Argonne NATIONAL LABORATORY | Transportation Technology R&D Center

U.S. DEPARTMENT OF ENERGY

Vehicle-Grid Interface Key to Smart Charging Plug-in Vehicles

The U.S. Department of Energy (DOE) and Argonne National Laboratory have created an interactive technology display to illustrate the relationship between the nation's energy supplies, electric power grid operators/utilities, plug-in vehicles and consumers in the future.

Vehicle electrification is an important element in the nation's plan to transition from petroleum to electricity as the main energy source for urban/suburban transportation – to enhance energy security, reduce environmental impact and maintain mobility in a carbon-constrained future. Well over half of America's passenger cars travel between 20 and 40 miles daily – a range that electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs) can provide with little or no petroleum consumption. DOE, the national laboratories and industry are working together to refine and manufacture vehicle and battery technology to support volume production of plug-in vehicles and the Administration's goal to have 1 million PHEVs on the road by 2015.

Charging millions of plug-in vehicles will place additional demands on the nation's electric power supply. DOE, electric utilities and the automotive industry are cooperating on technology and standards to ensure that these demands can be met without negatively impacting environmental quality or reliability of the grid. This requires **smart charging**, i.e., avoiding charging during peak demand periods (when costs and environmental impact are high), managing electricity use at the local level (to avoid overloads in your neighborhood) and balancing loads within individual homes (to minimize cost and environmental impact while maintaining lifestyle).

The key enabler to smart charging is the **vehicle-grid interface** that allows communication between the vehicle, consumer and electric power grid operator/utility. As DOE and the utility industry implement a national **Smart Grid**

through the application of digital technology (to improve reliability, security and efficiency), the automotive and utility industries are collaborating with DOE to develop **real-time, two-way communication** technologies to connect directly with the grid. The smart connection could inform the grid operator of the energy required to recharge, consumers' recharge preferences (e.g., time, cost threshold) and billing information; in turn, consumers could be provided the consequences of charging at that time and the recommended time to charge that would minimize cost as well as the impact on the grid and the environment.

In addition to technology development to implement the Smart Grid and smart charging, DOE and the national labs are working with other governments and standards organizations (domestically and internationally) to develop/disseminate best practices, such as test procedures/protocols and vehicle-grid communication, that will expedite the adoption of **compatible global codes and standards** in an effort to minimize the barriers to volume production of environmental vehicles.

Argonne's Role

As the Smart Grid moves from concept to reality, Argonne is helping to ensure this technology will interact seamlessly with the emergence of plug-in vehicles. At Argonne's Center for Transportation Research, engineers are actively pursuing the development of standards related to PHEVs and methods to test PHEVs. Argonne is also **validating communications technologies** designed to communicate between a vehicle's smart charger and the electrical infrastructure's smart meters.

An important component of integrating PHEVs into the grid is the vehicle's plug. Argonne researchers are part of an **international codes and standards** committee working to develop the Society of Automotive Engineers' (SAE) new connection standard called J-1772. The group is defining this standard so manufacturers can build compatible connectors and vehicle sockets that will support both charging and two-way communication.

To maximize the use of intermittent renewable energy sources, grid energy storage is another critical component of modernizing the electrical grid. These large-scale energy storage facilities can provide a secondary use for old PHEV batteries. When a battery's useful life for powering a vehicle is over, it can be recycled as a grid storage device.

Argonne has developed **battery technology** for many years, known most recently for lithium battery development. The current vision is to develop transformational energy storage systems that enable and enhance electric-drive vehicles and the Smart Grid by:

- Advancing electrochemical storage beyond lithium-ion batteries to other systems with new material discoveries;
- Developing energy storage prototype, manufacturing, and recycling processes and technologies;
- Developing large energy storage and power management systems that improve grid reliability and efficiency, and enable steady power supply from renewable sources; and
- Optimizing efficiency, performance, and emissions of electric-drive powertrains.

About the Display

The display debuted in December 2009 at the Bright Green Expo in Copenhagen, Denmark (part of the Climate Change Conference events). The display depicts the interdependent system of power production (with different variable energy sources), grid operators (power brokers), and end users (commercial, municipal and private – including plug-in vehicles and consumers). The overall system reacts to changes in production, demand and consumer preferences, including features such as input from mobile devices for consumers to communicate with their vehicles and the grid.

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