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Dow team including ORNL receives $9 million for carbon fiber R&D

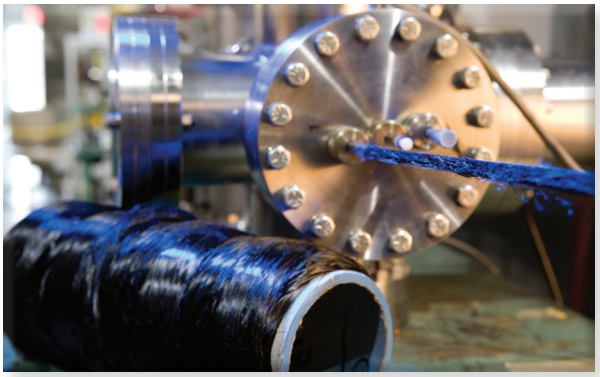
ORNL is a member of a team led by Dow Chemical that was recently awarded $9 million to pursue development of a low-cost carbon fiber production process. Under the award from the DOE EERE Advanced Manufacturing Office, Dow, ORNL, and Ford Motor Company will scale up current R&D efforts on polyolefin feedstock in ORNL's Carbon Fiber Technology Facility to demonstrate commercial viability for automotive composite components. Dow and Ford are providing in-kind cost sharing, and Michigan Economic Development Corporation is also providing funding for the $13.5 million project.

Carbon fiber already has a number of commercial applications such as vehicle bodies, wind turbines, and other industrial uses and would be more widely used if costs for the material could be reduced.

Polyolefins offer a low-cost alternative to the more expensive polyacrylonitrile (PAN) feedstock that accounts for about 90% of today's carbon fiber. The materials and process being pursued under this award have the potential to reduce carbon fiber production costs by 20% and to reduce the total CO_2 emitted in the manufacturing process by 50% by dramatically cutting the amount of energy required. The higher chemical yield of the polyolefin-based process is a large factor in the energy efficiency advantage: about 1.4 lb of polyolefin is needed to produce 1 lb of carbon fiber, versus 2 lb of PAN for the same yield.

The effort is one of 13 advanced manufacturing projects across the United States that were awarded $54 million in DOE funding. The projects are part of a strategy for promoting emerging technologies that create domestic manufacturing jobs and enhance the competitiveness of US companies in global markets while improving energy efficiency, reducing pollution, and boosting industrial productivity.

ORNL is home to the Carbon Fiber Technology Facility, an advanced carbon fiber scale-up facility for developing and demonstrating low-cost manufacturing processes that can be transferred to industry.



Fully carbonized fiber exiting the microwave-assisted plasma carbonization unit.

VENUS on the horizon: Neutron imaging tool approved for construction at SNS

The world's brightest neutron source could soon shed light on new ways to improve the energy efficiency and productivity of industrial and manufacturing applications. Approved for construction at the Spallation Neutron Source, the nuclear imaging instrument VENUS will provide a truly translational research platform that links science to engineering applications and solutions.

"Neutron imaging is a noninvasive, nondestructive imaging technique that is complementary to other methods such as x-ray or gamma imaging," said Ken Tobin, Measurement Science and Systems Engineering Division director and member of the VENUS Instrument Development Team (IDT).

"VENUS will be equipped with the brightest neutron source, highest energy resolution, and largest field of view available to far surpass conventional neutron imaging capabilities in the world."

Read more about VENUS on page 9.

In the Spotlight

Travis Smith's years of experience with private and public utilities is an excellent foundation for his wind power and power system research at ORNL.

After graduating from University of Tennessee–Chattanooga, Travis worked for more than 15 years as an electrical systems protection engineer for Georgia Power (part of the Southern Company) and the Tennessee Valley Authority (TVA) and a power systems consulting firm. He came to ORNL in 2008 as a research engineer with a focus on wind power interconnection and protection. Today he is with ORNL's Energy and Transportation Science Division.

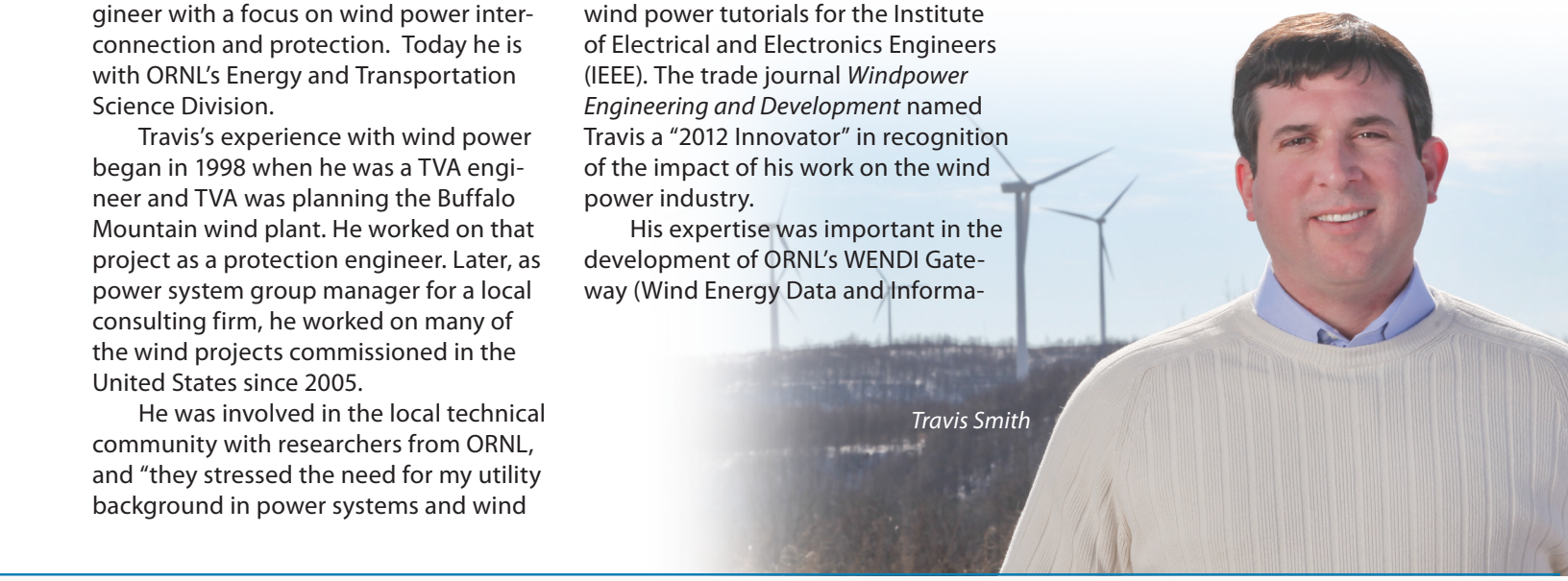
Travis's experience with wind power began in 1998 when he was a TVA engineer and TVA was planning the Buffalo Mountain wind plant. He worked on that project as a protection engineer. Later, as power system group manager for a local consulting firm, he worked on many of the wind projects commissioned in the United States since 2005.

He was involved in the local technical community with researchers from ORNL, and "they stressed the need for my utility background in power systems and wind power system research at ORNL," Travis said. So when a position in wind power and power system research opened at ORNL, he made the move.

His utility-sector experience serves him well as a liaison with industry. Since coming to ORNL, he's organized education and training events for industry such as wind energy roundtables bringing together industry, utility, technical, and financial experts; workshops for power company staff; and wind power tutorials for the Institute of Electrical and Electronics Engineers (IEEE). The trade journal *Windpower Engineering and Development* named Travis a "2012 Innovator" in recognition of the impact of his work on the wind power industry.

His expertise was important in the development of ORNL's WENDI Gateway (Wind Energy Data and Information), an online clearinghouse for data and information about wind energy (http://windenergy.ornl.gov). He developed the inventory of existing and planned wind installations and provided input to develop data "layers" for industry, manufacturers, developers, utilities, and policy makers.

A senior IEEE member, Travis is active in several IEEE working groups related to wind power and has published dozens of IEEE papers.



Travis Smith

Inventory approach increases precision of carbon accounting

Researchers in ORNL's Environmental Sciences Division are using an inventory-based method of assessing carbon reservoirs to determine the carbon balance in North America more precisely.

The team used inventory records from the United States, Canada, and Mexico to track carbon fluctuations in reservoirs such as plants, soils, and wood. They estimated the rate at which the continent sequesters atmospheric CO_2 and calculated the state of the science used to measure the carbon balance.

The results examine methods of quantifying CO_2 sources and sinks at regional scales and across cropland, forests, and other land types. "Estimates suggest the land-based sink offsets approximately 20 to 50% of total continental fossil fuel emissions," said team leader Daniel Hayes.

Land and ocean carbon sinks aren't fixed, Daniel noted, and the extent to which they continue to operate is a critical question. Currently, forests in the Southeast and Northwest are the largest carbon sinks in North America; but they can be affected by changes such as drought, fires, and insect outbreaks. North America accounts for up to a third of the global land and ocean sink for atmospheric CO_2.

Atmospheric and land-based models are the most common methods of assessing carbon. Inventory methods offer the advantage of extensive, repeated measurements, but many important processes can't be measured accurately. Thus the models are needed to fill in the knowledge gaps. There are large uncertainties in all three approaches.

Other team members are ESD's Yaxing Wei, Mac Post, and Robert Cook and scientists from several US, Canadian, and Mexican agencies. The research was supported by the DOE Office of Science, the Department of Agriculture, and NOAA.

BESC submits 32 gene disclosures for future patents

The Bioenergy Science Center at ORNL is preparing invention disclosures for 32 different genes that can help improve the yield of ethanol from cellulosic biomass. These genes or their variants function to overcome recalcitrance—difficulty in breaking down cellulosic biomass to release sugars.

Several members of ORNL's Biosciences Division are submitting disclosures: 16 genes by Wellington Muchero, 10 genes by Udaya Kalluri, and 6 genes by Jay Chen. Seven of the genes are being readied for patent application, whereas the others are in early stages of the process, said Jay. "We have nominated these seven genes to go through the first phase of patent applications."

Wellington worked with a population of poplar trees to explore natural genetic variants, he said. "We sampled the natural diversity and determined how different the trees are in terms of how easily sugar can be released from cellulosic biomass. Out of that we came up with 16 genes that were highly correlated with the sugar release phenotype."

Udaya's gene discoveries were made by profiling tension wood, which is created as trees bend and straighten, said Jerry Tuskan, Distinguished Scientist in ORNL's Plant Genetics Group. The cell walls in tension wood contain over 90% cellulose. Udaya profiled differences between normal and tension wood and identified ten genes that appear to affect cellulose deposition.

These genes are being overexpressed or underexpressed in poplar trees. The researchers aim to select genetically modified poplar trees with optimal traits for conversion of biomass to ethanol.

So how do you patent a gene that's a naturally occurring part of a plant? "What's being patented is a specific application of the gene or sequence," Jerry explained. "We can relate a specific gene sequence to a specific application. It's not like a widget—we don't make it. We have information companies don't have, and they license that. They can use that information in their breeding program—look for that variant in their stock, or, if they're growing another species, use genetic engineering to introduce that sequence or shut it off."

By the end of its second 5 years, BESC researchers expect to have about 100 genes patented, Tuskan said.

Plant geneticist Wellington Muchero examines phenotypic traits of Populus *transgenic lines grown in a greenhouse.*

Researchers come full circle with competition that jump-started their careers

On his wedding anniversary in 2009, Energy and Transportation Science Division's David Smith took a different kind of plunge when he defended his doctoral dissertation at the University of Tennessee. Having pursued his Ph.D. in mechanical engineering for a decade, David earned the review committee's approval and three days later joined ORNL as program manager for advanced vehicle systems research.

"It was a series of opportunities and experiences that led me to ORNL, but the journey really started in 1995," explained David, who is now with ETSD's Power Electronics and Electric Power Systems Research Center. Then a senior at UT, David was a member of the university's team competing in the HEV (hybrid electric vehicle) Challenge, a DOE Advanced Vehicle Technology Competition (AVTC).

Over the years, David's roles with AVTC have included student competitor, student team leader, judge, and advisor. He is pictured at right with fellow judge and current ETSD coworker John M. Miller, then with Maxwell Technologies, during the Challenge X series.

Since 1988, DOE has sponsored 28 AVTCs—9 multiyear series including the HEV Challenge—in partnership with Natural Resources Canada and the North American auto industry. The intercollegiate competitions are designed to help educate the next generation of automotive engineers and accelerate the development and demonstration of technologies of interest to DOE and the automotive industry.

"HEVs were a new concept at the time, so it was an amazing experience as a student to get hands-on experience working with these technologies," said David. With HEVs just emerging, the HEV Challenge set unprecedented performance benchmarks and testing procedures that continue to impact industry. When vehicle designs and overall dynamic performance were evaluated, UT won the HEV Challenge that year, defeating more than a dozen fellow university teams.

David as a competitor during the FutureTruck series.

David eventually participated in three AVTCs under the FutureTruck series, serving as graduate student team leader for controls in his last year of competition. His participation led to other research opportunities and eventually a two-year run working for Ford in Detroit. Several years prior to joining ORNL, David also worked for Sentech, providing technical and strategic subcontract support to DOE's Vehicle Technologies Program.

"The competitions opened my eyes to the career I wanted to pursue and provided exposure and connections to world-class organizations," explained David, one of many ORNL researchers who has benefitted from the DOE-sponsored student competitions.

As a UT senior studying mechanical engineering, Scott Curran joined the competitions in 2007 during the Challenge X series. UT was among 17 university teams selected to redesign a Chevrolet Equinox SUV to minimize energy consumption, emissions, and greenhouse gases while maintaining or exceeding the vehicle's utility, safety, and performance.

Scott, standing far left, served as graduate student team leader for UT's Challenge X team in 2008.

Scott brought to UT's team both technical and outreach experience gained through undergraduate projects involving biodiesel and small engines research. After focusing that year on both aftertreatment research and strengthening outreach efforts, Scott went on to serve as graduate student team leader for UT's Challenge X team in 2008.

"Challenge X allowed me to think outside the box. For the first time I could see research and development from a systems perspective, beyond a single aspect of vehicle design or performance," said Scott. "The competitions also proved to me how important it is for researchers to assist the public in understanding the impact of research on everyday life," he added, emphasizing the role of outreach in cultivating interests in science, technology, engineering, and mathematics.

After the competitions, Scott based his master's thesis on the evaluation of on-road emissions of student-produced biodiesel using the UT Challenge X vehicle. In 2009, he began a postgraduate position at ORNL through the Fuels, Engines, and Emissions Research Center and also began supporting the ORNL fleet manager for the Sustainable Campus Initiative. After spending nearly three years in the position, Scott became a full-time researcher with ORNL in 2011 and now works on advanced combustion, engine efficiency, and alternative fuels projects.

Today Scott serves as advisor to the Eco CAR 2 series. He's pictured, center, with UT EcoCAR 2 team members at ORNL's 2012 Earth Day event.

Today, through their continuing relationships with UT, David and Scott participate in the current AVTC series in an advisory capacity. EcoCAR 2 is a three-year series sponsored by DOE and GM that requires students to explore a variety of powertrain architectures focusing on electric drive vehicle technology. An adjunct professor at UT, David is co-faculty advisor to the university's EcoCAR 2 team and teaches a modeling, simulation, and controls class each semester. Scott, who maintains research staff privileges at UT, serves as co-outreach advisor to the team. For the last year, both worked closely with the 21-member team and cheered them on as they completed the first year of EcoCAR 2 competition ranked 6th. Both also look forward to working with new UT teams in the next two years of the EcoCAR 2 series and future DOE-sponsored competitions.

UT's EcoCar 2 team placed 6th in the first year of competition.

"The DOE competitions demand industry-level performance out of students who in turn deliver results that benefit everyone," said David. DOE and industry sponsors not only receive a wealth of solid research but also get to know first-hand the highest caliber of students coming out of school. He added, "While many students receive job offers, they all come out winners with incredible experiences and new connections that will help guide them in the future."

Facts about the DOE Advanced Vehicle Technology Competitions

- 89 universities have participated in North America since 1989
- 455 individual university teams have competed since 1989
- 16,500 students have been involved
- 75% of graduates enter the automotive industry on average

Students compete in DOE Biggest Energy Loser Challenge

The "Biggest Energy Loser Challenge" program takes advantage of students' competitive instincts to focus them on shaving energy usage in their homes.

The online middle school pilot curriculum was developed for students in Louisiana, Hawaii, and Japan through a DOE–ORNL–Southern University partnership. It focuses on energy types, usage, and consumption. Each student in the program conducts a home energy audit, calculating the amount of energy consumed by everything from heating and cooling to laptops and light bulbs.

Roderick Jackson of the Energy and Transportation Science Division helped develop the curriculum. "Our focus was to generate excitement in the students about saving energy," Roderick said. "Once the students are energized, they spread their enthusiasm to their peers and parents."

"Biggest Loser" teaches students about renewable, nonrenewable, and nuclear energy and the proportion of energy used by sector (e.g., buildings, transportation, industry) in the United States, Japan, China, Europe, India, and Russia. The curriculum includes information about energy sources used in each country, consumer energy prices in countries around the world, and cultural influences on energy use in homes.

The activity was an eye opener for students at Southern University Laboratory School in Baton Rouge, Punahou School in Honolulu, and the University of the Ryukyus Junior High School in Okinawa. One student commented "I didn't know the type of window made such a difference!" Another said "I had no idea my family used so much electricity until I completed the audit. Now I'm making an effort to conserve energy."

In the finale, students competed to reduce energy costs in a model home representative of their region. The winners from each class were announced live via Skype and on the course Web site.

Dual-laser technique advances the art of sensing at a distance

A pump-probe laser sensing technique being developed at ORNL enables rapid identification of biological and chemical compounds at a distance.

The method uses a quantum cascade infrared laser to strike or "pump" a target sample and a second laser to probe the material's response. The probe laser reads the absorption spectrum of the molecules present, and the readings can be distilled into pixels that form an image representing the molecules that constitute the sample surface.

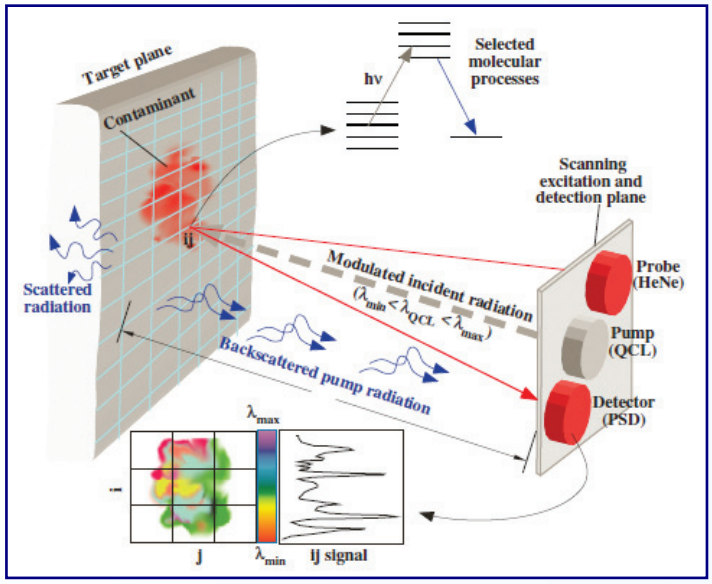
The use of a second laser to extract information is a novel aspect of the approach, said Ali Passian of the Measurement Science and Systems Engineering Division (MSSED). "The use of a second laser provides a robust, stable readout approach independent of the pump laser settings."

Like radar and lidar, the technique uses a return signal to convey information about the substance to be detected, but it differs in important ways, said Ali. It employs a photothermal spectroscopy configuration in which the pump and probe beams are nearly parallel.

Probe beam reflectometry provides the return signal in standoff sensing, minimizing the need for expensive wavelength-dependent infrared components such as cameras, telescopes, and detectors.

The findings provide proof of principle for the technique. The work could lead to advances in standoff detectors for use in quality control, airport security, medicine, and forensics. The analysis could be extended to hyperspectral imaging, which provides topographical as well as high-resolution chemical information. "This would allow us to effectively take slices of chemical images and achieve spatial resolution down to individual pixels," said Ali.

Other authors are MSSED's Rubye Farahi and Laurene Tetard, and Thomas Thundat of the University of Alberta. Funding was provided by ORNL's Laboratory Directed Research and Development program.



An infrared pump laser scans a region of interest of the sample and an accompanying probe laser reads out the absorption spectrum of the constituent molecules. An image can thus be formed that represents the molecules making up the sample surface. This figure was selected for the cover of Journal of Physics D: Applied Physics.

Better additive manufacturing tools target of partnership with Stratasys and Arcam

ORNL is working closely with Stratasys and Arcam AB to develop new materials and improved processes to increase the applicability and impact of polymer and metal additive manufacturing technologies. Additive manufacturing is a next-generation manufacturing process that conserves material and energy, and needs no molds or expensive fixtures.

Stratasys, inventor of the fused deposition modeling (FDM) process and industry leader in direct digital manufacturing and rapid prototyping, is working with ORNL's Manufacturing Demonstration Facility (MDF) to develop process monitoring and closed-loop feedback control systems to increase the mechanical properties and production quality of FDM components. FDM represents one approach to polymer-based additive manufacturing that is based upon extrusion of the material. This approach is advantageous because of its high deposition rate and ease of large-scale production. However, the material properties and lack of process control limit this technology to the prototyping market. The goal of the MDF program is to transition the FDM process and materials from prototyping to manufacturing.

Craig Blue and Lonnie Love, front left to right, with Stratasys' Thomas Stenoien, Chief Operating Officer, back left, and Jeff DeGrange, Vice President, Direct Digital Manufacturing.

Arcam AB is the only producer of metal additive manufacturing systems using an electron beam as the heat source for melting metal powder to produce a solid metal component. Arcam is working with MDF to improve the process reliability of the electron beam melting (EBM) technology by developing in-situ process monitoring and closed-loop control; expand the technology to various materials systems, including Ni-based superalloys and stainless steel; increase the material deposition rate; and increase the build volume. The goal is to evaluate several fundamentally different in-situ monitoring technologies for the EBM system that will be capable of detecting porosity and other processing defects.

Final dig uncovers increased soil carbon storage under elevated carbon dioxide

Elevated carbon dioxide concentrations can increase carbon storage in the soil, according to results from a 12-year DOE-sponsored carbon dioxide–enrichment experiment led by the Environmental Science Division. The increased storage of carbon in soil could help to slow down rising atmospheric carbon dioxide concentrations.

In a paper published in *Global Change Biology*, ESD's Colleen Iversen and colleagues quantified the effects of elevated carbon dioxide concentrations on soil carbon by excavating soil from large pits that were nearly 3 feet deep. The dig marked the final harvest of the Free-Air Carbon dioxide-Enrichment–or FACE–experiment that ended in 2009.

"Under elevated carbon dioxide, the trees were making more, deeper roots, which contributed to the accumulation of soil carbon," Colleen said.

She pointed out that processes such as microbial decomposition and root dynamics change with soil depth, and information on processes occurring in deeper soil will help to inform large-scale models that are projecting future climatic conditions.

Co-authors on the paper, "Soil carbon and nitrogen cycling and storage throughout the soil profile in a sweetgum plantation after 11 years of carbon dioxide-enrichment" are ESD's Charles Garten and Richard Norby, FACE project leader; and Chapman University's Jason Keller.

From the left, Joanne Childs, Colleen Iversen, and Rich Norby dig soil pits and excavate roots and soil at the FACE site.

Tool investigates population, climate impacts on global water resources

A method combining geographic information systems data with climate models and statistical analysis is providing insight into the relative impact of population growth and climate on global freshwater supplies.

"Our tool provides a simple method to integrate disparate climate and population data sources and develop preliminary per capita water availability projections at a global scale," said Esther Parish of the Environmental Sciences Division.

When Esther and co-authors Auroop Ganguly, Karsten Steinhaeuser, and Evan Kodra began working on this approach in 2009, it was unusual to integrate population, climate, and water data in one model. The toolkit they developed, which is freely available, may be developed further for more complex analyses.

The study considered water stress to be less than 450,000 gallons available per person per year. However, how a society stores and allocates water—for example, among residential, agricultural, and industrial uses—will determine whether an actual shortage exits.

The team used ORNL's Global LandScan population distribution dataset in combination with population growth projections from the Intergovernmental Panel on Climate Change to estimate freshwater demand by 2025, 2050, and 2100. They used the Community Climate System Model 3 to estimate water availability during the same periods and then combined supply and demand projections to estimate water availability worldwide.

To test the tool, they plugged in four IPCC greenhouse emissions projections and global population projections to arrive at potential scenarios. None of the scenarios looks good: the results suggest 56 to 75% of the world's population, including residents across much of the United States, might experience freshwater stress by 2100.

The study offers preliminary insights, but future research needs to incorporate output from multiple climate models, Esther noted.

Auroop and Evan, both of Northeastern University, and Karsten, University of Minnesota, are former ORNL staff. The work was funded by ORNL's Laboratory Directed Research and Development program and the National Science Foundation.

Materials expertise helps solve manufacturing challenge

Pumpkin pie is a small sacrifice when it comes to assisting a user. Last November during the Thanksgiving holidays, High Temperature Materials Laboratory staff members worked around the clock to assist global automotive parts manufacturer Cosma International in resolving a component materials issue that briefly interrupted its Clinton, TN, operations as well as those at an original equipment manufacturer's (OEM) production plant.

After receiving a call from Cosma, a subsidiary of Magna International, HTML Director Edgar Lara-Curzio assembled a rapid-response team to assist the parts manufacturer in identifying mechanisms affecting materials integrity during automotive components assembly at the OEM plant. Cosma uses hot-stamping to manufacture these high-strength steel components for vehicle structures.

Through fractography, x-ray diffraction, finite element stress analysis, and other analyses, HTML researchers determined the state of residual stresses in the components before and after they were assembled. They then recommended process modifications that enabled Cosma and the OEM to rapidly resume operations with no deviation in material integrity and product quality.

Magna and Cosma officials wrote to Secretary of Energy Steven Chu in March, praising HTML's quick response and unique capabilities. In the letter, general manager Steve Esman and quality manager Allan Navarro note that they turned to HTML for its expertise, powerful tools, and "most importantly the staff's understanding of the relationships between manufacturing processes and the microstructure and physical and mechanical properties of materials."

In addition to Edgar, HTML team members who participated in the effort include Measurement Science and Systems Engineering Division's Claire Luttrell and Materials Science and Technology Division's Roberta Peascoe-Meisner, Christopher Stevens, Rosa Trejo, and Thomas Watkins.

Tom Watkins prepares the surface of the A-pillar inner post on the drive side of a body in white to determine its state of residual stresses.

Continued from page 1...

VENUS on the horizon

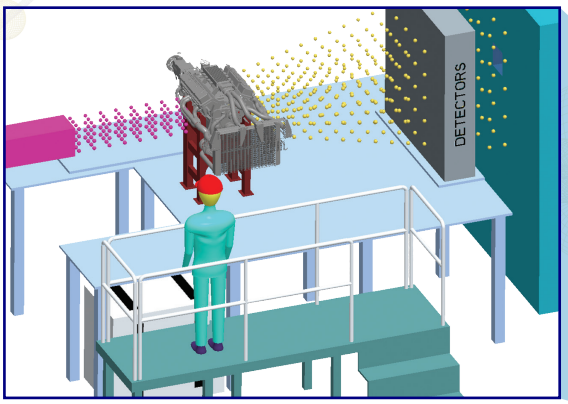
The VENUS instrument will offer novel energy-selective imaging techniques that directly connect the structures, properties, and function of complex engineering materials and systems to reveal practical and fundamental answers about their real-world performance. Time-of-flight neutrons produced by the neutron source will enable unique nondestructive imaging similar to hyperspectral imaging in the optical domain. For many engineered components, VENUS will provide three-dimensional residual stress and strain mapping to uncover material and mechanical behaviors during operation and under exposure to extreme conditions such as heat and pressure.

In late 2008, the IDT received provisional approval from the Neutron Scattering Science Advisory Committee to build VENUS at one of the three available beam lines at the SNS. Approval followed three years of preparation, design, and preliminary testing by the team, whose representatives include researchers from various fields around the world. Construction is expected to take place over the next five years.

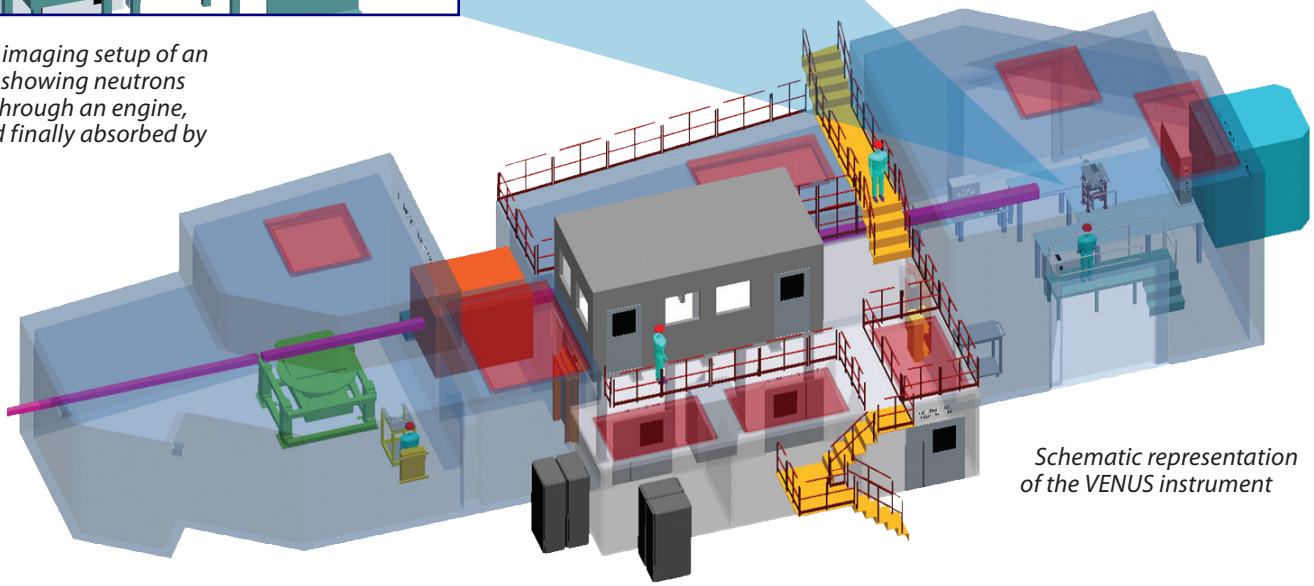
Throughout the process, the team engaged the DOE Office of Energy Efficiency and Renewable Energy (EERE) in identifying science and engineering problems uniquely addressed by the capabilities of VENUS. Its design will enable direct studies of practical systems in energy production (including renewable, nuclear, and fossil sources), energy storage, fuel cells, hydrogen storage, vehicle technologies, building technologies, and industrial engineering component design.

EERE support of conceptual designs and early testing at a prototype beam line at the High Flux Isotope Reactor revealed the technology's importance and potential impact. In less than one year and with a fraction of the capabilities planned for VENUS, the prototype beam line addressed an influx of user projects with major manufacturers and industry leaders including Ford, GM, Chrysler, Toyota, United Technologies Research Center, Cummins Engines, Detroit Diesel, Mack, Delphi, Navistar, PACCAR, John Deere, Caterpillar, Volvo, GE, Whirlpool, DuPont, Thermacore, Mars, and Bush.

In addition to supporting EERE, VENUS will contribute to fundamental understanding in areas important to the Office of Science such as materials chemistry, physical and mechanical materials behavior, geosciences, plant biology and physiology, and climate change. It will also benefit advanced materials science and engineering programs such as DARPA and ARPA-E and support studies in archaeological, biological, biomedical, forensic, and homeland security applications.



Stroboscopic imaging setup of an engine block showing neutrons transmitted through an engine, detected, and finally absorbed by a beam stop.



Schematic representation of the VENUS instrument

Final report on intermediate ethanol blends research published

ORNL published a final report on the Intermediate Blends Catalyst Durability Study in February. The two-year program, led by researchers from the Fuels, Engines, and Emissions Research Center, involved driving 82 vehicles over 6 million miles with periodic emissions tests to evaluate the effects of ethanol blends (E10, E15, and E20) on emissions control system durability. The program was closely monitored by DOE, the Environmental Protection Agency, and industry, and garnered the attention of Congress, the Secretary of Energy, and the EPA Administrator.

Statistical analysis of the data showed that aging vehicles produced increased emissions. However, aging vehicles fueled by ethanol blends showed no differential effect over those fueled by ethanol-free gasoline. Immediate effects of ethanol were consistent with prior studies: addition of ethanol to certification gasoline decreased carbon monoxide, nonmethane hydrocarbons, and fuel economy, while increasing nitrogen oxides, ethanol, and aldehyde emissions.

The study results were the basis of the recent EPA rulings on the Growth Energy E15 waiver. EPA described the study as unprecedented in size and scope when they cited the E0 and E15 data in granting partial approval of the Growth Energy waiver, allowing E15 use in 2001 and newer light-duty vehicles. The report's analysis also addresses the emissions impacts of E20; intermediate blends (E15 and E20) were not found to contribute to more rapid emissions control system degradation compared with ethanol-free gasoline.

Mileage accumulation dynamometers at subcontractor facilities were used to "age" many of the vehicles being researched. Program research was co-sponsored by DOE's Vehicle Technologies and Biomass Programs.

DOT boosts funding for three established projects

The Department of Transportation's Federal Highway Administration and Federal Motor Carrier Safety Administration recently reconfirmed their confidence in ORNL research capabilities by approving increased funding for three established projects led by the Center for Transportation Analysis.

- FMCSA has awarded $7.8 million over 60 months to ORNL's Commercial Motor Vehicle Roadside Technology Corridor team for conducting a wireless roadside inspection field operational test in Tennessee and four neighboring states along the interstate corridors and on state highways. This project will develop, test, and field a deployment-ready system that will wirelessly inspect commercial motor vehicles in real time, providing roadside enforcement personnel and state and federal audit systems with information including driver, carrier, vehicle identification and status (including driver hours of service), and historical data contained in federal systems. A new interagency agreement is being prepared specifically for this effort that is expected to be completed in 2017.
- FHWA Office of Freight Management and Operations has awarded $550,000 for conducting statistical reliability analysis on the Freight Analysis Framework, the most comprehensive freight movement database available that provides domestic and international freight flows. The analysis will include variance estimations for FAF data quality obtained at aggregated levels.
- FHWA Office of Highway Policy has awarded $100,000 to address a new task under the National Household Travel Survey project to develop a web-based application that can be used as a tool to analyze traffic data contained in the national Highway Performance Management System and identify missing or unreasonable milepost data.

In addition to leading these projects for FMCSA and FHWA, CTA provides research for a variety of DOT agencies including the Research and Innovative Technology Administration and National Highway Traffic Safety Administration.

ARPA-E project aims to accelerate vehicle electrification

The future of America's energy security is tightly coupled to the advancement of electric and hybrid vehicle technologies. Efficiencies in the traction drive and charging systems are critical parameters for researchers and designers who are creating these next-generation vehicles, and cost and reliability remain vital parameters, especially to consumers.

With long track records for successfully developing highly integrated, low-power electronics in a number of semiconductor processes, research engineers in the Measurement Science and Systems Engineering Division and Energy and Transportation Science Division are addressing the traction drive and charging system challenges through new research funded through ARPA-E, DOE's Advanced Research Projects Agency–Energy.

Working in collaboration with Toyota USA, Arkansas Power Electronics Center, the University of Arkansas, and CREE, Inc., ETSD's Laura Marlino and MSSED's Chuck Britton, Nance Ericson, and Shane Frank are integrating gate drivers into the same substrate as the power transistors using Cree's silicon carbide (SiC) power electronic semiconductor process. Although risks to successful implementation exist, the outcome of this work has the potential to revolutionize power electronics for electric and hybrid electric vehicles by reducing overall part count and the need for ancillary systems, increasing overall efficiency and reliability.

So far the ORNL team has been successful in implementing, for the first time, gate drivers in the SiC process. These gate drivers are currently undergoing in-lab testing, and the results are promising. In August researchers will attempt to integrate the isolation architecture and the gate drivers onto one substrate. The final step, projected to occur in the spring of 2013, will be to integrate the isolation architecture, gate drivers, and power transistors onto a single SiC substrate configured to function as a bidirectional charging system, which will be tested later in a plug-in hybrid electric vehicle.

Taking research on the road for industry partner

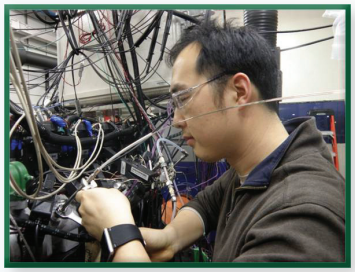
In recent months, Energy and Transportation Science Division researchers made two trips to facilities in Columbus, Indiana, to work on-site with industry partner and leading engine manufacturer Cummins, Inc.

For a week in December, Maggie Connatser, Jim Parks, and Bill Partridge worked at the Cummins Engine Plant to assist the manufacturer in achieving a time-critical product-development milestone. Work involved the application of technologies developed as part of a DOE Vehicle Technologies-funded CRADA, yet was performed as part of a work-for-others agreement. Cummins partner Ryo Fuchinoue emphasized the importance of this partnership in meeting Cummins' development milestones. "Thanks to your team's help, we were able to complete the initial calibration work prior to the first prototype vehicle start up…it certainly sped up the process and helped us tremendously to finish initial calibration in time."

In an unrelated project, Bill and Oak Ridge Associated Universities post-doctoral research associate Jon Yoo worked with their CRADA partners at the Cummins Technical Center in January to assess the performance of a development exhaust gas recirculation (EGR) system. The efforts led to a successful field demonstration of the CRADA-developed EGR probe that provides single-port measurement access for more ready and flexible application to further developed and packaged engine systems. The work focused on spatio-temporal EGR uniformity and provided new insights relevant to product development. Based on the work, modifications are planned for both the instrument and the EGR system.

According to Bill, principal investigator for these and other Cummins projects, the partnership's successful history has led to a growing number of opportunities to provide research support inside Cummins facilities. "These joint research campaigns span a wide range of technologies including catalysis, combustion, controls, and hardware assessment," he explained. The team is already planning two summer trips to Columbus for follow-up measurements, one on the EGR system and a second related to the Cummins SuperTruck ISX engine platform.

In addition to these working campaigns, the Cummins-ORNL teams conduct monthly teleconferences and meet frequently to discuss advanced catalysis, combustion, and controls. "This is a uniquely effective partnership," said Bill, adding, "Together we are working hard to push the DOE barriers for improved efficiency, durability, and emissions."



ORAU post-doctoral research associate Jon Yoo assesses the performance of a development exhaust gas recirculation system using the CRADA-developed EGR probe.

Industry impact: Collaboration produces breakthrough heat pump technology

In late March, ClimateMaster announced an efficiency breakthrough with the introduction of the Trilogy™ 40 series, the first geothermal heat pumps ever certified by the Air Conditioning, Heating, and Refrigeration Institute (AHRI) to exceed 40 EER (energy efficiency rating) at ground-loop conditions.

The outcome of a five-year-collaboration between ClimateMaster and ORNL's Building Technologies Research and Integration Center, the revolutionary Trilogy™ 40 uses variable-speed technology to provide an extremely wide range of heating and cooling capacities, with the ability to perfectly match loads to as low as 30% of maximum. Based on field tests and analysis by ORNL, the Trilogy 40 Q-Mode can save 55–65% of annual energy use and cost for space conditioning and water heating in residential applications versus new minimum efficiency (SEER 13) conventional systems and 30–35% versus current state-of-the-art two-stage geothermal heat pumps.

"The Trilogy 40 Q-Mode represents a major breakthrough in comfort and efficiency," said John Bailey, senior vice president of sales and marketing at ClimateMaster. "With variable-speed fan, pump and compressor (Trilogy technology) plus four operating modes (Q-Mode technology), it far exceeds the capabilities of any other HVAC unit on the market today. Plus, it can completely eliminate the use of auxiliary heat even in far northern climates."

Headquartered in Oklahoma, City, ClimateMaster is the leading manufacturer of geothermal and water-source heat pumps, which are considered to be the most energy efficient and environmentally friendly type of heating and cooling systems available on the market today. The Trilogy 40 Q-Mode series is currently in limited production, with full availability scheduled for late 2012.

Prototype of the ClimateMaster Trilogy™ 40 Q-Mode™ geothermal heat pump.

ORNL researchers help assess potential of hydropower

In a study of the energy-producing potential of untapped US dams, ORNL researchers found that 54,000 dams not currently used to generate power have the capacity to generate more than 12 gigawatts, enough to power more than 4 million homes.

ORNL and Idaho National Laboratory researchers conducting a hydropower resource assessment for DOE calculated that the 100 dams with the highest energy potential could generate 8 gigawatts of power. The top 10 power-generating dams are along the Ohio, Mississippi, Alabama, Tombigbee, Arkansas, and Red rivers.

Equipping existing dams with power-generating plants avoids additional environmental impacts because the dams are already operating. Additionally, installing hydropower won't change the timing of flows released from the dams.

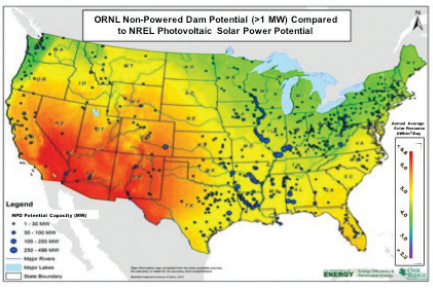
"Most non-powered dams and potential capacity can be developed outside of critical habitat, parks, and wilderness areas," said Environmental Sciences Division's Brennan Smith, ORNL water power program manager. "Most of today's large dams that aren't generating power are used for navigation and flood control, but they have the potential to act as a renewable energy source."

ORNL found that hydropower energy is available in areas that are not rich in wind or solar power, such as the Ohio River Valley and the Southeast.

To determine the energy potential of non-power generating dams, ORNL researchers used data from the US Geological Survey and the Army Corps of Engineers to map stream networks, dams, and stream flows. Through geospatial processing techniques, ORNL researchers were able to overlay the mapped data and collectively define energy potential at each site. The flow and elevation difference of the dam determined the power potential and allowed researchers to compute how much energy the dam could produce.

Now that researchers have quantified the potential energy of non-power generating dams, the next step will be to figure out how much it will cost to build these hydropower plants.

"The high-value opportunities for development are likely to be at large dams operated by the federal agencies," Brennan said. "The private sector can work with these agencies to develop projects that provide additional energy for the nation's electric power systems."



ORNL found that hydropower energy is available in areas that are not rich in solar power, such as the Ohio River Valley and the Southeast.

Looking for life in all the wrong places

A scientist finds himself two miles below ground in a gold mine in Africa carrying 40 pounds of equipment and extremely precious bacterial samples. There's a rumble from above and debris trickles off the walls.

No, he's not Indiana Jones in the Temple of Doom. He's Tommy Phelps, ORNL scientist in the Biosciences Division, and he seeks out extreme bacteria for the sake of science in locations such as Africa, Micronesia, Colorado, Virginia, and Mississippi.

Tommy has made a career of finding and preserving extremophiles—organisms that thrive in physically and geochemically difficult conditions. The bacteria that he obtains are desirable for a number of reasons. They grow only at super high or low temperatures, are extremely tolerant of metals and salt deposits, and are fast growing. Additionally, extremophiles have "sloppy" control over their end products, meaning that researchers can change their conditions, which can alter bacterial metabolism.

These extreme bacteria are essential for a process called nanofermentation, which uses bacteria and sugar to convert salts that contain metal into semiconducting nanoparticles. Because nanofermentation can be used with abundant, low-cost salts as starting materials and sugar as the energy source, the process has the potential to be much cheaper than conventional high-temperature and chemical synthesis routes. Nanofermentation could be used to produce a range of nanoparticles, including metal oxides for batteries, metal-sulfides and selinides for photovoltaic solar cells, superparamagnetic nanoparticles for medical imaging, and semiconducting quantum dots for lighting applications.

Before researchers can even think about applications, though, someone has to obtain the bacteria that researchers across the country use for nanofermentation. Although Phelps practices extreme caution in extreme environments, one instance left Phelps fearing for his life.

In 1999, Tommy joined his wife's research project to look for microorganisms in the fractured rocks and deep formation waters in gold mines in South Africa, about two miles underground. After six hours collecting samples, the group was still completing a corehole into the side of a wall.

"I heard a series of pings, felt a concussion wave and then felt debris fall on my hard hat," he said. "A few minutes later, I heard another set of pings, felt a concussion wave, and felt debris fall on my hard hat. When I asked the lead driller what was going on, he said we had missed the elevator we were scheduled to take and workers on the next shift were blasting about 100 meters above us."

The research group waited two hours for the next elevator to arrive and they made it out safely. "When you're working in mines, you have to work within miners' constraints," Tommy said. "If you're deep underground and you're not concerned, there's something wrong. You're a long way from the surface."

Once he obtains samples from these extreme environments, Tommy preserves them and ships them to labs across the country. He brings some samples back for Ji-Won Moon, ORNL scientist in microbial ecology and physiology, who adds a specific combination of salts and sugars to the bacteria to make a material with ideal properties. Tommy calls Ji-Won a "master of the art" because he can add the perfect ratio of metal salts to bacteria to make a material with either superconducting or magnetic properties.

As Tommy and his colleagues work to perfect the nanofermentation technology, they are planning to scale the process from the laboratory bench to a pilot plant that could provide 200-gallon fermentation batches to make 1 to 3 kilogram quantities of nanoparticles, compared with the 3 to 5 gallons of culture volume they are using now. Tommy calls himself the "expensive plumber" in the nanofermentation project because he brings the 20 different people across the lab together for the big picture. He's just as involved with the research side as the implementation side as he works with his collaborators to plan the pilot plant, on the west end of ORNL's campus, and the fermentation vessels.

Although Tommy may downplay his role in advancing nanofermentation technology, he and the team are expanding our understanding of science.

"You're looking for something different," Tommy said. "It's not an adrenaline rush. You're looking for something that could help us understand science and expand horizons."

Tommy Phelps looks for bacteria samples at Yellowstone National Park.

USCAR, DOE visit includes tour of new Battery Manufacturing Facility

While visiting ORNL transportation research facilities in June, officials from the United States Council for Automotive Research (USCAR) and DOE were on hand for the launch of the lab's new Battery Manufacturing Facility.

A boost for US automotive and other industries, the new facility is the country's largest open-access battery manufacturing research and development facility. It complements the lab's existing energy storage material processing capabilities, providing scientists the ability to analyze every aspect of battery production, from raw materials to finished product. The facility is co-located with ORNL's Manufacturing Demonstration Facility and National Transportation Research Center off Hardin Valley Road.

USCAR is the collaborative technology organization of Chrysler Group, LLC, Ford Motor Company, and General Motors Company. Since 1993, USCAR has teamed with DOE and industry in several partnerships that evolved into US DRIVE in 2011, a government-industry partnership focused on advanced automotive and related infrastructure technology research and development.

ORNL's Claus Daniel, left, shows DOE and USCAR representatives a battery pouch produced in the new facility. Continuing left to right are USCAR's Steve Zimmer, DOE's Yury Kalish, General Motor's William Peirce, and DOE's Richard Farmer.

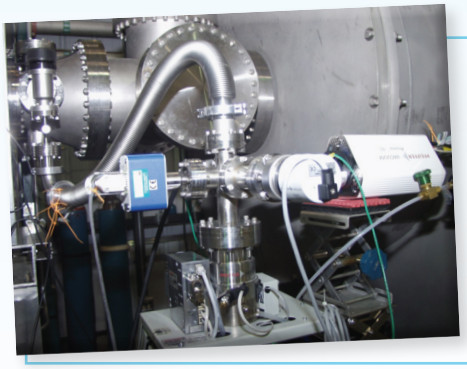
Snapshot from inside the laboratory...

During the last six months, Measurement Science and Systems Engineering Division's Chris Marcus and Fusion Energy Division's T.M. Biewer have been analyzing gas outflows from a cryogenic viscous compressor (CVC) and a high-intensity radio frequency source called a Helicon, which is capable of producing high-density, linear plasma.

Of particular interest are times when both helium and deuterium are present in the gas stream. The two masses are separated by approximately 0.0026 of an atomic mass unit (amu). This imposes a challenge in resolving discrete peak intensities, especially when one of these analytes exists in a minute quantity (≤ 1% of the fill mixture) relative to the other. The mass (or amu) of helium is 4.0026; for deuterium, 4.0282.

While most broad, ion mass range residual gas analyzers (RGAs) are not capable of resolving ion masses below 3–4 amu because of inadequate ion filtering along the pathway to the detector region, Chris and T.M. recently applied anharmonic resonant electrostatic trap mass spectrometer, or IT-RGA.

Miniaturized hardware, IT-RGA offers high resolution across a wide mass range at an ultrafast scanning rate (up to 0.086 seconds). The benefits from this rapid, spectral output include the ability to detect real-time changes in the CVC efficiency in response to changes in the gas stream input as well as determine how efficient plasma generation is in the Helicon under varying power intensities, and using either helium or deuterium as the filling gas.



Gas sampling configuration between Helicon and gas ballast tank.

Employee Excellence

John Hsu

Energy and Transportation Science Division's John Hsu has been selected to receive the 2012 Cyril Veinott Electromechanical Energy Conversion Award, presented by the Institute of Electrical and Electronics Engineers (IEEE) Power and Energy Society. It will be presented at the annual meeting in July 2012. John is a distinguished engineer and lead scientist for ETSD's Power Electronics and Electric Machinery Research Group. An ORNL employee since 1992, John presently focuses on motor and inverter technologies for electric vehicles, including one of his ongoing pioneer works, the brushless non-permanent magnet motor. In contrast to the permanent-magnet synchronous motor that requires costly rare-earth materials, the brushless non-permanent magnet motor concept generates magnetic flux in the stator that is injected into the rotor. The prototype motor built according to this concept has successfully passed validation tests, and ongoing improvements are in progress. A UT-Battelle Distinguished Inventor, John holds 48 US patents. He is the author and co-author of more than 100 technical publications and is a Fellow of the Institution of Engineering and Technology.

ORNL's third annual Community Sustainability Award goes to Laurence Eaton, Environmental Sciences Division, and his colleagues at Old North Knoxville Restoration, LLC, Lauren T. Rider and Ernie Roberts, for their exceptional leadership in promoting and implementing the principles of sustainability in our community. Through this team's initiative, a historical residential structure in Laurence's neighborhood was renovated to meet Leadership in Energy and Environmental Design silver specifications. The house became a home for its new owners and contributed to the sustainability of the Old North Knoxville neighborhood in which it is located.

Energy and Transportation Science Division's Andre Desjarlais has received the American Society for Testing Materials (ASTM) Award of Merit and the title of Fellow. It is the highest society award granted to an individual member for distinguished service and outstanding participation in ASTM International committee activities.

Energy and Transportation Science Division's Bill Miller, Edgar Stach, and Leon Tolbert, members of the LIVING LIGHT team, recently received the 2012 UT Multidisciplinary Chancellor's Award for creating an energy-efficient, solar-powered home as part of DOE's Solar Decathlon.

Materials Science and Technology Division's Felix Paulauskas received a 2012 DOE Vehicle Technologies Program R&D Award during the DOE Vehicle and Fuel Cell Technologies Annual Merit Review in May in recognition of his significant contribution to plasma oxidation of carbon fiber as an enabler to reduce the cost of this advanced material. Felix, left, accepts the award from Patrick Davis, program manager of DOE's Vehicle Technologies Program.

Congratulations to Biosciences Division's Brian Davison, who has been elected to the Society for Biological Engineering Managing Board.

Hats off to Environmental Sciences Division's Keith Eckerman, who has received the Gold Medal for Radiation Protection of the Royal Swedish Academy of Sciences.

David Greene, Energy and Transportation Science Division, has accepted an appointment to the Transportation Research Board of the National Academies' Special Task Force on Climate Change and Energy, A0020T. The term is for 3 years beginning April 15, 2012.

The Environmental Sciences Division recently announced the following internal awards: Tara Hall, Admin of the Year; Kenneth Lowe, Outstanding Research Support; Xiaojuan Yang, Post-Grad Researcher; Gbadebo Oladosu, Stanley I. Auerbach award. Congratulations!

Jonathan R. Mielenz

Biosciences Division's Jonathan R. Mielenz has been elected to a three-year term as a director for the Society for Industrial Microbiology and Biotechnology. SIMB is a non-profit scientific society, founded in 1949, dedicated to advancement of applied microbiology and biotechnology.

Welcome, Terry Hazen

In late 2011, Terry Hazen began serving as the University of Tennessee–ORNL Governor's Chair for Environmental Biotechnology. The Governor's Chair program, funded by the state of Tennessee and ORNL, attracts top scientists to enhance the unique research partnership that exists between the state's flagship university and the nation's largest multi-program laboratory. An environmental biologist and authority on bioremediation and bioenergy formerly with Lawrence Berkeley National Laboratory, Terry is a fellow of the American Academy of Microbiology and holds patents on 5 bioremediation processes that are being used in 35 states and several countries in Europe and Asia. In 2005, he received the Distinguished Scientist Fellowship award sponsored by DOE's Office of Biological and Environmental Research. Terry currently is a faculty member of the UT College of Engineering civil and environmental engineering department and works closely with UT's Joint Institute for Biological Sciences and the Center for Environmental Biotechnology. Hazen also holds a joint appointment with the microbiology and earth and planetary sciences departments of UT's College of Arts and Sciences.

Terry Hazen

- The Biological and Environmental Research Information System (BERIS) was recognized recently at the Society for Technical Communication 2011–2012 Summit Competition for tools prepared for DOE's Biological and Environmental Research (BER) Program. The technical publication *Grand Challenges for Biological and Environmental Research: A Long-Term Vision* received an Award of Distinction, the highest rating. For online technical communications, the site http://genomicscience.energy.gov/ received the Award of Merit. Congratulations to ORNL BERIS team members involved, including Biosciences Division's Betty Mansfield, Judy Wyrick, Jennifer Bownas, Kris Christen, Holly Haun, and Marissa Mills; Information Technology Services Division's Sheryl Martin; and Creative Media's Brett Hopwood.
- A paper coauthored by Environmental Sciences Division's Annetta Watson and Fredrick Dolislager has been selected as the 2011 Risk Management Paper of the Year by *Human and Ecological Risk Assessment: An International Journal* (HERA). The paper is titled "Developing Health-Based Pre-Planning Clearance Goals for Airport Remediation Following Chemical Terrorist Attack: Decision Criteria for Multipathway Exposure Routes" (HERA, 17(1): 57-121). HERA cited the paper for its "salient management actions should airports experience terrorists' release of toxic substances into airport environments."

ORHS graduate Adam LaClair receives UT-Battelle Scholarship

Adam LaClair, a recent graduate of Oak Ridge High School, is the recipient of the 2012 UT-Battelle Scholarship, a four-year scholarship to the University of Tennessee awarded by the ORNL managing contractor. The $20,000 scholarship, presented annually to a graduating senior with a parent who works at ORNL, is designed for an outstanding student who plans to study science, engineering, or mathematics at UT. Adam plans to major in mathematics or physics and is inspired to pursue a career in medicine. His father, Tim, works in the Center for Transportation Analysis.

Adam LaClair (right), the 2012 UT-Battelle scholar, is congratulated by ORNL Director Thom Mason.

Making Connections

Pictured at left, David Danielson, Assistant Secretary for the DOE Office of Energy Efficiency and Renewable Energy, visited ORNL facilities in March where he received ORNL overviews and toured the Building Technologies Research and Integration Center, the National Transportation Research Center, and the Manufacturing Demonstration Facility. Also pictured, Energy and Environmental Sciences Associate Laboratory Director Martin Keller, center, and Energy and Transportation Science Division's Madhu Chinthavali.

In April and May, ORNL scientists participating in the Next-Generation Ecosystem Experiments (NGEE Arctic) project made several return trips to Barrow, Alaska, the Inupiat Eskimo village located at the northernmost point in the United States, approximately 330 miles north of the Arctic Circle. The trips were their first visit since September. The work included laying out trail mat within sensitive areas of research plots; installing water sampling wells; sampling permafrost soils; geophysical surveys, and other preparations for additional work in Barrow later in the summer. Environmental Sciences Division's Stan Wullschleger, pictured here, is among those who made the journeys. The purpose of NGEE Arctic is to develop a better understanding of Arctic ecosystems with the goal of using that knowledge to improve climate prediction.

US Secretary of Labor Hilda Solis and Jill Biden, wife of Vice President Joe Biden, visited Roane State Community College and toured the Advanced Materials Training and Education Center. ORNL is an active partner with Roane State and AMTEC, which trains individuals for entry-level materials technician jobs in carbon fiber and solar energy industries. Pictured here, ORNL's Connie Jackson (standing at right) addresses Solis and Biden during a panel discussion held during the visit. Connie is operations manager for the Lab's Carbon Fiber Technology Facility and is also an AMTEC volunteer instructor.

ORNL hosted the second annual regional Sustainability Summit at the Conference Center in May. More than 100 representatives from cities, counties, states, universities, industry, and power providers attended. The goal for the Summit was to advance the deployment of sustainable technologies in the Southeast. It covered three major subject areas: low-carbon power generation, sustainable transportation, and energy efficiency in buildings.

ORNL and Virginia Tech have signed a five-year memorandum of understanding to collaborate on wireless communications and cognitive radio research at Virginia Tech. ORNL will be working with Wireless@Virginia Tech, one of the largest university wireless research groups in the United States. The aim of the collaboration is to pursue and execute joint programs in wireless communications and to create joint intellectual property in the form of software, algorithms, and research papers. Special emphasis will be on developing cognitive radio systems, radios that incorporate artificial intelligence into their operation. Seated left to right are Robert Walters, Virginia Tech vice president for research, and Ian Anderson, ORNL director of graduate education and university partnerships. Standing left to right, B.D. Kim, deputy director for high performance computing; Terry Herdman, associate vice-president for research computing; and Bob McGwier, director of research for the Hume Center for National Security and Technology, all of Virginia Tech; Paul Ewing with ORNL's Measurement Science and Systems Engineering Division; Jeffrey H. Reed, director of Wireless@Virginia Tech; and Roop Mahajan, director of Virginia Tech's Institute for Critical Technology and Applied Science.

Curt Maxey

In April, Energy and Transportation Science Division's Curt Maxey attended the ribbon cutting ceremony for the 5 MW West Tennessee Solar Farm near Memphis. Curt served as a technical advisor throughout the project. The solar farm is the largest in the state.

Students and teachers from Fernbank Science Center-LINKS were hosted by Measurement Science and Systems Engineering Division's Lonnie Love for a tour of the Manufacturing Demonstration Facility to learn about additive manufacturing technology and its applications in robotics. LINKS is an aerospace and engineering extension to the Science, Engineering, Mathematics and Aerospace Academy (SEMAA) program for students in grades 9–12 who have been in SEMAA or other programs at Fernbank Science Center.

In April, Energy and Transportation Science Division's Thomas Wenning coordinated an in-plant training event at the Verallia-Saint Gobain glass plant in North Carolina as part of DOE's Better Buildings, Better Plants Program. The program was sponsored by DOE's Advanced Manufacturing Office to help partner companies achieve the energy intensity reduction goal of the BBBP program, which is 25% over ten years. Seventeen individuals from multiple plants and organizations were involved in the event; a core group representing 9 plants received in-depth training over the 3.5 days on process heat systems, data measurement techniques, data processing and analysis, and system energy modeling.

A cooperative research and development agreement has been fully executed with Emerson Climate Technologies for the development of cold-climate heat pump solutions. A team from Emerson visited with the Energy and Transportation Science Division's Building Equipment Research Group to participate in the CRADA project kickoff meeting.

Looking Ahead...

In April, DOE recommended that funding for the BioEnergy Science Center be renewed for five more years. Be sure to watch for the next issue of the EES Quarterly for a look at BESC—the first five years.

In the News...

- Ford and Dow team up to bring low-cost, high-volume carbon fiber composites to next-generation vehicles. Partnership leverages ORNL R&D.
  http://www.bizjournals.com/prnewswire/press_releases/2012/04/12/DE86332

- In February, Aleisa Bloom received the 2012 "Technologist of Distinction" award from the College of Engineering at Tennessee Tech University. Read more about Aleisa and her award.
  http://blogs.knoxnews.com/munger/2012/02/tennessee-tech-honors-ornls-bl.html.

- In late February the article "Downstream mercury in Poplar Creek, Clinch River reflects Y-12 discharges" appeared in the *Knoxville News Sentinel*, including a quote from Mark Peterson.
  http://blogs.knoxnews.com/munger/2012/02/downstream-mercury-in-poplar-c.html.

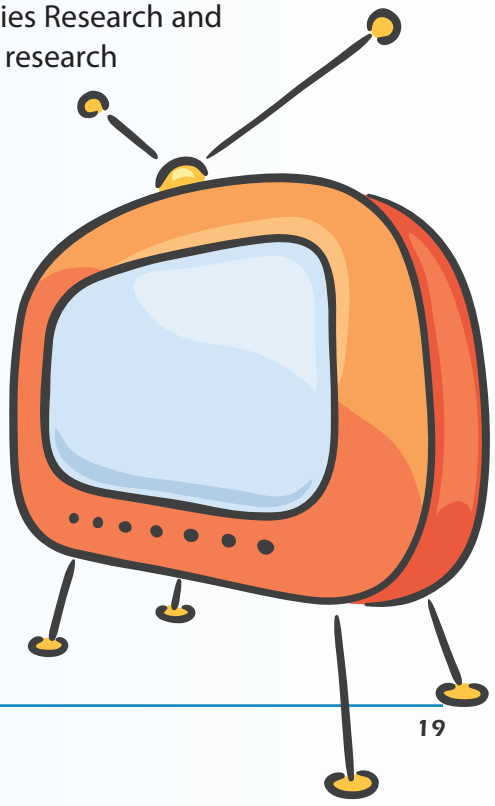
- Terry Hazen's article "Oil Biodegradation and Bioremediation: A Tale of the Two Worst Spills in U.S. History" (coauthored by Ronald M. Atlas) has been selected by *Environmental Science & Technology* as its Best Feature of 2011. http://pubs.acs.org/doi/abs/10.1021/es2013227.

- Energy and Transportation Science Division's John M. Miller is among several researchers interviewed for this *New York Times* article discussing opportunities and challenges to retaining the advantages of permanent-magnet motors while using little or no critical rare earth material.
  http://www.nytimes.com/2012/04/22/automobiles/a-push-to-make-motors-with-fewer-rare-earths.html?_r=2&ref=rareearths

- In March, an article on the Free-Air Carbon Dioxide Enrichment (FACE) Experiment "CO_2 experiment over, but results still coming in" appeared in the *Knoxville News Sentinel*.
  http://www.knoxnews.com/news/2012/mar/14/frank-munger-co2-experiment-over-but-results-in/.

- The Metal Construction Association and ORNL's Building Technologies Research and Integration Center are embarking on the final phase of a multi-year research program to design what might be called the roof of the future.
  http://www.durabilityanddesign.com/news/?fuseaction=view&id=7544

- On March 26 the article "Can ORNL's White Oak Creek be a testbed for mercury problems at Y-12 and East Fork Poplar Creek?" appeared in the *Knoxville News Sentinel* and featured Teresa Mathews.
  http://blogs.knoxnews.com/munger/2012/03/can-ornls-white-oak-creek-be-a.html.



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2. Deliver sustainable transportation solutions
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4. Advance understanding of climate change impacts
5. Invigorate science through graduate research and education
6. Scale computing, data infrastructure, and analysis for science
7. Discover and demonstrate advanced materials for energy applications
8. Advance the scientific basis for breakthrough nuclear technologies and systems
9. Achieve breakthroughs in biomass production and conversion for energy and materials

ORNL 2012 Laboratory Agenda
Science & Technology Initiatives