

Southwest Energy Efficiency Project

Achieving 30% or greater energy savings in commercial buildings:

Building design options and technical assistance resources

March 4, 2008

Overview

State and local governments across the country are actively pursuing programs and initiatives that require new or substantially renovated commercial buildings to exceed commercial energy codes by 30% or more. Information is provided below regarding national, state and local commercial above-code programs. Most of the programs highlighted are designed to achieve a 30% or greater improvement in energy performance in commercial buildings. Experience from project implementation, however, suggests that 30% savings is cost-effective to the building owner; in some cases buildings have been constructed at this savings level at no additional incremental cost. Advanced buildings have been constructed that achieve savings of 50% or more by using energy-efficient designs and systems, including a combination of natural daylighting, highly efficient lighting systems and controls, and a well-designed and highly efficient thermal envelope, HVAC and water heating systems. Additional savings (above 50%) could be achieved through additional efficiency strategies, and by incorporating on-site renewables, including PV, solar thermal, and ground-source heat pump systems. Technical assistance and incentive programs are available at the federal, state and local levels to support high performance building projects, along with utility programs offered by Xcel Energy.

Program Design Options: Advanced Commercial Building Codes

30% Above-Code Performance

New commercial buildings can be constructed that achieve 30% or greater energy savings using energy efficiency best practices in the building design process, construction, and operation of the building.¹ One approach that local governments (e.g., Albuquerque) have used for implementing a more efficient commercial energy code is to amend the ASHRAE 90.1 requirements with more stringent requirements in targeted areas, such as building envelope, mechanical systems, lighting, and domestic hot water. Other states and cities (e.g., California, Seattle) have developed their own versions of energy codes that are more stringent than ASHRAE, and address additional aspects of building energy use (e.g., cool roofs). Links to individual state and local code programs are provided in the information resources section at the end of this paper.

The process for designing, building and operating a commercial building that achieves 30% energy savings is similar to a typical building, but with additional emphasis given to the design of the building and mechanical systems, performance of the building envelope and fenestration, and the efficiency and performance of building systems, including lighting, HVAC, and domestic hot water. For most commercial buildings, the 30% savings target can be achieved by following well defined prescriptive requirements that make incremental improvements to standard building design and construction practices. An illustrative example of the types of changes that could be used to achieve 30% energy savings is provided in Table 1. The table shows that achieving 30% savings can be accomplished with relatively modest improvements to the building heating and cooling systems and envelope, and a modest reduction in

¹ Compared to ASHRAE 90.1 – 2004 standard. ASHRAE recently updated Standard 90.1 in 2007. The new standard achieves 10% more energy savings than the 2004 standard

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lighting levels. Examples of commercial buildings that have achieved 30% energy savings relative to ASHRAE Standard 90.1 are included in the information resources.

Table 1. Examples of building design changes implemented to achieve 30% energy savings

	90.1-2004	2006 IECC	90.1-2007	AEDG-Small Office	189P
Mandatory	90.1-2004	90.1-2004	90.1-2004?	90.1-1999	90.1-2004
Heating Efficiency	80% E _c	80% E _c	80% E _c	80% E _c	81% E _c
Cooling Efficiency	10.3 EER	9.9 EER	11.2 EER	11.0 EER/ 11.4 IPLV	11.2 EER
Economizer	NR	NR	Yes	Yes	Yes
SWH Efficiency	80% E _t	80% E _t	80% E _t	90% E _t	80% E _t
Roof Insulation	R-15 ci	R-20 ci	R-15 ci	R-20 ci	R-25 ci
Wall Insulation	R-13 + R-3.8 ci	R-13 + R-3.8 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-10.0 ci
Slab Insulation	NR	NR	NR	NR	R-10 for 24"
Window U-Factor	0.57	0.55	0.55	0.42	0.45
Window SHGC	0.39	0.40	0.40	0.46	0.35
LPD	1.0 W/ft ²	1.0 W/ft ²	1.0 W/ft ²	0.9 W/ft ²	0.9 W/ft ²

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Source: Mark Halverson, PNNL. What Does 30% Better than Standard 90.1-2004 Look Like?

http://www.energycodes.gov/news/ecodes2007/presentations/commercial/Halverson_panel1.pdf

Guidelines are available from ASHRAE and the New Buildings Institute for achieving predictable energy savings at the 30% level for a variety of small- to medium-sized buildings (i.e., projects ranging from 10,000 to 70,000 square feet). ASHRAE has developed a series of *Advanced Energy Design Guides* that include prescriptive measures for achieving 30% energy savings in small office buildings, small retail, and K-12 schools. The Guides are available at no cost from ASHRAE. *Advanced Buildings Core Performance*, developed by the New Buildings Institute, is designed to achieve energy savings of 20 to 30% over ASHRAE 90.1-2004 through a series of integrated design strategies and prescriptive measures. For larger projects (>50,000 square feet), free energy design assistance and incentives for building efficiency improvements are available from Xcel Energy.

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Compliance options and paths

Compliance options could include the following:

- Demonstrate compliance using a prescriptive or system performance approach using the DOE COMCheck software program. Small office and retail buildings could comply by following the prescriptive measures contained in ASHRAE's Advanced Energy Design Guide, or the Advanced Buildings Core Performance Guide.
- Achieve LEED-NC Silver or higher, with minimum of 7 E&A points
- Achieve an ENERGY STAR rating of 80 or higher (ENERGY STAR qualification level is 75 out of 100 points)

50% Above-Code

A 50% improvement in building energy performance can be achieved by employing enhanced performance strategies that build upon the improvements made for a 30% savings. In addition to incremental improvements to the building envelope, mechanical systems, and lighting, a 50% improvement target could be achieved by employing a combination of advanced building design and performance strategies, including:

- Incorporating daylighting into the building design
- Additional lighting controls and power reductions
- Use of indirect evaporative cooling
- Heat recovery and night ventilation
- Premium economizers, variable speed controls, and
- Additional building commissioning using a third-party commissioning agent (CxA)
- On-site supply of renewable energy

It is more feasible to achieve 50% or greater savings level in the following building types:

- Low-rise buildings (less than 3-4 stories) with space for skylights and PV systems
- Warehouses and standalone retail stores

Examples of building achieving 50% or greater energy savings are provided in the information resources section.

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Technical assistance and incentives for advanced commercial buildings

There are many technical assistance resources available to help commercial building project developers design and construct highly efficient buildings. At the national level, the ENERGY STAR program offers project design tools, guidelines, and technical information resources to help design, build and operate highly efficient commercial buildings. In Colorado, Xcel Energy offers energy design assistance, including energy modeling to calculate LEED qualification levels for new commercial projects greater than 50,000 square feet. Incentives for prescriptive measures are available for smaller projects.

Technical Assistance Resources

ENERGY STAR www.energystar.gov

- Target Finder
- Guidelines for Energy Management
- Portfolio Manager (for tracking building energy use and operating performance)
- ENERGY STAR product information and savings calculators

Xcel Energy's technical assistance and incentive programs include:

- **Energy Design Assistance**, including free consultation, computer modeling and verification of measures for new buildings, additions and/or major renovations. The program includes analysis of energy savings to support LEED Certification. Eligible projects include:
 - New construction, additions or major renovations
 - Commercial buildings 50,000 sq. ft. or more, in early design stages
 - Housing and condominium projects 150,000 sq. ft. or more, not including garage space
- **Prescriptive rebates** for efficient cooling, compressed air, lighting (new construction and retrofit), and motors
- **Custom Efficiency programs** that provide rebates of up to \$200 per kW saved for cash incentives for choosing energy-efficiency measures that exceed standard options but aren't covered under Xcel's standard energy conservation programs.

For more information, see Xcel Energy's web site at: www.xcelenergy.com.

Federal commercial buildings tax credit

Advanced buildings may also be eligible for the federal commercial building tax credit of up to \$1.80 per square foot for improving the efficiency of existing buildings, or designing high efficiency into new buildings.

- To qualify for the full deduction, a building owner or tenant must make investments designed to reduce energy costs by 50% or more, compared to ASHRAE Standard 90.1-2001. A partial deduction of \$0.60 per square foot is available for investments in one of three systems—lighting;

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heating and cooling; or building envelope— designed to reduce energy costs by 16 and 2/3% (i.e., one-third of the 50% requirement).

For more information on the federal tax credit for commercial buildings, see:

- ENERGY STAR's fact sheet on commercial building tax incentives:
http://www.energystar.gov/ia/business/comm_bldg_tax_incentives.pdf
- DOE Building Technologies Program Fact Sheet
http://www.eere.energy.gov/buildings/info/documents/pdfs/bt_comm_tax_credit.pdf
- Energy Tax Incentives Assistance Project Web site
http://www.energytaxincentives.org/business/commercial_buildings.php
- NREL Energy Savings and Modeling Guidelines for Commercial Building Federal Tax Deductions
<http://www.nrel.gov/docs/fy07osti/40228.pdf>

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Information Resources on Advanced Commercial Energy Codes

ASHRAE Standards

Program: ASHRAE 90.1, 2007 (current commercial building code)

Description: ASHRAE 90.1 2007 is the latest version of ASHRAE's commercial building code. It includes additional energy efficiency measures in the areas of lighting, mechanical systems and building envelope. The 2007 version of 90.1 is about 10% more stringent than 90.1-2004.

Websites Overview of 90.1, 2007:
http://www.govenergy.com/2007/pdfs/lpl/Jarnigan_LPLtrack_S5.pdf
Standard:

Program: ASHRAE Standard 189, Standard for the Design of High-Performance, Green Buildings, Except Low-Rise Residential Buildings

Description

Proposed Standard 189, *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings*, will provide minimum requirements for the design of sustainable buildings to balance environmental responsibility, resource efficiency, occupant comfort and well-being, and community sensitivity. Using USGBC's LEED Green Building Rating System, which addresses the top 25% of building practice, as a key resource, Standard 189P will provide a baseline that will drive green building into mainstream building practices. This standard provides minimum criteria that:

(a) Apply to new buildings and major renovation projects (new portions of buildings and their systems): a building or group of buildings, including on-site energy conversion or electric-generating facilities, which utilize a single submittal for a construction permit or which are within the boundary of a contiguous area under single ownership

(b) Address sustainable sites, water use efficiency, energy efficiency, the building's impact on the atmosphere, materials and resources, and indoor environmental quality (IEQ).

Status: Draft issued; scheduled for a 45-day public review from February 22, 2008 to April 7, 2008.

Websites: general information: <http://www.ashrae.org/pressroom/detail/13571>
draft standard: <http://www.ashrae.org/technology/page/331#849>

Program: ASHRAE Advanced Energy Design Guides (30% above ASHRAE 90.1 -1999)

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Description: The ASHRAE Advanced Energy Design Guides (AEDG) are a series of publications designed to provide recommendations for achieving energy savings over the minimum code requirements of ANSI/ASHRAE/IESNA Standard 90.1-1999. The guides have been developed in collaboration with these partnering organizations: The American Institute of Architects (AIA), the Illuminating Engineering Society of North America (IESNA), the U.S. Green Building Council (USGBC), and the U.S. Department of Energy (DOE). The New Building Institute (NBI) participated only in the development of the Advanced Energy Design Guide for Small Office Buildings.

The initial series of guides have an energy savings target of 30% which is the first step in the process toward achieving a net zero energy building - defined as a building that, on an annual basis, draws from outside resources equal or less energy than it provides using on-site renewable energy sources. Each 30% Guide addresses a specific building type. Additional guides for existing buildings and at 50% energy savings towards a net zero energy building are also planned.

Status: Guidelines published for small office, small retail, and K-12 schools; available free from ASHRAE

Website: <http://www.ashrae.org/technology/page/938>

USGBC – LEED Standards

LEED-New Construction, Version 2.2

LEED-NC Version 2.2 requires new commercial buildings to be built at a minimum of 14% higher efficiency than conventional buildings (compared to ASHRAE 90.1 – 2004). Additional energy savings are achievable by specifying additional mandatory LEED points in the energy & atmosphere category.

Web site: <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=220>

State / Local Codes

California Title 24 – Commercial Building Regulations

Web site: www.energy.ca.gov/title24/

City of Albuquerque Energy Code

Provides amendments to ASHRAE 90.1 - 2004

<http://www.cabq.gov/sustainability/green-goals/green-building>

City of Seattle Energy Code

Estimated to achieve 10% savings over ASHRAE 90.1 – 2004

http://www.seattle.gov/DPD/Codes/Energy_Code/Overview/info_link.asp

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Eagle County Green Building Code (Residential and Commercial) (effective May 19, 2008 for commercial projects)

Provides a points-based checklist for commercial energy efficiency measures.

<http://www.eaglecounty.us/news.cfm?id=2838>

Background Information on commercial codes

Articles and Fact Sheets

John Hogan and Steve Ferguson. August 2007. ASHRAE Standard 189. *Building Safety Journal*. <http://www.iccsafe.org/news/green/0807BSJ36.pdf>.

Paul Torcellini. August 2007. Zero energy buildings defined.

<http://www.buildings.com/articles/detail.aspx?contentID=4987>

Commercial building tax credit. ENERGY STAR.

http://www.energystar.gov/ia/business/comm_bldg_tax_incentives.pdf

Presentations

ASHRAE 30% Code Improvement

Strategies for managing commercial building energy consumption. Paul Torcellini, NREL.

<http://www.metromayors.org/Downloads/TorcelliniPPT.pdf>

The ENERGY Performance of LEED Certified buildings. New Buildings Institute.

www.newbuildings.org/downloads/LEED_presentation_11-13s.pdf

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Commercial Building Examples

Small office

- Nature Conservancy Regional Headquarters, Boulder
http://www.bouldercolorado.gov/files/Environmental%20Affairs/naturecon_cs.pdf

Large office (including buildings with ground-floor retail)

- Public sector
 - EPA Region 8 Offices (LEED Gold), Denver, CO
<http://www.epa.gov/oaintrnt/facilities/denver-hq.htm>
http://www.epa.gov/oaintrnt/documents/denver_epabroch_508.pdf
 - Alfred Arraj Courthouse, Denver, CO
<http://www.eere.energy.gov/buildings/database/energy.cfm?ProjectID=179>
 - Wolf Law Building, CU Boulder
http://www.colorado.edu/conservation/documents/CULawSuccessStory_001.pdf
- Private sector
 - Scowcroft Building, Ogden UT
<http://www.eere.energy.gov/buildings/database/energy.cfm?projectID=423&language=en&submit=Go#select>
 - 7 Generations Office Park, Fort Collins, CO
(LEED Platinum application; 50% more efficient than ASHRAE 90.1-2001)
http://7genllc.com/7gop_overview.html

Retail space

- REI – Boulder (20-30% energy savings)
<http://www.rei.com/greenbuilding/boulder>
- Belmar, Lakewood
<http://www.greenconsortium.com/projects/other.php>
- Big Horn Home Improvement Center, Silverthorne (54% source energy savings)
Technical data:

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<http://www.eere.energy.gov/buildings/database/energy.cfm?ProjectID=54>

Brochure:

<http://www.eere.energy.gov/buildings/info/documents/pdfs/28545.pdf>

NREL report:

<http://www.eere.energy.gov/buildings/database/energy.cfm?ProjectID=54>

K-12 Schools

- Poudre Valley School District – Fossil Ridge High, Fort Collins
<http://www.fmlink.com/ProfResources/Sustainability/Articles/article.cgi?USGB C:200701-10.html> and
<http://fcgov.com/conservation/pdf/cs-fossilridge.pdf>
60% more efficient than a standard school; built at no additional cost.
- Poudre Valley School District – Kinard Junior High School
<http://www.greenconsortium.com/projects/other.php>

Manufacturing / Light Industrial

- New Belgium Brewing, Fort Collins
http://www.intermountainchp.org/casestudies/New_Belgium_Project_Profile.pdf

For more information, see SWEEP's Energy Efficiency Guide for *Colorado Businesses*, at:

- <http://www.coloradoefficiencyguide.com>