Advanced Commercial Buildings Research

The National Renewable Energy Laboratory (NREL), a U.S. Department of Energy (DOE) laboratory, is leading the way in improving the energy efficiency of commercial buildings. Through innovative research, the Advanced Commercial Buildings Research team at NREL develops strategies and techniques to reduce energy use in commercial buildings and improve overall quality.

Addressing the energy impacts of buildings is key to reducing the nation's fossil fuel consumption. The buildings sector uses 39% of the primary energy in the United States. Commercial buildings account for 18% of that consumption and use 36% of the electricity, thus offering a huge opportunity for savings, increased energy independence, and reduced environmental impacts.

Our team addresses all commercial buildings–new and existing. For new construction, the goal is cost-effective net-zero energy commercial buildings, which produce as much energy as they consume annually. We also identify ways to improve the efficiency of the vast existing building stock. Both of these efforts are important to securing our nation's energy future.

Reaching the Goal of Net-Zero Energy Buildings

Advanced Commercial Buildings Research, in support of DOE's goals, develops technologies and design approaches to achieve net-zero energy buildings (NZEBs) with a focus on:

• Whole-building systems integration
• Comprehensive building energy modeling
• Cutting-edge energy efficiency technologies
• Systematic performance metrics and monitoring.

Our team's key strength lies in combining all these tools to design well-integrated buildings that reach the goal of cost-effective NZEBs.

Advancing the Whole-Building Design Approach

Whole-building design improves the efficiency and quality of buildings while minimizing costs. In this approach, everyone involved with a new building or major retrofit sets performance goals early to drive the design. This ensures systems are fully integrated and properly sized. Our researchers use whole-building design principles for projects such as:

• **Applied Industry Research.** We work with retail, commercial real estate, schools, and other sectors to create highly efficient buildings–from 50% energy savings to NZEBs.

> ## Working with Advanced Commercial Buildings Research at NREL
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> NREL's researchers establish technology partnerships to conduct joint research, provide technical assistance, and perform testing. To learn more, visit: *www.nrel.gov/buildings/working_with.html*.

RNL Design/PIX 16251

NREL's newest net-zero energy office building will utilize on-site renewable technologies to offset all of its energy use.
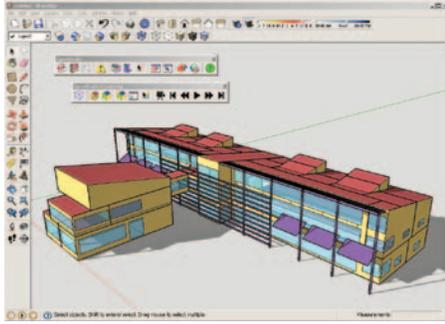
Our group helps to define measurable goals, procure design teams, apply life-cycle optimization, verify performance, and set up overall processes that ensure success.

• **Advanced Energy Design Guides.** In partnership with DOE and the American Society of Heating, Refrigerating and Air-Conditioning Engineers, we create climate-specific, comprehensive building recommendations to help a variety of facilities significantly reduce energy use.

Designing Better Buildings with Energy Analysis

Our experts develop advanced energy modeling tools to help the commercial building industry understand the energy impacts of design, maximize energy efficiency, and implement cost-effective measures for new and existing buildings. The following tools work as an integrated suite, each providing a unique set of capabilities:

• **EnergyPlus.** This whole-building energy simulation program models heating, cooling, ventilation, lighting, water systems, and other energy flows. Our team provides development support for this powerful tool and many in our group are expert users.

NREL

National Renewable Energy Laboratory
Innovation for Our Energy Future

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

OpenStudio bridges the gap between energy simulation and the design process, making it possible to perform simulations in a user-friendly 3-D environment.

- **OpenStudio.** This plugin generates an EnergyPlus input file from the Google SketchUp 3-D drawing program. We built OpenStudio to help architects and engineers quickly create energy models to assess a building's performance early in design.
- **Opt-E-Plus.** This analysis platform explores optimal energy-efficient design solutions by systematically evaluating multiple energy efficiency options. Our researchers use Opt-E-Plus while working with industry partners and to develop the Advanced Energy Design Guides.

Developing Technologies for Low Energy Buildings

Advanced Commercial Buildings Research develops technologies to improve the efficiency of new and existing commercial buildings in areas such as:

- **Heating, ventilating, and air conditioning (HVAC).** Our researchers run extensive tests on HVAC units in advanced laboratories and develop new, efficient technologies.
- **Lighting.** We are refining daylighting strategies to maximize the use of natural light and designing electrochromic windows that automatically control solar heat.
- **Controls.** By improving building controls, we are ensuring HVAC systems, lights, and miscellaneous electric loads provide optimal functionality at the lowest energy use.
- **Water and energy connections.** Our group is investigating the critical areas of water and energy systems and

how to balance the trade-offs between these two valuable resources.

The key to effectively retrofitting a building or constructing an NZEB is integrating these technologies to optimize a building's overall performance. Our team focuses on designing buildings as systems to achieve maximum efficiency.

Improving Building Performance Analysis

We produce metrics, benchmarks, and case studies to provide consistent building performance analysis. Additionally, these tools inform and validate energy modeling results to ensure simulations reflect real-world conditions:

- **Performance Metrics.** Our team develops standard performance metrics to evaluate the energy, carbon, and environmental performance of NZEBs.
- **Commercial Benchmark Building Models.** To ensure a consistent evaluation of energy codes and new technologies, we create standardized energy models of prototypical buildings representing the majority of commercial buildings in the United States.
- **U.S. Life-Cycle Inventory Database.** We lead development and data population of this database, which provides an accounting of the energy and material flows from producing a material or component and helps experts determine the lifetime environmental impacts of specific items.

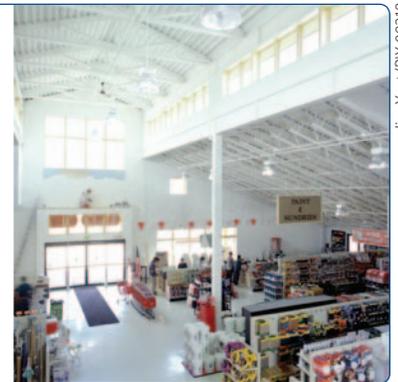## Realizing Net-Zero Energy Buildings and Communities

Our team is committed to improving the energy efficiency and quality of buildings in a cost-effective manner. Net-zero energy commercial buildings are possible and are being built today using tools developed at NREL. We are now looking toward the next goal by extending the lessons learned to create net-zero energy communities.

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Partnering to Ensure our Research is Market Ready

Advanced Commercial Buildings Research actively works with industry, universities, and government agencies to identify energy-efficient building technologies that can be used today. We participate in key DOE partnerships—the Commercial Building Energy Alliances and National Accounts—which involve representatives from various commercial sectors working toward more efficient buildings.

National retailers and the U.S. Army Corp of Engineers have also called on our researchers to improve the efficiency and design of their buildings. In addition, Sacramento, New Orleans, Greensburg, and other cities have asked Advanced Commercial Buildings Research to help with their energy goals. These partnerships ensure that our research applies to real-world situations.

Jim Yost/PIX 09218