LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division NEWS

A new Division Director for the Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory, a story about one of his research team's projects to remove naturally-occurring arsenic from water, and an invitation to participate in planning the scientific program for the new low-energy buildings user test facility are a few of the articles you will find in this issue of EETD News. Also, an EETD researcher leads the development of an international standard to reduce the energy use of Internet-connected computers, and this year's edition of an annual report evaluates the status of wind power technologies.

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].

Summer Newsletter: Vol. 9, No. 1 [http://eetd.lbl.gov/newsletter/nl32/]
Environmental Energy Technologies Division News [http://eetd.lbl.gov/newsletter/]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Ashok Gadgil Named New EETD Director

Ashok Gadgil has been named Director of Lawrence Berkeley National Laboratory's (Berkeley Lab's) Environmental Energy Technologies Division (EETD). Serving as the Acting Division Director since October, he replaces Arun Majumdar who is now Director of the DOE's Advanced Research Projects Agency—Energy (ARPA-E). Gadgil is a Professor in Civil and Environmental Engineering at UC Berkeley and joined EETD in 1988. He is recognized for his work as a researcher, inventor, and humanitarian.

Dr. Gadgil has substantial experience in technical, economic, and policy research on energy efficiency and its implementation —particularly in developing countries. Among his several patents and inventions are the "UV Waterworks"—an effective, inexpensive technology to disinfect drinking water to reduce life-threatening diseases in developing countries, and the Berkeley-Darfur cook stove for safer indoor use in Darfur, Sudan. His research interests also include experimental and modeling research in indoor airflow and pollutant transports. He serves on several international and national advisory committees dealing with energy efficiency, invention and innovation, and development and environmental issues.

In announcing the appointment, Lawrence Berkeley National Laboratory Director Paul Alivisatos wrote, "As Division Director, Gadgil's leadership on energy and environmental research and his projects bringing solutions to the developing world will continue to align the division well with Berkeley Lab's energy and environmental initiatives. Please join me in congratulating Ashok and in wishing him well in this important leadership position."

—Allan Chen

Additional information:

View Gadgil's home page [http://eetd.lbl.gov/staff/gadgil/agadgil.html].

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Helps Reduce Deaths from Arsenic in Water Supplies

One in five deaths in Bangladesh are caused by drinking arsenic-contaminated water, according to a study published by an international research team in *The Lancet*. In all, some 70 million people are drinking arsenic-contaminated water. The study's publication has generated renewed public interest in finding a quick, cost-effective solution to a problem that is turning into a human catastrophe.

Arsenic occurs naturally and contaminates many shallow groundwater aquifers. In the 1970s, Bangladeshis began a massive shift from biologically contaminated surface water to cleaner groundwater for drinking supplies. They installed more than 10 million shallow bore wells fitted with hand pumps to access this groundwater—which, it turned out, is frequently contaminated with toxic levels of arsenic. The situation is often called "the largest mass poisoning in human history." Arsenic contamination of groundwater is a problem in other parts of the world as well in such countries as Argentina, Chile, Mexico, Ghana, Hungary, Greece, Vietnam, China, and India.

"We are not aware of locally affordable modern pharmaceutical methods to reverse chronic arsenic poisoning, but the first and most urgent step must be to switch to safe drinking water for the tens of millions of people who are still drinking water with highly toxic levels of arsenic," says Ashok Gadgil, leader of the group at the Lawrence Berkeley National Laboratory (Berkeley Lab) that is working on this problem. Gadgil was recently appointed Director of the Lab's Environmental Energy Technologies Division (EETD).

"*The Lancet* study raises the question "why aren't low-cost technologies for arsenic removal being used in Bangladesh now?'" says Susan Addy, a guest researcher at Berkeley Lab, and postdoctoral scholar at UC Berkeley's Department of Civil and Environmental Engineering. As a former research associate at Berkeley Lab, Addy served on Gadgil's development teams for ARUBA (Arsenic Removal Using Bottom Ash) and ECAR (ElectroChemical Arsenic Remediation).

Berkeley Lab Approach Combines Technology Development and Community Deployment

ARUBA and ECAR are two novel, low-cost arsenic-removal technologies that have proven effective in lab studies. The ARUBA technology is fully field tested and could be deployed now to provide safe drinking water. Meanwhile, a working prototype for ECAR has been completed and is scheduled for field-testing later this fall.

"We started working on an affordable, robust, and technically effective approach to remove arsenic from Bangladesh groundwater back in the year 2000, as soon as I became aware of the enormity of the human tragedy that was in the making," says Gadgil. "Now that this catastrophe has come to major media attention in CNN, Reuters, and elsewhere, we have not one but two different inventions that meet our above criteria."

An ARUBA arsenic removal plant prototype installed at the Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh (July 2008).
Photo credit: Mahbuba Iasmin

Although many researchers are developing technologies that can remove arsenic from water, affected areas in Bangladesh have not adopted them widely enough to affect the health problem. The Berkeley Lab/UC Berkeley team has studied both the technological dimension of the problem and its sociopolitical dimension: how can local institutions create the economic and social conditions that facilitate adoption of these low-cost, effective technologies for reducing arsenic in water?

The business deployment model they have outlined, called the *micro-utility*, provides economic mechanisms for financing community-scale water treatment facilities and a market mechanism for sustaining their operation.

Clean Water From a Waste Stream

A proven technology for removing arsenic, ARUBA uses bottom ash, a widely available waste material from coal-fired power plants. The fine powdered ash is coated with an iron-containing chemical, which absorbs and chemically binds to arsenic in the water. The resulting solids settle to the bottom of a container and can be filtered out, leaving the water safe for drinking. "The technology is innovative," says Addy "because it used a low-cost, ubiquitous waste material as a substrate and can be manufactured using simple room temperature and pressure processes."

Lab testing shows that this process can reduce arsenic concentrations from 1,000 parts per billion (ppb) to 3 ppb—well below the World Health Organization standard of 10 ppb for drinking water. Tests also confirm that the arsenic-to-ash chemical bond is secure, so the arsenic won't dissolve back into the water cycle, and the small amount of solid waste produced in the process can be safely disposed of, in accordance with U.S. Environmental Protection Agency standards.

The ARUBA technology is inexpensive—raw materials would cost about 8 cents per year per person, and the total treated water costs would be $7 to $15 per person per year, assuming 10 liters of drinking water per person per day. However, ARUBA would require an in-country centralized facility to process the ash and manufacture the arsenic-removing raw material, which would be distributed to local communities for them to use to produce safe drinking water in their micro-utilities.

Beneficial Rust

For the ECAR process, a small amount of electricity continuously dissolves an iron electrode immersed in a container of arsenic-contaminated water. The iron forms rust particles in the water, and the arsenic binds to the rust. The resulting material is filtered or settled out of the water. Lab-based testing has demonstrated that when applied to water with arsenic concentration as high as 2,000 ppb, the ECAR process reduces arsenic concentration to below the 10 ppb WHO limit, and can reduce concentrations to as little as 2 ppb or less. Waste generated in this process also binds the arsenic securely, and is safe for disposal.

The 12-volt Solution

Electricity for the ECAR process could be supplied from a grid, a solar power system, or even a 12-volt automotive battery. The use of electricity in the process increases the efficiency of arsenic removal compared to passive chemical processes, so ECAR generates much less waste than ARUBA and many other chemical processes for arsenic removal. Neither ARUBA nor ECAR use toxic or corrosive chemicals at any stage in the field application—an important point for technologies intended for use in remote rural areas where technically trained personnel would be generally unavailable.

A small-scale ECAR prototype device operated from a 12-volt car battery at the Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh (July 2008).
Photo credit: Kristin Kowolik.

The ECAR team estimates that the total energy and materials cost to provide 10 liters of treated water per person per day is $0.99 per person per year. Some additional electricity is needed to agitate the water during treatment, so the total cost of treatment is probably a little under one cent per person per day—$3.65 per person per year, for the bare treatment alone. The cost of a shed to house the equipment and to pay operator salaries would raise these costs somewhat.

Two Strategies Address Site-Specific Needs

Why two technologies for one problem? "The arsenic remediation problem is not going to be solved by just one technology," says Addy. "ARUBA is very low cost, requires no electricity, and it's easy to manufacture the materials because this can be done at room temperature and pressure. But it requires a central facility for making the materials, which then need to be distributed throughout the country."

"ECAR requires electricity but it doesn't need a central manufacturing facility for process chemicals. It's also low-cost, produces less waste than ARUBA and other chemical methods, it's easy to maintain the equipment, and ECAR doesn't require an extensive supply chain." ECAR might be suitable for harder-to-reach areas that an ARUBA supply chain would be less likely to reach.

A Successful Market Mechanism for Community-Scale Facilities

In addition to developing and proving the technology itself, the development teams have analyzed the economics and outlined a financing and operations model called the micro-utility for deployment in communities in Bangladesh and elsewhere. This model is based on the successful dissemination experience with a previous invention, UV Waterworks, that also came out of Berkeley Lab, from Gadgil's team.

"Technology development alone will not solve this problem. It needs local community education in Bangladesh about the risks posed by arsenic and the importance of switching to safe water. This needs strong local community partners and continuous feedback from the field on which aspects of solutions work, and which ones need improvement," says Addy. "Our team is dedicated to this approach—we collaborate intensively with researchers in other fields, gather and incorporate feedback continuously from the field, and work with all stakeholders from the beginning of the technology/implementation design effort.

"In 2009, we held open-mike meetings in Kolkata, India—one for the scientific/engineering community at a major university in Kolkata, and another one in a remote village for the population of a severely arsenic-affected community. Our teams have spent time both in Bangladesh and West Bengal (India) to talk to local NGOs and community advocates, government officials, and religious leaders, and we have had in-depth conversations with affected families. We work with UC Berkeley's School of Public Health, Haas School of Business, and other departments at UC Berkeley, as well as the Economics Department and Global Change Programme at Jadavpur University, India. We try to engage with and learn from other efforts, public and private, to solve this problem."

Experience has shown that household-scale water-treatment filters and devices have not worked well in developing economies such as Bangladesh. They are too expensive, or they require too much maintenance and training to operate. A locally owned community-scale facility is more likely to succeed, as shown by successful examples in India, which use another of Gadgil's water treatment technologies, UV Waterworks.

Developed in the 1990s, UV Waterworks-based treatment facilities for removing disease-causing bacteria are now gaining traction in India and other developing nations, serving more than a million people daily with safe drinking water, through Berkeley Lab's licensee, WaterHealth International.

Both ARUBA and ECAR provide the most cost-effective water remediation in small facilities designed to supply drinking water for about 500 to 1,000 people. "A local financial institution can provide capital to a local government which would contract with a private company to build a treatment facility," says Addy.

The company operates and maintains the facility under contract to the local government, which sets the price of water to the community. Community members don't have to learn how to operate and maintain the equipment. Revenues from sales fund the facility's operation over the long term.

This fall, with funding from the Blum Center and Sustainable Products and Solutions Program, and the U.S. Environmental Protection Agency's People, Prosperity and the Planet (P3) program, the ECAR team will set up a pilot program in West Bengal in India in collaboration with Jadavpur University (Kolkata) to undertake a technical trial of the ECAR technology in a field setting. Meanwhile, ARUBA is ready for deployment, and in search of non-governmental agencies, funding institutions, and private sector licensees.

—Allan Chen

Broad Funding for a Widespread Problem

Development of ARUBA is funded by:

The Blum Center for Developing Economies, the UC Berkeley Big Ideas Competitions, the National Collegiate Inventors and Innovations Alliance (NCIIA), the Blue Planet Run Foundation, Clean Water LLC, and Berkeley Lab's Technology Transfer Department.

Development of ECAR is funded by:

UC Berkeley's Blum Center for Developing Economies, the Sustainable Products and Solutions Program at UC Berkeley's Haas School of Business, and U.S. EPA's P3 Program.

Web pages, articles, and technology transfer information for these technologies:

- Arsenic-Free Bangladesh [http://arsenic.lbl.gov]
- *Water Filter Could Help Millions of Bangladeshis* [http://www.lbl.gov/Science-Articles/Archive/EETD-Gadgil-water-filter.html]
- ElectroChemical Arsenic Remediation [http://launch.org/presentations/view/10/electrochemical-arsenic-remediation]
- *JU, Berkeley to Work on Arsenic Pollution* [http://m.timesofindia.com/PDATOI/articleshow/4703737.cms]
- *Study: Millions in Bangladesh Exposed to Arsenic in Drinking Water* [http://www.cnn.com/2010/WORLD/asiapcf/06/20/bangladesh.arsenic.poisoning/index.html?hpt=T2]
- Available Technologies: *Low Cost Electrochemical Arsenic Removal from Drinking Water Supplies* [http://www.lbl.gov/Tech-Transfer/techs/lbnl2126.html]
- Available Technologies: *Cost Effective Method for Removing Arsenic from Water* [http://www.lbl.gov/Tech-Transfer/techs/lbnl1742.html]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

ARPA-E Funds Berkeley Lab's Advanced Battery and Building Technology Research

Scientists at Lawrence Berkeley National Laboratory (Berkeley Lab) have been awarded funding by the U.S. Department of Energy's Advanced Research Projects Agency-Energy (ARPA-E) for advanced battery and building technology research.

A team of scientists at Berkeley Lab's Environmental Energy Technologies Division (EETD), along with their private-sector partners (DuPont, Bosch, 3M, and Proton Energy), have been awarded more than $1.5 million from ARPA-E to research a novel flow battery system for storing energy on the electric grid. The Berkeley Lab researchers are Venkat Srinivasan, Vince Battaglia, and Adam Weber of EETD.

ARPA-E Funding will help boost EETD research in batteries with energy storage for the electricity grid applications.

Flow batteries pump reactive chemicals through the battery cell when electricity is needed. This project's battery will use hydrogen and bromine as its active materials. Although this type of flow battery has existed for decades, it has been plagued by high costs, short lifetimes, and safety concerns.

Developing cost-effective, long-lived stationary batteries connected to the electric grid is a major goal of clean technology research. Large-capacity storage technologies for the grid can store energy generated by intermittent clean, renewable sources such as wind, solar, and tidal sources, and deliver it back to the grid when needed.

The Berkeley Lab team will deliver a proof-of-concept cell that will demonstrate the potential of this chemistry in grid-scale energy storage applications.

In the area of building technology research, Berkeley Lab's EETD is also a subawardee in a project titled "Innovative Building-Integrated Ventilation Enthalpy Recovery." The EETD's Philip Haves will participate, along with prime contractor, Architectural Applications. The project's goal is to develop a new technology that will recycle building-exhausted air to partially cool and dehumidify incoming fresh air. This design promises a performance increase of 25% to 40%, compared to conventional air conditioning systems.

The mission of ARPA-E is to fund projects that will develop transformational technologies that reduce America's dependence on foreign energy imports; reduce U.S. energy-related emissions (including greenhouse gases); improve energy efficiency across all sectors of the U.S. economy; and ensure that the U.S. maintains its leadership in developing and deploying advanced energy technologies.

—Allan Chen

Department of Energy Awards $92 Million for Groundbreaking Energy Research Projects [http://www.energy.gov/news/9205.htm]

ARPA-E Website [http://arpa-e.energy.gov/]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

A New National User Facility for Low Energy Integrated Building Systems

Lawrence Berkeley National Laboratory (Berkeley Lab) will soon begin to construct a National User Facility for Low Energy Integrated Building Systems. It will consist of a series of unique research testbeds designed to address key technical challenges for integrated low-energy building technologies, systems, and controls. The facility will serve a national audience—and need—in an aggressive pursuit of the U.S. Department of Energy's (DOE's) goals for maximizing cost-effective energy-efficiency strategies for existing and new buildings, and in the widespread deployment of these strategies.

Berkeley Lab's Advanced Windows Test Facility is an example of an existing test bed that allows researchers to install prototypes or existing products and measure their performance over time, and under changing conditions.

The User Facility will be managed by Berkeley Lab's Environmental Energy Technologies Division (EETD). The test beds will be made available to collaborating organizations including manufacturers, designers, technology startups, academia, and other national labs. The facility and its users represent the broad range of approaches and stakeholders essential to achieving low-energy new construction and retrofit building goals.

Fulfilling a Critical Buildings Research Need

Buildings account for more than 40 percent of U.S. energy use and carbon emissions. If building energy efficiency remains as it is today, the Energy Information Administration (EIA) estimates that by 2030 we will experience a 16 percent growth in building energy consumption. Strategies that dramatically reduce the energy consumption of new buildings and address the low-energy retrofit of existing buildings will be essential in reducing energy use and its climate-related impacts. The new laboratory facilities will help researchers develop, test, and validate promising technologies, systems, and design approaches. Projects will focus on cost-effective energy savings strategies that can be rapidly deployed into the nation's building stock.

Broad Stakeholder Participation

Berkeley Lab is currently working with numerous stakeholder organizations, including industry partners, utilities, universities, nonprofits, and public agencies to further refine the requirements for the facility. Berkeley Lab invites inquiries from additional potential partners in both the public and private sectors.

Diverse Capabilities to Address Multiple Sectors

The User Facility will be designed to conduct side-by-side field tests of interchangeable prototype building systems such as windows; lights; heating, ventilation, and air conditioning (HVAC); energy control systems; plug loads; and skylights. The facility will allow researchers to focus on just one building system component or on fully integrated systems. For example, a research project could address energy-efficient window system prototypes alone or the energy performance of an integrated lighting, daylighting, and HVAC system with optimized controls.

The facility will include a virtual design testbed, featuring EnergyPlus and other design tools that users can access to perform integrated simulation-based design and life-cycle focused analysis. These simulation tools will also allow testbed results to be extrapolated to other building conditions and climates. A controls system testbed will enable users to evaluate the performance of wireless systems; test the interoperability of controls for HVAC, lighting, shading, plug load, and electrical controls systems

hardware and communications protocols; and assess monitoring tools. The controls testbeds will also include on-site hardware and analysis tools and software to allow for the analysis of the experiments conducted in the test bed facilities, and to validate performance of software tools.

Benefits

The Low Energy Integrated Building Systems User Facility will provide the following key benefits:

- It advances the Department of Energy's goals for very low-energy buildings for both new construction and retrofit building research.
- The facility can be used to validate and quantitatively demonstrate the value of whole-building systems integration, in addition to component efficiency improvements, in reducing energy consumption and improving indoor environments.
- The use of multiple discrete testbeds maximizes user access to the facility, increasing industry engagement and throughput.
- The facility will allow testing under controlled laboratory conditions, as well as in a lived-in office environment, thus allowing the impacts of behavioral strategies to be assessed.

Actively Seeking Partners

Berkeley Lab has selected an outside design team to complete the detailed design of the testbed facilities. In parallel with this design process LBNL is seeking partners to work with us and better define use scenarios for the new facility. A proposal call and evaluation process will be announced in the near future, along with further details of the facility design and its capabilities. However, there are many ways to engage now with the facility and Berkeley Lab researchers. To explore how your organization could contribute to and benefit from becoming a facility partner, contact Doug Davenport.

—Doug Davenport

For more information, or to partner with us, contact:

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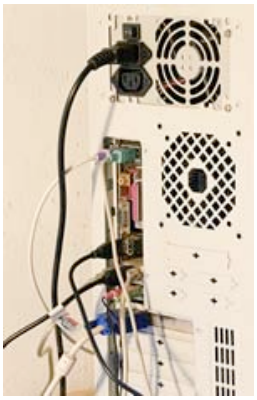
LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Researcher Leads Development of a Standard to Reduce Energy Use of Computers Connected to the Internet

"Most energy use in personal computers takes place when no one is there," says Bruce Nordman, a researcher in the Environmental Energy Technologies Division of Lawrence Berkeley National Laboratory (Berkeley Lab). Summing up what many probably intuit but don't think much about, PCs are fully on and using considerable energy even if they are idle. This is also true of game consoles and set-top boxes. And this is wasted energy.



Sleep modes that dramatically reduce PC power use have been available for many years, but this does not reduce the waste of energy if the PC is always fully on. Reducing energy use, of course, lowers energy bills, and reduces the emissions of climate-changing greenhouse gases.

Residential and commercial buildings use more than 70 percent of the 3,600 terawatt-hours (trillion watt-hours, TWh) of electricity used in the U.S. each year. Electronics already account for more than 10 percent of a building's electricity. More than half of this load (currently at least 150 TWh/year) is digitally networked, and the portion is rising.

Today's sleep mode cannot be used if a PC needs to stay connected to the Internet because it can't engage in ongoing conversations with the network in this mode. Without the computer's persistent network presence, it loses its connection to the Internet, and to other devices on the local network.

Nordman, who instigated a research program called Energy Efficient Digital Networks, became aware of a possible solution thanks to Ken Christensen, a faculty member of the University of South Florida, in 1997. Christensen and a colleague wrote a paper addressing the problem of how to provide power management to computers that are network-attached, which, these days, includes most PCs in the United States.

In 2003, Nordman and Christensen began collaborating on an approach to reducing the energy use of network-connected devices. Called *proxying,* this approach hides the sleep mode state of the device from the network.

The PC transfers its network presence operation to the proxy, a small portion of the hardware, while the rest of the computer's hardware goes into its sleep mode, saving energy (typically 95 percent). The proxy responds to requests from the network to maintain the PC's presence. If a larger response (such as accessing a file) is needed, the proxy will wake the rest of the PC.

"Proxying is a like your reptilian brain," says Nordman. "It keeps your heart beating when you go to sleep, it listens for noises indicating danger and wakes you if it detects one, but it doesn't wake you up for unnecessary reasons like birds tweeting."

To make proxying a reality on computers in the marketplace, the researchers needed to find a way to get as many computer, printer, and other electronic device manufacturers as possible to include proxying hardware and software in their products. A key for proxying is that it does not necessarily require new hardware or increase sleep power, so it is a highly cost-effective way to save energy.

Nordman provides technical assistance to the U.S. Environmental Protection Agency's (EPA's) ENERGY STAR program for its efforts to define and identify the most efficient personal computers in the marketplace. In 2003 he began to champion the inclusion of network connectivity proxying in the ENERGY STAR specification. The EPA and the PC manufacturing community responded, and a growing awareness spread through the industry that here was an energy efficiency issue they needed to address, and one which had a relatively simple, inexpensive solution—with no need to develop new hardware technology.

To move the process forward, Nordman and his colleagues attended conferences and technical meetings to discuss proxying as a way of improving the energy efficiency of electronics. As an industry consensus began to build, Ecma International, a non-profit technology standards development body based in Geneva, was approached about developing an Ecma standard for network proxying.

Ecma formed a committee of experts from AMD, Apple, Hitachi, HP, Intel, Lexmark, Microsoft, Oce, Realtek, Sony, and Terra Novum, as well as Nordman, and Christensen, to develop the standard collaboratively.

After a little over a year of intensive work, Ecma International published their "Proxzzzy Standard for network connected sleep states in Information and Communications Technology (ICT) devices" as ECMA-393 on their public website for unrestricted download in April of this year.

In their announcement, the organization noted that "The energy savings potential of Proxzzzy enabled devices is measured in billions of dollars per year for PCs, and grows even larger when application to game consoles, printers, set-top boxes and other digital devices is considered."

The announcement also quoted Katharine Kaplan, Acting Branch Chief ENERGY STAR Products at EPA, who said "This standard, the product of public/private partnership, is a great example of the leadership IT companies can offer in developing energy saving solutions that deliver users a better experience and also help to fight climate change."

The EPA will use the standard in the ENERGY STAR Computers Version 5 specification to deliver greater energy savings and will look to do the same in other ENERGY STAR categories.

Last summer, Apple became the first electronics manufacturer to incorporate network proxying into the control software of some models of its computers. In December 2009, network proxying migrated to the hardware of Apple computers. Other computer manufacturers are expected to introduce products soon.

"The standard wouldn't have been possible without the support of the ENERGY STAR program," says Nordman. "They provided the mechanism for getting the industry interested in and motivated to address the problem."

"What's particularly exciting is that technology standards are a new tool for saving energy, one with great advantage for cost-effectiveness and in ability to permeate markets," he adds.

—Allan Chen

Made possible through funding from the CEC PIER Buildings program [http://www.energy.ca.gov/research/buildings/description.html].

More about Bruce Nordman's [http://eetd.lbl.gov/ea/nordman] research: Energy Efficient Digital Networks [http://efficientnetworks.lbl.gov/]

More information about the standards organization Ecma International [http://www.ecma-international.org/].

Download the Ecma-393 standard [http://www.ecma-international.org/publications/standards/Ecma-393.htm].

LAWRENCE BERKELEY NATIONAL LABORATORY

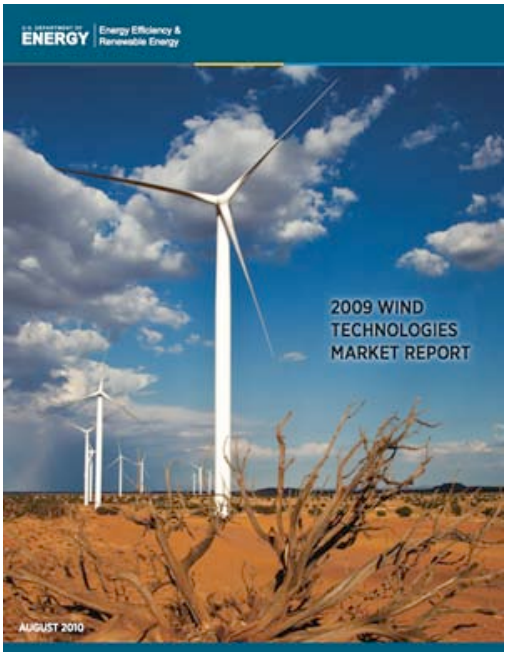
Environmental Energy Technologies Division

NEWS

Study Details U.S. Wind Power Market Growth

In 2009, the United States was the second fastest-growing wind power market in the world, behind China, according to the *2009 Wind Technologies Market Report* released by Lawrence Berkeley National Laboratory (Berkeley Lab) and the U.S. Department of Energy. This annual report provides a comprehensive overview of developments in the rapidly evolving U.S. wind power market, meeting the demand for this type of information as the wind power industry enters an era of unprecedented expansion, both globally and in the United States.

Wind power additions in the United States set a new record in 2009, with 10 gigawatts of new capacity installed, representing a $21 billion investment. "At this pace, wind power is on a path to becoming a significant contributor to the U.S. power mix," says co-author Ryan Wiser, a scientist in Berkeley Lab's Environmental Energy Technologies Division (EETD). "Wind power projects accounted for 39 percent of all new electric generating capacity added in the U.S. in 2009, and wind energy is now able to deliver 2.5 percent of the nation's electricity supply."



Source: Lawrence Berkeley National Laboratory

At the same time, as the report documents, the past year has been one of upheaval. The global financial crisis and lower wholesale electricity prices have negatively affected the industry's near-term growth prospects, while new federal policies are pushing it toward continued aggressive expansion.

"With the market evolving at such a rapid pace, keeping up with the latest developments has become increasingly difficult," says co-author Mark Bolinger of EETD. "Yet, the need for timely, objective information on the industry and its progress has never been greater... this report seeks to fill this need."

The report analyzes trends in wind power capacity growth, industry and manufacturing trends, turbine size and prices, installed project costs, project performance, wind power prices, and how wind prices compare to those of conventional generation options. It also describes trends among developers, project owners, and wind power purchasers, and discusses financing issues. Finally, the report examines other factors affecting the domestic wind power market, including grid integration, transmission issues, and policy drivers. It concludes with a preview of possible near-term market developments.

For the first time, the report presents estimates of the proportion of U.S. wind turbine equipment costs that have derived from imports from other countries, finding that a growing percentage of equipment is being manufactured domestically. "The overall fraction of wind turbine equipment manufactured domestically grew from 50 percent in 2008 to roughly 60 percent in 2009," notes Wiser.

Some of the key findings from the just-released 2009 edition include:

- **The U.S. is the second-fastest-growing wind market worldwide.** After leading the world for the past four years, the U.S. lost its top-market status in 2009, being overtaken by China as the country with the fastest pace of new wind power additions. Nonetheless, despite earlier grim predictions due to the financial crisis, the U.S. market continued to expand in 2009 and shattered its 2008 record for new wind power additions.
- **Growth is distributed across much of the U.S**. Texas led the nation with 2,292 MW of new wind power capacity, but 28 states saw new wind power plants constructed within their borders in 2009. Wind power now provides more than 10 percent of in-state electricity generation in four states: Iowa (20 percent), South Dakota (13 percent), North Dakota (12 percent), and Minnesota (11 percent). Offshore wind power project and policy developments also accelerated in 2009.
- **Market growth is spurring manufacturing investments in the U.S.** Wind turbine manufacturers whose U.S. plants manufacture modern wind turbines installed in the United States now hail from not just the United States, Europe, and Japan, but also from India and, for the first time, China. Seven of the 10 wind turbine manufacturers with the largest share of the U.S. market in 2009 now have one or more manufacturing facilities operating in the United States, and two of the remaining three have announced plans to open facilities in the future.
- **A growing percentage of the equipment used in U.S. wind projects is domestically manufactured.** Trade data show that the United States remained a large importer of wind turbine equipment in 2009, with $4.2 billion of imports, up from $2.5 billion in 2006, but down from $4.6 billion in 2007 and $5.4 billion in 2008. Wind power capacity growth has outpaced import growth in recent years, so a growing amount of wind power equipment is being sourced domestically, as domestic and foreign companies seek to minimize transportation costs and currency risks by establishing local manufacturing capabilities.
- **Wind power project costs continued to increase into 2009, but reductions may be on the horizon.** Installed wind power project costs in 2009 averaged $2,120/kW, up by 9 percent over the 2008 figure. There are expectations that costs will drop in the near future as past cost pressures ease.
- **Wind project performance has improved over time but dropped off in 2009.** The longer-term improvement in project performance, as measured by capacity factor, has been driven in part by taller towers and larger rotors. The drop in 2009 is, in part, attributable to a relatively poor wind resource year in many parts of the country, along with increasing amounts of wind power curtailment—particularly in Texas, where 17 percent of all potential wind energy generation was curtailed in 2009 because of transmission inadequacy.
- **Rising wind power prices and sharply lower wholesale prices make the near-term economics of wind energy more challenging**. Although some of the cost pressures facing the industry in recent years have eased, 2009 was another year of rising average wind power prices. The average 2009 sales price from projects built in 2009 was roughly $61/MWh.
- **Looking ahead, expectations are for a slower year in 2010.** Lower expectations stem from a combination of the financial crisis, lower wholesale electricity prices, and lower demand for renewable energy. Projections among industry analysts range from 5,500 MW to 8,000 MW of wind power capacity likely to be installed in the United States in 2010, a drop of 20 to 45 percent compared to the nearly 10,000 MW installed in 2009. After a slower 2010, most predictions show market resurgence in 2011 and 2012, as programs funded by the American Recovery and Reinvestment Act mature and as financing constraints ease. Beyond 2012, however, the picture is considerably less certain, because of the scheduled expiration of a number of federal policies at the end of that year.

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—Allan Chen

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The report, *2009 Wind Technologies Market Report*, can be downloaded here: Renewable Energy Publications : Electricity Markets and Policy [http://eetd.lbl.gov/ea/ems/re-pubs.html].

A PowerPoint presentation summarizing key findings from the report can be found here: Presentations : Electricity Markets and Policy [http://eetd.lbl.gov/ea/ems/emp-ppt.html]

Read the DOE press release: DOE Releases Annual Wind Market Report, Finds U.S. Wind Projects using a Growing Percentage of Domestically Manufactured Equipment [http://apps1.eere.energy.gov/news/progress_alerts.cfm/pa_id=376].

Read the article from Berkeley Lab News Center: New Study Sheds Light on U.S. Wind Power Market [http://newscenter.lbl.gov/news-releases/2010/08/04/new-study-sheds-light-on-u-s-wind-power-market/]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Berkeley Lab Initiative Opens Clean Energy Ministerial

In July, ministers from 24 governments met for two days in Washington, D.C., at the first Clean Energy Ministerial (CEM), to spur a global transition to clean energy. The attendees represented more than 80 percent of the world's energy consumption (and a commensurate market for clean energy technologies). In all, 11 new initiatives were launched to help bring clean energy technologies to both developed and developing countries.

Jayant Sathaye

Amol Phadke

Aimee McKane

James McMahon

Participating in this historic event were Lawrence Berkeley National Laboratory (Berkeley Lab) researchers Jayant Sathaye, Leader, and Amol Phadke, Principle Scientific Engineering Associate, of the Environmental Energy Technology Division's (EETD's) International Energy Studies group; and Aimee McKane, Senior Program Manager of the Industrial Partnerships program.

Supporting Deployment of Advanced Technologies

The first initiative announced at the ministerial was the Super-Efficient Equipment and Appliance Deployment (SEAD) initiative, presented by U.S. Secretary of Energy and former Berkeley Lab Director Steven Chu. This initiative had grown out of an efficiency partnership that Sathaye and Phadke were conducting with India on a state level since 2006. Jim McMahon, Head of the Energy Analysis Department, participated in coordinating the effort with analysis of appliance standards. Sathaye recounts, "As it grew to a national level, we realized it could be expanded to multiple countries, and we proposed that to DOE in October 2009." A few months later, Secretary Chu announced the effort at the Copenhagen climate summit, and it was adopted at the CEM.

The initiative seeks to establish common super-efficiency standards for key appliances, so that major manufacturers will design and produce super-efficient products to meet that market demand. The initiative is first focusing on televisions, fans, air conditioners, and lighting products, since those products consume a large chunk of the electricity used in the participating countries. To complement the strong appliance standards, the initiative also focuses on helping participant countries develop incentives that will help convince consumers to buy these technologies.

"Since the initiative was announced," says Phadke, "there is significantly more cooperation from other countries." At last count, twelve countries and the European Commission were participating, and it is expected that the program will expand and that even non-participating countries will benefit. "We expect that there will be a lot of spill-over benefits," says Phadke. Sathaye agrees. "Smaller, poorer countries will benefit as well," he says. "Manufacturing is concentrated, and they're not going to run a separate production line to supply a small market."

Supporting Energy Efficiency in Industrial Buildings

Another initiative announced at the CEM was an international partnership for energy efficiency that is based on the Global Superior Energy Performance (GSEP) Partnership that McKane has been designing with the U.S. Department of Energy's (DOE) Industrial Technologies Program over the past four years. This international effort will help large buildings and industrial facilities measure and reduce their energy consumption and greenhouse gas emissions. They plan to accomplish this through an internationally recognized certification program, public-private task groups targeting energy-intensive industries, promoting the best technologies and practices, standardizing protocols, facilitating communication among stakeholders, and promoting the adoption of cool roofs. It is estimated that the large buildings and industrial facilities that this initiative addresses account for nearly 60 percent of all global energy use.

—Mark Wilson

For more information:

The Clean Energy Ministerial [http://www.cleanenergyministerial.org/] website.

The Clean Energy Ministerial Summary Fact Sheet [PDF [http://www.energy.gov/news/documents/Clean-Energy-Ministerial-Fact-Sheet.pdf]]

The Clean Energy Ministerial Press Fact Sheet [PDF [http://www.eenews.net/assets/2010/07/21/document_cw_01.pdf]]

"Secretary Chu Announces Initiatives to Promote Clean Energy at First Clean Energy Ministerial" [http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=16177]

"Berkeley Lab Report: Simple Energy Efficiency Measures Can Eliminate Electricity Shortage in India" [http://newscenter.lbl.gov/feature-stories/2010/05/25/energy-efficiency-measures-can-eliminate-electricity-shortage-in-india/]

Fact Sheet: The Global Superior Energy Performance Partnership [PDF [http://www.energy.gov/news/documents/GSEP-Fact-Sheet.pdf]]

Global Superior Energy Performance (SEP) Partnership [http://www.cleanenergyministerial.org/gsep/index.html]

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Research Highlights

Battery R&D Directions Discussed

Tien Duong, the Department of Energy's BATT Program Manager, discusses the past achievements and future of advanced battery research.

Advanced battery researchers from around the U.S. gathered at Lawrence Berkeley National Laboratory (Berkeley Lab) June 27 to discuss future directions for the Batteries for Advanced Transportation Technologies (BATT) Program. BATT's U.S. Department of Energy (DOE) Program Manager, Tien Duong, reviewed successes from two decades of DOE-funded research. He discussed R&D contributions that helped bring to the marketplace technologies like the nickel metal hydride batteries used in today's hybrid vehicles, and he also spoke about the positive funding outlook for advanced batteries research.

DOE BATT Program Manager Tien Duong

The all-day meeting drew BATT program researchers from Berkeley Lab, Argonne National Laboratory, Brookhaven National Laboratory, Case Western Reserve, Deppe Consulting, Drexel, Energy & Environmental Resources Group, Hydro-Quebec, MIT, the National Renewable Energy Laboratory, North Carolina State, Oak Ridge National Laboratory, Penn State University, Pacific Northwest National Laboratory, the SouthWest Research Institute, Stanford University, University of Kentucky, University of Pittsburgh, University of Rhode Island, University of Texas at Austin, and University of Utah.

Piette Elected to Smart Grid Architecture Committee

Mary Ann Piette, Deputy Head of EETD's Building Technologies Department, and Research Director of the Demand Response Research Center, has been elected to the Smart Grid Architecture Committee (SGAC). The Committee is responsible for creating and refining a conceptual reference model, including lists of the standards and profiles necessary to implement the Smart Grid.

The Committee is part of a collaborative effort called the Smart Grid Interoperability Panel, coordinated by the National Institute of Standards and Technology, to bring together the parties that are developing and implementing the Smart Grid. Its responsibility is to develop a framework that includes protocols and model standards for information management to achieve interoperability of smart grid devices and systems.

For more information, see the NIST Smart Grid Collaboration website [http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/WebHome].

EETD Researchers and Microsoft Corp. Win R&D 100 for Home Energy Saver/Hohm

Lawrence Berkeley National Laboratory (Berkeley Lab) and Microsoft Corporation won an R&D 100 award from *R&D Magazine* for developing a free online tool that helps consumers identify the best, most cost-effective ways to save energy and reduce greenhouse gas emissions from their homes.

Berkeley Lab's Environmental Energy Technology Division scientists Evan Mills and Rich Brown developed the tool, called the *Home Energy Saver (HES)*. A powerful building energy simulation program is at its core, providing each user with a customized home energy profile and recommendations for home improvements that can be readily made. The web-based interface enables millions of potential users who have no special knowledge of home energy technologies or retrofits to estimate energy use and savings that are tailored to their home, climate, and lifestyle.

The Berkeley Lab technology was licensed by award co-winner Microsoft in 2009 for its online application, *Hohm*. Both tools feature an advanced, easy-to-use graphical interface that enables users to customize inputs to match their situation. The Home Energy Saver and Hohm can recommend efficiency measures based on the answers to only 15 questions.

As of January 2010, the Home Energy Saver website had more than 6 million unique visitors. About one-third of users reported making home energy-efficiency improvements based on the recommendations they received. Other web-based energy calculators are available; however, only Home Energy Saver uses actual nationwide electricity tariffs and offers such detailed customization.

Home Energy Saver is supported by the U.S. Department of Energy's Building Technologies Program in the Office of Energy Efficiency and Renewable Energy.

For more information:

Home Energy Saver [http://hes.lbl.gov]

Microsoft Hohm [http://www.microsoft-hohm.com/]

The R&D 100 Awards [http://newscenter.lbl.gov/news-releases/2010/07/08/berkeley-lab-wins-four-2010-rd-100-awards/]

Berkeley Lab Contributes to DC-Powered Data Center Tests

A consortium of researchers from the public and private sectors, including William Tschudi of Lawrence Berkeley National Laboratory's (Berkeley Lab's) Environmental Energy Technologies Division, have embarked on a real-world experiment to gauge whether large computing facilities can operate on less power if they cut alternating current (AC) out of the equation.

At the University of California, San Diego, engineers recently switched a set of servers in a campus data center to operate continuously on 380-volt direct current (DC). This effort is part of a project that allows researchers to track in great detail the energy savings that servers and data centers can achieve through a variety of architectural and procedural efficiencies, including the use of DC power.

Researchers and technicians in front of the GreenLight Instrument modular datacenter prepare to switch ten servers to continuous direct-current electrical power in an experiment to show the potential real-world rewards of switching datacenters to DC power throughout.
[Photos by Tom DeFanti. PI, Project GreenLight]

The experiment at UC San Diego is part of Project GreenLight, a National Science Foundation-funded initiative that has deployed a modular data center on campus with sensors and other instruments to measure the energy efficiency of information and communication technologies. The project's goal is to help researchers build greener IT systems and software.

"The UC San Diego campus has made substantial investments for energy savings," said Thomas A. DeFanti, principal investigator on Project GreenLight and a senior research scientist in the California Institute for Telecommunications and Information Technology (Calit2). "The switch to DC powering of servers holds great potential on a campus where supercomputers and other high-tech facilities represent a disproportionately large share of energy consumption."

It is estimated that companies could save billions of dollars each year in capital costs and ongoing energy savings by using all-DC distribution in their data centers.

In a traditional server facility, AC power is provided at a high voltage and converted to DC in the uninterruptible power supply (UPS) system to charge batteries and condition the power. From there it is converted back to AC to drive the power supplies of computing equipment to run processors, memory, disks, and communications components. Skipping or consolidating the above conversion steps can save considerable electricity usage in the power distribution chain, and in cooling.

"Each conversion loses power and generates additional heat, both of which reduce the overall power and cooling efficiency of the server facility," said Tschudi. "By providing DC power directly to the server facility, many conversion steps are bypassed and less heat is generated, leading to overall higher efficiency." Tschudi has provided technical leadership and represented the California Energy Commission's Public Interest Energy Research (PIER) program in GreenLight's DC power server experiments.

In 2006, a temporary installation using best-in-class equipment was slightly modified. That initial modification demonstrated that further research was merited. In cooperation with Berkeley Lab and others, Direct Power Technologies, Inc. provided equipment and design assistance. The UC San Diego project has now installed first-generation 380-volt DC equipment specifically manufactured to enable this technology to evolve to the next level of commercial availability.

The researchers hope to prove that switching to an all-DC power distribution should increase the "computing work per watt"—a key barometer of energy efficiency in computing environments. In addition to significant energy savings, other potential benefits include improved power quality, reduced cooling needs, higher equipment densities, reduced heat-related failures, improved reliability (from fewer components), and easier use of renewable sources of DC power. The DC power researchers also point out that the industry has the opportunity to make this a worldwide standard through the ongoing collaborative efforts.

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Additional information:

Calit2. "Researchers Flip the Switch to Test Energy Saving in Data Centers Using DC Power Directly." [http://www.calit2.net/newsroom/release.php?id=1730] August 24, 2010.

LAWRENCE BERKELEY NATIONAL LABORATORY

Environmental Energy Technologies Division

NEWS

Sources and Credits

Sources

DOE's Consumer Information Fact Sheets

These web pages [http://www.eere.energy.gov/consumer/] 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 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://www.er.doe.gov/]

U.S. EPA, ENERGY STAR Program [http://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.
