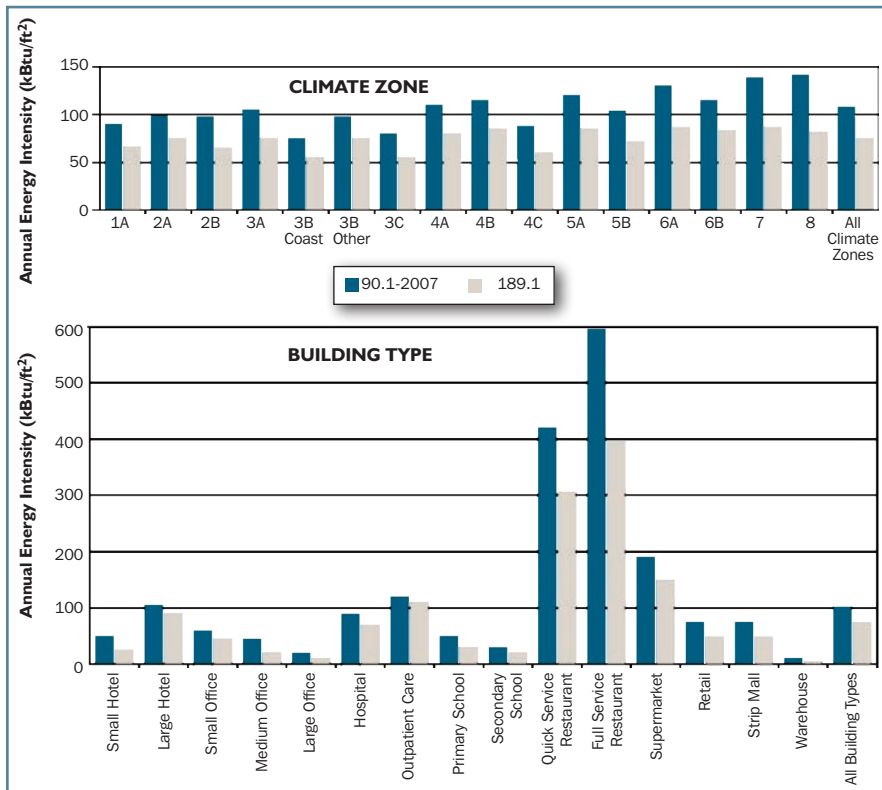


ASHRAE Journal's Guide to Standard 189.1



Energy savings attributable to Standard 189.1 vary substantially by climate zone and building type.

Climate Zone	City
1A	Miami
2A	Houston
2B	Phoenix
3A	Atlanta
3B-Coast	Los Angeles
3B-Other	Las Vegas
3C	San Francisco
4A	Baltimore
4B	Albuquerque, N.M.
4C	Seattle
5A	Chicago
5B	Boulder, Colo.
6A	Minneapolis
6B	Helena, Mont.
7	Duluth, Minn.
8	Fairbanks, Alaska

Energy performance modeling for Standard 189.1 used the climates zones from Standard 169-2006, the same climate zones as in Standard 90.1 with the 3B climate modified according to the DOE Commercial Building Reference Models for Energy Simulation.

Modeling Energy Savings

By Drury Crawley, Ph.D., Fellow ASHRAE; Paul Torcellini, Ph.D., Member ASHRAE; Nicholas Long, Member ASHRAE; Eric Bonnema, Associate Member ASHRAE; Kristin Field, Associate Member ASHRAE; Kent Peterson, P.E., Fellow ASHRAE

Developers of Standard 189.1—with its provisions for renewable energy, peak load reduction, and other efficiency improvements—were ambitious in setting the bar for energy performance. Their goal: an average 30% increase in site energy efficiency (i.e., a 30% decrease in site energy consumption) in comparison with Standard 90.1-2007.

Does Standard 189.1 hit the mark? That was the question evaluated by the U.S. Department of Energy (DOE) and researchers at the National Renewable Energy Laboratory (NREL). With the completion of the standard, NREL was tasked to run a series of simulations to measure the order-of-magnitude, site-energy-saving potential of Standard 189.1, modeling the performance of commercial reference prototype buildings across 16 climate zones.

The savings predicted by the initial modeling were impressive—and right on target. Indeed, the weighted energy savings across all modeled reference buildings was calculated to be 29.7% versus Standard 90.1-2007.

Yet, the more revealing story is in the details, as demonstrated in *Evaluation of Standard 189.1*, issued by NREL in May 2010. The report reveals substantial differences in the results across climate zones and building types and also highlights the importance of miscellaneous loads, which are sometimes more significant than any other factor in determining energy performance. Understanding the variables driving energy performance under Standard 189.1 is vital in setting appropriate expectations and achieving successful outcomes.

Methodology and Assumptions

Any simulation is only as good as its underlying methodology and assumptions. NREL relied as much as possible on



Section 7: Energy Efficiency

The goal of the developers of Standard 189.1 is an average 30% increase in site energy efficiency (i.e., a 30% decrease in site energy consumption) in comparison with Standard 90.1-2007.

established reference buildings and modeling assumptions, applying updates and changes as necessitated by the new standard. The DOE commercial building reference models for new construction, created with EnergyPlus¹ and OpenStudio² software, served as starting points for the models used in this study.^{3,4}

Approximately 2,000 simulations were performed with EnergyPlus over a two-week period as the basis for the initial analysis. Researchers were charged with generating minimally code-compliant models for Standards 90.1-2004, 90.1-2007, and Standard 189.1 for 15 of the 16 reference buildings (only the mid-rise apartment building type was excluded), with envelope, lighting, and occupancy based on the standards and incorporating mandatory provisions for vertical glazing/skylights, continuous air barrier, high-albedo roofs, daylighting controls, interior and exterior lighting power density, and exterior lighting controls.

Prototypical HVAC systems in the reference models were replaced with HVAC systems as defined by Standard 90.1, Appendix G, encompassing cooling/heating efficiencies, economizers, energy recovery, fan power limitations, supply fans, ventilation, and dampers. Sizing was determined from building size, number of floors, and residential or nonresidential status. These assumptions may have resulted in impractical system types for some building applications and may ignore system/control complexities for some situations (transfer air in restaurants, humidifiers in hospitals, etc.).

Energy-efficient plug and process loads (such as dishwashers, laundry machines/dryers, supermarket refrigeration, cooking equipment, and service water heating) were included from

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reference prototype research drawn from standards, industry-specific guides, and input from industry professionals.

According to Standard 189.1, there are two possible prescriptive paths for compliance with the equipment efficiencies portion (7.4.3.1). The “higher efficiency” path (7.4.3.1b) was modeled, instead of the “EPAAct baseline” path (7.4.3.1a). Notably, the “higher efficiency” choice reduced the amount of annual renewable energy production required from 6.0 kBtu/ft² (68 MJ/m²) of conditioned space to 4.0 kBtu/ft² (45 MJ/m²).

Modeling was done for each of the 16 U.S. climate zones defined in Standard 169. Once the simulations had run, the research team averaged the results across building types and climate zones using new construction weighting factors developed by the Pacific Northwest National Laboratory (PNNL)⁵ Finally, the team examined differences in energy intensity and percent savings between building types and climate zones (see Page S30).

Future simulations may incorporate some fine-tuning in model parameters, such as including refrigeration heat recovery and peak demand reduction and examining in finer detail the achievable plug and process load reductions offered by ENERGY STAR equipment.

Conclusions

Based on an initial analysis, Standard 189.1 yields significant energy savings over previous standards. In a weighted average, savings are approximately 30% relative to Standard 90.1-2007, with roughly one-third of those savings attributable to renewable energy and two-thirds attributable to energy efficiency.

Results vary substantially by sector and climate zone. Sectors seeing the greatest savings impacts relative to Standard 90.1-2007 are:

- Low-energy-use-intensity (EUI) sectors, such as offices and warehouses, where the renewables added by Standard 189.1 constitute a larger percentage of total EUI;
- Restaurants, where ENERGY STAR equipment requirements

tackle the largest end uses, and where variable speed drive (VSD) hood requirements also have a significant impact; and

- Lodging, where occupancy-based controls of lights, plugs, and HVAC play an important role, especially in smaller hotels and motels that are guestroom dominated.

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