

TransForum

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Idling Reduction: The Low-Hanging Fruit of Fuel Economy

On the face of it, vehicle idling—running an engine without using it for its primary purpose, propulsion—doesn't seem like a weighty issue. From a power-consumption perspective, however, engaging an engine to, say, run a vehicle's radio is like using an industrial Viking oven to toast half a bagel. In the United States, idling consumes more than 6 billion gallons of fuel per year. The cost? More than \$20 billion annually.

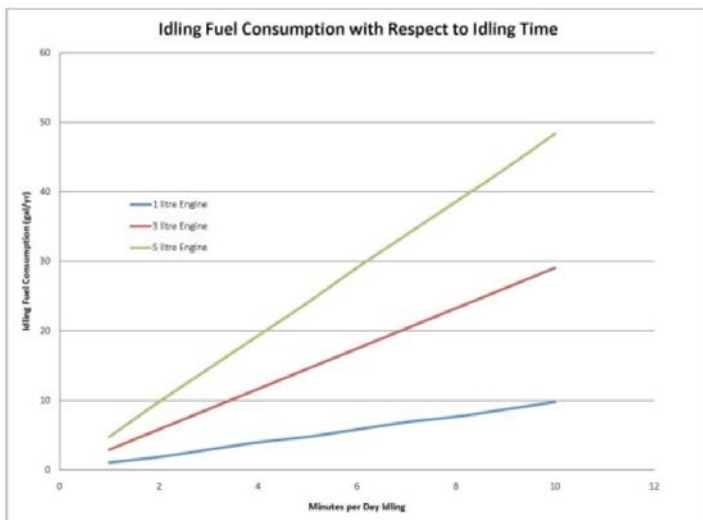
Since the publication of its *Analysis of Technology Options to Reduce the Fuel Consumption of Idling Trucks* in 2000, Argonne has been at the forefront of the study of idling reduction. In 2004, Argonne planned and coordinated the National Idling Reduction Planning Conference, an event that brought together stakeholders in industry and government to begin identifying consistent, workable solutions to heavy-duty vehicle idling. Since then, Argonne has led the information-sharing network with the publication of the U.S. Department of Energy's monthly newsletter, *National Idling Reduction Network News*. Argonne scientists continue to analyze and compare the alternatives to idling in cost, payback time, petroleum use and emissions reductions. They assess not only overnight truck idling, but workday truck idling, as well as the idling of buses, locomotives, marine vehicles, and, more recently, light-duty vehicles.

Currently, Argonne researchers are partnering with the Illinois Tollway Authority to identify ways to reduce costs and heighten the efficiency of the Tollway's fleet. They are seeking ways to reduce "engine-on" (surveillance mode) idle time for

patrol cars without sacrificing operational capabilities. Because the Illinois Tollway spends about \$2 million on fuel per year, even a one-percent reduction in fuel consumption would save about \$20,000 annually. Read more about this story on page 14.

Argonne is also working with the City of Chicago to assess the fuel savings and emissions reductions achieved with its nearly two-year-old diesel idling ordinance. An Argonne team will evaluate data from GPS-equipped city vehicles that monitor location and engine status. Argonne scientists are also collecting data on passenger car idling, including startup emissions, catalyst warm-up times and idling emissions. This data will shed light on the fuel and emissions costs of buying lunch at a drive-through, for example, compared to shutting off the engine and making the purchase inside.

Funding for this work is provided by the U.S. Department of Energy's Energy Efficiency and Renewable Energy Office, Clean Cities Initiative.



For more information, contact

Linda Gaines
lgaines@anl.gov

Argonne Idling Website:

<http://www.transportation.anl.gov/engines/idling.html>

National Idling Reduction Network News:

http://www1.eere.energy.gov/vehiclesandfuels/resources/fcvt_national_idling.html

Reducing Truck Idling: A Historic Study

In 2006, Argonne presented the first study that compared idling-reduction technologies with each other and with idling on the basis of both costs and full fuel-cycle emissions, for different locations, fuel prices and idling patterns. With renewed government interest in promoting energy-efficient trucks, this study is still relevant today.

All of the idling-reduction technologies considered in the study reduced emissions of carbon dioxide (CO₂), nitrogen oxides (NO_x) and particulate matter (PM₁₀) by a factor of three or more compared to idling. All paid back the truck owner's investment in two years or less at the 2006 diesel fuel price of over \$4 per gallon.

Idling the main engine was the standard method of providing truck cab comforts such as heating and cooling. Systems such as small diesel-fired heaters, air conditioners that used thermal or battery storage to store energy generated during the truck's operation, auxiliary power units that converted diesel fuel to electricity to supply space conditioning, and power for appliances and wayside systems (electrified parking spaces or EPS) that allowed the driver to plug into stationary power were proposed as non-idling alternatives.

Argonne's study concluded that for trucks that idled fewer than 20 hours per week, idling reduction technologies with low capital investment were the most attractive to the truck owner from a total cost perspective. These included electrified parking spaces and idling. From an emissions standpoint, of course, idling was the least attractive alternative. Again, heaters supplied heat with the lowest impacts, and the most desirable methods for supplying air conditioning (AC) were storage AC if the truck was a 2007 or later model or EPS. For older trucks, there was a trade-off.

For trucks that idled over 20-30 hours per week, technologies using onboard equipment, including dual-system (requires both onboard and offboard equipment to plug into electrical outlets) electrified parking spaces, resulted in the lowest total cost to the truck owner over five years of operation, while single-



Idling the main engine is the standard method of providing truck cab comforts such as heating and cooling.

system EPS (offboard equipment provides heat, ventilation and air conditioning) resulted in the highest total cost of idling alternatives. NO_x from pre-2007 trucks and CO₂ emissions could be reduced by air conditioning via EPS, but this option resulted in an increase in PM₁₀ because of the use of coal in the grid mix in all states. However, most of these PM₁₀ emissions were upstream, in rural areas, leading to low population exposure and lower health costs.

In this study, Argonne found that heating plus storage air conditioning and dual-system EPS were among the options preferred on both economic and environmental grounds over a wide range of idling behaviors, regardless of location.

Funding for this work was provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy Office, Vehicle Technologies and FreedomCar Program, under the late Sid Diamond.

For more information, contact

Linda Gaines
lgaines@anl.gov

Read the study: "Which Idling Reduction Technologies are Best?" at www.transportation.anl.gov/pdfs/EE/533.pdf

Fuel Spray Modeling for Alternative Fuels

Biodiesel is a promising, renewable alternative fuel because it is compatible with the world's current diesel fuel infrastructure. Incorporating biodiesel into this infrastructure can be accelerated using computational modeling tools that explain what happens to the fuel as it is injected—experiencing atomization and primary breakup—and combusted in the engine.

Argonne researchers have developed a new, improved primary breakup model that uniquely integrates the effects of fuel in-nozzle flow to engine processes. The new model is needed to optimize the performance of biodiesel in engines, and because the physical and chemical properties of biodiesel are significantly different from those of traditional diesel fuel.

Current spray atomization models used in diesel engine simulations generally consider aerodynamically induced breakup using the Kelvin-Helmholtz (KH) instability model, which does not account for in-nozzle flow effects.

Argonne's new primary breakup model, the Kelvin-Helmholtz-Aerodynamics Cavitation Turbulence (KH-ACT) model, considers in-nozzle effects such as cavitation (formation of fuel vapor in low-pressure regions) and turbulence, along with aerodynamically induced breakup, thereby providing the ability to capture the influence of nozzle flow and fuel properties on spray, combustion and emission processes.

For the first time, a primary breakup model accounts for in-nozzle flow effects

Results Using the KH-ACT Model

Extensive validation of the KH-ACT model was performed against X-ray data collected at Argonne's Advanced Photon Source (Fig. 1). Under the conditions investigated, the KH-ACT model provides better predictions for spray penetration and dispersion, as well as liquid and lift-off lengths.

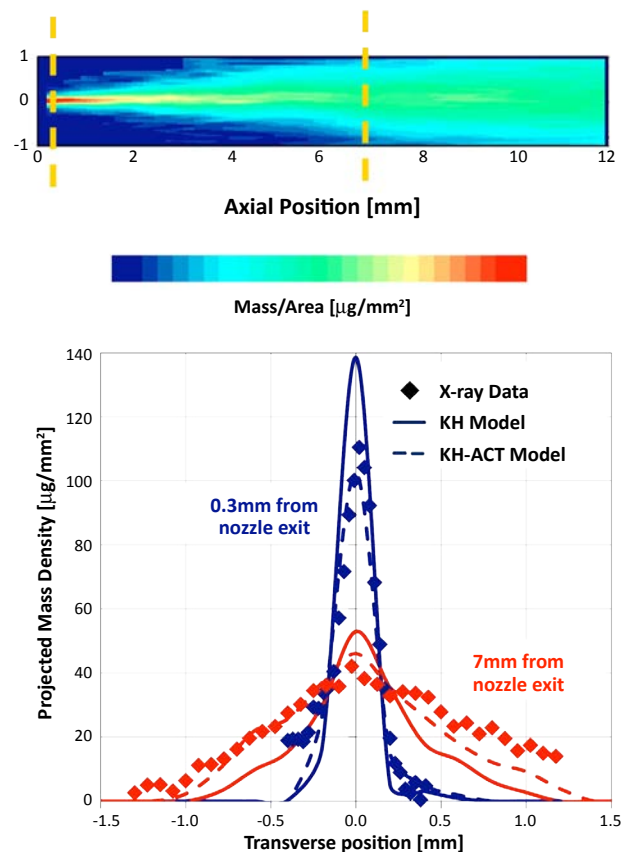


Figure 1: KH vs. KH-ACT model in predicting Argonne's X-ray radiography data.

Benefits of the KH-ACT Model

The new KH-ACT model has several benefits:

- ▶ Using the KH-ACT model reduces the expense of experimental research by integrating nozzle flow, spray, combustion and emissions modeling.
- ▶ Disparities in viscosity, vapor pressure and density reveal important differences in nozzle flow characteristics for diesel and biodiesel (Fig. 2), which influence spray and combustion behavior. For example, as shown in the figure,

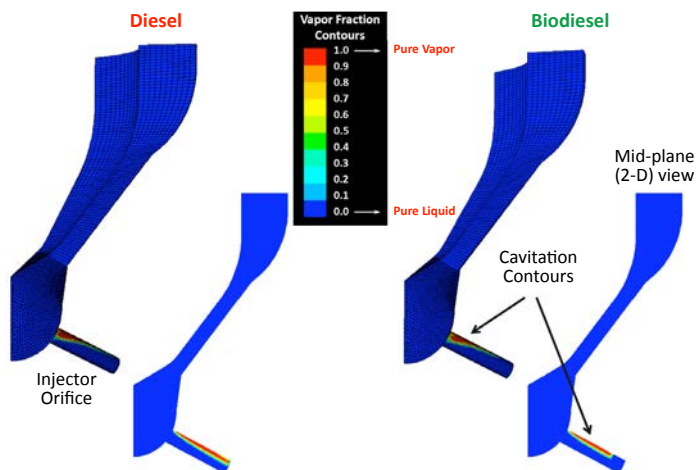


Figure 2: Fuel vapor distribution inside the injector for diesel and biodiesel fuels. Both 3-D (60° sector) and 2-D (mid-plane) views are shown.

the cavitation characteristics of diesel and biodiesel fuels are significantly different. This results in differences in spray characteristics such as penetration and dispersion, thus influencing the mixing and combustion processes.

- ▶ The KH-ACT model provides engine manufacturers with a more accurate predictive tool for efficient injection system design.

Argonne researchers also captured the influence of biodiesel on nozzle flow, spray, combustion and emission processes. Fuel spray penetration was enhanced with biodiesel while the dispersion decreased. In addition, soot emission characteristics with biodiesel were observed to be lower than with diesel fuel.

The KH-ACT model and the coupled nozzle flow and spray modeling approach are currently being implemented by Caterpillar Inc.; Convergent Science, Inc.; Ford, LLC.; and the University of Wisconsin at Madison in their in-house codes for internal applications.

Future research using this model will include:

- ▶ Implementation with high-fidelity turbulence models,
- ▶ Performance of full-cycle diesel engine simulations with different fuels and nozzle geometries, and
- ▶ Parametric studies on the effect of biodiesel feedstock variability on engine processes.

Funding for this work is provided by the U.S. Department of Energy's Energy Efficiency and Renewable Energy Office, Vehicle Technologies Program under Gurpreet Singh.

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For more information, contact

Sibendu Som
ssom@anl.gov

Learn more:

http://www.transportation.anl.gov/engines/multi_dim_model_home.html

New Program Bridges Gap Between Laboratory and Battery Industry

Argonne researchers have successfully scaled up the production of a new molecule that protects advanced lithium-ion batteries from thermal overcharge.

When Argonne materials scientist Khalil Amine and chemists Zhengcheng Zhang and Lu Zhang invented a redox shuttle additive material known as 2,5-di-tert-butyl-1,4-bis(2-methoxyethoxy)benzene or DBBB, the amount of the molecule they produced was sufficient for scientific testing and validation at the laboratory bench scale. But their process yielded too little material—less than 1 gram—for a company that may be interested in licensing and manufacturing the material to validate and test.

Applied researchers in Argonne's Advanced Battery Materials Synthesis and Manufacturing Research & Development Program took the formula and developed an improved, scalable process that created 1,576 grams in a single batch—enough to study and validate in a real battery cell, said Argonne's Greg Krumdick, a systems engineer whose team developed the scale-up process.

Scientists typically do not need large amounts of materials to work with, but companies that want to manufacture a new material do. And therein lay the challenge—it is critical for companies to test the viability of a new material they are looking to mass produce.



Initial discovery amounts of battery materials are small compared to the kilo-scale amounts needed for validation of new battery technologies. Argonne researchers have developed an improved, scalable process for the synthesis of a lithium-ion battery overcharge protection redox shuttle.

The scale-up of a specialty material like DBBB is no small feat. It is not like the doubling or tripling of a cake recipe. Other considerations—like time, temperature, concentration, mixing speeds and even the chemical ingredients themselves—that do not come up when making very small amounts of a material arise when attempting to make vastly larger volumes for commercial testing and mass market production.

“Unless you have a process to make a material in sufficient quantities, you simply can’t get enough of the material,” Krumdick said. “It is often wrongly assumed that industry will do the scale-up work, but most companies don’t want to make the significant financial investment required to develop the scale-up process. It’s too risky, especially if you don’t know if it will be economical to make the material at scale.”

That is where the process engineering and scale-up expertise and facilities of Argonne’s federally funded Advanced Battery Materials Synthesis and Manufacturing Research & Development Program are brought to bear.

The goal of process scale-up is to find economical ways to make a material. The bench-scale process used to discover DBBB would have cost 20 times more and generated 50 times as much waste as the scaled-up process to make 1 kilogram. The new process also is three times faster.

However, the bench-scale process was never intended to make commercial quantities of materials, Krumdick said. “When discovering new materials, it’s not your objective to be sure it is made economical; it’s to make it quickly. Once a new material has been discovered and is shown to have promise, it’s my group’s job to scale it up, meaning find economical ways to make large volumes of the materials.

“After finishing work on DBBB, we had made a kilogram-scale batch that was chemically analyzed and its electrochemical performance characterized. It was found to be identical to the initial material synthesized. The new process is also highly reproducible in yield and purity from batch to batch.”



Argonne researcher Sabine Gallagher prepares a surface area analyzer for the characterization of battery materials.

Krumdick worked with Krzysztof Pupek and Trevor Dzwiniel to scale-up DBBB at the Material Engineering Facility (MEF), where the scale-up work was done.

The U.S. Department of Energy invested \$5.8 million from the American Recovery and Reinvestment Act to help fund MEF's construction to help close the lag time between innovation and commercialization. The U.S. Department of Defense (DoD) provided another \$4 million toward MEF construction.

DoD is also interested in Argonne's battery research. According to the assistant secretary of defense, Sharon Burke, the average U.S. soldier on a 72-hour patrol carries between 10 and 20 pounds of batteries. "You can follow a U.S. infantry patrol by the disposable batteries that it trails behind it," Army Chief of Staff General Martin Dempsey said at an Institute of Land Warfare breakfast in May. "At the highest levels, there appears to be recognition of the inadequacy of disposable batteries."

The military uses batteries in a wide range of electronics, including the electronics systems in tanks, which would be able to remain in the field longer and without detection if some of its systems were run on batteries.

The MEF is not yet fully constructed. The facility is expected to be completed in January 2012 and will contain three pilot labs and high bays for continuous batch production of large volumes—up to 100 kilograms—of specialty materials for industry validation, said Krumdick, who oversees MEF construction.

Argonne plans make the MEF a quasi-user facility that will be accessible to other R&D organizations and companies, said Jeff Chamberlain, who leads Argonne's energy storage research initiative. The facility and the close teaming of scientists and engineers are part of a full-circle approach that Argonne employs to help industry move U.S. energy innovations into the marketplace more quickly.

"There are at least two battery manufacturers interested in the DBBB redox shuttle," Chamberlain said. "I believe that the success that Greg and his team have had in scaling up production of the material will allow Argonne to significantly shrink the time between product innovation and commercial licensing and manufacturing. Not only will the payback to the taxpayer's investment in R&D be shortened, but innovation's contribution to the growth of the U.S. economy will be realized that much sooner."

Funding for this work is provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Program.

For more information, contact

Greg Krumdick
gkrumdick@anl.gov

Learn more:

<http://www.transportation.anl.gov/batteries/scaleup.html>

Transportation Modeling Visualization at TRACC

The Transportation Research and Analysis Computing Center (TRACC) at Argonne National Laboratory uses visualization techniques to better model transportation systems and to educate and inform its transportation clients. Visualization provides a framework for the human visual system to perform technical analysis of highly complex and detailed data, which would otherwise be difficult to interpret.

TRACC creates models using the TRANSIMS software package, which has the novel capability to micro-simulate multimodal traffic over entire metropolitan areas.

Interpreting and tuning a highly dynamic transportation system spanning such a large area is a challenge that requires unique visual paradigms and specialized software. The most fundamental element of the software is its ability to display vehicles and their movements (Fig. 1), as well as to create a



Figure 1: Basic 3D car and roadway visualization.

recognizable world through satellite imagery and 3D building models (Fig. 2). TRACC has developed specific paradigms, including regional congestion analysis, signal coordination and transit ridership. Visually, these paradigms can take the form of mountains growing and shifting over a metropolitan region



Figure 2: Building models for downtown Chicago.

to show congestion patterns (Fig. 3), undulating multicolored graphs illustrating traffic statistics atop roadways (Fig. 4) or even a computational fluid dynamics model of a radioactive plume enveloping a virtual city.

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**TRANSIMS is able to micro-simulate
 the traffic of entire cities.**

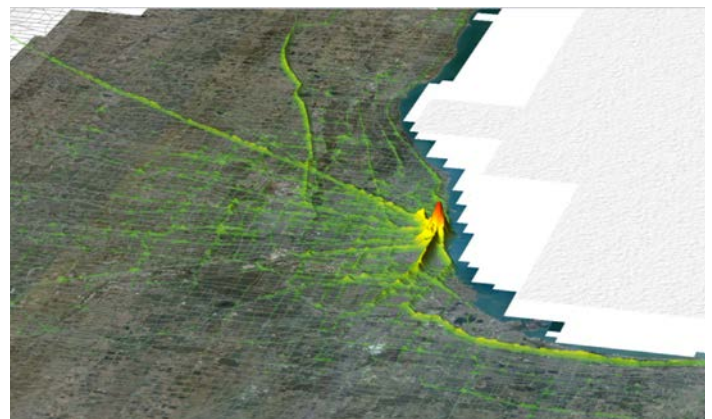


Figure 3: Heat plot illustrating congestion in Chicago.

TRACC also makes use of visualization to train users, raise awareness about TRACC, communicate information within project groups and convey results to sponsors.

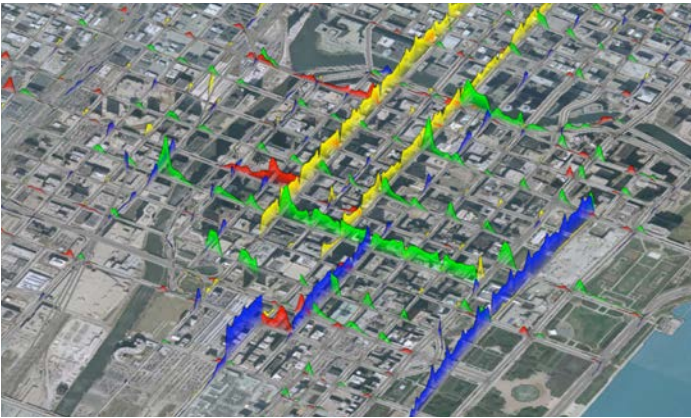


Figure 4: A link plot graphing information above roadways.

Components of the Visualization System

At the heart of visualization technology is the computer processor, graphics card and memory system. Each of these components has amazing potential in the context of transportation modeling and visualization. However, without understanding the hardware and using the proper programming techniques, this potential often cannot be reached.

Enter the world of video games. The gaming industry has always been driven by fierce competition to deliver the highest quality graphics and the highest performance play in an extremely reliable package on a wide variety of PC and console systems. This industry has taught TRACC many important lessons when developing a high-performance application. Fundamental visualization concepts include:

- ▶ Using a graphics library that will fully employ graphics hardware to bear the computational load of visualization,
- ▶ Using an efficient programming language and multi-threading the programs to make full use of a multicore processor,
- ▶ Understanding the relative performance differences between basic programming operations and data structures, and
- ▶ Profiling code diligently to identify and eliminate all the bottlenecks.

While TRACC aims to develop visualization software for the transportation modeling community and its hardware needs, TRACC also wants to “push the envelope.” This objective means taking a holistic approach to visualization system design by optimizing the software and hardware that it operates on. Hardware optimizations include the use of multiple graphics cards, solid state hard drives, large quantities of high-speed RAM and the best consumer processors available. These upgrades allow TRACC to develop interactive visualization capabilities on novel platforms such as a six-screen high-resolution display, an 88” multi-touch aware surface or a stereoscopic 3D-ready display. Each advance in visualization technology, if properly used, has the potential to bring the engineer, modeler and planner closer to grasping the truth in even the most complex transportation systems.

Visualization Projects

Visualization has played a pivotal role in each of TRACC’s transportation modeling projects. Before TRACC, the TRANSIMS software had no efficient method to look at results visually. The current project fueling the visual paradigms illustrated in this article is the RTSTEP (Regional Transportation Simulation Tool for Evacuation Planning) project funded by the Office of Emergency Management and Communications (OEMC) under the City of Chicago. The core concept of this project is to develop a novel tool that would allow evacuation planners to configure different evacuation cases using TRANSIMS and then view and compare the results. The interactivity and visual components of this project are vital to its successful reception. The tool cannot simply show the regional vehicle movements in such a disaster; it must also find creative ways to visually highlight the pros and cons of different evacuation management strategies.

Funding for TRACC research is being provided by the U.S. Department of Transportation and for RTSTEP research, by the City of Chicago.

For more information, contact

Mike B. Hope
hope@anl.gov

TRACC Website: www.anl.gov/TRACC

Argonne's Hydrogen Engine Performance Exceeds DOE Targets

Hydrogen remains an intriguing alternative fuel option for the transportation sector, but major barriers, such as cost and refueling infrastructure, must still be overcome before hydrogen cars are able to make a commercial splash.

At Argonne National Laboratory, engineers are wrapping up a research effort that shows that hydrogen internal combustion engines hold promise as a bridging technology toward a large-scale hydrogen vehicle infrastructure.

Argonne engineer Thomas Wallner and his colleagues in the Transportation Technology R&D Center (TTRDC) recently demonstrated a direct-injection hydrogen engine that met the stringent efficiency and emissions targets set by the U.S. Department of Energy (DOE), including a peak brake thermal efficiency of 45.5 percent (Fig. 1).

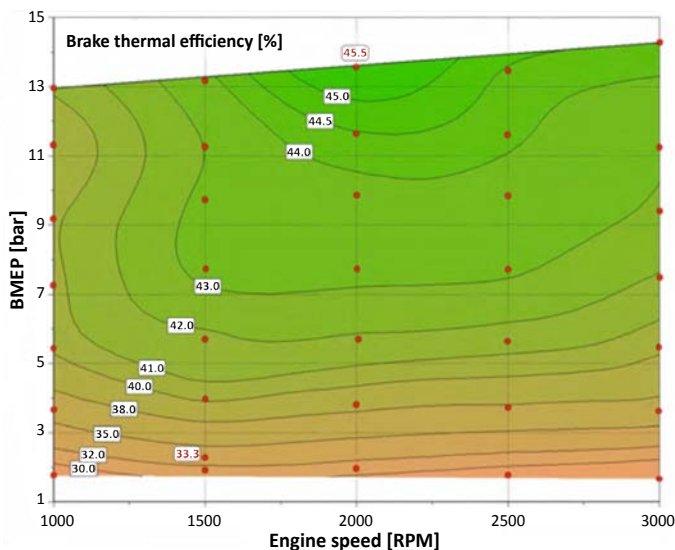


Figure 1: Full mapping of brake thermal efficiency results from Argonne's optimized direct-injection hydrogen combustion system.

"Peak brake thermal efficiency measures the amount of fuel converted into useful power during combustion," Wallner said. "The percentage we achieved with our hydrogen test engine is significantly higher than that of modern gasoline engines."

Other DOE targets for hydrogen internal combustion engines include:

- ▶ NO_x (nitrogen oxide) emissions of less than 0.07 grams per mile
- ▶ Equal or better power output than that of a comparable gasoline engine

Argonne's optimized hydrogen engine produced NO_x emissions of less than 0.02 grams per mile during a federal test drive cycle, and it is also expected to meet the most stringent emissions regulations without any aftertreatment system (Fig. 2).

However, to avoid the creation of NO_x emissions, hydrogen engines typically run lean (higher air-to-fuel mass ratio), which results in less power than that of a traditional gasoline engine. By turbocharging the hydrogen engine, the researchers were able to produce a power output that is slightly higher than what is produced by naturally aspirated gas engines.

To meet the DOE's challenging goals, Wallner and his team researched advanced mixture formation and combustion concepts, as well as engine-internal emissions reduction measures, such as water injection.

Their research on single-cylinder hydrogen engines focused on advanced injector design and injection strategies to improve the efficiency of hydrogen combustion engines, while simultaneously reducing emissions.

To complement their experimental data, the researchers used three-dimensional computational fluid dynamics (CFD) simulations for engine diagnostics and injection strategy optimization.

“We carefully tested and validated our CFD simulations against optical results from a hydrogen engine operated at Sandia National Laboratories,” said postdoctoral appointee Riccardo Scarcelli, who led the simulation activities for the project. “This proved to be an effective and cost-efficient development tool.”

Argonne researchers Nick Matthias (experimental work), Tim Rutter (technical support) and Jason Kwon (Autonomie simulations) were also instrumental to the project’s success.

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This hydrogen engine is expected to meet emissions regulations without aftertreatment systems.

According to Wallner, the optimized Argonne test engine would have a fuel economy better than that of most cars on the road today.

“If our hydrogen engine was used in a conventional vehicle, we estimate it would have a fuel economy comparable to a midsize car getting 39 miles per gallon,” he said. “And further improvements are attainable through engine downsizing and hybridization.”

Argonne collaborated with Sandia National Laboratories (for in-cylinder optical data), Ford Motor Company (for hydrogen engine and technical support) and Westport, Inc. (for hydrogen injector support) on the project.

Funding for this research was provided by the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy, Vehicle Technologies Program under the direction of Gurpreet Singh.

For more information, contact

Thomas Wallner
 twallner@anl.gov

Learn more about Argonne’s engine research:

<http://www.transportation.anl.gov/engines/index.html>

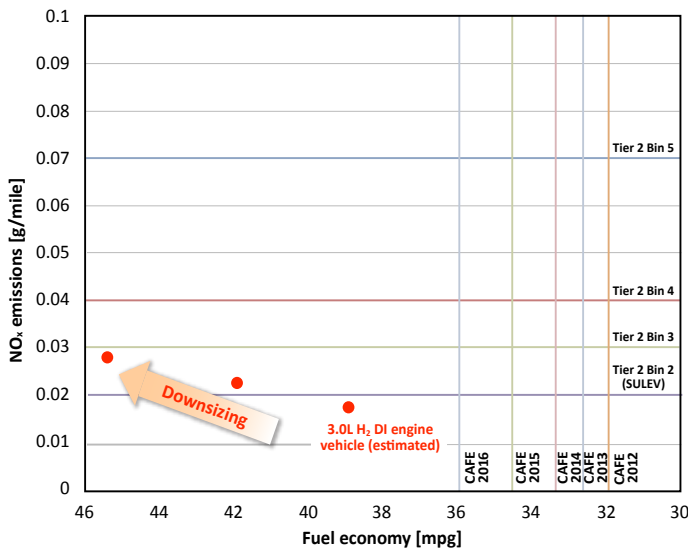


Figure 2: Estimation of drive cycle results for fuel economy and emissions.

Five Myths About Diesel Engines

Diesel engines, long confined to trucks and ships, are garnering more interest for their fuel efficiency and reduced carbon dioxide emissions relative to gasoline engines. Argonne mechanical engineer Steve Ciatti takes a crack at some of the more persistent myths surrounding the technology.

Myth #1: Diesel is dirty.

“We all have this image of trucks belching out dirty black smoke,” Ciatti said. This smoke is particulate matter from diesel exhaust: soot and small amounts of other chemicals produced by the engine.

But the U.S. Environmental Protection Agency’s emissions requirements have significantly tightened, and diesel engines now have to meet the same criteria as gasoline engines. They do this by adding a diesel particulate filter (DPF), which removes visible smoke. “DPFs are very effective,” Ciatti said. “They remove 95-plus percent of the mass of smoke.”

The smoke, trapped in a ceramic matrix, accumulates until the car’s computer determines it’s time to clean it out in a process called a “regeneration cycle.”

While running, a small amount of extra fuel is added to the combustion chambers in the engine; the resulting heat and oxygen activate a catalyst in the DPF to burn off the accumulated soot. This renders a small fuel consumption penalty.

“Visible smoke is essentially gone, as of the 2007-2010 regulations,” Ciatti said. “If you’re buying a diesel car from 2007 or later, it’s no dirtier than a gasoline-powered vehicle.”

And in the invisible range, diesel engines actually emit less carbon dioxide than gasoline engines do.



Steve Ciatti works on a diesel engine that can run on gasoline.

Myth #2: Diesel engines won’t start in the winter.

“Today’s technologies for cold-start are very effective,” Ciatti said. “Modern diesel engines start in cold weather with very little effort.”

The problem is that diesel gels at low temperatures. Below about 40°F, certain hydrocarbons in diesel turn gelatinous. “Since an engine depends on aerosolizing fuel, you don’t want goopy fuel,” Ciatti explained.

Often this is remedied with glow plugs, which are heated by the battery and help warm up the fuel so it can vaporize.

Low temperatures aren’t a problem for gasoline engines because gasoline is much more flammable than diesel. Even at room temperature and pressure, gasoline is partly vapor. “Toss a match into a pool of gasoline, and the match will never even hit the surface of the liquid; it will ignite the layer of vapor above the pool,” Ciatti said. “That’s why gasoline has to be handled extremely carefully around any ignition source. Diesel isn’t so volatile; if you tossed that match into a pool of diesel, it would go out.”

Glow plugs and other remedies, however, effectively vaporize diesel to prepare it for combustion.

Myth #3: Diesel cars don't perform well.

Because diesel engines are still most common in trucks, many people assume that diesel-powered cars would behave like a truck behaves: slow and sluggish. "But keep in mind, that truck's likely hauling around 50 tons," Ciatti said. "In fact, to some degree, some people who drive diesels find they perform better than gasoline engines."

That's because diesel-powered engines get their best power when the engine's revolutions per minute (RPMs) are low—that is, at speeds below 65 miles per hour, where most driving takes place. Gasoline engines, in contrast, get to peak power by running the engine very high and fast; a gasoline car only reaches its peak horsepower with the accelerator pedal to the floor and the engine running at 5,000 RPM.

"Diesel car performance is far better than the perceived horsepower rating, because you're getting all that power at speeds where you actually drive the vehicle," Ciatti said. "You've got more pulling power and more acceleration at those speeds."

Myth #4: You can't find diesel at the pump.

Diesel-powered pickups and cars are popular enough that the market has taken interest; most neighborhood gas stations now have automotive diesel pumps.

"I drove a diesel car myself for 10 years. I can count on one hand the number of times I had to actually search for a pump," Ciatti said.

Myth #5: Diesel fuel is more expensive than gasoline.

Though Chicagoland diesel prices are generally higher than gasoline, in most parts of the country, diesel fuel and gasoline are priced comparably. Today, Illinois taxes diesel at higher rates than gasoline.

"Diesel fuel is not more expensive to produce than gasoline," Ciatti explained. "Its price usually has to do with the local tax structure."

Finally, diesel engines actually perform better at high altitudes than gasoline engines.

Why? Gasoline engines operate at a very specific ratio of fuel and air. At high altitudes, the air is thinner—literally: there are fewer molecules of air per cubic foot. In the mountains, then, gasoline engines have to add less fuel to keep the ratio perfect, which affects performance.

"But a diesel engine runs fuel-lean; you don't have to keep the ratio perfect," Ciatti said. Diesel engines have turbochargers, which are pumps driven by exhaust gas. They add more air to the combustion chamber, and more air means more fuel can be added. At high altitudes, it can pull in more air and more fuel, and thus gets more power than gasoline engines can. Turbochargers don't use extra energy; they run off thermodynamically "free" energy that would be lost as exhaust if not used.

"Drive a diesel at high altitudes and you'll see other cars struggling while you zip past," Ciatti said. "The effect is very noticeable."

For more information, contact

Steve Ciatti
sciatti@anl.gov

Learn more:

http://www.transportation.anl.gov/engines/compression_ignition.html

Argonne Teams Up with the Illinois Tollway to Study Fuel Use

Argonne National Laboratory and the Illinois Tollway Authority have partnered to study fuel consumption reductions across the Illinois Tollway's fleet of vehicles in order to reduce the state's fuel use and costs, and to maximize the efficiency of its roadway operations.

The Illinois Tollway is providing \$150,000 in funding toward this research. The Illinois Tollway's fleet consists of 725 vehicles, including Illinois State Police District 15 squad cars. Its aim is to make its operations more efficient and sustainable. It spends \$2 million a year on gasoline, and reducing fuel use by even 1 percent will save \$20,000 annually.

This project involves a study of the state's police fleet to identify those operations where gasoline consumption can be reduced in a highway patrol car. Argonne researchers will perform controlled laboratory studies in the Advanced Powertrain Research Facility using a patrol car outfitted with special sensors that will measure electrical load from devices such as radios, emergency lights, on-board computers, video camera and radar units; and the associated fuel used to power these electrical accessories. Further, the fuel used to power the cabin air conditioning and heat will be isolated and measured during idling in both hot and cold operation.

Concurrently, Argonne researchers will instrument an equivalent patrol car on loan from Illinois State Police District 15, monitoring its daily operations on both rural and urban patrols, and gathering the same data measurements on critical vehicle functions during actual service for later analysis. Data from both patrol cars will be compared and used to determine fuel saving strategies that can be implemented cost effectively and will not impair police vehicle use.

Using collected data, Argonne will also develop idling reduction technologies that will allow state troopers to use radar, communications, computers and air conditioning with the engine turned off. Right now, troopers on patrol need to leave the engine idling in order to use cabin comfort devices and police gear such as the radar and computer. Idling increases gasoline use and expense and contributes to greenhouse gas emissions. Research results may also suggest other changes to vehicles or driver behavior to reduce fuel consumption.

This research effort is also part of a strategy to develop a regional application for other municipal fleets. The project is expected to take a full year so the patrol cars can be tested during all four seasons. The tools that Argonne will develop will be more advanced than what are now available from commercial auto manufacturers, and will eventually benefit not only Tollway fleet vehicles, but consumer vehicles and other fleets, as well.

This is the first research project to come out of a three-year collaborative agreement between Argonne and the Illinois Tollway Authority, which was announced in November 2010. The agreement proposes study areas including energy, fleet, intelligent transportation systems and the natural environment. The partnership combines the expertise of both organizations to accomplish transportation sustainability goals, use specialized knowledge and facilities and increase interagency cooperation.



Argonne Director Eric Isaacs addresses the crowd during a kickoff meeting of the Illinois Tollway/Argonne collaborative project. The Illinois Tollway vehicle on loan to Argonne is in the background.

For more information, contact

Glenn Keller
gkeller@anl.gov

Learn more:

<http://www.transportation.anl.gov/facilities/aprf.html>

Hillebrand Named to Automotive News' Electrifying 100 List

Don Hillebrand, director of Argonne's Center for Transportation Research, was recently recognized by *Automotive News* as a key player in the international push toward vehicle electrification.

As part of *Automotive News'* Electrifying 100, Hillebrand finds himself on a list that includes President Barack Obama, U.S. Department of Energy Secretary Steven Chu and a Who's Who of prominent figures from the world's leading automakers and suppliers.

While Hillebrand is honored to be included in the Electrifying 100, he is more enthused about how it reflects on Argonne's transportation research.

"To me, this list calls attention to the places across the world that are making the most critical advances with electric vehicles," Hillebrand said. "Being named to this list says a lot about Argonne and how our transportation research is helping pave the way for next-generation automobiles."

With the Electrifying 100, *Automotive News* aimed to identify the 100 people making the most significant difference in the development and deployment of electric vehicles.

The publication explained that compiling the list was no easy feat.

"As soon as we had decided to go forward, though, we realized that we had a major challenge. Many movers in vehicle electrification were familiar to us: leading automakers and suppliers. But many were not.

If EVs are to sell in significant numbers, it will require collaboration involving the traditional industry and new automakers, battery makers, government, utilities, advocacy groups, makers of chargers and other infrastructure equipment, investors and—oh, yes—big-budget customers who can jump-start the market with fleet purchases."



Don Hillebrand (right), director of Argonne's Center for Transportation Research, briefs Chinese Minister of Science and Technology Wan Gang on Argonne's Engine Research Facility in July 2010.

Automotive News scoured the globe to identify its Electrifying 100. They interviewed contacts, solicited nominations and finally had a committee decide on the candidates for the final 100.

"Geographically, (the list) runs from Korean battery makers to California EV true believers to the mayor of Paris," the article said. "We hope the Electrifying 100 stirs debate and serves as a snapshot of this fascinating, tumultuous time in automotive history."

For more information, contact

Don Hillebrand
hillebrand@anl.gov

Electrifying 100 Website:

<http://www.autonews.com/section/electric100>

Virginia Tech Takes Top Honors in Year Three of EcoCAR

In the EcoCAR Year Three Competition, held June 5-16 at General Motors' Milford Proving Ground and at locations throughout Washington, D.C., Virginia Tech took top honors and was named the overall Year Three winner for the team's E85-powered extended-range electric vehicle.

EcoCAR: The NeXt Challenge is a three-year collegiate advanced vehicle technology engineering competition established by the U.S. Department of Energy (DOE) and General Motors (GM), and is being managed by Argonne National Laboratory.

"The ingenuity and dedication shown by the students of Virginia Tech in building this next-generation vehicle will help them launch careers as leaders in the clean energy field," said U.S. Secretary of Energy Steven Chu. "With the experience and skills these innovative students have gained through the EcoCAR competition, they will help reduce our nation's reliance on oil imports and keep U.S. industries competitive in the global marketplace."

Virginia Tech's design paired a GM 2.4-L E85 ethanol FlexFuel engine and an 8-kW Kollmorgen electric motor used as a belted alternator starter with a 125-kW Unique Mobility permanent magnet electric motor in the rear to "make their car all Eco and no compromise."



Virginia Tech's vehicle took first place in the 2011 EcoCAR competition.

Their chosen electric vehicle design was well-executed and very efficient, achieving 81.9 miles per gallon gas equivalent—a 70 percent improvement over the stock vehicle.

Virginia Tech also outperformed the stock vehicle's autocross time, completing the course in 55.92 seconds. Co-team leader and future Argonne employee, Patrick Walsh, beat the General Motors driver by four-tenths of a second in a student fun-run drive. Combined with strong scores on their pre-competition deliverables and their technical presentations, the team took home 15 awards and more than \$20,000 in prize money.

During the Year Three competition, all teams competed in more than a dozen dynamic and static events, including a 300-point safety and technical inspection, dynamic and static consumer acceptability, braking, acceleration, autocross, and emissions and energy consumption testing.

"EcoCAR vehicles underwent engineering tests similar to those conducted by the automotive industry to determine a prototype vehicle's readiness for production," said Kristen De La Rosa, director of the Advanced Vehicle Technology Competitions at Argonne.

Teams traveled to Washington, D.C., where EcoCAR sponsors judged their technical and outreach presentations. Teams also participated in a sponsored social networking and recruiting event, enjoyed a tour of the White House and joined Secretary of Energy Steven Chu for the EcoCAR finish line event at the DOE's headquarters.

Argonne is working with DOE and General Motors in the new advanced vehicle technology competition series, EcoCAR 2: Plugging In to the Future, which began in August.

For more information, contact

Kristen De La Rosa
kdelarosa@anl.gov

Website: www.ecocarchallenge.org

Learn more:

<http://www.transportation.anl.gov/competitions/index.html>

Chu, Durbin Break Ground for Argonne's New Energy Sciences Building



From left to right: U.S. Senator Dick Durbin, University of Chicago President Robert Zimmer, U.S. Department of Energy Secretary Steven Chu and Argonne Director Eric Isaacs break ground for Argonne's new Energy Sciences Building.

U.S. Energy Secretary Steven Chu and U.S. Sen. Dick Durbin joined officials from Argonne National Laboratory and the University of Chicago at a June 3 groundbreaking event for the new Energy Sciences Building (ESB) at Argonne. The ESB will be a future home to energy-related science research, some of which will be applicable to transportation.

The \$95-million building, slated for completion in 2013, will house some 200 research personnel dedicated to addressing the world's most critical energy challenges.

"The research that will be performed here will transform the energy landscape and help America win the clean energy race—creating good jobs for decades to come," Secretary Chu said.

The research efforts to be conducted in the new facility include the development of highly reliable, safe and long-lived battery systems; revolutionary, efficient and environmentally friendly chemical transformation processes for creating novel feedstocks and fuels; and transformational systems for solar energy production.

"The Energy Sciences Building will be key in getting our scientists and engineers to deliver on our mission: doing basic science to generate, supply, transmit, store and use new energy," Argonne director Eric Isaacs said. "The building will bring together many different scientists under one roof to talk, collaborate and create new knowledge for this new economy."

The facility is being funded through the U.S. Department of Energy's Science Laboratories Infrastructure Program.

For more information, contact

John Szott
jszott@anl.gov

ESB Website: www.anl.gov/esb/

In the News

Here's a taste of Argonne's transportation news stories as published across the nation. See more stories at http://www.transportation.anl.gov/media_center/press_coverage.html.

JULY 2011

Don Hillebrand and Mike Duoba were interviewed on *Chicago's Nightly Business Report*. Watch the video at http://www.pbs.org/nbr/site/onair/transcripts/new_fuel_efficiency_standards_110729/.



The article "Idling Cars and Trucks Waste All of Our Gasoline," cites **Argonne research** in the July 30, 2011 *Morning Call* online at <http://www.mcall.com/opinion/yourview/mc-truck-idling-gavin-yv-20110730,0,1421223.story>.

Ted Bohn is quoted in the article, "Car Experts Offer Tips for Better Gas Mileage," online at the *Lansing State Journal*, www.jsonline.com/business/121476794.html.

Argonne's research MOU (Memorandum of Understanding) with South Korea is mentioned in the article, "Smart Grid Surges Ahead in South Korea." Argonne is assisting in this work. Read more on the *TriplePundit* site at <http://www.triplepundit.com/2011/07/smart-grid-surges-forward-south-korea/>.

Michael Wang is interviewed in the U.S. Department of Energy's blog on *Energy.gov* on what it's like to be a senior scientist. Find out more at <http://energy.gov/articles/10-questions-senior-scientist-michael-wang>.



Daniel Abraham

Daniel Abraham was interviewed on how to extend the life of lithium-ion batteries by *R&D Magazine* online in the article, "Diagnosing Advanced Batteries for a Longer Life." View it at <http://www.rdmag.com/News/2011/07/Energy-Batteries-Diagnosing-Advanced-Batteries-For-A-Longer-Life>.

JUNE 2011

Thomas Wallner was featured on the *Energy.gov* blog in the interview, "10 Questions for an Automotive Engineer: Thomas Wallner." Read the interview at <http://energy.gov/articles/10-questions-automotive-engineer-thomas-wallner>.

Argonne's transportation research is cited in the article, "The Rush To Electric Cars Will Replace Oil Barons With Lithium Dictators," online at the *Fast Company* website, <http://www.fastcompany.com/1763984/how-do-you-build-an-energy-independent-electric-car>. The article notes that "unlike oil, lithium can be recycled; once you get it out of the ground, it's yours."

Daniel Abraham's lithium-battery life extending research is featured in the online article, "Why Lithium-ion Batteries Die So Young," on the *Reuters* website at <http://www.reuters.com/article/2011/06/29/idUS106854550620110629>.

On *PoliticalNews.me*, **Argonne research** is cited in its coverage of “Kohl, Blunt Reinroduce Bill to Promote Energy-Efficient Trucks,” at

<http://politicalnews.me/?id=8054&keys=TAX-CREDITS-HYBRID-TRUCKS>.

Steve Ciatti is heading a team collaborating with General Motors to explore the possibilities of a gasoline-diesel engine. Read more in *Automotive World’s* article, “Argonne Works on Gasoline-Diesel Hybrid,” at

<http://www.automotiveworld.com/news/environment/87874-us-argonne-works-on-gasoline-diesel-hybrid>.

Forrest Jehlik debunks five myths about ethanol fuel on *Wired’s AUTOPIA* blog at

<http://www.wired.com/autopia/2011/06/five-ethanol-myths-busted-2/#more-36218>.

There have been 542 comments posted to this blog post.

Virginia Tech’s 82 mpg car wins the **Argonne**-managed collegiate EcoCAR challenge competition. Read more on *USA Today’s* website at

<http://content.usatoday.com/communities/driveon/post/2011/06/virginia-techs-82-mpg-car-wins-gmusecocar-challenge/1>.

In “Behind the Wheel at the EcoCAR College Engineer Competition,” *Mother Nature Network* explains how sixteen teams from colleges across the country spent three years building hybrids, plug-in hybrids and even hydrogen cars in the **Argonne**-managed EcoCAR advanced vehicle competition. See the article at

<http://www.mnn.com/green-tech/transportation/blogs/behind-the-wheel-at-the-ecocar-college-engineer-competition>.

Argonne’s solid oxide fuel cell research and **Jeffrey Miller** star in the article, “The Goal? Cooler, Smaller, Fuel Cells,” online at *PhysOrg*, <http://www.physorg.com/news/2011-06-goal-cooler-smaller-fuel-cells.html>.

In “Smart Planning for a Smart Grid,” Argonne researchers **Guenter Conzelmann** and **Vladimir Koritarov** lay out the ingredients for a smart grid and what’s needed to make it a reality. Read the complete article on the *Electric Light and Power* website at

<http://www.elp.com/index/display/article-display/8094560760/articles/utility-automation-engineering-td/volume-15/issue-9/features/smart-planning-for-a-smart-grid.html>.

Argonne National Laboratory is trying to combine the positive elements of the gasoline engine and the diesel engine for use in such vehicles as Chrysler’s popular Town and Country minivan. **Steve Ciatti** is leading the team. Read more on *Biodiesel Magazine’s* website at <http://www.biodieselmagazine.com/articles/7864/diesel-gasoline-hybrid-engine-in-the-works-at-chrysler>.

Eric Isaacs authored the op-ed article, “U.S. Can Break Its Addiction to Foreign Oil,” on the *CNN* website at <http://www.cnn.com/2011/OPINION/06/06/isaacs.oil.addiction/index.html>.



Vladimir Koritarov

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MAY 2011

Argonne’s nickel-cobalt-manganese cathode technology licensed to BASF is described in “Chemicals Giant Gambles on Li-ion Batteries,” on *Forbes* at <http://www.forbes.com/sites/williampentland/2011/05/31/chemicals-giant-gambles-on-li-ion-batteries/>.

Argonne is part of the history of lithium-ion batteries described in the article, “Knock-down, Drag-out Fight Over Next Generation Batteries,” on *Gizmodo* at <http://www.gizmodo.com.au/2011/05/knock-down-drag-out-fight-over-next-generation-batteries/>.

Christopher Marshall is quoted in this article about biofuels, “Putting the ‘Fuel’ in Biofuels,” online at *PhysOrg*, <http://www.physorg.com/news/2011-05-fuel-biofuels.html>.



Christopher Marshall

Steve Ciatti’s innovative engine is highlighted in “Gas-powered Diesel Engine May Double Fuel Efficiency,” online at *SmartPlanet*, <http://blogs.physicstoday.org/politics/2011/01/cutting-co2-transportation-emi.html>.

The range of electric vehicles is discussed by **Don Hillebrand** in *Nature News’* article, “Destination Within Range,” at <http://www.nature.com/news/2011/110520/full/news.2011.312.html>.

An article about **Autonomie**, “Optimizing Battery Size and Vehicle Control Parameters for a PHEV Using Autonomie,” is excerpted on *Automotive Engineering Online* at <http://www.sae.org/mags/aei/9821>.

Steve Ciatti’s gasoline-diesel engine is featured in an article and video called “Gas, Diesel Combo May Be Best Bet” on the *Lab Equipment* website at <http://www.laboratoryequipment.com/news-gas-diesel-combo-may-be-best-bet-05101.aspx>.

Argonne’s transportation work is mentioned by Congresswoman Judy Biggert in the *ENS Newswire* article, “Congress Considers \$4 Billion for Electric Cars,” at <http://www.ens-newswire.com/ens/may2011/2011-05-09-091.html>. Argonne is being considered for funding.

Ted Bohn offers tips for increasing gas mileage in this *Journal Sentinel* article, “Car Experts Offer Tips for Better Gas Mileage,” at <http://www.jsonline.com/business/121476794.html>. The bottom line: don’t drive like a teenager.

In “Combining Gas and Diesel Engines Could Yield Best of Both Worlds,” **Steve Ciatti’s** engine research is highlighted. Read the article on the *R&D Magazine* website at <http://www.rdmag.com/News/2011/05/Energy-Transportation-Combining-Gas-And-Diesel-Engines-Could-Yield-Best-Of-Both-Worlds/>.

Argonne’s engine lab and **Steve Ciatti’s** diesel research is featured in the article, “The Other Hybrid Engine on *Forbes* at <http://www.forbes.com/sites/williampentland/2011/05/05/the-other-hybrid-engine/>.

Argonne’s Star Shines on Jeopardy!

Argonne’s transportation research was the subject of questions in the category, “Cars of the Present,” on the game show, *Jeopardy!*, on May 23, 2011. Questions starred highlights of the lab’s transportation program, including the omnivorous engine, advanced dynamometers, lithium-ion batteries, combustion studies and the X Prize competition.

Watch the video-clip questions and contestant answers in this YouTube video at <http://www.youtube.com/watch?v=kKtzZH90zk>.



FASTRAX

SEPTEMBER 2011



Thomas Wallner

and lubricants, and mechanical engineering, this award is presented to a few outstanding presenters aged 35 years and younger.

Marianne Mintz was named Member Emeritus of the Transportation Research Board (TRB). Her selection represents peer recognition at the highest level. TRB established the emeritus membership category to recognize the significant and long-term contributions of individuals who have provided outstanding service through participation in standing committees.

AUGUST 2011

Argonne's TTRDC hosted the 2011 U.S.-China Electric Vehicle and Battery Technology Workshop, August 1-4. Argonne transportation and battery researchers met with their Chinese counterparts to discuss collaborative efforts in advanced vehicle technologies and propulsion methods. Chairs were **Khalil Amine** and **Larry Johnson**. Learn more at <http://www.cse.anl.gov/us-china-workshop-2011/index.html>.

Argonne National Laboratory hosted the 5th International Conference on Polymer Batteries and Fuel Cells, August 1-5. This annual conference is for all who are interested in materials for and systems based on lithium polymer, lithium-ion, metal-air, and flow batteries, and proton-exchange membrane and alkaline-exchange membrane fuel cells. Chairs were **Khalil Amine** and **Debbie Myers**. Learn more at <http://www.cse.anl.gov/pbfc-5/index.html>.

JULY 2011

Seth Snyder gave a presentation on renewable energy issues at the WIndiana 2011 and Indiana Renewable Energy Conference, held July 20-21, 2011 at the Indiana Convention Center in Indianapolis, Indiana.

Argonne's Green Racing Simulator Trailer Exhibit made an appearance at the American Le Mans Northeast Grand Prix, Lime Rock Park, Connecticut, on July 8.

The University of Chicago presented Distinguished Service Performance Awards to **Ali Erdemir** and **Aymeric Rousseau** for their remarkable research and scientific contributions to the transportation field. Distinguished Performance Awards recognize the outstanding scientific or technical achievements, or a distinguished record of achievement of select Argonne employees.

Michael Wang, Ignasi Palou-Rivera and **Jennifer Dunn** demonstrated GREET (Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation) model and the new travel carbon calculator tool to the U.S. Department of Energy's Biomass 2011 Conference attendees on July 26 and 27, National Harbor, Maryland.



Michael Wang

Beihai Ma presented his talk, "Ferroelectric PLZT Films Grown on Metal Foils for Power Electronic Applications," at the 20th IEEE International Symposium on Applications of Ferroelectrics (ISAF-2011), Vancouver, Canada, July 24-27, 2011. **Manoj Narayanan, Shanshan Liu, Sheng Chao** and **Balu Balachandran** are co-authors of this presentation.

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JUNE 2011

Beihai Ma, Manoj Narayanan and **Balu Balachandran** won a 2011 R&D Award for their work on advanced ceramic film capacitors for power electronics in electric drive vehicles. Argonne's ceramic-film capacitor bridges a technology gap that addresses a critical need of the next generation of electric-drive vehicles. It substantially reduces the weight, volume and cost of capacitor materials of the inverters that will be used to power the motors of electric vehicles. The ceramic film—a lanthanum-modified lead zirconate titanate—is deposited on an inexpensive metal foil that can be stacked on or embedded into printed wire boards. The arrangement frees surface space, increases reliability and minimizes electromagnetic interference and inductance loss in the inverter. And because the capacitor is made of ceramic and metal, degradation due to high-temperature when the engine is running is eliminated. The R&D 100 Awards, organized by R&D Magazine, have been given out annually since 1962 for the top high-technology products of the year and are considered to be the "Oscars of Innovation."

Jennifer Dunn participated in Cornell University's Northeast Bioenergy and Bioproducts Education Program for high school and college educators on June 23 in Ithaca, New York. Dunn provided educators with information on using GREET in the classroom to explore the impacts of biofuels. Attendees were able to try GREET in a computer lab. The program seeks to arm teachers with tools and ideas that will help them interest students in science and engineering careers.

Yan Zhou gave two presentations at the 2012 TRB National Household Travel Survey workshop, "Using National Household Travel Survey (NHTS) Data for Transportation Decision Making," in Washington D.C. The first, "Use of NHTS Data in Assessment of Impacts of PHEVs on Greenhouse Gas (GHG) Emissions and Electricity Demand," was co-authored with **Anant Vyas**. The second, "Analysis of Household Vehicle Usage by Vehicle Type, Age and Area Type," was co-authored with **Vyas** and **Dan Santini**.

Balu Balachandran presented his invited talk, "Ferroelectric Film Capacitors with High Energy Density for Electric Drive Vehicles" at the International Conference on Materials for Advanced Technologies (ICMAT 2011), Singapore, June 26-July 1, 2011. **Beihai Ma** and **Manoj Narayanan** are co-authors of this presentation.

Argonne's **Green Racing Simulator Trailer Exhibit** made an appearance at the Indianapolis Motor Speedway, Indianapolis, Indiana, on June 29.

Argonne researchers participated in the Clean Cities 2011 Stakeholder Summit, held June 27-30 in Indianapolis, Indiana. Talks included **Marianne Mintz** on "Natural Gas Benefits, Markets, and Opportunities;" **Andy Burnham** on "Propane Benefits, Markets, and Opportunities;" **Terry Levinson** on "Idle Reduction Benefits, Markets, and Opportunities;" **Don Hillebrand** on "Electric Vehicles Benefits, Markets, and Opportunities;" and **Linda Gaines** and **Andy Burnham** on "What's the Right Solution for Your Fleet?" **Marcy Rood Werpy** assisted in preparing the Summit. See more on the summit at http://www1.eere.energy.gov/cleancities/stakeholder_summit.html.

Seth Snyder gave a presentation titled, "Partnering with Argonne: North Dakota CleanTech 2011," at the CleanTech 2011 conference held June 19-21 in Grand Forks, North Dakota.



Seth Snyder

MAY 2011

Balu Balachandran presented his talk, "High Dielectric Constant Capacitors for Power Electronic Systems" at the 2011 Hydrogen and Fuel Cells and Vehicle Technologies Programs Annual Merit Review and Peer Evaluation Meeting, Arlington, Virginia, May 9-13, 2011. **Beihai Ma, Manoj Narayanan, Shanshan Liu, Sheng Chao, Sheng Tong** and **Stephen Dorris** are co-authors of the paper.

Bob Erck, Oyelayo Ajayi, C. Lorenzo Martin and **George Fenske** presented their talk, "Boundary Lubrication Regime: Effect of Surface Texture," at the 66th Annual Meeting and Exhibition of the Society of Tribologists and Lubrication Engineers in Atlanta, Georgia, May 15-19.

Jennifer Dunn presented her poster summarizing recent work on the life cycle analysis of biofuels, including sugar cane ethanol, at the 6th Frontiers in Bionergy: United States-Brazil Symposium on Sustainable Bioenergy, May 15-18, Purdue University, West Lafayette, Indiana.

PARTING SHOTS



Above, Illinois Governor Pat Quinn (center) visited Argonne to learn about green technology and transportation research and to speak with laboratory management about innovation in Illinois. Argonne Lab Director Eric Isaacs (right) and Don Hillebrand, director of the Center for Transportation Research (left), showed Gov. Quinn some of Argonne's electric cars.

Below, Ted Bohn (right) and his Traveling Smart Grid Show demonstrate smart grid technologies to Argonne Director Eric Isaacs at the laboratory's Earth Day celebration.



Above, Chinese delegates discuss the finer points of energy storage at the 2011 U.S.-China Electric Vehicle and Battery Technology Workshop. The workshop brought together American and Chinese experts in vehicle battery research and development for discussion and collaboration.



Above, Larry Johnson, 2011 U.S.-China Electric Vehicle and Battery Technology Workshop organizer, chats with a Chinese delegate.

WORKING WITH ARGONNE

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.

Technology Development and Commercialization
Argonne National Laboratory, Bldg. 201
9700 South Cass Avenue, Argonne, IL 60439
800.627.2596
partners@anl.gov
www.anl.gov/techtransfer

www.transportation.anl.gov



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Editor: Else Tennessen
Associate Editor: Jim Collins
Designer: Cindi Andersen
Proofreader: Angela Manning
Contributors: Dana Bubonovich, Angela Hardin, Mike Hope,
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Else M. Tennessen
TransForum
Argonne National Laboratory
9700 South Cass Avenue, Bldg. 362
Argonne, IL 60439-4815
630.252.8170
etennessen@anl.gov



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