

Sustainable Transportation Update

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Key findings show benefits of high-octane fuels

Is it possible to realize vehicle performance benefits for consumers, help automakers meet aggressive new fuel economy standards, benefit the environment through fewer greenhouse gas (GHG) emissions, increase use of renewable domestic fuel, and decrease America's dependence on foreign oil—all at once? A growing volume of research conducted at ORNL in collaboration with other national laboratories and industry points to a potential path to achieve these goals simultaneously.

The pathway involves optimizing advanced engine and vehicle technologies for use with high-octane fuels, specifically blends of gasoline with increased concentrations of ethanol. The necessary technologies already exist. Properly coupling them is the trick.

Realizing vehicle performance benefits

Automakers have long known that boosting the octane level of fuels can translate to performance benefits such as faster acceleration, improved fuel economy, or greater towing capacity. This is why many high-performance vehicles require the use of premium (higher octane) fuel.

Through a series of studies ranging from single-cylinder engine research to whole vehicle experiments, ORNL researchers and collaborators have demonstrated that multiple benefits can be garnered when high-octane ethanol blends are used in vehicles designed for these advanced fuels.

Single-cylinder engine studies conducted by researchers Jim Szybist and Derek Splitter have shown that high-octane E30 fuel (gasoline blended with 30% ethanol) enables twice the available torque compared to fuel containing no ethanol (E0, octane rating: 87) in a high-compression research engine. By increasing the torque, the same amount of power can be delivered to the wheels using smaller engines (downsizing) and at reduced revolutions per minute (downspeeding). These approaches maintain vehicle performance while significantly improving vehicle efficiency.

Researcher Scott Sluder's work with a multicylinder Ford EcoBoost engine explores the benefits of technologies such as high-compression pistons paired with fuel blends with various octane ratings. These studies, conducted in collaboration with Ford, have demonstrated significant thermal efficiency increases with increasing levels of ethanol. The same engine is being used to support related work for the Coordinating Research Council (CRC).



Researchers are conducting evaluations of TGDI technologies with high-octane fuels using this modified Cadillac ATS.

Vehicle-level studies led by Brian West using a late model Cadillac ATS with a turbocharged gasoline direct-injection (TGDI) engine have demonstrated that 5%–10% fuel efficiency gains are indeed achievable using high-octane fuels. These vehicle-level efficiency gains were previously projected based on modeling results in the literature.

These vehicle experiments have demonstrated that engine and system efficiency can offset the lower energy density of ethanol blends for future vehicles. Because ethanol contains only 2/3 the energy of gasoline per volume, it typically decreases the “tank mileage” you can get from a gallon of blended fuel. In these experiments, researchers modified the Cadillac ATS with assistance from General Motors (GM) and showed that this hurdle can be overcome using advanced engines designed for high-octane blends like E30.

Experimental data show that vehicle efficiency improvements on some cycles were adequate to achieve “volumetric fuel economy parity” such that the miles per gallon (mpg) with the lower energy density E30 in the future vehicle would be equal to the mpg of today's equivalent vehicle with regular E10. These results point to a major opportunity to increase the volume of ethanol in fuels without a loss of vehicle driving range.

Displacing billions of gallons of petroleum

These fuels (E25–E40) are already legal to use in more than 17 million flex-fuel vehicles (FFVs) on the road today. Research conducted by the ORNL Fuels, Engines, and Emissions Research Center (FEERC) documents the acceleration boost that FFVs can achieve when fueled with these high-octane mid-level blends.

In these experiments three of four FFVs showed significant acceleration performance improvement when fueled with high-octane E30 rather than regular E10. The results demonstrate that most legacy FFVs can realize performance benefits right away with mid-level ethanol blends like E30. This could help establish consumer demand for these fuels and ease the transition to a new fueling infrastructure and new vehicles designed for high-octane fuels.

“If half of the current FFV owners filled their tanks with E30 half of the time, we would consume a half-billion more gallons of ethanol,” said Tim Theiss, manager of the ORNL Bioenergy Technologies Program.

Lowering GHG by up to 30%

Increased concentrations of ethanol in the fuel can mean significant reductions in GHG emissions. Researchers have identified a pathway to reduce GHG emissions by 30% using a gasoline blend containing 40% ethanol (E40) generated from cellulosic feedstocks such as corn stover or other nonedible sources of biomass. E25 and other ethanol blends were also analyzed, and all lowered GHG emissions compared to fuel with no ethanol. Smaller benefits were realized for lesser concentrations of ethanol.

Data also show that, overall, refinery efficiency is comparable with use of high-octane mid-level ethanol blends like E25 and E40 versus the current E10 blend. And ORNL-led compatibility studies confirm that currently available materials are viable for use in the fueling infrastructure with mid-level ethanol fuel blends.

Analyzing consumer acceptance

Using models, including ORNL’s MA3T (Market Acceptance of Advanced Automotive Technologies),

EPA cites ORNL research in rulemaking for new heavy-duty truck standards

Paul Chambon and the team in the Vehicle Systems Integration (VSI) Laboratory played prominent roles in assisting the US Environmental Protection Agency (EPA) with the development of proposed phase 2 GHG and fuel efficiency standards for medium- and heavy-duty trucks. ORNL is contributing to the development and evaluation of the new engine and powertrain test procedure options associated with the GHG certification process.

In the rulemaking, EPA refers to the new powertrain test procedures that ORNL is helping to develop as having the potential to “become an optimal certification path that leverages the accuracy of powertrain testing along with the versatility of the Greenhouse Gas Emissions Model, which alleviates the need to test a large number of vehicle or powertrain variants.”

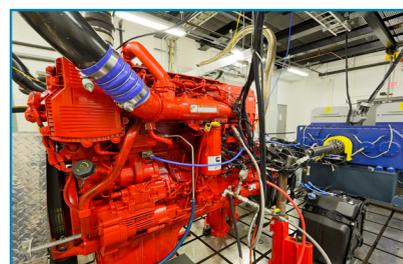
researchers have evaluated the market conditions and potential consumer acceptance for high-octane-fuel vehicles. The studies show these vehicles can be market competitive. They are attractive in part because the fuel they require is projected to cost no more than E10.

In short, if automakers offered vehicles dedicated to the use of high-octane-fuels, America’s goals for greater fuel economy, decreased dependence on foreign oil, and reduced greenhouse gas emissions might be met—all at once.

Targeting maximum efficiency

Additional research and analyses are under way. ORNL organized the High-Octane Fuels Symposia starting in 2013 and has been working with the National Renewable Energy Laboratory and Argonne National Laboratory to explore the benefits and challenges of new high-octane- fuel blends. The effort is funded by the DOE Bioenergy Technologies Office (BETO) and includes compatibility studies, well-to-wheels and market analyses, and vehicle studies. The DOE Vehicle Technologies Office (VTO) is supporting several ORNL engine and vehicle studies in collaboration with industry partners Ford, GM, and CRC.

In the future, these projects will fall under the umbrella of a new DOE research focus called Optima, which explores the co-optimization of fuel and engine technologies for maximum performance and carbon efficiency. Optima will leverage resources across the national laboratory system and build on decades of groundbreaking research in vehicle technologies. The new initiative targets a 30% reduction in per-vehicle petroleum consumption beyond expected evolutionary improvements to current engine and fuel technologies.



Researchers are working with a Cummins engine paired with automatic and manual transmissions from Allison and Eaton as part of the analysis that is informing the development of new powertrain test procedures.

VSI Lab findings helped support the National Highway Traffic Safety Administration (NHTSA) and EPA in determining that the rules, while tough, are attainable for the time period covered, model years 2021–2027. Other ORNL organizations and researchers were involved in corroborating the societal benefits and energy security implications of the new rules.

The new standards, jointly proposed by NHTSA and EPA, are designed to cut carbon pollution by about 1 billion metric tons and save about 1.8 billion barrels of oil (75 billion gallons of fuel) over the lifetime of the vehicles covered by the standards.

R&D Magazine announces 2015 R&D 100 Award finalists

R&D Magazine editors have announced the finalists for this year's R&D 100 Awards, and ORNL has 13 finalists with two of those focused on Sustainable Transportation Program (STP) technologies.

R&D Magazine has changed the format of the annual awards substantially from previous years, with a list of finalists announced first. The competition also has new "Market Disruptor" and "Green Tech" categories, and finalists can be listed in those categories, along with the traditional technical categories.

The R&D 100 winners will be announced in November at the 2015 R&D 100 Awards and Technology Conference in Las Vegas. The following are the STP finalists, both nominated in the Analytical/Test and Market Disruptor categories.

• Atmosphere 200 Environmental Gas Cell



Researcher Larry Allard assisted with the development of the Protochips Atmosphere 200 device and system.

Protochips, Inc., developed this technology in collaboration with ORNL. According to Protochips and STP's Larry Allard, Atmosphere is a complete environmental gas cell system that frees researchers from the confines of the transmission electron microscope vacuum. Based on unique semiconductor technology, the system

can operate at up to one atmosphere of pressure within a "closed-cell" specimen holder, while still maintaining atomic resolution. It features ultralow-drift heating and automated closed-loop temperature control that can quickly reach and maintain temperatures of 1,000°C. Through its novel holder design, evaluated through several generations of development at ORNL, Atmosphere is compatible with today's most advanced spectroscopic systems and can turn any electron microscope into a high-performance gas-reaction system, allowing scientists to explore the composition of materials at very small scales (nano to atomic) at elevated temperatures and at high pressures in gas environments. ORNL's work on this project is supported through the DOE VTO Propulsion Materials program.

• Infrared Nondestructive Weld Examination System

Developed by researchers Zhili Feng and Jian Chen, the infrared (IR) nondestructive examination (NDE) system allows real-time nondestructive weld inspections on production lines. Currently welds are examined in an expensive, time-consuming process that involves prying selected pieces apart for inspection. The IR NDE system developed by Feng and Chen will enable inspection of all welds on an assembly line, without damaging the parts, reducing costs and improving safety. The technology will also help advance lightweighting as advanced high-strength steels and other lightweight materials require more stringent welding conditions and are more difficult to check with standard "pry methods." The technology has been licensed by APLAIR Manufacturing Systems for further development. Research on the technology was supported by VTO.



Researcher Jian Chen observes as the IR NDE system measures the quality of a spot weld.

Successful wireless charging demo clears road to next phase

With the successful demonstration of a 6.6 kW wireless power transfer (WPT) system boasting 85% grid-to-vehicle efficiency, ORNL and partners are gearing up for the next phase of this VTO-funded electrified vehicles project. The recent demonstration, hosted by the Clemson University



ORNL's wireless power transfer technology was successfully demonstrated at CU-ICAR.

International Center for Automotive Research (CU-ICAR), featured several Toyota vehicles equipped with WPT technology developed by ORNL. Next, researchers will install a sequence of coils at CU-ICAR to evaluate the same

ORNL technology for dynamic wireless charging.

Dynamic wireless charging over electrified roadways would enable drivers to charge their vehicles during their daily commutes, expand electric vehicles range, and enable fuel economy benefits through downsizing of the battery.

Jae Lee, Toyota R&D manager explains, "We see great potential in understanding the technology of wireless charging to deliver value to our customers—in particular we see the need to work more on dynamic wireless charging and to automate the charging process."

In addition to Toyota and CU-ICAR, ORNL is collaborating with Cisco, Duke Energy, and Evatran on this project.

Briefs

ORNL and Hyundai to collaborate on new research initiatives



ORNL's Martin Keller (left) and Hyundai's Tae Won Lim shake hands after signing the agreement to spur collaboration on vehicle R&D.

Martin Keller, associate laboratory director for the Energy and Environmental Sciences Directorate, and Tae Won Lim, vice president of Hyundai Motor Company, recently signed a memorandum of understanding (MOU) to strengthen Hyundai's US R&D portfolio. In addition to sharing information on R&D needs and technology development, ORNL will provide tailored technology and technical expertise through coordination with other DOE labs. The program will kick off this fall with a workshop on materials development and multimaterial joining, with additional research areas added as the partnership matures. Claus Daniel, deputy director of ORNL's transportation program, expects the relationship to "bring vehicles to life," from design and engineering to production in the United States.

ORNL partners on ARPA-E project to achieve 40% efficiency in a small natural gas engine

ORNL is partnering with Michigan-based MAHLE Powertrain, Ltd., on a \$2.5 million ARPA-E project to design and develop a prototype 1 kW natural gas internal combustion engine for third-party evaluation. The proposed concept combines downsizing, novel fuel injection, lean combustion, and reduced friction to meet the 40% efficiency target. Researchers

will work with team lead MAHLE to develop a novel low-temperature after-treatment system to reduce exhaust emissions. The ORNL proposal team included Mike Kass, Derek Splitter, Brian Kaul, Jim Szybist, Josh Pihl, and Dean Edwards.

Sustainable Transportation Program research figures prominently in National Research Council report

STP research is cited extensively throughout the recently released National Research Council report *Cost, Effectiveness and Deployment of Fuel Economy Technologies for Light-Duty Vehicles*, including figures and papers on advanced combustion methods and transportation analyses published by FEERC and the Center for Transportation Analysis and posted on fueleconomy.gov. The report, which was commissioned by NHTSA will be used by NHTSA and EPA in a midterm review of the Corporate Average Fuel Economy or CAFE standards for 2017–2025.

ORNL Battery Manufacturing Facility helping to power Formula-E racing—and the future

What's clean, sustainable, and capable of speeds up to 140 mph (0–60 mph in less than 3 seconds)? Formula-E race cars, the world's first fully electric racing series. When industry partner XALT Energy, a leader in the lithium-ion battery field, was recently selected to provide the high-energy lithium-ion cells for all Formula-E cars on the circuit, the researchers in DOE's Battery Manufacturing R&D Facility (BMF) could justifiably feel proud. BMF researchers have been working with XALT (previously known as Dow Kokam) for years, improving electrode structure and performance (93% capacity retention after 50 cycles), optimizing manufacturing, and supporting electrode prototyping.

Formula-E, originally proposed by the French International Automobile Foundation, was founded to provide a framework for R&D centered on developing electric vehicles/vehicle technologies, to create interest in electric cars, and to promote clean energy and sustainability. As with conventional race cars, the technologies developed for Formula-E cars will eventually filter into the everyday vehicle market.

Switchgrass to hydrogen



Renewable biomass like switchgrass offers a path to lower greenhouse gas emissions.

Biorefineries could benefit from a new process developed at ORNL that produces hydrogen from plant sources such as switchgrass. The method converts biomass waste streams into hydrogen through heating and processing in microbe-based electrochemical cells. This approach reduces the use of natural gas during biofuel production, which could help biorefineries lower their greenhouse gas emissions. "The production of renewable hydrogen from biomass is a long-sought technology for moving away from fossil fuels and toward a low-carbon economy," said researcher Abhijeet Borole. The team's prototype setup, which yields more than 4 L of hydrogen per day, is detailed in *Bioresource Technology*. This work is funded by DOE BETO.

–Morgan McCorkle

New work zone alert system could ease tensions, save lives



Traffic stalls at a construction zone.

Gary Capps and Oscar Franzese have finalized the preliminary design for a work zone alert system that would take advantage of new technologies to precisely determine the end of the queue that forms at roadway construction projects when the demand (i.e., traffic volume and composition) exceeds the capacity of the roadway at the bottleneck (i.e., work zone).

Highway work zones are inherently dangerous, and commercial vehicles such as large trucks appear to be overrepresented in work zone crashes. Hence, the Federal Motor Carrier Safety Administration (FMCSA), the Federal Highway Administration, and various law enforcement agencies are interested in using what are known as “smart vehicle” technologies to reduce work zone crashes and fatalities. The proposed system would update a centralized database with information on the location where alerts should be conveyed to drivers to help them avoid accidents. While this project is sponsored by FMCSA, the proposed solution could be used not only by commercial motor vehicle drivers but also by the general public.

New pilot program helps small businesses tap ORNL expertise

ORNL was among five national laboratories selected to participate in a new DOE small-business voucher (SBV) program that aims to connect small clean-energy businesses with technical experts and world-class facilities at the national labs. The DOE Office of Energy Efficiency and Renewable Energy (EERE) is funding the \$20 million pilot as part of its National Laboratory Impact Initiative. ORNL will receive \$5.6 million to conduct outreach, merit review, matchmaking, and voucher implementation for small-business projects. “Through this program, we will help small businesses achieve their goals of developing innovative, energy-efficient products and being more competitive in the marketplace, particularly in manufacturing, building, and vehicle technologies,” said Energy and Transportation Science Division Director Johney Green, Jr. As part of the pilot, companies will have access to unique equipment and expertise at ORNL facilities such as the [National Transportation Research Center \(NTRC\)](#), the [Manufacturing Demonstration Facility](#), and the [Building Technologies Research and Integration Center](#). The application process recently opened for proposals. Interested companies can learn more about the program at the [SBV website](#). –Sara Shoemaker

Ionic liquid works synergistically with lubricant additive

A new hybrid lubricant additive discovered by ORNL and Shell Global Solutions shows tremendous promise for improving energy efficiency and durability of the nation’s 250 million cars and trucks. The research team, led by Jun Qu, recently reported on synergistic effects between ORNL-invented ionic liquids and a classic lubricant anti-wear additive, zinc dialkyldithiophosphate (ZDDP). With a treat rate of about 1% in a base oil, the hybrid lubricant

additive demonstrated reductions in friction and wear of 30% and 70%, respectively. Characterizations revealed a significantly higher-than-nominal additive concentration at the lubricant interface, which researchers believe is responsible for the superior lubricating behavior. The results are published in [Advanced Materials](#) and highlighted at [MaterialsView.com](#). The research was sponsored by DOE VTO. – Ron Walli

Kodak, ORNL collaborate on roll-to-roll manufacturing



Martin Keller (left) ORNL’s associate laboratory director for energy and environmental sciences, signs the MOU with Terry Taber, chief technology officer for Eastman Kodak.

Eastman Kodak Company and ORNL have signed an agreement to increase national competitiveness in roll-to-roll manufacturing. Roll-to-roll technologies allow manufacturers to boost efficiency, yields, and savings through continuous operation of production lines for coated products, including batteries, fuel cell electrodes, thin film solar cells, energy-saving window films, and flexible electronics such as touch screen sensors. “Oak Ridge National Laboratory and Kodak’s Eastman Business Park will provide a seamless support system for the generation of innovative technologies—from invention to evaluation to scale up to market-ready consumer product. Together, we aim to transform the way new materials and systems are developed and manufactured in the United States,” said ORNL associate laboratory director Martin Keller.

Employee Excellence

Curran receives SAE industry leadership award

FEERC's Scott Curran received the 2015 Stefan Pischinger Young Industry Leadership Award from the SAE Foundation, the charitable branch of SAE International. The Pischinger award highlights early career individuals who have demonstrated leadership potential and promote science, technology, engineering, and mathematics (STEM)-based research in their respective fields. The ceremony at the foundation's annual celebration in Detroit included dinner with Fiat Chrysler Automobiles' CEO and Chairman Sergio Marchionne.



Scott Curran (center) is congratulated by SAE Foundation Board Chairman Mazen Hammoud of Ford Motor Company and Patrick Hupperich, FEV North America, Inc. president and CEO.

Dudney named ORNL corporate fellow

STP's Nancy Dudney joined Lonnie Love and David Radford in becoming ORNL corporate fellows, a designation that recognizes a researcher's significant accomplishments and continuing leadership in scientific, engineering, and technological fields.

This is just the latest in a long string of accomplishments for Dudney, who came to ORNL as a Eugene P. Wigner fellow, is a fellow of the Electrochemical Society and a UT-Battelle Distinguished Inventor, and is the winner of four R&D 100 Awards and three Federal Laboratory Consortium Excellence in Technology Transfer Awards. Dudney's work at ORNL has focused on battery technologies, most recently research on novel materials for hybrid vehicle batteries funded by DOE VTO.

Robert Wagner coedits special journal issue on cyclic dispersion

Robert Wagner of ORNL and Todd Fansler of the University of Wisconsin served as coeditors on a special issue of the *International Journal of Engine Research* on the topic of cyclic dispersion in engine combustion. The issue has 13 articles that exemplify the state-of-the-art research, including an invited review paper coauthored by Charles Finney and other FEERC staff members, "A Review of Deterministic Effects in Cyclic Variability of Internal Combustion Engines."

STP projects and people receive DOE recognition

Bob Bowman was recognized by the DOE Hydrogen and Fuel Cells Program for outstanding dedication and achievements in hydrogen storage material R&D. He was cited in particular for the design and development of a metal hydride cryo-collar that flew for 4 years aboard the European Space Agency's Planck mission to map the cosmic microwave background.

The Power Electronics and Electric Machinery (PEEM) group's 3D-printed inverter team received a 2015 DOE VTO Distinguished Achievement Award for demonstrating a first-of-its-kind 3D-printed electric drive inverter incorporating wide bandgap devices and advanced packaging techniques.

PEEM was also involved in another 2015 VTO Distinguished Achievement Award as part of the UQM Technologies–led team that developed and patented a new non-rare-earth magnet motor for electric vehicles.

Changzheng Liu wins best presentation award

Changzheng Liu and Zhenhong Lin attended the 28th International Electric Vehicle Symposium and Exhibition in Goyang, Korea, where they presented three papers. The paper "Economic Analysis of Early Hydrogen Stations," presented by Changzheng, was recognized for the Best Presentation Award.

Gonzales takes first place in National GEM Consortium Competition

Jon Gonzales, a GEM fellow in the PEEM research group, received first place in the PhD category in the National GEM Consortium's Technical Presentation Competition. Jon's presentation, "Optimal Design and Control of Wireless Power Transfer (WPT) Systems for Electric Vehicle Applications," explained a solution to recent challenges in optimizing the design and control of WPT systems to attain higher power transfer and greater efficiency. He was mentored by ORNL's Burak Ozpineci and Omer Onar.



ORNL's Bob Bowman (center) receives his Hydrogen Storage R&D award from Dr. Sunita Satyapal and Dr. Ned Stetson of DOE FCTO.



Josh Ley of UQM (left) and ORNL's Burak Ozpineci (center) and Madhu Chinthavali receive awards from DOE VTO Electric Drive Technologies Program Manager Susan Rogers.

Zawodzinski elected ACS POLY fellow

Dr. Thomas A. Zawodzinski was recently selected as a fellow of the American Chemical Society (ACS) POLY division. Dr. Zawodzinski was also awarded a Royal Academy of Engineering Distinguished Visiting Fellowship to spend 1 month in England, hosted by Imperial College. Zawodzinski's work is focused on energy storage materials and systems, including electrolytes and membranes for fuel cells. He is currently the Governor's Chair in Electrical Energy Storage with a joint appointment at the University of Tennessee, Knoxville, and ORNL.

Kass selected for UL Renewable Energy Council

Mike Kass was selected by UL (Underwriters Laboratories) to serve on its Renewable Energy Council (REC). REC advises UL on key topics such as standards development and management, service programs development and

sustainability, and navigating UL's engagement within the energy industry as a whole. Council membership is based on leadership, expertise, and contributions to UL's mission of safety to the community. Mike Kass joins Tim Theiss as the only ORNL committee members.

Dudney, Nanda authors on *Handbook of Solid State Batteries*

Researchers Nancy Dudney and Jagjit Nanda are authors on the recently published *Handbook of Solid State Batteries*. The [handbook](#) covers topics related to solid-state batteries including advanced enabling characterization techniques, fundamentals of solid-state systems, novel solid electrolyte systems, interfaces, cell-level studies and three-dimensional architectures. Nancy is the lead editor on the handbook, published by *World Scientific Publishing*

In the News

- CNN interviewed Claus Daniel and P.T. Jones about the electrification of transportation and ORNL's dynamic wireless charging technology. The [piece](#) is part of a series on solving big problems that was released online first and will be paired with an interview with Elon Musk on the future of transportation for broadcast on TV.
 

P.T. Jones discusses ORNL's wireless charging technology with CNN reporter Rachel Crane.
- Research from the ORNL-managed Fuel Economy Information (FEI) project has been highlighted in the media repeatedly through the summer and fall. Hot topics included the following:
 - A study of the fuel economy benefits and penalties associated with various modes of driving (e.g. running the air conditioner vs. windows down) was covered by media outlets throughout the country including [The Baltimore Sun](#) and the [Los Angeles Times](#).
 - ORNL's Bo Saulsbury was quoted in an article on fuel economy tips in [Money](#).
 - A report from the FEI team about variances in real world fuel economy compared to EPA test cycle data received coverage from [CNBC](#) and other major media.

- [Automotive Engineer](#) covered research by the Georgia Institute of Technology, ORNL, University of Wisconsin-Madison, Arizona State University, and Xiamen University to develop new fabrication techniques that reduce the amount of platinum needed in fuel cells.
- Researcher John Storey was quoted as an emissions expert in articles and blog posts from the [Washington Post](#), [Scientific American](#), [Climate Wire](#), [MSN](#), and other media on the Volkswagen emissions-control software and test results.
- [Materials Today](#), [Biofuels Digest](#), and other media reported on the new ORNL-developed catalyst that works effectively at low temperatures with no precious metal content.



Researcher Andrew Binder works with the three components of ORNL's innovative low-temperature catalyst.

- [Biomass Magazine](#) published an article about Vertimass and Technip's new partnership to scale up ORNL technology for converting ethanol into hydrocarbon blendstocks that can be blended with gasoline, diesel, and jet fuel and are compatible with the current transportation fuel infrastructure.

Visits and Events



DOE Deputy Assistant Secretary for Transportation Reuben Sarkar enjoys a drive in the Green Racing Simulator with researcher P.T. Jones.

- When DOE hosted its first [Sustainable Transportation Day](#) at DOE headquarters in Washington, DC, the projects highlighted included ORNL's [3D-printed Shelby Cobra](#) and the [Freightliner SuperTruck](#), which ORNL contributed to as a member of the Daimler—Detroit Diesel SuperTruck team. Researcher P.T. Jones, Green Racing initiative lead, was on hand to assist with the [Green Racing Simulator](#), a particular favorite. The event was held to showcase the many ways EERE's strategic investments in sustainable transportation technologies are improving vehicle efficiency, advancing the use of alternative fuel vehicles, and creating jobs.
- A Sabic Global Technologies delegation from the United States, the Netherlands, and Saudi Arabia visited ORNL for 2 days to explore collaboration opportunities in energy storage. An initial Sabic-funded project focused on water-based processing technology for lithium ion batteries has been approved.



From left: Claus Daniel and Jagjit Nanda of ORNL; Kapil Sheth, Anne Bolvari, Roy l'Abee, Cameron Youngstrom, James Mahood, and Ranjan Dash of Sabic; David Wood, ORNL; Sreekanth Pannala and Prince Xavier of Sabic.

- A team from ORNL visited Knoxville Locomotive Works (KWL) under the Tech-to-Market initiative and discussed synergies between the lab's capabilities and the needs of KWL in bringing its remanufactured diesel-electric locomotives to market.



From left: KWL's Tom German welcomes Jim Parks, Robert Wagner, Brian West, Keith Kahl, and Claus Daniel of ORNL on a visit to discuss KWL's clean diesel technologies.

- The DOE Transportation Working Group (TWG) met at NTRC recently. TWG is an effort to provide a collaborative forum for DOE's EERE transportation programs and its core labs to identify and shape future R&D opportunities. Attendees included representatives from national laboratories and DOE leaders Reuben Sarkar, Dave Howell, Sunita Satyapal, and Jonathan Male.



Ron Graves, STP director, welcomes the DOE leadership and national lab representatives at the DOE TWG meeting.

- ORNL electric drive and lightweighting technologies were displayed at the National Lab Day on the Hill event. Congressmen and Senators learned about technologies developed through the national lab system, including advances in batteries and power electronics, multimaterial joining, and carbon fiber.



Researcher Tim Burress (center) shows Dave Howell of DOE new capabilities in PEEM.

- DOE VTO Acting Director Dave Howell got an overview of progress in key research areas and toured research facilities during a visit to NTRC.
- Dennis Smith and Shannon Shea of DOE VTO visited ORNL for an annual review of the Fuel Economy Information Project. Dennis is the national Clean Cities director and VTO deployment manager, and Shannon is the Clean Cities communications manager. This program supports ORNL's efforts in maintenance of the [fuel economy.gov](#) website, which is managed by the Center for Transportation Analysis. FEERC supports the program by developing and validating driving tips.
- John Storey and other FEERC team members organized an [international workshop on Arctic black carbon \(BC\)](#) held in Milan, Italy. The workshop, jointly hosted by DOE EERE, the European Commission's Joint Research Centre, Regione Lombardia, and ARPA Lombardia, brought together more than 80 atmospheric pollution experts from around the world. BC measurement and modeling methods, results of studies, and policy papers were presented at the workshop. Of particular note was a first-of-its-kind presentation by Russian researchers describing BC pollution from ships in the Arctic Ocean.
- ARPA-E program director James Klausner toured FEERC and PEEM during his recent visit to ORNL.

Outreach

Energy Efficiency and Renewable Energy Industry Day



Assistant Secretary for EERE Dr. David Danielson speaks at the Industry Day opening session.

ORNL hosted EERE Industry Day to build relationships and encourage dialogue among research, industry, and federal representatives. The 2-day event attracted more than 350 participants and showcased energy-efficient innovations in transportation, buildings, and advanced manufacturing, including a demonstration of the [Additive Manufacturing Integrated Energy \(AMIE\)](#) project.



Novel 3D-printed vehicle can power the novel 3D-printed building using fast, efficient bi-directional wireless power transfer.



From left: ORNL's Ron Graves, Claus Daniel, Roderick Jackson, and David Wood; DOE's Reuben Sarkar and Sunita Satyapal; and ORNL's Johnney Green and Martin Keller.

AMIE is a model for energy-efficient systems that link vehicles and buildings—on or off the grid. It consists of a 3D-printed house, a 3D-printed utility vehicle, and an integrated energy system with smart controls that connects the two.

The printed vehicle features a hybrid electric powertrain with onboard power generation from natural gas. A single engine extends vehicle range and produces power for both vehicle and building. Energy flows back and forth between the car and house using fast, efficient bi-directional wireless power transfer—a first for level 2 charging.



Dr. Johnney Green, director of the ORNL Energy and Transportation Science Division, and Reuben Sarkar, DOE deputy assistant secretary for transportation, in the printed utility vehicle.

The demonstration and event were made possible through a combination of ORNL and DOE EERE funding. The development of the bi-directional wireless charging technology was funded by DOE VTO, whose long-standing support for the ORNL Sustainable Transportation Program also enabled the facilities and expertise used in creating the novel vehicle.



Roger England of Cummins Inc. discusses how his company has partnered with ORNL to advance its technology.

Transportation seminar highlights advanced research in powertrain materials

Allen Haynes, manager of the Vehicle Technologies Propulsion Materials Program at ORNL, recently presented a seminar on critical research to accelerate the development of affordable, high-performance engine and after-treatment materials. The talk, titled "Atoms to Engines: Powertrain Materials Research at ORNL," included discussion of ORNL's use of high-performance computing to develop low-cost, 300°C-capable cast aluminum alloys.

The Transportation Science Seminar Series features the crosscutting capabilities of transportation R&D to encourage collaboration across the lab. To view past presentations, please contact Kim Askey at askeyka@ornl.gov or 865-946-1861.



Allen Haynes discusses advances in ORNL powertrain materials research.

Patents

Method of synthesizing bulk transition metal carbide, nitride, and phosphide catalysts

US patent 9,012,349

Jae-Soon Choi, Beth L. Armstrong, and Viviane Schwartz have developed a method to make shaped bulk transition metal catalysts such as doped metal carbides. The resulting catalysts are catalytically active, mechanically robust, and suitable for packed-bed reactor applications. Especially attractive properties of the synthesized catalysts include hydrothermal stability and regenerability. The catalysts are therefore excellent candidates for biomass upgrading processes such as pyrolysis bio-oil hydrotreating, where catalyst durability is the single most important technical barrier. They also offer an economical alternative to current state-of-the-art precious metal catalysts used in the petrochemical industry. The work was conducted with support from DOE BETO.

EGR distribution and fluctuation probe based on CO₂ measurements

US patent 9,068,933

In this patent, an addition to US patent 9,000,374, Bill Partridge, Jim Parks, and Ji Hyung Yoo have added laser-based and four-probe-multiplexing capabilities to the exhaust gas recirculation (EGR) probe described in the [May 2015 Sustainable Transportation Update](#) (p. 4). Among the benefits of a laser light source are linear sensitivity over a wide CO₂ range, spectral discrimination of interfering species, and simultaneous pressure measurements. The use of multiple probes facilitates simultaneous measurement and analysis at different locations resulting in more extensive uniformity/anomaly mapping and accelerating validation and development. This patent is the sixth issued in the last 5 years for technologies developed through the long-standing Cummins–ORNL collaborative R&D agreement. The work is conducted with support from DOE VTO.

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Please submit to Kim Askey,
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