LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

SUMMER NEWSLETTER: VOL. 8, NO. 1

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The *EETD News* is resuming publication on the web after a hiatus of a couple of years. With a higher national profile for energy efficiency and other solutions to reducing greenhouse gas emissions, we hope you find something of value in these descriptions of ongoing research at the Environmental Energy Technologies Division of the Lawrence Berkeley National Laboratory.

For other sources of R&D news at Berkeley Lab's EETD, please look at the Berkeley Lab Energy and Environment Research blog [http://bleer.lbl.gov/] , and the news feed in the upper right hand corner of the Division's website [http://eetd.lbl.gov/] .

—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] .

Cool the Neighborhood, Cool the Planet

It's grade-school science: white reflects sunlight better than dark, so on a hot day people who are wearing light-colored clothing will stay cooler than people wearing black.

Clothes, roofs, and even pavements that reflect sunlight stay cooler. Staying cool saves energy, so one way to keep greenhouse gases (GHGs) out of the atmosphere is to use more cool roofing and paving materials, especially in urban areas.

This basic principle could help the world fight global warming, as more advanced science has recently helped to demonstrate. Hashem Akbari and Surabi Menon, scientists at the Environmental Energy Technologies Division (EETD) of the Lawrence Berkeley National Laboratory (Berkeley Lab), and Art Rosenfeld, California Energy Commissioner, Professor Emeritus at the University of California, Berkeley, and former Berkeley Lab scientist, have proposed a "Cool World" plan that would use white roofs, and solar-reflective roofs of other colors, to reduce greenhouse gas emissions and help delay atmospheric heating effects.

Cities like Atlanta, shown here, are heat islands whose temperatures are significantly higher than in surrounding regions. (NASA graphic)

Most existing flat roofs reflect only 10 to 20 percent of sunlight. These roofs absorb much of the remaining solar radiation and heat up the buildings they cover. Buildings with air conditioners expend energy to cool down—energy that's mostly generated from burning fossil fuels.

On a larger scale, cities heat up more than their rural surroundings because of their dark roofs, dark pavements, and the absence of vegetation—an urban "heat-island" effect that raises the average air temperature of cities and their suburbs.

An effective way to counter the heat-island effect is to reflect more of the sun's energy back into space. In a paper to be published in the journal *Climatic Change*, Akbari, Menon, and Rosenfeld estimate that an effort to reroof and repave buildings and streets in the world's urban areas with "cool" materials, which reflect more sunlight than conventional materials, could offset the global-warming effects of 44 billion metric tons of carbon dioxide (CO_2) emissions.

The average car emits about four metric tons of CO_2 per year. Implemented successfully, the Cool World plan would be the equivalent of taking the world's 600 million cars off the road for 18 years. Rosenfeld, Akbari, and Menon argue that such a global program could achieve the desired result in 20 years, using white and cool-colored roofing and paving materials that are already on the market.

Reducing the Urban Heat Island: From Local to Global Benefits

Researchers at EETD have been studying the potential effects and benefits of reducing the urban heat island since the 1980s. Akbari (Head of EETD's Urban Heat Island Group), Rosenfeld (former Director of EETD's Center for Building Science), and others performed research demonstrating that replacing conventional roofs with cool roofs—using solar-reflective materials or just painting them white—could reduce air conditioning energy use on average 20 to 30 percent. With the help of computer simulations the Heat Island Group demonstrated that, on a regional scale, the widespread adoption of cool roofs could actually reduce an urban area's average summertime temperature.

Berkeley Lab research has shown that the chance of a smoggy day in urban areas such as Los Angeles increases as the average air temperature increases. Reroofing and repaving enough of a city with cool, solar-reflective materials would have the effect of cooling the area and reducing the number of smog episodes.

From traditional Mediterranean houses painted white to modern cool-roof metals, tiles, and shingles that come in colors, cool roofs reduce greenhouse-gas emissions by saving energy. (Santorini photo by Stacy Cashman, licensed under Creative Commons Attribution ShareAlike 3.0. Photos of cool-color roofs courtesy California Energy Commission)

In the 1990s the roofing industry responded to these findings by creating a variety of cool-roof products, including paints, coatings, and elastomeric materials for commercial and industrial buildings. Municipalities, air quality districts, and states began creating incentive programs to hasten the adoption of cool roofs by the marketplace, and the U.S. Green Buildings Council qualified cool roofs as a measure that would count toward receiving a LEED (Leadership in Energy and Environmental Design) rating for an energy-efficient building.

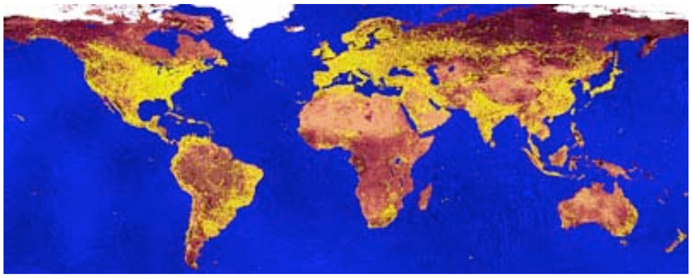
However, while white roofs are common on homes in some parts of the world—notably in the Mediterranean and other hot regions—residential roofs in most of the industrialized world come in a variety of colors and materials. Making asphalt shingle, metal, and tile into cool roofing materials was a challenge.

With funding from the California Energy Commission's Public Interest Energy Research Program, Berkeley Lab established a research plan for developing colored cool-roofing materials. The Urban Heat Islands Group worked with U.S. companies that manufacture more than 90 percent of roofing material products. Akbari, Ronnen Levinson, Paul Berdahl, and Mel Pomerantz conducted this research, in collaboration with colleagues at Oak Ridge National Laboratory and the roofing industry.

The fruits of this cooperation are now widely available in the U.S. marketplace. Cool, solar-reflective roofing materials in a wide variety of colors and all common types, including asphalt shingle, clay and cement tile, and metal, are available from several U.S. roofing material manufacturers. These products have received ENERGY STAR labels, and an industry council, the Cool Roof Rating Council, ensures that cool roofing products are correctly labeled.

Cooling the World

The research by Akbari, Rosenfeld, and Menon estimates how much cooling might be possible, in equivalent mass of CO_2, by converting roofs and pavements in the world's urban areas to solar-reflective surfaces. They calculate that retrofitting 1,000 square feet (about 100 square meters) of roof with cool material that reflects 60 percent or more of the sun's heat would offset the emissions of 10 metric tons of CO_2.



Within 30 years, more than two-thirds of all the people on Earth will live in cities. Cooling cities helps cool the planet. (NASA)

In Europe, which has a system of tradable permits for pricing CO_2 that uses markets to encourage measures to reduce emissions, CO_2 trades at about $25 per metric ton. That makes a 10-metric ton offset worth $250. At this price, the 44 billion metric tons of GHG emissions that cool materials could offset is equal to about $1.1 trillion.

The researchers also estimate that 50 percent of the world's population now lives in urban areas; by 2040, that fraction is expected to rise to 70 percent. Growth in the urban population of the planet helps explain why measures focused on reducing urban GHG emissions could have such a large impact on climate change.

"Cool surfaces are a simple, tried-and-true technology for cooling the earth," says Akbari. "Using them is a simple but effective solution to help reduce earth's climate change. And by doing this globally, we can gain experience in how to work together to implement large scale solutions to reducing global warming."

— Allan Chen

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- "Global Cooling: Increasing World-wide Urban Albedos to Offset CO_2," by Hashem Akbari, Surabi Menon, and Arthur Rosenfeld, appeared in *Climatic Change* June 2009 and is available online [http://www.energy.ca.gov/2008publications/CEC-999-2008-020/CEC-999-2008-020.PDF] .
- More about the Heat Island Group [http://heatisland.lbl.gov/] in Berkeley Lab's Environmental Energy Technologies Division.
- More about cool colors for roofing materials is available in this article [http://www.lbl.gov/Science-Articles/Archive/sb/Aug-2004/3_coolroofs.html] and the Cool Colors website [http://coolcolors.lbl.gov/] .
- More about standards for cool roofing products is at the ENERGY STAR Roof Products [http://www.energystar.gov/index.cfm?c=roof_prods.pr_roof_products] and the Cool Roof Rating Council [http://www.coolroofs.org/] websites.

This research is sponsored by the California Energy Commission's Public Interest Energy Research (PIER) Program.

LAWRENCE BERKELEY NATIONAL LABORATORY
Environmental Energy Technologies Division
NEWS

OpenADR Specification to Ease Building Power Reductions

In collaboration with colleagues at other universities and in the private sector, researchers at the Environmental Energy Technologies Division of the Lawrence Berkeley National Laboratory have developed a new data model that will help facilities and buildings save power through automated demand response technology and advanced "Smart Grid" development.

From left: Sila Kiliccote, Girish Ghatikar, and Mary Ann Piette.

The researchers who developed OpenADR (Open Automated Demand Response) are part of the Demand Response Research Center (DRRC), which is funded by the California Energy Commission's Public Interest Energy Research (PIER) Program. The DRRC's goal is to develop technologies to make it possible for buildings and facilities to adopt demand response as a way of saving peak power use and reducing stress on the electric grid during times of high energy demand.

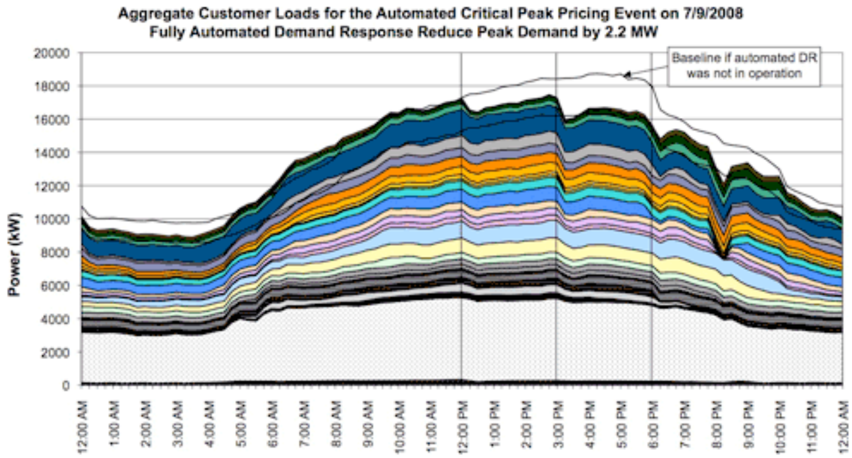
"The purpose of this specification is to help building and facilities managers implement automated demand response in their facilities, as well as assist electric utilities to help their commercial and industrial customers participate in power pricing programs that incorporate automated demand response," said Mary Ann Piette, Deputy Head of the Building Technologies Department and DRRC Research Director.

"OpenADR also helps manufacturers of building automation equipment design products for Smart Grid implementation and power aggregators incorporate demand response into their work. OpenADR builds on six years of research in California to develop autoDR technology and demonstrate it in buildings with our utility and commercial partners."

With widespread interest nationally in turning the electric grid into a more responsive "Smart Grid," the new OpenADR specification will help more facilities adopt autoDR—and help building automation companies develop products for it—by providing a common, open specification that everyone can use as a reference.

What is DR and AutoDR?

Demand response, DR, is a central part of the so-called "Smart Grid." DR is the process of managing energy use dynamically through cooperation between power customers, their electric utility, and the electric system's operator (the independent system operator, or ISO). When the electrical grid is near capacity—for example, when too many air conditioners start laboring on a hot summer's day—the ISO informs electric utilities and power consumers that there's a problem in the offing, and demand is reduced.



Tests of automated demand response in commercial buildings throughout California show significant reductions in peak electricity load. The white area under the baseline curve represents the amount of power not used because of automated demand response. These tests are being conducted as part of a multi-year testing program funded by the California Energy Commission's Public Interest Energy Research program. This graph includes data from 28 sites around California.

AutoDR enhances the solution. Shutting building systems down by hand can help reduce electric demand; however, manual interventions are not always reliable, consistent, or persistent. AutoDR provides an automated alternative that increases DR effectiveness. Significant reductions in peak electricity load are being revealed in studies conducted as part of a multi-year, PIER-funded testing program of automated demand response in commercial buildings throughout California.

AutoDR is the technology and communications platform developed by the DRRC, which was launched by the PIER program at Berkeley Lab in 2003 to support all forms of demand response. Under Piette's direction, the center manages a portfolio of research projects that address pricing, valuation, behavior, building dynamics, and technology development.

Features of OpenADR

"The OpenADR specification uses open, non-proprietary, industry-approved data models—any interested party can develop products around it. Its communications interfaces and protocols are flexible, platform-independent, interoperable, and transparent to end-to-end technologies and software systems," says Piette.

An open specification encourages innovation and interoperability. It also allows system designers to build on existing controls and communications strategies used within their facilities to reduce technology operation and maintenance costs, stranded assets, and obsolesce in technology.

System designers can integrate their facility's energy management and control systems (EMCS), centralized lighting, and other end-use devices that can receive a relay or internet signals using, for example, eXtensible Markup Language (XML).

The specification includes provisions for including opt-out or override functions through a web portal. Research on facility managers' preferences suggest that providing manual control over automatic, pre-programmed changes in building energy use is an essential feature for facility managers interested in joining utility demand response programs.

The OpenADR specification was developed by: Mary Ann Piette, Girish Ghatikar, and Sila Kiliccote (the Demand Response Research Center at the Lawrence Berkeley National Laboratory), Ed Koch and Dan Hennage (Akuacom), Peter Palensky (University of Pretoria), David Holmberg (National Institute of Standards and Technology), Dave Robin (Automated Logic Controls), Jim Butler (Cimetrics), and Charles McParland (Computational Research Division, Lawrence Berkeley National Laboratory).

— Allan Chen

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- Download Open Automated Demand Response Communications Specification (Version 1.0) [http://drrc.lbl.gov/openadr/pdf/cec-500-2009-063.pdf] .
- Find out more about the Demand Response Research Center [http://drrc.lbl.gov/] .
- Another article about automated demand response [http://www.lbl.gov/Science-Articles/Archive/sabl/2008/Feb/ADR.html] .

This research was sponsored by the California Energy Commission's Public Interest Energy Research (PIER) Program.

Berkeley Lab Analysis Finds Reduced HVAC May Improve Health

Research conducted at the Environmental Energy Technologies Division (EETD) of the Lawrence Berkeley National Laboratory suggests that operating buildings more energy efficiently could have benefits for the health of occupants and, surprisingly, also for their comfort.

The researchers, Mark Mendell and Anna Mirer of Berkeley Lab's EETD, analyzed data collected from 95 air-conditioned office buildings across the United States. The data had been gathered by the U.S. Environmental Protection Agency in a study called BASE (Building Assessment Survey and Evaluation). The study produced data about indoor environmental conditions and the health of occupants in a representative set of U.S. office buildings.

The study collected standard measurements in each building on factors such as temperature and humidity, during one week in either summer or winter. Building occupants filled out a survey at that time with questions about "building-related symptoms," defined as symptoms that were experienced in the building but improved away from the building. Symptoms assessed were related to the upper and lower respiratory tract, eyes, skin, headache, fatigue, and difficulty concentrating.

Using the data from this study, the Berkeley Labs scientists conducted cross-sectional statistical analysis of two questions:

1. How did the temperatures in the 95 buildings from the BASE study compare to the temperature comfort ranges recommended for summer and winter by ASHRAE (the Association of Heating, Refrigerating and Air-Conditioning Engineers)? ASHRAE is the technical organization that creates widely used recommendations about the proper operation of building heating, ventilation, and air conditioning (HVAC) systems.
2. Were there associations between the occurrence of building-related symptoms and indoor temperature or humidity?

Buildings Substantially Overcooled in Summer

In winter, the researchers found, the buildings were kept mostly within the recommended temperature comfort range for winter, but in summer building temperatures were, on average, below the comfort range for summer. Surprisingly, buildings were, on average, kept even cooler in the summer than in the winter, by almost 1°F (0.5°C), even though people are more comfortable with warmer temperatures in summer.

These low temperatures in summer suggest that many occupants would be too cold in their offices, and this overcooling by the air conditioning systems also indicates wasted energy.

Some Building Temperatures Associated with Increased Symptoms in Office Workers

Furthermore, in summer, a variety of building-related symptoms such as headache, fatigue, and difficulty concentrating were increased by over 50 percent in the buildings kept below 73.4°F (23°C). These buildings, kept too cold for comfort in summer, included almost half the buildings measured in summer. These symptoms thus might be expected to decrease if buildings were air-conditioned less and kept warmer in the summer.

In winter, buildings with higher indoor temperatures (above 73.4°F, even though that is near the middle of the recommended temperature range) were associated with approximately 30 to 80 percent increases in building-related nose, eye, and skin symptoms, as well as headache. This included more than half the buildings measured in winter. These symptoms thus might decrease if buildings were kept cooler in the winter.

Simply put, avoiding overcooled buildings in the summer, and keeping buildings at the cooler end of the recommended temperature range in the winter, may result in a substantial decrease in building-related symptoms. This should still maintain thermal comfort in the buildings in winter and should actually improve comfort in the summer.

Benefits Seen for Both Energy Efficiency and Occupant Health

Keeping air-conditioned buildings warmer in summer will save energy, and keeping buildings cooler in the winter will in many cases also save energy, through reduced heating. However, many of the buildings studied in winter, especially those with moderate outdoor temperatures at the time, may have been in "cooling" mode to handle internally generated heat from occupants, lights, and equipment. For these buildings, lowering indoor temperatures in the winter to decrease occupant symptoms would not be expected to provide energy savings, and in some cases might increase energy use.

"As we look for ways to save energy, these results suggest a potential win-win situation," says Mendell. "Our findings suggest that energy efficiency and keeping buildings healthy and comfortable for the occupants are not necessarily in conflict. Less summer cooling in air-conditioned buildings and less winter heating in heated buildings might reduce energy use in buildings substantially, yet have health benefits for the occupants that we did not expect, and still keep occupants as comfortable as before or even more comfortable."

— Allan Chen

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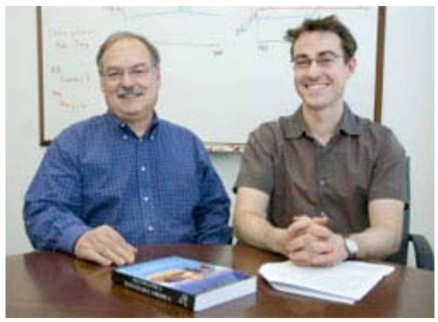
- The paper, "Indoor Thermal Factors and Symptoms in Office Workers: Findings from the U.S. EPA BASE Study," by Mark Mendell and Anna Mirer, has been published online in the journal *Indoor Air*.
- Berkeley Lab research was supported by the Centers for Disease Control and Prevention/National Institute for Occupational Safety and Health. The BASE study was conducted and funded by the Indoor Environments Division, Office of Radiation and Indoor Air of the U.S. Environmental Protection Agency.

Sustainability and the U.S. Energy System

Since 2000 the United States has made progress toward a more sustainable energy system in some areas, and has moved away from sustainability in others, according to an analysis by Berkeley Lab scientists Mark Levine and Nathaniel Aden. Their analysis is published in a chapter of a new book, *Agenda for a Sustainable America*. The volume contains contributions from 41 experts on various aspects of sustainability.



Mark Levine (left) and Nathaniel Aden

On the positive side, from 2000 to 2006, the energy and carbon intensity of gross domestic product (GDP) continued its long-term decline even as GDP increased. Energy intensity is the amount of energy consumed in the United States. divided by the GDP; carbon intensity is the amount of greenhouse gas emissions divided by GDP. Declining intensity values show that the U.S. has increased its economic output without increasing energy use and greenhouse gas emissions commensurately.

Per capita energy use remained constant. In 2000, per capita electricity use was 12.76 megawatt-hours (MWh) per person per year. It was slightly lower in 2006 despite a 16 percent increase in GDP over the same period.

However, "increased fossil fuel consumption, stagnant energy efficiency standards and expanding corn-based ethanol production have moved the energy system in the opposite direction, toward a less sustainable energy system," say Levine and Aden in the new report.

Levine and Aden used the definition of *sustainability* articulated in the 1987 Brundtland Commission report: "meeting the needs of the present without compromising the ability of the ability of future generations to meet their needs."

A Comprehensive Analysis of Sustainability in America

Edited by Widener University professor of law John Dernbach and published by the Environmental Law Institute, the book's 31 chapters authored by 41 writers assesses trends in 28 separate areas of American life—including forestry; transportation; oceans and estuaries; religion; and state, local, and national governance.

The chapter by Levine and Aden, scientists in Berkeley Lab's Environmental Energy Technologies Division, examines and assesses trends in the U.S. energy economy. "From 2000 to 2006," the authors say, "the U.S. energy system moved both toward and away from sustainability." The aforementioned decreasing trends in energy and carbon intensity, increased energy efficiency, and improved air quality all indicate improvement.

At the same time the U.S. also increased fossil fuel combustion, especially of coal (which increases greenhouse gas emissions). The nation has also seen increases in the use of corn ethanol, which is not an efficient source of fuel, and slowness in implementing stricter energy efficiency standards as mandated by acts of Congress.

Lower Carbon Intensity, Higher Efficiency

Carbon intensity has declined two percent per year from 2000 to 2006, comparable to a long trend that has been taking place in the U.S. since 1970. The authors suggest that if this decline were about twice as high—three to four percent per year—through increased energy efficiency, the U.S. would be well on course to achieve carbon goals that are sought by many.

The U.S. annual energy consumption per capita declined even as the per capita GDP grew from $34,883 in 2000 to $36,122 in

2006 (in year 2000 dollars). Per capita electricity consumption remained constant during these years, another positive sign. Without energy efficiency, electricity use tends to increase in industrialized nations, where it is the preferred form of energy. These indicators suggest to the authors that the economy has become more energy-efficient as its output increased.

Air quality in the U.S. has improved between 2000 and 2005. For example, air quality monitoring stations throughout the U.S. showed that 4.5 percent of air quality readings were above ozone standards between 1999 and 2001. However, between 2003 and 2005, this percentage dropped to 2.1 percent. Other indicators of air quality also showed improvement during these years.

Increased Use of Coal Noted

Levine and Aden note that from 1970 to 2000, the U.S. economy saw a reduction in the carbon intensity of energy use, but from 2000 to 2006, this trend reversed itself. The increased use of coal is one reason for this change.

"It is important to recognize how far outside the norm of energy use and carbon emissions per capita the United States is in comparison with other industrialized countries," they write. The U.S. emits 2.5 times the per capita carbon dioxide emissions of the major European Union nations. This number has changed very little over 35 years.

Ethanol Analysis Indicates New Approaches Needed

From 2000 to 2006, the consumption of biomass in the U.S. grew at an average rate of one percent annually. The use of wood declined seven percent while biofuel consumption tripled. "However, the current American production of biofuels through corn-based ethanol is unsustainable," write the authors, citing three reasons:

- The energy return from ethanol is low: between 1.2 and 1.6 units of energy are returned for each one unit used to manufacture ethanol, while the same ratio is 15:1 for petroleum. This means that much more energy is required to produce the same amount of energy in liquid fuels.
- Second, the increase in biofuel demand has led to a problematic rise in food prices. Maize production has risen to historic levels, but its cost increased from $78/ton in December 2000 to $142/ton in December 2006.
- Finally, various studies have suggested that there is insufficient production capacity in the U.S. for ethanol to replace petroleum as a fuel that could meet U.S. demand. Dedicating all current U.S. corn and soybean production would meet only 12 percent of gasoline, and six percent of diesel demand.

Recommendations For Moving Forward

Levine and Aden suggest the U.S. can develop a more sustainable energy system if it increases its energy efficiency through standards and better technology. There is considerable technical and economic opportunity to increase appliance efficiency standards and to improve the energy efficiency of cars and light- and heavy-duty vehicles. They also urge support of R&D for energy-efficient commercial buildings, for technologies that can move these buildings toward zero net-energy use.

Another priority should be on research leading to higher-efficiency biofuels that would supplant the use of ethanol and to technologies that would lead to the economy's transition to a modern solar energy-based system. Levine and Aden argue that the use of either taxation on energy production and consumption of carbon, or a cap-and-trade system of carbon emissions can help reduce these emissions by aligning private-sector incentives with the societal costs of energy production.

Finally, they argue that the U.S. should set targets for industrial sector carbon emissions, because U.S. industry is less energy-efficient, "in many cases by a substantial margin," than industry in other developed countries.

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Research Highlights

Lab Role in Project Vulcan Greenhouse Gas Emissions Map

Scientists in the Berkeley Lab's Environmental Energy Technologies Division (EETD) played a role in developing the Google Earth map of North American fossil fuel carbon dioxide (CO_2) emissions known as the *Vulcan Project*. The NASA and DOE-funded effort, based at Purdue University, quantifies CO_2 emissions at space and time scales much finer than has been achieved in the past. EETD's **Marc Fischer**, the project leader, **Stephane de la Rue du Can**, and former EETD staff Scott Murtishaw used data from the U.S. Environmental Protection Agency and the California Air Resources Board to develop emissions estimates.

EETD's Levine Receives Japanese Architecture Prize

Mark Levine, former director of the Environmental Energy Technologies Division and head of the China Energy Group, will receive the 2009 Appreciation Prize of the Architectural Institute of Japan at a ceremony in Tokyo. The award cites his "series of accomplishments on outstanding research works, promotion of energy projects and dissemination of energy efficiency technologies in the field of architecture for global warming protection." This is the third major award Levine has received in the past 12 months, having also received the Obayashi Prize and the Public Service Award of the Federation of American Scientists.

Renewable Energy Team Wins Wind Power Award

The renewable energy team of the Environmental Energy Technologies Division, led by **Ryan Wiser**, received a Wind Powering America award, announced at the annual U.S. Department of Energy Wind Powering America State Summit. The Friend of the Program Award was presented to Berkeley Lab in recognition of excellence and leadership in wind energy policy and market analysis. The team—honored for its long-standing policy and analysis activities in the wind power market—includes Wiser, **Mark Bolinger**, **Galen Barbose**, **Andrew Mills**, **Ben Hoen**, **Naim Darghouth**, **Carla Peterman**, and **Anna Rosa**.

Sources and Credits

Sources

DOE's Energy Savers

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

DOE's Energy Information Administration (EIA)

EIA [http://www.eia.doe.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 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://www.er.doe.gov/]

U.S. EPA, Energy Star Program [http://energystar.gov/]

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

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Environmental Energy Technologies Division

The mission of the Environmental Energy Technologies Division is to perform research and development leading to better energy technologies and the reduction of adverse energy-related environmental impacts.

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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 3,800 employees, Berkeley Lab's total annual budget of nearly $500 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.
