Sustainable Transportation Program Update

Oak Ridge National Laboratory
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

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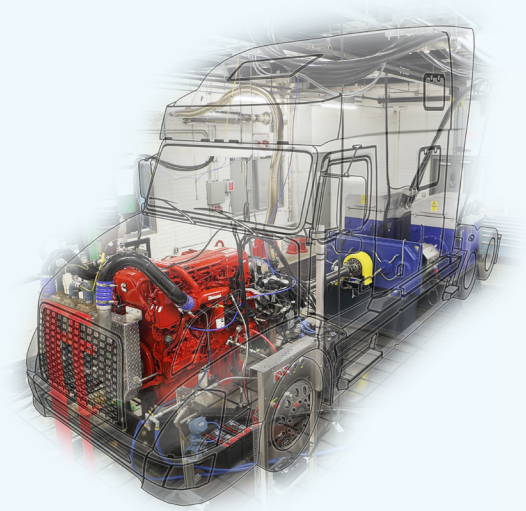
VSI Lab opening to accelerate pace of powertrain R&D

This summer, the Vehicle Systems Integration (VSI) Laboratory will become fully operational, offering unique capabilities to evaluate and simulate engines, electric motors, and transmissions in conventional and hybrid powertrain configurations for vehicles ranging from light-duty cars to Class 8 heavy-duty trucks. The VSI Lab is accelerating the pace of powertrain development by performing prototype research and characterization of advanced systems on a component level.

"We can run analyses on specific vehicle components – simulating or emulating various driving scenarios and road conditions – and provide data that industry partners could use to adjust their vehicle designs accordingly to meet federal regulations on fuel efficiency and emissions control," said David Smith, manager of the Advanced Vehicle Systems Research Program.



The lab comprises a powertrain test cell with twin AVL 500 kW AC transient dynamometers and a component test cell – both share energy storage system emulation and dSPACE hardware-in-the-loop (HIL) real-time platform capabilities. The VSI Lab also features "X"-in-the-loop hardware evaluation of powertrain components and/or subsystems in virtual vehicle environments, where "X" represents any experimental component or subsystem.

Through the VSI Lab's first industry CRADA partner, Meritor Inc., David and his team – Paul Chambon, Dean Deter, Norberto Domingo, Steve Whitted, and PT Jones – are able to bridge modeling/simulation/analysis and controls development of prototype hardware in transient operation of the Meritor Class 8 tractor hybrid electric drivetrain.

Other significant collaborations with the VSI Lab include DOE, EPA, the International Council on Clean Transportation, Eaton Corporation, California Air Resources Board, National Renewable Energy Laboratory, Argonne National Laboratory, and SAE International. The VSI Lab is sponsored by the DOE Vehicle Technologies Office.

Ford's top management visits ORNL, reviews automotive R&D capabilities

In February, ORNL hosted a two-day visit for Ford Motor Company's senior managers interested in reviewing current research projects ongoing between the Lab and the automaker. Tour stops included demonstrations by scientists and engineers who specialize in leading-edge research methods that are helping to address some of the greatest challenges facing the automotive industry today.

Project examples given at each tour stop focused on Ford's specific interests in carbon fiber and composites, computational modeling, manufacturing methods and products, engine research and development, materials characterization, and advanced battery technology. Information gleaned from these areas of research is expected to aid Ford's progress on pressing issues surrounding fuel economy, low emissions, and electrification/alternative fuels.

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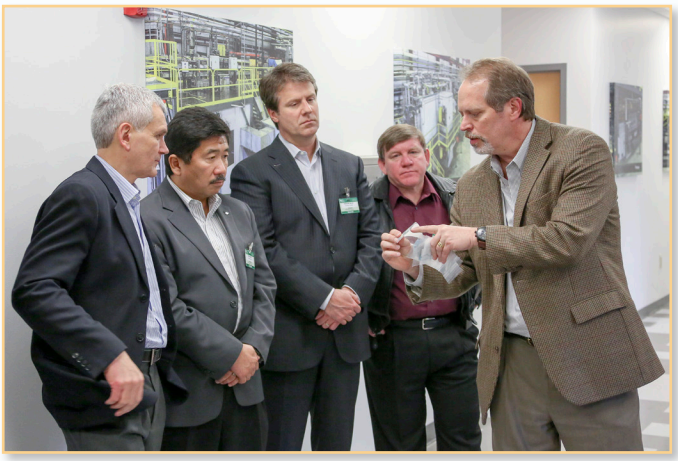
Ford's top management visits ORNL...continued from p.1

ORNL's ties with Ford span more than three decades, more recently through a DOE EERE-funded project in collaboration with Dow Chemical Company to develop low-cost, lightweight carbon fiber composite materials that could be used in vehicle bodies, wind turbines, and other industrial products. Ray Boeman, Strategic Partnerships, presented Ford representatives with a detailed look at ORNL's R&D efforts with Dow and Ford to develop and scale-up polyolefin-based carbon fiber that offers the potential for a less expensive alternative to most of today's carbon fiber.

The tour group visited the Fuels, Engines, and Emissions Research Center (FEERC), which also has a long standing relationship with Ford and much work has been done in the past four years to address emissions control functionality and component durability.

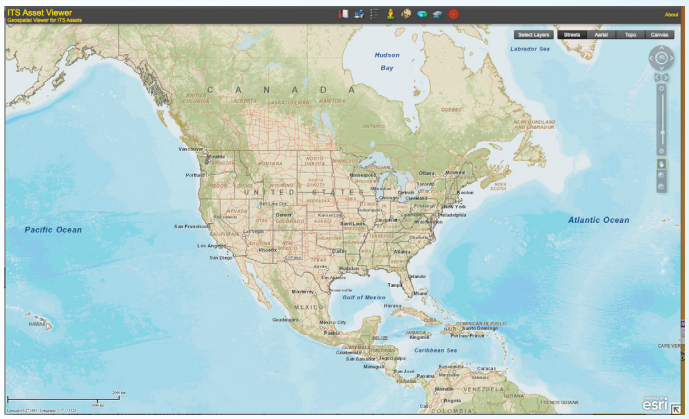
"This exposure broadens Ford's view of ORNL's unique scientific research tools that could foster additional opportunities to address their key challenges in the near- and mid-term, as well as for longer range objectives," said Ron Graves, director of the Sustainable Transportation Program.



(Left photo) In the lobby of the Carbon Fiber Technology Facility, ORNL's Ray Boeman (right), Strategic Partnerships, shows representatives from Ford Motor Company a photomicrograph of the cross section of a polymer fiber made with bi-component melt spinning. (Right photo) Inside the Fuels, Engines, and Emissions Research Center, ORNL's Shean Huff (left) discusses with Ford visitors the catalyst, engine, and vehicle roles in forming the connection between the chemical laboratory, combustion research, and production vehicle applications.

ORNL expertise recognized at ITS America meeting

In April, ORNL staff were highlighted at the Intelligent Transportation Society of America (ITSA) Annual Meeting and Exposition in Nashville when DOT launched the first-ever Intelligent Transportation Systems (ITS) Asset Viewer. This viewer visually displays ITS deployment locations (such as traffic cameras, roadway dynamic message signs, and weather condition and vehicle sensors) in the US, enabling better understanding of ITS deployment status across the country. ORNL's Center for Transportation Analysis has had the responsibility for developing the Deployment Tracking Survey since 1997. To see the ITS Asset Viewer, visit http://itsdeployment.ornl.gov/itsassets/.



Note from Ron Graves

Although there's been a break in the Sustainable Transportation Update newsletter, our important and impactful R&D continues at ORNL, and we've done our best to catch up in this issue. First, I wanted to recognize the outstanding communications and outreach support that Kathy Graham has provided us during the past four years. We wish Kathy the very best in her new position as marketing communications manager for ORNL, where we know she'll be a great asset to the Lab.

In January, I was honored to give opening remarks at the 2013 SAE International High Octane Fuels Symposium in Washington, DC. This symposium was co-organized by Brian West, Jim Szybist, and Scott Sluder. We are expecting further research in this field.

I completed my fifth year as a PACE Award Judge in February, attending the judges selection meeting in Dearborn, Mich. The awards were announced on April 15 in Detroit. You can view a listing of this year's winners at www.autonews.com/Assets/html/pace_award/winners.html.

At Clemson University, I co-chaired a session at the SAE Natural Gas Symposium in March and toured the CU International Center for Automotive Research facility, an event co-organized by Robert Wagner. Also, in Detroit, I attended the Advanced Combustion Emission Control technology team meetings in January and March.

During the SAE World Congress event in April, it was a career highlight to see Robert Wagner and Brian West awarded SAE Fellow status, and congratulations to Scott Sluder and Sujit Das for being appointed to the SAE Engineering Meetings Board. If your research has a transportation focus, I strongly recommend that you join SAE. It's a great way to get recognition among your peers for your research efforts and take advantage of opportunities for personal and professional growth. ORNL presented 23 papers at this year's Congress.

Ron Graves

It was truly a special event to have 10 executives from Ford Motor Company visit our transportation research facilities in February. We have also hosted representatives recently from Cummins Power Systems, Brookings Institute, Volkswagen, and General Motors.

Congratulations to Lee McGetrick's team on the successful opening of the Carbon Fiber Technology Facility. The event was well covered internally and in the media, including a brief article in this issue.

I have begun duties on the National Academies Committee on Medium and Heavy-Duty Vehicle Fuel Economy, Phase II. Panel participation will require a portion of my time and will be rather intense for the first eight months of this multi-year commitment as we try to prepare an interim report by the end of the calendar year.

Lastly, I want to recognize all the hard work by our program participants and business staff in making budget adjustments as the fiscal year has progressed with partial funding. Thanks to your extra efforts, our research activities continue to make progress even as we are faced with budget uncertainties.

ORNL paper featuring research at HTML is highly cited

"Single-atom catalysis of CO oxidation using Pt_1/FeO_x," which appeared in Nature Chemistry in July 2011, has garnered 37 citations in various scientific literature in only 19 months after publication. This leads the way for a number of similar studies, including work under way at ORNL led by Chaitanya Narula. This paper was the first to unambiguously confirm with atomic resolution, using the aberration-corrected JEOL 2200FS electron microscope at ORNL's High Temperature Materials Laboratory, identifying the ability of dispersions of catalytic species at the single-atom level to show improved catalytic behavior over commercially available materials. Co-authors included Larry Allard, Materials Science and Technology Division, with colleagues Jingyue (Jimmy) Liu, now at Arizona State University; B. Qiao, A. Wang, T. Zhang, Z. Jiang, and Y. Cui, Chinese Academy of Sciences, and X. Yang and J. Li, Tsinghua University.

Carbon Fiber Technology Facility offers scalability to current, future industry collaborators

ORNL's Carbon Fiber Technology Facility (CFTF) officially opened in March and has already experienced an increase in inquiries from those interested in learning more about R&D collaboration opportunities, according to Connie Jackson, CFTF operations manager. The 42,000-square-foot new materials research lab, located in the Horizon Center on the Oak Ridge Turnpike, is a scale-up facility that is currently operating three, 8-hour shifts, five days per week, which will ramp up to 24/7/365 as demand increases.

(Foreground, from left) DOE Assistant Secretary for EERE David Danielson joined Council on Competitiveness CEO Deborah Wince-Smith, Congressman Chuck Fleischmann, and Gov. Bill Haslam for the dedication of the Carbon Fiber Technology Facility.

The CFTF includes a 390-foot-long carbon fiber production line that is flexible and highly instrumented for demonstrating advanced technology scalability and producing market-development volumes of prototypical carbon fibers while also addressing ways to bring down the cost of carbon fiber for vehicle applications.

R&D leaders from Ford Motor Company and Dow Chemical Company attended the CFTF ribbon cutting ceremony along with Tennessee Governor Bill Haslam, Tennessee Congressman Chuck Fleischmann, Council on Competitiveness President and CEO Deborah Wince-Smith, ORNL Director Thom Mason, and DOE Assistant Secretary for EERE David Danielson.

"My staff has called this project a textbook example of perfect execution and have told me that they have never seen a project run so well," said Danielson, in reference to CFTF's construction and operationalization. Nearly all the speakers mentioned the Carbon Fiber Technology Center's example of bringing public research together with private entrepreneurship to push important energy saving technologies to the market. "Otherwise, the research goes nowhere," said James DeVries with Ford Motor Company's Manufacturing Systems Department.

PEEM Group meets milestone with SiC power module

Researchers at the ORNL Power Electronics and Electric Machinery (PEEM) Research Group's Packaging Laboratory manufactured their first ever 50 A/1,200 V rated all silicon carbide (SiC) power module using in-house packaging technologies. This accomplishment met a DOE Vehicle Technologies' Performance Management Measurement Milestone Q1 Target Objective. An initial assessment to characterize state-of-the-art SiC materials at 50 A/1,200 V was also initiated. The ORNL SiC power module prototype will lead to reduced size and cost of electric drive inverters.

ORNL's Zhenxian Liang works in the PEEM Research Group's Packaging Laboratory

Do you have news or information you would like to share?

Please submit to Kathi Vaughan,
ORNL Sustainable Transportation Program Office
865-946-1206 or vaughankh@ornl.gov

ORNL well represented at TRB meeting, wins top award

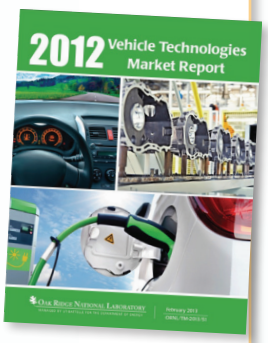
ORNL's Center for Transportation Analysis (CTA) was well represented at the 92nd Annual Transportation Research Board (TRB) meeting in Washington, DC, in January. The meeting theme was "Deploying Transportation Research—Doing Things Smarter, Better, Faster." TRB is one of six major divisions of the National Research Council. This year's event drew an estimated 12,000 participants from around the globe with more than 4,100 presentations and papers addressing the latest developments in transportation research, policy, and practice. ORNL staff – including Shih-Miao Chin, Sujit Das, Stacy Davis, Rick Goeltz, David Greene, Ho-Ling Hwang, Keith Kahl, Tim LaClair, Jan-Mou (James) Li, Zhenhong Lin, Changzheng Liu, Francisco Moraes Oliveira-Neto, Tim Reuscher, Rob Taylor, and Daniel Wilson – contributed technical papers and posters, served as panelists, led in key committee activities, and attended sessions.

One of ORNL's critical links to the federal government regarding transportation energy policymaking is senior economics researcher David Greene. An ORNL Corporate Fellow, David was recognized in January as the 2012 recipient of TRB's Roy W. Crum Distinguished Service Award and hailed for his significant contributions to research on transportation energy and related issues. David is the first Crum award honoree whose principal area of research is energy and environmental analysis, which puts a spotlight on all the outstanding, high quality transportation research that comes out of the Lab.

"This award recognizes not only the outstanding contributions David has made in the course of his career, but those of his colleagues as well," said Johney Green, Director of the Energy and Transportation Science Division. "The research accomplishments of CTA have been recognized by major awards from the Department of Energy, the TRB, the Society of Automotive Engineers, the International Association of Energy Economists, and many more."

David Greene (center) receives top recognition for his significant contributions to research on transportation energy and related issues with TRB's highest honor, the Roy W. Crum Distinguished Service Award. Deborah H. Butler (left) is the 2013 Chair of the TRB Executive Committee, and Robert E. Skinner, Jr., is the TRB Executive Director. (Photo courtesy of TRB)

Vehicle Technologies Market Report released



Stacy Davis, Susan Diegel, and Debbie Bain with ORNL's Center for Transportation Analysis delivered the draft of the 2012 Vehicle Technologies Market Report to the DOE Vehicle Technologies Office on Jan. 31, and it was released on Feb. 28. The report details the major trends in US light-duty vehicle and medium- and heavy-duty truck markets. Also, the website for this report was debuted at http://cta.ornl.gov/vtmarketreport/index.shtml. Here, a PDF-formatted version of the report can be accessed, along with the data behind the graphics in Excel format.

Greene briefs NAS committee on alternative vehicles, fuels report

ORNL's David Greene briefed the DOE Hydrogen and Fuel Cell Technical Advisory Committee on the recently released National Academy of Sciences (NAS) report on Transitions to Alternative Vehicles and Fuels. The committee was charged with assessing how US light-duty vehicles could achieve a 50% reduction in petroleum use by 2030, and an 80% reduction in petroleum use and greenhouse gas (GHG) emissions by 2050. David, who is also a committee member, and ORNL's Changzheng Liu developed the Light-Duty Alternative Vehicles and Energy Transition model used by the committee to evaluate how the GHG and petroleum reduction goals could be met.

Commercial Motor Vehicle Roadside Technology Corridor expands

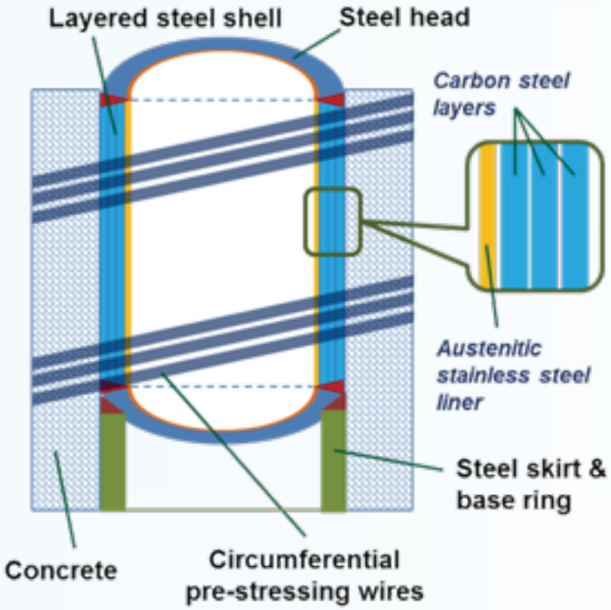
ORNL's Center for Transportation Analysis (CTA) expanded the Commercial Motor Vehicle Roadside Technology Corridor (CMVRTC), a Federal Motor Carrier Safety Administration (FMCSA) research asset that receives technical direction and support from CTA. The addition of more inspection sites in Tennessee, Georgia, Kentucky, and North Carolina extends this family of interstate locations to cover approximately 2,200 miles of roadway. Each location can gather valuable operating information such as load distribution, vehicle performance, tire and brake conditions, a driver's record and compliance with mandatory rest periods, and license plate number. All of this data can be obtained during a routine weigh-in or future planned on-the-fly scanning. In particular, one of the sites in upper East Tennessee on I-26 will employ unmanned, weigh-in-motion technology to automate screening. Discussions are also being held with Arkansas, Mississippi, and Virginia to expand the corridor even further.

ORNL contributes to special feature on sustainability of bioenergy systems

The February 2013 issue of Environmental Management had a special feature called, "Sustainability of Bioenergy Systems: Cradle to Grave," edited by Jie Zhuang from The University of Tennessee, Knoxville. Individual papers in this special feature included contributions from several Bioenergy staff members, including Virginia Dale, Rebecca Efroymson, Michael Hilliard, Keith Kline, Esther Parish, Allen McBride, and Peter Schweizer. Critical technical and scientific concepts essential to assessing the relative sustainability of potential bioenergy systems were discussed. Together, these papers cover key issues regarding sustainability of bioenergy systems when considered from the cradle to the grave and arose from a workshop held at ORNL's Center for Bioenergy Sustainability in September 2009.

Hydrogen storage project becomes major priority in fuel cells

During a mid-year review, Materials Science and Technology Division researcher Zhili Feng presented a project titled, "Vessel Design and Fabrication Technology for Stationary High-Pressure Hydrogen Storage", which has been identified as a major priority for the EERE Fuel Cell Technologies Office (FCTO) Hydrogen Production and Delivery Program. The project, which started in 2010, is moving to the prototype construction phase after a series of successful technology demonstrations centered around low-cost modeling, joining and sealing of dissimilar materials, and multi-layer tank design validation. These storage tanks are targeted for below ground hydrogen storage at refueling stations for fuel cell electric vehicles and are a critical component of the FCTO roadmap for establishing a US hydrogen refueling infrastructure.



Design schematic of a mock-up research tank (1/4 to 1/5 scale)

"DOE, in line with the Quadrennial Technology Review completed in 2011, should continue to invest in technologies for still greater vehicle efficiency, alternative fuels, and vehicle electrification." -- Ernest J. Moniz, US Secretary of Energy, April 2013

Brake tester upgrade to better facilitate heavy vehicle safety research

The Federal Motor Carrier Safety Administration (FMCSA)'s Analysis, Research, and Technology Division has awarded ORNL's Center for Transportation Analysis (CTA) a project to upgrade the existing performance-based brake tester (PBBT) located at the Greene County Commercial Vehicle Inspection Station. The new machine, expected to be in place this fall, will better facilitate the heavy vehicle safety research needs of CTA's Transportation Systems Research Group and FMCSA within the Commercial Motor Vehicle Roadside Technology Corridor (CMVRTC). ORNL is working to define the requirements for the new hardware and software. The software developed as a part of this effort will be installed on three other existing PBBT machines in Tennessee to collect data that will support FMCSA rulemaking. CTA's CMVRTC team members are Gary Capps, Oscar Franzese, Mary Beth Lascurain, Sheila Moore, and Adam Siekmann.

ORNL study on fuel economy versus increasing speed catches media attention

Following publication on Green Car Congress, ORNL research performed in the FEERC lab showing that fuel economy declines linearly with increasing speed garnered considerable attention from other media including The Detroit Bureau, NBC News, the Detroit Free Press, Michigan Radio, Consumer's Digest, The Raleigh News Observer, and others. While it was clear that fuel economy would decrease with increasing speed, the study quantifies the fuel economy loss. ORNL researchers John Thomas, Shean Huff, and Brian West with FEERC were cited in the media for this trend through analysis of dynamometer testing results for 74 vehicles at steady-state speeds from 50 to 80 mph. The data are being used to develop models that would allow predicting highway fuel economy as a function of speed for any vehicle listed on FuelEconomy.gov.

Employee Excellence

- Ron Graves, Director of the Sustainable Transportation Program, was invited to join an ad hoc committee formed by the National Research Council to perform a Phase II assessment of technologies for reducing the fuel consumption of medium- and heavy-duty vehicles. The Phase II committee will reassess the technologies analyzed in the Phase I report, providing updated estimates of the cost, potential efficiency improvements, and barriers to commercial deployment of technologies that might be employed in model years 2022 and beyond.
- Hua-Tay Lin, Materials Science and Technology Division, was selected to receive the 2013 Distinguished Engineering Accomplishment Award of The Engineers' Council for pioneering contributions and global leadership in the science, engineering, and application of advanced ceramic and composite materials and technologies.
- SAE International recommended Scott Sluder with FEERC for appointment as Chair of the SAE Engineering Meetings Board Land & Sea Operating Group for 2013–2014. The Land & Sea Operating Group is charged with overseeing the business of SAE's ground vehicle activities, their committees, and the General/Steering Committees of ground vehicle conferences with which SAE is affiliated.

Scott Sluder

- Claus Daniel, Deputy Director of the Sustainable Transportation Program, received a 40 Under 40 Award, presented by the Greater Knoxville Area Business Journal. The award honors his leadership, professional successes, and contributions to the community.

Claus Daniel

- Virginia Dale has been recognized by the US Regional Association of the International Association for Landscape Ecology with the Distinguished Landscape Ecologist Award. This award is given to individuals whose long-term scientific contribution has helped to define the field of landscape ecology. Virginia's work at ORNL has been at the center of landscape ecology since the 1980s. She is an ORNL Corporate Fellow and the leader of the Landscape Ecology and Regional Analysis group.

New Patents and Patent Applications in Power Electronics and Electric Machines

Congratulations to the following PEEM Research Group researchers for their innovations:

- John Hsu, "Substantially Parallel Flux Uncluttered Rotor Machines"
- Gui-Jia Su, "Electrical Motor/Generator Drive Apparatus and Method"
- Zhenxian Liang, Laura D. Marlino, Puqi Ning, and Fei Wang, "Power Module Packaging with Double Sided Planar Interconnection and Heat Exchangers"

Research sponsored by the DOE Vehicle Technologies Program

Visits & Events

- ORNL staff have co-organized multiple SAE events in the first quarter of 2013:
  SAE 2013 International High Octane Fuels Symposium on Jan. 28-29 in Washington, DC. Event organizers included Scott Sluder, Jim Szybist, and Brian West.
  SAE 2013 International Natural Gas Symposium on March 12-13 at Clemson University International Center for Automotive Research (CU-ICAR). Event organizers included Robert Wagner and Ron Graves.
  SAE 2013 High Efficiency IC Engine Symposium on April 14-15 in Detroit, Mich. Robert Wagner served as a co-organizer.

- The Oak Ridge Carbon Fiber Composites Consortium held a membership meeting on April 10-11 at ORNL. Agenda items included an update by Carbon Fiber Technology Facility Director Lee McGetrick, as well as a tour of the CFTF and the Manufacturing Demonstration Facility.

- In April, ORNL's Andreas Malikopoulos hosted a visit for Cummins Power Systems principals who heard a variety of presentations by ORNL staff designed to facilitate discussion on potential collaboration in research areas of interest. The Cummins group toured the Vehicle Systems Integration Laboratory; the Battery Manufacturing Facility; the Fuels, Engines, and Emissions Research Center; the Distributed Energy Communications & Controls Laboratory, and the Power Electronics and Electric Machinery Laboratory.

- David Greene played a critical role in organizing two electric transportation events at the Howard H. Baker Jr. Center for Public Policy on the University of Tennessee campus:
  Electric Vehicle Community Readiness Workshop on May 1, which brought together leaders of the 16 EV Community Readiness projects across the country funded by DOE's Clean Cities Program.
  Electrifying the Vehicle Market in the Southeast on May 2-3, designed to explore strategies that could advance the market for electric drive vehicles in general and in the Southeastern region.

- Karren More, Materials Science and Technology Division (MSTD), presented a mid-year summary of all seven ORNL research projects to the Fuel Cell Technologies Office program managers on Feb. 14 at DOE Headquarters. The projects included ORNL's baseline research on characterization of fuel cell materials as well as the status of ORNL subcontracts with 3M (two projects), Los Alamos National Laboratory (two projects), National Renewable Energy Laboratory, and Argonne National Laboratory. The project titled, "Characterization of Fuel Cell Materials," presented by Karren and MSTD's David Cullen, which was initiated in 2000, now has 12 national laboratory, industry, and university collaborators and is making an international impact on the design of polymer electrolyte fuel cell electrocatalysts and electrode layers.

- At the invitation of John Conti, Assistant Administrator for Energy Analysis, Energy Information Administration, David Greene gave a presentation entitled "Light-Duty Vehicle Markets and E85: Theory, Econometrics and Modeling" at an Energy Information Administration workshop on biofuels projections in the Annual Energy Outlook, Washington, DC, on March 20.