



Commercial Buildings

Commercial buildings include, but are not limited to, stores, offices, schools, churches, gymnasiums, libraries, museums, hospitals, clinics, warehouses, and jails. The design, construction, operation, and demolition of commercial buildings impact natural resources, environmental quality, worker productivity, and community well-being.

Patterns of Use

- In the U.S., 5.6 million commercial buildings covered 87 billion square feet of floor space in 2012—an increase of 46% in number of buildings and 71% in floor space since 1979.^{1,2}
- By 2050, commercial building floor space is expected to reach 126.1 billion square feet, a 36% increase beyond 2018.³
- Education, mercantile, office, and warehouse/storage buildings comprise 60% of total commercial floor space and 50% of buildings.¹

Resource Consumption

Energy Use

- Commercial buildings consumed 18% of all energy in the U.S. in 2018.⁴
- In 2018, the commercial sector consumed 18.61 quadrillion Btu of primary energy, a 76% increase from 1980.^{4,5}
- Operating phase energy represents 80-90% of a building's life cycle energy consumption.⁶ In under 2.5 years of operation, a UM campus building with an estimated lifespan of 75 years consumed more energy than material production and construction combined.⁷

Material Use

- Typical buildings contain concrete, metals, drywall, and asphalt.⁸ Cement is a combination of ground minerals, which are mixed with sand, water, gravel, and other materials to create concrete.⁹ Structural steel made up 46% of the structural building material market share, followed by concrete in 2017.¹⁰
- In 2011, the construction of new low-rise non-residential buildings in the U.S. consumed about 627 million board feet of lumber, accounting for approximately 1% of all lumber consumed in the U.S.¹¹

Water Consumption

- In 2005, the commercial sector used an estimated 10.2 billion gallons of water per day, an increase of 23% from 1990 levels.⁵
- Domestic/restroom water is the largest end use in commercial buildings except in restaurants where 52% of the water is used for dishwashing or kitchen use.¹²

Life Cycle Impacts

Construction and Demolition Waste

- The EPA estimates that 230-530 million metric tons of construction and demolition waste are generated every year in the US.¹³ This amounts to at least 4.2 lbs per capita daily compared to the U.S. average of 4.4 lbs per capita per day of municipal solid waste.^{13,14,15}
- Approximately 40% of building waste was recovered for processing and recycling in 2007.¹⁶ Most frequently recovered and recycled were concrete, asphalt, metals, and wood.¹⁷

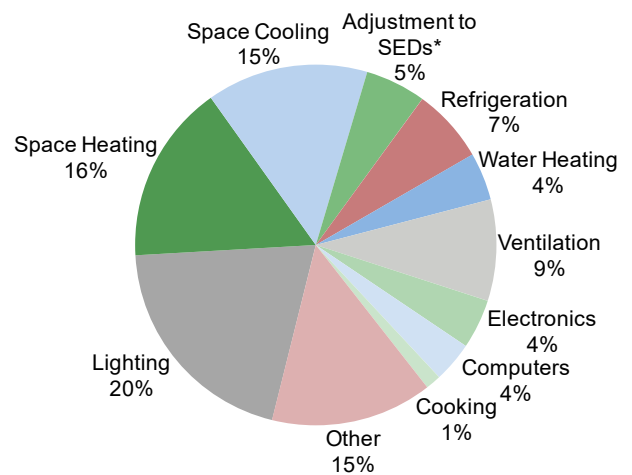
Indoor Air Quality

- Volatile Organic Compounds (VOCs) are found in concentrations 2 to 5 times greater indoors than nature. Exposure to high concentrations of VOCs can result in eye, nose, and throat irritation; headaches, and nausea; and extreme effects, such as cancer or nervous system damage. VOCs are emitted in buildings through adhesives, paints, solvents, aerosol sprays, and disinfectants.¹⁸

Greenhouse Gas Emissions

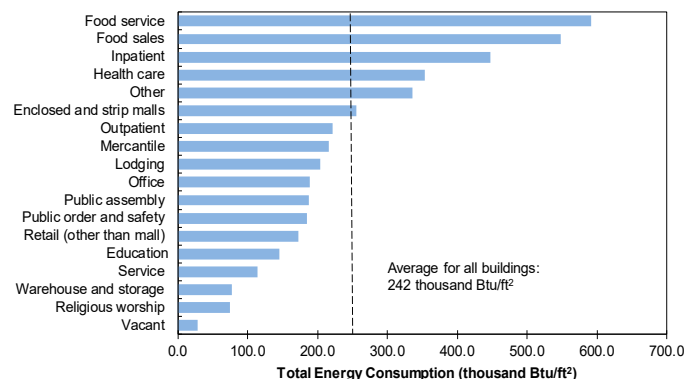
- The combustion of fossil fuels to provide energy to commercial buildings emitted 876 million metric tons of carbon dioxide (CO₂) in 2018, approximately 17% of all U.S. CO₂ emissions that year.³
- As operational emissions drop with the adoption of renewable energy, embodied emissions, those which are attributed to the building materials and energy for construction, will likely dominate new building emissions by 2050.¹⁹

U.S. Commercial Sector Primary Energy End Use, 2010⁵



*State Energy Database System (SEDS) is an energy adjustment that EIA uses to relieve discrepancies between data sources. Energy in this case is attributable to the commercial sector, but not to specific end uses.

Total Energy Consumption, U.S. Commercial Buildings, 2012¹



Solutions and Sustainable Alternatives

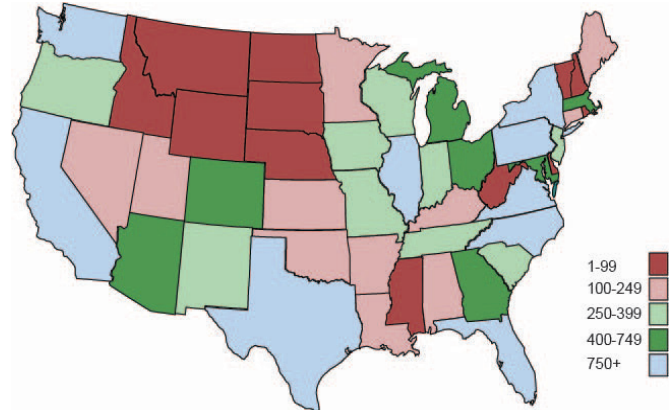
Opportunities

- Before 2000, little attention was paid to energy use and environmental impact of buildings, during design and construction. In 2013, an estimated 72% of buildings were more than 20 years old.²⁰ For typical commercial buildings, current energy efficiency measures can reduce energy consumption by 20-30% with no significant design alterations.²¹
- NREL found that 62% of office buildings, or 47% of commercial floor space, can reach net-zero energy use by implementing current energy efficiency technologies and self-generation (solar PV). By redesigning all buildings to comply with current standards, implementing current energy efficiency measures, and outfitting buildings with solar panels, average energy use intensity can be reduced from 1020 to 139 MJ/m²-yr, an 86% reduction in energy use intensity.²²
- Energy Star's Portfolio Manager tracks energy and water consumption.²³ The tool includes over 300,000 commercial buildings, and could serve as a national database to benchmark building performance and provide transparency to building managers and tenants.²⁴
- Erosion and pollution from stormwater runoff can be mitigated by using porous materials for paved surfaces and native vegetation instead of high maintenance grass lawns. A typical city block generates more than 5 times more runoff than a woodland area of equal size.²⁵

Design Guidelines and Rating Systems

- The U.S. Green Buildings Council developed the Leadership in Energy and Environmental Design (LEED) rating system. LEED is an evaluation metric for overall building performance, assigning points for design attributes that reduce environmental burdens and energy use.²⁶
- Passive House Institute US provides a climate specific building standards to minimize energy use and emissions. There are 5 principles of passive building, mainly focused on insulation and airtightness.^{27,28}
- The U.S. EPA Energy Star buildings program recognizes and assists organizations that have committed to energy efficiency improvement.²⁹
- The Living Building Challenge, an initiative by the International Living Future Institute, comprises seven performance areas, or 'petals': place, water, health and happiness, energy, materials, equity, and beauty.³⁰

LEED Registered Green Building Projects, New Construction³¹

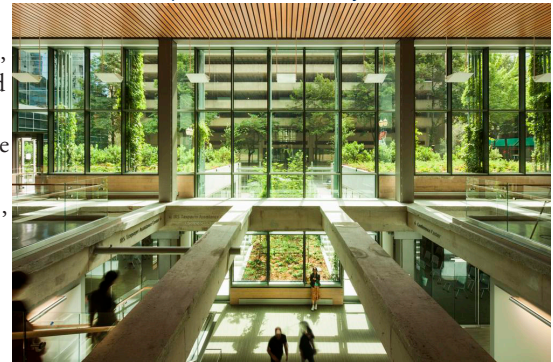


46,034 total U.S. certified projects (commercial, residential, etc.) as of May 2016.

Case Studies

- The Samuel Trask Dana Building, a 100-year-old structure located on University of Michigan's Ann Arbor campus, was renovated in 2004 to improve energy and environmental performance. Design features include photovoltaic electricity generation, natural lighting, radiant cooling, composting restrooms, and selective materials use and reuse. The renovation attained a LEED Gold rating.³²
- The Center for Sustainable Landscapes (CSL), was recognized by the American Institute of Architects in their 2016 Commitment to the Environment Top Ten Projects,³³ was the first building to meet these four green certifications: Living Building Challenge v1.3, LEED Platinum, SITES certification for landscapes, and WELL Building Platinum.³⁴
- Comparing the materials used in CSL to those of a conventional building reveals a 10% higher global warming potential and near equal embodied energy, due mainly to solar panels and inverters, concrete, steel, and gravel. Energy savings can come from flyash and blast furnace slag replacement in the concrete and the use of recycled steel.³⁵
- The AIA awarded the Edith Green - Wendell Wyatt Federal Building in Portland, Oregon the 2016 Top Ten Plus winner. This 512,474 square foot building achieved a 55% reduction in energy consumption, a 65% reduction in water consumption, and improved occupant satisfaction.³⁶
- Energy Star sponsors a "Battle of the Buildings" each year. In 2015 the ESCO project at Texas A&M, reduced average energy usage by 35.5% in six buildings, which saved \$548,900 and avoided 1,726 metric tons of greenhouse gas emissions. One building reduced energy usage by 89%.³⁷

The Edith Green - Wendell Wyatt Federal Building
AIA Top Ten Plus Green Project, 2016³⁶



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