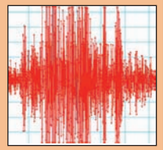
Latest Research Posted On Lab's News Center

Berkeley Lab recently launched an online News Center, which features articles on our latest research, as well as YouTube videos of Lab scientists describing their work. Go to the Lab's homepage (www.lbl.gov) and click on the "News Center" link. Among the recent highlights are:

> **YouTube Video: Human Contribution to the Increasing Impacts of Climate Change**
www.youtube.com/watch?v=5utFeFUn5GA



> **A Stress Meter for Fault Zones: The Speed of Seismic Waves is a Measure of Stress in Rocks During — and Possibly Before — Earthquakes** www.lbl.gov/publicinfo/newscenter/pr/2008/ES-stress-meter.html

> **Sniffing Out Trouble: Technique to Detect Explosives and Chemicals Dogged as a Bloodhound on a Week-Old Scent**
www.lbl.gov/publicinfo/newscenter/features/08/05/02/eet-sniffing-out-trouble.html

UC Buildings and Green Research

continued from page one

University of Illinois at Urbana-Champaign. It is supported by funds from BP, a global energy firm, as well as other research programs.

Helios research will concentrate on developing transportation fuel from biomass and from solar energy driven electrochemistry. It will also target solar technologies, including artificial photosynthesis (see story on page two), a new generation of solar photovoltaic cells, and the conversion of electricity into chemical storage to meet future energy demands. The facility will be a model of "green" construction with roofs that provide natural cooling, absorb and reuse rainwater, and minimize runoff. The project will seek to include alternative energy sources such as solar and wind energy for ventilation, lighting, and other electrical power uses.

The Computational Research and Theory (CRT) Facility will be on the forefront of high-performance supercomputing research (see story on page three). Key research areas expected to benefit from such proximal computing collaboration include global climate change research, fusion energy research, biological and environmental research, basic energy science, and astrophysics.

CRT's electrical demand may be partially offset by high efficiency lighting and day lighting, and high performance cooling towers and chillers.

Visit www.lbl.gov for more information on Berkeley Lab
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SCIENCE ON THE HILL

the Community Newsletter of Berkeley Lab

Taking on the Energy Crisis and Global Warming

Staggering price increases at the gas pumps combined with melting glaciers and shrinking polar ice caps have put Americans on notice that we must end our dependence on petroleum and other fossil fuels, and develop sustainable energy technologies that will reduce green house gas emissions. In one hour, enough sunlight strikes the earth's surface to meet an entire year's worth of energy needs for all of humankind. Harnessing solar power through non-polluting, efficient, cost-effective and practical technologies would go a long ways towards solving the energy crisis worldwide and mitigating global climate change.

In 2005, Berkeley Lab director and Nobel laureate Steven Chu launched an ambitious effort to develop solar-based energy technologies, which he called the "Helios Project,"

Lab scientists are researching the use of biomass, like the Miscanthus grass pictured above, to create alternative fuels

after the sun god of ancient Greek mythology. A major thrust of this effort is the development of advanced biofuels derived from the biomass found in agricultural waste products, perennial wild grasses, algae and other plants not used for food. Unlike ethanol, such biofuels could replace gasoline on a gallon-for-gallon basis in today's combustion engines, and could be plugged into the existing gasoline infrastructure. Burning gasoline in ground transportation accounts for about 60-percent of U.S. petroleum consumption and generates about 25-percent of our nation's greenhouse gas emissions.

"We face challenging scientific, economic and social problems in finding better, cleaner transportation fuels," Director Chu has said. "The advanced biofuels we plan to develop must make the transition from the laboratory to the fuel pump as soon as possible and on a global scale."

Through the Helios Project, Berkeley Lab researchers are also investigating the direct conversion of water and carbon dioxide into transportation fuels, and the application of artificial nanostructures to other solar energy technologies. Berkeley Lab is the lead partner in the Joint BioEnergy Institute, a participant in the Energy Biosciences Institute, and sponsor of the Solar Energy Research Center (see story on page two). It is also one of the nation's premier institutes for advancing energy conservation and efficiency technologies.

Proposed Buildings Will Enable Green Research

Few scientific challenges loom as large as understanding climate change and developing secure and sustainable sources of energy. And few institutions are playing as large a role in addressing these intertwined challenges as Berkeley Lab.

Illustration of the Computational Research and Theory Facility

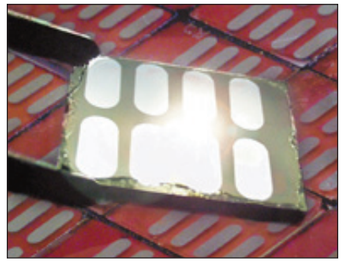
The Helios Energy Research Facility will house the Energy Biosciences Institute, a partnership between UC Berkeley, Berkeley Lab, and the

Continued on Page Four

PROPOSED NEW BUILDING: HELIOS ENERGY RESEARCH FACILITY

Photosynthetic Approach to Creating Fuels From Sunlight

"One of the most interesting conversations we can have with nature is a discussion of photosynthesis and photovoltaics," says Paul Alivisatos, Deputy Director of Berkeley Lab, co-leader of Berkeley Lab's Helios Project and one of the world's premier authorities on nanoscience and its application to photovoltaics — solar cells that convert sunlight directly into electricity.



The key to commercial use of artificial photosynthesis for fuel production will be the development of novel photovoltaic materials that are much cheaper and easier to make than the semiconductors used in solar cells today

As part of the Helios Project, Alivisatos has been leading an effort to mimic nature with an artificial form of photosynthesis. The idea is to develop photovoltaics that can provide electrical currents for powering chemical reactions that produce liquid fuels. Such fuels would be carbon-neutral (meaning they would not contribute to global climate change), and could be used for transportation and other purposes.

"Through photosynthesis, green plants are very good at collecting sunlight and using it to produce energy in the form of sugars from water and carbon dioxide, but the overall power efficiency is not high enough to meet our energy needs," Alivisatos says. "Artificial systems can be made with enough power efficiency, but right now they are much too expensive and complex to use on a large-enough scale."

Alivisatos and his colleagues want to use photovoltaics to convert water and carbon dioxide into sugars. Then, through catalysis, these sugars would be converted into carbon-neutral fuels that, ideally, could replace gasoline on a gallon-for-gallon basis.

"Plants efficiently gather light and carry out chemical activities, such as generating oxygen and making sugars, on each leaf," says Alivisatos. "In effect, by placing all the elements of light collection, electrical charge generation, and chemical catalysis to make fuels from water and carbon dioxide on the same membrane of photovoltaic material, we want to create a synthetic leaf."

This synthetic leaf will come in the form of a single, solar-powered chemical reactor called a PhotoElectroChemical (PEC) cell. Creating carbon-neutral transportation fuels using PEC cells has the potential to be even more efficient than creating such fuels from biomass. However, the highest efficiency prototype PEC cells today are made from relatively scarce and expensive semiconductors. Alivisatos and his Helios colleague want to replace these semiconductors with novel photovoltaic materials that would make commercial-scale applications of PEC cells practical. They also want to synthesize new catalysts that are less expensive but more effective than what is available today.

"Our goal is to deploy an artificial photosynthetic system across a large geographical area, at a level of efficiency that could provide the United States a significant alternative fuel source," says Alivisatos. "The land we use would not need to be arable, and follow-up research and development would aim to improve upon the system's efficiency."

Towards this end, Alivisatos proposed the creation of a Solar Energy Research Center (SERC). Scientifically fast-tracked to achieve its goals within 10 years, SERC would focus on the development of advanced nanomaterials for use in solar light collectors and electrodes; a new generation of catalysts for faster and more energy-efficient chemistry; and specialized soft and hard membranes for integrating the light harvesting, charge-separating and fuel-forming components of PEC cells.

Berkeley Lab Deputy Director and materials scientist Paul Alivisatos is developing an artificial form of photosynthesis

SERC and the Helios Project demonstrate Berkeley Lab's committment to replacing today's atmosphere-heating and non-sustainable fossil fuels with superior energy technologies that are carbon-neutral and sustainable.

Says Alivisatos, "The problem is not that the world is running out of fossil fuels, the problem is we're running out of atmosphere."

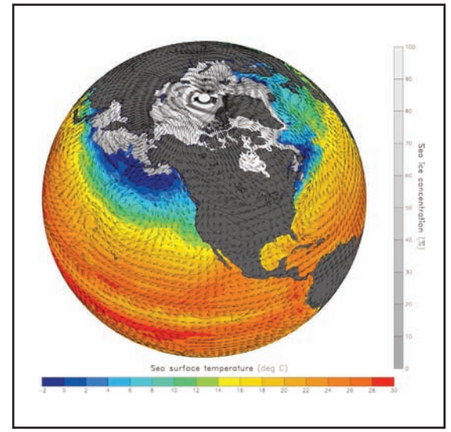
SCIENCE ON THE HILL | SUMMER '08

PROPOSED NEW BUILDING: COMPUTATIONAL RESEARCH AND THEORY FACILITY

Building a Better Climate Model

How will human activities contribute to global climate change over the next several decades? What are the effects of such activities on terrestrial and oceanic carbon cycles? What is the likelihood and nature of abrupt climate changes? How will regional ecosystems be affected? What are the environmental costs and benefits of changing the primary modes of energy production? How will alternative energy sources affect climate change?

These and other pressing questions will be tackled by the Computational Research and Theory Facility, a new Berkeley Lab facility that will be on the forefront of high-performance supercomputing research. The facility will foster collaborative research by bringing Berkeley Lab and UC Berkeley scientists to one facility, and by giving these scientists immediate access to advanced supercomputing resources.



The Computational Research and Theory Facility will help Berkeley Lab scientists develop climate models that will predict global interactions between climate, water, and energy

Together, they'll attempt to create a new kind of climate model, one that will be able to zoom in on the regional scale, make accurate predictions for the near term, and account for what humans actually do. The goal is not to predict climate alone but interactions among climate, water, and energy on a global scale.

Much of this work will be led by scientists in Berkeley Lab's Climate Science Department. This world-class team is working to create a climate model that integrates cutting-edge climate science, such as the pioneering work on the carbon cycle conducted at Berkeley Lab, and draws on work by scientists at UC Berkeley and other universities and national laboratories. It's goal is to incorporate fresh data and generate new scenarios: energy demand and carbon emissions; changes in the composition of the atmosphere and the heat entering and leaving it; impacts on ecosystems and human well-being; and different strategies to mitigate or adapt to change.

Berkeley Lab has long played a lead role in climate change research. Last year, Lab scientists were important contributors to the research on global climate change that won the 2007 Nobel Peace Prize. And earlier this year, Lab researchers proposed an innovative way to improve global climate change predictions by using a supercomputer with low-power embedded microprocessors, an approach that would overcome limitations posed by today's conventional supercomputers.

Energy Efficiency: The Other Grand Challenge

The push to develop sustainable and carbon-neutral sources of energy isn't Berkeley Lab's first foray into energy research in order to meet pressing national needs. In 1973, when an oil embargo rattled the nation's dependence on foreign energy, Lab scientists began to tackle the problem of energy consumption.

They found opportunities for more efficient uses of energy everywhere they looked, and launched a diverse research portfolio that continues to this day. Along they way, Berkeley Lab's energy efficiency research has wrung a fortune in savings from a myriad of technologies that consume energy.

The list includes efficient lighting technologies, compact fluorescent lamps, appliance standards, smart windows, cool roofs, and tools for building designers.

Today, as a new crisis looms in the form of climate change, Berkeley Lab can harness more than thirty years of pioneering leadership in energy efficiency research to help curb greenhouse gas emissions by attacking consumption.