

# Quarterly

Energy & Environmental Sciences

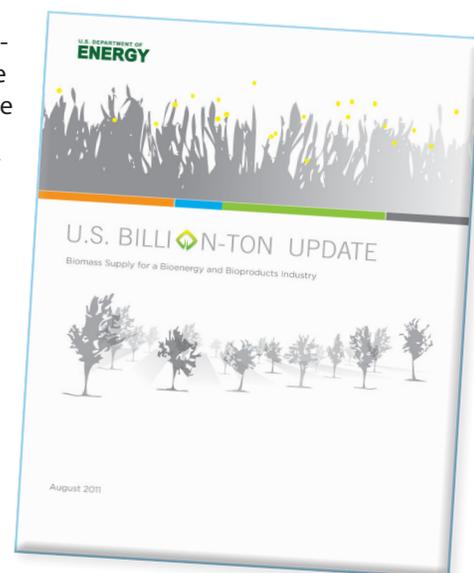
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## Billion-Ton Study update released

In 2005, ORNL led the Department of Energy's Billion-Ton Study for the Department of Agriculture. Their first report, "Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply," played a pivotal role in the development of the Energy Independence and Security Act of 2007 with findings confirming the technical feasibility of U.S. lands supplying a billion tons of biomass annually. ORNL recently completed a second report for DOE, "U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry." The update expands on the first report to include a spatial, county-by-county

inventory of potentially available primary feedstocks, price, and available quantities (e.g., supply curves) for the individual feedstocks, and a more rigorous treatment and modeling of resource sustainability. Released in August by DOE, the Billion-Ton Update can be found online at [http://eere.energy.gov/biomass/pdfs/billion\\_ton\\_update.pdf](http://eere.energy.gov/biomass/pdfs/billion_ton_update.pdf) and <http://bioenergykdf.net>.



## New DOE funding to accelerate ORNL advanced vehicle R&D



*Ionic liquid additives significantly enhance the performance of engine lubricants. Pictured here are synthetic polyalphaolefin base oil (left) and 0W10 racing lubricant containing 3% ionic liquid.*

The Department of Energy has awarded ORNL \$1.2 million to investigate the use of ionic liquids as a new class of multifunctional (anti-wear and friction modifier) lubricant additive to allow the use of lower viscosity engine oils in order to improve engine efficiency. Project researchers include Materials Science and Technology Division's Jun Qu and Peter Blau, Energy and Transportation Science Division's Bruce Bunting and Huimin Luo, and Chemical Sciences Division's Sheng Dai.

The new funding is part of the \$175 million that DOE is awarding over the next three to five years to help advance research, development, and deployment of next-generation vehicle technologies. On August 10, U.S. Secretary of Energy Steven Chu announced funding for 40 projects in eight categories that focus on better fuels and lubricants, lighter weight materials, longer-lasting and cheaper electric vehicle batteries and components, and more efficient engine technologies.

In addition to leading the study of ionic liquids, ORNL is expected to receive approximately \$6 million to help support 12 additional projects. See page 4 for a listing.

## Agreement to boost battery performance

Dow Kokam and ORNL are working together to enhance the Michigan-based company's capabilities to develop and commercialize advanced lithium ion batteries. Formalized in August with the signing of an agreement worth up to \$5.5 million over six years, the relationship supplements Dow Kokam's overall research and development strategy by providing specialized technical and research management expertise and many specialized battery development capabilities that are exclusive to ORNL.

A team of a dozen ORNL researchers will provide support in the areas of electrochemical and microstructural analysis, in-line quality control process development, raw material characterization, and battery components processing. Other aspects of the effort will focus on new technology evaluation and technical strategic advice designed

to optimize Dow Kokam's materials and manufacturing processes. The agreement builds on a successful partnership stemming from a collaborative research and development agreement funded by DOE's Office of Energy Efficiency and Renewable Energy and Dow Kokam.



Dow Kokam President/CEO Ravi Shanker, left, with ORNL Director Thom Mason.



Energy and Transportation Science Division's Matt Scudiere points to the wireless power transfer prototype as he demonstrates it for Dow Kokam and ORNL representatives visiting NTRC.

## Super magnet to support materials processing

A new commercial prototype 9 tesla, ~8 inch bore vertical superconducting magnet has been installed in Building 5500's sample handling system that is capable of 2,000 pound extraction force. The system represents the world's first commercial prototype thermomagnetic/electromagnetic acoustic transducer system. The new magnet

will support materials processing research and development activities currently under way, supported by the ORNL Industrial Technologies Program's advanced materials and energy intensive processing activities.

*The world's first commercial prototype thermomagnetic/electromagnetic acoustic transducer system is almost ready for experimental trials on industrial-scale components.*



## From the raceway to your driveway

In the early days of motorsports, automakers used competitive speedways as testing facilities to showcase the latest vehicles, spur innovation, and drive consumer enthusiasm for the automobile and its new place in American society.

A century later, the Department of Energy, the Environmental Protection Agency, and the Society of Automotive Engineers are helping industry win the race to cleaner fuels and more efficient technologies through Green Racing. Launched in 2006, the initiative is designed to recognize and reward automotive manufacturers that go the farthest and fastest with the smallest environmental footprint.

"Green Racing incorporates a scoring formula developed by the working group that takes into account the amount of fuel consumed during the race, number of laps completed, speed, energy efficiency, and amount of greenhouse gases emitted during the race," said Energy and Transportation Science Division's PT Jones, who was recently named DOE's Green Racing project lead. "Technologies and fuels used by manufacturers and racing teams might range from renewable fuels and fuel blends that incorporate ethanol,

biodiesel and isobutanol, to multiple propulsion systems and regenerative energy powertrains such as hybrids."

The Green Racing Protocols, SAE technical document J2880, were published in October of 2008. That same month the American Le Mans Series (ALMS) applied the scoring formula to the racing vehicles at Petit Le Mans, where DOE and EPA awarded the first Green Racing winners. ALMS became the first racing series to formally adopt the scoring system in 2009 in a season-long Green Challenge™ championship for teams and manufacturers. At season's end, DOE, EPA, and SAE award the lowest scoring manufacturers in the Le Mans Prototype and Grand Touring classes. The MICHELIN® GREEN X® Challenge awards a team from both classes at each ALM race using the same Green Challenge formula and criteria.

"ORNL involvement in Green Racing is relatively new and we're excited about the opportunity to work more closely with Argonne National Laboratory (ANL), which has played a pivotal role in Green Racing since the beginning," said PT. Together, they are helping educate consumers by using the ANL-developed Green Racing Simulator, which incorporates scoring information



*Lyn St. James, first female Indy 500 driver and Indy Rookie of the Year—1992, experiences the Green Racing Simulator at the Clean Cities Summit held at Indy in July 2011.*

that mirrors the metrics of the Green Challenge™ competition. Both labs staff this unique teaching tool at ALMS races and other events throughout the country, teaching race fans about advanced fuel saving strategies and performance enhancing technologies.

In Green Racing's future, PT foresees that ORNL expertise in engine/fuel efficiency testing and intelligent transportation technologies will come into play as DOE, EPA, and SAE continue to support industry efforts to accelerate the transfer of efficient automotive technologies from the raceway to the driveway.



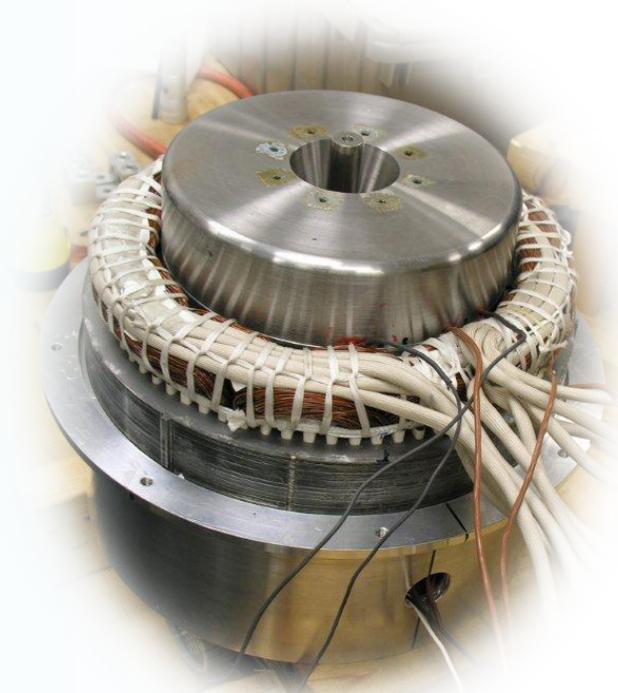
*Hope Hybrid, left, is the first Hybrid Vehicle to race in LMP1, the fastest class at the 24 hours of Le Mans.*

## New DOE funding ... continued from page 1

- Optimize fuel-based control of novel combustion strategies in light- and heavy-duty vehicles to enable diesel-like efficiencies with ultra-low engine-out emissions. Project lead is Wisconsin Engine Research Consultants, LLC.
- Evaluate and validate models for predicting the crash behavior of carbon fiber composites by building and testing subcomponent structures. Project lead is Plasan Carbon Composites.
- Develop and validate a new passenger vehicle design architecture that facilitates a 50% weight reduction through the extensive use of lightweight and high strength materials. Project lead is Vehma International of America, Inc.
- Develop and deliver low cost, large format cells with extremely high energy density that meet performance, life, and safety requirements of electric drive vehicles. Project lead is Dow Kokam, LLC.
- Design and assemble a low cost, high volume manufacturing module for a fabricating high capacity metal alloy anodes in a continuous roll-to-roll configuration. Project lead is Applied Materials, Inc.
- Develop and demonstrate ultraviolet and electron beam curing technology to reduce the cost of manufacturing lithium ion battery electrodes more than 50%. Project lead is Miltec UV International, LLC.
- Develop high performance, low cost power module and inverter switching technologies that lead to the design and fabrication of the next generation of power inverters. Project lead is General Motors, LLC.
- Develop high performance motors with non-rare-earth materials by concurrently engineering advanced motor designs, materials, thermal management, and motor controls. Project lead is General Electric.
- Develop a non-rare-earth permanent magnet motor architecture that will enable the use of low energy magnet technology. Project lead is UQM Technologies, Inc.
- Develop a thermoelectric generator system to convert waste heat to electric power, with the control systems necessary to utilize that power in a vehicle. Project lead is General Motors, LLC.
- Demonstrate a robust thermoelectric exhaust waste heat recovery system that provides >5% fuel efficiency improvement for a light-duty vehicle. Project lead is GMZ Energy, Inc.
- Develop a simple and inexpensive driver feedback and powertrain management technology to reduce driver bias on commercial fleets and improve average fleet fuel economy by at least 2%. Project lead is Eaton Corporation.

## Milestone reached with nonpermanent magnet motor

Congratulations to Power Electronics and Electric Machinery Research Center researchers who have met a DOE Performance Management Measurement Milestone Q3 Target Objective after completing a motor component technologies evaluation of the Novel Flux Coupling (NFC) motor. The unique technology eliminates the use of permanent magnet material, resulting in a significant cost reduction. Experimental data generated in May indicates that the NFC motor excitation coil can also be used to perform the function of the inductor in the ORNL current source inverter (CSI), another promising opportunity for system savings. In FY12, researchers will be moving forward with the integration of the NFC and CSI.



*Novel Flux Coupling motor*

## BERIS group receives international recognition

The Society for Technical Communication has awarded ORNL's Biological and Environmental Research Information System (BERIS) two international technical publication awards at the organization's 2010–2011 International Summit Awards Competition. The publications were prepared for DOE's Biological and Environmental Research Program.

"New Frontiers in Characterizing Biological Systems; Report from the May 2009 Workshop" received the Award of Excellence for clearly demonstrating an exceptional understanding of technical communication principles.

"U.S. Department of Energy's Bioenergy Research Centers: An Overview of the Science" received the Award of Mer-

it. One judge noted, "The brochure is an excellent example of scientific writing used to promote the capabilities and importance of basic research and research critical to finding and developing new and sustainable energy sources."

Biosciences Division's (BSD's) Betty Mansfield, Jennifer Bownas, Holly Haun, Judy Wyrick, Shirley Andrews, Marissa Mills, Kris Christen, Sheryl Martin, and Christopher Caldwell, and Information Technology Services Division's Sheryl Martin were recognized for their efforts on both publications. BSD's Mitchel Doktycz, DOE's Arthur Katz, and H. Steven Wiley of Pacific Northwest National Laboratory contributed to the publication first noted.

## ORNL completes review of two new US nuclear power reactors

ORNL researchers led by Environmental Sciences Division's (ESD's) Greg Zimmerman, in conjunction with the Army Corps of Engineers, have completed only the second environmental review of "next generation" nuclear power reactors proposed for construction in the United States. Conducted on behalf of the U.S. Nuclear Regulatory Commission (NRC), the review focused on two new reactors at the Comanche Peak site about 40 miles southwest of Fort Worth, Texas. The two reactors propose to generate power in addition to two that have been in operation at the site since the early 1990s.

"The 104 nuclear power reactors currently operating in the United States produce approximately 20% of all U.S. electrical energy needs," said Greg. "The two proposed at Comanche Peak are among 26 that utilities and industry are hoping to construct at 17 different locations, mostly at existing nuclear power reactor sites."

NRC's licensing process includes separate environmental and safety reviews of each reactor. The environmental review conducted by ESD researchers evaluates the potential

environmental impacts of constructing and operating the proposed new reactors. ORNL's review of Comanche Peak examined potential impacts to land use, water use, water quality, ecosystems (both aquatic and terrestrial), air quality, historic and cultural resources, human health, transportation, and waste management systems, as well as socioeconomic impacts and environmental justice impacts.

Based on the team's review, NRC published a 1200-page environmental impact statement (EIS) in May to meet requirements of the National Environmental Policy Act of 1969. The EIS recommends that the license be granted for each of the two proposed reactors. Upon completion of an in-progress safety review, the hydrology portions of which are being conducted by ESD's Brennan Smith and David Watson, NRC will issue its decision on whether to grant or deny the license application for the two new Comanche Peak units.

According to Greg, ESD staff will continue to assist NRC with the environmental reviews of other proposed reactors.

## Charging forward

"The Nissan Leaf is perfect for our 11 mile commute to ORNL. In a few years we expect to see lots of these on the road," says Environmental Sciences Division's Rich Norby, pictured here with Ellen Smith. DOE recently celebrated the installation of 25 solar-assisted charging stations at ORNL to support commuters like Rich and Ellen. The units are part of a larger, 125-station program that DOE—partnering with companies, like Nissan—is targeting to complete by the spring of 2012.



## Construction updates

The \$20.2 million American Recovery and Reinvestment Act-funded Maximum Energy Efficiency Building Research Laboratory project broke ground in June. Dubbed the MAXLAB, it includes a new facility of approximately 17,800 gross square feet with high- and low-bay laboratory space and 22 offices at the corner of Bethel Valley Road and Fifth Street, as well as two light commercial building flexible research platforms (FRPs) along Bethel Valley Road just west of Fifth Street. Fourteen industry partners have lined up to participate in research and development associated with the first test buildings on the FRPs, which should be operational by July 2012. The larger building is scheduled to be operational by December 2012.



MAXLAB construction site

The Carbon Fiber Technology Facility continues to take shape at the Horizon Center. Designed to foster collaborations with industry and academia, the 40,000-square-foot facility will operate at a pilot scale and demonstrate the scalability of technology for lowering the cost of carbon fiber and making affordable the use of carbon fiber in applications such as vehicle and wind energy technologies. The facility is projected to be operational by late 2012.



Carbon Fiber Technology Facility construction site

## Transport membrane condenser unit installed

The ORNL-led Industrial Technologies Program project “Advanced Membrane Separation Technologies for Energy Recovery from Industrial Process Streams” has fully installed a Transport Membrane Condenser (TMC) unit at the City Brewery in Latrobe, Pennsylvania. The standard commercial unit contains nine 400-tube (ceramic) TMC bundles and is designed to recover heat from the flue gas of a 300 Hp boiler burning natural gas. In addition to the TMC subsystem, other major equipment includes low- and high-pressure heat exchangers and associated pumping and flue ductwork hardware. Cannon Boiler Works has licensed the TMC technology for steam boilers and is working with the ORNL project team, the Gas Technology Institute, and Media and Process Technology Inc. to generate the cost and energy savings data necessary for an economic evaluation of the technology.



TMC membrane module installed in the flue gas ductwork.

## Learning from leftovers

Contrary to mom's advice, leaving food on your plate is not necessarily wasteful. Throughout the world, scraps and leftovers have been used for years as natural compost, and in more recent times the material is being processed into electricity.

Supporting the Lab's Sustainable Campus initiative, a cross-divisional team is exploring the possibility of converting post-consumer organic material disposed at the main campus and SNS cafeterias into renewable resources. The "Food for Fuel" project is led by Energy and Transportation Science Division's Sirisha Nukala, Biosciences Division's Abhijeet Borole, and University of Tennessee students Gautham Rajappa and Tyler Pannell.

"The project goal is to learn what kind and how much biogas is produced to help ORNL decision-makers determine whether it's reasonable to collect, sort, and convert food waste to electricity to help power lab facilities or, at minimal, compost to support an environmentally friendly and aesthetically beautiful campus," said Sirisha.

Three days during June the team collected an average of 100 pounds of food scraps and 40 pounds of other organic waste being tossed by employees each day. Abhijeet and Tyler homogenized the food waste in a blender and mixed 1:1 with water, then fed it into a single-phase four-liter anaerobic digester that uses biogas recirculation for mixing. The digester was seeded with 10% anaerobic sludge from a wastewater treatment plant and contained approximately 7% volatile solids from food waste. The pH of the food waste was adjusted for optimal growth of methanogens. Over the course of 20 days, they measured alkalinity, gas production rate, gas composition, volatile solids, total solids content, and chemical composition of the digestate, paying particular attention to methane levels.

## JASON project wins CODiE Award

The Software and Information Industry Association has awarded the 2011 CODiE Award for Best Science or Health Instructional Solution to the JASON Project for Operation: Tectonic Fury. A team of ORNL staff contributed to the educational project, which provides a way for middle school students to use basic science skills to understand how geologic and human forces shape the earth. Because of ORNL's contributions, farming practices and planting of energy crops are included as influences.

ORNL involvement was suggested by Energy and Environmental Sciences Associate Laboratory Director Martin Keller and led by Environmental Sciences Division's (ESD's) Virginia Dale with expert advice provided by ESD's Esther Parish. Amy Johnson and Sam Jackson from the University of Tennessee helped engage middle school students and a teacher in sampling soils under switchgrass in fields near

Abhijeet and Tyler are continuing to relay their findings to Sirisha and Gautham, who are conducting economic and environmental feasibility testing and modeling based on the scientific findings and documented research.

While not complete, the research indicates that the food waste mixed with discarded paper products may produce an excellent compost to naturally fertilize campus vegetation. Testing also shows that producing electricity is possible, but using food waste to help power the lab is not feasible based on very early indicators, one of which the researchers consider a very "good" problem.

"Aside from the fact that the conversion process would be very costly, ORNL employees simply don't generate enough food waste to make it possible," said Sirisha, adding, "They enjoy food as it was primarily intended—to nourish and power the body and mind."

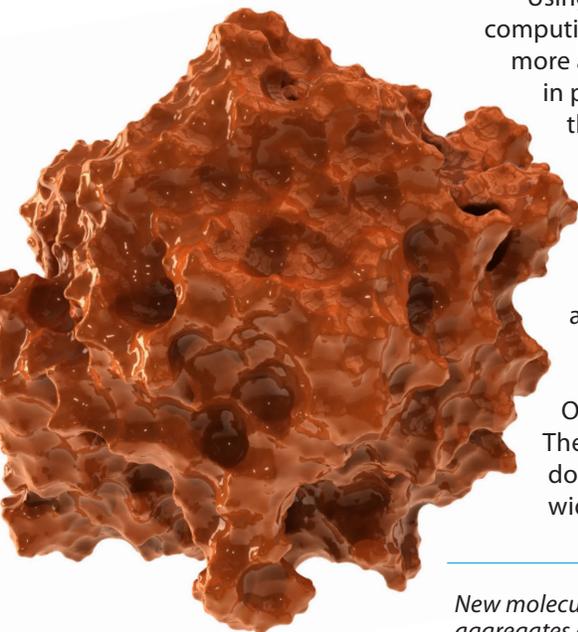


*University of Tennessee Biosystems Engineering student researcher Tyler Pannell monitors the anaerobic digester.*

Vonore, Tennessee. The soils were analyzed under the guidance of ESD's Deanne Brice and Charles Garten. Energy and Transportation Science Division's Mike Hilliard and Computational Sciences and Engineering Division's Alex Sorokine shared model results about the sustainability implications of energy crops via EVEREST. Bobby Whitten, Center for Computational Sciences, showed the students how ORNL's supercomputers are used to expand knowledge.

The CODiE is a highly competitive and prestigious award for online educational publishers, game developers, and software programmers. The judges for the education categories come from industry, schools, colleges, and universities. When selecting winners, they consider all of the online content including the text, photos, technical art, games, videos, and teacher resources such as tests and classroom handouts.

## Scientists discover wrinkles in biofuels production



Using ORNL neutron sciences and super-computing capabilities, scientists are learning more about lignin, the chemical compound in plant cell walls that largely interferes in the production of biofuels.

"Neutron scattering experiments at the High Flux Isotope Reactor combined with large-scale simulations on Jaguar have revealed the surface of pretreated softwood lignin aggregates to be highly folded," said Biosciences Division's (BSD's) Jeremy Smith, team leader and director of ORNL's Center for Molecular Biophysics. The research revealed lignin's structure down to 1 angstrom—smaller than the width of a carbon atom.

*New molecular models of lignin aggregates are helping scientists understand a limiting factor in the production of ethanol. (Image courtesy of <http://www.scistyle.com>)*

"Compared to a smooth surface, a wrinkled surface is able to trap more passing enzymes that help break down sugar. Its texture may be one of nature's mechanisms for protecting plants against enzymatic attack, which in turn reduces the efficiency of converting feedstocks into biofuels. The improved understanding of lignin will aid scientists in efforts to design a more effective pretreatment process, which in turn could lower the cost of next-generation biofuels."

The research was supported by DOE's Office of Science and used the resources of the Leadership Computing Facility at ORNL under a DOE INCITE award. Team members include BSD's Loukas Petridis and Marcus Foston; Neutron Scattering Science Division's Hugh O'Neill, Sai Venkatesh Pingali, Volker Urban, and William Heller; and Arthur Ragauskas from Georgia Institute of Technology.

## Growing graphene

Step aside, silicon. A new age of electronics is nearer with the support of ORNL researchers and others who have demonstrated a new technique for growing single-crystal graphene—a material that is nearly transparent, extremely strong, and able to conduct electricity with little resistance or heat generation. Potential applications of graphene span from electronics, photovoltaics, and composite materials to highly energy efficient membranes for separations such as water desalination.

"The technique is based on the discovery that hydrogen, not carbon alone, helps dictate graphene shape and size by activating absorbed molecules that initiate growth and eliminating weak bonds at the grain edges," said Measurement Science and Systems Engineering Division's Ivan Vlassiuk, co-lead for the project. Until now, grown graphene mostly has consisted of irregular-shaped grains of different sizes, rarely single crystals.

"With a new understanding of hydrogen's role, we developed a way to synthesize graphene with well-defined hexagonal grains and near-faultless single-crystal structure," Ivan said, adding, "Gaining control over grain size and boundaries may result in improved functionality of the graphene materials in transistors, semiconductors, and hundreds of other electronic devices, surpassing performance of silicon devices."

Project researchers include co-lead Sergei Smirnov of New Mexico State University, and Materials Science and Technology Division's Murari Regmi and Gyula Eres, Chemical Sciences Division's Pasquale Fulvio and Sheng Dai, and MSSED's Panos Datskos. The team authored the paper "Role of Hydrogen in Chemical Vapor Deposition Growth of Large Single-Crystal Graphene" that is published in *ACS Nano* (<http://pubs.acs.org/doi/abs/10.1021/nn201978y>).

The research was supported by DOE's Office of Science, in part through the Fluid Interface Reactions, Structures and Transport Center, a DOE Energy Frontier Research Center led by ORNL.



*Graphene grains come in several different shapes. Hydrogen gas controls the grains' appearance.*

## Ethanol blends/materials compatibility study released

ORNL, in collaboration with National Renewable Energy Laboratory and Underwriters Laboratories, is conducting an ongoing study of mid-level ethanol blends' compatibility with infrastructure materials. The study looks at the metals, elastomers, sealants, cork, and plastics that are used in both aboveground and underground components. Many of these systems are in service for several years and not designed for ethanol concentrations greater than 10%.

"Before E15, E20, or higher levels of ethanol intermediate blends are introduced into the nation's fueling infrastructure, their effects on the fueling infrastructure must be determined," said team member Mike Kass, Energy and Transportation Science Division (ETSD). To do so, Kass explained that the team conducts tests under controlled, accelerated conditions to reflect possible damage over a lifetime of component use in E15 or E20.

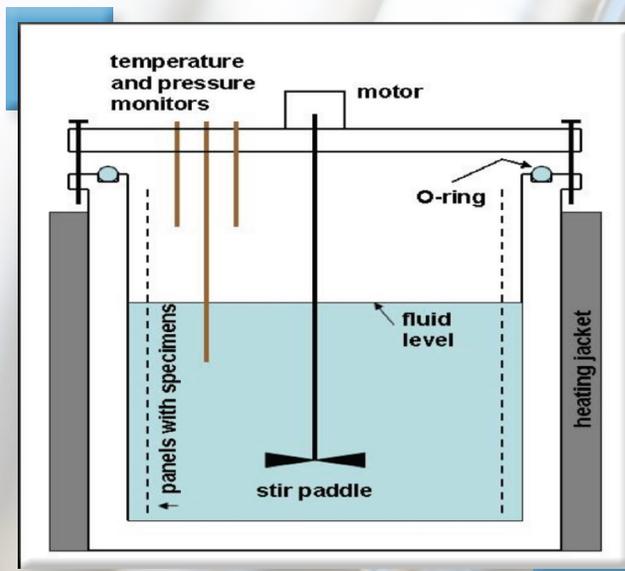
ORNL developed a unique stir tank facility to expose material samples to various test fuels, allowing many materials to be screened in a relatively short time. The tanks are sealed, held at elevated temperature, and continuously stirred for 4–16 weeks. Some of the samples are immersed in the test fluid, while others are tested in the vapor space to determine if the fuel vapors are more damaging to the materials. Samples are removed periodically and analyzed for corrosion, sealability, durability, and leakage.

A first report has been released, with results showing metals exhibited little to no measureable corrosion. Different classes of elastomer materials (fluorocarbons, etc.) exhibited generally consistent behavior, with some showing very little change when exposed to mid-level ethanol blends and others changing substantially. The researchers found that newer sealants passed the leakage tests; older sealants not designed for ethanol do not. Study results for plastics and cork are still pending. According to Kass, "This information collectively may play a critical role in developing adequate retrofit kits for the existing infrastructure, which will enable higher levels of ethanol to be sold."

Other ORNL team members include ETSD's Tim Theiss and Sam Lewis, and Materials Science and Technology Division's Chris Janke and Steve Pawel. The work supports the Intermediate Ethanol Blends Program, funded by the Department of Energy Office of Energy Efficiency and Renewable Energy Biomass and Vehicle Technologies Programs.

"Before E15, E20, or higher levels of ethanol intermediate blends are introduced into the nation's fueling infrastructure, their effects on the fueling infrastructure must be determined."

*Materials specimens were exposed to the test fluid(s) in a large stainless steel tank with stainless steel hardware (stir chamber), then subjected to multiple tests after fluid exposure.*



## EES contributes to five R&D 100 awards

Researchers from across the Energy and Environmental Sciences Directorate contributed to five of the seven 2011 R&D 100 Awards. The award honors the 100 most outstanding advances in technology for the past year, and the winners are selected by an expert panel of independent judges and the editors of *R&D Magazine*. EES researchers were recognized for the following technologies:

*Mesoporous Carbon for Capacitive Deionization Electrodes for Desalination*, developed and jointly submitted by ORNL's Sheng Dai and Richard Mayes of the Chemical Sciences Division, Energy and Transportation Science Division's David DePaoli and Costas Tsouris, James Kiggans Jr. of the Materials Science and Technology Division, Energy Materials Program Director Craig Blue, Measurement Science and Systems Engineering Division's Charles Schaich, former post doctoral researcher Xiquing Wang, and Frederic W. Seamon III of Campbell Applied Physics. This novel technology makes it possible to desalinate large quantities of water more

effectively than conventional technologies. It could make it possible for large numbers of the world's population to create safe drinking water at a relatively low cost. The DOE Office of Science and Office of Energy Efficiency and Renewable Energy (EERE) provided research funding.

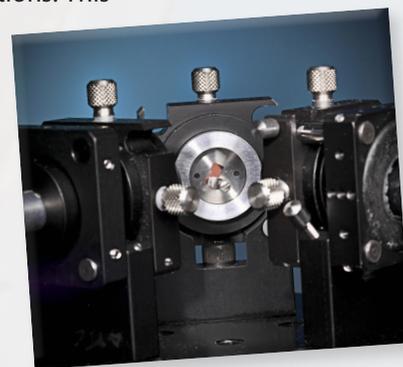
*CermaClad*, jointly developed and submitted by Meso-Coat of Euclid, Ohio; Edison Materials Technology Center of Dayton, Ohio; and ORNL. The ORNL team consists of Craig Blue and Art Clemons of the Energy Materials Program; Materials Science and Technology Division's Nancy Dudney, Chad Duty, David Harper, Adrian Sabau, and Vinod Sikka; Energy and Transportation Science Division's Ron Ott; and John Rivard of the Global Security Directorate. This cladding technology fuses to various substances onto metal substrates 25 to 50% cheaper and 10 to 100 times faster than current technology. It produces casings that are resistant to chemical corrosion and can endure extreme pressure while also costing a fraction of the price of current technologies in industrial settings. The EERE Industrial Technologies Program (ITP) provided funding for this research.

*NextAire Packaged Gas Heat Pump*, jointly developed and submitted by Energy and Transportation Science Division's Ed Vineyard, Abdolreza Zaltash, Randall Linkous, and Isaac Mahderekal; Measurement Science and Systems Engineering Division's Randall Wetherington; Neutron Facilities Development Division's Patrick Geoghegan; Southwest Gas, an investor-owned utility serving customers in Arizona, Nevada, and portions of California; and IntelliChoice Energy,

headquartered in Phoenix. The gas heat pump technology is used to heat and cool small- and medium-sized buildings using fuel—typically natural gas—instead of electricity to power the compressor. By reducing conversion and transmission losses, the NextAire unit significantly reduces greenhouse gas emissions. By converting fuel at the gas heat pump location, waste heat to the atmosphere is dramatically reduced and exhaust heat given off by the engine can be used to supplement the heat provided by the unit. The EERE ITP and the National Energy Technology Laboratory funded this joint venture.

*New Stainless Steel Alloy Tooling for High Temperature Presses That Form Aircraft Components*, developed and jointly submitted by Roman Pankiw, Don Voke, and Alberto Jablonski of Duraloy Technologies and an ORNL team consisting of Materials Science and Technology Division's Govindarajan Muralidharan, Phil Maziasz, Neal Evans, Mike Santella, Chris Stevens, Jackie Mayotte, and Vinod Sikka; Fuel Cycle and Isotopes Division's Ed Kenik; and consultant Ken Liu. This new tooling can be used in high-temperature presses that are used to form commercial and military aircraft components. Because of the oxidation resistance and strength of the newly patented alloy, it can be fabricated into tools that will have a longer life than products on the market. This project was originally funded by EERE ITP. It is currently funded by the EERE Technology Maturation Program in a Cooperative Research and Development Agreement with Duraloy.

*Nano-Optomechanical Hydrogen Safety Sensor Based on Nanostructured Palladium Layers*, jointly submitted and developed by Nickolay Lavrik of the Center for Nanophase Materials Sciences; Measurement Science and Systems Engineering Division's Panos Datskos, Scott Hunter, and Barton Smith; and the University of Tennessee's Michael Sepaniak and James Patton. This technology utilizes nano-sized palladium particles to more efficiently detect hydrogen levels at a lower cost than the competition. It eliminates that threat and can be used to monitor industrial building activities, rechargeable battery manufacturing, and many other hydrogen-sensitive operations. This work was sponsored by the DOE Fuel Cell Technologies Program and conducted in part at the Center for Nanophase Materials Sciences.



*Nano-Optomechanical Hydrogen Safety Sensor Based on Nanostructured Palladium Layers.*



*Mesoporous Carbon for Capacitive Deionization Electrodes for Desalination.*

# Making Connections

## DOT renews commitment to CMVRTC

Members of Energy and Transportation Science Division's (ETSD's) Transportation Systems Research Group hosted the quarterly meeting of the Commercial Motor Vehicle Roadside Technology Corridor (CMVRTC) Management Team in July. During the meeting the Federal Motor Carrier Safety Administration (FMCSA) renewed its commitment to the CMVRTC, stating that the upcoming Wireless Roadside Inspection Pre-Field Operation Test would be led by ORNL and conducted with the CMVRTC. Additionally, FMCSA will fund ORNL to conduct various other commercial motor vehicle (CMV) safety related research over the next three years as well as fund the Tennessee Highway Patrol (a CMVRTC partner) to conduct real-world data collections to feed ORNL research. The CMVRTC is located on I-40 and I-81 with the Knox County and Greene County CMV inspection stations as anchor points. The charter of the CMVRTC is to increase stakeholder awareness, acceptance, and adoption of CMV safety technologies and serve as a catalyst for technology transfer. The renewed contract includes FMCSA funding of more than \$4 million through 2014. Congratulations to ORNL team members including ETSD's Gary Capps, Oscar Franzese, Sheila Moore, Mary Beth Lascurain, and Adam Siekmann, all with the Center for Transportation Analysis.



Trucks traveling Interstate 81 roll into the Greene County inspection station.

## Oak Ridge establishes carbon fiber composites consortium

Fourteen companies have agreed to join with ORNL to establish the Oak Ridge Carbon Fiber Composites Consortium, which will work to accelerate the development, demonstration, and commercial application of new low-cost carbon fiber and composites materials in many different industry sectors. Charter members of the consortium include Dow Chemical Company, 3M, Faurecia, Toho Tenax America, Plasan Carbon Composites, Composite Applications Group, Umeco Composites Structural Materials, Graftech International, United Technologies Research Center, Harper International, Hills Material and Chemistry Laboratory, SSOE Group, Innovation Valley, and UT-Battelle, the managing contractor for ORNL.

## Advancing India-ORNL strategic partnerships

In late July, ORNL Deputy for Science and Technology Thomas Zacharia hosted a roundtable on U.S.-India clean energy research and development cooperation. The purpose of the roundtable was to improve understanding of India's key energy security and climate change challenges and to identify ORNL innovations and engagement opportunities to advance India-ORNL strategic partnerships to support the U.S.-India clean energy science and technology roadmap. ORNL and Indian clean energy leaders will reconvene this fall in India.



Energy and Transportation Science Division's Robert Wagner talks with Professor Anuradda Ganesh, Head of Department of Energy Science and Engineering, Indian Institution of Technology Bombay, inside the Fuels, Engines, and Emissions Research Center.

## Industry interested in power electronics

ORNL hosted a Power Electronics Symposium in July to help educate industry and entrepreneurs on the capabilities, expertise, technologies, and opportunities available through the Power Electronics and Electrical Power Systems Research Center to address existing problems and/or the development of new business lines. The center specializes in the advancement of inverters; converters; motor control techniques; efficient, compact electric machines; and high voltage, high speed power systems.



*More than 100 participants attended the Power Electronics Symposium.*

## Project to address truck technology efficiency

Representatives from the Energy and Transportation Science Division and the Sustainable Transportation Program met with National Highway Transportation Safety Administration (NHTSA) officials in May to kick off the Truck Technology Efficiency Assessment project. Led by ETSD's Tim LaClair, the NHTSA-funded study will assess the potential fuel savings and emissions impacts of advanced efficiency technologies for Class 8 long-haul trucks, based on a comprehensive analysis of drive cycle data collected in the Heavy Truck Duty Cycle (HTDC) project. ORNL will develop characteristic drive cycles that represent the usage of the fleet measured in the HTDC project, apply a tractive energy analysis of the data to estimate fuel savings potential of advanced efficiency technologies, and develop a simple approach to quantify emissions reduction potential.

## ORNL hosts Hydrogen Storage Tech Team

A meeting of the Hydrogen Storage Tech Team was held at ORNL in June. Ned Stetson and Grace Ordaz from DOE's H2 Storage Program attended and chaired the meeting. Other attendees included members of the U.S. Council for Automotive Research Hydrogen Storage Tech Team, as well as industry representatives and other national laboratories. The meeting included tours of SNS, CNMS, HTML, several carbon fiber facilities, and technical presentations. Special thanks to Materials Science and Technology Division's Andrew Payzant, and David Geohegan, Center for Nanophase Materials Sciences, for tours of SNS; and to Materials Science and Technology Division's Camden Hubbard and Tom Watkins, who presented information about fuel cell user projects and related characterization expertise.

## ORNL takes training to industry

ORNL and other DOE specialists conducted five days of intensive in-plant training at the ALCOA Primary Aluminum and Hot Rolling Mill in Warrick, Indiana. Training included in-class sessions on compressed air, steam, pumping, and fan systems as well as field training on wireless sensors for metering and sub-metering applications.



*Inside ALCOA Primary Aluminum and Hot Rolling Mill.*

## MOU signed with Oklahoma's largest utility company

Oklahoma Gas and Electric, Oklahoma's largest utility company, has invited Energy and Transportation Science Division's Xiaobing Liu to participate in a research project on evaluating emerging ground coupling technologies for geothermal heat pump (GHP) applications. This project will test and evaluate up to 10 combinations of new ground heat exchanger designs, grouting material, and installation techniques. The results of this project will help reveal the potential and limitation of these emerging ground coupling technologies, which may be able to break the high initial cost barrier of GHP applications. Both parties have signed a Memorandum of Understanding to collaborate on the project.

## Hybrid solar lighting technology patented

Congratulations to inventors of the Hybrid Solar Lighting Distribution Systems and Components, which was recently issued U.S. Patent 7,973,235. The system concentrates sunlight into a fiber optic bundle so the resulting “concentrated sunlight” can be routed around obstacles to enable the distribution of natural daylight within existing buildings. The hybrid lighting technology has received significant attention in the popular press since its inception and was awarded R&D 100 recognition in 2006. The technology has had mixed commercialization success, attracting significant attention with the systems deployed by the original licensee. It has recently been relicensed with new offerings expected to appear on the market soon. ORNL inventors are Energy and Transportation Science Division’s Curt Maxey, and Measurement Science and Systems Engineering Division’s Duncan Earl and Randall Lind. Others include former ORNL employees Jeff Muhs, David Beshears, and John Jordan.

## US–China to monitor building energy

Energy and Transportation Science Division’s Piljae Im and Mahabir Bhandari attended the kickoff meeting for the U.S.–China Clean Energy Research Center Building Energy Monitoring Project hosted by Lawrence Berkeley National Laboratory (LBNL). The goal of this project is to install energy monitoring systems in selected commercial buildings in the United States and China to collect building energy use data for both countries. Data analysis will compare building energy performance to identify key drivers for the differences in building energy use. Representatives participating in the kickoff included Tsinghua University, LBNL, Honeywell, and Schneider Electric.

## Team conducts process heating assessment, workshop in China

In June, Energy and Transportation Science Division’s Michaela Martin, Sachin Nimbalkar, and Robert Ihle conducted an abbreviated process heating assessment of the Longmen Steel Rolling Mill in Xi’an, China. The team toured the factory and discussed operations of the reheat furnace and the coal gasification system in detail with factory staff. They were very inter-

ested in recommendations for improving energy efficiency. Several safety hazards were identified during the visit and were noted in the team safety plan.

*Following the assessment, the ORNL team delivered a process heating workshop to a group of 50 participants representing Nanjing/Jiangsu Energy Conservation Center, University Alliance for Industrial Energy Efficiency, and the steel industry.*



## In the Spotlight

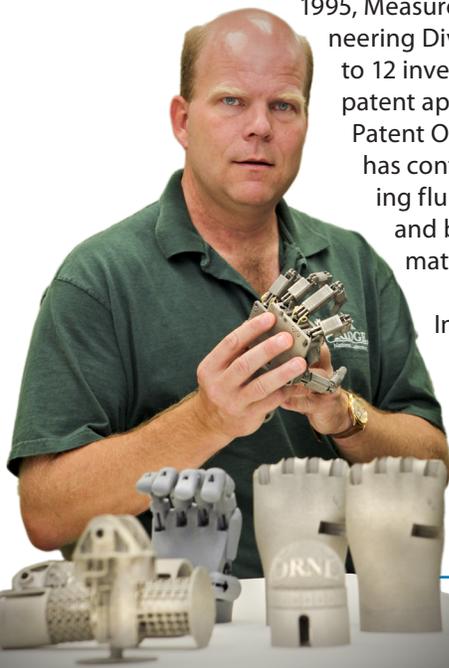
He’s been in the spotlight a lot. Since joining ORNL in 1995, Measurement Science and Systems Engineering Division’s Lonnie Love has contributed to 12 invention disclosures, resulting in six patent applications being filed with the U.S. Patent Office and five with DOE. His work has contributed to a variety of fields, including fluidics controls, biomedical robotics, and biogeneration of energy-related materials.

In 2009 Lonnie was named ORNL Inventor of the Year for his mesofluidics research, or miniaturized hydraulics, that has been applied to prosthetic systems, orthotics, and rehabilitative biomedical systems, to name a few. His work could

lead to devices that significantly improve the lives of amputees and the disabled.

This summer Lonnie was named one of 85 engineers to take part in the National Academy of Engineering’s 17th annual U.S. Frontiers of Engineering symposium. The participants—engineers of ages 30 to 45 who are performing exceptional engineering research and technical work in industry, academia, and government—were nominated by fellow engineers or organizations and chosen from approximately 315 applicants.

Today, Lonnie is a headliner on DOE’s website, answering “10 Questions” and providing insight on innovative approaches to advancing robotics, clean energy technology, and nanomaterials. The feature is located at <http://energy.gov/articles/10-questions-robotics-engineer-lonnie-love>.



Lonnie Love

# Employee Excellence

Congratulations and best wishes to Environmental Sciences Division's Robin Graham, Biomass Program Manager, who has accepted a new position as Deputy Associate Laboratory Director in Computing, Environment, and Life Sciences at Argonne National Laboratory. Robin has been an ORNL employee since 1986.

"I will miss Robin's contributions very much. She has done environmental impact assessment work, led a NASA data center, led CSiTE, managed the EERE/Office of Biomass Programs, been a group leader, and much more," ESD Director Gary Jacobs noted in a letter to staff, adding, "She is one special scientist and we will miss her."

Energy and Transportation Science Division's Tim Theiss has been named Interim Program Manager. Joining ORNL in 1987, Tim has served as group leader of ORNL's Fuels & Engines Research Group since 2008 and has been very active in the ORNL intermediate ethanol blend effort for the past few years, working closely with the DOE Biomass and Vehicle Technologies Programs, and other stakeholders. Tim and Robin will be working together to ensure a smooth management transition by October 14.

Environmental Sciences Division's Erin Webb has been invited to join the Biomass Research and Development Initiative's Interagency Working Group for Bioenergy Logistics. This working group was established to define means of overcoming technical challenges to systems integration, scalability, and deployability for biorefinery feedstock supplies and products. The group includes representatives from DOE, national labs, USDA, DOT, and other agencies.

The Stanley I. Auerbach Award for Excellence in Environmental Science has been awarded to Environmental Sciences Division's Melanie Mayes for her research on coupled hydrological and geochemical mechanisms that govern the migration of radionuclides and toxic metals in the vadose zone and molecular-scale mechanisms of stabilization of organic matter on mineral surfaces in soil. The SIA Award serves to recognize sustained, high-quality, creative scientific contributions in support of basic research, technology development, or analysis as demonstrated by publication in refereed journals of high reputation or by significant impact through application of science in solution of complex environmental problems.

Melanie also was recognized recently with a Citation of Excellence for Associate Editors related to her service as an Associate Editor for the

*Soil Science Society of America Journal*. She both received a certificate from the Society and will be featured in an upcoming article in *CSA News*, the official magazine for members of the Crop Science Society of America, Soil Science Society of America, and American Society of Agronomy.

Energy and Transportation Science Division's Sujit Das made an invited presentation on "Transportation Challenges in Biofuels Supply Chain Logistics" at the U.S. Department of Transportation's Interagency Biofuels Infrastructure Workshop held in June in Washington, D.C. The invitation-only workshop focused on supply chain issues considering transport and distribution challenges from the point of domestic feedstock production through finished biofuel retail distribution, and each segment in between.

Wayne Manges, Measurement Science and Systems Engineering Division, has been elected to the distinguished grade of International Society of Automation (ISA) Fellow. Fellow membership is conveyed in acknowledgement of an outstanding achievement in scientific or engineering fields as recognized by ISA peers and is the highest grade of membership. Candidates must have a minimum of five years of ISA membership; currently be an ISA Senior Member; and have at least 10 years in instrumentation development, application, operation, management, or teaching. Wayne currently serves ISA as co-chair for both ISA100, Wireless Systems for Automation, and the Trustworthy Wireless Working Group.

Energy and Transportation Science Division's Roderick Jackson and Melissa Lapsa, along with co-authors Marilyn A. Brown, Matt Cox, Rodrigo Cortes, and Benjamin Deitchman from Georgia Institute of Technology, announced the publication of "Making Industry Part of the Climate Solution: Policy Options to Promote Energy Efficiency." This report evaluates seven federal policy options aimed at improving the energy efficiency of industry. Detailed analysis generated a series of benefit/cost metrics spanning private and public costs and energy bill savings, as well as air pollution benefits and the social cost of carbon.

Biosciences Division's Jonathan Mielenz, Miguel Rodriguez, Jr., and Choo Hamilton have received Significant Event Awards (SEAs) for "Genetic manipulation of lignin reduces recalcitrance and improves ethanol production from switchgrass" in the first half of 2011. Their work was highlighted in the February PNAS paper by the same name. Read their paper online at [www.pnas.org/cgi/doi/10.1073/pnas.1100310108/](http://www.pnas.org/cgi/doi/10.1073/pnas.1100310108/)



Robin Graham



Wayne Manges



Melanie Mayes



Natalie Griffiths

Environmental Sciences Division's Natalie Griffiths was recently honored at the 2011 University of Notre Dame commencement ceremony, receiving the Eli J. and Helen Shaheen Graduate School Award for the sciences. These awards are given to the top graduating doctoral student in the humanities, social sciences, science, and engineering fields.

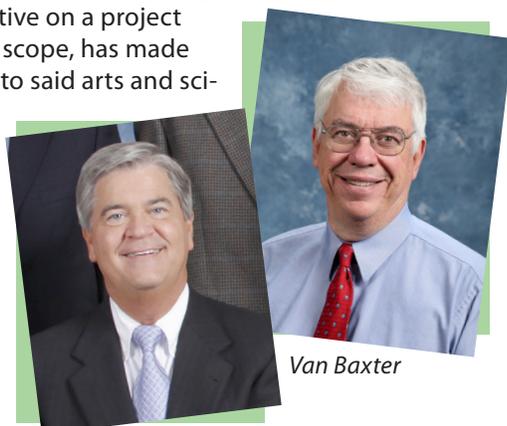
Energy and Transportation Science Division's Curt Maxey and Norm Durfee received a letter of appreciation from Jake Tisinger, lead for Knoxville Solar America Cities, thanking them for their time and effort dedicated over the past few years to the Knoxville initiative. Accompanying the letter of appreciation was a Certificate of Recognition plaque signed by Secretary Chu addressed to the Knoxville Solar America City team for "... advancing the city's solar market and serving as a model for communities nationwide through the U.S. DOE's Solar America Cities program."



Diane Davidson

U.S. Secretary of Transportation Ray LaHood has reappointed Energy and Transportation Science Division's Diane Davidson, Director of the Center for Transportation Analysis, to a two-year term on the Transit Rail Advisory Committee for Safety. The purpose of the committee is to advise the Secretary, through the Federal Transit Administrator, on rail transit safety issues. Diane is serving as Acting Chairman.

Energy and Transportation Science Division's Van Baxter and Ed Vineyard were elected to Fellow grade at the recent American Society of Heating, Refrigerating, and Air-Conditioning Engineers summer meeting in Montreal. Fellow status recognizes a member who has attained distinction in the arts relating to the sciences of heating, refrigeration, air conditioning or ventilation, or the allied arts or sciences, or in teaching of major courses in said arts and sciences, or who by reason of invention, research, design, original work, or an engineering executive on a project of an unusual important scope, has made substantial contribution to said arts and sciences, and has been in good standing as a full grade member for the last 10 years. Election to the grade of Fellow is by the Board of Directors.



Ed Vineyard

Van Baxter

DOE has awarded Ecology and Evolutionary Biology graduate student Melissa Cregger with the 2011 Marvin L. Wesely Award from DOE. This award was established in honor of the late Marvin L. Wesely, Argonne National Laboratory senior meteorologist and chief scientist of the DOE Atmospheric Chemistry Program. It is presented to the Graduate Research Environmental Fellow who has made the best use of their DOE mentor and facilities in improving the quality of his/her research efforts. The award is given for a one-year period to a current Fellow who has been supported to do global change research as part of the Global Change Education Program.

Claus Daniel is the new Deputy Director for the Sustainable Transportation Program. Claus moved to this position from the Materials Science and Technology Division where he most notably helped build and lead ORNL's battery research for vehicles and industrial technologies. Claus succeeds Keith Kahl, who now leads the Transportation Systems Research Group in the Energy and Transportation Science Division.



Claus Daniel

Congratulations to Biosciences Division's Lee Gunter and Ninell Mortensen and Energy and Transportation Science Division's Teresa Barone, Gary Capps, Oscar Franzese, and Bill Partridge. Each recently received the Outstanding Mentor Award presented by the DOE Office of Science. This prestigious award is in recognition of outstanding contributions and dedication in mentoring and is based on nominations and testimonials from mentored students.

Environmental Sciences Division's Maggie Stevens recently led outreach to Brazilian bioenergy researchers from Brazilian Bioethanol Science and Technology Laboratory, Fundação de Amparo à Pesquisa do Estado de São Paulo, Universidade de São Paulo to develop technical collaborations on sustainability, land use, and soil carbon change.

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## Researchers engage and educate summer visitors

Summer brought hotter than usual temperatures to East Tennessee and a constant flow of visitors through ORNL facilities. While researchers met with numerous collaborators and leading industries to discuss capabilities and partnership opportunities, they also shared their time with young students who were eager to learn about ORNL research and career opportunities.



Energy and Transportation Science Division's Scott Curran pictured here with a group of middle school students prior to touring the Fuels, Engines, and Emissions laboratories at NTRC.

## For more information...

- The June issue of the journal *Environmental Management* is devoted to the results from ORNL's Biological Monitoring and Abatement Program (BMAP) and entitled "Long-Term Biological Monitoring of an Impaired Stream: Implications for Environmental Management." Read the articles online at <http://www.springerlink.com/content/0364-152x/47/6/>.
- ORNL transportation researchers made 83 oral and poster presentations at the Annual Merit Review and peer evaluation meetings for DOE's Vehicle Technologies Program and Fuel Cell Technologies Program held in May in Washington, D.C. They also contributed to numerous other presentations on projects in which ORNL is a collaborator. Proceedings of the merit review and peer evaluation can be found at [www.eere.energy.gov/vehiclesandfuels/resources/proceedings/2011\\_merit\\_review.html](http://www.eere.energy.gov/vehiclesandfuels/resources/proceedings/2011_merit_review.html) (Vehicle Technologies Program) and [www.hydrogen.energy.gov/annual\\_review11\\_proceedings.html](http://www.hydrogen.energy.gov/annual_review11_proceedings.html) (Fuel Cell Technologies Program).

## Quality Counts...

Research and development shall be conducted and communicated in accordance with the highest scientific, professional, and ethical standards and in a manner that fosters mutual respect and enhances the reputation of the individual researcher, his/her colleagues, and the Oak Ridge National Laboratory in its mission to address the Department of Energy's and the nation's scientific and technical challenges.

--- ORNL Research Code of Conduct