy Independence and Security Act of 2007 (EISA 2007) increased the number of rulemakings DOE must issue to the highest level. Figures 36 shows the products for which DOE developed and issued standards. Figure 37 shows the schedule for issuing new energy conservation.

DOE's full rulemaking schedule is updated every six months. The schedule is available online (http//www1.eere.energy.gov/buildings/appliance_standards/schedule_setting.html) and includes updates on rulemakings in progress .

Figure 36
Appliance Standards Developed and Issued by DOE (1987–2009)

- Residential Refrigerators (two standards)
- Residential Room Air Conditioners Residential Central AC & HP
- Residential Water Heaters (two standards)
- Residential Furnaces
- Residential Boilers
- Residential Small Furnaces, <45 kBtu/hour (two standards)
- Mobile Home Furnaces
- Residential Dishwashers
- Residential Clothes Washers (two standards)
  Residential Clothes Dryers
- Commercial Fluorescent Lamp Ballasts
- Commercial Warm Air Furnaces*
- Commercial Water-Cooled AC/Water—Source HP*
- Commercial Water Heaters*
- Commercial Distribution Transformers, Medium Voltage Dry and Liquid-Immersed
- Incandescent Reflector Lamps
- General Service Fluorescent Lamps
- Commercial Beverage Vending Machines
- Commercial Clothes Washers
- Commercial Refrigeration Products
- Residential Kitchen Ranges and Ovens (two standards)
- Packaged Terminal Air Conditioners and Heat Pumps
- Very Large Commercial Package Heating and Air-Conditioning Equipment**
- Small Electric Motors
- Direct Heating Equipment
- Pool Heaters

*DOE Adopted ASHRAE 90.1 as revised in October 1999

** DOE Adopted ASHRAE 90.1 as revised in January 2008 for commercial package boilers and water cooled and evaporatively cooled commercial packaged air conditioners and heat pumps with a cooling capacity at or above 240,000 Btu/h and less than 760,000 Btu/h.

Figure 37
Appliance Standards Scheduled to be Issued (2010–2011)

- Fluorescent Lamp Ballasts
- Residential Clothes Dryers
- Room Air Conditioners (residential)
- Residential Central Air Conditioners and Heat Pumps
- Refrigerators (residential)*
- Battery Chargers and External Power Supplies*
- Room Air Conditioners (residential)*
- Clothes Washers (residential)
- Residential Furnaces
- Microwave Ovens
- Elliptical Reflector, Bulge Reflector and Small-Diameter Incandescent Reflector Lamps

*EISA
A determination for HID lamps is scheduled for June 2010.

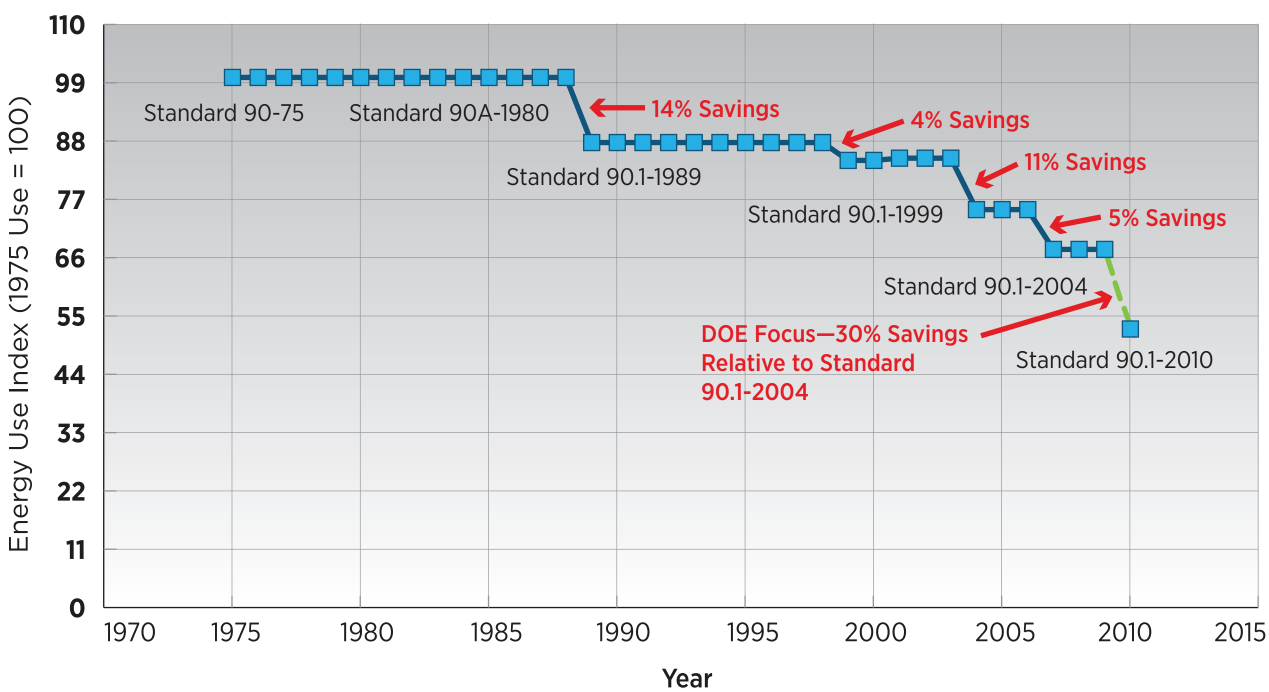
Commercial Energy Codes

Commercial Energy Code Stringency

Energy use in commercial buildings is affected by the adoption of commercial energy codes, which originated in 1975 with the development of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 90-75 ("90" for ASHRAE Project Committee 90 and "75" for 1975, the year of publication). All energy codes are historically linked to this original standard. Over the years, ASHRAE has added the Illuminating Engineering Society of North America (IESNA) as a co-sponsor to its code, which was developed under American National Standards Institute (ANSI) processes, so these organizations were added to the title as well. In a parallel development, the requirements of ASHRAE building codes have also been codified for adoption by states. This codification was first carried out in 1977 by the National Council of States on Building Codes and Standards (NCSBCS) in its Model Code for Energy Conservation (MCEC) (1977), then by the Council of American Building Officials (CABO) in its Model Energy Codes (MEC) (1983 to 1995) and currently by the International Code Council (ICC) in its International Energy Conservation Code (IECC) (1998 to present).

Since the passage of the Energy Policy Act of 1992, DOE has been responsible for tracking progress in ASHRAE Standard 90.1 and alerting states to the need for adopting new commercial energy codes that meet or exceed the provisions of any version of Standard 90.1 that DOE determines to save energy. Figure 38 shows the relative progress since the advent of U.S. commercial energy codes with ASHRAE Standard 90-75 in 1975 through ANSI/ASHRAE/IESNA Standard 90.1-2007. Through DOE's latest determination for this standard, new commercial codes allow 29% less site energy for code-regulated end uses than the original commercial energy codes. DOE is focused on achieving an additional 30% improvement between Standard 90.1-2004 and Standard 90.1-2010.

Figure 38
Commercial Energy Code Stringency (measured on a code-to-code basis)



Source: Pacific Northwest National Laboratory for the U.S. Department of Energy, Building Energy Codes Program

Commercial Energy Codes Broadly Adopted between 1992 and 2010

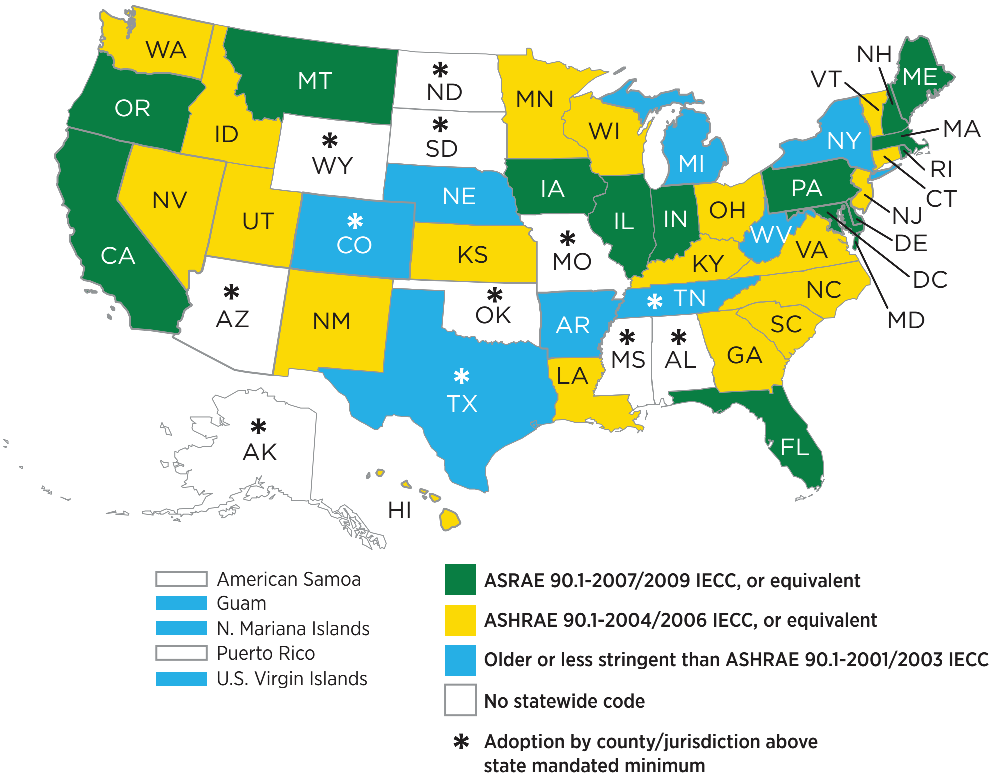
In 1992, only five states and one U.S. territory had a commercial code that met the Energy Policy Act of 1992 requirements, which called for codes that met or exceeded the provisions of the ANSI/ASHRAE/IESNA Standard 90.1-1989. In 1992, there were other states with statewide codes, but the codes adopted in those states were older than Standard 90.1-1989.

On December 30, 2008, DOE issued the determination that Standard 90.1-2004 would achieve greater energy efficiency in buildings subject to the code than the 1999 edition (Standard 90.1-1999 or the 1999 edition). By January 2010, all but 10 states and one U.S. territory had statewide energy codes. Of the states without statewide codes (shown on the map in white), all had county or local adoption of energy codes. In at least two of these states, Arizona and Hawaii, a significant fraction of construction is covered by codes. Not all of the codes adopted by 2010 met the standards in the DOE determination process set out in the Energy Policy Act of 1992. Thirty states including the District of Columbia and one U.S. territory (shown in dark and light green) meet DOE's latest published determination. States and territories marked in blue, yellow, purple and grey have retained or adopted Standard 90.1-2001 or an older one, which no longer meets the standards set by DOE in the determination process.

Figure 39 also shows the nominal equivalence of versions of ASHRAE Standard 90.1 and the MEC or IECC. Some version of ASHRAE Standard 90.1 is used as a reference standard in each version of the MEC or IECC, and that reference standard was used to develop the equivalence shown in the map key.

DOE Commercial Determinations currently under review at DOE include ANSI/ASHRAE/IESNA Standard 90.1-2007.[30]

Figure 39
Status of Commercial Energy Codes as of June 2010



Source: BECP's Status of State Codes http://www.energycodes.gov/states/maps/commercialStatus.stm

[30] DOE is assessing whether the 2007 edition of Standard 90.1 would achieve greater efficiency compared to the 2004 version.

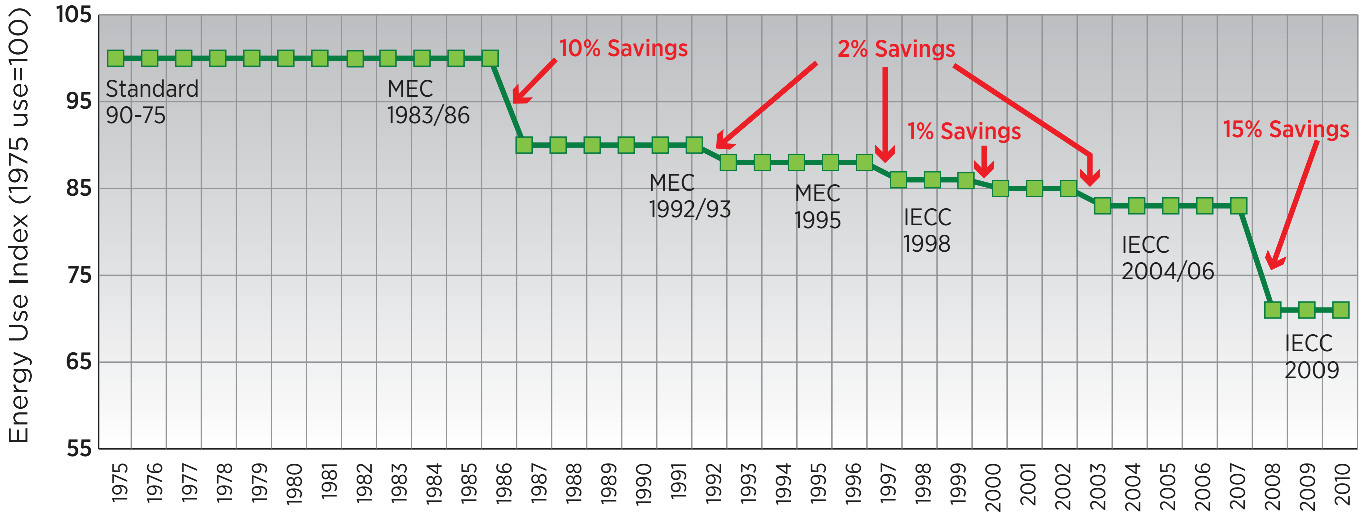
Residential Energy Codes

Residential Energy Code Stringency

Figure 40 shows projected savings from improvements in the leading national residential energy-efficiency code from 1975 to 2009. The advent of U.S. residential energy codes came with ASHRAE Standard 90-75 in 1975. In 1983, office code organizations issued the first edition of the Model Energy Code (MEC), renamed the International Energy Conservation Code (IECC) in 1998. Most states have incorporated some version of the IECC into their residential building energy code.

Figure 40 includes only the energy end uses originally addressed by the IECC and its predecessors for residential buildings: heating, cooling and domestic water heating (lighting was added in 2009). It does not factor in code adoption, building design (e.g., increasing average house size) or other factors outside the scope of these codes, notably mandatory federal equipment efficiency improvement standards (for air conditioners, refrigerators, etc.). The 2009 IECC allows approximately 29% less energy use for code-regulated end uses than the original code of 1975. DOE is focused on achieving 30% improvement between the 2006 IECC and the 2012 IECC, and is halfway to this goal with the savings achieved in the 2009 IECC.

Figure 40
Residential Energy Code Stringency (measured on a code-to-code basis)



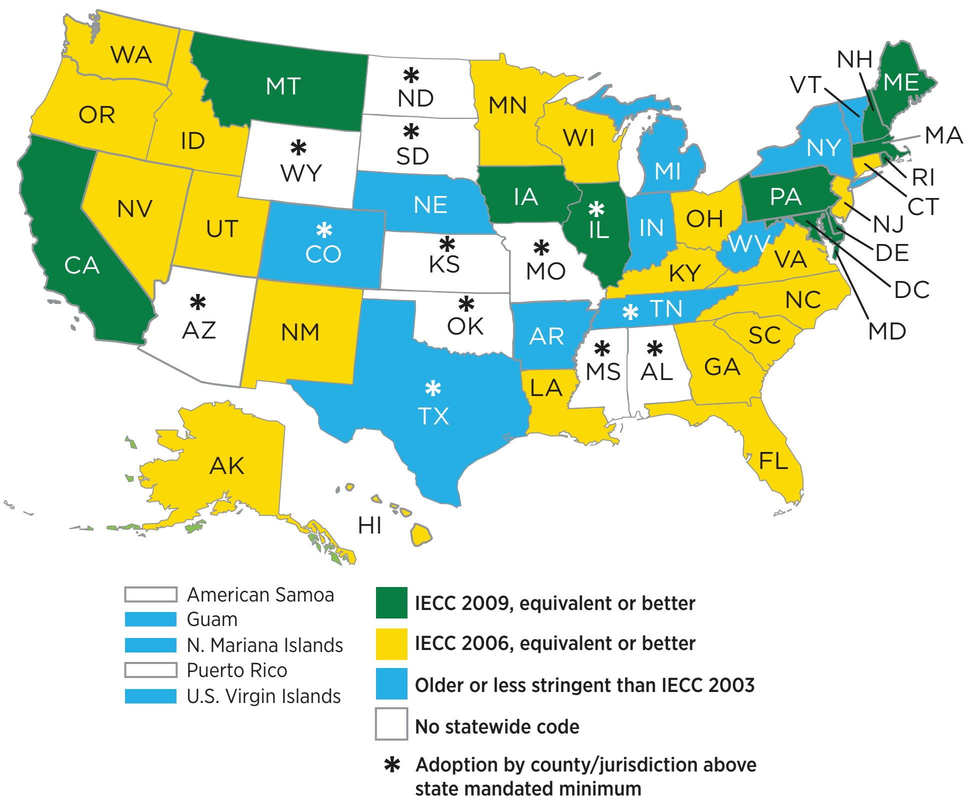
Source: Pacific Northwest National Laboratory for the U.S. Department of Energy, Building Energy Codes Program

Residential Energy Codes Broadly Adopted Between 1992 and 2010

In 1992, only four states and two U.S. territories had a residential energy code that met or exceeded the requirements set forth in the Energy Policy Act of 1992, which established the 1992 Model Energy Code (MEC 92) as the recommended standard for low-rise residential buildings. While other states had adopted codes, they were older than MEC 92.

As of January 2010, all but 12 states and one U.S. territory have a statewide code. Among the states without a statewide code or having older codes, there is some adoption of codes by individual counties or local jurisdictions. In some of these states, a significant fraction of construction is covered by codes. One example is Arizona, which has no state code, but has newer local codes in Phoenix and Tucson. Thirty-nine states, including the District of Columbia, and one territory have codes that meet or exceed the requirements of the code covered in DOE's latest published determination (the 2000 IECC—see the light and dark green, blue and yellow on the map). States and territories marked in purple have adopted a code that is less stringent than the IECC 1998.[31]

Figure 41
Status of Residential Energy Codes as of June 2010



Source: BECP's Status of State Codes http://www.energycodes.gov/states/maps/residentialStatus.stm

[31] DOE is required by the Energy Policy Act of 1992 to determine whether the low-rise residential requirements of new versions of the MEC (or its successor, the IECC) save energy. Following an affirmative DOE determination for a new IECC revision, each state is required to certify to DOE that it has reviewed its residential energy code and made a determination as to whether it is appropriate to update its code to equal or exceed the requirements of the new revision of the IECC. Formal determinations currently under review at DOE for the 2003, 2006 and 2009 IECC.

Utility Incentives for Energy Efficiency

The financial incentives provided by utilities have been a major component of the strategy to promote energy efficiency in buildings.

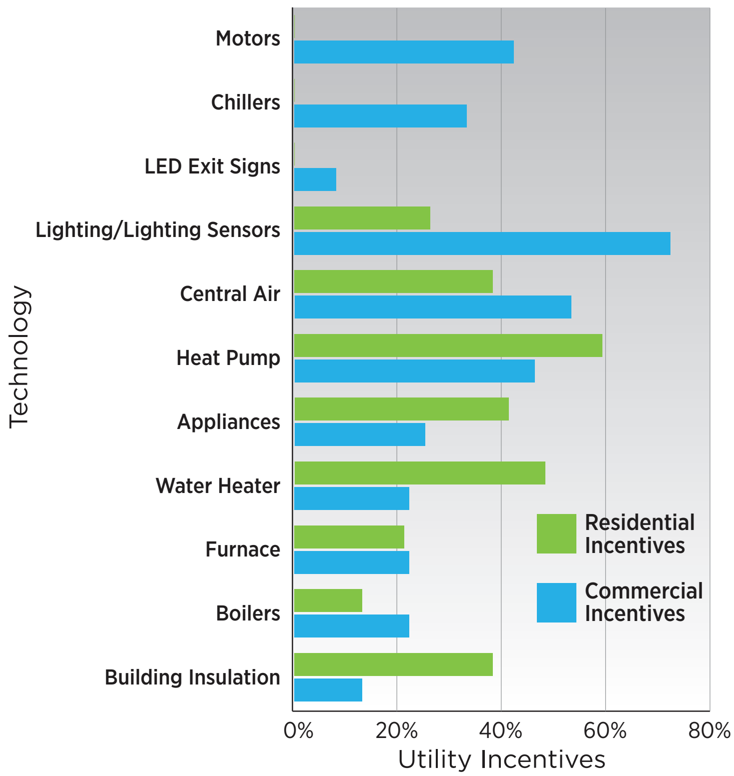
Utilities in 48 states offer over 1,000 rebates, grants and loans for improving building energy performance.

- 45% of them are incentives targeted to the residential market.
- 29% are targeted to the commercial market.
- 16% provide incentives for both.

Rebates make up over 80% of the residential and commercial incentives. Loans are more common for residential buildings than for commercial ones, with 15% of the residential incentives consisting of loans, compared to only 6% of the commercial incentives.

Since the majority of the incentives are rebates, funds are invested based on the type of technology specified. Heat pumps are the most popular overall technology, comprising 59% of the residential incentives and 46% of the commercial incentives. For residential buildings, water heaters are also included in nearly half of the incentives offered. In the commercial marketplace, lighting and light sensors are most common, included in 72% of the incentives offered. Lighting provides benefits in nonresidential structures with a relatively small capital investment.

Figure 42
Percentage of Utility Incentives that Mention Specific Technologies



Source: Database of State Incentives for Renewables and Efficiency (DSIRE), <www.dsireusa.org> through March 2010

Chapter 6

Voluntary Programs and Local and State Policies for Green and Energy-Efficient Buildings

Growth in the number and influence of voluntary green building and energy-efficiency programs has been considerable since the data was gathered for the last Energy Efficiency Trends report. The two systems reported previously, ENERGY STAR and LEED, are still the best known and most widely adopted, and in both cases, the number of projects being rated have doubled since 2007. The influence of these systems, however, extends beyond the buildings that pursue labeling or certification and has had an impact on the general practices of design and construction.

In addition to ENERGY STAR and LEED, other voluntary programs, ranging from Green Globes for commercial construction to various residential rating systems, also provide the means for commercial building owners and tenants, as well as consumers in the market for homes, to gauge the energy efficiency of buildings.

State and local governments have been employing incentives and mandates to achieve better performance in the built environment. An early trend of mandating that all public and publicly funded buildings are constructed as green buildings, whether by requiring them to register with the LEED rating system or by specifying specific green standards to be achieved, has been followed by closer attention to large private, commercial buildings in many locations.

Some policy trends are shifting. As concerns about energy consumption, costs and climate change grow more prominent in the public as well as in policy, a stronger focus on energy performance in buildings is being reflected in recent legislative trends, particularly the emergence of policies requiring all commercial buildings (public and private) to report their energy use, including stringent policies in Washington, DC, and New York City.

New requirements for energy efficiency and green building in residential buildings also reflect that local and state governments nationwide increasingly consider the built environment to be an important part of reducing overall energy and environmental impacts.

What is ENERGY STAR?*

The ENERGY STAR system is best known to the general public for its rating of various appliances and electronic devices based on their energy efficiency.

Commercial buildings can also be ENERGY STAR labeled based on their energy performance by comparing energy use among other, similar types of facilities on a scale of 1 to 100; buildings that achieve a score of 75 or higher can earn the ENERGY STAR label.

Another ENERGY STAR program evaluates single-family homes, and the EPA states that the homes that earn the label are "at least 15% more energy-efficient than homes built to the 2004 International Residential Code (IRC), and include additional energy-saving features that typically make them 20%–30% more efficient than standard homes."

*According to http://www.energystar.org

Appliances

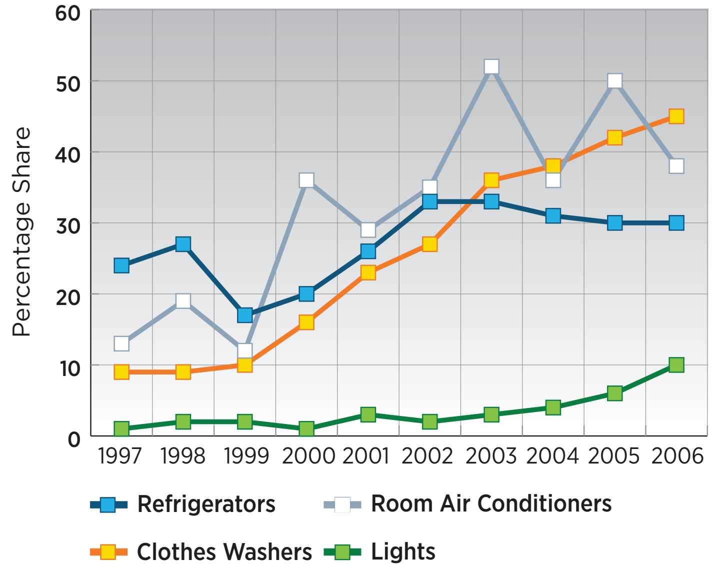
Increasingly Strict Standards for ENERGY STAR Appliances Impact Overall Market Share Growth

Consumer awareness of the ENERGY STAR label for appliances is significant, with 78% of households in a 2008 survey recognizing the purpose of the label and 76% of consumers influenced at least partly in their appliance purchase decision by the presence of the label.[32]

In the last five years, the following trends have emerged in ENERGY STAR appliances:

- **Clothes washers and light fixtures:** These appliances have had steady increase in ENERGY STAR market penetration, especially for clothes washers. Overall penetration of ENERGY STAR light fixtures still remains far below that of other product types, but ENERGY STAR clothes washers now comprise nearly half of the market.
- **Room air conditioners:** The variability of room air conditioners ultimately yields little actual growth in that sector since 2004.
- **Refrigerators:** There was a slight decline in market share after 2004 that is likely due to a revision in the standard for earning an ENERGY STAR label that increased efficiency requirements from 10% to 15% over the federal efficiency standard. The impact of the most current update for refrigerator requirements to 20% over federal efficiency standards has yet to be documented.

Figure 43
Market Share of Select ENERGY STAR Products



Source: Energy Star Program, U.S. EPA/U.S. Department of Energy <http://www.energystar.gov>

[32] *2008 ENERGY STAR Awareness Survey*, Consortium for Energy Efficiency <http://www.cee1.org/eval/2008_ES_survey_rep.pdf>.

Commercial Buildings: ENERGY STAR and LEED Green Building Certification

Recent strong growth in the ENERGY STAR program for commercial buildings and an increasing specification rate for the term ENERGY STAR demonstrate increased focus on energy efficiency.

ENERGY STAR Buildings

From 2007 to 2009, the growth of ENERGY STAR-labeled commercial buildings accelerated from earlier in the decade. From 2007 to 2009, the number of buildings labeled more than doubled, from 4,000 to almost 9,000.

Factors influencing the sharp increase in use of the ENERGY STAR label include the following:

- Increasing government incentives promoting energy efficiency
- Dramatic increases in fuel prices during 2008
- Recession-induced cost-cutting measures, including reducing overhead on existing buildings

In context, the total 8,741 buildings that had been labeled by the end of 2009 represents less than 0.2% of the total existing commercial building stock.[33] However, the marked increase in labeling buildings despite adverse economic conditions does suggest interest in energy efficiency in the commercial building sector that may be sustained once the economy improves.

ENERGY STAR IN PROJECT SPECIFICATIONS

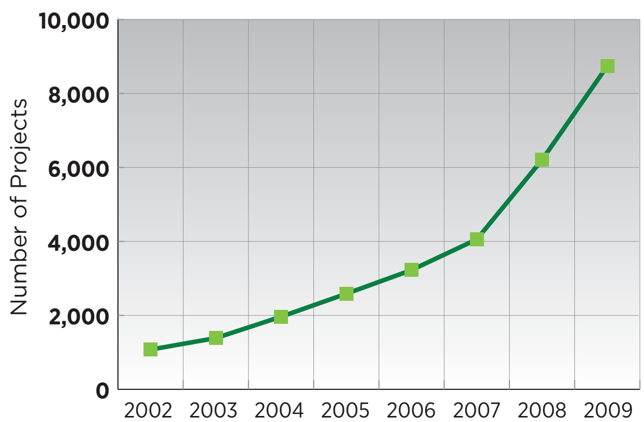
From 2006 to 2009, references to ENERGY STAR in the specifications have nearly doubled. As previously noted, awareness of ENERGY STAR among consumers has remained relatively high since 2004, and market penetration of common appliances grew from 2006 to 2009, but at a much lower rate than the level of growth of ENERGY STAR in project specifications. This may be affected by the fact that appliances are not typically included in project specifications.

[33] Percentage of 5.3 million total U.S. commercial buildings at end of 2009 as calculated based on the total 2009 square footage from Annual Energy Outlook 2010, U.S. Department of Energy, Energy Information Administration http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_5.xls> divided by the average size of a commercial building from Commercial Buildings Energy Consumption Survey, 2003, U.S. Department of Energy, Energy Information Administration, table a1 <http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003pdf/a1.pdf>.

ENERGY STAR and the McGraw-Hill Construction Specification Database

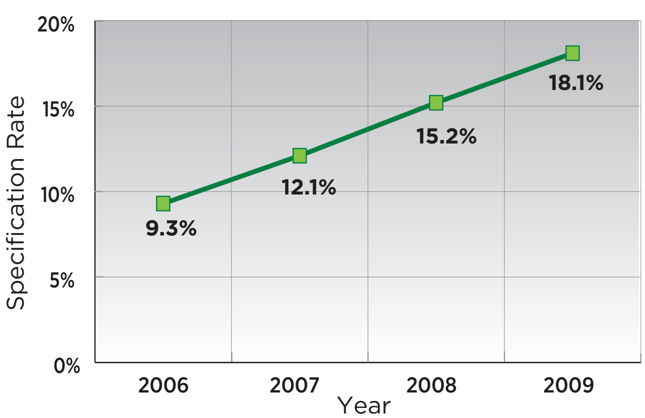
Project specifications provide information on contractual obligations, specific or general product types and all other information not directly included on the design drawings needed to construct a building. ENERGY STAR may be mentioned in the specifications for many reasons, including the specification of ENERGY STAR-rated building products or appliances to be installed in the building, requirements regarding achieving an ENERGY STAR label on the building or targeted energy use goals for the whole building or a specific system based on ENERGY STAR. (For a fuller description of the Specification Database, please see page 17).

Figure 44
Commercial ENERGY STAR Labeled Buildings (cumulative)



Source: Energy Star Program, U.S. EPA/U.S. Department of Energy <http://www.energystar.gov>

Figure 45
Appearance of ENERGY STAR in Project Specifications by Year



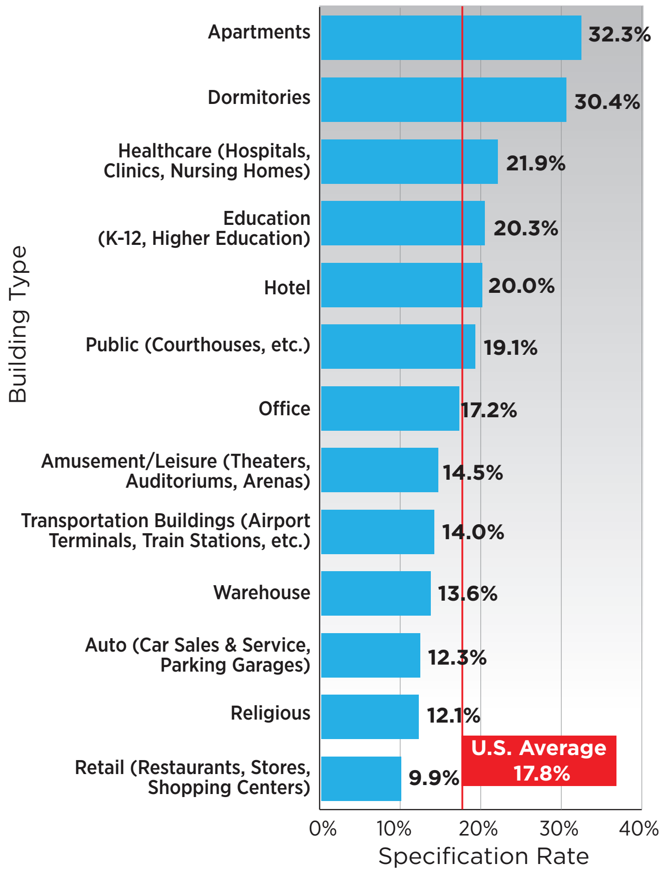
Source: McGraw-Hill Construction Analytics, SpecShare, 2006-2009

Specification Differences by Building Type

The breakdown of the use of the term ENERGY STAR in the specifications by building type is impacted by several factors:

- **Appliances:** Buildings such as apartments and dormitories that contain appliances rated by ENERGY STAR, such as laundry machines and dishwashers, contain the most references to ENERGY STAR of any building type.
- **Intensity of energy use:**
  - Healthcare buildings rank third among commercial building types for the most intensive energy use, which corresponds to its third-place ranking in the use of ENERGY STAR in the specifications.
  - Though food service and sales are two of the most energy-intensive building types (see Figure 9 on page 10), the retail building type at right also includes lower-intensity buildings, such as shopping centers and non-grocery stores, which may contribute less specific notation of energy efficiency in the project specifications.
- **Public buildings and education:** The public sector has been aggressively examining energy use in its facilities for at least a decade. Public policies relating to schools and universities have also mandated or encouraged green building practices, including increased energy efficiency.

Figure 46
Appearance of ENERGY STAR in Project Specifications by Building Type (January 2009–March 2010)



Source: McGraw-Hill Construction Analytics, SpecShare, January 2009-March 2010

Growth of LEED Rating Systems

Despite the decline in overall projects due to the recession, projects that are registered and certified under the LEED Green Building Ratings program have increased. This growth may, in part, suggest green building and energy-efficient building practices are becoming more commonplace.

LEED PROJECT PENETRATION

As of the end of 2009, a total of 26,385 projects had been registered with the U.S. Green Building Council (USGBC), while 4,327 projects had achieved LEED certification. Figure 47 shows the number of projects registered with and certified by the USGBC since 2002. Both LEED registration and certification activity have steadily grown since 2006, and there appears to be no negative impact from the recession and corresponding overall decline in construction activity. Certification, which requires an additional fee and significant investment in documentation, actually grew at its most rapid pace during 2009.

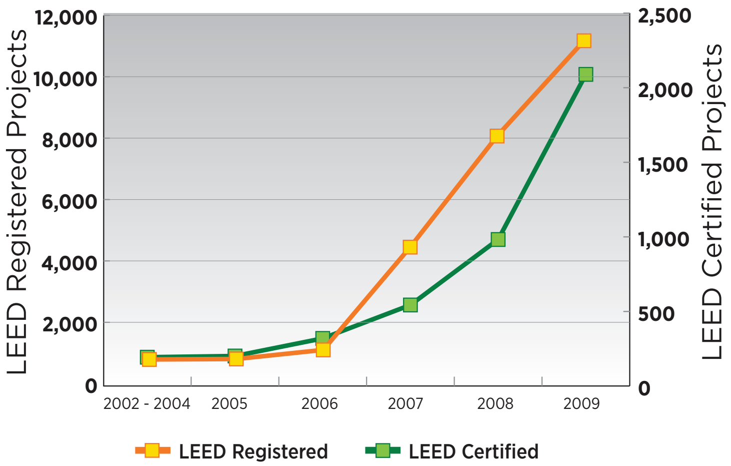
However, it is important to note that the share of building stock that is LEED registered or certified is still very low at one half of one percent for registered projects and less than one tenth of one percent for certified projects.[34]

The level of LEED certification earned by buildings has also evolved over time. The increase in LEED-certified buildings at the Gold level suggests green buildings are becoming easier to design and construct.

- **Reduced percentage of LEED projects earning the lowest level certification:** The percentage of LEED projects at the certified level has dropped, from over 40% in 2004 to less than 25% in 2009.
- **Increased percentage of LEED projects achieve Gold level certification:** The percentage of Gold projects has shown consistent growth, increasing from 27% in 2004 to 39% in 2009.
- **Percentage of Silver and Platinum projects has remained steady.**

[34] Percentage of 5.3 million total U.S. commercial buildings at end of 2009 as calculated based on the total 2009 square footage from Annual Energy Outlook 2010, U.S. Department of Energy, Energy Information Administration http://www.eia.doe.gov/oiaf/aeo/excel/aeotab_5.xls divided by the average size of a commercial building from Commercial Buildings Energy Consumption Survey, 2003, U.S. Department of Energy, Energy Information Administration, table a1 <http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set1/2003pdf/a1.pdf>.

Figure 47
LEED Registered and LEED Certified Projects (annual)



Source: U.S. Green Building Council, through January 2010 <http://www.usgbc.org>

What is LEED?*

The Leadership in Energy and Environmental Design (LEED) green building rating system is a program of the U.S. Green Building Council (USGBC). The rating is based on five categories: energy and atmosphere, sustainable sites, water efficiency, indoor environmental quality and materials and resources. The number of points scored in each category determines the level of LEED certification a building can earn—Certified, Silver, Gold or Platinum. Each level represents more green elements incorporated into the design and construction of the building.

LEED Registered Versus LEED Certified
Projects can be registered with the USGBC at any point in the project lifecycle. Certification for LEED occurs after the project is completed and independently assessed. There are a variety of reasons why a registered project may never be certified, such as additional time and cost of certification or perceived value of certification.

Types of LEED Programs
Currently, there are five different systems under which a project can earn LEED certification. The two most popular programs are LEED for New Construction (LEED NC), which involves new buildings and major renovations, and LEED for Existing Buildings: Operations & Maintenance (LEED EBO&M), which addresses operational and maintenance opportunities to keep the building performing efficiently after the initial construction is complete. Other programs are LEED Core and Shell, LEED Commercial Interiors and LEED for Schools.

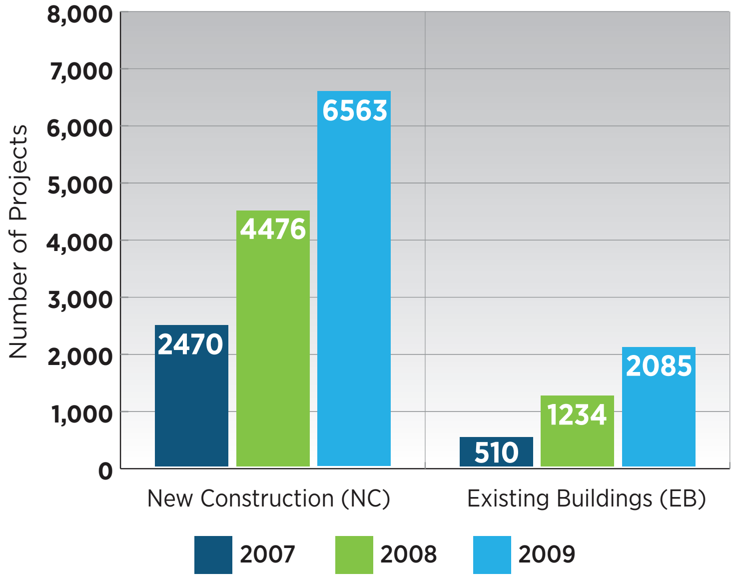
*According to USGBC (http://www.usgbc.org)

LEED PROGRAM GROWTH

Registration of projects under the two most common LEED certification systems, LEED NC and LEED EBO&M, saw high levels of growth in the last three years.

- **LEED NC:** The most well-established LEED system grew dramatically despite significant decreases in total construction activity in 2009.
- **LEED EBO&M**: Unlike the other LEED rating systems, LEED EBO&M is primarily concerned with greening a building's operation and maintenance after construction is complete. LEED EBO&M did not move beyond the pilot stage until 2007, yet the number of buildings registered in 2009 nearly equals those registered under LEED NC in 2007. The stronger growth rate of this rating system reflects increasing investment in energy efficiency in existing commercial buildings.

Figure 48
LEED Registered Projects by Rating System (annual)



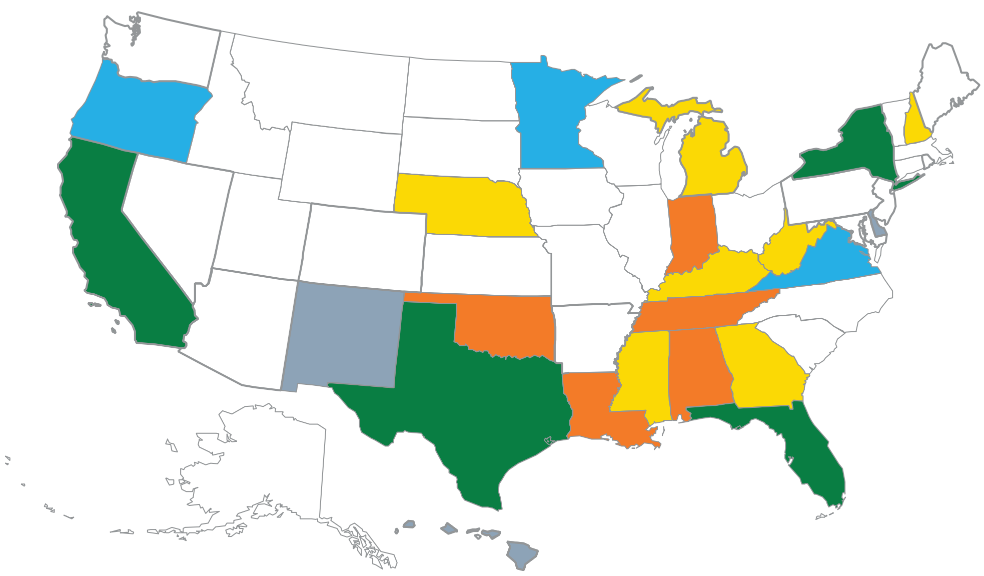
Source: U.S. Green Building Council, 2007-2009

LEED IN DIFFERENT REGIONS

The four states with the most LEED-registered projects are also the four states with the highest level of construction activity over the last 10 years. For the most part, the number of LEED-registered projects in each state corresponds to the amount of construction in general in that state, as measured by the total number of projects reported in the McGraw-Hill Construction project database from 2000 to 2009. Exceptions include the following:

- **States ranking higher in number of LEED-registered projects than in the total amount of construction:** The relatively high level of LEED registration for projects in Virginia, Maryland and the District of Columbia, where a number of buildings are owned or leased by the federal government, correlates with policy set by the federal government. For example, Virginia ranks fifth in total number of LEED-registered projects but only ranks 12th in terms of total construction activity. Other states with a higher proportion of LEED-registered projects compared to total construction activity include Minnesota, Oregon, New Mexico and Hawaii.
- **States ranked lower in the number of LEED projects than in the total amount of construction:** The majority of southern states, including Tennessee, Georgia, Alabama, Mississippi and Louisiana, all have a relatively low level of LEED-registered projects compared to their total construction activity. Some of the industrial states to the north, including Michigan and Indiana, also rank significantly lower in LEED registration than they do in amount of construction.

Figure 49
LEED Registered Projects Compared to Overall Construction Activity
State Ranking in LEED Projects Versus State Ranking of Construction Activity



Top 4 States with the most LEED Registered projects and most construction activity.

States where the level of LEED activity is significantly HIGHER than the level of overall construction activity. The comparative ranking for LEED activity is at least 10 HIGHER than its ranking level for construction activity.

States where the level of LEED activity is HIGHER than the level of overall construction activity. The comparative ranking for LEED activity is 5 HIGHER than its ranking level for construction activity.

States where the level of LEED activity is equivalent to the rate of construction activity.

States where the level of LEED activity is LOWER than the level of overall construction activity. The comparative ranking for LEED activity is 5 LOWER than its ranking level for construction activity.

States where the level of LEED activity is significantly LOWER than the level of overall construction activity. The comparative ranking for LEED activity is at least 10 LOWER than its ranking level for construction activity.

Source: U.S. Green Building Council, LEED registered project data, through 2009; McGraw-Hill Construction, Dodge Project Data

LEED IN PROJECT SPECIFICATIONS

Though LEED-registered projects in 2009 represented 14% of new buildings started over that time and 0.5% of the overall building stock,[35] mention of LEED in commercial project specifications has grown steadily at higher percentages. In 2009, mention of LEED was found in nearly 25% of the projects in the McGraw-Hill specification database captured that year, accounting for over 50% of the total value of projects.

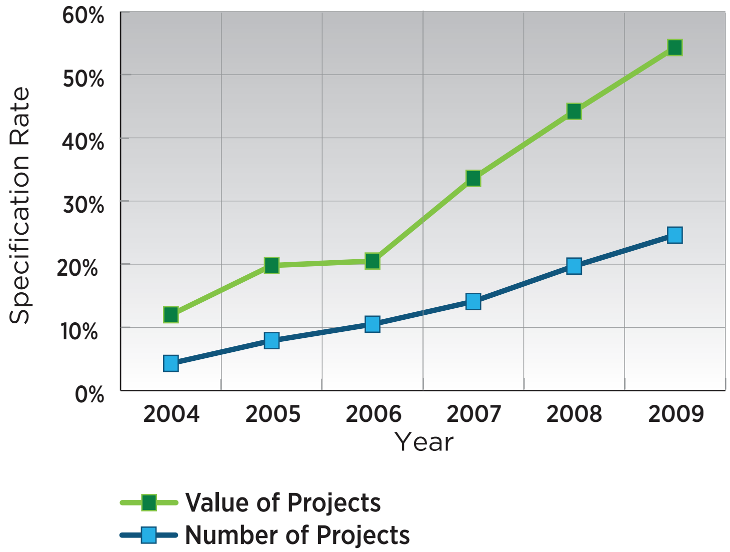
The high level of LEED specification compared to LEED registration may suggest that architects and specifiers are viewing LEED not only as a whole building certification program but also as a way of describing processes, systems and products.

LEED and the McGraw-Hill Construction Specification Database

LEED may be mentioned in the specifications for many reasons, including notification that the project is required or encouraged to achieve LEED certification or notification that the project is required to achieve a LEED certifiable building (without requiring actual certification). Another common reason for LEED to appear in the specifications is when a particular aspect of the building, such as energy performance, is required to meet the standards required to earn LEED points for that area. (For a fuller description of the Specification Database, please see page 17).

The occurrence of LEED in the specifications may be an indication of the influence the voluntary standard is having beyond those engaged in building a LEED project.

Figure 50
Appearance of LEED in Project Specifications
Number of Projects Versus Value of Projects



Source: McGraw-Hill Construction Analytics, SpecShare, 2004-2009

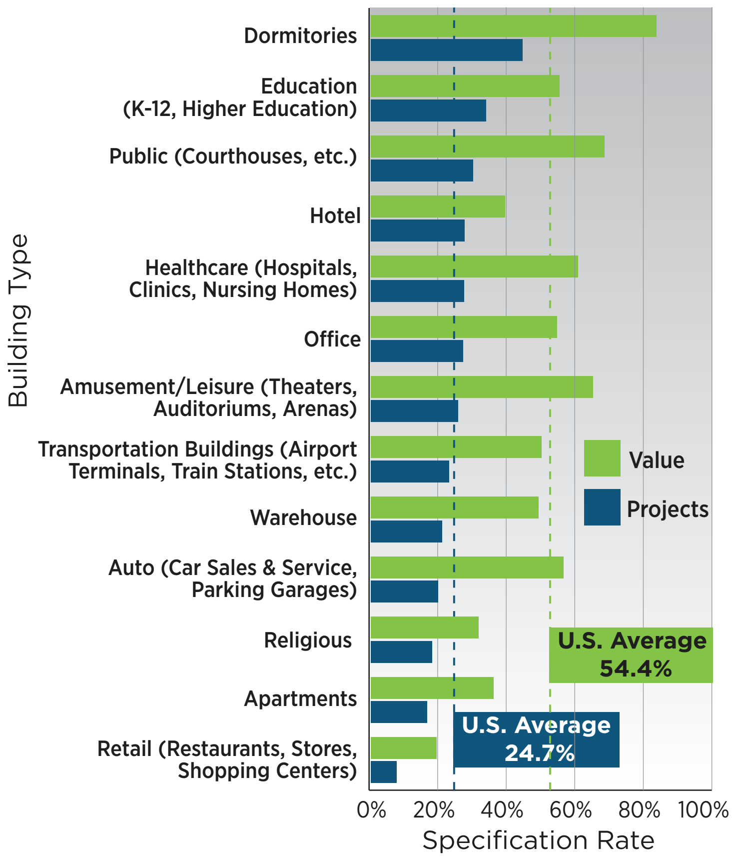
[35] McGraw-Hill Construction Building Stock Database (count of new starts from 2005-2009); Commercial Buildings Energy Consumption Survey, 2003, U.S. Department of Energy, Energy Information administration (total building stock count) <http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/detailed_tables_2003.html#enduse03>. Though not a completely accurate representation of the market due to the fact that LEED registered projects may not have come to start, it provides an order of magnitude of LEED activity in relation to the market.

Specification Differences by Building Type

The green building trends revealed by the use of LEED in the specifications of specific building types are similar to the energy-efficiency trends noted on page 41.

- **Dormitories:** Dormitories rank at the top of both the ENERGY STAR and LEED specification rate lists. The adoption of green building policies by public and private universities, combined with concerns over indoor environmental quality, are demonstrated by the references to LEED in projects that account for over 80% of the money invested in dormitory construction.
- **Public Buildings:** Based on the total value of the projects, public buildings are the next significant category, reflecting the widespread adoption of policies mandating or advocating LEED or green public buildings.
- **Healthcare:** The healthcare sector has seen a major investment in green building in the latter half of the decade, with over 60% of the projects by value including a reference to LEED.
- **Amusement/Leisure:** The high performance in this category differs from the energy-efficiency trends noted with the ENERGY STAR specification rates (Figure 46 on page 41). The high-profile nature of these projects and the public relations value of LEED are likely factors that contribute to the high specification rate. However, for large stadiums and other projects that make up the majority of the value in this category, high levels of energy efficiency are difficult to achieve.

Figure 51
Appearance of LEED in Project Specifications by Building Type
Number of Projects Versus Value of Projects



Source: McGraw-Hill Construction Analytics, SpecShare, January 2009-March 2010

Residential Buildings

A number of voluntary programs measuring and certifying green and energy-efficient homes exist, creating a market matching the industry—more fragmented and geographically driven.

Though many local energy efficiency and green home building programs exist through local Home Builder Associations (often based on the criteria from the National Association of Home Builders (NAHB) Model Green Home Building Guidelines created by the NAHB Research Center) and governments, there are three that have the most resonance at the national level—ENERGY STAR for Homes (U.S. EPA and DOE), LEED for Homes (U.S. Green Building Council) and the NAHB National Green Building Program.

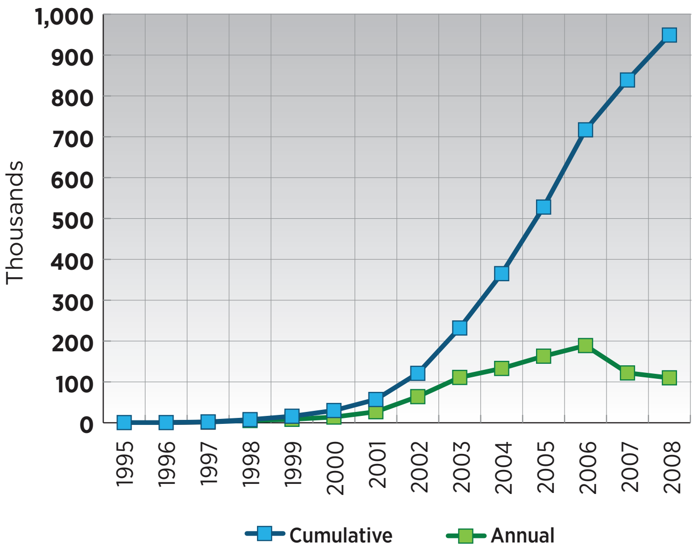
ENERGY STAR for Qualified New Homes

The ENERGY STAR label for single-family homes[36] helps homeowners to build and renovate their homes while keeping energy efficiency in mind. More than one million homes, located in every U.S. state, have been built to meet ENERGY STAR standards between 1995 and 2008.[37]

During this same time frame, approximately 18.3 million new homes were constructed,[38] with ENERGY STAR for Homes having a 5.5% penetration into the market. Additionally, from 2007 to 2008, approximately 640,000 new homes were built and 110,000 (or 17%) were ENERGY STAR homes, showing strong growth in recent years despite the economic downturn.

According to the ENERGY STAR program, its labeled homes are, on average, 15% more energy efficient than homes built to the 2004 International Residential Code.[39] With an average annual household energy bill of $2,003,[40] ENERGY STAR homes can save, on average, approximately $300 in annual energy costs.[41]

Figure 52
Annual and Cumulative ENERGY STAR Homes



Source: Energy Star Program, U.S. EPA/U.S. Department of Energy <http://www.energystar.gov>

[36] U.S. EPA defines single family home under ENERGY STAR for Homes to include single family detached homes as well as townhomes, row houses, duplexes and triplexes <http://www.energystar.gov/index.cfm?c=new_homes.nh_history>.
[37] "Benefits for Homeowners" ENERGY STAR, U.S. Environmental Protection Agency, U.S. Department of Energy. February 3, 2010 <http://www.energystar.gov/index.cfm?c=new_homes.nh_benefits>.
[38] U.S. Department of Census, 1995-2008 for single family and 1-3 unit homes <http://www.census.gov/const/starts_cust.xls>.
[39] "Features & Benefits of ENERGY STAR Qualified New Homes" ENERGY STAR, U.S. Environmental Protection Agency, U.S. Department of Energy <http://www.energystar.gov/index.cfm?c=new_homes.nh_features>.
[40] Buildings Energy Databook, U.S. Department of Energy, Table 2.3.9 <http://buildingsdatabook.eren.doe.gov/TableView.aspx?table=2.3.9>.
[41] "Benefits for Homeowners" ENERGY STAR, U.S. Environmental Protection Agency, U.S. Department of Energy. February 3, 2010 <http://www.energystar.gov/index.cfm?c=new_homes.nh_benefits>.

LEED for Homes

LEED for Homes, created by the USGBC, measures performance in eight areas: indoor environmental quality, energy efficiency, water efficiency, site selection, site development, materials selection, residents' awareness and innovation.

As of January 2010, there were 2,612 projects and 4,422 units certified under LEED for Homes—0.4% of the overall new single-family detached homes created from 2008 to 2009.[42]

Additionally, the LEED for Homes program has an Initiative for Affordable Housing (in partnership with The Home Depot Foundation) and the REGREEN Residential Remodeling Program (in partnership with the American Society of Interior Designers' Foundation). The LEED for Homes Pilot Rating System was released in September 2005, and the LEED for Homes Rating System was released in January 2008.[43]

National Association of Home Builders (NAHB) National Green Building Program

The NAHB National Green Building Program has two major components: building guidelines and a rating system. The NAHB Model Green Home Building Guidelines, which were published in 2005, focus on single-family homes and recognize three levels of green building performance: Bronze, Silver and Gold. A residential project can be Green Certified based on the NAHB Model Green Home Building Guidelines and the ICC 700-2008 National Green Building Standard. As of January, 2010, there were 850 certified projects and 500 projects with scheduled inspections, a relatively insignificant share of homes built during this time frame.[44]

Green Certification addresses several areas of green construction, including lot and site development, resource efficiency, energy efficiency, water efficiency, indoor environmental quality and homeowner education.[45] Only new, single-family homes can be certified under the NAHB Model Green Home Building Guidelines, while most types of residential construction or development projects can be certified under the National Green Building Standard.[46]

[42] LEED project information through January 2010, U.S. Green Building Council; Calculation of share of new home buildings based on the total number of homes built from 2007–2009 according g to U.S. Department of Commerce, Census Bureau <http://www.census.gov/const/starts_cust.xls>. Note, this time frame was used given that LEED for Homes Ratings System was released in 2008.
[43] "LEED for Homes" U.S. Green Building Council. February 3, 2010.
[44] Information from NAHB, telephone call with Calli Barker Schmidt, February 2010.
[45] "Project Certification Overview" The National Association of Home Builders. February 3, 2010. http://www.nahbgreen.org/Certification/default.aspx
[46] Ibid.

Energy Efficiency and Green Building Policy—State and Local

By the end of 2009, 35 states and Washington, DC, had instituted policies on green building (see definition of a green building on page 25) as did 253 city and local governments. In fact, the number of cities/local governments with a green building policy in place increased 66% between 2008 and 2009 alone.

Major Green Building Trends in State and Local Legislation

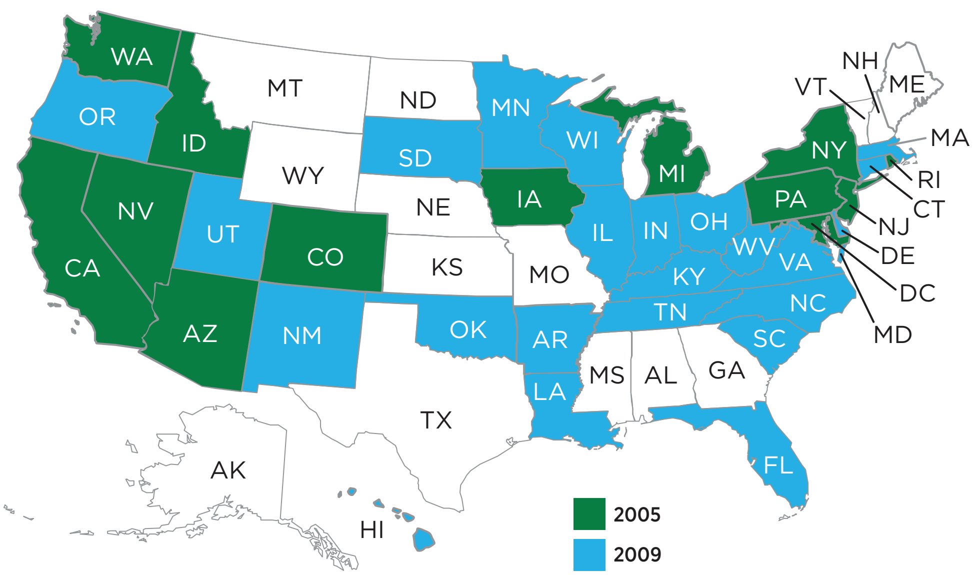
- **Mandating that public buildings achieve a green standard:** States and cities across the U.S. require public buildings to achieve a green building standard, either by requiring LEED or other green building certification or requiring projects to meet the city or state's own green requirements. Typically, these policies refer to new construction or major renovation work. This approach to encouraging green building is occurring in a wide variety of locations, including the State of Arizona; Atlanta, GA; and Evanston, IL. The policies in these areas require all public buildings to achieve a specific LEED standard.
- **Mandating that large private commercial buildings must meet green requirements:** A newer trend at the municipal level is mandating that commercial buildings meet green standards, including large cities, such as Boston, MA and Los Angeles, CA as well as small communities, such as the town of Babylon, NY.
- **Encouraging green building through incentives:** Rather than mandates, many local governments encourage green building by private firms by offering incentives to encourage voluntary adoption. Typical incentives include expedited building permits for green buildings, such as in Chicago, IL and Ventura, FL, or offering tax credits like those in Carroll County, MD.

Other Policy Trends Around Energy Efficiency and Buildings

Though not specific green mandates, newer trends are emerging around energy efficiency of both homes and commercial buildings.

- **Reporting commercial building energy performance:** Washington, DC and New York City have recently passed laws requiring all buildings to report their energy performance, and that information will be made publicly available. High energy use could impact a building's attractiveness as a property to buy or lease, thus encouraging energy-efficiency improvements without mandating them. Washington, DC will phase in reporting requirements over four years based on the size of the buildings, with buildings over 200,000 square feet required to report energy performance by the end of 2010 and buildings 50,000 square feet and over by the end of 2013.
- **Residential building energy-efficiency and green mandates:** Dallas, TX, and San Francisco, CA, both have energy-efficiency mandates in place for new construction and renovation of residential buildings. Dallas requires all residential buildings to be 15% more efficient than the 2006 International Energy Conservation Code (IECC). San Francisco has developed a Green Point rating system for residential work and requires that all buildings achieve a minimum score.

Figure 53
States with Green Building Policies (2005-2009)



Source: McGraw-Hill Construction Research & Analytics, 2005 - 2009

Chapter 7

Resources for More Information

Please note that due to space limitations, this is only a partial list of some programs available for further information and does not include state or academic resources. For more links, view the Information Resources on the U.S. Department of Energy's Building Technology Program website (http://www1.eere.energy.gov/buildings/information_resources.html) or visit the resource sites of the organizations listed below.

Federal Government Agencies and Programs

- **U.S. Department of Energy (DOE):** http://www.energy.gov
  - Department of Energy, Office of Energy Efficiency and Renewable Energy Site: http://www.eere.energy.gov/
  - Department of Energy Buildings Energy Databook: http://buildingsdatabook.eren.doe.gov/
  - U.S. Energy Information Administration: http://www.eia.doe.gov
- **U.S. Environmental Protection Agency (EPA):** http://www.epa.gov
  - EPA Clean Energy Information: http://www.epa.gov/cleanenergy/index.html
  - EPA Energy Portal: http://www.epa.gov/energy/
  - National Plan for Energy Efficiency: http://www.epa.gov/cleanenergy/energy-programs/napee/index.html
- **ENERGY STAR:** http://www.energystar.gov
- **National Laboratories Building Resources**
  - E.O. Lawrence Berkeley National Laboratory: http://eetd.lbl.gov/eetd.html
  - National Renewable Energy Laboratory: http://www.nrel.gov/buildings/
  - Oak Ridge National Laboratory: http://www.ornl.gov/sci/ees/etsd/btric/index.shtml
  - Pacific Northwest National Laboratory: http://eere.pnl.gov/building-technologies/
- **National Institute of Standards and Technology:** http://www.nist.gov
- **White House**
  - Energy and Environmental Issues : http://www.whitehouse.gov/issues/energy-and-environment
  - Council on Environmental Quality: http://www.whitehouse.gov/administration/eop/ceq
- **U.S. Department of Housing and Urban Development:** http://www.hud.gov
  - Office of Environment and Energy: http://www.hud.gov/offices/cpd/library/energy/index.cfm
- **U.S. Department of Commerce:** http://www.commerce.gov
  - U.S. Census Bureau: http://www.census.gov
  - Manufacturing, Mining and Construction Statistics: http://www.census.gov/mcd/

Nonprofit and Professional Organizations (alphabetical)

- Alliance to Save Energy: http://www.ase.org
- American Council for an Energy-Efficient Economy: http://www.aceee.org/index.htm
- The American Institute of Architects (AIA): http://www.aia.org
- American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): http://www.ashrae.org
- Associated General Contractors of America (AGC): http://www.agc.org
- Building Owners and Managers Association (BOMA): http://www.boma.org
- Building Performance Institute: http://www.bpi.org
- Clinton Climate Initiative: http://www.clintonfoundation.org/what-we-do/clinton-climate-initiative/
- Database of State Initiatives for Renewables and Efficiency (DSIRE): http://www.dsireusa.org
- Electric Power Research Institute (EPRI): http://my.epri.com/portal/server.pt
- Energy and Environmental Building Alliance (EEBA): http://www.eeba.org
- International Facility Management Association (IFMA): http://www.ifma.org
- National Association of Home Builders (NAHB), National Green Building Program: http://www.nahbgreen.org
- National Association of Home Builders Research Center (NAHBRC): http://www.nahbrc.org
- National Association of State Energy Officials (NASEO): http://www.naseo.org
- New Buildings Institute: http://www.newbuildings.org
- Portland Energy Conservation, Inc. (PECI): http://www.peci.org
- Pew Center on Global Climate Change, Energy Efficiency Resources: http://www.pewclimate.org/energy-efficiency/
- Sustainable Buildings Industry Council (SBIC): http://www.sbicouncil.org
- U.S. Conference of Mayors, Climate Protection Center: http://www.usmayors.org/climateprotection
- U.S. Green Building Council (USGBC): http://www.usgbc.org
- Zero Energy Commercial Buildings Consortium: http://www.zeroenergycbc.org
- The 2030 Challenge: http://www.architecture2030.org/2030_challenge/index.html

Global Agencies and Organizations (alphabetical)

- European Commission, Climate Action: http://www.ec.europa.eu/climateaction/eu_action/index_en.htm
- United Nations Environment Programme: http://www.unep.org
- United Nations Foundation, Climate and Energy: http://www.unfoundation.org/global-issues/climate-and-energy/
- World Business Council for Sustainable Development, Energy Efficiency in Buildings: http://www.wbcsd.org

McGraw-Hill Construction

- Main website: http://www.construction.com
- Research & Analytics: http://www.construction.com/market_research
- GreenSource: http://www.greensourcemag.com
- Architectural Record: http://www.archrecord.com
- Engineering News Record: http://www.enr.com
- Sweets: http://www.sweets.com
- Green Reports: http://www.greensource.construction.com/resources/SmartMarket.asp

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