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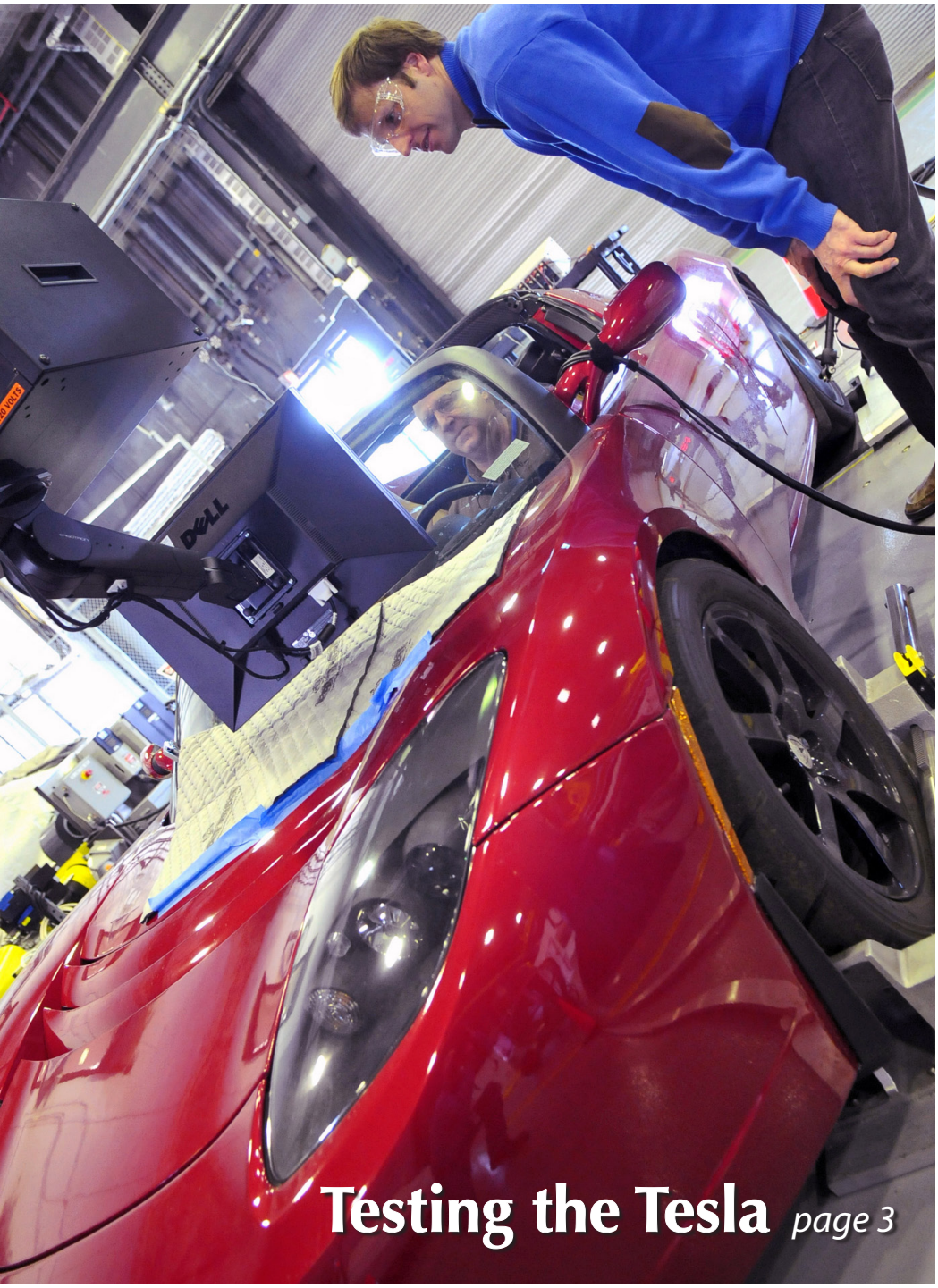

Testing the Tesla *page 3*

Volume 10, No. 2 — Summer 2010

RESEARCH REVIEWS

From Trash to Treasure: Turning Plastic Bags into Battery Anodes

Turning an environmental nuisance into a potential energy solution – now, that's innovation!

After much trial and error, Argonne Scholar Vilas Pol has figured out a way to convert those pesky plastic grocery bags into carbon nanotubes, which could be used as components of lithium-ion batteries for many applications, including cars.

Plastic bags are burned in a vessel at high temperatures (above) until carbon nanotubes are formed as seen in the vial (below).

Plastic bags have taken over the grocery market since they were introduced more than 30 years ago. Billions of them are used around the world each year. The bags are recyclable, but a majority of them still end up in landfills.

"They take hundreds of years to decompose," said Pol.

The bags are made of polyethylene, which is non-biodegradable and made from nonrenewable resources (crude oil and natural gas). They are one of the most challenging items for the recycling industry to manage.

Pol's groundbreaking process involves heating the plastic bags in a reactor with a cobalt catalyst to 700° C and then allowing it to cool. He found that the chemical bonds within the plastic completely break down, causing the carbon in the plastic to grow as nanotubes (cylindrical carbon molecules) on the cobalt particles.

These nanotubes can be used as anode material in advanced batteries such as lithium-ion (and eventually lithium-air) batteries.

"We have used the as-prepared cobalt-encapsulated nanotubes as an anode material for lithium-ion batteries and they work fantastically," said Pol. "The specific capacity of these carbon nanotubes is higher than commercial nanotubes."

The Argonne-developed technology is one of the cheapest and most environmentally-friendly ways to grow nanotubes yet to be discovered.

The method could potentially result in less-expensive batteries, while reducing the amount of waste going into landfills. The technology can also be applied to other plastic products including water bottles, another notorious environmental nuisance.

The process is now available for licensing to potential industry partners.

Funding for this project was provided by Argonne's Center for Electrical Energy Storage: Tailored Interfaces, an Energy Frontier Research Center funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences.

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watch the YouTube video:
http://www.youtube.com/watch?v=q17Bd6t0MHI

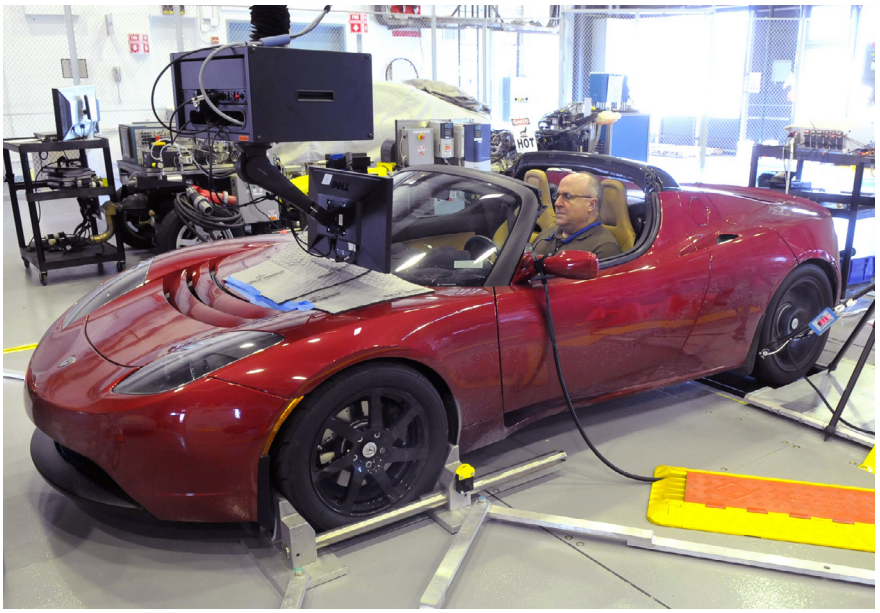
Testing the Tesla

Argonne transportation engineers recently evaluated an all-electric Tesla Roadster at the Advanced Powertrain Research Facility's (APRF's) new two-wheel drive dynamometer laboratory.

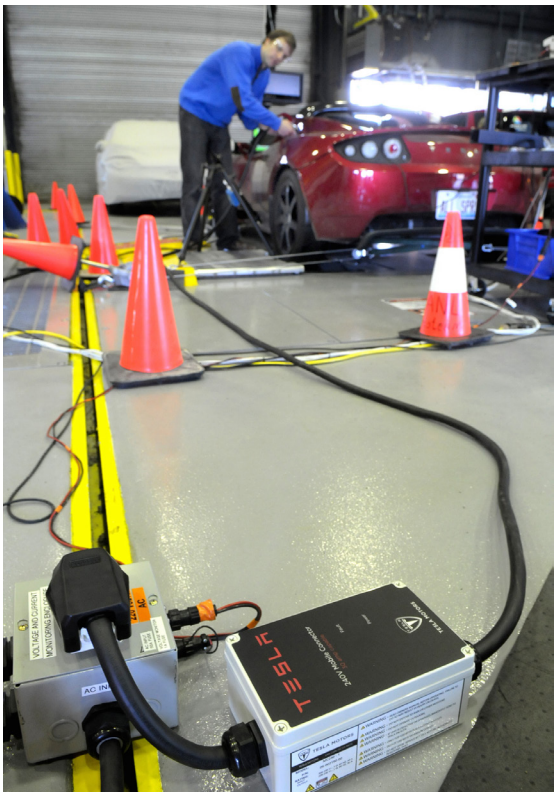
Data obtained from the Tesla will help researchers develop test procedures that provide an unbiased, consistent and practical approach to evaluating electric vehicles.

"As we study these advanced vehicles, our knowledge base of the progression of vehicle electrification technology is enhanced," said chief engineer Mike Duoba. "In a rigorous, controlled manner, we are able to study many vehicle operating conditions to determine the impact on fuel consumption.

"Testing the Tesla at Argonne resulted in some of the best information we've obtained from electric cars," he added.



Geoff Amann, senior technician at Argonne's APRF, takes the all-electric Tesla Roadster through a driving cycle at the Lab's two-wheel dynamometer laboratory.



Mike Duoba, chief engineer at APRF, prepares the all-electric Tesla Roadster for testing.

For example, researchers were able to evaluate several shortcut procedures used to report electrical energy consumption. This could potentially reduce dynamometer test time from 12 hours to 2 hours.

Argonne's work with the Tesla continues its support of the Society of Automotive Engineers (SAE) J1634 standard on electric vehicle testing. Ultimately, the new standard will result in more accurate assessments of electric vehicle range and electrical energy consumption.

The Tesla is owned by a private citizen, who allowed Argonne to test the car for several months.

According to the Environmental Protection Agency, the Tesla Roadster can travel 244 miles on a single charge of its lithium-ion battery pack. The all-electric sports car can also accelerate from 0–60 mph in 3.7 seconds.

Funding for this project was provided by the U.S. Department of Energy, Vehicle Technologies Program under the direction of Lee Slezak.

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Scientists Develop Greener, Cheaper Method to Produce Brake Fluid Component

Argonne scientists have identified a new class of silver-based catalysts for the production of propylene oxide that is both environmentally friendly and less expensive. Propylene oxide is commonly used in the production of propylene glycols for automotive brake fluids.

The study is the result of work by a collaborative team of researchers from five Argonne divisions, the Fritz-Haber-Institut in Berlin and the University of Illinois in Chicago. Argonne's efforts were led by chemist Stefan Vajda, materials chemist Larry Curtiss and nanoscientist Jeff Greely.

Vajda found that nanoscale clusters of silver (three-atom silver clusters, as well as larger clusters of 3.5 nanometers in size) are highly active and selective catalysts for the production of propylene oxide. (Catalysts help to initiate or accelerate chemical reactions.) Curtiss and Greeley then modeled the underlying mechanism behind the creation of propylene oxide by the ultrasmall particles of silver. They discovered that the open-shell electronic structure of the silver catalysts was the impetus behind the nanoclusters' selectivity.

"The production of propylene oxide now results in a significant amount of by-products that are harmful to the environment. We discovered that using nanoclusters of silver as a catalyst to produce this chemical results in fewer by-products at low temperatures," said Vajda.

Their discovery will, in the long run, contribute to cleaner automotive technology.

Argonne scientists (from left) Stefan Vajda, Larry Curtiss and Jeff Greeley have developed a new way of creating propylene that eliminates the many environmentally unfriendly by-products.

The experimental work was performed at Argonne's Advanced Photon Source, complemented with studies conducted at BESSY/Fritz-Haber-Institut in Berlin.

Funding for this project was provided by the U.S. Department of Energy, Office of Science, and from the U.S. Air Force Office of Scientific Research. A paper on this work was published in the April 9 issue of the journal *Science*.

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View *Science* article:
http://www.sciencemag.org/cgi/content/full/328/5975/224

Argonne Receives Funding for Two Projects to Improve Fuel Efficiency

Argonne is receiving funding for two of the nine projects recently announced by the U.S. Department of Energy (DOE) aimed at improving fuel efficiency in heavy-duty trucks and passenger vehicles.

The Lab will receive more than $5 million for its two efforts, which include the Navistar heavy-duty truck project and a passenger vehicle research project for Chrysler.

Navistar Project

Argonne will work with Navistar, Inc., to develop and demonstrate technologies to improve the combustion efficiency and waste heat recovery for Class 8, long-haul trucks. Mechanical engineer Thomas Wallner will head Argonne's participation in the project. Navistar was awarded more than $37.2 million; Argonne expects to receive $1 million per year for four years for the project work.

According to the DOE announcement, this collaborative effort aims to create a "super truck" by developing and demonstrating "technologies to improve truck and trailer aerodynamics, combustion efficiency, waste heat recovery, hybridization, idle reduction, and reduced rolling resistance tires."

Steve McConnell

Thomas Wallner

Chrysler Project

Argonne will also conduct combustion and fuel spray research on an advanced engine for Chrysler Group, LLC. When implemented on a large scale, improved combustion can significantly reduce fuel consumption and thereby reduce emissions. Engine research engineer Steve McConnell will head the combustion and spray project work for Argonne. Chrysler was awarded nearly $14.5 million, of which McConnell said the lab expects to receive $1.4 million for the combustion study this year.

DOE stated that the overall goal of the work with Chrysler is to "develop a flexible combustion system for their minivan platform based on a downsized, turbocharged engine that uses direct gasoline injection, recirculation of exhaust gases, and flexible intake air control to reduce emissions."

Nine Total Projects Announced

Secretary of Energy Steven Chu made the funding announcement, which included nine projects totaling more than $187 million. The funding includes more than $100 million from the American Recovery and Reinvestment Act, and with a private cost share of 50 percent will support nearly $375 million in total research, development and demonstration projects across the country.

"Improving the efficiency of our vehicles is critical to reducing America's dependence on foreign oil and addressing climate change," said Secretary Chu. "Today's awards will help demonstrate the potential benefits for long-haul trucks and passenger vehicles and will play an important role in building a more sustainable transportation system for the country."

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Argonne's Integrated Approach to Developing Biofuels and Engines

A diverse group of Argonne scientists and engineers are involved in a highly collaborative effort to make biofuels and engines work together more efficiently.

Biophysicists, theoretical chemists and mechanical engineers are among the researchers working together toward an integrated approach that combines the production of new biofuels with the design of internal combustion engines.

"Not only could this effort lead to cleaner, more efficient vehicles, it could also result in groundbreaking, new paradigms for the transportation industry," said Doug Longman, a mechanical engineer in Argonne's Transportation Technology R&D Center.

The multidisciplinary team combines basic and applied science, shares its findings and brainstorms solutions that will lead it to the ultimate goal of new higher-performance, lower-emissions combustion strategies and engine designs.

Argonne is uniquely qualified to pioneer this integrated approach. The Lab has programs in theoretical and experimental combustion chemistry and a renowned transportation program with strengths in engine characterization and testing, environmental impact analysis and fuel development. Bringing these programs together enables a design-test-feedback cycle that covers the critical aspects of fuel design and use.

Building on a National Plan

Biofuels have emerged as a key part of the national plan to reduce dependence on imported energy and decrease greenhouse gas emissions.

Argonne's work aims to design biofuels and engines that meet these goals, while also remaining affordable to consumers. The team is currently focused on developing infrastructure-compatible "drop-in" fuels that can be deployed in the existing petroleum pipeline, refinery and service station system. This compatibility will facilitate the transition from petroleum to biofuels without requiring billions of dollars of investment.

The group is joining forces for in-depth research on fuel production, combustion analysis, engine evaluation, and life cycle analysis and process economics. The success of the project relies on constant communication and collaboration across each of the scientific disciplines involved.

Fuel Production

Biophysicists and biochemical engineers are creating new bacteria to produce next-generation biofuels and feedstocks. Their work includes:

- Developing plant and algal-type feedstocks that efficiently use sunlight, carbon dioxide, nutrients and water to produce biofuels,
- Separating and converting biofuels from engineered bacteria to improve the energy efficiency of the fuel production process,
- Tailoring feedstock composition and processing techniques to produce and enhance fuel properties while controlling fuel costs, and
- Scaling up production of promising biofuels for combustion simulation and performance testing.

Argonne biophysicist Philip Laible oversees the growth of new variants of photosynthetic bacteria designed to produce target biofuel molecules. In this culture mode, it is easy to extract cells during all phases of growth for analysis, and add chemicals (shown here) to speed growth or induce the production of target fuels.

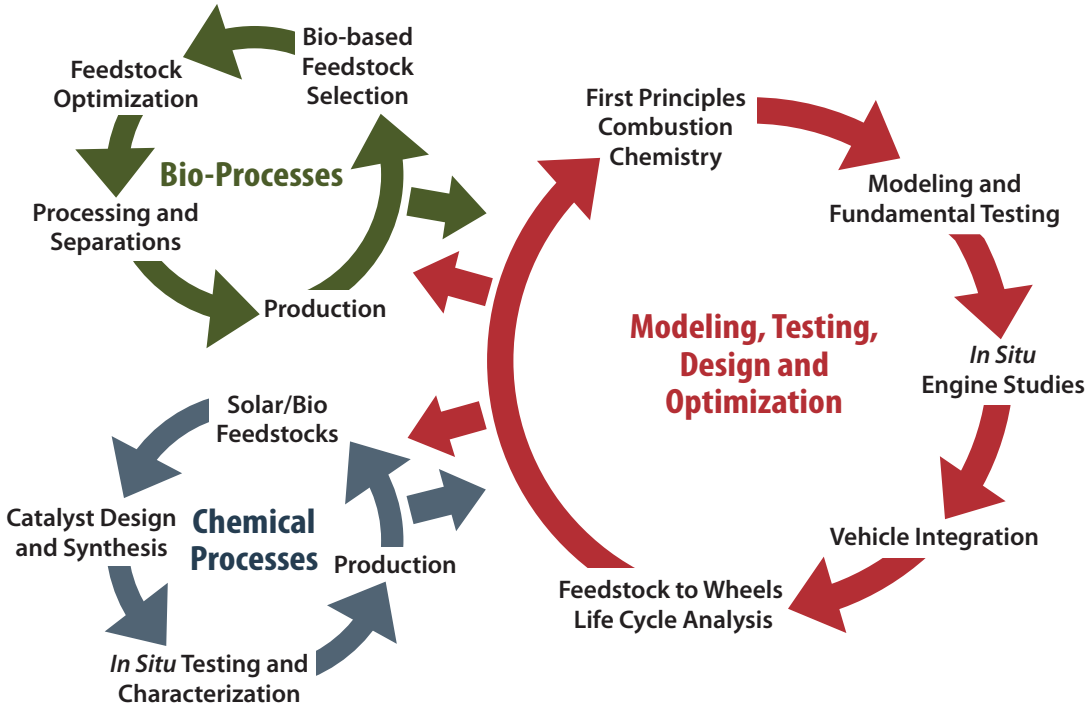
Argonne researcher Matthew Culpepper analyzes a gel pattern of proteins produced in the bacteria employed in biofuels production strategies. The engineered forms of many key proteins involved in the research can be purified easily, as seen in the gel lanes where patterns become simpler as samples become enriched in the protein of interest (left to right).

Combustion Analysis

Theoretical chemists are developing complex chemical models that describe the combustion of a variety of biofuels; these models will ultimately help predict and optimize the performance of current and future engines. This work includes:

- Performing theoretical calculations to provide kinetics data for important chemical reactions,
- Incorporating the data into a full chemical-kinetics model that provides ignition delay data and predictions on emissions formation during the combustion event,
- Using global sensitivity analysis to identify key data needs for an improved mechanism, and
- Performing new experiments and calculations to determine the data identified by this analysis, and then continuing to improve the model.

Continued on page 8



Argonne's unique research cycle provides the opportunity to specifically design fuel properties around the engine requirements. Fuel analysis and chemical kinetics modeling provides detailed information on the chemical reaction pathways and allows prediction of emissions. Feedstock and fuel processing analysis provides preferred, high-efficiency production pathways. The properties of new fuels enable increased benefits of advanced engine technologies, such as variable valve timing and compression ratio, to maximize efficiency and significantly reduce emissions.

Biofuels, Engines continued from page 7

Engine Evaluation

Mechanical engineers are running state-of-the-art, electronically controlled engines fueled with new biofuels to measure performance, emissions and efficiency. Their work includes:

- Conducting engine dynamometer tests to validate the model predictions of combustion characteristics, and measure gaseous emissions and fuel conversion efficiency,
- Applying computational fluid dynamics models with detailed chemical kinetics to simulate complex combustion and emissions processes, and
- Using visualization tools to conduct *in situ* analysis of combustion characteristics.

Argonne mechanical engineer Doug Longman uses a volt meter to check the electronic system on a modern diesel engine. The research team will use Argonne's engine testing facilities to measure the performance and emissions of newly developed biofuels.

Life Cycle Analysis and Process Economics

Environmental system analysts are tracing the environmental impact of various fuel and engine combinations using Argonne's GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) modeling software. This work includes:

- Calculating the total energy consumption of new fuel/engine scenarios,
- Determining greenhouse gas emissions and other criteria pollutants,
- Comparing the environmental impacts of fuels and engines on a full life cycle basis,
- Considering the implications on water use, water quality, land use and co-product production, and
- Developing models for the cost of commercial-scale fuel production.

Funding

Funding for this project was provided by the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass and Vehicle Technologies Programs, and the Office of Science, Basic Energy Sciences Program.

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Facility Spotlight: MATT

Many promising vehicle technologies have been developed in recent years, from engines and transmissions to advanced batteries and fuel cells. A cost-effective method was needed to bring all these technologies together for testing in a single vehicle system, so Argonne engineers created the Modular Automotive Technology Testbed (MATT).

MATT is a test platform that looks like a vehicle stripped down to its bare essentials. The base is a frame with wheels, but the test bed is outfitted with the different component modules that make up the vehicle powertrain.

The Argonne tool has been compared to an automotive Erector Set® because its modular approach enables the evaluation of different engines, transmissions and other core powertrain components.

For researchers in Argonne's Advanced Powertrain Research Facility, MATT provides an efficient new means of performing vehicle systems research and evaluating advanced technology components.

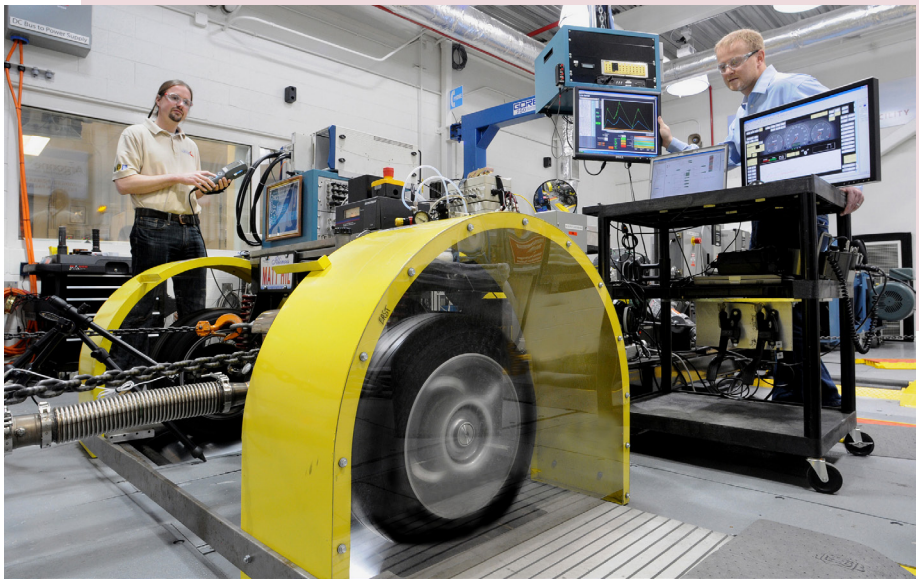
"One of the major advantages of MATT is that it allows us to separately test and benchmark individual components as they work in a system," said Argonne engineer Henning Lohse-Busch.

The scalable, virtual hybrid module enables MATT to operate as a conventional vehicle, a hybrid or even a pure electric vehicle using the exact same hardware. Special computer programs are used to help simulate real-world vehicle operation.

Data obtained using MATT helps researchers understand which combination of components result in a vehicle that best meets efficiency, emissions and performance targets.

When used with Argonne's PSAT and PSAT-PRO (Powertrain System Analysis Toolkit) modeling and simulation software along with component hardware-in-the loop principals, MATT allows researchers to:

- Add, rearrange and interconnect a variety of systems and components,
- Emulate different vehicle behaviors (conventional, hybrid and electric vehicle),
- Have complete flexibility to implement any energy management and torque split strategies,
- Measure physical energy consumption and emissions data over drive cycles, and
- Equip selected systems and components with instrumentation.



Argonne automotive engineers Thomas Wallner (left) and Henning Lohse-Busch put an engine through its paces on MATT.

Funding for this project is provided by the U.S. Department of Energy, Vehicle Technologies Program under the direction of Lee Slezak.

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Modeling PHEV Thermal Effects on Engine Efficiency

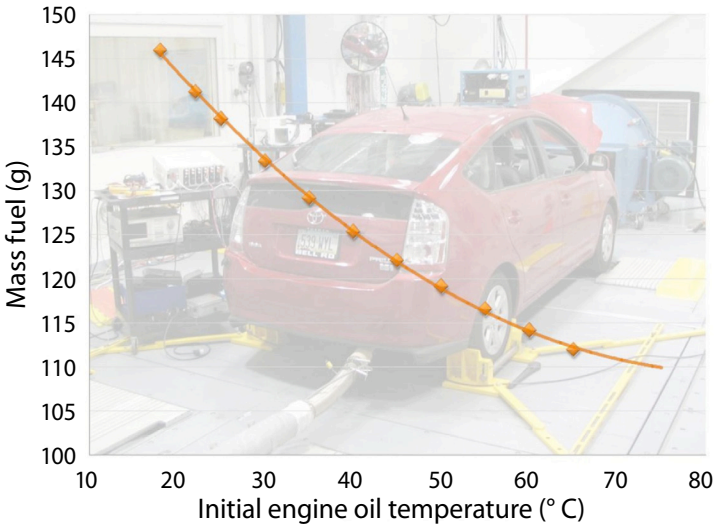
Efficiency losses of 25-40 percent are seen in plug-in hybrid vehicles (PHEVs) between ambient 20° C cold starts to optimal hot temperature urban drive cycle operation. These losses are especially critical for PHEVs, when long durations between running the engine result in reduced engine temperature.

"Variations in ambient temperatures and driving styles have a significant impact on fuel consumption by advanced powertrain vehicles. Understanding these efficiency losses will ultimately result in engineering more fuel-efficient vehicles," said Argonne's Forrest Jehlik, principal mechanical engineer.

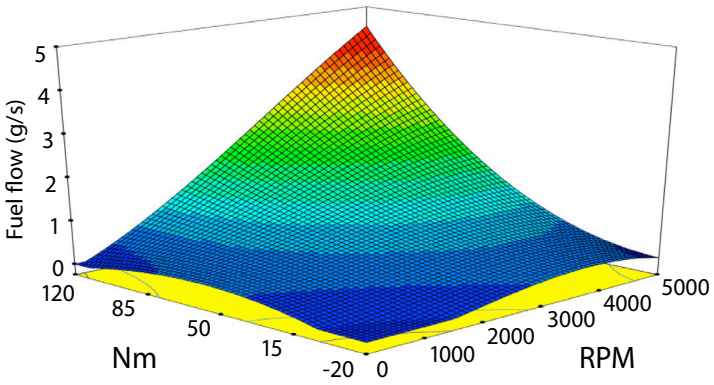
To learn more, Jehlik and his team used response surface methodology (a type of statistical modeling) to characterize the thermal effect on PHEV engine efficiency. Combined with a technique for predicting the engine's thermal state from its initial temperature, this unique method accurately predicts the fuel efficiency over a drive cycle from engine cold start to its fully operational temperature.

Their modeling experiments showed that

- Engine efficiency improved significantly with increasing engine temperature.
- Projected optimal engine temperature was ~25 percent more efficient than a 20° C ambient cold start.
- The initial enrichment spike during a cold start accounted for a ~3 percent fueling increase compared to a warm engine. Even greater accumulated losses (~20 percent) followed this cold start enrichment until the optimal engine temperature was reached.
- Between the range of 25-60° C, each 5° C increase in initial engine temperature decreased fuel consumption by 3.2 percent and 1.9 percent.
- Losses associated with the electric components, rolling losses and transaxles were minimal relative to engine and transmission thermal losses.



Modeled urban dynamometer driving schedule (UDDS) fuel consumption as a function of initial engine temperature. Background photo is a test vehicle on chassis dynanometer.



Fuel flow rate response surface shown at engine oil temperature of 22° C. Fuel flow rates and surface changes as temperature increases.

Jehlik and his colleagues are working to develop a displacement-independent engine model to be used in vehicle simulation work that will account for engine thermal efficiency effects.

Funding for this project was provided by the U.S. Department of Energy, Vehicle Technologies Program under the direction of Lee Slezak.

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New Battery Facilities Will Help Accelerate Commercialization of Technologies

Argonne will soon have three new battery facilities to bolster its research and development of battery materials and batteries for hybrid electric vehicles, plug-in hybrid electric vehicles and all other electric vehicles.

The Lab was recently awarded $8.8 million in American Recovery and Reinvestment Act (ARRA) funding to build a Battery Prototype Cell Fabrication Facility, a Materials Production Scale-Up Facility and a Post-Test Analysis Facility.

After more than a decade of experience in lithium-ion battery research, Argonne scientists are well aware of the challenges of getting manufacturers interested in advanced materials for their batteries. The new facilities will help to greatly accelerate this process.

"Argonne has developed a great number of new and innovative battery materials but most never make it to industrial production," said Gregory Krumdick, a principal systems engineer at Argonne, who will lead the Materials Production Scale-Up Facility. "This facility will be the link to connect the bench-scale research with the battery manufacturing industry."

He said the purpose of the facility is to develop manufacturing processes for producing advanced battery materials in sufficient quantity for industrial-scale testing.

"Processes developed in the lab are not always suitable for large-scale production," Krumdick said. "This facility will provide the means to scale up these processes, as well as to actually produce larger quantities of the materials for evaluation."

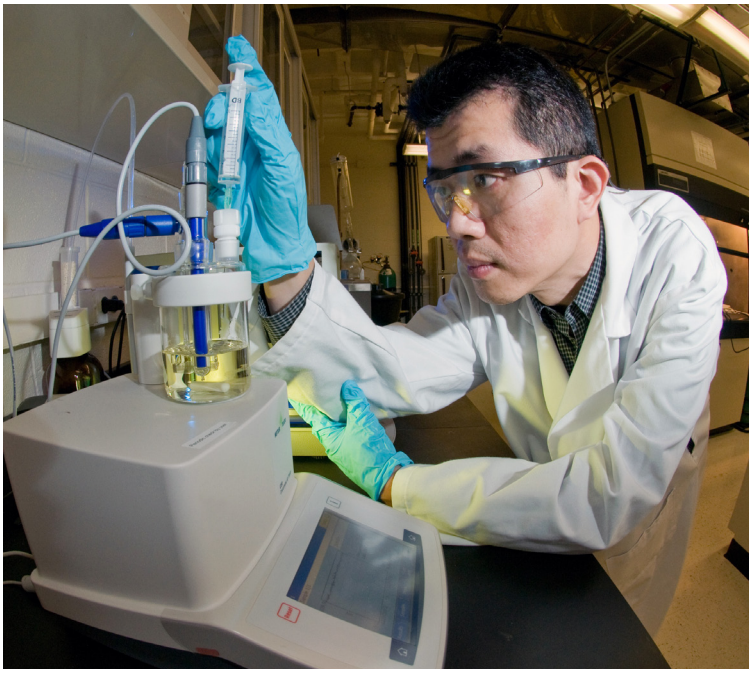
The Materials Production Scale-Up Facility will receive $5.8 million of the ARRA award.

Dennis Dees, an electrochemical engineer at Argonne, will help oversee the new Prototype Cell Fabrication Facility.

"This facility will create a direct pipeline between materials research and battery developers," said Dees. "It will greatly reduce the time to get battery improvements into production."

Dees said the laboratory will spend $1 million on equipment designed to improve the quality and evaluate the performance of newly fabricated cells.

Ira Bloom, a chemist at Argonne, will run the Post-Test Analysis Facility, which is slated to receive $2 million in ARRA funding.



At existing Argonne battery testing labs, researcher Gang Cheng conducts an experiment to detect moisture in battery electrolytes. Moisture is detrimental to the performance and longevity of battery cells.

"Post-test analysis is the natural extension of the battery testing that Argonne has been doing for many years," he said. "As a battery ages during use or testing, performance degrades and changes occur in the battery materials. Post-test analysis lets us see what physical changes occurred."

Bloom said his facility will be up and running in the next two years. Its activities' data will inform scientists and engineers of deficiences so they can make improvements in battery performance and life.

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Argonne Charges Ahead with Smart Grid Research

President Barack Obama has called for one million plug-in hybrid electric vehicles (PHEVs) to hit the road by 2015. Subsidies encouraging both PHEVs and electric vehicles (EVs) support this goal. If the combined demand for these vehicles skyrockets, utilities' power networks could be strained to the limit, requiring upgrades.

That is why the U.S. Department of Energy (DOE) is analyzing how the power grid can be redesigned to better meet America's energy needs. A multidisciplinary mix of scientists and engineers from Argonne National Laboratory is working to help develop a "smart grid" that will not only adapt in real-time to handle larger electricity loads, but also operate more efficiently and reliably than the existing grid.

The smart grid will move our country's electrical grid into the digital age. By integrating real-time, two-way communication technologies into the power grid, the nation will have a more robust and efficient system that empowers consumers to "talk" to the grid to choose where their electricity comes from and when they want it delivered.

"The smart grid doesn't propose to revolutionize the way we do power," said Ted Bohn, an electrical engineer at Argonne's Center for Transportation Research. "It's just about doing the same things more efficiently—smarter."

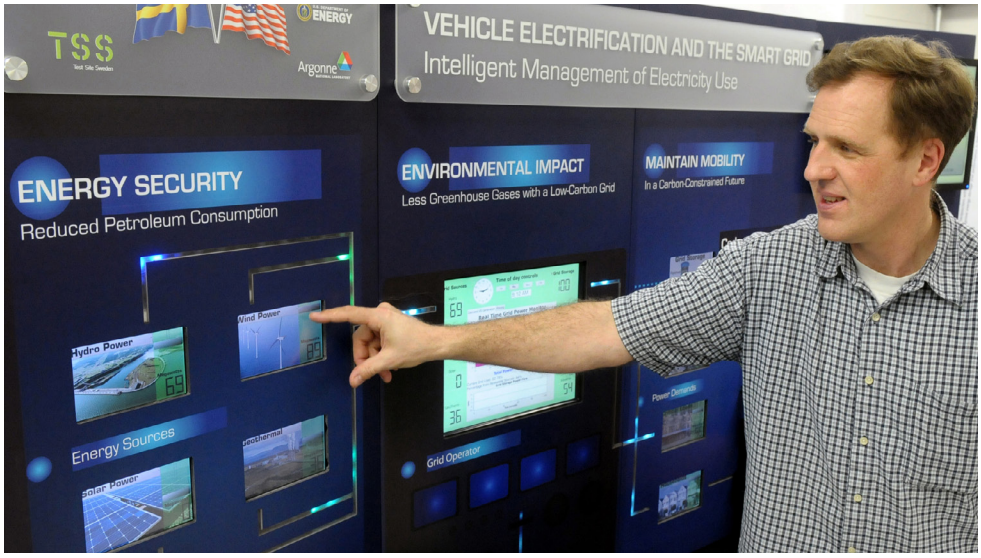
Plugging Away with Electrified Vehicles

Argonne transportation engineers are working to develop suitable standards for PHEVs and EVs, enabling cost-effective and smart interaction with the grid. For example, Bohn sits on the international committee working to develop the Society of Automotive Engineers' new connection standard called J-1772. The group is defining this standard, so manufacturers can build compatible connectors and vehicle sockets that will support both charging and two-way communication.

Transportation researchers are also validating some of the communications technologies that are being proposed to communicate between the vehicle's smart charger and the electrical infrastructure smart meters.

In December 2009, Bohn and Keith Hardy represented Argonne at the Bright Green Expo in Copenhagen, Denmark. They were on hand to discuss the efforts of DOE and Argonne to help facilitate the interaction of PHEVs and EVs with an updated smart grid.

To help visitors grasp the big picture, Bohn and Hardy brought along an interactive demonstration created by Argonne that illustrates the possible relationships between the nation's energy supplies, electric power grid operators and utilities, vehicles and consumers.



Using Argonne's interactive demonstration, engineer Ted Bohn demonstrates how the Smart Grid can play a role in lessening our country's dependence on foreign oil. The demo shows the possible relationships between energy supplies, operators and utilities, PHEVs and consumers.

The Argonne display features a mock-up of the J-1772 standard for connectors being developed for plug-in vehicles.

Supply and Demand

Les Poch and Matt Mahalik of Argonne's Center for Energy, Environmental, and Economic Systems Analysis (CEEESA) are concerned with the demand on the existing power grid as more and more electric vehicles hit the road. Poch and Mahalik model the generation capacity needs and the potential strain on the transmission grid if millions of new PHEVs and EVs were to plug in every night.

"Depending on what Americans do with their new cars, electricity suppliers could be overwhelmed—or they could stand to gain a lot," Poch said.

Electricity suppliers closely monitor regional demand. To prevent shortages, they must predict how much electricity will be needed at any given time.

Electric vehicles stand poised to throw off the now stable pattern. No one knows how quickly electric cars will catch on, in what areas they'll be most popular, or when everyone will choose to plug in their cars.

Today's electricity demand follows well-defined cycles. Demand increases during the daytime when commuters head to work, as homes and offices turn up the air conditioning and factories power up the machinery, and falls sharply during nighttime.

"The way we build power plants now is to make sure we have enough to meet the highest demand possible—the maximum amount of power on the afternoon of the hottest day of the year," said Vladimir Koritarov, deputy director of CEEESA. "Then they add some more for backup in an emergency. The rest of the year we won't need nearly so much power, but we have to be prepared for that one day."

For this reason, utilities must maintain a large reserve capacity that is unused for the majority of the year. Koritarov thinks that with the right approach, the smart grid could work out to everyone's advantage.

By using incentives to smooth out demand for electricity between day and night, a utility can produce power more economically. Also, smart charging of electric and hybrid vehicles during the off-peak periods can significantly help with that goal by filling up "demand valleys."

Grid Energy Storage

A significant stumbling block for power distribution is the lack of technology to store power for extended periods. Stored energy from variable resources, such as solar and wind, could be fed back into the grid at peak times to reduce the strain on the grid and conventional power plants.

Vehicle charging stations, like Coulomb Technologies' ChargePoint, will enable communication between the vehicle, consumer and electric utility companies. Argonne engineers are active in validating these technologies.

A team of Argonne materials scientists, chemists and engineers—already renowned for their successes in the field of advanced battery development for vehicles—is working to develop large-scale energy storage technologies that will capture energy whenever it's available and store it for use at a later time.

"The smart grid isn't a theoretical concept," said Bohn. "It's happening now."

Across the country, aspects of the smart grid are being tested in homes and neighborhoods. As America moves forward, science and Argonne work to improve the future—for households, businesses and utilities alike.

Funding for this research effort was provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Fuel Cell Technologies Program under Fred Joseck and Vehicle Technologies Program under Patrick Davis.

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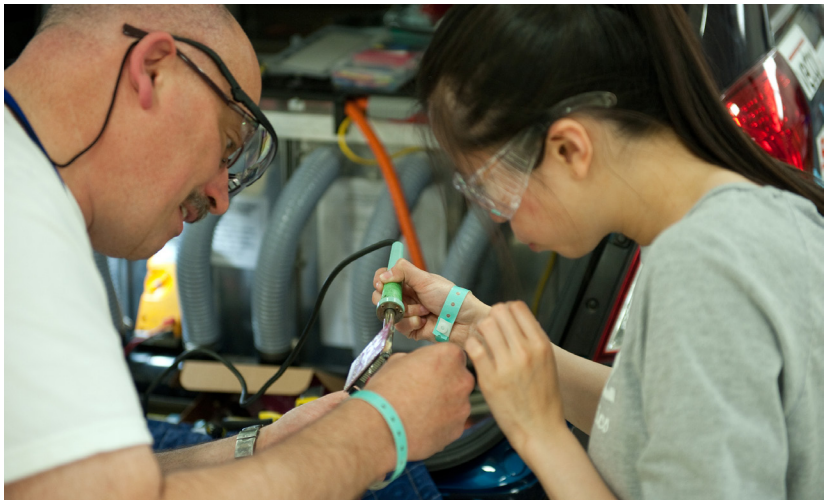
EcoCAR: Mississippi State University Wins Year Two Competition

Mississippi State University competed against 15 other universities to win first place in Year Two finals of the three-year EcoCAR: The NeXt Challenge competition sponsored by the U.S. Department of Energy (DOE) and General Motors (GM), and managed by Argonne.

In the three-year competition, EcoCAR challenges university engineering students from across North America to re-engineer a GM-donated vehicle to minimize the vehicle's fuel consumption and emissions, while maintaining its utility, safety and performance.

During Year Two of the EcoCAR competition, the teams used cutting-edge automotive engineering processes, such as hardware-in-the loop (HIL) simulation, to move their designs into real vehicles.



Team mates Pierre Hinse and Helen Qin, from the University of Ontario Institute of Technology, work on parts for their EcoCAR vehicle.

For the Year Two competition, the student vehicles went through a series of safety and technical tests at GM's Desert Proving Grounds in Yuma, Ariz., similar to those conducted on production vehicles. Each of the cars was evaluated based on the ability to decrease fuel consumption and greenhouse gas emissions, and maintain consumer acceptability in the areas of performance, utility and safety.

The Mississippi State University winning EcoCAR team chose to design an extended-range electric vehicle (EREV) hybrid with a 21.3 kWh A123 Systems battery pack that provided an electric range of 60 miles. The vehicle was also equipped with a 1.3 L GM turbodiesel engine and 75 kW UQM generator in a series plug-in configuration. During testing, the vehicle's fuel economy stood out, achieving 118 miles per gallon gas equivalent (combined city/highway cycle).

Tom Garcia from GM (center) works with students from Rose-Hulman during the EcoCAR competition at the General Motors Desert Proving Grounds.

In addition to the overall winner's award, Mississippi State won nine additional awards including performance events in auto-cross and acceleration.

Virginia Tech earned second place in the Year Two competition with an ethanol EREV design and Penn State came in third with a biodiesel EREV vehicle.

"I congratulate Mississippi State on its outstanding work and well-deserved first-place finish," said Pat Davis, program manager of DOE's Vehicle Technologies Program. "The students' hard work goes beyond this competition—each EcoCAR team member's contribution and innovation is also helping to build a cleaner energy future."

About EcoCAR

EcoCAR is a three-year competition that builds on the 20-year history of DOE advanced vehicle technology competitions. It gives college engineering students the chance to design and build advanced vehicles that demonstrate leading-edge automotive technologies. General Motors provides production vehicles, vehicle components, seed money, technical mentoring and operational support. DOE and its research and development facility, Argonne National Laboratory, provides competition management, team evaluation, and technical and logistical support. Through this important partnership, EcoCAR aims to inspire and support the next generation of scientists and engineers to unite around the common goal of sustainable mobility.

Funding for this project was provided by the U.S. Department of Energy, Vehicle Technologies Program under the sponsorship of Connie Bezanson.

Mississippi State University's car won first place in Year Two of the EcoCAR competition.

For more information, contact
Kristen de la Rosa
kdelarosa@anl.gov
Website: http://www.ecocarchallenge.org
Blog: greengarageblog.org

Student Benefits from EcoCAR

Beth Bezaire, who is earning her graduate degree in automotive engineering from Ohio State University (OSU), is one of only a few women in her graduate program. Since high school, she's been active in internships, specialty classes in math and science, and programs like EcoCAR.

TransForum asked Beth: What has EcoCAR meant to you personally and as a team member?

Beth: EcoCAR continues to be an excellent experience. Working on a real-world, long-term project has given me hands-on experience that complements my coursework and helps me become more excited about engineering. As an OSU EcoCAR team member, I have been inspired by our team's culture of teaching one another; this helps to unify our team and make us all better team members and engineers. And personally, as one of our team's leaders, EcoCAR is preparing me for a career in industry. In addition to the technical skills I am gaining, EcoCAR is also challenging me to develop "soft skills," such as learning how to manage my time effectively, how to give and receive direction, how to use my strengths (while also stretching myself in areas that I am weaker), and how to work collaboratively with a wide network of people.

OSU student Beth Bezaire (left) and Chris Fillyaw (corporate sponsor MathWorks) discuss plans for the Ohio State team's EcoCAR vehicle before taking it out for a test drive.

In the News

APRIL 2010

Naperville's (Ill.) "green fuels depot demonstration project," in conjunction with **Argonne** and Packer Engineering, would convert yard waste into electricity, ethanol and hydrogen under a federally funded pilot program, reported the Chicago Tribune. Yard waste that Naperville picks up each spring would be placed into a reactor that would create energy sources. The reactor will be located at a Naperville city site.
http://www.chicagotribune.com/news/local/naperville/chi-napervillebrush-100412,0,4446372.story

Argonne will partner with Los Alamos National Laboratory and Nuvera Fuel Cells on the Sustained Power Intensity with Reduced Electrocatalyst (SPIRE) project, which will study and identify strategies to assure durability of fuel cells designed to meet DOE 2015 cost targets. The study is featured in the article, "Nuvera Fuel Cells Receives $8.4M in DOE Awards for Two Fuel Cell Stack Projects," on the GreenCarCongress website.
http://www.greencarcongress.com/2010/04/nuvera-20100412.html

Argonne's plug-in hybrid vehicle work is featured in the *Medill Reports Chicago* article, "Smart Grid Thwarts Energy Costs." **Les Poch** and **Tom Veselka** (Energy Systems Division) were quoted.
http://news.medill.northwestern.edu/chicago/news.aspx?id=163826

MARCH 2010

On March 5, the staff of the Austrian Trade Commission visited **Argonne's Transportation Technology R&D Center**. The visit and tours of various facilities were arranged and facilitated by fellow Austrian and Argonne engineer **Thomas Wallner**. The purpose of the visit was to gain insight into technologies of the future. *Advantage Austria* summed up the visit in its article, "Peeking into the Future."
http://www.advantageaustria.org/us/news/local/Peeking-into-the-future.en.jsp

Argonne's battery work is featured in the March-April issue of *BatteryPower* magazine in the article, "Funding to Push Battery Technology from Argonne Laboratory to Marketplace," on page 30.
http://www.batterypoweronline.com/images/BatterPowerMarchApril2010.pdf

Argonne's "smart grid" research was featured in *EarthTechling's* article, "Scientist Think Tank Thinking About PHEVs and the Smart Grid."
http://www.earthtechling.com/2010/03/scientist-think-tank-thinking-about-phevs-and-the-smart-grid/

FEBRUARY 2010

Argonne's work on ethanol and butanol was featured in the January issue of *AMFI Newsletter*. **Thomas Wallner** reported on progress in this research area. The report can be found on page 5 of the issue, which can be downloaded at:
http://virtual.vtt.fi/virtual/amf/news/amfinewsletter2010_1january.pdf.

Keith Hardy and **Ted Bohn** were mentioned in the article, "New Tech Team to Help Pave Way for Vehicle Electrification," on *USCAR.org*. Hardy and Bohn are part of the FreedomCAR and Fuel Partnership Tech Team, formed to address the technologies required to connect PHEVs to the nation's electrical energy grid.
http://www.uscar.org/guest/article_view.php?articles_id=316

In "Obama's Budget May Jump Start Future Electric Cars," scientists hope funding to develop an electric car battery that breathes air, and could eliminate gasoline in the process, will result from money allocated to Argonne National Laboratory in the proposed federal budget. **Khalil Amine** talked about the lithium-air battery with *Medill Reports Chicago*.
http://news.medill.northwestern.edu/chicago/news.aspx?id=155462

Finalists in the Progressive Insurance Automotive X Prize Competition will undergo dynamometer testing at **Argonne's Transportation Technology R&D Center** in August 2010, reports *CosmicLog*.
http://cosmiclog.msnbc.msn.com/archive/2010/02/09/2198526.aspx

Shore power for trucks at truckstops is far from dead, says *FleetOwner.* **Linda Gaines** and **Terry Levinson** commented on technologies for reducing idling.
http://fleetowner.com/green/archive/shore-power-trucks-0209/

JANUARY 2010

High-speed railways will be coming to Chicago with a $1.2 billion grant announced by Barack Obama. Illinois' grant will go toward making diesel-fueled trains more efficient. TTRDC Director **Larry Johnson** is quoted in an article by *Medill Reports Chicago*.
http://news.medill.northwestern.edu/chicago/news.aspx?id=155007

Larry Johnson

The IBM Blue Gene/P supercomputer will be used by the INCITE program to design materials for lithium-air batteries.

Through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program, a research team including scientists from **Argonne National Laboratory**, Oak Ridge National Laboratory and IBM will use two of the world's most powerful supercomputers to design new materials required for a lithium-air battery, reports *Nanowerk*.
http://www.nanowerk.com/news/newsid=14541.php

DECEMBER 2009

Henning Lohse-Busch was featured in an interview on the *Green Garage Blog*: "Where Are They Now: How AVTCs Led One Alumni Down a Road of Success." Lohse-Busch described his rise from FutureTruck competitor to research engineer at Argonne.
http://greengarageblog.org/2009/12/02/where-are-they-now-how-avtcs-led-one-alumni-down-a-road-of-success/

Henning Lohse-Busch

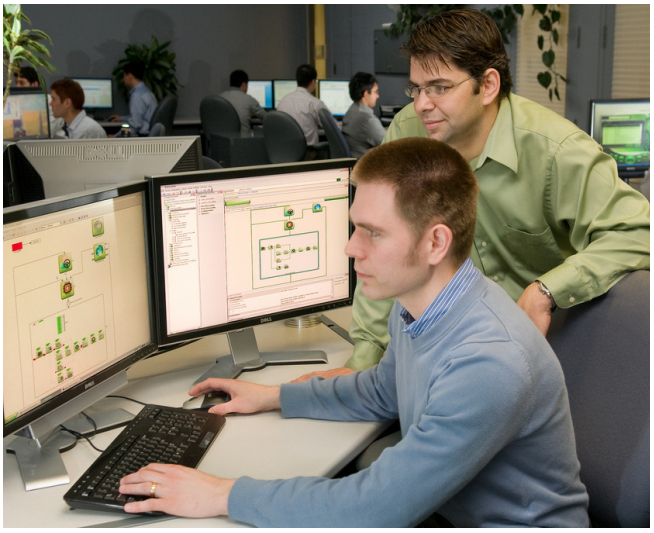
FASTRAX

MAY 2010

Argonne researcher **Khalil Amine** is the 2010 winner of the Battery Division Technology Award of the Electrochemical Society. The award is given to those individuals who have made outstanding contributions to the technology of primary and secondary cells, batteries and/or fuel cells. The intent of the award is to recognize recent contributions to the field that can be expected to have an impact on future battery and/or fuel cell applications. Amine will formally receive the award at the fall meeting of the Electrochemical Society in Las Vegas, Nev. at the Battery Division luncheon.

APRIL 2010

Researchers from Argonne's Transportation Technology R&D Center presented papers at the 2010 SAE World Congress. **Shane Halbach**, **Phillip Sharer**, **Sylvain Pagerit**, **Charles Folkerts** and **Aymeric Rousseau** presented "Model Architecture, Methods, and Interfaces for Efficient Math-Based Design and Simulation of Automotive Control Systems." **Dominik Karbowski**, **Jason Kwon**, **Namdoo Kim** and Aymeric Rousseau gave the talk, "Instantaneously Optimized Controller for a Multimode Hybrid Electric Vehicle," and **Ram Vijayagopal**, **Neeraj Shidore**, Shane Halbach, **Lawrence Michaels** and Aymeric Rousseau spoke on "Automated Model-Based Design Process to Evaluate Advanced Component Technologies."



Phil Sharer (front) and Aymeric Rousseau

Don Hillebrand

Don Hillebrand was the keynote speaker at the 2010 SAE World Congress in Detroit, Mich. http://www.sae.org/mags/AEI/SAEWC/8076

MARCH 2010

Jeffrey Miller received the 2010 F. G. Ciapetta Lectureship in Catalysis Award, presented by the North American Catalysis Society. The award honors substantial contributions to one or more areas in the field of catalysis, with emphasis on industrially significant catalysts and catalytic processes, and the discovery of new catalytic reactions and systems of potential industrial importance. http://pubs.acs.org/isubscribe/journals/cen/88/i11/html/8811awards4.html

May Wu presented results of water quality modeling for increased biofuel production during the "Bioenergy for a Sustainable Future" panel discussion at the U.S. Department of Energy's Biomass 2010 conference. Wu examined the impact of various biofuel feedstock production scenarios on water quality for the Upper Mississippi River Basin where the majority of existing U.S. biofuels are produced. Using a soil and water assessment tool watershed modeling approach, this study quantified environmental loading changes resulting from increased production of conventional corn ethanol, cellulosic ethanol produced from agricultural residue and switchgrass. Other Argonne team members included **Yonas Demissie**, **Eugene Yan** and **Gayathri Gopalakrishnan**. This study is supported by Department of Energy, Office of Energy Efficiency and Renewable Energy, Biomass Program.

FEBRUARY 2010

Linda Gaines presented "Lithium-ion Batteries: Examining Materials Demand and Recycling Issues" (co-authored with **Paul Nelson**) at The Minerals, Metals & Materials Society 2010 Annual Meeting and Exhibition in Seattle, Wash. Based on detailed estimation of material required for expanded market penetration, Gaines concluded that even an aggressive program of vehicles with electric drive can be supported for decades with known supplies of lithium, if recycling is instituted. However, larger vehicles with longer ranges require more material, and so heavy reliance on pure electrics could eventually strain supplies of lithium and cobalt. Download the paper at http://www.transportation.anl.gov/pdfs/B/626.PDF.

Peter Stair received the George A. Olah 2010 American Chemical Society National Award for his work in hydrocarbon/petroleum chemistry. In a series of studies using UV raman spectroscopy, Stair identified reaction intermediates during zeolite-driven conversion of methanol to hydrocarbons, as well as various type of coke deposits that accumulate on catalyst surfaces. He used the same methods to deduce critical relationships between catalyst structure and performance in hydrocarbon conversion reactions.

Thomas Wallner

Thomas Wallner received the SAE Engineering Meetings Board Outstanding Oral Presentation Award for his presentation, "Assessment of Multiple Injection Strategies in a Direct Injection Hydrogen Research Engine." The award recognizes individuals who make outstanding presentations at SAE technical sessions as evaluated by audience members.

Bob Larsen was chosen to be on the judging panel for the Hermance Vehicle Efficiency Award, which recognizes the most efficient and technologically advanced vehicle for sale in the U.S. The award was named after David Hermance, an early advocate of electric-drive and highly efficient vehicles. The award was presented to Ford Motor Company's 2010 Fusion Hybrid on Feb. 10, 2010, at the Chicago Auto Show.

JANUARY 2010

Khalil Amine

Khalil Amine was awarded the International Battery Materials Association's Technology Award in recognition of his outstanding contribution to advances in lithium-ion technology. This award recognizes scientists that make a significant impact in battery technology during their careers.

Orli Gill, the counsel general of Israel to the Midwest and Noa Asher, Israel's trade commissioner of economic affairs to the Midwest, visited **Argonne's Transportation Technology R&D Center** on January 14. Several areas for potential collaboration were identified, including lithium-air batteries.

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PUTTING ARGONNE'S RESOURCES TO WORK FOR YOU

Industrial technology development is an important way for the national laboratories to transfer the benefits of publicly funded research to industry to help strengthen the nation's technology base. The stories highlighted in this issue of TransForum represent some of the ways Argonne works with the transportation industry to improve processes, create products and markets, and lead the way to cost-effective transportation solutions, which in turn lead to a healthier economic future.

By working with Argonne through various types of cost-sharing arrangements, companies can jump-start their efforts to develop the next generation of transportation technologies without shouldering the often prohibitive cost of initial R&D alone. Argonne has participated in dozens of these partnerships and has even been involved in helping to launch start-up companies based on the products and technologies developed here.

If working with world-class scientists and engineers, having access to state-of-the-art user facilities and resources, and leveraging your company's own capabilities sound like good business opportunities to you, please contact our Technology Development and Commercialization Division and see how we can put our resources to work for you.

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www.transportation.anl.gov (under "Working with Argonne")

TransForum ›› Volume 10, No. 2, Summer 2010
ISSN 2156-3594 (print)
ISSN 2156-373X (online)

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TransForum is published by the Transportation Technology R&D Center, Argonne National Laboratory. Publishing support services are provided by Argonne's Technical Services Division. Art direction/design by Cindi Andersen.

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