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Message from Martin

2011 was an exciting and successful year for the newly-formed Energy and Environmental Sciences Directorate. Over the course of a single year we formed a cohesive and highly-integrated organization that had great success in positioning the directorate for the future and generating impactful breakthroughs in many of ORNL's science initiatives.

EESD set the stage for delivering on sustainable transportation and advanced manufacturing by constructing the National Transportation Research Center expansion (NTRC-2). In a single year we went from a graded surface to an operating facility that now houses our new Manufacturing Demonstration Facility in addition to areas for transportation materials research, robotics, and office space. The fast and safe stand-up of this facility showcases our ability to work in a collaborative manner across organizations to get things done.

The Directorate continues to advance the understanding of climate change impacts by establishing the Climate Change Science Institute. The Next Generation Ecosystem Experiment (NGEE) Project demonstrated science leadership in assembling a diverse science team to study interactions that drive ecosystem-climate feedbacks through greenhouse gas fluxes and changes in subsurface energy balance in the Arctic.

BioEnergy Science Center researchers genetically modified switchgrass, which has been shown to produce up to one-third more ethanol fuel than the wild type. This series of collaborative experiments shows conclusively that we have the tools to overcome the recalcitrance of plants and produce more economically priced cellulosic biofuels. Furthermore, the team submitted an impressive proposal for a five-year renewal that would extend their activities from the most basic research of plant and microbial interactions through to commercial pilot scale testing of improved feedstocks.

2012 looks to be a challenging year as we face the effects of last year's voluntary separations and ongoing budget pressures. However, we are poised to deliver impactful science to the community through scientific collaborations, publications, and inventions. I encourage everyone to stay focused on the exceptional opportunities that lie ahead and to join me in celebrating our successes.

-- Martin

ORNL expands capabilities on NTRC campus

A second building on the National Transportation Research Center campus is opening its doors to innovation and partnership growth in several technology areas.

Advanced transportation and manufacturing research facilities are quickly filling 30,000 square feet of laboratory space inside the new NTRC-2, while drawing industry's attention and commitment to participate in research activities.

NTRC campus continues on page 4.

In the Spotlight

Alex Johs, Environmental Sciences Division, is using his background in biochemistry and biophysics to determine changes in permafrost soil as temperatures in the Arctic rise. He's conducting neutron measurements for the Next-Generation Ecosystems Experiments project that will support the development of high-resolution models to predict feedbacks of the Arctic ecosystem to a changing climate.

"As a biophysicist I'm working at the interface between biology, physics, and chemistry. I'm interested in fundamental principles that determine complex physical and biological processes in our environment. I believe that understanding mechanisms at a molecular scale can help us make the right decisions at larger scales."

The NGEE seeks to improve understanding of ecosystem–climate interactions in the Arctic and improve the way computer modeling represents those interactions. NGEE researchers are studying how permafrost degradation will affect the climate system.

Permafrost covers about 25% of Earth's surface and stores immense amounts of carbon—twice the amount in the atmosphere. Scientists think that as it thaws, microbes may degrade the stored carbon, releasing more greenhouse gases that will exacerbate warming. The distribution of water and solutes in the permafrost, and in the "active layer" of thawing soil where microbes are more active, is key to the biogeochemical behavior of the soils and their response to warming.

"Since neutrons are extremely good at detecting hydrogen and certain metal ions, we investigate the underlying mechanisms of the freeze/thaw process using neutron imaging. The first data sets of our proof-of-principle experiment show that slow freezing results in preferential accumulation of solutes at interfaces. These findings are consistent with the concept of brine pockets that may harbor nutrients in permafrost, supporting microbes at subzero temperatures."

In other projects, Alex is investigating mechanisms of mercury transformation in the environment, specifically, enzymes that are highly specialized for handling toxic mercury species. He uses neutrons as a tool to study the structure and function of these biological macromolecules. He also recently began work on a new Laboratory Directed R&D project developing lignin-based materials for energy storage.

Alex has a Ph.D. in biophysics from the Austrian Academy of Sciences and Graz University of Technology and an MSc in biochemistry and biotechnology from Graz. He's been at ORNL since 2007.

Alex Johs

Capturing biomass supply chain on film

ORNL employees recently assisted the DOE Office of Energy Efficiency and Renewable Energy in producing footage on biomass supply and logistics in East Tennessee for a DOE-EERE informational video. Environmental Sciences Division's Laurence Eaton helped coordinate a number of shots in the area, including working with Elliott Barnett, Utilities Division, to capture footage of the ORNL steam plant and biomass delivery.

Filming inside the ORNL biomass fuel storage building

ORNL teams with industry in advanced manufacturing initiative

ORNL and the lab's industrial partners have come together in a big way, showing tremendous response to the DOE Industrial Technologies Program's call for proposals in advanced manufacturing. With its industrial partners, the lab has submitted 58 concept papers and has partnered with industry on another 77 concept papers in response to the initiative. ITP expects up to $120 million will be available over three years to develop transformational manufacturing technologies and innovative materials to reduce time, cost, and energy requirements associated with manufacturing, with $25 million in funding available in FY 2012. Awards notifications are expected to begin in January 2012.

Conceptual design of ITER diagnostic technology approved

ORNL researchers and collaborators from UCLA, Princeton Plasma Physics Laboratory, and the ITER Diagnostic Group received approval this summer from an international design review board for their conceptual design of a low field side reflectometer for ITER. A first-of-a-kind global collaboration, ITER will be the world's largest experimental facility designed to demonstrate the scientific and technological feasibility of fusion, the process that powers the sun and stars.

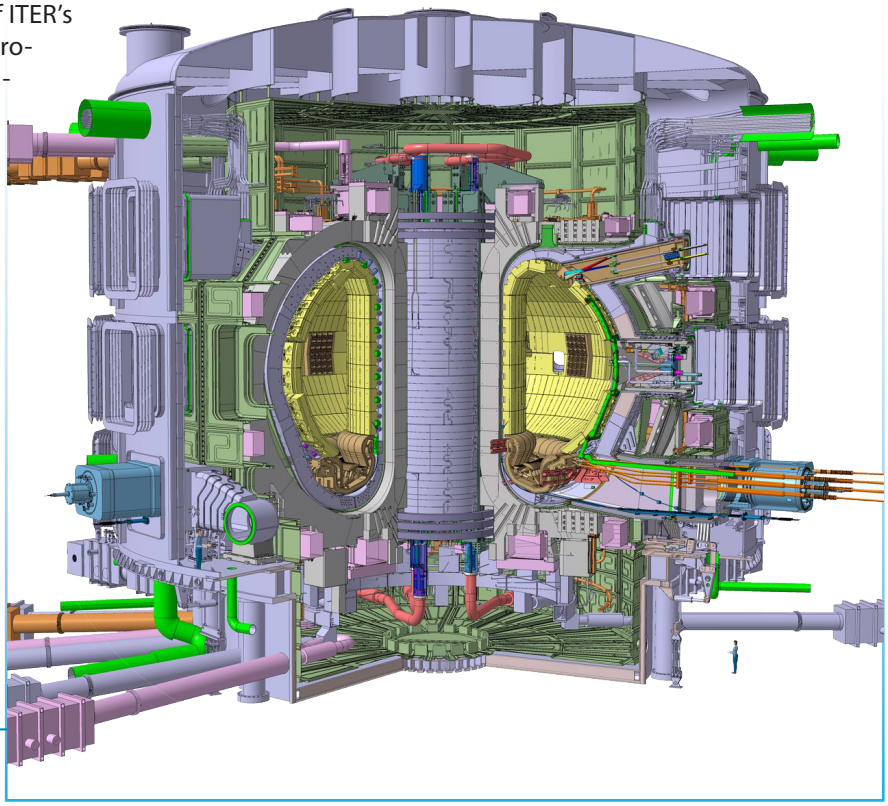
Team member Greg Hanson, Measurement Science and Systems Engineering Division, explained that of ITER's four separate reflectometry systems, the LFSR will provide most of the reflectometry data for physics studies and be part of an extensive diagnostic system that provides the measurements necessary to control, evaluate, and optimize plasma performance inside ITER.

"Reflectometry will be used to measure the density profile and fluctuation characteristics of electrons in the plasma. Microwaves or millimeter waves are launched at the plasma then reflected from it at a specific density for each frequency," Greg said, adding, "The phase of the reflected signal is then used to calculate the location of the reflection, which helps reveal the electron density profile and fluctuation characteristics."

The ITER design review board, which included reflectometry experts from Germany, France, Portugal, and Russia, generated only two Class 1 chits—design issues that must be resolved before the design can proceed to the next phase. According to Greg, both chits have already been resolved.

Twenty-three Class 2 chits were also submitted, noting issues that are significant enough to require formal tracking and resolution during the next design phase that culminates in the preliminary design review two years from now.

Currently being constructed in Cadarache, France, ITER facilities are projected to be operational by late 2019.



The ITER machine is based on the tokamak concept of magnetic plasma confinement, in which the fusion fuel is contained in a doughnut-shaped vessel. With a height of 29 meters and a diameter of 28 meters, ITER will be the world's largest tokamak.
© ITER Organization

ORNL expands capabilities on NTRC campus (continued from p.1)

"The addition of NTRC-2 reflects the success of earlier strategies," said Associate Laboratory Director Martin Keller, Energy and Environmental Sciences Directorate. "We've learned that co-locating ORNL capabilities creates synergies that have benefitted and continue to benefit the transportation sector and will now support the advancement of other manufacturing industries."

Since 2000, about half of ORNL transportation research has been conducted at NTRC by the Energy and Transportation Science Division's Fuels, Engines, and Emissions Research Center, Advanced Power Electronics and Electric Machines Research Group, and Center for Transportation Analysis; and the Global Nuclear Security Division's Packaging Research Facility. Many of these help constitute the NTRC User Program.

This past summer, the Transportation Analysis and Visualization Laboratory (TRAVL) became the first new capability to go live inside NTRC-2. TRAVL is a state-of-the-art, 32-seat facility designed to showcase ORNL-developed transportation energy modeling and simulation tools. Managed by ETSD's Center for Transportation Analysis, TRAVL features a 15x high-definition LCD Video Wall that accommodates simultaneous display of up to 40 high-definition sources. With processing power for multi-HD 3D graphics, the system facilitates researchers' requirements for the most advanced real-time simulation modeling collaborations and sharing of science-based applications. The entire system, including room lighting and audio, operates via a custom touch-controlled iPad application.

Supporting revitalization of the nation's manufacturing industries and the development of new products in emerging industries, NTRC-2's advanced manufacturing laboratories concentrate on materials and processing innovations in energy storage, additive manufacturing, and advanced robotics. Measurement Science and Systems Engineering Division staff are leading robotics efforts focused on fluid-powered systems, from large multi-ton material handling equipment to very small biomedical devices. Additive manufacturing capabilities led by Materials Science and Technology Division researchers are helping redefine how robotic systems are designed and manufactured.

TRAVL provides staff and users the ability to showcase ORNL-developed modeling and simulation tools. TRAVL is managed by the Center for Transportation Analysis.

Both groups are working together with several additive manufacturing companies to develop next-generation additive manufacturing systems, consumables, and application concepts.

New battery cell manufacturing R&D facilities with a dual dry room operation, staffed by MSTD and ETSD, complement ORNL's existing energy storage concentration on materials testing and characterization. Housing equipment for nondestructive evaluations and inline quality control, the lab's focus includes developing and refining new technologies for materials processing and battery assembly to innovate manufacturing procedures.

Scheduled to be operational by late spring 2012, the Vehicle Systems Integration laboratory will capitalize on ORNL's existing core vehicle research competencies to enable fully-integrated, system-level research of advanced combustion, electric drivetrain, controls, and fuel technologies within applicable emissions constraints. Equipped for light-, medium-, and heavy-duty powertrain architectures, the VSI lab will help deepen understanding of advanced transportation technologies operating under real-world conditions to reveal vehicle efficiency and emissions improvement opportunities. VSI will be managed by ETSD.

With the addition of advanced manufacturing research teams, approximately 220 ORNL employees representing the EES, Physical Sciences, Nuclear Science and Engineering, and Computing and Computational Sciences Directorates are based at the NTRC campus, located just off Hardin Valley Road in the Pellissippi Corporate Center.

"We've learned that co-locating ORNL capabilities creates synergies that have benefitted and continue to benefit the transportation sector and will now support the advancement of other manufacturing industries."

Additive manufacturing and robotics platform in the new manufacturing demonstration facility.

DOE's Sharlene Weatherwax, Associate Director of Science for the Office of Biological and Environmental Research, is one of many recent visitors to the new NTRC-2. Here she is briefed by Claus Daniel, deputy director of the Sustainable Transportation Program, while touring the battery cell manufacturing facilities.

ORNL reports environmentally safe destruction of lethal chemical weapons

The US Army Chemical Materials Agency has published a report written by ORNL researchers supporting its Record of Environmental Consideration for the continued operation of the Anniston Chemical Agent Disposal Facility (ANCDF), located at the Anniston Army Depot in Alabama.

Environmental Sciences Division's Greg Zimmerman and Harry Quarles authored the report that updates information on existing environmental conditions near ANCDF and evaluates the potential environmental impacts of continued operations. ANCDF's mission is to destroy the depot's inventory of lethal chemical weapons by the end of 2011.

To date, the Army's Chemical Stockpile Disposal Program has successfully destroyed 90% of the 31,000 tons of lethal chemical warfare agents in the US inventory. The environmental reviews conducted by ESD staff have allowed the Army to execute the destruction operations with the appropriate level of environmental protection and in concert with the provisions of the National Environmental Policy Act.

Environmental effects of hydrokinetic technologies studied

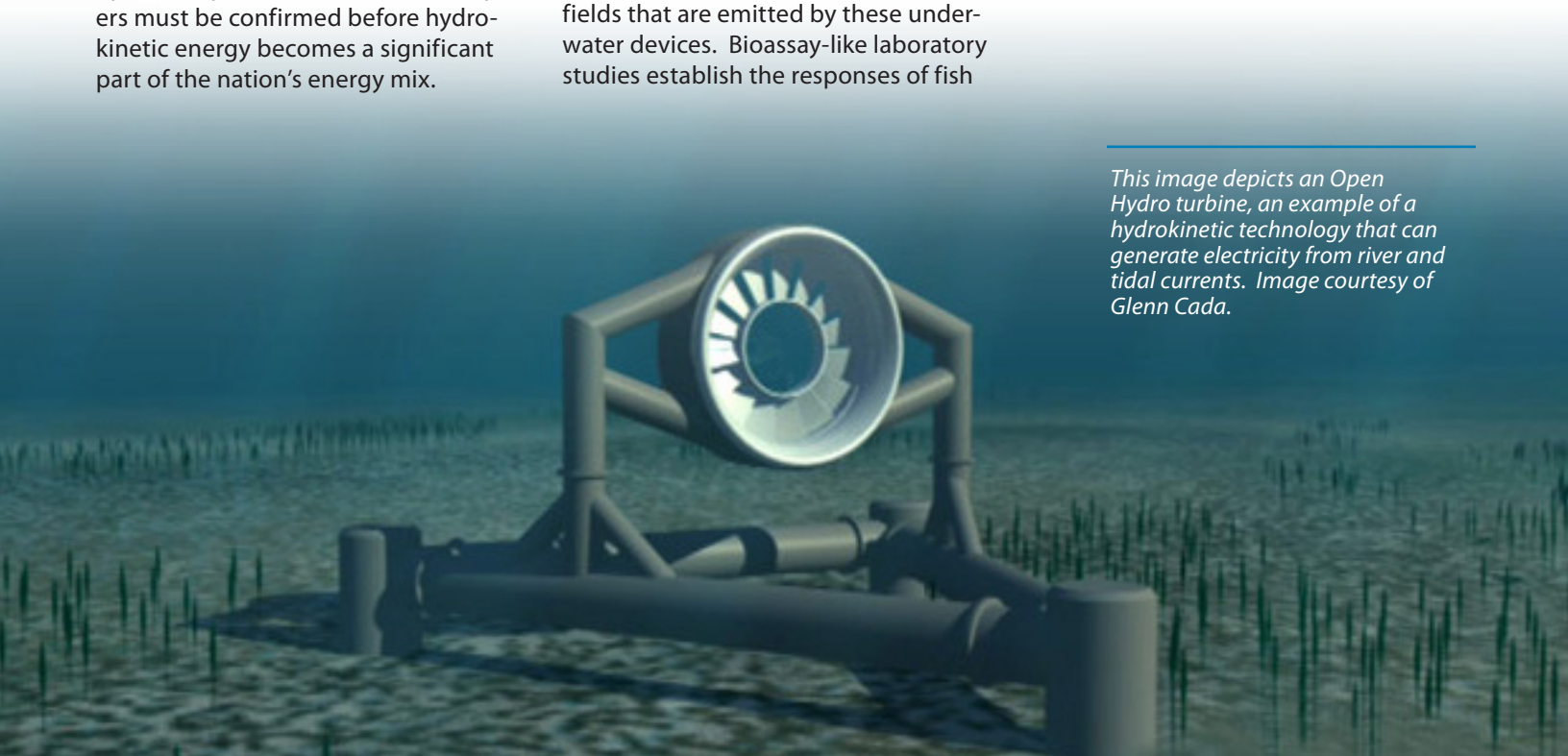
Picture hundreds of turbines spinning unseen below the surface of the Mississippi River, generating vast amounts of clean, renewable energy.

This is the dream of developers of hydrokinetic energy projects. These dam-free hydropower technologies promise to generate electricity from the movements of river currents, without obstructing navigation, recreation, and fish migration and with few of the environmental impacts associated with other energy technologies. However, as with all new technologies, there are unknowns; and the optimistic predictions of the developers must be confirmed before hydrokinetic energy becomes a significant part of the nation's energy mix.

With the support of DOE's Water Power Program, technological and environmental constraints on the deployment of these technologies are being resolved. For example, researchers in ORNL's Environmental Sciences Division are midway through a series of laboratory and field studies of the environmental issues that have concerned the regulatory and resource agencies that must approve the deployment of hydrokinetic projects.

Mark Bevelhimer of ESD leads a research program that includes studies of impacts to fish by turbine blade strikes and the noises and electromagnetic fields that are emitted by these underwater devices. Bioassay-like laboratory studies establish the responses of fish and other aquatic organisms to the new stressors, and the subsequent predictions of impacts (or lack thereof) are verified by field studies in the large rivers where the new hydrokinetic devices are being tested.

The results of the ongoing ORNL studies are finding their way into the peer-reviewed literature, and the technical reports are immediately made available to the public at ORNL's Wind and Water Power Technologies website: http://www.esd.ornl.gov/WindWaterPower/FactSheets.shtml



This image depicts an Open Hydro turbine, an example of a hydrokinetic technology that can generate electricity from river and tidal currents. Image courtesy of Glenn Cada.

Arctic experience connects researcher and young students

Third grade students at Karns Elementary School had a magical experience this fall when Environmental Sciences Division's Stan Wullschleger blogged with them for several days about his experiences with plants and animals in the high Arctic.

The project on which Stan and his colleagues were engaged is part of the Next-Generation Ecosystem Experiments, focused on developing a high-resolution, process-rich model of Arctic ecosystems that can simulate high-latitude landscapes in a changing climate. This effort will advance climate model development for use at regional and global scales.

Stan made the contact through his wife, who works at Karns Elementary. "She was approached by a third grade teacher, who asked if I could help her with teaching kids about plants and animals in unique ecosystems. This evolved into my offering to set up a blog so that I could interact with her students during my trip. I also met with a third grade class in Barrow, Alaska, and have been sharing with them as well. Now the two classes are interacting."

In one blog post to the Karns students, Stan wrote, "Yesterday was a great day to get an introduction to what it will be like to be a scientist in Barrow. We worked a long day in cold, windy, and snowy weather. Ground that was soft and spongy just a few days ago has now frozen. We walked on boardwalks and matted trail to protect fragile tundra, but were able to complete much of our sampling without any disturbance to the tundra.

"We collected soil samples and put them in small containers so we can analyze them later in the laboratory. We stored them in a cooler, but then found out that we had no refrigerator to get them cold. What do you think we did to keep them cold? Can you think like a scientist?"

Stan holds a drawing of an Arctic fox, one of many pictures and thank-you notes he received from Karns Elementary School third-graders.

Stan said there are two take-home messages for the Karns students. "The first is that unique environments require unique adaptations by plants and animals in order to survive cold winters and short growing seasons," he said. The second message is that people are the same wherever they live. "Kids in Alaska study hard and enjoy recess and playing the same games as kids in East Tennessee even when temperatures are well below zero."

ORNL aboard Coast Guard project

ORNL researchers are helping guide the United States Coast Guard (USCG) through uncharted waters. Applying expertise in fuels and engines research, the lab is supporting the military organization's new mandate to increase the use of alternative fuels in their marine fleet.

"The Coast Guard has decided to use biobutanol rather than ethanol to mix with gasoline in their smaller craft, and biodiesel rather than petroleum diesel in their larger engines," explained Energy and Transportation Science Division's Tim Theiss, group leader with the Fuels, Engines, and Emissions Research Center. Tim and ETSD's Jim Szybist and Brian West are serving as subject matter experts on the three-year project led by USCG Research and Development Center with the marine engine manufacturers Mercury, Honda, and Cummins, and implementation partners.

Until now, ORNL fuels and engines research projects have concentrated primarily on "dry land" transportation applications powered by gas, diesel, and ethanol blends. In addition to evaluating biodiesel, the USCG project concentrates on the performance benefits of using butanol in gas engines.

"Butanol does not mix with water as much as ethanol does, which makes it preferable to the Coast Guard for marine applications," explained Tim. The project also explores the maximum acceptable level of these renewable fuels with the marine engines and infrastructure materials while operating in a saltwater environment.

One of five armed forces of the United States and the only military organization within the Department of Homeland Security, the USCG has safeguarded America's maritime interests and environment around the world since 1790.

Defusing black carbon's role in Arctic warming

Black carbon is a powerful contributor to Arctic warming and the arduous target of a new ORNL research project aimed at reducing emissions in Russia and bordering regions.

Produced through incomplete combustion of fossil fuels, biofuels, and biomass, black carbon could deliver significant damage to the climate over a brief period of time. Compared to the same mass of carbon dioxide, it remains in the atmosphere 30 days versus 100 years and generates heat while absorbing approximately 1000 times more infrared light. Black carbon particles that land on snowpack also absorb infrared light, which can cause ice melting.

"Because black carbon is powerful yet short-lived, reducing emissions could almost immediately mitigate climate changes," said Energy and Transportation Science Division's John Storey. Over the next two years, John and ETSD's Teresa Barone, Environmental Sciences Division's Meng-Dawn Cheng, and the University of Tennessee's Joshua Fu will be researching black carbon sources emissions, tracking, and opportunities to improve technologies, including inefficient Soviet-era district heating systems that warm many Russian homes and worksites. As of 2008, approximately 40,000 municipalities in Russia had such heating systems that were in need of repair.

"We will use available pollution data and ORNL modeling tools to map the sources and establish an inventory that also includes estimated emissions and the combustion and emissions control technologies currently used," said John. With the information, the researchers will identify a subset of sources and locations for demonstrating emissions reduction technologies, such as state-of-the-art combined heat and power systems. Demonstration sites will depend on both the site's degree of opportunity to reduce emissions and the level of government and public/private party willingness and financial support.

To ensure that lessons learned throughout the project activities are disseminated broadly in Russia and surrounding countries, outreach and education will be critical and will include the development of a global network of experts. Through the network, John explained, experts will be able to share best practices for identifying black carbon sources, developing or enhancing inventories, and identifying the appropriate technology to mitigate the sources. A workshop in January 2012 is being planned for networking and exchange of technical information.

ORNL efforts represent one-third of a larger Global Superior Energy Performance Partnership project supported by the State Department that also involves the Environmental Protection Agency and the United States Forest Service. Representing GSEP's Combined Heating & Power and Efficient District Heating & Cooling Working Group, ORNL researchers will coordinate with EPA and USFS efforts related

to other key black carbon sources—diesel engines and forest/agricultural burning.

Launched in 2010 by Secretary of Energy Steven Chu, GSEP was established to reduce global energy use by encouraging industrial facilities and commercial buildings to pursue continuous improvements in energy efficiency, and promoting public-private partnerships for cooperation on specific technologies or in individual energyintensive sectors. Governments participating in GSEP include Canada, Denmark, the European Commission, Finland, France, India, Japan, Korea, Mexico, Russia, South Africa, Sweden, and the United States.

In many areas of Russia, aging inefficient heating systems release black carbon into the atmosphere.

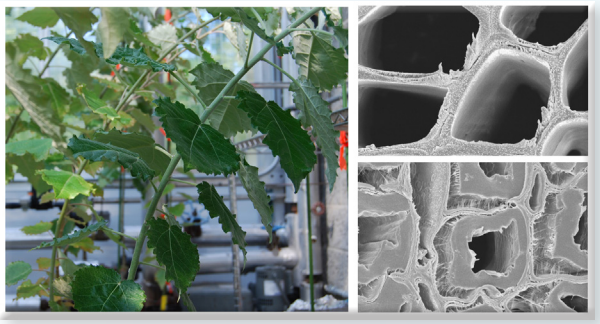
Tension wood holds clues to higher fuel yields from biomass crops

The properties that enable trees to flex in the wind might also prove useful in designing better biomass crops. Researchers at the BioEnergy Science Center at ORNL are studying those properties to understand how they affect the release of plant sugars that become biofuels.

Tension wood forms in broadleaf woody plants in response to bending stresses. It has several features desirable in biomass, including higher amounts of fiber, less lignin, thicker cell walls, and more crystalline forms of cellulose, the sugar that ferments into ethanol and other transportation fuels. Previous studies have focused on individual features of tension wood, but the BESC team is the first to characterize comprehensively the gene expression and protein networks that come into play during tension wood formation.

"Tension wood in poplar trees has a special type of cell wall that is of interest because it is composed of more than 90% cellulose, whereas typical woody biomass is composed of 40 to 55% cellulose," said team member Udaya Kalluri of the Biosciences Division. "If you increase the cellulose in your feedstock material, then you can potentially extract more sugars." The team is extending its study of tension wood to the molecular level and hopes to reveal the genetic basis of the desirable physical features.

The work is supported by the DOE Office of Science. The team also includes Sara Jawdy and Gerald Tuskan of Biosciences Division; Marcus Foston, Chris Hubbell, Reichel Samuel, Seokwon Jung, and Hu Fan of Georgia Tech; and Robert Sykes Shi-You Ding, Yining Zeng, Erica Gjersing, and Mark Davis of the National Renewable Energy Laboratory.



Poplar stems (left) respond to bending stress by producing tension wood, which has characteristics desirable in a bioenergy feedstock. Electron micrographs from a comprehensive BESC study reveal how tension wood (bottom right) develops a secondary cell wall layer, in contrast to normal wood (top right).

Future US electric grid designers and engineers work with ORNL researchers

2011 GIL Fellows represented the University of Tennessee, University of South Carolina, North Carolina State, Georgia Tech, and Florida State. Several are pictured here with ORNL's Jim Roberto, far left, and Terry Payne, far right.

The ORNL Grid Innovation Leaders (GIL) Fellowship Program is building research partnerships with select universities that have an interest in and capabilities for developing the electric grid of the future. The program has two major components: facilitating ORNL participation in key industry/university consortia and facilitating electric-grid research collaborations between ORNL and key universities.

A major element of the latter is the assignment of GIL Fellows to work with ORNL researchers developing technologies germane to the future electric grid. GIL Fellows are drawn from students pursuing research-based degrees in disciplines related to the electrical power delivery system. During their time at ORNL, they work on research projects with ORNL mentors, attend seminars on topics relevant to the electric grid of the future, and tour electric research facilities. The aim is to offer a multi-university environment for training the workforce needed to ensure that the US power system can satisfy changing energy needs.

The current GIL Fellows have attended eight seminars conducted by ORNL and university researchers, including transmission planning, energy data management, energy use in the South, use of electric vehicle batteries, integrating renewable energy into the grid, and grid security. They have toured the Knoxville Utilities Board electricity distribution center, the Tennessee Valley Authority operations center, and the Raccoon Mountain Pumped Water Storage Plant.

The Fellowship is for a maximum of one year and is open to any US citizen, national, or permanent resident who has a bachelor's degree in a science, technology, or mathematics field and is enrolled in a graduate program in a power systems engineering discipline (e.g., electrical engineering, power engineering, controls systems engineering, computer engineering). For more information, contact Terry Payne at ORNL via email (preferred) at paynetl@ornl.gov or 865-425-6485.

Detecting energy savings hiding in plain sight

Sensor technology for wirelessly gathering basic information in commercial buildings is clearing a path to significant energy savings.

Sponsored by DOE's Building Technologies Program, ORNL and Pacific Northwest National Laboratory researchers have developed and demonstrated the feasibility of a low-cost wireless sensor system that can quickly notify building owners of problems or opportunities to optimize building energy use.

"The system has the potential to overcome two problems," said Measurement Science and Systems Engineering Division's Peter Fuhr, "the high cost of diagnosing building energy losses and equipment inefficiencies, and the tendency to do nothing until absolutely necessary." Today, Peter explained, commissioning, retro-commissioning, and continuous commissioning are common building maintenance strategies. Each can be very expensive, especially if maintenance is neglected until something breaks.

To speed detection of energy saving opportunities, researchers created a portable "suitcase" of technologies containing ORNL wireless sensors developed under the DOE Industrial Technologies Program for harsh industrial environments. At about a tenth of the cost of current commercial offerings, the wireless sensors measure parameters such as temperature, humidity, CO_2 concentration, lighting level, and power. The suitcase also contains network communication architecture and a laptop interface that is easily deployable in commercial buildings at a fraction of the cost of other building energy management systems.

In June 2011, ORNL deployed the suitcase at the Alcoa Warrick, Indiana, aluminum production facility. Conducting tests over a three day period, the team successfully demonstrated the feasibility of the low-cost wireless system for building energy management.

According to Alcoa's Ray Chatfield, Alcoa World Alumina Global Energy Management, "These inexpensive DOE-ORNL sensors were up and operational within 30 minutes. We were taking energy-related measurements on the other side of the plant in an electrical substation then relaying the readings across the plant within an hour. This demonstration shows that wireless sensors for energy measurements can be inexpensive, quick to deploy, and work in tough environments."

In addition to Peter Fuhr, ORNL researchers involved in the project include Computational Sciences and Engineering Division's Ken Woodworth, MSSED's David Fugate, and Energy and Transportation Science Division's Nasr Alkadi.

ORNL wireless sensor suitcase used to demonstrate wireless capability in the Alcoa manufacturing plant.

Nasr Alkadi beside an ORNL-deployed wireless sensor module in the Alcoa manufacturing plant.

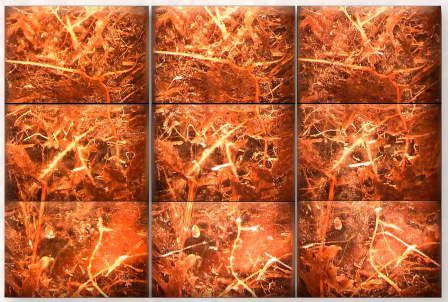
Tiny cameras spy on plant roots in wetlands

Tiny video cameras aimed at plant root systems will help researchers study how wetland plants respond to rising temperatures and CO_2 levels. The cameras, called minirhizotrons, allow observation of living roots in the soil without harming the plants.

"One of the benefits of minirhizotron technology is the ability to track the birth and death of individual roots," said Colleen Iversen of the Environmental Sciences Division. Fine roots, which plants use to take up water and nutrients, are key to plant survival in wetlands where a large amount of carbon is stored deep in the soil but where there are limited nutrients available for plant uptake.

In a multi-year experiment called SPRUCE (Spruce and Peatland Responses Under Climatic and Environmental Change), researchers will place the minirhizotrons in a bog in Minnesota to study the fine roots. Large chambers encompassing the trees, shrubs, sedges, and moss in the bog will allow the scientists to manipulate soil and air temperatures and CO_2 levels and measure the responses of the plant community, both above- and belowground, to changing environmental conditions.

Bogs and other wetland ecosystems cover only about 3% of global land mass but store nearly a third of the terrestrial carbon. If temperatures continue to rise and bogs dry out, increased microbial decomposition could release massive amounts of CO_2 into the atmosphere, triggering even more rapid warming.



Imaged by minirhizotrons, or mini underground cameras, these photos show root growth over a series of three weekly measurements in the summer of 2011 (from left to right) and also show changes in root distribution with peat depth (from top to bottom).

The research was funded by the DOE Office of Science and the New Phytologist Trust. In addition to Iversen and Joanne Childs of ESD, the research team included M.T. Murphy, McGill University; M.F. Allen, University of California–Riverside; D.M. Eissenstat, Penn State; E.A. Lilleskov, US Department of Agriculture Forest Service; T.M. Sarjala, Finnish Forest Research Institute; V.L. Sloan, University of Sheffield; and P.F. Sullivan, University of Alaska–Anchorage.

They creep, they rotate, they jump: Study tracks how atoms move inside proteins

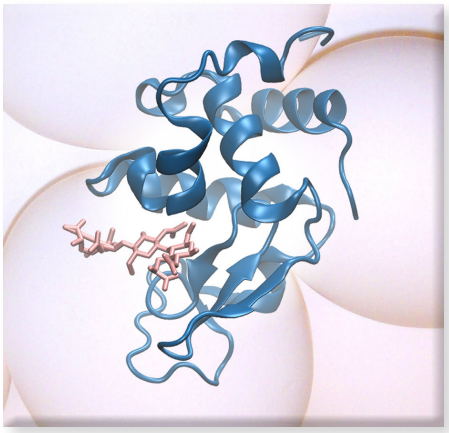
Researchers have long known that the atoms inside protein molecules move, but they couldn't see what form the motion takes. Now research conducted at ORNL's neutron scattering and computing facilities has classified the motions into three distinct classes—localized diffusion, methyl group rotations, and jumps.

Defining the atomic-level motions that underpin protein functioning will guide scientists as they explore how the motions determine the functions of proteins. The ORNL–University of Tennessee research team was directed by Governor's Chair scholars Jeremy Smith, Biosciences Division, and Alexei Sokolov, Chemical Sciences Division.

The team analyzed the protein lysozyme, a natural antibacterial enzyme found in tears and saliva. They expect the combined simulation and neutron scattering approach they used to have a wide impact in the neutron scattering community, aiding research in areas such as biofuels and environmental cleanup and on nonbiological materials such as polymers.

"The analysis and interpretation of neutron scattering spectra are always difficult for complex molecules such as proteins," said Smith, director of ORNL's Center for Molecular Biophysics. "We've performed experiments and then shown that simulation can provide a clear view of them. It allows us to see through the complexity and find out what motions are going on. First, we found that experiment and simulation agreed perfectly with each other, which is remarkable. Second, the simulations told us that this type of neutron scattering can be interpreted in a very simple way."

The research was conducted by Liang Hong, with support from Benjamin Lindner and Nikolai Smolin, all of BSD. Neutron scattering experiments were conducted at the BASIS instrument at the Spallation Neutron Source and at NIST.



Lysozyme (shown in blue)—a natural enzyme found in tears, saliva and egg whites—can break down bacterial cell walls (shown in pink). ORNL researchers have combined computational simulation and neutron experiments to clarify the complicated motions of proteins such as lysozyme into three distinct classes.

Making Connections

ORNL recently hosted a field day at the University of Tennessee Arboretum to foster information exchange about the BioBaler harvesting system. In a single pass with a single operator, the BioBaler can cut and compact biomass into a dense round bale. The bales can then be transported to a power plant or other facility for processing into fuel.

Demonstration attendees included more than 40 state, federal, and private industry representatives interested in economical ways of converting woody products into biomass fuel. ORNL, UT, USDA Forest Service, Tennessee Division of Forestry, Genera Energy, and Domtar Paper representatives were on hand, as well as staff from BioBaler manufacturer, the Anderson Group.

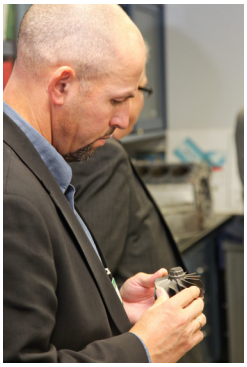
In late September, Energy and Transportation Science Division's Michaela Martin, Deputy Director of the US–China Clean Energy Research Center for Building Energy Efficiency, attended the CERC Steering Committee Meeting in Beijing, China. The steering committee meeting was led by Energy Secretary Steve Chu and the Chinese Minister of Science and Technology Wan Gang. Michaela provided a brief overview of CERC-BEE activities to the steering committee attendees and recognized contributions of industry partners Dow Chemical, Saint Gobain, ClimateMaster, Bentley, Honeywell, and Schneider Electric.

Energy and Transportation Science Division's Burak Ozpineci discusses ORNL's power electronics and electric machinery research with Patricia Hoffman, Assistant Secretary for the DOE Office of Electricity Delivery and Energy Reliability, who visited ORNL facilities in October.

In late October, Energy and Transportation Science Division's Claus Daniel and Materials Science and Technology Division's David Wood attended the dedication ceremony for Dow Kokam's new state-of-the-art Global Research and Development Center for prototype-to-production lithium-ion battery technology. Located in Lee's Summit, Missouri, the facility is designed to provide customers with cutting-edge energy storage solutions for transportation, stationary, and defense applications. Media coverage for the event reinforced the roles of DOE and ORNL in the company's research and development strategy. In an official press release marking the facility opening, Dow Kokam Vice President of Technology Joon Kim is quoted as follows: "The support from partners like the DOE and ORNL reinforces the strength of Dow Kokam's R&D strategy focused on leading edge flexible energy storage solutions that meet the unique needs of a wide range of industries. The market is rapidly expanding, and the demand for advanced battery solutions is growing; our collaboration with the US government and technology institutions is an essential complement to our in-house R&D capabilities."

Inside dry room at Dow Kokam's new Global Research and Development Center.

Energy and Transportation Science Division's Pat Love and Tracie Curtright staffed the Building America booth at the 2011 Greenbuild International Expo in Toronto in October. Greenbuild showcases the latest in innovative products and services, exemplifying the idea of utilizing green to grow business to attendees from around the world.



ORNL hosted a meeting of the 21st Century Truck Partnership, which includes both Federal and private sector representatives. Topics on the agenda included a Partnership business meeting, the High Temperature Materials Laboratory, Spallation Neutron Source, manufacturing science, carbon fiber and composite material technologies, power electronics, fuels and engines, and transportation systems and analysis.

ORNL hosted DOE's Vehicle Technologies Program FY 2012 Kickoff Meeting for Advanced Power Electronics and Electric Motors R&D in November. Approximately 100 representatives from universities, industry, and national laboratories performing research and development for the Vehicle Technologies APEEM Program attended the invitation-only meeting.

Energy and Transportation Science Division's Thomas Wenning organized and hosted DOE's annual Industrial Assessment Center (IAC) Program's Lead Student Meeting held in Chicago, in conjunction with the Association of Energy Engineers' World Energy Engineering Congress. Student representatives from 27 IACs were in attendance. The two-day meeting included presentations and discussions by DOE employees, prominent energy organizations, students, and numerous industry representatives. The meeting provided students with program highlights, technical training, and networking events with industry. Presentations from the meeting can be found at the IAC forum website (www.iacforum.org).

A workshop on "The Billion Ton Study: What can be Learned about Bioenergy Sustainability?" was hosted by ORNL in late September. It included field trips to the National Transportation Research Center, switchgrass energy crop sites, and the Genera Energy, LLC, Biomass Innovation Park. Presentations and other information about the workshop can be found at http://www.ornl.gov/sci/ees/cbes/workshop.shtml.

Employee Excellence

John M. Miller

Energy and Transportation Science Division's John M. Miller, with the Power Electronics and Electrical Power Systems Research Center, has attained the prestigious distinction of Fellow from the Society of Automobile Engineers. Fellowship status is the highest grade of membership bestowed by SAE International. It recognizes outstanding engineering and scientific accomplishments by an individual that have resulted in meaningful advances in automotive, aerospace, and commercial-vehicle technology.

Congratulations to Energy and Transportation Science Division's Joanna McFarlane, whose chapter, "Processing of Soybean Oil into Fuels," was published in the book entitled, *Recent Trends for Enhancing the Diversity and Quality of Soybean Products*, editor Dora Krezhova, ISBN 978-953-307-533-4.

Postdoctoral Fellow Xiaojuan Yang, Environmental Sciences Division, received honors for her poster at the 27th New Phytologist Symposium, "Stoichiometric Flexibility in Terrestrial Ecosystems under Global Change," held at Biosphere 2, in Oracle, AZ. The title of her poster is "C:N:P stoichiometry in soil organic matter: A synthesis of soil phosphorus data using Hedley fractionation method."

A cross-directorate project, "White Light Produced by a Scalable Biosynthesized Zinc Gallate Mixture," received the Best Seed Money Fund Poster Award at the 6th annual Laboratory Directed R&D poster session. Congratulations to ORNL co-authors including Biosciences Division's Ji-Won Moon and Tommy Phelps; Materials Science and Technology Division's Chad Duty, Pooran Joshi, and Gerald Jellison, Jr.; and Measurement Science and Systems Engineering Division's Lonnie Love.

2011 ORNL Awards Night EES Honorees

UT-Battelle, LLC honored outstanding employees in November during the annual Awards Night celebration at the Knoxville Convention Center. Honorees representing the Energy and Environmental Sciences Directorate are highlighted below.

Science/Technology, Distinguished Scientist

Patrick Mulholland, Environmental Sciences Division, was recognized for a distinguished career in environmental science that has made critical contributions to our understanding of forested watersheds and their response to environmental stressors, including acid precipitation, nitrogen deposition, and climatic variability and change.

Laboratory Operations, Bargaining Unit Support

Steven Whitted, Energy and Transportation Sciences Division, was recognized for excellence and innovation as an automotive research mechanic in supporting and leading research staff in the Fuels, Engines, and Emissions Research Center.

Community Outreach, Community Leadership

Sherry Livengood, Safety and Business Operations, was recognized for more than 15 years of volunteer community service to impoverished families in Anderson County and East Tennessee.

Laboratory Operations, Administrative Support

Jennifer Seiber, Safety and Business Operations, served on a team recognized for transforming, automating, and improving the ORISE educational appointment hiring process, thereby promoting outstanding customer satisfaction, significant time reductions, and substantial cost savings.

Exceptional Community Outreach

Measurement Science and Systems Engineering Division's Lonnie Love and Randall Lind, Energy Materials Program's Craig Blue, Biosciences Division's Tommy Phelps, and Ray Boeman with Energy Partnerships were recognized for outstanding dedication in the mentoring of young people, through a complex engineering challenge, to be science and technology leaders.

Engineering R&D

Measurement Science and Systems Engineering Division's Thomas Karnowski, Ryan Kerekes, and James Goddard served on a team recognized for development of the Roadside Tracker, a highly innovative instrument for the detection of illicit nuclear materials in freely flowing vehicular traffic.

Excellence in Technology Transfer

Energy Materials Program's Alan Liby and Craig Blue served on a team recognized for development and licensing of AFA steels, a revolutionary new class of heat-resistant steels for higher-efficiency energy production and chemical process industry applications.

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Construction Update

Progress continues on the $20.2 million American Recovery and Reinvestment Act-funded Maximum Energy Efficiency Building Research Laboratory (MAXLAB) project. The structural steel erection is completed for the approximately 17,800 gross square foot main MAXLAB building. In addition the "active foundations" for the two light commercial building flexible research platforms have been completed. The FRP foundations include in-slab heating/cooling loops, which will enable research equipment to control the temperature of the working fluid circulating in the loops in order to eliminate heat transfer between the ground and test buildings installed on the FRPs.

MAXLAB construction site in late October as seen from Bethel Valley Road.

Carbon Fiber Technology Facility construction reached a milestone in November, with ORNL taking beneficial occupancy of the building. Staff may now use the building for some functions, while office space is expected to be occupied by early 2012. Fabrication and installation of melt spinning and carbon fiber semi-production lines are also continuing on schedule. 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. Located at the Horizon Center, the facility is projected to be operational by early 2013.

Inside Carbon Fiber Technology Facility production area.

Quality Counts…

Quality counts in everything we do.
Our commitment to excellence in science and technology…

- IMPACT – Deliver science and technology of the highest possible strategic impact to our customer
- VALUE – Provide the greatest return on our customer's science and technology investment
- REPUTATION – Develop and maintain an outstanding world-class science and technology reputation with customers and among peers