Center for Sustainable Systems

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factsheets

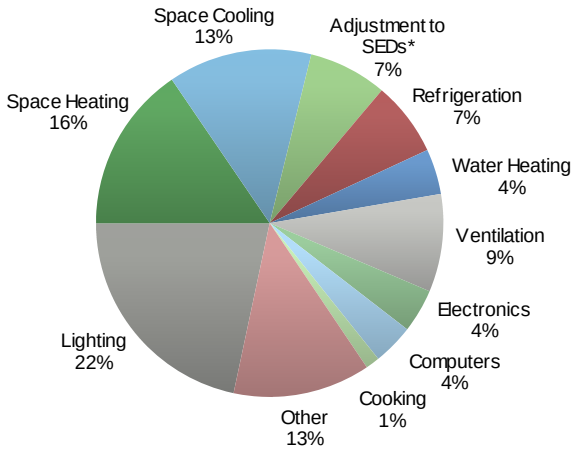
Commercial Buildings

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. Existing strategies offer tremendous opportunities for enhancing the overall sustainability of these structures.

Patterns of Use

- Commercial buildings consumed 19% of all energy in the U.S. in 2009.[1]
- 4.9 million commercial buildings in the U.S. covered 72 billion sq ft of floor space in 2003 – an increase of 28% in number of buildings and a 40% increase in floor space since 1979.[2]
- By 2035, commercial building floor space is expected to reach 109.8 billion sq ft – a 53% increase over 2003 levels.[3]
- Four activities dominate the commercial buildings sector – education, mercantile, office, and warehouse/storage – comprising 60% of total commercial floor space and 51% of buildings.[2]

U.S. Commercial Sector Primary Energy End-Use (2008)[4]



*SEDS is an adjustment made by EIA to relieve discrepancies between data sources.

Resource Consumption

Energy Use

- In 2008, the commercial sector consumed about 18.4 quadrillion BTUs of primary energy – a 74% increase over 1980 levels.[4]
- Lighting and indoor climate control consumed 41% of commercial sector primary energy in 2008.[4]
- Average site energy intensity per sq ft decreased by 7% between 1980 and 2008, from 118,000 BTU/sq ft to 110,000 BTU/sq ft.[1]

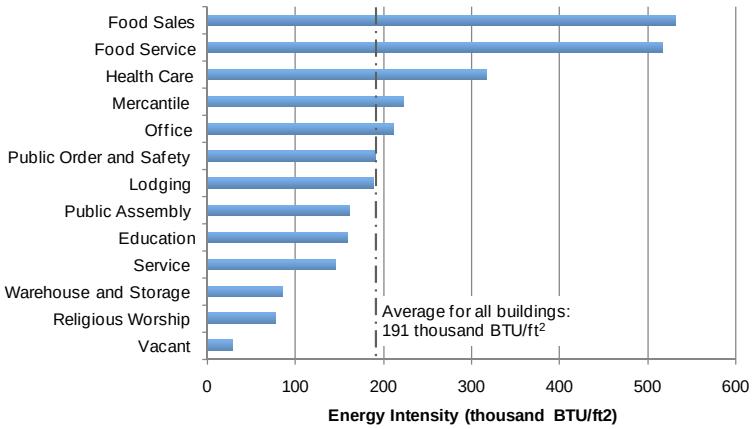
Material Use

- In 1998, the construction of new non-residential buildings in the U.S. consumed more than 4 billion board feet of lumber, accounting for approximately 12% of wood used in construction.[5]
- In 2001, construction of commercial buildings used 19 million metric tons of cement. From 1996 to 2001, 19% of all U.S. cement use was for commercial building construction.[6]

Water Consumption

- In 1995, the commercial sector used 9.6 billion gallons of water per day, an increase of 16% from 1990 levels.[7]
- Three applications account for 88% of water used in commercial buildings – sanitary (e.g. toilets and sinks), landscaping, and heating and cooling.[8]

Primary Energy Intensity for U.S. Commercial Buildings (2003)[2]



Life Cycle Impacts

Construction and Demolition Waste

- In 2003, the EPA estimated that construction, renovation and demolition of non-residential U.S. buildings generated 103 million tons of waste. This amounts to 1.94 lbs per capita per day – compared to 4.45 lbs per capita per day of municipal solid waste.[9]
- Between 20% and 30% of non-residential building waste was recovered for processing and recycling in 1996. The materials most frequently recovered and recycled were concrete, asphalt, metals, and wood.[9]

Indoor Air Quality

- Volatile Organic Compounds (VOCs) are found in concentrations 2 to 5 times greater indoors than naturally occurs in the environment. High exposure to VOCs can result in eye, nose, and throat irritation; headaches, loss of coordination, nausea, and extreme effects if concentrations are high enough, such as cancer or damage to the nervous system. VOCs are emitted into commercial buildings through carpet adhesive, paints, paint strippers, and other solvents; aerosol sprays; cleansers and disinfectants; and dry-cleaned clothing.[10]

Greenhouse Gas Emissions

- The combustion of fossil fuels to supply energy to commercial buildings resulted in the emission of 1,018 million metric tons of carbon dioxide (CO_2) in 2009. This represented nearly 19% of all U.S. CO_2 emissions in that year.[3]

Solutions and Sustainable Alternatives

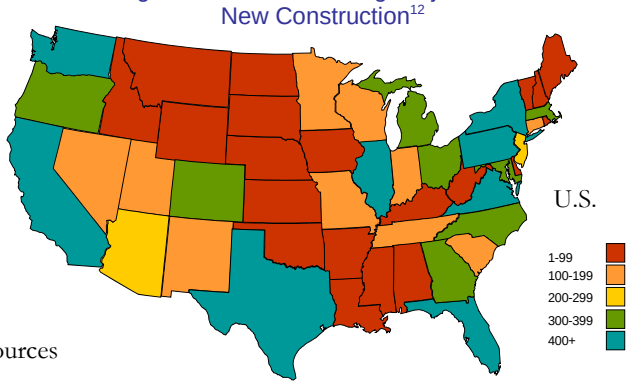
Opportunities

- Find ways to reduce environmental impacts and energy use during building operation – when a majority of building impacts occur. For example, in as little as 2.5 years of operation, commercial buildings may consume more energy than was required for material production and construction combined.[11] Consider workplace awareness initiatives on recycling, energy and water conservation.
- Consider opportunities to purchase energy from renewable sources to reduce fossil fuel use and emissions. Additional strategies for reducing building energy impacts include the use of passive solar heating and lighting, low emissivity windows, structural insulating panels, and energy efficient landscaping.
- Utilize renewable materials to improve sustainability and indoor air quality while reducing environmental impact and maintenance costs. The use of porous materials for paved surfaces can reduce pollution and erosion caused by stormwater runoff.

Design Guidelines and Rating Systems

- The Leadership in Energy and Environmental Design (LEED) rating system developed by the U.S. Green Buildings Council provides a system for evaluating overall building performance. The LEED system assigns points to buildings based on design attributes that reduce environmental or energy impacts. Additional information and resources: http://www.usgbc.org/LEED
- The Net-Zero Energy Commercial Building Initiative, sponsored by the Department of Energy (DOE), is a government research program focused on improving the energy efficiency of commercial buildings in the United States. Additional information and resources: http://www1.eere.energy.gov/buildings/commercial_initiative
- The U.S. EPA Energy Star buildings program provides recognition and resources to assist organizations that have committed to continuous energy efficiency improvement. Additional information and resources: http://www.energystar.gov

LEED Registered Green Building Projects* in the U.S: New Construction[12]



*30,116 Commercial Projects Were LEED Registered as of March 2011

Case Studies

- The Samuel Trask Dana Building, a 100 year-old structure located on the Ann Arbor campus of the University of Michigan, was recently renovated to improve energy and environmental performance. Added or enhanced building attributes include on-site photovoltaic electricity generation, natural lighting, radiant cooling, composting restrooms, selective materials use (cork, bamboo, linoleum, recycled glass, recycled plastics, biocomposites), and reclamation/reuse of original building materials.[13]
- The National Park Service recently renovated the visitor center at Zion National Park in Utah. The result was a 70% reduction in energy use achieved through the design and implementation of natural ventilation, efficient lighting, window glazing, insulation, passive cooling, Trombe walls, photovoltaics, energy-efficient landscaping, and digital energy management systems.[14]
- The American Institute of Architects recognized Twelve West in Portland, Oregon as one of the top ten green projects of 2010. This mixed-used commercial and residential structure received a LEED platinum rating and was designed to achieve the highest levels of urban sustainability. A large solar water heating system and wind turbines help to reduce fossil fuel use while efficient fixtures, low water roof plantings and rainwater recycling reduce water use. Simulations suggest an energy savings of over 45% above code and water savings of 47% compared to similar sized structures (complete top ten lists are available at http://www.aiatopten.org).[15]

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[1] U.S. DOE, Energy Information Administration (EIA) (2010) Annual Energy Review 2009.
[2] EIA (2006) *2003 Commercial Buildings Energy Consumption Survey*.
[3] EIA (2011) *Annual Energy Outlook 2011*.
[4] U.S. DOE, Office of Energy Efficiency and Renewable Energy (2011) *2010 Buildings Energy Data Book*..
[5] McKeever, D.B. (2002) *Domestic market activity in solid wood products in the United States, 1950-1998*. Gen. Tech. Rep. PNW-GTR-524. Portland, OR: USDA, Forest Service, Pacific Northwest Research Station.
[6] Portland Cement Association (2003) *United States Cement Industry Fact Sheet, 2003 Edition.*
[7] U.S. Geological Survey (1998) *Estimated Use of Water in the United States in 1995.*
[8] U.S. General Services Administration (1999) *Water Management Guide.*
[9] U.S. Environmental Protection Agency (EPA) (2003 and 1998) *Characterization/Estimation of Building-Related Construction and Demolition Debris in the United States*.
[10] EPA (2007) *An Introduction to Indoor Air Quality – Organic Gases (Volatile Organic Compounds - VOCs).*
[11] Sheuer, C., G.A. Keoleian, and P. Reppe (2003) "Life cycle energy and environmental performance of a new university building: modeling challenges and design implications." *Energy and Buildings* 35, 1049-1064.
[12] U.S. Green Buildings Council (2008 and 2011) "About LEED." Presentations.
[13] School of Natural Resources and Environment, University of Michigan (2003) "The Greening of Dana."
[14] U.S. Department of Energy (2003) "Zion National Park Visitor Center, Case Study."
[15] American Institute of Architects (2011) "AIA's Top Ten Green Projects."