

# Sustainable Transportation Update

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## ORNL Achieves Breakthrough in Energy-Saving Lubricants Research

**New ionic lubricant additive technology could save US billions of gallons of oil annually**

A team of ORNL and General Motors (GM) researchers has developed a new group of ionic liquids as lubricant additives that could help improve the energy efficiency of light-duty cars and trucks. The ionic liquid, when added to prototype low viscosity engine oil, boosted fuel economy by more than 2% compared to a commercially available synthetic 5W-30 oil, as demonstrated by an industrial standard fuel efficiency engine test.

Results from these tests, performed by an independent firm, Intertek Automotive Research, with oversight by GM, show a promising path for ORNL to achieve DOE's goal of a 2% efficiency gain through lubricants. "There are more than 250 million cars and trucks on the road,



*Jun Qu shows breakthrough ionic lubricant technology.*

consuming approximately 200 billion gallons of oil per year and accounting for 70% of the US's annual oil consumption. A 2% improved engine fuel economy would potentially save billions of gallons of oil annually," said ORNL researcher Jun Qu. The prototype oil also successfully passed a 100-hour high-temperature, high-load engine dynamometer test.

This research is sponsored by the Department of Energy's (DOE) Vehicle Technologies Office (VTO).

## David Greene's Fuel Economy Future

After an illustrious 36-year career, energy policy research analyst David Greene retired from ORNL this month. Yet, he leaves behind a wealth of fuel economy knowledge that impacts mobility across the US and around the globe. During an interview with Bill Cabage with ORNL media relations, David offers his vision for the future of the nation's sustainable transportation architecture. **Continued on page 6**



## ORNL will lead three new projects from DOE's Vehicle Technologies Office

ORNL will participate in eight new projects awarded by DOE-VTO, three of which ORNL will lead. ORNL's lightweight materials research teams will lead three separate projects to develop an improved understanding of corrosion in advanced magnesium alloys, develop and validate solid-state spot joining technology to join body-in-white high strength steel and aluminum, and demonstrate laser-assisted joining of aluminum and carbon fiber components to reduce vehicle weight.

A team of ORNL energy storage researchers will work with Envia Systems to help develop high-energy lithium batteries for plug-in electric vehicles by pairing high capacity manganese-rich cathodes with high capacity silicon/carbon-based nanocomposites. ORNL's energy storage researchers will also collaborate with Sandia National Laboratories to assist with developing computer-aided tools to predict and understand the implications of thermal runaway of lithium-ion batteries.

In power electronics and electric machinery research, an ORNL team will assist Sigma

Technologies International Group on a project by performing finite element analysis modeling of the new extruded capacitors, working with project partners to iterate the final design, and doing product evaluations to determine whether the capacitors meet specifications.

An ORNL research team comprising fuels/lubricants and materials science researchers will work with Pacific Northwest National Laboratory to help develop and evaluate new viscosity and friction modifier compounds. The team will perform initial viscometry screenings, followed by fired-engine fuel consumption measurement analysis.

A team of ORNL vehicle systems researchers will assist Delphi Automotive Systems with developing and integrating a phase change heating system for vehicles and demonstrating a significant reduction in the energy used for passenger cabin heating in electric vehicles (EV).

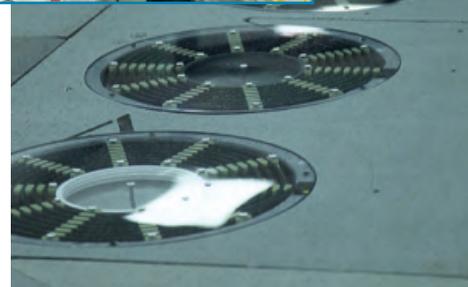
Congratulations to all of our transportation research teams.

### Wireless charging coils installed on Toyota Prius

In September, ORNL's wireless power transfer (WPT) team successfully installed and demonstrated wireless charging technology on a Toyota Prius, as well as in-motion wireless charging using a small EV that was charged while driving across a series of six roadway coils. The DOE- and ORNL-funded project produced lab results showing wireless coils could bring an EV's battery pack to fully charged with 90% efficiency, which is comparable to the current plug-in method and is the highest charge rate among competing WPT technologies. ORNL's WPT team will continue developing stationary charging functionality and remain active in international standardization and interoperability of wireless charging technologies.



*The Toyota Prius is equipped with wireless charging coils (covered) and ready for future stationary and in-motion demonstrations.*



## Successful seminar series kick-off

Sustainable Transportation Program Director Ron Graves launched a new seminar series in August with a detailed look at how ORNL is addressing the major challenges in transportation. STP will offer presentations on a quarterly basis focusing on the significant impacts and breadth of transportation science research at ORNL and new directions to achieve efficient, clean, and sustainable mobility. Ron's talk attracted researchers from varying disciplines in hopes of encouraging the potential for cross-cutting R&D across the lab. Burak Ozpineci, program manager with the Power Electronics and Electric Machinery (PEEM) research group, will present the next seminar on November 15 at 10 a.m. in Building 5100, Room 128 (JICS).



About 75 researchers and scientists from across ORNL attended Ron Graves' transportation science overview.



In the PEEM lab, ORNL's Burak Ozpineci shows an inverter with WBG devices.

## New WBG test beds in PEEM lab

The PEEM research group is expanding the wide bandgap (WBG) evaluation facilities in the PEEM lab. The facilities, which will comprise four WBG test beds inside the PEEM lab, will allow ORNL researchers to engage in more comprehensive analysis of WBG devices for DOE's Advanced Power Electronics and Electric Motors Program and for various industry requests. ORNL funded the lab's expansion in anticipation of ramping up WBG analysis projects with increased DOE and national interest in WBG devices. WBG semiconductors use less electricity and are highly efficient and reliable, producing better performing electronics that will meet the power needs of the future.

## Volvo DME truck benchmarking project completed

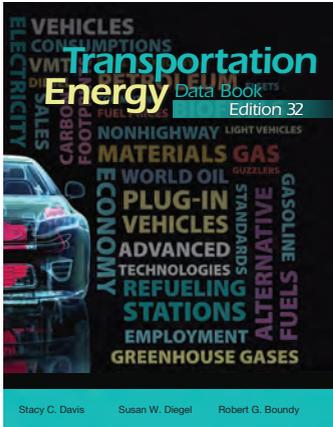
Penn State, Volvo, and ORNL collaborated on an experimental characterization of dimethyl ether (DME) as a fuel for Class 8 trucks. DME produces virtually no particulate matter (PM) emissions when operated in a diesel engine and can be produced from a variety of sources including natural gas. The fuel properties of DME also allow the engine to be calibrated so that it does not require any NOx aftertreatment. Data collected includes fuel consumption, gaseous emissions, and PM emissions.



Volvo DME truck evaluation performed in the Penn State Heavy Vehicle lab

## New projects explore funding and incentive formulae

In July, ORNL was awarded a project from the Department of Transportation's (DOT) Federal Motor Carrier Safety Administration (FMCSA) for the FMCSA Grant Formula Development and Revision. The goal of the project is to determine if the current Motor Carrier Safety Assistance Program basic funding and incentive funding formulae remain effective at providing financial assistance to states in a manner that maximizes commercial motor vehicle safety. ORNL also began a new project from Federal Highway Administration (FHWA) to recalibrate or reformulate existing models in use by FHWA for estimating non-highway gasoline use in several private and public sectors, as well as on-highway gasoline use in the public sector. This critical information is then used in formulas to attribute Highway Trust Fund receipts to the states.



## Latest Transportation Energy Data Book 32 released

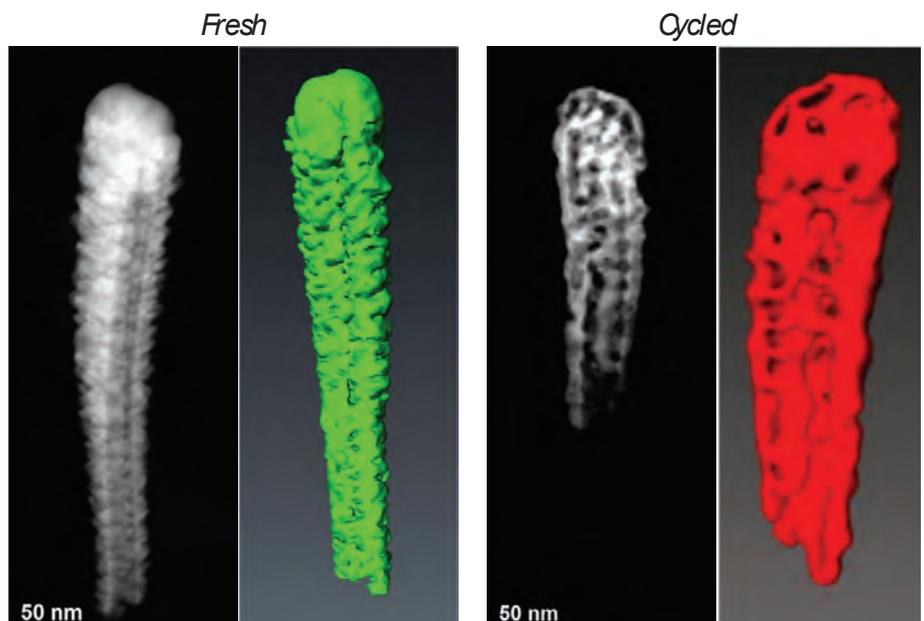
The 32nd edition of the Transportation Energy Data Book (TEDB) debuted online in July. Produced for DOE's VTO, TEDB provides transportation data with an emphasis on energy that includes statistics and information that characterize transportation activity and presents data on other factors that influence transportation energy use. The TEDB's most current electronic version is available in Excel and PDF formats and can be found at [cta.ornl.gov/data/index.shtml](http://cta.ornl.gov/data/index.shtml). Email Stacy Davis at [davissc@ornl.gov](mailto:davissc@ornl.gov) to request hard copies.

## FuelEconomy.gov launches used vehicle tool

A used vehicle fuel economy tool was launched in September on FuelEconomy.gov, a website developed and maintained by ORNL for the DOE and the Environmental Protection Agency (EPA). The new tool produces labels that feature EPA fuel economy and CO<sub>2</sub> emissions estimates for used vehicles sold in the US since 1984.

## 3D reconstruction shows changes in fuel cell performance

ORNL fuel cell researchers used electron tomography as part of a collaboration with CEA-Grenoble in France. The data gathered was reconstructed into a 3D view of 3M's Pt<sub>3</sub>Ni<sub>7</sub> nanostructured thin films before and after voltage cycling. During voltage cycling, a pore structure formed throughout the thin film's whisker surfaces and interior structure due to the rapid dissolution of nickel in the acidic fuel cell environment. The 3D visualization will aid in determining changes in the total surface area and the subsequent impact on fuel cell performance.



Nanostructured thin films shown before (fresh) and after (cycled) voltage cycling using electron tomography

## Neutron imaging capability being established for fuel injector research

Through internal funding, ORNL will begin a two-year research project to establish a dynamic high-resolution neutron imaging capability for studying fuel injector technology. The project's objective is to develop and implement a non-destructive, non-invasive neutron imaging technique to improve understanding of advanced vehicle technologies. Using neutron imaging and precise fuel injector and detector controls, researchers will obtain a series of images that allow visualization of a composite 1 millisecond injection event with 0.02 millisecond time resolution. This will allow visualization of intra-nozzle fluid dynamics, which will guide and validate data-intensive models of internal flow patterns.

*Reconstruction of gasoline direct injector using neutron-computed tomographic techniques.*



## GCC features ORNL clean transportation

Transportation science blog Green Car Congress (GCC) featured ORNL in a comprehensive article titled, "Big Science tools for clean transportation: neutron scattering at ORNL". Visit [www.greencarcongress.com/2013/08/20130821-neutrons.html](http://www.greencarcongress.com/2013/08/20130821-neutrons.html) to read the full article.

## Freight Analysis Framework cited in *The New York Times*

In an opinion article published by The New York Times, the author cited his use of the DOT's Freight Analysis Framework (FAF) and shared specific data he extracted. ORNL powers the FAF online tool for DOT's FHWA. To view the full article, visit <http://krugman.blogs.nytimes.com/2013/10/07/trends-in-interregional-and-international-trade/>.

## NTRC home to first plug-in hybrid in ORNL fleet

ORNL has added a new 2013 Ford C-MAX Energi, the first plug-in hybrid electric vehicle (PHEV) in the lab's fleet, which will be housed at the National Transportation Research Center (NTRC). ORNL transportation researchers will be able to collect data from the C-MAX for a variety of purposes including real-world fuel economy, driver behavior, and energy source-specific information by tracking electric power consumption and gasoline use. The C-MAX will join the ORNL fleet that consists of primarily alternative fuel and hybrid vehicles.



*STP Director Ron Graves charges a new Ford C-MAX Energi, ORNL's first PHEV in the lab's fleet, housed at the NTRC.*

## David Greene's Fuel Economy Future

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**B:** What's changed in 36 years—1977 to 2013?

**D:** In 1977, people weren't thinking about climate change and greenhouse gases as an urgent problem. Since then, there has been a realization and understanding that we need to completely change the energy basis of our transportation systems over the next 40 to 50 years.

So, our understanding may have changed but our practice hasn't, and history tells us that's going to be a challenge.

**B:** Why is it so hard?

**D:** It's not so much about the automobile but the energy. The internal combustion engine has become extremely sophisticated over the years, and we have a fuel supply system to support that. Changing that petroleum energy infrastructure is going to be very difficult because of what systems analysts call "technology lock-in", the difficulty of introducing novel technologies like fuel cells or battery electric vehicles.

**B:** What are the difficulties with new technologies?

**D:** It could take the industry 10 to 20 years to make a viable transition for several reasons: Technology lock-in, the upfront expense of electric and hybrid cars, and the inconvenience of their shorter travel range before charging. All the while, companies that are selling cleaner, new technologies are losing money.

The good news is that if the estimates are right, you're going to receive roughly 10 times the cost in benefits over the long run. The benefits to the environment, the climate, and to energy security are probably going to save a significant amount of money on energy. It's going to be cheaper to operate these vehicles.

**B:** What are the benefits?

**D:** Obviously one benefit is the potential to reduce greenhouse gases. If you want to get to near-zero or 80% reduction in greenhouse gases [as cited in a March 2013 National Research Council report], you can't do that by burning petroleum, even if we make the vehicles as efficient as possible. Another is reducing petroleum dependence to increase our energy security. This is a hard problem for our political system because there's a certain amount of pain upfront.

We are doing well with improving energy efficiency – what I've spent my career on. About 30 years ago, I realized that fuel economy standards were the most important thing in transportation and energy. Right now, the standards are in good shape. The EPA just set appropriately strict standards that, more or less, call for doubling the efficiency of cars and light trucks by 2025.

**B:** Will those standards be met through engine technologies, lightweighting materials, going to electric vehicles, or hybrids?

**D:** All of the above. It will be mostly engine transmission and body technologies—like aerodynamics, rolling resistance, and engine efficiency and transmission improvements. But, I think they're still going to need some degree of lightweighting, and there will be more hybridization than the EPA and the DOT have predicted.

Manufacturers spend hundreds of billions of dollars making improvements to these vehicles, and consumers save hundreds of billions of dollars every year. So, even though we're still roughly 95% dependent on petroleum, we're using it more efficiently now, and we will continue doing so in the future.

## Employee Excellence

- ORNL will recognize Kathy Gambrell from the PEEM group during ORNL's 2013 Annual Awards Night in November. She is honored for exceptional contributions to administration and budgetary management of ORNL's DOE-VTO subprogram in advanced power electronics and electric motors, exemplary contributions to the yearly Annual Operating Plan process, and completion of the U.S. DRIVE Electrical and Electronics Technical Team roadmap update.



- ORNL's David Greene was surprised with the US DOE Distinguished Career Service Award during his retirement party on September 26, given by Fred Joseck with DOE's Fuel Cell Technologies Office (FCTO) on behalf of David Danielson, Assistant Secretary for DOE EERE. ORNL Laboratory Director Thom Mason was on hand to present David's ORNL retirement certificate.



- After 8 ½ years as the Group Leader of the Bioconversion Science and Technology Group in the Biosciences Division, Jonathan Mielenz has retired from ORNL. He worked in research for advanced microorganisms for production of biofuels from biomass.



Mielenz will continue his involvement with the Society for Industrial Microbiology and Biotechnology and plans to remain active part-time in industrial biotechnology especially as it applies to renewable fuels and chemicals with White Cliff Biosystems. Jonathan's new email address is [biofuels4me@gmail.com](mailto:biofuels4me@gmail.com).

- SAE International elected John Storey as an SAE Fellow. John is an emissions and catalysis researcher and is recognized for pioneering new techniques in the characterization of particulate matter and unregulated exhaust emissions species, for leading a critical sub-committee for the diesel fuel sulfur rule, and for multiple contributions to the development of lean exhaust emissions control.



- Bill Peter, Materials Science and Technology Division, has been selected to the Greater Knoxville Business Journal's "40 Under 40," a program that recognizes East Tennessee's next generation of leaders in business and the community. The complete list will be published in the business journal's January 2014 issue.



## Visits & Events

- In September, Martin Keller, Energy and Environmental Sciences Directorate Director, attended the 2013 China Automotive Industry Development International Forum in Tianjin, China where he was invited to speak about developing new energy vehicles in a low-carbon economy.
- Ramamoorthy Ramesh, ORNL's Deputy Lab Director for Science & Technology, visited some of NTRC's transportation science research facilities in August, engaging researchers about their current and planned projects and sharing ideas for future collaborations.
- ORNL transportation research teams hosted DOE sponsors from the VTO and the FCTO during the past several months. Our visitors included:
  - Susan Rogers from the Advanced Power Electronics and Electric Motors Team who led a quarterly review meeting, July 22–26.
  - Carol Schutte with Materials Technology.
  - Jerry Gibbs from Propulsion System Materials.
  - Brian Cunningham and Peter Faguy from Energy Storage.
  - Jake Ward with VTO Analysis.
  - Fred Joseck, Grace Ordaz, and Scott McWherter with the FCTO.
- In August, ORNL researcher Brian West was invited to participate in a panel discussion at the Bioenergy Technologies Office's annual Biomass 2013 Conference in Washington, DC. He gave the opening talk in the panel session titled, "End Use and Fuel Certification" with a presentation called, "Making Better Use of Ethanol as a Transportation Fuel With 'Renewable Super Premium.'" The presentation addressed challenges surrounding today's use of ethanol in E10 and in conventional flex fuel vehicles and the potential for improved petroleum displacement if ethanol's excellent properties are appropriately exploited in future engines.
- ORNL hosted representatives from Local Motors in August, including co-founder and CEO Jay Rogers. The group visited the Manufacturing Demonstration Facility (MDF), the Carbon Fiber Technology Facility, the Battery Manufacturing Facility (BMF), the Fuels, Engines, and Emissions Research Center (FEERC), and PEEM lab.
- Dave Stanley of RIVR Media toured the MDF, the BMF, the Vehicle Systems Integration Lab, the PEEM lab, and the FEERC lab to identify potential story ideas. RIVR Media produces TV shows that have appeared on The History Channel, such as Modern Marvels.
- ORNL's David Wood from fuel cell technologies hosted Cindy Mah and Amy Yang from Automotive Fuel Cell Cooperation Corporation and Jerry Forbes and Mark Fowles from Frontier Industrial Technology, Inc., to carry out proof-of-concept experiments on fuel cell membrane electrode assemblies.

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

Please submit to Sara Shoemaker,  
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The Sustainable Transportation Update newsletter aims to cover news and technical highlights associated with transportation and transportation-related research activities and projects. This publication is produced and distributed by the Oak Ridge National Laboratory's Sustainable Transportation Program Office.