Scott Backhaus's engine is low-cost, low-tech and highly reliable. Page 2.

DOE Pulse

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Research Highlights . . .

Blood from a turnip?

Researchers at DOE's Pacific Northwest National Laboratory are genetically modifying tobacco plants to produce human blood proteins and tissue growth factors. Since plants can't transmit human diseases, this could lead to safer and less expensive treatments for hemophiliacs, and an alternative way of sealing wounds. Even with screening programs, viruses such as Epstein-Barr, Hepatitis B and C and the flu can be transmitted between humans. Researchers expect the cost of synthesizing blood factors in genetically modified plants to be 10 times cheaper than current methods. And, unlike human blood donors, plants provide a stable production source and yield much higher amounts of the desired blood factors.

[Susan Bauer, 509/375-2561, susan.bauer@pnl.gov]

Even ash has a productive role to play

A new publication by DOE's National Renewable Energy Laboratory highlights the beneficial uses of common ash from municipal waste-to-energy operations and includes the experiences of companies already demonstrating the performance of ash in varied applications. *Beneficial Use and Recycling of Municipal Waste Combustion Residues—A Comprehensive Resource Document* focuses on specific guidance in the use of ash in asphalt paving, concrete products and landfill cover. It includes data on the physical properties of ash and its performance in different applications. Call 303-275-4363 to obtain a copy.

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Mysterious moons of Saturn

Using the world's largest telescope, researchers at DOE's Lawrence Livermore National Laboratory report obtaining the best images ever of Saturn's mysterious moon, Titan, whose surface may include icy landforms and frigid hydrocarbon seas. Using the Keck telescope with colleagues from the University of California campuses at Los Angeles and Berkeley, the researchers took pictures with infrared light and a technique called "speckle interferometry" to see features as small as 150 miles through Titan's smoggy atmosphere, 800 million miles away. Livermore's effort was led by planetary scientist Seran Gibbard. The work is described in the journal *Icarus*.

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Taking the toil out of creating software

Producing software for computers ranging from desktop workstations to embedded processors can be tedious and time-consuming. A new approach to the task, called ATLAS, makes much of that toilsome process automatic. Developed by Jack Dongarra, a distinguished scientist with DOE's Oak Ridge National Laboratory and the University of Tennessee, and UT's Clint Whaley, ATLAS is an approach for automatically generating and optimizing numerical software for processors with deep memory hierarchies and pipelined functional units. Another Dongarra program, NetSolve 1.2, enables users to solve complex scientific problems remotely. It searches for computational resources on a network, chooses the best available, solves a problem and returns the answers.

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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).

Center to study storing carbon on land to reduce atmospheric levels

The buildup of carbon dioxide in the atmosphere is believed to be a major contributor to global warming, or climate change. For that reason, scientists are exploring ways to reduce the CO_2 buildup. Several DOE national labs are collaborating with universities to explore one part of that overall strategy, called terrestrial carbon sequestration—storing the carbon long-term in plants and soil.

DOE's Center for Research on Enhancing Carbon Sequestration in Terrestrial Ecosystems (CSITE) includes Oak Ridge National Laboratory, Pacific Northwest National Laboratory and Argonne National Laboratory, with collaborators from Texas A&M University, Colorado State University, the University of Washington, North Carolina State University, Ohio State University, the Rodale Institute in Pennsylvania and the Joanneum Research Institute in Austria.

ORNL's Gary Jacobs and PNNL's Blaine Metting are co-coordinators of CSITE, which has a primary mission of carbon storage on land. CSITE's research will be complemented by another DOE consortium, the Center for Research on Ocean Carbon Sequestration, which will explore technologies for storing carbon in the ocean. Lawrence Berkeley and Lawrence Livermore national labs are co-leaders of that center.

"The Energy Department centers will help coordinate research across an enormous breadth of disciplines from both government and academia. Breakthroughs from these centers could lead to new, environmentally acceptable ways to help address this global problem," says Martha Krebs, director of DOE's Office of Science.

The increase of atmospheric CO_2 has been attributed to a number of human activities, such as the burning of fossil fuels and clearing of forests. With terrestrial carbon sequestration, the carbon from the atmosphere is taken up by plants; the increased carbon can then be stored in plants and soils.

"The Oak Ridge Reservation in Tennessee is an example," ORNL's Jacobs says. "Approximately 50 years ago when the government began the Manhattan Project, farming, forestry and development were halted over much of the land area. As the ecosystems have been allowed to rebound naturally, we would expect that a significant amount of carbon has been sequestered above ground in vegetation and below ground in soils."

CSITE researchers will study a number of related issues, including determining how to increase the rate of carbon uptake and the duration of the carbon storage through natural processes and possibly through engineered steps.

"We want to discover the pathways that will promote this behavior so that we could choose to manage other land areas for increased carbon sequestration," Jacobs says. "We believe that agriculture and forestry sectors offer the largest near-term potential."

Adds Cesar Izaurralde of PNNL, "By making modest changes in farming and forestry practices, plants and soils can be used much more efficiently to remove carbon dioxide from the atmosphere. This not only cleans the atmosphere but also benefits soil by increasing soil organic matter, which leads to improved fertility, water retention, and texture."

CSITE's researchers will also explore ways to verify and measure the amount of carbon that is being stored.

More information on recent carbon sequestration research is available on DOE's "Carbon Sequestration: State of the Science" Website.

Submitted by DOE's Oak Ridge National Laboratory

LANL's Backhaus designs an engine for the future

Someday, homeowners may run appliances and heat their homes and water using small, low-cost engines modeled on one developed at the Department of Energy's Los Alamos National Laboratory. Los Alamos postdoctoral researcher Scott Backhaus' work, funded by DOE's Office of Basic Energy Sciences, has produced a simple, energy-efficient thermoacoustic Stirling heat engine with no moving parts that is highly reliable and decidedly low-tech.

The engine, consisting of a long, baseball-bat-shaped resonator with an oval "handle" on the lower end, is filled with compressed helium and constructed of inexpensive steel pipe. By applying heat to the compressed helium inside the system through a heat exchanger located on the "handle," the engine creates acoustic energy in the form of sound waves that can be used directly in acoustically powered refrigerators or to generate electricity. Because it contains no moving parts and is constructed of common materials, it requires little or no maintenance and can be manufactured inexpensively.

"The effficiency of conventional heat engines is limited both by the laws of thermodynamics and practical concerns over the cost of building and operating complex engines," Backhaus said. "Typically, the highest efficiencies can only be obtained from expensive engines like the large turbines used by electrical utilities. Our engine is neither mechanically complex nor expensive."

Backhaus and his advisor, Greg Swift. both of whom are Omaha, Neb., natives, see many possible applications for the engine, and have been working on ways to use solar power to heat the engine and, in turn, generate electricity. Cars may even be able to use the exhaust heat from internal combustion engines to power air conditioning. A related project may produce a combustion-driven thermoacoustic refrigerator that liquifies natural gas, allowing oil companies to transport gas that is currently flared at remote wells.

Submitted by DOE's Los Alamos National Laboratory