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Controlling the Charge: Exploring the Promise of PHEVs

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Plug-in hybrid electric vehicles (PHEVs) hold the potential for huge environmental and financial gain. Wide-scale adoption of PHEVs offers the possibility of reducing fossil fuel consumption and greenhouse gas emissions while simultaneously delivering greater energy independence and improving the economics of the electricity industry.

Numerous assessments by the nation's leading research institutions, from the National Renewable Energy Laboratory (NREL) to the Pacific Northwest National Laboratory (PNNL), have supported this optimistic outlook for the impact of PHEVs. In fact, NREL concludes that "no additional capacity would be required for even a massive penetration of PHEVs" and PNNL asserts that "84 percent of the cars, pickup trucks and sport utility vehicles (SUVs) could be supported by the existing infrastructure, suggesting a gasoline displacement potential of 52 percent of the nation's oil imports."

To date, PHEV studies have all made the critical, yet under-emphasized, assumption that the charging behavior of these vehicles, and thus their impact on the existing grid, will somehow be controlled. NREL suggests charging will occur overnight, PNNL assumes the entire PHEV load will be "managed to fit perfectly into the valleys of load demand without setting new peaks" and the Electric Power Research Institute (EPRI) asserts that PHEVs will significantly reduce greenhouse gas emissions given the existence of "programs to actively manage the charging load."

Until recently, the ability to control the timing and pace of PHEV charging and discharging had remained a tacit assumption – undefined, yet essential, to realizing the potential of plug-in vehicles. Now, with the launch of Xcel Energy's PHEV demonstration project, vehicle charging control has become a reality. Seattle-based V2Green is providing the technology to implement Smart Charging and Vehicle to Grid (V2G) strategies and Xcel Energy has become the first utility to explore the full potential of plug-in vehicles under real-world conditions. This project is part of the utility's larger strategy to design a smart grid, which will more easily allow customers and energy providers to work together to balance and stabilize the power grid.

Charging Management from V2Green

V2Green has pioneered a charging management platform enabling Smart Charging – the ability to control when and to what extent charging occurs – as well as V2G applications that allow energy to be returned to the grid. The V2Green System establishes intelligent two-way communication between plug-in vehicles and the grid, allowing utilities to manage the flow of electricity between them, within parameters set by vehicle owners. In real time, utilities can reduce grid stress and more effectively integrate renewable energy sources. With the V2Green System in place, utilities can avoid expensive infrastructure upgrades, reduce existing operating costs and minimize their greenhouse gas emissions.

Putting Theory Into Practice: The Xcel Energy PHEV Field Trial

In 2006, Xcel Energy collaborated with NREL to understand the impact PHEVs will have in the company's Colorado service territory. Using advanced modeling tools and simulation programs, the study concluded that widespread PHEV adoption could significantly reduce fuel costs and harmful vehicle emissions, while simultaneously leading to better use of renewable energy sources and grid reliability.

Acting on a commitment to advance new transportation technologies and a desire to bring the environmental and

economic benefits of PHEVs to their customers, in late 2007 Xcel Energy initiated a PHEV demonstration project to not only further substantiate the findings of the NREL study but also to test the technology in a real, day-to-day operation, including new vehicle-to-grid technology.

The field trial puts six PHEVs, converted Ford Escape Hybrids, equipped with Smart Charging and V2G capabilities on the road in real-life driving conditions. The goal is to explore the ability of plug-in vehicles to minimize greenhouse gas emissions while enhancing energy security by reducing dependence on foreign oil. The demonstration will also evaluate the impact of charging control on grid stability and the possibility of using PHEVs as energy storage devices for renewable energy and low-cost production of ancillary services.

With operations in eight states, Xcel Energy is exploring how the vehicles perform in varied geographic regions and climates over a six-month period. Three company employees are serving as test drivers, using three of the PHEVs in typical personal use scenarios. The remaining three PHEVs have been deployed in the company's fleet.

V2Green's server software is communicating with each vehicle, providing real-time control of the timing, pace and extent of vehicle charging and discharging. Each PHEV is equipped with a V2Green Communication Module (VCM), containing embedded electronics, software and communication capabilities. Via cellular modem, the VCMs communicate with the V2Green Server, transmitting commands to the car's power electronics and collecting and logging operational statistics from the vehicle. In addition to enabling detailed, real-world exploration of Smart Charging and V2G strategies, the V2Green System delivers online data collection and aggregation of field trial data – including vehicle performance, efficiency, and driver behavior – for analysis by Xcel Energy and NREL and other trial participants.

Over the course of the six month demonstration, Xcel Energy will have the opportunity to adaptively reduce or increase vehicle charging to match grid requirements, successfully delivering peak shaving, firming of renewables and cost-effectively producing ancillary services such as system regulation and spinning reserves.

Driving Toward the Clean Energy System of the Future

Media interest and consumer buzz around PHEVs is increasing steadily and the window for utilities to establish strategic plans prior to their commercial availability is narrowing. With V2Green technology enabling charging control today, more and more utilities are following in Xcel Energy's footsteps and planning for Smart Charging and V2G field trials of their own. Given that each grid has unique challenges and constraints, particularly at the distribution level, utilities are eager to inform their planning process with real-world experience and data.

Plug-in vehicles promise to reduce greenhouse gas emissions without requiring significant investment in the utility infrastructure. In all likelihood, these vehicles will play a key role in solving global climate change.

Xcel Energy CEO Dick Kelly recently said, "When I look ahead to the future of my industry, I see electric production that will be highly efficient, harness diverse resources and be nearly emission-free. I believe this future is possible, but we need to support both smart policy and new technology today to make it happen tomorrow."

Xcel Energy's Smart Charging and V2G field trial is one of many indications that the energy industry is embracing the future foreseen by Mr. Kelly and many others.

About the Authors

John Clark is Chief Executive Officer & President of V2Green. He is an experienced entrepreneur and senior executive, having spent over twenty years starting, building and running technology and telecommunications companies. Most recently John was based in London as Senior Vice President / Managing Director for Telecommunication Systems (Nasdaq TSYS) with responsibility for establishing the company's operations in Europe and Asia. He was also Founder and President of Toll Free Cellular.

As executive director of Utility Innovations, **Michael Lamb** is responsible for guiding the company's efforts, in conjunction with key business partners, to integrate existing technologies and create new technologies that will change the way utility customers are served. Michael has extensive experience in change management, systems improvement, distribution planning, and has been responsible for projects and crews across ten states. He has over two decades of service with Xcel Energy and Northern States Power. Prior to joining Utility Innovations in February 2006, Michael was Xcel Energy's General Manager of Distribution Engineering and Emergency Response, where he oversaw nearly 300 emergency first responders and support personnel and guided the utility through severe weather events impacting its delivery system. He served as General Manager of Delivery Engineering and Design from 2000 to 2003, and has held various leadership positions in power delivery, operations and planning dating back to 1985. Michael earned a master of business administration degree from the University of St. Thomas. He also holds both a bachelor of electrical engineering and a bachelor of science in economics from the University of Minnesota, and is a graduate of the Minnesota Executive Program at the Carlson School of Management.