LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

WINTER 2013:
VOL. 11, NO. 3

Better tools to simulate building energy use, new funding for advanced research in batteries and energy-efficient buildings, and a look back at energy savings in The New York Times' new headquarters building are just a few of the topics we look at in this packed Winter 2013 issue of *EETD News*.

EETD is pleased to be part of the latest U.S. Department of Energy hub, the Joint Center for Energy Storage Research, JCESR, just as we are pleased to be funded by the Advanced Research Projects —Energy agency of DOE to develop new, highly innovative technologies for buildings and the electric grid.

We also report on the construction of the FLEXLAB testbeds, and describe the work that facility's first four partners will be or already are doing with FLEXLAB.

We round out the issue with articles on the insurance industry's work to address climate change, the growth of energy-efficiency programs in the U.S., and the latest California Energy Future report.

If you are new to *EETD News*, please subscribe [http://eetd.lbl.gov/newsletter/sub/newsletter_signup.php].

—Allan Chen

EETD News reports on research conducted at Lawrence Berkeley National Laboratory's Environmental Energy Technologies Division, whose mission is to perform research and development leading to better energy technologies that reduce adverse energy-related environmental impacts. The Division's staff of nearly 400 conducts research on energy efficiency in buildings, indoor environmental quality, U.S. and international energy issues, and advanced energy technologies. The newsletter is published online once a quarter. For more information, contact Allan Chen, (510) 486-4210.

The *Center for Building Science News* was published between 1993 and 1998. It covered news of the Division's research in energy efficiency and buildings, the indoor environment, and energy analysis. You'll find all back issues, from Winter 1993 through Summer 1998, available here [http://eetd.lbl.gov/newsletter/cbs_nl/cbsnews.html].

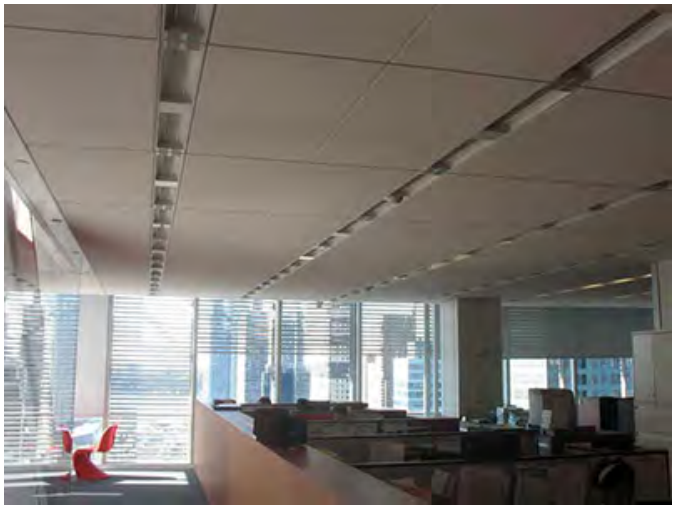
Winter Newsletter: Vol. 11, No. 3 [http://eetd.lbl.gov/newsletter/nl42/]
Environmental Energy Technologies Division News [http://eetd.lbl.gov/newsletter/]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Study Finds Big Energy Savings in The New York Times Building



Interior view of the Times Building five years after occupancy.
Photo credit: The New York Times Company

Designing a building holistically, and making sure that its components and systems work together according to design intent, can pay big dividends in energy savings and occupant satisfaction, according to a Lawrence Berkeley National Laboratory (Berkeley Lab) study of the performance of The New York Times Building in New York City.

Measured results from the post-occupancy evaluation showed a 24 percent reduction in annual electricity use and a 51 percent reduction in heating energy use, compared to expectations from a design that just met the prescriptive energy-efficiency code in effect at the time of construction (ASHRAE 90.1-2001), and a 25 percent reduction in peak electric demand. In addition, a significant fraction of occupants indicated a high level of satisfaction with the overall building and its design features. The Times Company's investment in advanced energy-efficiency technologies is estimated to yield a 12 percent rate of return on their initial investment.

"We aggressively pursued innovative designs to improve the quality of the workplace for our employees and to reduce energy use and other operating costs of our facility," said Angelo Salvatore, executive director of building operations at the Times Company, "and the outcomes of this study confirm that we were successful. More importantly, our hope is that the energy-efficient measures and designs documented in this independent study may inspire other companies' workplace designs."

Located near Times Square in New York, the 52-story building has 1.5 million square feet of commercial office space, and the Times Company has occupied floors 2 through 21 since the building's opening in 2007. A Berkeley Lab research team from its Environmental Energy Technologies Division (EETD) began working with the Times Company in 2003 to design, evaluate, and specify an integrated solution with energy-efficient lighting and automated shading systems for the windows in a full-scale mockup at a nearby Times Company site in Queens. The goal of the 18-month collaboration at the mockup, supported by The New York State Energy Research and Development Authority (NYSERDA), was to determine whether the advanced technologies could provide comfortable working conditions for the building occupants while maximizing energy savings. The test results in the mockup led to new performance specifications, a positive response from the manufacturing community, and ultimately the incorporation of these high-performance lighting, shading, and HVAC systems into the final building design. The completed building was occupied in 2007.

Since its completion, and because of the innovations incorporated into the design, the Times Building has attracted a lot of attention in the architectural and energy-efficiency community. The key unanswered question for this building, and most buildings, is "how is it performing?"

Members of the Berkeley Lab team and collaborators from the University of California, Berkeley's Center for the Built Environment assisted with the commissioning of the innovative HVAC system. They returned to the Times Building in 2011 and 2012 as part of their participation in the U.S. Department of Energy (DOE) Commercial Buildings Partnership (CBP) program to conduct a monitored evaluation of three installed energy-efficiency measures: dimmable lighting, automated interior roller shades, and the underfloor air distribution system (UFAD). The CBP aims to demonstrate validated, cost-effective low-energy technologies and systems that can be widely replicated nationwide in both new construction and retrofit projects in the commercial buildings market.

Designing from a system point of view yields best results

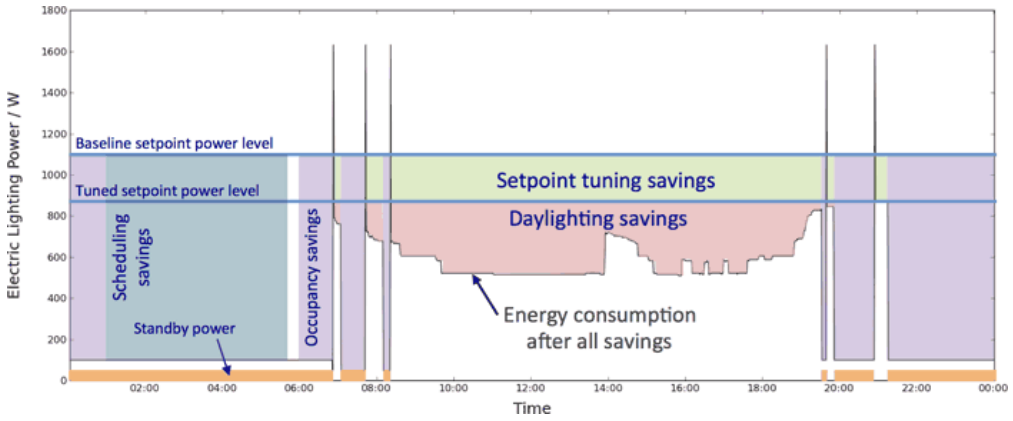
"The message of our study," says Eleanor Lee, the project's Principal Investigator, "is that by designing the building holistically—that is, considering the energy efficiency, indoor environmental quality, new technologies, and other factors like interior design and aesthetic appearance of the building together, you can achieve very high occupant satisfaction, as well as significant energy efficiency." It is not just designing for energy efficiency, but following through in the execution stages that lead to a successful result.

"During construction and after," Lee adds, "the Times Company facilities staff took the time to make sure the building was constructed according to design intent, and they commissioned the building before its opening—testing and adjusting the building's systems to ensure that they were performing properly. After the building opened, they continued to monitor the building's operation and made small adjustments to improve performance."

In an occupied building, for technical and practical reasons, the energy use of each system of interest cannot always be directly measured. To evaluate this building, the research team measured energy use and other data from the automated shading system, dimmable lighting system, and underfloor air distribution system on a typical floor in the building, and gathered other data throughout the building. The team used the measured data to calibrate the EnergyPlus model, then used the model to predict annual energy savings. (EnergyPlus is building simulation software developed by Berkeley Lab.) They also used occupant survey data, which was conducted for another report and gathered by Sustainable Energy Partnerships, to evaluate the success of the building in maintaining comfortable working conditions.

Dimmable lights with setpoint and sensors save energy

The building uses automatically dimmable lighting controls together with an automated shading system to minimize energy use and maximize occupant comfort. Occupancy-based controls turn off light fixtures eight minutes after occupants leave the area. The digitally addressable, dimmable lighting system enables staff to tune the lighting to their preferred lighting levels (called *setpoint tuning*). Whenever the daylight is present in the perimeter areas, the lighting control system dims or turns off the overhead lights automatically.



Example of how lighting energy use savings are attributed to each control strategy over a 24 h day. Control strategies include scheduling, occupancy, setpoint tuning, and daylighting.

Annual lighting energy use savings from the lighting control strategies (occupancy, setpoint tuning, and daylighting) was 56 percent (3.94 kWh/ft^2-yr) across a 40-foot deep perimeter zone compared to a code-compliant building with only the standard scheduled lighting controls.

The Sustainable Energy Partnerships survey results report that 57 percent of the occupants responded with greater-than-neutral satisfaction with the automatic lighting controls (occupancy sensors, dimming in response to daylight conditions). Seventy-eight percent of the occupants were very satisfied with the overall quality of the lighting in their workspace from daylight and the overhead lighting system. (The average rating was 5.53 on a 7-point scale, where a value of 4 is neutral.)

Automated shading system keeps sunlight within acceptable range

The automated motorized shading system regulates sunlight entering through the windows to reduce cooling, and can reduce glare from the sky. Its control algorithm is programmed to maximize incoming natural light but minimize the negative effects of glare and direct sunlight on occupant comfort. The system is also designed so that occupants can override the automatic system and raise or lower the shades if they are not satisfied with their environmental conditions.

The automated shading enabled lighting and cooling energy use reductions, and reductions in peak electric demand. Energy savings due to the shading system alone could not be measured directly, but the reduction in annual site energy use due to the combination of the three systems was estimated to be 26 percent (10.17 kBtu/ft^2-yr) across a typical tower floor compared to a code-compliant building.

Occupants on all floors overrode the automated shading system infrequently. For motors overridden at least once, 80% of these motors were overridden an average of 18 times per year (1.5% of the year), for an average total time of 38 hours per year during primary work hours. Forty-one percent of the occupants responded with slightly greater-than-neutral satisfaction with the automatic window shades, with an average rating on all 20 floors of 4.12 on a 7 point scale.

Underfloor air distribution system adds to comfort and energy benefits

A UFAD system distributes air from the plenum under the floor to ventilate and condition the space above. It helps save air conditioning energy by maintaining comfortable conditions in the lower occupied zone of the space, while allowing warmer and less comfortable conditions to exist in the higher-space elevations. The air conditioning setpoint can be higher (therefore lowering the airflow and reducing cooling) while still allowing the average conditions in the occupied zone to remain comfortable.

Temperature measurements in the interior zone showed a reasonable amount of air stratification (2°F–3°F difference between standing head height [67 in.] and ankle height [4 in.]) in the occupied zone—an indicator of good UFAD cooling performance.

Design, engineering, and follow-through on intent for better performance

"The care that the Times Company took to design, engineer, and follow through on the design intent behind the energy-efficiency measures and the actual performance of the technological measures themselves led to the building's meeting its goals for occupant comfort," says Lee. "A high percentage of building occupants said they felt that the new building enhanced their ability to do their job." Energy efficiency and occupant satisfaction are being achieved without an increase in operating expense. After some fine-tuning of the systems for a year after occupancy, Patrick Whelan, the Times Company's facilities director, said that maintenance and operations needs for the three systems were surprisingly minimal given the advanced technology incorporated into the three systems.

This study confirms that office buildings in an urban environment can deliver measured energy performance that substantially beats the energy codes with a combination of smart design, efficient technology, and properly integrated building systems, carried from design to construction and commissioning and into operations. The Times Company did its homework in 2004, well before the construction of the building, evaluating the shading and daylighting technologies in a 4,500 ft^2 full-scale mockup prior to installation in the actual building. Improved design tools and evolving building systems allow designers to capture the performance benefits without the use of such sophisticated studies. The lesson for replicating the success of this building on a large scale is that the technologies and systems solutions are available, but it is essential to pay attention to details such as procurement of building equipment and verifying the proper performance of the equipment after it is installed.

—Allan Chen

Additional information:

The study was conducted by: Eleanor S. Lee, Luis L. Fernandes, Brian Coffey, Andrew McNeil, and Robert Clear (Berkeley Lab) and Tom Webster, Fred Bauman, Darryl Dickerhoff, David Heinzerling, and Tyler Hoyt (Center for the Built Environment, University of California, Berkeley). It had support from the U.S. Department of Energy Commercial Buildings Partnership program and the California Energy Commission through its Public Interest Energy Research (PIER) Program. This DOE study incorporated findings on occupant response undertaken in a separate effort by Sustainable Energy Partnerships, with support from NYSERDA.

The report title is *A Post-Occupancy Monitored Evaluation of the Dimmable Lighting, Automated Shading, and Underfloor Air Distribution System in The New York Times Building*. Download the report here [http://buildings.lbl.gov/sites/all/files/lbnl-6023e.pdf].

Daylighting the New York Times Headquarters Building [http://windows.lbl.gov/comm_perf/newyorktimes.htm]

U.S. Department of Energy Commercial Building Partnerships program [http://www1.eere.energy.gov/buildings/commercial/cbp.html]

The U.S. Department of Energy and the California Energy Commission through its Public Interest Energy Research (PIER) Program provided funding for the research, along with in-kind support from The New York Times Company. The New York State Energy Research and Development Authority supported the occupancy survey, which began prior to the start of this research.

LAWRENCE BERKELEY NATIONAL LABORATORY

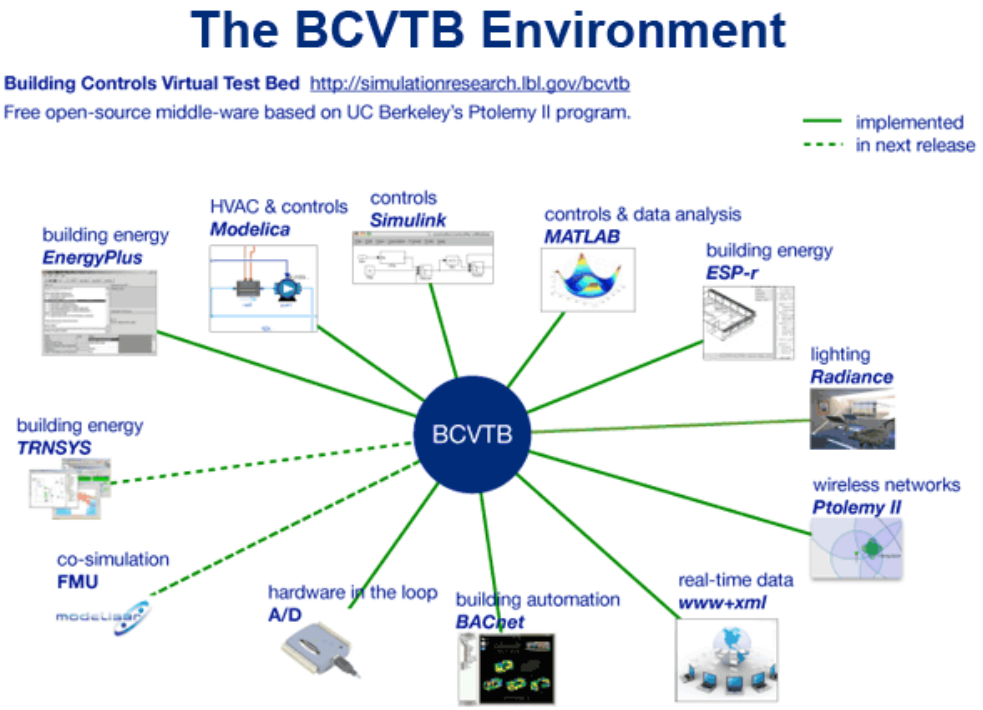
Environmental Energy Technologies Division

NEWS

The Building Control Virtual Test Bed: Improving Building Design and Operations

In today's complex building design environment, designers are increasingly using computer modeling to help them manage calculations, technologies, budgets, and occupant needs.

Using EnergyPlus—the U.S. Department of Energy's software that simulates energy use in buildings—designers can determine the most energy-efficient use of technologies and designs for the building. Other simulation and modeling platforms and languages accomplish other tasks; for example, the Modelica language can be used to simulate complex engineered systems (such as mechanical, electrical, and control systems), and the MATLAB and Simulink simulation tools can be used for scientific computing (creating algorithms to automate decision making and analyze data to find better ways to design and operate engineered systems).



Building Controls Virtual Testbed. Image credit: Johnson's Controls Building in Milwaukee, WI

In 2008, Lawrence Berkeley National Laboratory (Berkeley Lab) developed the Building Controls Virtual Test Bed (BCVTB), which enables these various simulation environments to "talk" to each other. The BCVTB is a software environment that allows expert users to couple simulation programs together virtually, and to couple simulation programs with actual hardware. Based on the Ptolemy II software environment (an open-source modeling and design software developed by the University of California at Berkeley), the BCVTB allows users to expand the capabilities of individual programs by linking them to other programs.

"The BCVTB allows users to test building control systems before they are installed in an actual building," said Michael Wetter, a BCVTB developer in Berkeley Lab's Simulation Research Group. "For example, the BCVTB allows users to simulate a building in EnergyPlus and the HVAC and control system in Modelica, while exchanging data between the software programs as they simulate," he said.

Advanced Co-Simulation

This ability to "co-simulate" gives designers the ability to use models that best accomplish the task needed for each function, rather than trying to modify one model to make it do something it was not specifically designed to do.

According to Wetter, the impetus to develop the BCVTB was to address some of these deficiencies that emerged as researchers and designers used models in more complex and innovative ways. For example, building simulation programs were not designed for multi-disciplinary analysis, and tools were unable to properly analyze innovative systems, control sequences, and equipment not yet included in software packages. When models or tools were not available, designers had to develop them themselves or to rely on expensive and time-intensive full-scale experiments.

The BCVTB overcomes these deficiencies with its co-simulation ability for a variety of software programs:

- The EnergyPlus whole-building energy simulation program
- The Modelica modeling and simulation environment Dymola
- The MATLAB and Simulink tools for scientific computing
- The Radiance ray-tracing software for lighting analysis
- The ESP-r integrated building energy modeling program
- The BACnet stack, which allows data exchange with BACnet-compliant Building Automation Systems (BAS)
- The analog/digital interface USB-1208LS from Measurement Computing Corporation that can be connected to a USB port

Other programs can be used and combined in the BCVTB environment as well.

Typical applications of the BCVTB include:

- Performance assessment of integrated building energy and control systems
- Development of new control algorithms
- Formal verification of control algorithms prior to their installation in a building—to reduce commissioning time

For example, by combining Modelica with EnergyPlus through the BCVTB, users can model the building heat flow and daylight availability and use Modelica to model innovative building energy and control systems using its "Buildings" library [http://simulationresearch.lbl.gov/modelica]. This allows even more advanced uses of the BCVTB:

- Define on-the-fly new HVAC components and systems in a modular, hierarchical, object-oriented, equation-based graphical modeling environment and couple them to EnergyPlus
- Innovate new HVAC system and control architectures for which models do not yet exist in off-the-shelf building simulation programs
- Analyze dynamic effects of HVAC systems, modeled in Modelica, and their local and supervisory control loops, modeled in MATLAB/Simulink, Modelica, or Ptolemy II
- Simulate virtual experiments prior to full-scale testing in a laboratory or a real building to determine the range of required boundary conditions, the type of experiments that need to be conducted and, for example, to improve a control logic in simulation where iterations can be made faster than in an actual experiment

Real-Time Data Inputs

In addition to coupling software programs together, the BCVTB can also be used as an interface between the simulated building and the actual sensors in the physical building. This approach allows real-time data to pass from the sensors into the simulated environment and be analyzed against best-case design scenarios. It can be used in a variety of applications, including research to improve equipment and controls, as well as in commissioning buildings once constructed and in operation.

Yao-Jung Wen, senior researcher at Philips Research North America, was one of the first BCVTB users.

"Philips is interested in lighting—what lighting controls can do for energy efficiency and how they interact with other building systems such as blinds or shades, heating or air conditioning," Wen said. "When we started working with the BCVTB, we wondered, 'What if we take EnergyPlus out, and plug in a real building?'"

In this scenario, sensors gave Wen's team actual light levels, which went to the BCVTB interface and were translated into the format that BCVTB recognizes. Then the data were sent to the control algorithm in MATLAB, back to the interface, and then back to the building—moving the blind or shade, for example.

"We used the BCVTB to create a separation between the controls and the physical systems so that the controller could easily be implemented, tested, and tuned with real performance feedback from a physical implementation," he said.

In another example, the research group at Johnson Controls is working with two universities who are using the BCVTB to couple simulation programs to test the way buildings and HVAC equipment are controlled—with a goal of improving energy efficiency while maintaining comfort.

With McMaster University in Ontario, they are developing and testing a new way to control an air conditioning unit using an advanced control strategy.

"McMaster is coupling an EnergyPlus model of the building with a Modelica model of the HVAC equipment, and is using MATLAB for optimization," said John House, a principal research engineer with Johnson Controls who is involved with the project. "The BCVTB has been directing the data flow between these various platforms."

On another project, Johnson Controls worked with the University of Southern California to study how to control building temperatures to minimize the cost of cooling a building.

"Specifically, they were trying to shift cooling loads from the afternoon when electricity was relatively expensive to early morning before occupancy, when the electricity rates were lower. The BCVTB was used to couple an EnergyPlus building model with optimization routines in MATLAB," House said. The team demonstrated the capability of the control algorithm to shift cooling loads in a Johnson Controls building in Milwaukee, Wisconsin.

"The BCVTB makes us much more efficient—it allows us to use the simulation tools that are best for a particular task," House said.

Worldwide Collaboration on Modelica

In June, the International Energy Agency—under the implementing agreement on Energy Conservation in Buildings and Community Systems—approved a five-year project called "Annex 60: New generation computational tools for building and community energy systems based on the Modelica and Functional Mockup Interface standards." In this project, led by Michael Wetter from Berkeley Lab and Christoph van Treeck from RWTH Aachen University in Germany, 30 institutes from 9 countries will share, further develop, and deploy free, open-source next-generation software for building and community energy systems.

The project will create and validate standardized tool chains that link building information models to energy modeling; building simulation to control design tools; and design tools to operational tools. By extending, unifying, and documenting existing Modelica libraries, the team aims to accelerate innovation and use of integrated energy-related systems and performance-based solutions for buildings and communities. Using the Functional Mockup Interface standard—a standard for co-simulation and for sharing models—users can link existing building performance simulation programs with such libraries and other tools.

The technology will allow for better design, analysis, and operation of multi-domain systems in building and community energy systems. It will also allow modeling across the whole-building life cycle to ensure that the design intent is realized and sustained.

—Kyra Epstein

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Building Controls Virtual Test Bed [http://simulationresearch.lbl.gov/bcvtb]

This research was funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Simergy Brings the Power of EnergyPlus to Designers and Architects

The U.S. Department of Energy's (DOE's) open-source EnergyPlus building energy simulation program has helped architects and engineers design more efficient buildings for more than a decade. However, it can take a great deal of effort to input information and analyze the output. As a result, many have avoided using the program, while others have turned to third-party graphical user interfaces (GUIs) to increase its effectiveness. As entities such as the California Energy Commission, Hydro Québec, and Trane switch from DOE-2 to EnergyPlus, it is more important than ever to combine an easy-to-use GUI with the powerful capabilities of EnergyPlus.

Simergy screenshots

Easier Access to EnergyPlus

To address the need for a more flexible, usable interface, the Simulation Research Group at Lawrence Berkeley National Laboratory (Berkeley Lab) worked with a public/private team to develop Simergy—a new GUI for EnergyPlus. Specifically designed for practitioners, the new, free GUI enables users to access the benefits of EnergyPlus much more easily. The beta version was released in October 2012 and is undergoing testing.

"The focus was on the end-user from the start of the project," says the Environmental Energy Technologies Division's (EETD) Philip Haves. "Berkeley Lab initiated and participated in a series of workshops where practitioners helped to define features that would enable them to use EnergyPlus effectively. We used their recommendations to develop a product that would meet their specific needs."

Evolving Simergy Development Will Continue to Broaden Usability

Version 1 of Simergy will address design for new construction and is slated to be released in the first quarter of 2013. It will incorporate feedback from several months of beta testing, and users will benefit from the following key features:

- Capability to manage and evaluate design alternatives.
- Ability to translate building envelope geometry from CAD or Building Information Models (BIM) to Building Energy Models (BEM). Workflows are based on the industry standard protocols IFC-Design Concept BIM and gbXML, or they can be generated by Simergy. The CAD input is an improvement over previous GUIs, especially when using IFC.
- Extensive sets of libraries and templates for construction materials, schedules and HVAC equipment, and systems for both conventional and low-energy systems.
- Drag-and-drop component-based HVAC schematic editing.
- Summary reports that can be customized to the user's desired level of detail.
- Interactive detailed results visualization.

Future developments are planned to include:

- Support for early-stage integrated design.
- Automated code compliance.
- For existing buildings, an integrated approach to semi-automated retro-commissioning, retrofit analysis, retrofit commissioning, and performance tracking for fault detection.
- Support for enhanced daylight modeling using a computationally efficient version of Radiance linked to EnergyPlus.

Using real-time EnergyPlus connected to a building control system, Version 2 of Simergy will be able to provide whole-building performance monitoring and fault detection. This capability will enable users to compare simulation and measurement for whole-building electric and gas, lighting, plug loads, and major HVAC components, to help maintain persistence of energy savings.

In addition, a professional version based on the free GUI is planned by one of the team's private-sector partners.

Simergy development is conducted by a public/private partnership led by Berkeley Lab and including Digital Alchemy, Hydro-Québec, Infosys Technologies, and Trane, with input on user requirements and template design from Arup, HOK, SOM, and Taylor Engineering. It has been funded by the California Energy Commission, DOE, Hydro-Québec, Infosys, the Northwest Energy Efficiency Alliance, and Trane.

—Mark Wilson

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Simulation Research Group's Simergy website [http://simulationresearch.lbl.gov/projects/gui]

Download the software [http://simergy-beta.lbl.gov/].

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Finds Climate Change to Be a High Priority in the Insurance Industry

Evan Mills

According to a Lawrence Berkeley National Laboratory (Berkeley Lab) study in the journal *Science*, the insurance industry—the world's largest business, with $4.6 trillion in revenues—is making larger efforts to manage climate change-related risks.

"Weather- and climate-related insurance losses today average $50 billion a year," says the study's author, Evan Mills, a scientist in Berkeley Lab's Environmental Energy Technologies Division. "These losses have more than doubled each decade since the 1980s, adjusted for inflation. Insurers have become quite adept at quantifying and managing the risks of climate change and using their market presence to drive broader societal efforts at mitigation and adaptation."

Hurricane Sandy is only the most recent U.S. example of the kinds of increasing liabilities posed by severe weather events in a changing climate.

Managing a portfolio of $25 trillion in assets, similar in size to mutual funds or pensions globally, the insurance industry has become a significant voice in world policy forums addressing the issue. It is also a market force, investing at least $23 billion in emissions-reduction technologies, securities, and financing, plus $5 billion in funds with environmental screens. The industry sees risks to investments in polluting industries and opportunities in being part of the clean-tech revolution.

Risk and Opportunity

"Where there are risks, there are opportunities," writes Mills. Responding to shareholder, regulatory, and market forces, three global initiatives (UN Environment Program Finance Initiative [1995], ClimateWise [2007], and the Kyoto Statement [2009]) have compelled 129 insurance firms from 29 countries to support climate research; develop climate-responsive products and services; raise awareness; reduce in-house greenhouse gas emissions; quantify and disclose climate risks; incorporate climate change into investment decisions; and influence public policy. The ultimate goals of these industry activities are to reduce climate-related losses among their customers and to reduce their own exposure to risk, which is rising in step with the magnitude and frequency of extreme weather-related events.

These insurers, together with reinsurance companies (the insurers of insurance companies), industry associations, brokers, catastrophe-loss modelers, and partners in the research community, have been using sophisticated analytical tools to quantify and diversify their exposure to climate change risk, more accurately price and communicate risk, and get adaptation and loss-prevention efforts up and running.

"Insurers from North America, Asia, and Europe worked with scientists through the three latest Intergovernmental Panel on Climate Change assessments dating back to the mid 1990s to better understand their exposure to climate change risk," says

Mills. "They expanded these collaborations into such projects as harmonizing economics-based insurer catastrophe models with climate models."

New Insurance Products and Services

According to the study, 1,148 climate change adaptation and mitigation activities have emerged from 378 entities in 51 countries, representing $2 trillion (44 percent) of industry revenue. For example, insurers have brought at least 130 products and services to market, encouraging the spread of more energy-efficient homes and commercial buildings by paying claims that encourage rebuilding to a higher level of energy efficiency after a loss. At least 65 other insurance-industry products address the risks and opportunities of the renewable energy industry.

For example, pay-as-you-drive insurance policies, now numbering nearly 3 million, offer auto insurance based on number of miles driven rather than a fixed premium. Global positioning system technologies verify driving distances, and policyholders benefit from a more accurate insurance premium. The price signal of lower premiums for miles actually driven could reduce U.S. driving by 8 percent, and oil use by 4 percent, reducing the cost of driving by $50 to $60 billion per year because of a lower chance of accidents and reduced traffic congestion.

Another innovative class of insurance products insures financial shortfalls if projects underperform at delivering energy savings or low-emissions power generation. Some insurance products manage the risks of carbon-trading transactions, such as wildfires that release carbon sequestered in forests. By assuming these risks and engineering the insured programs to minimize their losses, insurance companies pursue a broader policy objective of verifiable, bankable, persistent emissions reductions—all of which reduce the overall risks associated with climate change.

Leading by example is another type of climate change risk mitigation strategy being seen increasingly in the insurance industry. Many insurers have programs to reduce their own greenhouse gas emissions and purchase offsets, and 26 claim they have reached carbon neutrality. A creative example is the mangrove restoration by Tokio Marine and Nichido Insurance Co. taking place in India and southeast Asian countries. Begun in 1999, this project is close to reaching its goal of restoring 8,200 hectares (more than 20,000 acres) of mangrove forests in coastal areas of seven countries. Mangrove reforestation reduces exposure of coasts to storm damage and helps sequester carbon.

Activities in the Developing World

"In the developing world, poor populations have little access to insurance," says Mills. Decades ago, government and non-profit entities began issuing micro insurance policies that offer modest coverage in health, property, and life insurance for small premiums. Commercial insurers have followed suit, making tens of millions of these policies possible by integrating actuarial and environmental sciences into insurance models. Some of these products incorporate remote sensing and climate-sensitive methods to analyze the risks to crops and livestock.

There remain numerous opportunities to expand the innovation in the insurance industry, Mills believes. Some assert that the industry has not done enough. The federal government is the insurer of last resort for floods and crops in the U.S., but these climate risk techniques have not been applied to federal insurance programs. There's also not much research in the fields of loss modeling under future climates or comparative risk assessments of climate change response options—both of which could help guide policymakers about how to adapt to a changing climate.

Mills' study nonetheless demonstrates that market mechanisms are playing a large and growing role in the insurance industry's efforts to address the consequences of a changing climate.

—Allan Chen

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Insurance in a Climate of Change: The Greening of Insurance in a Warming World [http://insurance.lbl.gov]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Contributes to New Energy Storage Research Hub

Battery research at EETD

In November 2012, Lawrence Berkeley National Laboratory (Berkeley Lab) continued to expand its collaborative advanced battery and energy storage research by becoming a partner in the latest U.S. Department of Energy (DOE) Energy Innovation Hub—the Joint Center for Energy Storage Research (JCESR). Lead by Argonne National Laboratory, the JCESR partners —including other national laboratories, universities, and private-sector companies—are joining forces to develop the next-generation battery and energy storage technologies necessary to support electric and hybrid cars and the integration of renewable energy into the electric grid.

This new alliance follows on Berkeley Lab's creation of CalCharge, an energy storage research and development partnership, with CALCEF Catalyst earlier in 2012. The CalCharge consortium brings together academic and government resources with private-sector businesses to develop energy storage technologies and ease commercialization for vehicle, grid, and consumer electronics applications. Berkeley Lab's participation in JCESR will cast the net even wider, by contributing to and drawing upon the most advanced battery and energy storage research in the country.

United States Department of Energy Secretary Steven Chu lauded the collaborative effort. "This is a partnership between world-leading scientists and world-leading companies, committed to ensuring that the advanced battery technologies the world needs will be invented and built right here in America," said Secretary Chu. "Based on the tremendous advances that have been made in the past few years, there are very good reasons to believe that advanced battery technologies can and will play an increasingly valuable role in strengthening America's energy and economic security by reducing our oil dependence, upgrading our aging power grid, and allowing us to take greater advantage of intermittent energy sources like wind and solar."

Venkat Srinivasan, the Head of Berkeley Lab's Environmental Energy Technology Division's (EETD's) Energy Storage and Distributed Resources Department, sees benefits from not only the efficiencies inherent in collaborative energy storage research, but also from taking a fresh approach to the subject.

"The current practice is to pick a particular set of materials for the anode, cathode, and electrolyte and conduct R&D to see how these materials perform in terms of improving the energy density of the battery, cycle life, and other parameters," says Srinivasan. "But this has led to an improvement of only about five percent per year in battery energy density. To meet the energy challenges facing us, we need a revolution in battery energy density, cost, and lifetime."

Venkat Srinivasan

"In the Hub, we'll be bringing together a diverse group of scientists in chemistry, materials sciences, engineering, computational science, and others—some with battery research experience and some who are new to the field—and we'll focus on the mechanisms of energy storage in batteries. Instead of the specific material focus, we'll look at the mechanism as a whole and ask broad questions that no one has ever asked before. We hope that answering these questions will lead to new battery materials that no one has dreamed of."

Berkeley Lab Director Paul Alivisatos feels that the Lab's contribution will be substantial. "The energy storage Hub will leverage Berkeley Lab's core strengths in team science and in materials and chemistry for energy innovation. We're confident that the expertise Berkeley Lab researchers bring to the JCESR partnership will help this new Hub make great strides toward national energy solutions," he said.

All of the Hub partners bring high-level expertise to the effort. In addition to Berkeley Lab and Argonne, other national lab partners are Pacific Northwest National Laboratory, Sandia National Laboratories, and the Stanford Linear Accelerator Center (SLAC) National Accelerator Laboratory. University partners include Northwestern University, University of Chicago, University of Illinois-Chicago, University of Illinois-Urbana Champaign, and University of Michigan. Four industrial partners—Dow Chemical Company; Applied Materials, Inc.; Johnson Controls, Inc.; and Clean Energy Trust—will focus on smoothing delivery of the advanced products developed at JCESR into the marketplace.

The DOE is awarding as much as $120 million over five years to establish JCESR as a nationwide center for energy storage research. The Hub will be directed by George W. Crabtree, Argonne Senior Scientist and an internationally recognized leader in energy research. The program will coordinate the efforts of several successful independent research programs, working to overcome the current barriers to efficient, long-lasting energy storage. Illinois Governor Pat Quinn is providing $5 million from the *Illinois Jobs Now*! program to help build the JCESR facility on the Argonne National Laboratory campus just outside of Chicago. He is also working with the state's General Assembly to secure $30 million that the Hub could use in the future to fund capital projects.

Illinois Senator Dick Durbin summarized the benefits of this collaborative approach. "This new Hub brings together, under a single organizational roof, the world's leading scientists, engineers, and manufacturers in energy storage and provides them with the tools, resources, and market reach necessary to produce major breakthroughs. The large-scale, innovative research and transformational new battery systems that will result from this venture will mean more-effective, lower-cost, and longer-life energy storage technologies with real-world applications."

In California, the news was welcomed in Silicon Valley. "The Silicon Valley Leadership Group is excited to support the efforts of the Hub to develop next-generation batteries to make electric vehicles and clean energy technologies more efficient," said Carl Guardino, CEO of the 375-member Silicon Valley Leadership Group. "This public-private partnership between our national laboratories, universities, and member companies is exactly what we need to drive collaboration and innovation in the clean energy space."

Venkat Srinivasan, who will lead Berkeley Lab's involvement in JCESR, is excited at the possibilities that Berkeley Lab's new energy storage partnerships bring.

"With this hub and the creation of CalCharge, there's real momentum now towards making some progress in this important field," says Srinivasan. "We can all envision electric vehicles that travel hundreds of miles on a charge, or a battery to store electricity from solar panels for use at night. These partnerships will move us one big step closer to achieving those goals."

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Additional information:

Joint Center for Energy Storage Research (JCESR) [http://www.anl.gov/photos/joint-center-energy-storage-research-jcesr]

CalCharge [http://www.calcharge.org]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

ARPA-E Funds Berkeley Lab Projects on Buildings, Windows, and the Electric Grid

Lawrence Berkeley National Laboratory (Berkeley Lab) researchers have received two project awards from the U.S. Department of Energy's ARPA-E (Advanced Research Projects—Energy) program, and will participate in a third awarded to the University of California, Berkeley. One project will produce three-dimensional maps of commercial buildings, another will develop low-cost thermal window coatings, and a third will measure distribution lines on the electric grid.

Three-dimensional Maps Improve and Reduce Costs for Building Simulation

Prototype of the building mapping instrument package

Computer building simulations help architects and engineers design more energy-efficient buildings by identifying how a building is failing and what maintenance staff can do to tune up its energy-consuming systems. They can also suggest equipment upgrades for better energy performance and ensure that improvements are installed correctly and are delivering the expected energy savings.

"However, to do this, and do it in a lot of buildings," says Philip Haves, leader of the Simulation Research Group at Berkeley Lab's Environmental Energy Technologies Division (EETD), "we need better, cheaper, faster ways to generate computer models of the buildings we want to improve."

To do that, Haves will lead a project to develop sensing and computer hardware for generating physical and thermal maps of building interiors. The goal of the project, Rapid Automated Modeling and Simulation of Existing Buildings for Energy Efficiency, is to reduce the energy consumption of existing commercial buildings through computer simulation of building energy use. The team will produce three-dimensional indoor maps of buildings using backpack-mounted cameras and laser scanners.

Users walk through the building to gather data and video

A person wearing the instrument package will walk through the building to make a video of the building's interior and exterior, and a computer will then turn this video into a digital model of the building. Haves believes this technology can reduce the cost of building simulation by 30 to 40 percent and reduce the time it takes to develop a building model.

The Berkeley Lab team is collaborating with Professor Avideh Zakhor, who leads the Video and Image Processing Lab in the Electrical Engineering and Computer Science Department at the University of California, Berkeley, and Oliver Baumann of Ebert & Baumann Consulting Engineers in Washington, D.C. The image-processing techniques and the prototype backpack were developed by
Zakhor's group.

The project will receive up to $1.9 million in funding.

Controlling Light and Heat Through Windows With Electrochromic Technology

The goal of the Berkeley Lab Molecular Foundry project is to develop low-cost coatings that control how light and heat enter buildings through windows. Delia Milliron, Molecular Foundry Deputy Director, will lead the research to develop a new electrochromic window coating technology that can respond to changing weather conditions by regulating the visible light and heat entering a building through its windows, reducing energy usage. The Molecular Foundry team will work with the EETD Windows R&D team, headed by Stephen Selkowitz, and with Heliotrope Technologies.

By separately tuning the incoming infrared (heat) and visible (light) components, this technology will improve building energy efficiency by reducing the need for air conditioning and electric lighting, and enhance occupant comfort by managing the visible light that enters. The project's goal is to apply these coatings to windows using inexpensive techniques similar to spray-painting a car.

The Molecular Foundry will receive up to $3 million in ARPA-E funding for this project.

Advanced Monitoring for the Electric Grid's Distribution System

The California Institute for Energy and Environment (CIEE) at the University of California, Berkeley, is receiving ARPA-E funding to develop a device to monitor and measure electric power data from the grid's distribution system. Alexandra von Meier, Co-Director in CIEE's Electric Grid program area, is the project's principal investigator. She will be joined by EETD's Sila Kiliccote and David Watson, who will model and measure distribution lines on the electric grid.

"What's innovative about this work," says Watson, "is that while there are measurements on transmission lines, no one has been making measurements on distribution lines, where renewable resources are being added. This research will help enable more renewable power to be integrated with the grid, and it will lead to a more stable grid, less affected by the intermittency of renewable power."

This project will receive up to $4 million in ARPA-E funding.

—Allan Chen

Additional information:

Berkeley Lab press release [http://newscenter.lbl.gov/news-releases/2012/12/03/innovation-on-the-cutting-edge-advancing-energy-efficiency-through-two-new-arpa-e-projects-at-berkeley-lab/]

LAWRENCE BERKELEY NATIONAL LABORATORY

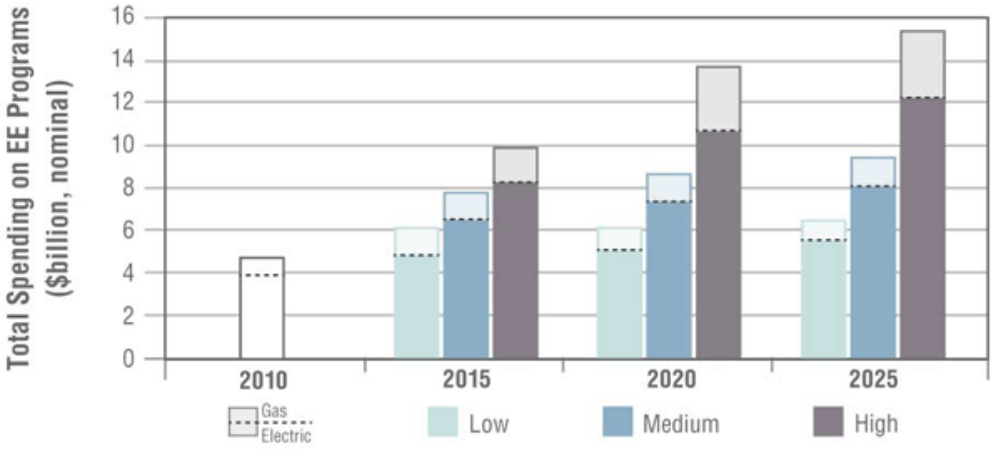
Environmental Energy Technologies Division

NEWS

Berkeley Lab Study Projects Explosive Growth of U.S. Utility Energy-Efficiency Programs

Spending on energy-efficiency programs funded by electric and natural gas utility customers will double by 2025 to about $9.5 billion per year, according to Lawrence Berkeley National Laboratory (Berkeley Lab) research.

These funds, which come from a charge on utility bills, historically constitute the nation's largest source of spending on programs to foster the adoption of more-efficient products and buildings. According to the Berkeley Lab report, energy-efficiency programs funded by utility customers are projected to continue to expand beyond the traditional bastions of energy efficiency in the Northeast and West.



Total spending on energy efficiency programs, $

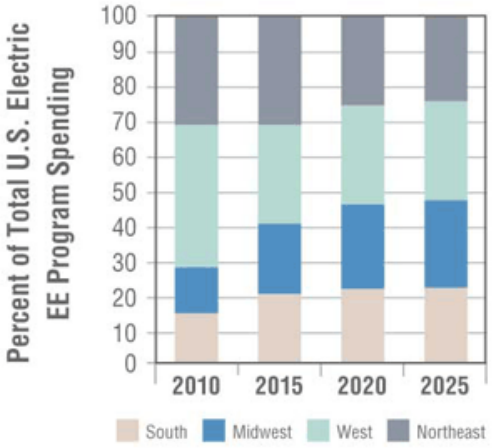
By 2025, states in the Midwest and South could account for 49 percent of total U.S. spending on customer-funded energy-efficiency programs, up from 27 percent in 2010. By 2025, only a handful of states would not have significant customer-funded efficiency programs.

The projected growth in program spending is driven by policies in a number of states that require utilities to obtain all cost-effective energy-efficiency savings. Another driver is energy-efficiency resource standards, which require electric utilities to meet minimum energy savings goals each year.

"In addition, we see some utilities turning to energy efficiency as part of their strategy for reliable delivery of electricity as older coal-fired generators are retired," said staff scientist Charles A. Goldman, a co-author of the study and head of the laboratory's energy analysis and environmental impacts department.

For the analysis, the Berkeley Lab team developed low, medium, and high scenarios for program spending and savings, intended to reflect a range of potential outcomes under the *current* policy environment—that is, without considering possible major new policy developments. The analysis was based on a detailed review of all relevant state policies and legislation, regulatory filings and decisions, and utility integrated resource and demand-side management plans. The researchers refined the scenarios through extensive interviews with regional and national energy efficiency experts, efficiency program administrators, regulatory staff, and other industry actors.

Galen Barbose, the report's lead author, explained that "this study is intended to provide a detailed, bottom-up analysis of state policies and to capture the market context in which programs operate."



Percent of total U.S. electricity energy efficiency program spending by region

Total U.S. spending on electric and gas efficiency programs (excluding load management programs) is projected to grow in all scenarios examined, ranging from $6.5 billion to $15.6 billion in 2025, with a mid-range projection of $9.5 billion under a scenario in which states are fairly successful in ramping up their programs to meet state energy-savings policies now on the books. This compares to total spending of $4.8 billion in 2010. As discussed within the report, the range in potential spending trajectories reflects a number of key challenges and significant uncertainties in market and policy drivers. These include concerns about utility rate impacts from energy-efficiency programs, the timing and pace of the economic recovery, the long-term trend in natural gas prices, and the impact of recent and possible future changes to federal and state minimum efficiency standards for appliances and building codes.

If states remain on their current policy paths, annual incremental savings from electric energy-efficiency programs could be expected to reach about 0.8 percent of retail electricity sales in 2025, compared to about 0.5 percent of retail electricity sales in 2010.

Significantly, electricity savings at that level in 2025 could offset the majority of load growth forecasted through that year in the Energy Information Administration (EIA)'s most recent reference case forecast for electricity usage. This assumes that the EIA forecast correctly estimates savings from future customer-funded energy-efficiency programs.

"So far, only a few very aggressive states have come close to offsetting growth in electricity needs through efficiency," Goldman said. "Our finding that, in aggregate, U.S. energy-efficiency programs could offset a significant portion of projected load growth in the electricity sector over the next decade is subject to some uncertainties but striking nonetheless."

In the *current* policy and market environment, spending on gas energy-efficiency programs is projected to continue its rise in the near term but flatten from 2015 onward, reflecting the influence of low natural gas prices and new state and federal equipment efficiency standards.

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The report, entitled *The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings to 2025*, was funded by the U.S. Department of Energy's Office of Electricity Delivery and Energy Reliability and can be downloaded [http://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf].

A PowerPoint briefing that summarizes key findings from the report can also be downloaded [http://emp.lbl.gov/sites/all/files/lbnl-5803e-brief.pdf].

An abbreviated version of the report, excluding the technical appendix, appeared in January in *Energy Efficiency Journal* [http://link.springer.com/article/10.1007%2Fs12053-012-9187-1].

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

California's Energy Future: Buildings and Industrial Efficiency

The California Council on Science and Technology has released the next in its series of studies documenting the technology required to meet radical greenhouse gas (GHG) emission cuts by 2050 (80 percent below 1990 levels). This report focuses on strategies for reducing energy use and greenhouse gas emissions through energy-efficient technologies and retrofits of the residential and industrial sectors. The report's authors are Jeffery Greenblatt, Max Wei, and James McMahon of Lawrence Berkeley National Laboratory (Berkeley Lab).

"We found that although we couldn't solve the entire GHG problem through efficiency alone, we expected that outcome. On the positive side, we were able to conclude that although it will be very challenging, substantial levels of additional efficiency and electrification in buildings and industry are possible, with large GHG benefits," says lead author Jeffery Greenblatt, a staff scientist in the Environmental Energy Technologies Division (EETD).

Because population and economic growth are projected to roughly double the total demand for energy services by 2050, achieving 80 percent GHG reduction from 1990 levels actually requires a 90 percent reduction from 2050 emissions if nothing is done (the business-as-usual [BAU] case). For the residential and commercial buildings sector, the research team examined the savings achievable through four categories of efficiency improvements: reduced capacity (downsizing, such as smaller refrigerators, or space conditioning one room rather than the whole building), increased efficiency (often through new technology), reduced usage (a combination of technology-facilitated control and behavior change), and system integration (combining elements of several service categories).

They found that although it was possible to reduce energy use *technically* to meet California's 80 percent GHG reduction goal in the residential and commercial buildings sector, the potential is limited by economic feasibility and finite rates of implementation. However, the report's analysis provides guidance to the policy community on which energy-efficiency strategies, combined with other greenhouse gas reduction policies in transportation, renewable energy, and electrification might move the state more rapidly towards its goal.

By looking at the rate of new construction, retrofit, and demolition, and by estimating the energy-efficiency improvements that are typical of existing homes, the report concludes that a 40 percent efficiency savings is possible in the 2050 California building stock relative to 2010 for both the residential and commercial sectors.

In the area of industrial energy efficiency, the research team estimated that the potential for a 48 percent overall reduction in energy use relative to BAU was possible by 2050. The analysis included a detailed examination of the oil and gas refining (60 percent of industrial energy use) and the food industry (17 percent of energy use), for which extensive data are available. They assumed that oil demand decreases substantially by 2050, replaced by large-scale vehicle and building electrification and the increased use of biofuels.

For other industrial sectors, the research team looked at similar processes (e.g., boiler systems, process heating, motor systems) for savings potential based on commercially available technologies, and then estimated the fraction of total industrial activity involving that process by industry sector.

The study does not examine policies that can realize these reductions in emissions—that is the subject of another study, called California's Energy Future Policy, which is now in progress.

—Allan Chen

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Additional information:

Download the report [http://ccst.us/news/2012/1129cef.php].

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Construction on FLEXLAB Testbeds Moves Forward with Groundbreaking

At Lawrence Berkeley National Laboratory (Berkeley Lab), the research environment for energy-efficient buildings is about to take a quantum leap forward, as construction of the Facility for Low-Energy eXperiments on Buildings (FLEXLAB) continues. In December 2012, Berkeley Lab leadership and distinguished guests from the U.S. Department of Energy, the state of California, utilities, and the building industry broke ground on the exterior portion of FLEXLAB; following closely on the opening of FLEXLAB's interior space in November. After the groundbreaking, Berkeley Lab hosted an industry roundtable focusing on the facility's capabilities, industry research needs, and possibilities for collaborative research.

"Our new FLEXLAB facility will open the doors to many new ideas on how we can reduce energy consumed by buildings," says Ashok Gadgil, director of Berkeley Lab's Environmental Energy Technologies Division (EETD). "Today, buildings are responsible for about 40 percent of our nation's greenhouse gas emissions. Finding new, advanced, building technologies should help us save up to 80 percent on new construction."

L-R: Don DePaolo, Assoc. Lab Director; Mark Chekal-Bain, Chief of Staff for Assemblymember Nancy Skinner; Robert Weisenmiller, Chairman, CA Energy Comm.; Steven Chalk, DOE Deputy Assistant Secretary for Renewable Energy; Horst Simon, Dep. Lab Director; Ashok Gadgil, Director, EETD

"FLEXLAB will be the most advanced, heavily instrumented facility for developing and validating the performance of new energy-efficient building controls and technologies in the U.S.," says Cindy Regnier, Technical Manager of the FLEXLAB facility. "By allowing scientists, the building industry, and the architecture and engineering community a chance to change out and combine building components to develop them as integrated systems, FLEXLAB will allow its users to develop low-energy-use building designs whose total energy savings will be greater than the additive savings of the individual components."

Construction teams are now building the four testbeds that collectively form FLEXLAB's exterior portion, just outside the building where two testbeds completed in November are beginning start up. When this construction is complete in early 2014, EETD researchers and their public- and private-sector research partners will be able to swap out building components and systems in the modules, and measure, analyze, and improve their performance under real-world conditions. Users will be able to replace windows, walls, access floor, lighting, HVAC systems, and other elements with prototypes for testing. The interior spaces are reconfigurable as well, and can be divided into zones and outfitted as offices.

The new, exterior portion of FLEXLAB will host four new testbeds.

The testbeds feature some unique designs. For example, one can be rotated to any orientation with respect to the sun and even reset its position every 60 seconds to align with solar orientation, to measure how sun position affects energy use and interior conditions. A double-height testbed is designed to test technologies used in two-story structures, with applications that include big-box retail environments. Normally, the test spaces will be unoccupied, but they can be used to test thermal and visual comfort and assess the interface with control systems.

Having this flexibility at their disposal will enable researchers and developers to accelerate the development and deployment of controls and technologies for retrofit and new construction. It will also enable researchers to benchmark energy use of innovative solutions against standard building practices. Together, the six interior and exterior testbeds will constitute more than 9,000 square feet of floorspace. The facility is funded with $15.9 million from the American Reinvestment and Recovery Act, through the U.S. Department of Energy.

FLEXLAB also will include one of the most extensive data acquisition and control capabilities ever used in a building test facility, allowing industry partners to remotely operate the facility and analyze performance data. Outdoor weather and solar conditions, occupancy sensors, airflow and room pressure measurements, lighting and glare, and thermal conditions are among the factors that the facility's instrumentation will be able to monitor.

Among the visitors participating in the groundbreaking were representatives from Philips Lighting and Daikin, early research partners; PG&E; and San Jose Prospect, an early deployment partner. Joining Berkeley Lab Deputy Director Horst Simon for the groundbreaking were U.S. Department of Energy Deputy Assistant Secretary for Renewable Energy, Steven Chalk, and California Energy Commission Chairman Robert Weisenmiller, among others.

—Allan Chen

Additional information:

Berkeley Lab press release [http://newscenter.lbl.gov/news-releases/2012/12/07/berkeley-lab-breaks-ground-on-flexible-design-building-to-test-low-energy-systems-and-components/]

FLEXLAB [http://flexlab.lbl.gov/]

The facility is funded by the American Reinvestment and Recovery Act, through the U.S. Department of Energy.

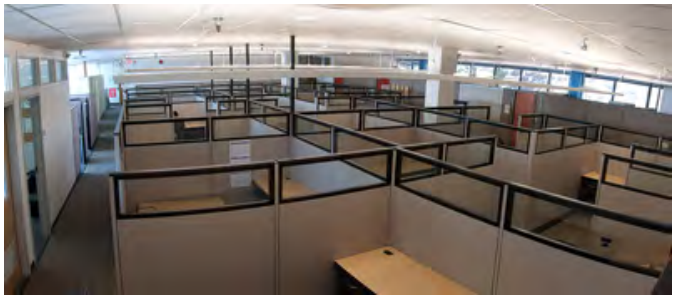
LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Four FLEXLAB Partners Announced

The first four partners of FLEXLAB (the Facility for Low Energy eXperiments in Buildings) are Philips Research North America, Daikin AC, PROSPECT Silicon Valley, and the Singapore Building and Construction Authority.



FLEXLAB's Lighting and Plugloads Testbed

FLEXLAB consists of a series of testbeds and supporting labs that facilitate development, demonstration, and deployment of innovative, high-performance commercial building technologies & practices with a focus on integrated systems to achieve deep energy savings. Two interior testbeds of FLEXLAB within an existing building at Lawrence Berkeley National Laboratory (Berkeley Lab) are complete or near completion, and construction has begun [http://eetd.lbl.gov/news/article/30481/berkeley-lab-breaks-ground-on-flexible-design-building-to-test-low-energy-systems] on the exterior modules of FLEXLAB. Completion is expected in early 2014.

Berkeley Lab is developing a public-private partnership model that will allow many different organizations to use FLEXLAB capabilities for purposes ranging from technology development, to performance measurement and validation, to integrated systems optimization and demonstration of deployment-ready efficiency solutions. The new test facilities build upon an extensive existing building research development, and demonstration (RD&D) staff and infrastructure at Berkeley Lab, as well as a network of U.S. and international building science collaborators.

The first four partners include two manufacturers of energy-efficient building systems: a regional commercialization/demonstration partner in San Jose and an international partner who will replicate portions of the FLEXLAB facility in Singapore.

Philips Research North America (PRNA) will shortly begin testing of integrated lighting and shade controls solutions in FLEXLAB's lighting and plug loads testbed [http://eetd.lbl.gov/news/article/30459/berkeley-lab-hosts-industry-for-preview-of-first-phase-of-flexlab-a-new-laborator]. This testbed is a densely instrumented, occupied living laboratory that can be used to test real-life office environments, allowing for a wide variety of lighting control strategies ranging from fully automated control to manual control by occupants. Because of its high degree of control, the testbed is ideally suited to testing a variety of new lighting control hardware systems with their different control algorithms and operational sequences in order to assist manufacturers such as PRNA to develop, test, and refine advanced control concepts in a well-controlled environment.

Users can monitor every change in the power use and lighting conditions of the testbed continuously and in real time. Every duplex power outlet is individually monitored and can be turned on or off by occupants, or can be programmed for other controls such as by occupancy. In perimeter offices the operation of the lighting systems will be integrated with dynamic shade controls to optimize daylight use and minimize glare.

Daikin Industries will work with the FLEXLAB staff to leverage expertise in building modeling and simulation, while preparing to use physical facilities to test the performance of innovative new HVAC technologies against model predictions.

PROSPECT Silicon Valley helps companies accelerate the commercialization and market adoption of clean technologies by providing a place to connect with private and public investors, and to collaborate with academic and industry partners. PROSPECT Silicon Valley will help shorten time periods to prove commercial viability and testing, and provide infrastructure for field trials and demonstrations that accelerate commercialization. PROSPECT Silicon Valley builds on San Jose's national

leadership in clean technology demonstration and will serve as a physical access point to a range of support services for clean technology companies. Participants in PROSPECT Silicon Valley will include clean tech companies, entrepreneurs and innovators, academic institutions and R&D labs, and training organizations.

"There's great alignment between FLEXLAB and Prospect Silicon Valley," says Kim Walesh, Director of Economic Development and Chief Strategist for the City of San Jose. "We believe Prospect can accelerate the commercialization of technologies developed at FLEXLAB by providing opportunities to showcase them to early adopters in an atmosphere conducive to new ideas."

The Building and Construction Authority (BCA) of Singapore inked a broad partnership with Berkeley Lab to collaborate on buildings R&D and to build a facility for testing green building technologies. The overall collaboration will focus on developing new innovations and solutions for greater energy efficiency of buildings in Singapore, reducing carbon emissions and contributing to the sustainability of the built environment.

The new facility to be built at the BCA Academy will be based upon the one-story, two-cell rotating unit of Berkeley Lab's FLEXLAB. While there will be differences in terms of size and scope due to space constraints, the new facility at BCA Academy will be the first rotating building research facility in Asia. The novel design will allow the daylighting and solar impact on all building envelope surfaces to be assessed, thus simulating the actual building site location with ease. In building the new lab, BCA will work closely with Berkeley Lab to tap their expertise in areas such as design and construction, data acquisition, and collaborative research projects.

The FLEXLAB team is developing additional partnerships with the business community, government agencies, research institutions, and others interested in its vision of integrated systems, design, and operations to achieve cost-effective, aggressive energy efficiency in new and existing buildings.

—Allan Chen

Additional information:

FLEXLAB website [http://flexlab.lbl.gov/]

A recent article about FLEXLAB [http://eetd.lbl.gov/news/article/30481/berkeley-lab-breaks-ground-on-flexible-design-building-to-test-low-energy-systems].

Partners:

Philips Research North America [http://www.research.philips.com/locations/briarcliff.html]

Daikin Industries, Ltd. [http://www.daikin.com/index.html]

PROSPECT Silicon Valley [http://www.sanjoseca.gov/?nid=3367]

Singapore Building and Construction Authority [http://www.bca.gov.sg/]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Research Highlights

President Obama Awards Art Rosenfeld the National Medal of Technology and Innovation

EETD's Art Rosenfeld with President Obama

Art Rosenfeld, Scientist Emeritus in the Environmental Energy Technologies Division (EETD) of Lawrence Berkeley National Laboratory (Berkeley Lab), received the National Medal of Technology and Innovation at a ceremony at the White House in February 2013. The medal recognizes those who have made lasting contributions to America's competitiveness and quality of life and helped strengthen the nation's technological workforce. Nominees are selected by a distinguished independent committee representing the private and
public sectors.

With a decades-long career in energy analysis and standards, Rosenfeld is often credited with billions of dollars in energy savings and is viewed by many as "the godfather of energy efficiency." He started his career at the University of California, Berkeley, and at Berkeley Lab in the 1950s as a physicist in the Nobel Prize-winning particle physics group of Luis Alvarez. However, in 1974, he decided to switch his focus to energy and the environment. In 1975 he founded the Center for Building Science at EETD, where a broad range of energy-efficiency concepts, analysis tools, policy ideas, and technologies were developed over the next 20 years.

"Art's long-standing efforts in the field of energy efficiency have truly changed the way we think about energy today," said Berkeley Lab Director Paul Alivisatos. "He epitomizes the spirit of Berkeley Lab with his dedication and innovation. This honor is well-deserved."

"We are thrilled with this award to Art," said EETD Division Director Ashok Gadgil. " It is a wonderful and timely recognition of his towering leadership role in the U.S. and internationally in understanding and capturing energy efficiency as a resource. We are very pleased and proud he helped found this division, and that after his careers at the Department of Energy and the California Energy Commission, he returned here as Distinguished Scientist Emeritus."

For more information

President Obama Honors Nation's Top Scientists and Innovators [http://www.whitehouse.gov/the-press-office/2012/12/21/president-obama-honors-nation-s-top-scientists-and-innovators]

Berkeley Lab press release [http://newscenter.lbl.gov/news-releases/2011/04/21/rosenfeld-wins-global-energy-prize/]

Art Rosenfeld's website [https://sites.google.com/a/lbl.gov/cool-white-planet/]

Art's EETD staff page [http://eetd.lbl.gov/staff/arthur-rosenfeld]

Ashok Gadgil Elected to National Academy of Engineering

Environmental Energy Technologies Division Director Ashok Gadgil has been elected a member of the National Academy of Engineering (NAE).

Ashok Gadgil

Election to the NAE is among the highest professional distinctions accorded to an engineer. Academy membership honors those who have made outstanding contributions to "Engineering research, practice, or education, including, where appropriate, significant contributions to the engineering literature," and to the "pioneering of new and developing fields of technology, making major advancements in traditional fields of engineering, or developing/implementing innovative approaches to engineering education."

Gadgil was elected for his "engineering solutions to the problems of potable water and energy in underdeveloped nations."

For more information

NAE press release [http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=02072013]

One Step Closer to Hydrogen Production From Photoelectrochemical Water-Splitting

In the quest to produce an environmentally benign renewable fuel, scientists have explored many techniques to split water molecules to produce hydrogen. Still, the current photovoltaic designs are not yet technically or economically viable. Materials research in this area has been promising, but research on the engineering design of these photoelectrochemical systems has been sparse.

Sophia Haussener

To advance this part of the puzzle, a team including Lawrence Berkeley National Laboratory (Berkeley Lab) researchers Sophia Haussener and Adam Weber recently conducted design research at the Joint Center for Artificial Photosynthesis (JCAP) and published their results in *Energy and Environmental Sciences*. The team used a validated multi-physics numerical model to examine two photochemical water-splitting designs.

The modeling revealed important information about the design impacts of these systems. For example, the use of transparent-conducting-oxide layers on top of the photoactive semiconductor resulted in smaller ohmic loss (voltage drop) across the cell. Ohmic losses were also reduced through smaller electrode lengths, larger electrolyte heights, and thinner separators. In addition, the research team found that electrolyte and product crossover, which limit the system's ability to keep the split hydrogen and oxygen molecules from recombining, was determined by the system's operational condition and pressure differentials over the system's separators. The researchers concluded that controlling the morphology of the separator could potentially reduce this crossover and improve hydrogen yields. Further research is planned.

Other team members were Chengxiang Xiang, Joshua M. Spurgeon, and Nathan S. Lewis (of the Joint Center for Artificial Photosynthesis at the California Institute of Technology) and Shane Ardo (of the Beckman Institute and Kavli Nanoscience Institute).

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"Modeling, simulation, and design criteria for photoelectrochemical water-splitting systems," by Sophia Haussener, Chengxiang Xiang, Joshua M. Spurgeon, Shane Ardo, Nathan S. Lewis, and Adam Z. Weber, is available to *Energy and Environmental Sciences* [http://pubs.rsc.org/en/content/articlelanding/2012/ee/c2ee23187e] subscribers.

What's the Cost of a Healthy Home?

California's residential ventilation requirements in Title 24 (the State energy code for buildings) are designed to balance healthy home ventilation with efficient energy use, but some studies suggest that whole-house ventilation systems don't always meet their expected performance in either category. Commissioning, a systematic evaluation of the installed system to identify deficiencies and offer solutions, can help homeowners achieve this balance. However, implementing those solutions is likely to cost money, so how should we determine whether commissioning and the recommended changes are worthwhile?

Will Turner

Using detailed thermal, airflow, and pollutant transport simulation models along with novel costing approaches, Will Turner, Jennifer Logue, and Craig Wray—three Lawrence Berkeley National Laboratory researchers—explored this question. In particular, the models quantified the energy and indoor air quality impacts of malfunctioning ventilation systems on occupant health and building energy use. Two existing approaches were used in combination to monetize the impacts: a Time Dependent Valuation (TDV) approach for energy and a Disability Adjusted Life Year (DALY) approach for air quality. This method allowed a direct, apples-to-apples comparison to be made between the health and energy costs associated with correcting ventilation system deficiencies.

The research team determined that health impacts dominate energy impacts—highlighting the importance of ventilating homes to provide good indoor air quality. They recommended that the metric for commissioning ventilation systems should be the net present value of the combined energy and health benefits to the occupant. Put simply, both energy and air quality should be considered together. In order for commissioning ventilation systems to be worthwhile, the value of the combined benefits should outweigh the cost of commissioning (plus any changes made). An interesting offshoot of the research is that this new method can be used to optimize ventilation rates in homes. With a bit more work, it should be possible to set ventilation rates that maximize health benefits to occupants while using as little energy as possible.

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The full article, "A Combined Energy and IAQ Assessment of the Potential Value of Commissioning Residential Mechanical Ventilation Systems," by William J.N. Turner, Jennifer M. Logue, and Craig P. Wray is available to *Science Direct* [http://www.sciencedirect.com/science/article/pii/S0360132312002818] subscribers.

New Battery University Program to Train Workforce to Lead Fast-Growing Industry

CalCharge, an energy storage innovation accelerator, and San Jose State University, the number one supplier of graduates to Silicon Valley, are teaming up to launch a "battery university" in the high-tech capital of the world.

Battery university courses—to be offered through SJSU's professional education program—will educate a specialty workforce needed now for the rapidly growing battery industry. Classes are expected to start this summer in partnership with SJSU's engineering college. Leading scientists, entrepreneurs, industry, and policy experts met in February at SJSU to provide feedback on the vision and proposed curriculum.

There are roughly 40 battery-related companies in California working to solve energy storage challenges, which are critical to the electric vehicle sector, the solar sector, the wind sector, consumer electronics, and more.

"California is both a patent and a venture capital leader in the battery sector in the United States, but we cannot rest on our laurels," said Venkat Srinivasan, head of the Energy Storage and Distributed Resources groups at Lawrence Berkeley National Laboratory. "Our sector is developing at such a rapid clip that if we want to maintain our leadership position, we must constantly innovate—and we need the top minds to do so."

More information: The CalCharge website [http://www.calcharge.org/]

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Sources

Energy Efficiency & Renewable Energy's Energy Savers

These web pages [http://energy.gov/energysaver/energy-saver] provide information about energy efficiency and renewable energy for your home or workplace.

DOE's Energy Information Administration (EIA)

EIA [http://www.eia.gov/] offers official energy statistics from the U.S. Government in formats of your choice, by geography, by fuel, by sector, or by price; or by specific subject areas like process, environment, forecasts, or analysis.

DOE's Fuel Economy Guide

This website [http://www.fueleconomy.gov/] is an aid to consumers considering the purchase of a new vehicle.

DOE's Office of Energy Efficiency & Renewable Energy (EERE)

EERE's [http://www.eere.energy.gov/] mission is to pursue a better energy future where energy is clean, abundant, reliable, and affordable; strengthening energy security and enhancing energy choices for all Americans while protecting the environment.

U.S. DOE, Office of Science [http://science.energy.gov/]

U.S. EPA, ENERGY STAR Program [http://www.energystar.gov/]

California Energy Commission [http://energy.ca.gov/]

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Ernest Orlando Lawrence Berkeley National Laboratory is a multiprogram national laboratory managed by the University of California for the U.S. Department of Energy. The oldest of the nine national laboratories, Berkeley Lab is located in the hills above the campus of the University of California, Berkeley.

With more than 4,000 employees, Berkeley Lab's total annual budget of nearly $600 million supports a wide range of unclassified research activities in the biological, physical, computational, materials, chemical, energy, and environmental sciences. The Laboratory's role is to serve the nation and its scientific, educational, and business communities through research performed in its unique facilities, to train future scientists and engineers, and to create productive ties to industry. As a testimony to its success, Berkeley Lab has had 11 Nobel laureates. EETD is one of 14 scientific divisions at Berkeley Lab, with a staff of 400 and a budget of $40 million.

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