Plug-In Electric Vehicle Integration with Renewables

DOE Annual Merit Review

PI & Presenter: Tony Markel
Organization: NREL

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Overview

Timeline

- Initiated FY10
  - Grid Interaction TT support
  - Review of Grid Integration studies
- FY11
  - “Green” Signal Development
  - V2G Comm. Standards
- End FY12 (proposed)
  - Systems testing with industry

Barriers Addressed

- Risk Aversion
  - Scenario analysis to reduce uncertainty
- Technology Cost
  - Research and identify value streams
- Infrastructure
  - Standards, functions, and strategy

Budget

- FY10
  - VT – $200K
- FY11
  - VT – $150K
  - DOE Office of Electricity - $75K (enhanced request)

Project Partners

- Pacific Northwest National Laboratory (PNNL)
- NREL Strategic Energy Analysis and Distributed Energy Systems Integration Groups

Co-funding in FY11 supports cross program coordination on current and future communication scenarios and energy management features compatible with distributed systems and Smart Grid standards.
Project Objective

PEV Integration with Renewables

- Identify opportunities for alternative value streams for plug-in electric vehicles through integration with renewables and support the definition of the infrastructure needed to enable these opportunities.

Contributes to VT Program Milestones
- Development of smart charge components and infrastructure (2013)
- Creation of vehicle/grid bidirectional communications standards (2013)

Source: Xcel Energy
Approach

- Participate and contribute towards the development of plug-in electric vehicle communications standards development.
- Review renewable energy integration studies and grid support roles for energy storage.
- Analyze the coordination of vehicles supplying grid services.
- Summarize vehicle renewable energy integration.
Vehicle Technologies Program Goals

- **2015**, enable 50% reduction in petroleum consumption
  - Based on simulations, PHEVs will reduce per vehicle petroleum savings by 40-60%
    - Contributing to communications codes and standards enables tech intro and adoption
    - Infrastructure assessment and planning enables vehicle utility

- **2030**, enable 80% of energy from non-carbon sources
  - PEVs powered by renewable resources achieves >80% reduction in CO₂ emissions
    - Smart Charge strategies and V2G enable connection between PEVs and Renewables
    - Demand for grid services increases with renewable growth – PEV value stream

Source: EPRI 2007 Report #1015325
Accomplishments

Integration of vehicles with the grid and the creation of alternative value streams to aid in PEV market expansion

- Reviewed existing literature for renewable energy integration challenges and methods of addressing these challenges.
- Published results of vehicle communications analysis scenarios and infrastructure challenges and opportunities.
- Contributed to the communications standards development process.
- Think of renewables as a load reduction resource, not as dispatchable generation
- With high penetration renewables, the net load is more transient and system inertia is decreased
- Growth of wholesale markets increases opportunities for energy storage

Western Wind and Solar Integration Study. Law, D. GE Energy; May 2010.
- Targeted 20-30% renewable energy integration in western region
- Included 5GW of nighttime electric vehicle load
- Increased evening loads due to PHEVs reduced the cost of RE generation by about 15% (see figure below)

- Discusses current and future applications for vehicles managed through grid communications
- Highlights the value of standards development efforts in enabling markets
- One-way communication enables load shaping functions while two-way communication in future enables market participation of vehicles with aggregators
Accomplishments
Strategy/Planning Publications

“Value of Plug-in Vehicle Grid Support Operation”

- Analysis of Smart Charge linked to grid regulation signal (ACE*)
- Vehicles respond to ACE broadcast signal
  - Scaled to represent value between [-1,1]
- Charge rate is adjusted from nominal depending on ACE

- 1% fleet as PEVs provided 70% of grid regulation demand (Scenario 1)
- 5% fleet as PEVs provides 100% of regulation services (Scenario 2)

ACE – Area Control Error (indicator of difference between grid supply and demand)
Accomplishments
Strategy/Planning Publications

“Plug-in Hybrid Electric Vehicle Infrastructure – A Foundation for Electrified Transportation”

• Summarized the components of the PEV infrastructure, challenges and opportunities related to the design and deployment of the infrastructure, and the potential benefits.

• Presented at MIT Transportation Electrification Symposium
Accomplishments

Communications Standards

- **SAE J2836** - *Use Cases for Communication between PEVs and Grid Components*

- **SAE J2847** - *Communication Messages between PEVs and Grid Components*

- Review and comment on the development of these standards as they relate to smart grid and renewable resources.
Collaboration and Coordination

• Society of Automotive Engineers

• Pacific Northwest National Laboratory

• NREL Strategic Energy Analysis and Distributed Energy Integration Groups
Integration challenges of renewables include:

- Increased transients in net load
- Reduced system inertia to maintain stability
- Localized distribution system stability impact
- Data collection, analysis, and forecasting methods are under development.

Plug-in vehicles can enable RE integration when,

- Charge and discharge events are planned and coordinated through communications
- Standards are defined that lead to consistent interfaces between vehicles and grid components
- Policies continue to support growth of renewables and PEVs in parallel and enable value stream accountability
Summary

FY11 Project Plans

- Define a “green” signal for charge and discharge management of plug-in vehicles that addresses both local and regional renewable energy and vehicle integration challenges
- Use industry-led communication standards definitions to evaluate and demonstrate vehicle energy management integrated with electricity grid operations
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NREL contacts:

- Tony Markel – tony.markel@nrel.gov

Questions?