Berkeley Lab's Jay Keasling.

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DOE Pulse

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Research Highlights . . .

Mutated organisms may hold key to hydrogen production

Researchers at the National Renewable Energy Laboratory are working on a novel way to use green algae to produce hydrogen directly from water and sunlight. Green alga produces oxygen during photosynthesis but oxygen inhibits the function of algal hydrogenase, the enzyme that allows the release of hydrogen gas. Under normal conditions such as sunlight, the alga cannot sustain hydrogen production for more than a few minutes. NREL researchers are addressing this issue by screening for naturally occurring organisms that are more oxygen tolerant and by creating new genetic organisms that can sustain hydrogen production in the presence of oxygen. Further research will determine if the modified enzymes will lead to the most-cost-effective, efficient route to hydrogen.

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Forgotten research leaps to the fore

When LLNL physicist Dmitri Ryutov gave a talk on the upper-bound estimate of a finite photon mass in 1996, he never thought it would have implications eight years later. But to his surprise, his paper "The Role of Finite Photon Mass in Magnetohydrodynamics of Space Plasmas," that appeared in a plasma physics journal in 1997, has recently piqued the interest of particle physicists and astrophysicists worldwide. Ryutov's estimate has been selected to appear in the 2004 edition of the "Review of Particle Physics," a bi-annual authoritative compendium of particle data, as the best estimate of photon mass to date.

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Nanoprobe boosts ability to detect

The ability to detect chemicals, explosives, drugs and other substances of interest has been enhanced by a detection technology developed by a team at DOE's Oak Ridge National Laboratory. The nanoprobe is an optical fiber tapered to a tip measuring 100 nanometers with an extremely thin coating of nanoparticles of silver, which induces the surface-enhanced Raman scattering (SERS) effect. The resulting probe, based on the SERS light scattering technique, can detect substances at a theoretical single-molecule level without sample preparation and on any surface. The nanoprobe is far more selective and accurate than conventional competing technologies.

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Computer code can help build better fluidized beds

DOE's National Energy Technology Laboratory has developed a computer program, known as MFIX, that will help scientists, engineers and industrial plant designers better understand fluidized-bed combustion (FBC) systems. Multiphase Flow with Interphase eXchanges will eventually allow engineers to operate FBCs under wider ranges of conditions, thereby facilitating moving them from pilot-scale to commercial-sized plants. The MFIX solves mathematical equations generated through capture of FBC physical behaviors. These resulting numerical solutions are then interpreted as graphics, which allow scientists to visualize the inner workings of fluidized beds and the fluid dynamics of flue gases.

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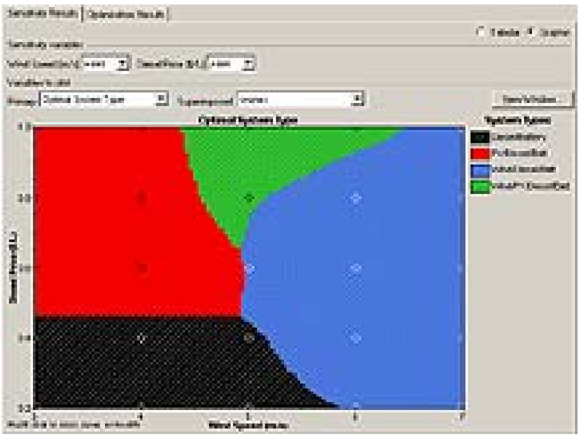
DOE Pulse highlights work being done at the Department of Energy's national laboratories. DOE's laboratories house world-class facilities where more than 30,000 scientists and engineers perform cutting-edge research spanning DOE's science, energy, national security and environmental quality missions. ***DOE Pulse*** (www.ornl.gov/news/pulse/) is distributed every two weeks. For more information, please contact Jeff Sherwood (jeff.sherwood@hq.doe.gov, 202-586-5806).

Innovative combinations push NREL's analysis to new levels.

Researchers at DOE's National Renewable Energy Laboratory have combined HOMER, the micro-power optimization model that can assist with designs for off-grid and grid-connected systems, with advanced automated mapping techniques that uses Geographic Information Systems (GIS) to identify the best sites for wind, solar and hybrid renewable energy systems in developing countries.



HOMER displays simulation, optimization, and sensitivity results in tables and graphs.

NREL recently applied these advanced wind and solar mapping and database development techniques to provide maps and databases of the amount and distribution of wind and solar resources for Sri Lanka. NREL collaborated with several agencies to gather climate and weather data that would be useful for resource assessment integrated GIS information with HOMER to discover the best ways to use these resources in developing energy systems.

Using HOMER, NREL analysts simulated the operation of possible micropower systems for every hour of the year and calculated the total cost of each system or combination of systems, and ranked them to identify the optimal system for a particular scenario (such as high solar resources or high wind resources). Most often these energy systems are renewable energy systems, but sometimes HOMER recommends diesels or hybrids that combine renewable resources with diesel.

Last summer, a new version of HOMER debuted, which also can look at grid-connected systems. HOMER can now be useful for examining applications such as cogeneration and has the capacity to analyze additional resources and systems, such as hydrogen fuel cells.

The wind-mapping results for Sri Lanka showed many areas that were estimated to have good-to-excellent wind resources and helped identify prospective areas for wind energy applications. For Sri Lanka and other parts of the world, innovations in both HOMER and resource mapping can be combined to a powerful end, a truly integrated assessment of resources and systems. For more information on Homer, visit http://www.nrel.gov/homer.

Submitted by DOE's National Renewable Energy Laboratory

BERKELEY LAB'S JAY KEASLING: FROM BUGS TO DRUGS

Berkeley Lab's Jay Keasling

Google "synthetic biology" and the first page brings up the world's first synthetic biology department, just a year old and chaired by Jay Keasling of Lawrence Berkeley National Laboratory's Physical Biosciences Division.

"I've been interested in synthetic biology ever since I got interested in biology," says Keasling, who's also a professor of chemical engineering at the University of California at Berkeley. Keasling's molecular-biology courses while a premed student at the University of Nebraska suggested that life could be engineered "to solve problems that cannot be solved in any other way."

A Ph.D. in chemical engineering from the University of Michigan and a postdoctoral stint in Arthur Kornberg's lab at Stanford equipped him with some of the necessary tools. His team has already made substantial progress with a project that combines bioengineering and Keasling's desire to help humanity: curing malaria, which annually kills millions, mostly children.

The most effective and expensive malaria drug is plant-derived artemisinin. "By inserting genes from three separate organisms into Escherichia coli, we're creating a bacterial strain that can produce the artemisinin precursor, amorphadiene." Production has been increased by many orders of magnitude, but the process isn't complete.

"We are now attempting to clone the remaining genes needed for the E. coli to produce artemisinin," Keasling says. "We've taken the engineering of a microbe about as far as anyone has at this point, but so far it's like building a radio with vacuum tubes. We need to be at the Pentium chip stage."

A new world of designer molecules awaits. Terpenoids, of which artemisinin is one, include promising drugs like cancer-fighting Eleutherobin, extracted from a rare form of marine coral, and anti-HIV Prostratin. "And there are many more beneficial things that can be done with E. coli and other microbes," says Keasling, "from orphan drugs to environmental clean-up."

Submitted by DOE's Lawrence Berkeley National Laboratory