OAK RIDGE National Laboratory

Sustainable Transportation Update

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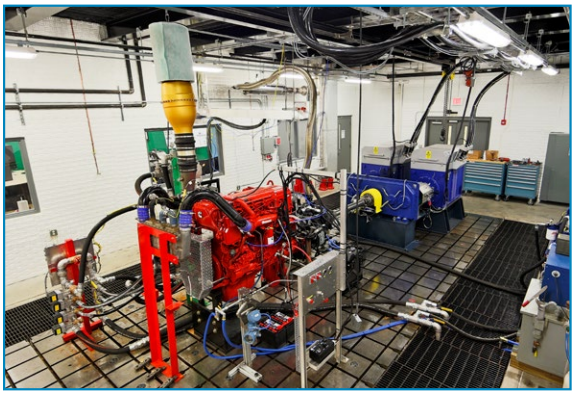
ORNL contributes to federal initiative for better fuel economy

In a recent announcement, President Barack Obama outlined the timing for developing and implementing new fuel economy standards for heavy-duty trucks. He spoke while standing in front of a SuperTruck demonstration vehicle built by ORNL partners Cummins and Peterbilt. ORNL research is supporting the 21st Century Truck Partnership's SuperTruck initiative and the broader federal goal of attaining higher fuel economy and lower greenhouse gas (GHG) emissions for Class 8 (large semitruck) vehicles.

Sustainable Transportation Program (STP) Director Ron Graves, who serves on the National Academy of Sciences panel to update the National Highway Traffic Safety Administration (NHTSA) on heavy-duty truck fuel economy technology and regulatory processes, expressed his excitement about ORNL's participation on two industry-led SuperTruck teams.

"Cummins-Peterbilt and Daimler tapped ORNL for specific and different capabilities and technologies, including advanced electric machines, combustion, and unique engine diagnostics. This is indicative of the breadth of research capabilities across ORNL," Graves said.



ORNL uses the unique capabilities of the VSI Laboratory to evaluate Class 8 engines and transmissions simultaneously.

President Obama speaks in front of the Cummins-Peterbilt SuperTruck in Maryland.

A team led by ORNL's Bill Partridge invented and applied a laser-based multiplex exhaust gas recirculation probe to measure gas mixing and distribution in the engine's six cylinders to help the Cummins team validate the computational fluid dynamics models used in developing an engine achieving 50% efficiency.

Another team—led by ORNL's Dean Edwards and working in collaboration with the Power Electronics and Electric Machinery (PEEM) group—developed and evaluated a novel generator design that avoids use of rare earth permanent magnets in a system that converts exhaust waste heat into electric power for the Detroit Diesel–Daimler Trucks North America SuperTruck Team. STP researchers are also working with the Detroit Diesel–Daimler Trucks team to explore advanced combustion strategies and their effects on fuel economy and GHG emissions.

In parallel with ORNL's support to improve the efficiency of Class 8 trucks, results of research at the ORNL Vehicle Systems Integration (VSI) Laboratory are informing the US Environmental Protection Agency and NHTSA rule-making process. Under David Smith's leadership as director of the ORNL Center for Transportation Analysis (CTA), VSI researchers are working to characterize and certify advanced truck powertrain GHG emissions. The VSI lab is the only national laboratory facility with the capacity to evaluate Class 8 engines and transmissions simultaneously.

ORNL's participation in the SuperTruck program is sponsored by the US Department of Energy (DOE) Vehicle Technologies Office (VTO).

SuperTruck visits ORNL

The Cummins-Peterbilt SuperTruck made stops at the National Transportation Research Center (NTRC) and the main ORNL campus in early April. ORNL contributed to the truck's advanced technologies as part of the Cummins-Peterbilt SuperTruck team.

David Koeberlein of Cummins and Bill Partridge of ORNL spoke at a media event about the technology in the truck and ORNL's contributions to the achievement of SuperTruck's 75% increase in fuel economy, 86% gain in freight efficiency, and 43% reduction in GHG emissions. The truck has demonstrated 10.7 miles per gallon under real-world driving conditions.

Local media, including the *Knoxville News Sentinel*, *Oak Ridge Today*, and *ABC* and *NBC* affiliates, covered the story.

The SuperTruck program was sponsored by the DOE VTO with private matching contributions from Cummins, Peterbilt, and their program partners.

Features

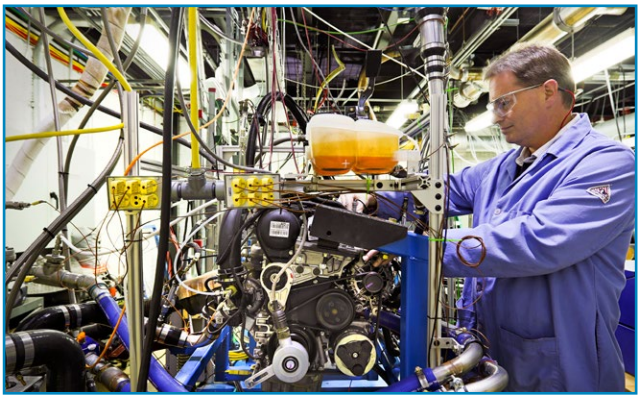
ORNL leads research, dialogue about renewable super premium fuels

ORNL researchers Brian West, Scott Sluder, and Jim Szybist—in collaboration with Southwest Research Institute—organized the second annual SAE High Octane Fuels Symposium, which brings together stakeholders from the automotive, petroleum, and ethanol industries; fuel retailers; and others to discuss renewable super premium (RSP) and other high octane fuels.

ORNL is leading research investigating RSP, or fuel that contains 20%–40% ethanol, to determine the benefits and potential impacts on the market, infrastructure, and vehicle fuel economy and emissions.

"RSP shows great potential," said West. "It offers an avenue for achieving new regulatory standards for greater fuel efficiency, increased use of biofuels, and reduced greenhouse gas emissions simultaneously."

Jonathan Male, director of the DOE Bioenergy Technologies Office (BETO), and Patrick Davis, director of the DOE VTO, served as moderators for the symposium, which was held in conjunction with the SAE 2014 Government/Industry Meeting and the Washington (DC) Auto Show.



Scott Sluder works with a Ford EcoBoost engine to determine benefits of high octane fuels on direct-injection turbocharged engines.

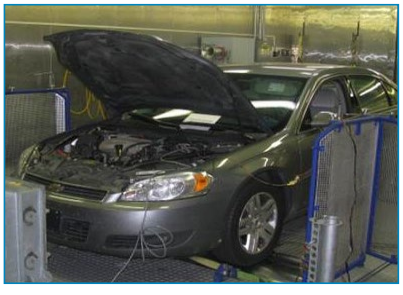
RSP gained attention recently when Green Car Congress, a transportation science blog, featured a two-part study by ORNL's Jim Szybist and Derek Splitter published in *Energy and Fuels* (Energy and Fuels dois: 10.1021/ef401574p and 10.1021/ef401575e). The study demonstrated that high octane biofuels, including an RSP blend of 30% ethanol, enabled higher efficiency and increased power, allowing up to 40% downsizing and "downspeeding" of the engines in midsize sedans.

ORNL's RSP research is jointly sponsored by DOE BETO and VTO and is conducted in collaboration with the National Renewable Energy Laboratory and Argonne National Laboratory.

ORNL research informs new EPA emissions standards

ORNL has developed a streamlined method to determine vehicle emissions that will impact every new vehicle emissions certification when new US Environmental Protection Agency (EPA) Tier 3 standards take effect in 2017, improving air quality and public health.

Recently finalized EPA Tier 3 standards will reduce the sulfur content in gasoline as well as vehicle emissions of carbon monoxide, nonmethane organic gases (NMOGs), and NO_X. The new certification process EPA endorsed in the standard is enabled by a correlation developed by ORNL researchers Scott Sluder and Brian West during their work for the DOE Intermediate Ethanol Blends Program.



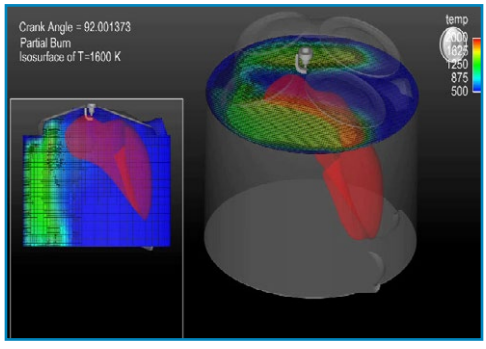
ORNL's analysis used more than 1,000 test results from emissions research conducted during the DOE Intermediate Ethanol Blends Program.

Sluder and West determined the correlation between fuel ethanol content and the resulting ratio of NMOG and nonmethane hydrocarbon (NMHC) emissions. They then derived a calculation to determine NMOG emissions levels through NMHC measurement, which reduces the regulatory burden on the automotive industry as NMHCs are simpler and less expensive to quantify. EPA adopted the method in the final ruling.

ORNL research was funded by DOE VTO and BETO.

High performance computing accelerates advanced engine development

ORNL's Dean Edwards and a crosscutting team leveraging expertise in computational science and engine and emissions-control technologies are working with Ford Motor Company to develop and demonstrate a method for identifying the impact of engine parameters that promote combustion instability in spark-ignition engines.



Computer simulation depicts an engine showing partial burn.

Using ORNL's TITAN supercomputer, researchers are conducting a second cycle of computational simulations to refine the metamodel generated using open geometry. The resulting method will be available to industry.

ORNL will continue work with industry partners Ford and Convergent Science to accelerate development of advanced internal combustion engines that will enable Ford and other automotive manufacturers to meet increasingly stringent fuel economy and emissions standards.

This research is sponsored by the DOE VTO with support from the Oak Ridge Leadership Computing Facility funded by the DOE Office of Science.

ORNL technology gives early warning of bridge failure

With 25% of the nation's 607,000 bridges structurally deficient or functionally obsolete, millions of people are at risk every day, but NuFortis and an ORNL technology could ease tensions and save lives. "Our patented system not only monitors a structure's health in real time, but also continuously warns of structural failure," said Jason Rebello of NuFortis, which was formed by three graduate students at the University of Illinois at Chicago. Sensors applied to the infrastructure monitor stress, strain, vibration, and movement and instantly transmit information to people who can take appropriate action. ORNL, working with the Federal Highway Administration, plans to fine-tune the system this fall by equipping a bridge in Virginia with this technology.

Employee Excellence

Scott Sluder received the SAE Forest R. McFarland Award at the 2014 SAE World Congress in April for his work as chairman of the Engineering Meetings Board (EMB) Land and Sea Operating Group. This is the second time Sluder has received this honor, which recognizes outstanding contributions to the work of the SAE EMB in the planning and development of technical meetings.

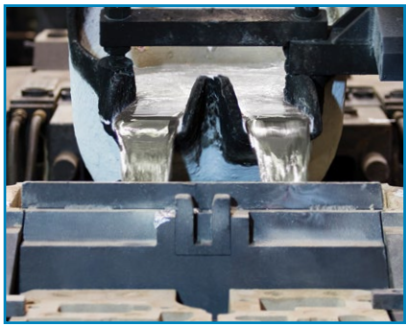
Brian West, an SAE Fellow, has been invited to serve a 3-year term on the SAE Fellows Committee. The committee consists of a dozen SAE members who evaluate and recommend nominees for Fellow status, the highest grade of SAE membership, honoring significant contributions to the automotive field.

Esther Parish was accepted into the Bredesen Center for Interdisciplinary Research and Graduate Education PhD program in Energy Science and Engineering. Parish will specialize in environmental and climate sciences as a doctoral fellow.

Briefs

Chrysler materials project to enable lighter, stronger engines

ORNL has signed a 4-year, $5.5 million agreement with DOE, Chrysler, and Nemak of Mexico to develop a new, high-strength cast aluminum alloy for use in manufacturing engine heads. ORNL Propulsion Materials researchers, led by principal investigator Amit Shyam, have completed a baseline analysis and started the materials development work. ORNL is leveraging integrated computational materials engineering capabilities with the objective of creating a stronger, lighter weight material that functions more efficiently in high temperature environments generated by engines.



Molten aluminum is poured to form engine cylinder heads.

ORNL wins Federal Laboratory Consortium Excellence in Technology Transfer award

SYMMETRIX wins FLC award.

The SYMMETRIX HPX-F Lithium-Ion Battery Nanocomposite Separator, developed jointly by ORNL and Porous Power Technologies, won an Excellence in Technology Transfer award from the Federal Laboratory Consortium (FLC) for Technology Transfer. The separator technology, recently re-released as the SYMMETRIX NC2020, replaces polymer separators in lithium-ion batteries with ceramic and mineral fillers, reducing cost and increasing safety. ORNL project participants were David Wood III, Claus Daniel, Wallace Porter, Amit Shyam, Cristian Contescu, Rosa Trejo, Edgar Lara-Curzio, Jane Howe, Harry Meyer III, Jianlin Li, Ralph Dinwiddie, Curt Maxey, Hsin Wang, and Beth Armstrong.

Wireless power transfer demonstrated for Google leader

ORNL researchers demonstrated their wireless power transfer system retrofitted to a second generation, commercially available Toyota Prius for Arun Majumdar, Google vice president and former ARPA-E director. The wireless charging was facilitated by wireless radio communication between the vehicle and the grid-side unit.

Majumdar also participated in an advanced mobility panel with STP researchers to discuss new, innovative research and development opportunities. He was visiting ORNL as a speaker in the Eugene P. Wigner Distinguished Lecture Series.

Arun Majumdar (center) participates in a wireless power transfer demonstration.

Wireless Roadside Inspection program moves to next phase

ORNL's CTA and principal investigator Gary Capps are leading the development of the Wireless Roadside Inspection (WRI) system for the Federal Motor Carrier Safety Administration. The WRI system will enable a dramatic increase in commercial motor vehicle (CMV) safety inspections without the need for additional enforcement personnel or new roadside infrastructure.

Commercial vehicles line up at a weigh station.

Currently, safety inspectors in the United States perform 3.4 million CMV safety inspections per year. WRI—the wireless transfer and evaluation of compiled safety records about the driver, carrier, and vehicle—will enable 1.2 billion safety inspections per year. This significant increase in efficiency and the resulting uptick in inspection rates will mean safer roadways for CMVs and passenger vehicles alike.

Capps and his team are currently writing specifications and developing the WRI software system from scratch to ensure system security and focused capabilities. System field operations testing with commercial trucks will begin next year.

Outreach

Transportation seminars continue with future of batteries talk

Claus Daniel, STP deputy director and founding director for the Battery Manufacturing Facility (BMF), presented "*Electrification of Transportation: Where Does the Battery Stand*?" on March 7. Daniel gave an overview of the challenges and opportunities in next generation battery manufacturing to lower costs and make electric vehicles truly competitive.

The Transportation Science Seminar Series features the crosscutting capabilities of transportation research and development to encourage collaboration across ORNL. To view the recorded presentation, please contact Kim Askey at 865-946-1861.

Claus Daniel speaks on the future of electric vehicles.

Next Transportation Science Seminar

"High Performance Computing for Accelerating Sustainable Transportation Innovations"
Presented by Sreekanth Pannala

Friday, May 16, 2014, at 10:00 a.m.
JICS Auditorium (Building 5100, Room 128)

Sreekanth Pannala shows students an electric vehicle.

Researchers promote STEM outreach during Science Saturday

ORNL researchers made science come to life for middle and high school students at Science Saturday, hosted by Oak Ridge Associated Universities (ORAU) and sponsored by ORNL to engage students in STEM programs. Claus Daniel discussed batteries, Sreekanth Pannala spoke about electrons and transport, Ashfia Huq discussed static electricity, and Jagjit Nanda highlighted fuel cells. The researchers then led hands-on experiments using fruit batteries, Mylar balloons, and toy cars operated by fuel cells to demonstrate each science area. Students also saw full-scale electric and plug-in hybrid electric vehicles.

STP leaders speak at ORICL community education forum

Ron Graves organized a series of presentations about STP research for the Oak Ridge Institute for Continued Learning (ORICL), a nonprofit group associated with Roane State Community College that offers unique learning opportunities for the community. Along with Graves, Johney Green, director of the Energy and Transportation Science Division; Claus Daniel, deputy director of STP; Robert Wagner, director of the Fuels, Engines, and Emissions Research Center (FEERC); and Burak Ozpineci, manager of the PEEM group, made presentations on research and technologies related to the future of sustainable transportation, including the electrification of transportation and high efficiency engines.

Johney Green speaks at ORICL.

In the News

- Green Car Congress featured ORNL research by James Li and Zhiming Gao that concluded speed synchronization through connected vehicle technology could generate fuel economy gains of more than 4% for conventional vehicle fleets and at least 7% for hybrid electric fleets.

http://www.greencarcongress.com/2013/12/20131231-ornl.html

- Cold weather fuel economy tips developed by the ORNL FuelEconomy.gov team were referenced in stories by *USA Today*, ABC News, and the *Detroit Free Press*.

http://www.usatoday.com/story/money/cars/2014/02/07/cold-weather-hurts-mpg/5287561

- Three tools produced by CTA for FuelEconomy.gov were named in EcoCentric's "Top Ten Energy Tools from Around the Web"—coming in at number 10 was "My Trip Calculator"; at number 7 was the "Can a Hybrid Save Me Money?" calculator; and at 5, "My Plug-In Hybrid Calculator".

http://www.gracelinks.org/blog/3140/top-ten-energy-tools-from-around-the-web

- During a podcast for Greentech Media, Greg Winfree, US Department of Transportation assistant secretary of research and technology, mentioned ORNL contributions to research and technology for developing an electrical power infrastructure along roadways that could power electric vehicles.

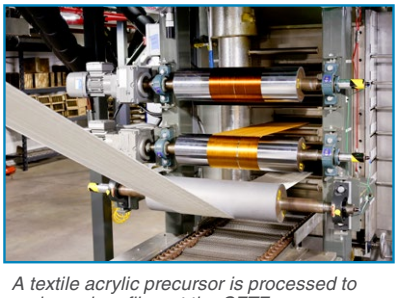
http://www.greentechmedia.com/articles/read/can-transportation-reach-zero-emissions-by-2050

- Brian West participated on the panel, "Engine Experts Talk Ethanol" at the Renewable Fuels Association's 19th Annual National Ethanol Conference. Bobby Likis, host of the national radio program "Bobby Likis Car Clinic," featured the discussion on his show.

http://www.prweb.com/releases/Automotive_Expert/Ethanol/prweb11600457.htm

- The DOE Energy Efficiency and Renewable Energy website highlighted the ORNL Carbon Fiber Technology Facility (CFTF) and its role in providing high strength, lightweight materials for use in vehicles and other clean energy industry applications.

http://energy.gov/eere/articles/carbon-fiber-and-clean-energy-4-uses-industry



A textile acrylic precursor is processed to make carbon fiber at the CFTF.

ORNL materials research featured on PBS MotorWeek

Amit Shyam outlines ORNL's use of integrated computational materials engineering for the MotorWeek crew.

MotorWeek, television's longest running automotive series, featured ORNL's lightweighting research during an episode that aired on PBS stations across the nation on April 5. Dave Scrivener, MotorWeek senior producer, and crew captured footage of researchers engaging in lightweighting projects at various facilities including materials and power electronics labs, the Manufacturing Demonstration Facility (MDF), BMF, CFTF, and the High Flux Isotope Reactor.

Visit *http://www.fueleconomy.gov/feg/motorweek.jsp* to view the lightweight technology video.

Materials research update

Pictured here, DOE VTO representatives Ed Owens (second from left), program manager – Materials Technologies, and Jerry Gibbs (right), Propulsion Materials technology manager, are briefed by ORNL Propulsion Materials program manager Allen Haynes (left) and researcher Jun Qu (center). Owens and Gibbs met with researchers for key project updates, toured materials facilities, and participated in the Carbon Fiber Consortium meeting.

Visits & Events

- Tim Theiss, manager of the ORNL Bioenergy Technologies Program, organized and facilitated a meeting with Butamax Advanced Fuels, and representatives of DOE BETO to discuss biobutanol, Butamax's proprietary blend of biofuel, and its potential for commercialization. Butamax is a joint venture between BP and Dupont that sponsors biofuels research at ORNL.
- The PEEM group recently hosted a series of visitors, including members of the Tennessee Valley Authority Board of Directors; Yongzhang Huang, deputy director of the State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources at North China Electric Power University; Ranga Pitchumani, chief scientist and director of DOE's SunShot Concentrating Solar Power Research and Development Program; and Aaron Yocum from the National Energy Technology Laboratory.
- Andrew Brown, vice president with Delphi Automotive, and Hamid Kia of General Motors toured NTRC and participated in the Energy and Environmental Sciences Directorate Scientific Advisory Committee meeting.
- FEERC hosted researchers from Los Alamos National Laboratory (LANL) to study LANL sensor technology for onboard measurement of emissions from advanced fuel efficient engines. This research campaign was the second of two visits to the NTRC User Facility under a user agreement.
- Amitai Bin-Nun, visiting fellow at the Harvard-Smithsonian Institute for Theory and Computation, toured NTRC with Ron Graves as part of a broader visit to ORNL. Bin-Nun was previously employed by DOE and wrote an internal memo while with DOE that focused attention on the possible benefits of driverless vehicle research.
- The Tennessee Automotive Manufacturers Association (TAMA), an organization focused on expanding the state's automotive industry, met at ORNL for its quarterly meeting. The group toured several facilities, including the PEEM lab, FEERC, MDF, BMF, and the VSI lab.

Robert Wagner and Brian West speak to the TAMA group in front of the chassis dynamometer laboratory.

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

Please submit to Kim Askey,
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(865) 946-1861 or askeyka@ornl.gov

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.

www.ornl.gov/transportation