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<th>Time</th>
<th>Paper No.</th>
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<td>8:00 a.m.</td>
<td>ORAL ONLY</td>
<td>Potholes And Promises on the Path to Vehicle Electrification</td>
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<td>Daniel Sperling, Univ of California, Davis and California Air Resources Board</td>
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<td>8:30 a.m.</td>
<td>ORAL ONLY</td>
<td>Advanced Vehicle and Market Price Projections</td>
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<td>Hybrid electric and plug-in vehicles (both hybrid and all-electric) and other advanced vehicle technologies offer the potential to greatly reduce petroleum use and greenhouse gas emissions. The U.S. Department of Energy’s Office of Vehicle Technologies supports the development and deployment of advanced vehicle technologies, including advances in electric vehicles, engine efficiency, and lightweight materials. Projections of future vehicle attributes, including fuel economy and price were made based on DOE technology program goals, and the potential market adoption and resulting fuel use and greenhouse gas emissions reductions due to these technologies were estimated at a U.S. national level to the year 2050. Thomas Stephens, Argonne National Laboratory</td>
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<td>9:00 a.m.</td>
<td>ORAL ONLY</td>
<td>From the Showroom to the Driveway - How are Consumers Responding to Greener Cars?</td>
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<td>Automakers are already using a wide range of advanced powertrain technologies to improve fuel economy and achieve real-world reductions in greenhouse gas emissions, and more are on the way. Although the internal combustion engine will be with us for a long time to come, consumers will also have a breadth of alternative powertrains to choose from. When consumers are ready purchase new vehicles, will they value fuel economy enough to invest in alternative powertrains? What role will the price of gasoline, the availability of alternative fuels and recharging infrastructure, and the use of financial and non-financial incentives play in this decision-making? Julie C. Becker, Alliance of Automobile Manufacturers Inc.</td>
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<td>9:30 a.m.</td>
<td>ORAL ONLY</td>
<td>Plug in Vehicle Purchasing, Driving, and Charging Behavior: Consumer Interaction with PEV Technology</td>
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<td>Gil Tal, University of California, Davis</td>
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<td>10:00 a.m.</td>
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10:30 a.m.  ORAL ONLY  PEV Infrastructure Deployment Costs and Drivers\‘ Charging Preferences

Data from the largest plug-in electric vehicle (PEV) and charging infrastructure study ever undertaken will be used to present residential and public Level 2 EVSE (electric vehicle supply equipment), and DC fast charger (DCFC) deployment costs as well as PEV drivers\‘s charging preferences by charger type, location, and time of day. Analysis results from the U.S. Department of Energy\‘s EV Project, which included data streams from Nissan (Leaf), OnStar (Chevrolet Volt), Daimler (Smart EV), and ECOtality (charging infrastructure) will be the presented. As of the end of September 2013, more than 103 million test miles, 3.5 million charging events, and 29,100 MWh of data were collected from 8,100 vehicles and 12,100 EVSE and DCFC.

John Smart, Idaho National Lab.

11:00 a.m.  ORAL ONLY  The Big Picture: History, Geometry and the Future of the Automobile

In the face of ever-more stringent emission and fuel economy regulation, concerns for global climate change, huge economic growth in Asia, global urbanization and finite fossil fuel resources, it is easy believe that the personal automobile is headed for extinction. However, many of the popular assumptions behind such a conclusion are not well supported by fact. We learn from history and use simple geometry assess the future of the private car in terms of three factors: want \( w \) the emotional desire for the freedoms of automobile ownership, need \( n \) the absence of an adequate alternative transportation mode, and ability \( a \) the physical viability of private cars in cities of the future. The result is quite surprising. Although usage patterns and personal tastes will certainly evolve, the modern automobile can be as efficient as public transit systems and can be viable in all but the densest cities. This optimistic finding in no way diminishes our challenge in developing clean, efficient, practical and emotive personal transportation in the coming decades.

Michael A. Tamor, Ford Motor Co.

11:30 a.m.  ORAL ONLY  Vehicle Electrification \( v \) Journey or Destination?

The global auto industry is facing unprecedented challenges to improve vehicle efficiency in the face of stable or declining fuel prices. Fundamental improvements in fuel efficiency will require a variety technologies which enthuse customers while being affordable and profitable. The role of Electrification in these technologies will be driven by three priorities: affordability, functionality and emotional appeal. HEVs, PHEVs and BEVs have delivered functionality and emotional appeal to meet early customer needs. Adoption of these technologies has begun a long journey, with multiple possible roads to take in delighting customers with the right technology at the right price.

Steven Tarnowsky, General Motors Co.

12:00 p.m.  ORAL ONLY  Networking Lunch with Exhibits

1:00 p.m.  ORAL ONLY  Test Standards Supporting New Advanced Technology Vehicles

The unique characteristics of new technology vehicles require rethinking how testing and evaluations should be conducted. In the recent past, procedures like J1711 and J1634 set the standard for efficiency measurements of HEVs, PHEVs and BEVs using a chassis dynamometer.

Michael Duoba, Argonne National Laboratory
1:30 p.m. ORAL ONLY Opportunities and Challenges for Integrating Future Engine Concepts into Hybrid Electric Vehicle Powertrains

Internal combustion engines are forecasted to be dominant prime mover for light-duty vehicles for the foreseeable future. Recent advances in the development internal combustion engine technology including fuel and combustion systems, advanced combustion strategies, waste heat recovery and advanced emissions controls provide an open landscape of options for integration into hybrid vehicle powertrains. It is important to understand the opportunities and challenges for integrating future engine concepts into hybrid vehicle powertrains in the scope of competing fuel economy and emissions regulations.

Scott Curran, Oak Ridge National Laboratory

2:00 p.m. ORAL ONLY MAGSPLIT: A magnetic eCVT

Magnomatics has developed a second generation of its MAGSPLIT eCVT system. This compact device is able to replace both the planetary gear and motor/generator that form a typical powersplit system. The MAGSPLIT device offers a lubrication-free eCVT that is more compact and efficient than existing solutions. It is also compliant and offers the potential to reduce the complexity of the flywheel and torsional dampers required in a clutch-less powertrain. The theory of this novel component will be described and dynamometer test results will be given.

Chris Kirby, Magnomatics Limited

2:30 p.m. BREAK

3:00 p.m. ORAL ONLY FIA Approach to Incorporate E-Drive Into Racing

Bernard Niclot, FIA

3:30 p.m. ORAL ONLY Formula E Electric Drive

Tim Strafford, McLaren Automotive, Ltd.

4:00 p.m. ORAL ONLY Pikes Peak Experiences

Steve Wickham, Toyota Motor Corp.

4:30 p.m. ORAL ONLY Pack Design and BMS for High Power Density Automotive Batteries

Ali Maleki, Ricardo Inc.
Energy Management Strategies

Electrification has entered the prime leagues of motorsports nearly 10-years ago. As typical for engineers working in motorsports, they develop innovative systems on the edge of physics and are front loaders for the automotive industry. Technical and sporting regulations challenge the race teams to find for each race the right balance between power and energy efficiency. This challenge was already common with non-electrified power trains and the adding of electrified components to the drive train and engine has increased the complexity significantly.

The merge of the conventional power train with electrical traction motors, electrical energy storage and controllers opens new operation strategies of the entire power train. Such strategies will be different for qualifying or race and require a scalable performance depending on the race situation - energy saving, overtaking, safety car - and need to be adjusted by the driver.

Looking at the 2014 regulations for Formula-1, in addition to the common Motor Generator Unit (MGU-K) mounted to the engine or gearbox for kinetic energy recovery and release, the mounting of an additional Motor Generator Unit (MGU-H) to the shaft of the turbo charger is permitted for energy recovery from the hot exhaust gas. Besides energy recovery the MGU-H offers the option of electric boosting in operation areas the turbo charger does not supply enough energy from the exhaust gas - typically at low engine speeds when accelerating out of tighter corners. Due to regulatory restrictions on energy recovery and release per race lap, the operation strategy of the power train is a key performance differentiator between the race teams.

For cost saving track testing is very much reduced and the engineers require other cost efficient possibilities to develop, validate and tune these complex power trains. It is common that already in the concept phase of a new power train the engineers use advanced vehicle simulation technologies to optimize the power train on various virtual race tracks. In the following development phase the prototypes of single components or sub systems are tested as "Hardware in the Loop" on high dynamic test beds. Such tests are important to confirm the performance of the concept and the reliability of entire power train before being installed the first time in the car for track testing.

For race series with electrified powertrains the most effective Energy Management will be a major key factor to win races and the championship.

Volker Niemeyer, AVL LIST GmbH

Wednesday, February 12

SAE 2014 Hybrid and Electric Vehicle Technologies Symposium - Day 2

Session Code: HYB200

Room TBD

Session Time: ALL DAY

Time Paper No. Title
8:00 a.m.  ORAL ONLY  
**Keynote Address: Electrified Powertrains - Innovation and Investment**

The effects of decades of Automotive Powertrain Electrification Innovation have reached all markets around the world. According to IHS 3rd Quarter 2013 data, more than 16 Million vehicles were produced with some degree of Powertrain Electrification, the majority being Start-Stop, but growing in other Electrified Powertrain solution categories, such as Mild, Full, Plug-In, Range Extender, and Battery Electric Vehicles. We must give credit to the technologist around the world that continue to innovate and invest. Innovators continue to seek solutions, that are not bound to the ‘traditional’ or ‘conventional’ powertrain thinking. Engines and transmissions continue to be optimized within integrated powertrain and vehicle solutions with e-Drives being maximized. Energy Management requirements and solutions are pushing the envelope of conventional thinking. The solutions are not exclusively in terms of compliance categories, but, can be also viewed in technology capability categories. This continues to be made possible as a result of ‘on’ vehicle and ‘off’ vehicle computing capabilities. Utilization of environmental data, such as GPS, terrain, traffic conditions, and on-board vehicle energy consumers within a closed loop simulation or model for real time adaptation resulting in best vehicle energy management. Last, but, not least, cost reduction for Energy Storage Solutions are materializing as products are created for the global automotive portfolio.

Denise Gray, AVI LIST GmbH

8:30 a.m.  ORAL ONLY  
**The All New Lexus Hybrid**

Effendi Dufford, Toyota Technical Center USA Inc.

9:00 a.m.  ORAL ONLY  
**Subaru XV Crosstrek Hybrid Vehicle**

The presentation will begin with a detailed explanation of the technologies applied to the Subaru XV Crosstrek Hybrid Vehicle, and will continue to describe its acceleration performance, handling performance and fuel efficiency.

Yosuke Ohtomo, Subaru (Fuji Heavy Industries Ltd.)

9:30 a.m.  
**BREAK**

10:00 a.m.  ORAL ONLY  
**Technical Evolution of One Motor Two Clutch Concept**

Nissan launched two new one-motor two-clutch (1M2CL) parallel hybrid systems in 2013 to aim at reducing CO2 steadily. One of which is second generation premium sports sedan RWD & AWD hybrid vehicle that has improved both fuel economy and acceleration from the first generation system and the other is SUV FWD & AWD hybrid vehicle introduced the combination of 1M2CL and CVT. In order to expand 1M2CL system, we are continuing to evolve this system through various technical approaches.

Tomoaki Momose, Nissan Technical Center NA

10:30 a.m.  ORAL ONLY  
**Forging a Legacy of Efficient Electrified Locomotion**

Since the early days of mass transportation, automakers have strived for improvements in vehicle efficiency. The improvements have traditionally covered all aspects of the transfer conversion of chemical energy toward locomotion. Through the years our understanding of energy losses and opportunities has improved to the point our analytics have capability to predict vehicle efficiency for known vehicle missions. This great capacity for measurement, understanding and analysis is presented with a new quartet of challenges: Improvement in vehicle efficiency as measured by both consumption and economy; increased sales with a new, broader customer base; unbridled driver feedback technology and interaction; and new expectations as defined by Monroney label changes. The challenge for the future is how to unlock these unique opportunities toward BIC customer satisfaction. The organization which can institutionalize change toward this effort creates a true legacy for the engineers who follow.

Robert R. Iorio, Ford Motor Co.
11:00 a.m.  ORAL ONLY  The Range Rover Hybrid - Maintaining Capability in a Modern Hybrid SUV
The presentation will describe the latest products in the Range Rover line-up. A hybrid version of the recently launched Range Rover and Range Rover Sport vehicles. This P2 hybrid architecture is combined with an 8 speed automatic gearbox and a 3.0 litre V6 diesel engine using a bespoke control system and a revolutionary package to maintain the vehicle’s breadth of capability.
Paul Bostock, Jaguar Land Rover

11:30 a.m.  ORAL ONLY  The Development of HONDA’s New Hybrid System ¿Sport Hybrid SH-AWD”
New hybrid system ¿Sport Hybrid SH-AWD¿ which is compatible in high driving performance and good fuel economy is developed for a large-sized passenger car, this system consists of a direct injection VTEC+VCM V6 engine, 7th Dual Clutch transmission with a built-in a motor, the 2 motor built-in TMU (Twin Motor Unit), and the Lithium ion battery and so on.
TMU can be achieved the ¿Torque Vectoring¿ by the right-left independent motors.
This system can selected the three drive modes, FWD(Engine Drive mode), RWD(EV mode) and AWD(Engine & Motor drive mode).
This system can be selected the optimum drive mode by the driver demand, automatically.
Hideki Morita, Honda R&D Co., Ltd.

12:00 p.m.  ORAL ONLY  Networking Lunch with Exhibits

1:30 p.m.  ORAL ONLY  Overview of Porsche Hybrid Electric Vehicles
The history of the Porsche name and hybrid gasoline-electric vehicles is actually the longest in the automotive industry. This brief overview will highlight some of the historical and technical aspects of Porsche¿s long history with hybrid gasoline-electric vehicles beginning with the first hybrid gasoline-electric vehicle in 1900 and then review the current production hybrid electric vehicles; concluding with the new 918 Spyder. The presentation will include technical information, photos, drawings, animations and video clips.  ¿All Hybrids don¿t have to be slow, odd, ugly and boring¿
Kenneth Gould, Porsche Cars North America Inc.

2:00 p.m.  ORAL ONLY  Toyota Plug In Hybrid Effectiveness In The Real World
Heraldo F. Stefanon, Toyota Technical Center USA Inc.

2:30 p.m.  ORAL ONLY  Development of the Mitsubishi Outlander PHEV
From product concept thru system design, the Mitsubishi Outlander PHEV is a revolutionary vehicle fully utilizing the benefits for electric drive. This presentation will describe the propulsion and chassis system characteristics as well as their operation.  Also, we will discuss the Outlander PHEV¿s recent rally racing results and well as a seek peek at Mitsubishi Motors future development paths.
David N. Patterson, Mitsubishi Motors R&D of America Inc.

3:00 p.m.  BREAK

3:30 p.m.  ORAL ONLY  Cadillac ELR On Demand Regenerative Breaking
Timothy M. Grewe, GM Engineering
4:00 p.m. ORAL ONLY The New Electric Powertrain In The 2013/2014 Nissan Leaf

Nissan LEAF was launched in December 2010 in Japan and the United States and in 2011 in Europe and other markets. Nissan continues improving LEAF’s performance and quality as well as convenience. The new electric powertrain in the 2013/2014 Nissan LEAF contributed significant improvement for the acceleration and EV range by weight reduction through the integration of high-voltage components. The presentation will describe feature of the electric powertrain technology.

Kazuyuki Higashi, Nissan Technical Center NA

4:30 p.m. ORAL ONLY Q&A Session

Moderators - Robert Larsen, OboTech. LLC
Robert Larsen, OboTech. LLC

Thursday, February 13

SAE 2014 Hybrid and Electric Vehicle Technologies Symposium - Day 3

Session Code: HYB300

Room TBD Session Time: ALL DAY

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<td>8:00 a.m.</td>
<td>ORAL ONLY</td>
<td>Honda/GM Fuel Cell Partnership &amp; Moving from Technical to Commercial Viability</td>
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<td>Fuel cell technology is now available that achieves performance and durability targets required for vehicle application. Likewise, H2 distribution technology is available to safely and quickly refuel these vehicles, providing the functionality customers have come to expect from fossil-fuel-powered vehicles. The challenge is now in the realm of economics providing vehicles and hydrogen at a price that customers are willing to pay. In this context, General Motors and Honda began a partnership in June 2013 to co-develop next-generation lower-cost fuel cell and hydrogen storage systems. This presentation will summarize fuel cell technical accomplishments to date by both GM and Honda and describe the remaining key cost-reduction challenges, putting them in terms of critical science/engineering problems. We will also discuss materials and system development targets that need to be achieved in order to accelerate the commercial viability of this technology.</td>
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<td>Mark Mathias, General Motors Co.</td>
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<td>8:30 a.m.</td>
<td>ORAL ONLY</td>
<td>Hyundai’s FCEV: A Pathway to the New Possibilities</td>
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<td>Due to the energy and environment issues, polymer electrolyte membrane fuel cell (PEMFC) power systems are currently being actively studied for use in passenger cars and fleet vehicles. Compared to other types of fuel cells, PEMFCs are known to possess high current density, and the stack structure is rather simple. Furthermore, as the electrolyte material is in solid state at all times, there is no leakage or loss of electrolytes during operation. PEMFC has other advantages such as rapid start-up and response, long endurance, and flexibility of fuel usage from pure hydrogen to methanol and natural gas. Among the core components of a PEMFC system are the electrolytes, the electrodes, and the bipolar plates. Other parts to significantly affect the fuel cell performance are the sub-systems for i) thermal and water management, ii) hydrogen supply and recirculation, and iii) air supply. These three core sub-systems are typically known as “balance of plant (BOP)”, and they compose a crucial portion in any fuel cell power plant.</td>
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<td>Byung Ki Ahn, Hyundai Motor Group</td>
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9:00 a.m. ORAL ONLY 2015 Toyota Fuel Cell Vehicle
Matt McCloy, Toyota Motor Engineering & Mfg NA Inc.

9:30 a.m. ORAL ONLY Hydrogen Fueling Standardization
Jesse Schneider, BMW

10:00 a.m. ORAL ONLY California’s H2 Infrastructure for FCEV Commercialization
To prepare for market introduction of fuel cell electric vehicles in California, California Fuel Cell Partnership’s 30+ member organizations developed FCEV rollout strategies to guide the industry and government in support of commercialization of FCEVs.

To start a sustainable hybrid FCEV consumer market in the US, an existing hydrogen fueling infrastructure has to be in place. Although implementation is starting in California, more is needed to improve process efficiencies, increase focus and provide stakeholder certainty. Globally, vehicle OEMs are investing towards FCEV manufacturing, where infrastructure providers and supply networks are working to match this.

Nico Bouwkamp, California Fuel Cell Partnership

10:30 a.m. BREAK

11:00 a.m. ORAL ONLY Qualcomm Halo, Wireless Electric Vehicle Charging (WEVC) Technology
This presentation will outline how Wireless EV Charging (WEVC) technology, works and the benefits it is set to bring to the electric vehicle (EV) industry. Qualcomm Halo WEVC technology is a high power, simple solution for charging EVs and Plug-in Hybrid Electric Vehicles (PHEV) that removes the need to use a cable to charge. Qualcomm Halo technology uses resonant magnetic induction to transfer energy between a ground-based pad and a charging pad on the electric vehicle.

The choice of frequency is of critical importance since wireless charging must coexist with and be noninterfering to other systems which exist both on the vehicle and within our complex electromagnetic ecosystem.

A single global standard for WEVC will facilitate compliance to regulations, interoperability between equipment from different manufacturers and help create the mass market uptake needed to drive down costs and thereby generate increased consumer demand for the technology. This talk sets out to address these points in more detail.

Paul Guckian, Qualcomm Technologies Inc.

11:30 a.m. ORAL ONLY Considerations for Deployment of In-Motion Wireless Power Transfer Technologies in Transportation
Perry Jones, Oak Ridge National Laboratory
12:00 p.m.  ORAL ONLY  DC Fast, Wireless & Conductive Charging Evaluation Projects

The Idaho National Laboratory (INL), as part of its conduct of the Department of Energy’s Advanced Vehicle Testing Activity, purchased four new 2012 Nissan Leaf battery electric vehicles that were instrumented with data loggers and operated over a fixed on-road test cycle. Each vehicle is operated over the test route, and charged twice daily. Two vehicles are charged exclusively by AC Level 2 EVSE, while two are exclusively DC fast charged with a Hasetec 50 kW charger. The vehicles were performance tested on a closed test track when new, and at the conclusion of the study. The traction battery packs were removed and laboratory tested when the vehicles were new, and at 10,000-mile intervals. Battery tests include constant-current discharge capacity, electric vehicle power characterization, and low peak power tests. The on-road testing will be carried out for at least 50,000 miles. At the conclusion of on-road cycling, the final battery tests will be performed. As of October 2013, each vehicle was approaching the fourth, 10,000-mile battery test cycle and it is anticipated that at the time of the SAE 2014 HEV/EV Symposium, at least 50,000 miles of results will be presented. In addition to the DC Fast Charge Effects study, INL has begun, as separate projects, evaluations of wireless and conductive charging systems. The results of these testing programs at the time of the symposium will be presented, along with a look at complementary laboratory testing going forward. The full results of each of these studies will be published upon completion.

Matthew Shirk, Idaho National Lab.

12:30 p.m.  ORAL ONLY  12:30 - 1:30: Networking Lunch with Exhibits

1:30 p.m.  ORAL ONLY  Advanced Auto Batteries

Menahem Anderman, Advanced Automotive Batteries
2:00 p.m.  ORAL ONLY

Performance Evaluation of Lower-Energy Energy Storage Alternatives for Full-Hybrid Vehicles

Automakers have been mass producing hybrid electric vehicles (HEVs) for well over a decade, and the technology has proven to be very effective at reducing per-vehicle fuel use. However, the incremental cost of HEVs such as the Toyota Prius or Ford Fusion Hybrid remains several thousand dollars higher than the cost of comparable conventional vehicles, which has limited HEV market penetration. The battery energy storage device is typically the component with the greatest contribution toward this cost increment, so significant cost reductions/performance improvements to the energy storage system (ESS) can correspondingly improve the vehicle-level cost vs. benefit relationship. Such an improvement would in turn lead to larger HEV market penetration and greater aggregate fuel savings.

In recognition of these potential benefits, the United States Advanced Battery Consortium (USABC) and Department of Energy (DOE) Energy Storage program managers asked the National Renewable Energy Laboratory (NREL) to collaborate with a USABC Workgroup and analyze the trade-offs between vehicle fuel economy and reducing the decade-old minimum energy requirement for power-assist HEVs. NREL’s analysis showed that significant fuel savings could still be delivered from an ESS with much lower energy storage than the previous targets, which prompted USABC to issue a new set of lower-energy ESS (LEESS) targets that could be satisfied by a variety of technologies. With support from DOE, NREL has developed an HEV test platform for in-vehicle performance and fuel economy validation testing of the hybrid system using such LESS devices. This presentation will describe development of the vehicle test platform, and laboratory as well as in-vehicle evaluation results with alternate energy storage configurations as compared to the production battery system. The alternate energy storage technologies considered include lithium-ion capacitors (LICs) i.e., asymmetric electrochemical energy storage devices possessing one electrode with battery-type characteristics (lithiated graphite) and one with ultracapacitor-type characteristics (carbon) and electrochemical double layer capacitors (EDLCs).

Jeffrey Gonder, National Renewable Energy Laboratory

2:30 p.m.  ORAL ONLY

Mild HEV Performance at Micro Hybrid Cost à A Low Voltage Advanced Lead-Acid Battery Approach

The Advanced Lead Acid Battery Consortium has for several years been retrofitting VRLA batteries into hybrid electric showing successfully that advanced designs with carbon-containing negative plates can handle this duty cycle and exhibit good reliability. With the wide acceptance of stop/start in Europe, the industry is looking for ways to increase functionality of these systems to obtain lower emissions to meet future standards, but at minimum extra cost. The effect of engine downsizing coupled with performance boosting by combining electric supercharging and conventional turbocharging has been explored in this project and offers significant reductions in CO2 without loss of performance.

Allan Cooper, European Adv Lead Acid Battery Consortiu
3:00 p.m.  **ORAL ONLY**  
**Advanced High Energy and High Power Battery Systems for Automotive Applications**  
To meet the high-energy requirement that can enable the 40-miles electric drive Plug in Hybrid Electric Vehicle (P-HEVs), long range electric vehicle (EV) and smart grid, it is necessary to develop very high energy and high power cathodes and anodes that when combined in a battery system must offer 5,000 charge-depleting cycles, 15 years calendar life as well as excellent safety characteristics. These challenging requirements make it difficult for conventional cathode materials to be adopted in P-HEVs and EVs. In this talk, we report several high energy systems that offer the potential of enabling next generation PHEVs and EVs. After a brief description of lithium ion battery concept, we will disclose several strategies to increase significantly the energy density of lithium battery through the development of novel functional materials. We will also describe some new approaches to improve the cycle life and safety of lithium batteries using advanced nanocoating at the particle level and functional electrolyte additives that play a significant role in stabilizing the interfaces during battery operation and abuse. Finally, we will also present some recent results on the beyond Li-ion systems.

Jun Lu, Argonne National Laboratory

3:30 p.m.  **BREAK**

4:00 p.m.  **ORAL ONLY**  
**Military Non-tactical to Tactical/Combat Vehicle Cyber Secure V2G Systems Development and Demonstration**  
The Tank Automotive Research Development and Engineering Center (TARDEC) has developed the capability of bi-directional cyber secure vehicle to grid power management for vehicle based grid services. The grid services include demand charge mitigation (peak shaving), Volt/VAR management, power regulation, and current source mode. Grid services will be used to cost justify electrification of the non-tactical fleet and provide capabilities to deployed Warfighters to improve microgrid stability and efficiency and progress to vehicle-to-vehicle power management. Discussed are the development efforts, alignment with SAE standards, results to date, and planned development.

Shukri Kazbour, US Army / TARDEC

4:30 p.m.  **ORAL ONLY**  
**Fuel Economy Comparison of Hybrid Diesel/Electric and Standard Diesel Heavy Duty Transit Buses**  
Public transit officials faced pressure in the mid-1990s to clean up their bus fleet, which was a major contributor to air pollution on city streets. One of the most promising and strategies in this effort is the hybrid-electric transit bus. These buses have gained in popularity and are currently in operation in major cities around the world including New York, Chicago, San Francisco, Minneapolis, London, Madrid, and Taipei.

Further, current heavy-duty diesel engine technology employed in transit buses has provided major reductions in exhaust emissions that were thought not to be possible just a few years ago. Historically, reductions in diesel exhaust emissions resulted in fuel economy penalties.

This paper will report on fuel economy tests of diesel powered heavy-duty transit buses configured in hybrid-electric and standard propulsion arrangement. The buses were tested using a cycle speed specific to Minneapolis/St Paul in-service operating profile on a controlled test track. This testing provides an analytical comparison of hybrid-electric versus the standard diesel engine/automatic transmission equipped buses. The results of the test are of significance in guiding future fleet planning.

Chuck Wurzinger, Metro Transit
5:00 p.m.  ORAL ONLY  Fuel Cell Power Plant Engineering and Experience for Commercial and Military Vehicles

Fuel Cell technology and product has demonstrated durability, power density and continuous cost reduction offering an attractive life cost proposition for powering the zero emission commercial vehicles. US Hybrid will be presenting a summary of Fuel Cell power train system power generation, energy storage and components sizing trade study, and environmental challenges for the design, integration and operation of Fuel Cell power plant in various specialty and military vehicles. In addition to infrastructure, the service and support tooling and facility requirements and training and safety code compliance is also a major part of capital and operation cost associated with FC powered fleet operation.

Abas Goodarzi, US Hybrid Corporation

5:30 p.m.  ORAL ONLY  Powertrain-In-the-Loop Development of a Heavy-Duty Hybrid Electric Vehicle

ORNL has been collaborating with Meritor, Inc. to validate the benefits of a novel series-parallel hybrid electric transmission suitable for Class 8 line haul applications. The Meritor Dual Mode Hybrid Powertrain (DMHP) is a full hybrid system capable of all electric operation at low to moderate speeds, with capabilities for substantial regenerative braking energy capture at high speeds. As a major focus of the collaboration, energy management strategies and powertrain control algorithms have been jointly developed between ORNL and Meritor using model-based design practices. In order to firmly assess the merits of the work, the supervisory control codes were targeted to the real-time HIL platform of the ORNL Vehicle Systems Integration laboratory to experimentally control the actual powertrain in a controlled test cell environment. This “power pack” test approach provided the flexibility to update, optimize, and modify control strategies in real time to quantify fuel economy benefits of the Meritor system. In addition, researchers were able to rapidly target the actual powertrain to a matrix of vehicle loads, duty cycles, and energy storage system size and configurations to understand impacts on fuel consumption and emissions. Real world duty cycles were developed and applied, based upon the ORNL Heavy Truck Duty Cycle database. An important feature of this database is actual grade information, which was found to have significant impacts for the hybrid application. The results of this work indicate that an approximate 10% increase in “real world” fuel economy is possible for Class 8 line haul applications utilizing this technology.

Paul Chambon, Oak Ridge National Laboratory