



Ford Plug-In Project: Bringing PHEVs to Market



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Overview

<p style="text-align: center;">Timeline</p> <ul style="list-style-type: none">• Start: October, 2008• Finish: June, 2012• 45% Complete (vehicle build – 100%)	<p style="text-align: center;">Partners</p> <ul style="list-style-type: none">• Johnson Controls-Saft (JC-S)• Electric Power Research Institute• Southern California Edison• Detroit Edison• NY Power Authority• Consolidated Energy• NY State Energy Research & Development Authority• Progress Energy• Southern Company• National Grid• American Electric Power• Pepco Holdings Inc.• Hydro-Quebec
<p style="text-align: center;">Budget</p> <ul style="list-style-type: none">• Total Project Funding<ul style="list-style-type: none">– DOE: \$ 10,000,000– Ford: \$ 10,027,792• Funding recv'd in FY08/FY09 = \$5,760,172• Funding for FY10 = pending approval	<p style="text-align: center;">Barriers</p> <ul style="list-style-type: none">• Battery Cost• Battery Charge Time• Extreme Temperature Operation• Lack of Uniform Codes & Standards

Objectives

- Identify a sustainable pathway toward accelerated and successful mass production of PHEV's.
- Launch a 21-vehicle demonstration fleet
 - Provide real-world usage data
 - Provide laboratory data
- Support a customer-valued PHEV production program
 - Propulsion system design
 - Vehicle controls
 - Two-way Communication
 - Vehicle to Meter
 - Meter to Vehicle

2009 Completed Milestones

Project Management	<ul style="list-style-type: none">- Reached agreements with 10 Partners for vehicle demonstration testing- DOE approval of Phase II milestones and completion
Vehicle & Design Build Updates	<ul style="list-style-type: none">- Completed build and commissioning for 10 Phase II vehicles- Implemented Two-way communication on all vehicles- Delivered 8 vehicles to utility partners
Battery Controls & Development	<ul style="list-style-type: none">- Validated JC-S designed and built HV battery system/controls- Integrated JC-S battery into the phase II vehicles
Vehicle Controls & Development	<ul style="list-style-type: none">- Developed and released Flex Fuel (E-85) calibration and strategy for phase II vehicles- Developed and implemented cabin heating/cooling strategy across the fleet
Testing	<ul style="list-style-type: none">- Supported DOE sponsored fuel economy and emission testing at ANL- Implemented vehicle data collection and reporting system

2010 Milestones

V2G/G2V Demonstration	<ul style="list-style-type: none">- Complete field demonstration of smart meter communication with remaining utility partners
Battery Software Improvements	<ul style="list-style-type: none">- Improve vehicle robustness at colder temperatures- Improve battery charge and cell balance algorithms
Vehicle Software improvements	<ul style="list-style-type: none">- Cabin heating software implementation on remaining vehicles
Vehicle Service	<ul style="list-style-type: none">- Weekly Customer Action team meetings to support and service in-field vehicles
Data Acquisition, analysis, and reporting	<ul style="list-style-type: none">- Support DOE sponsored fuel economy and emission testing- Continue data acquisition, analysis and reports

Approach

- Phase I
 - Validate battery/control enhancements
 - Demonstrate the technology on a new, more fuel efficient engine
- Phase II
 - Progress the battery/control system closer to production intent.
 - Demonstrate two-way communication
 - All Phase II vehicles will be flex-fuel capable
- Phase III
 - Continues with fleet demonstration, data analysis, and reporting
 - Demonstrates V2G and G2V communications
- Phase IV
 - Continues vehicle demonstrations from Phase III, to accumulate mileage/time in service and document effects

PHEV - Features and Specifications

Controls & HMI

- 1) PHEV Controls Strategy
- 2) Touchscreen: Information and Charge mode selection

SOC Display

- 1) Soc & Charge Status

Rear Cargo Area

- 1) Replace production high voltage battery with a ~11.5 kWh Li-Ion battery from JCS
- 2) Add 1.4 kW, 120V battery charger
- 3) Add Data Acquisition Module
- 4) Add ZigBee module (Bi-directional communication)

Structure and Suspension

- 1) Rear Suspension modifications
- 2) Structural enhancements
- 3) Exhaust System

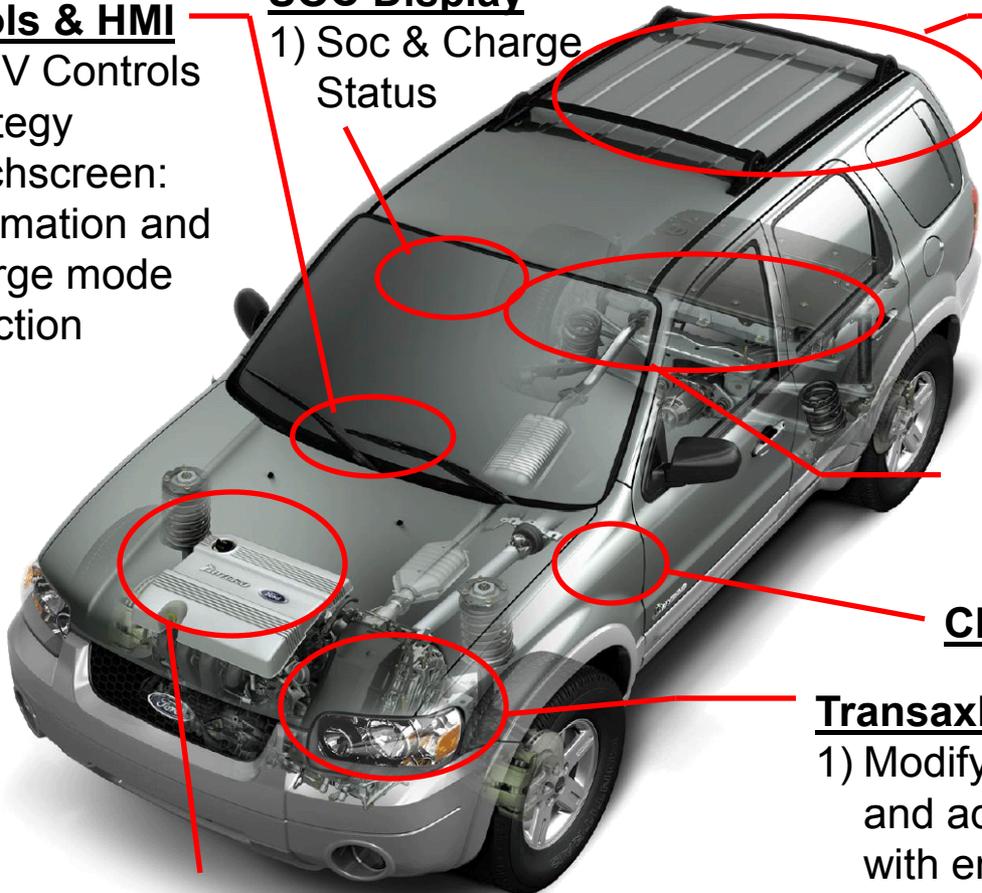
Charge Plug

Transaxle Modifications

- 1) Modify transaxle oil lubrication/cooling circuit and add external electric oil pump for oil flow with engine off
- 2) Add oil to air heat exchanger to increase continuous operating capability of electric machines

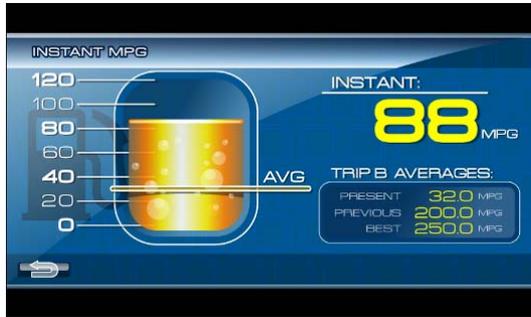
Engine & Fuel System

- 1) Flex Fuel (E-85) hardware and software

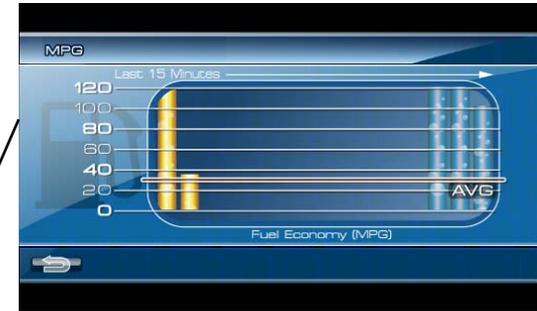


Human Machine Interface (NAV System)

Instant Fuel Economy

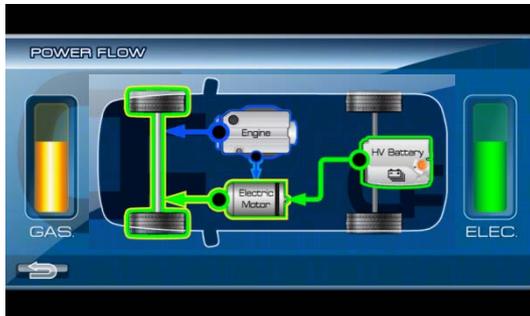


Average Fuel Economy

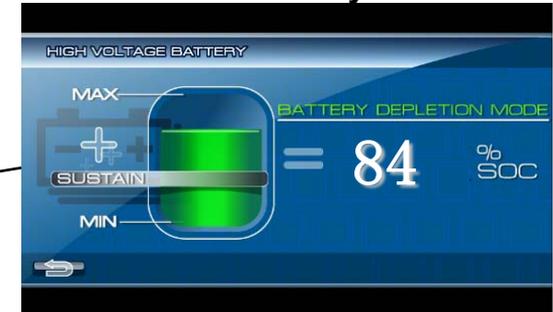


Main Menu

Powerflow



HV Battery



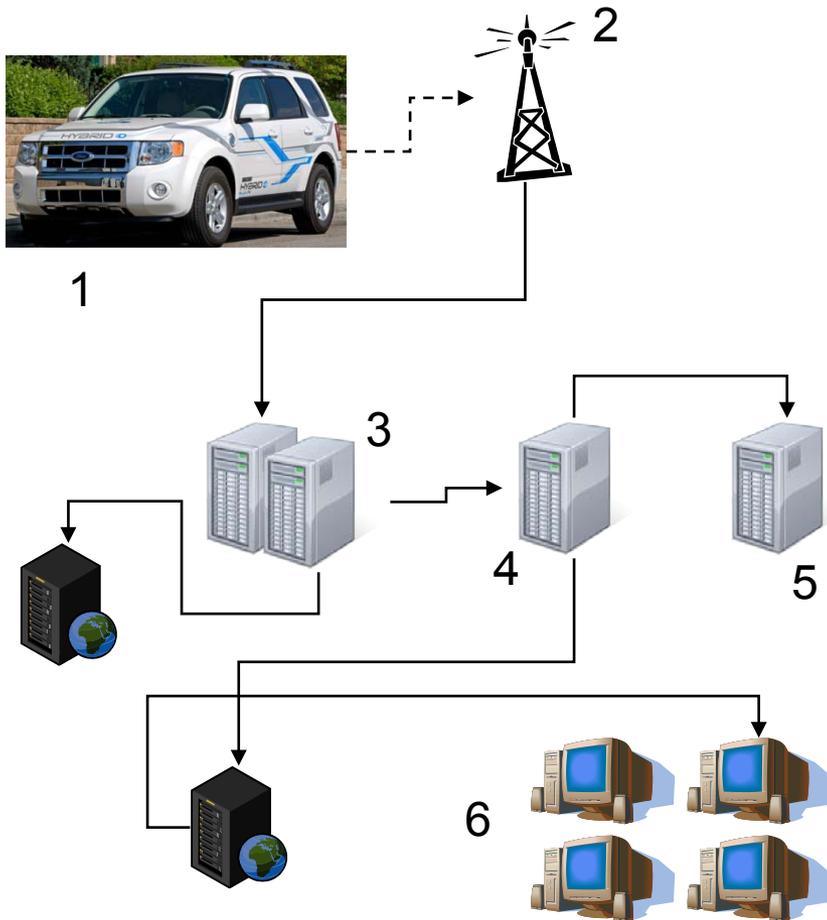
Trip Calculator



Charge Settings



Vehicle Data Collection and Reporting



1. Data collected on vehicle.
2. Data received by broadband wireless network
3. Data archived in collection server
4. Data relayed to website server
5. Website server backed-up nightly
6. Data available to authorized users through web

Customer Drive and Charge Experience

Partner	Verbatim
Southern	- <i>“Very positive feedback from multiple drivers”</i>
Detroit Edison	- <i>“Overall impression the vehicle is great”</i>
Hydro-Quebec	- <i>“The Escape enables you a better EV range. I believe the 50 km range of the escape is perfect.”</i>
NYSERDA	<i>“Intuitively, from what we’ve noted, it doesn’t use any gas at low speed.”</i>
Progress	- <i>“Overall experience is very positive”</i> - <i>“Transition between engine-on and engine-off is very smooth and the electric drive under 40mph is also very nice”</i>
American Electric Power	- <i>“Recently, I attained 28 miles of operation without the engine ever turning on. That, combined with the versatility, passenger room and cargo capacity of the small SUV design, makes the vehicle a remarkably capable.”</i>

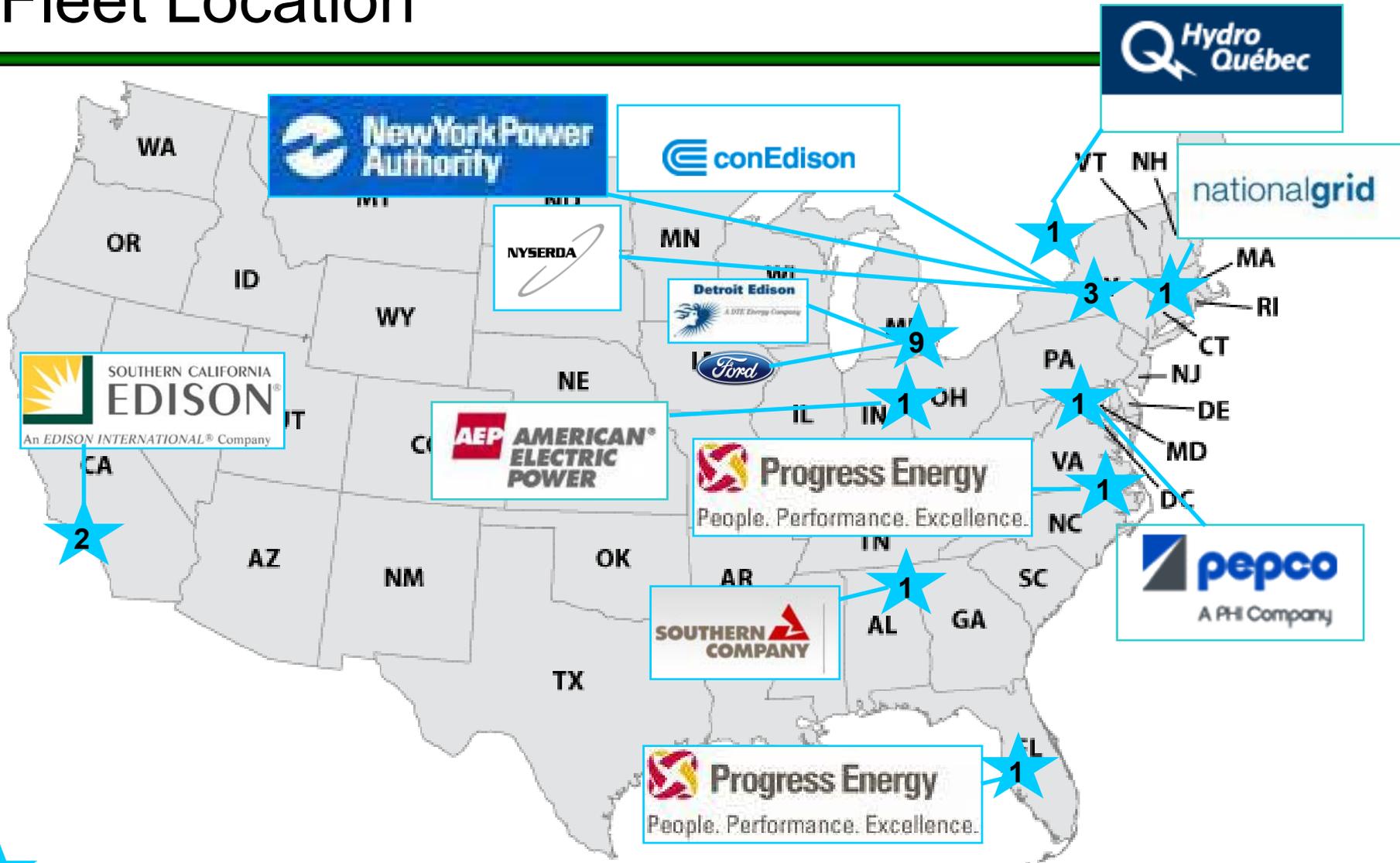
Technical Accomplishments: Phase II

- Vehicle & Design Build Updates
 - Provide Technology retrofits to vehicles 01-04
 - Upgrade vehicle structure and charge port
 - Implement flex fuel E85 capability
 - Improve Transmission cooling
 - Install data acquisition and Ford Works hardware
 - Vehicle build 12-21
 - Completed vehicle build and battery integration
 - Developed new model-year engine and fuel system hardware for flex fuel E-85
 - Developed and implemented V2G/G2V communication hardware
- Battery Controls and Development
 - LOS / Quit On Road Strategy completed and validated for JC-S supplied battery system
 - Developed and implemented V2G/G2V communication software
 - Completed software modifications for NAV system

Technical Accomplishments: Phase II

- Vehicle Controls & Development
 - Software modifications to allow Silent Key Start on 2009MY vehicles
 - Completed E-85 strategy and calibration development for 2.5L engine in 2009MY vehicles
 - Implemented on-board data acquisition system on the vehicles
 - Implemented on-vehicle data organization, analysis and web-based access
- Testing
 - Completed baseline FE testing of Phase I vehicle Argonne National Labs
 - Pre-delivery NVH and Performance evaluations completed
 - Continue collecting field data, analysis and reporting

Fleet Location



 **Number inside represents the number of vehicles delivered**

Fleet Mileage (March 23, 2010)

Vehicle	Vehicle Customer	Vehicle Odometer (miles)
PHEV 01	SCE	14,246
PHEV 02	DOE/HQ/Ford	16,179
PHEV 03	PHI	11,918
PHEV 04	AEP	10,431
PHEV 05	Ford Engineering	5,627
PHEV 06	DTE	17,264
PHEV 07	NYSERDA	15,096
PHEV 08	NYPA	8,527
PHEV 09	ConED	8,523
PHEV 10	Southern	32,353
PHEV 11	Progress	13,104
PHEV 12	National Grid	10,729
PHEV 13	DTE	6,430
PHEV 14	SCE	2,229
PHEV 15	DOE	604
PHEV 16	Progress	4,988
PHEV 17	DOE	1,387
PHEV 18	DOE	692
PHEV 19	TBD	1,157
PHEV 20	HQ	220
PHEV 21	TBD	883
TOTAL =		182,587

Public Education & Events

	Major Event
Ford Motor	<ul style="list-style-type: none">• North American International Auto Show – Detroit, MI• Washington Auto Show - Washington, DC• North Carolina Auto Show, Raleigh, NC• NHTSA Ride and Drive - Dearborn, MI• NCAA Final Four - Detroit MI• Hybrid Fest Event - Madison, Wisconsin• Vehicle Testing at Argonne National Laboratory• PHEV was used as back drop at Vice President Biden's announcement of Battery Grants• At the Ford PHEV Utility Partner's event on August 15, 2009, PHEV vehicles were available to partners and media personnel for a 'Ride and Drive'. The event generated dozens of media articles, as seen in The Associated Press, The Wall Street Journal, New York Times, The Detroit News, Fox Business Network, Autoblog.com, Forbes Online, Bloomberg, and NPR.• Channel 4 (WDIV) news segment on Plug-in Hybrid Escape http://mms.tveyes.com/ExpandGuest.asp?ln=367436• In-Car Technology and the State of Electrification, Boston, MA• Inside Ford's Electrification Strategy, San Francisco, CA• Beyond Oil: The Sustainable Communities Initiative, Microsoft Executive Conference Center, Redmond, WA• Media Ride and Drive at Los Angeles Auto show• Green Pillar Forum, Dearborn, MI

Public Education & Events

Partners	Major Event
SCE	<ul style="list-style-type: none"> • Fortune Magazines, Brainstorm Green Event in Laguna Niguel, CA • President Barack Obama Visits SCE's Electric Vehicle Technical Center • Edison Electric Institute Annual Convention, San Francisco, CA • Plug-In 2009 Conference and Exposition, Long Beach Long Beach, CA
Southern	<ul style="list-style-type: none"> • Media Kickoff at Barber Motorsports Park and Museum • Southern Company Media and Fleet event in Auburn, AL • Joint Leadership Development Conference (JLDC), Montgomery, AL
Detroit Edison	<ul style="list-style-type: none"> • Michigan Petroleum Conference Event, Grand Rapids, MI • Detroit Regional Chamber's annual policy conference on Mackinac Island, MI • ESD/DTE Energy Conference Novi, MI • Traverse City NARUC Mid America Regulatory Conference • The Business of Plugging In, Detroit, MI • Vehicle displayed at Detroit Tigers event at Comerica Park
AEP	<ul style="list-style-type: none"> • An Article "A Powerful Challenge" published in the "Columbus Dispatch"
National Grid	<ul style="list-style-type: none"> • Healthy Buildings, Syracuse, NY (http://www.hb2009.org/) • Smart Grid Lecture, Schenectady Museum, Schenectady, NY (http://www.schenectadymuseum.org/events.php?month=9&year=2009)
PHI	<ul style="list-style-type: none"> • DOE Solar Decathlon (National Mall, Washington DC)

Public Education & Events

Partners	Major Event
Progress Energy	<ul style="list-style-type: none"> • PGN Shareholder Meeting • NC Sustainable Energy Conference • National Science Foundation site visit to the Advanced Transportation Energy Center • Harris Nuclear Plant Community Day • Take Your Children to Work Day • EPA administrator Lisa Jackson's used a PHEV at a stimulus announcement event in St. Petersburg, Florida
ConEdison	<ul style="list-style-type: none"> • Green Event, Leihman College, Bronx, NY
Hydro-Quebec	<ul style="list-style-type: none"> • Media event with Ford Director of Sustainable Mobility Technologies and Hybrid Vehicle Programs Nancy Gioia and Hydro-Quebec CEO Thierry VanQuebec • Ride&Drive event with the auto journalists organized by Ford of Canada • PHEV 2009 conference in Montréal (http://www.emc-mec.ca/phev/en/home_en.html) • Alternative Energy Rallye (http://www.rallye-alternative.com/) • TV journalist made a review of the vehicle on a show called le guide de l'auto (http://www.voxtv.info/ga_videos/environ.html) See #4 (les voitures rechargeables) • Ride & Drive with Quebec minister of Natural Resources, members of the Quebec National Assembly
NYPA and NYSERDA	<ul style="list-style-type: none"> • Governor David A. Paterson press conference on battery consortium

Planned work for: Phase III

- V2G/G2V Demonstration
 - Continue with field demonstration of Vehicle/Smart Meter communications at utility partner locations and future public events
- Battery Software Improvements
 - Roll out battery software to improve phase II vehicle robustness at colder ambient temperature
 - Improve battery charge and cell balance algorithms based on field testing

Planned work for: Phase III

- Vehicle Software Improvements
 - Complete cabin heating software implementation on remaining vehicles
- Vehicle Service
 - Continue with weekly Customer Action Team meetings
 - On going service and support of field vehicles
- Data Acquisition, Analysis, and Reporting
 - Continue with vehicle data collection
 - Vehicle data analysis and reports to DOE and partners
 - Provide phase II vehicles for DOE testing

Moving Forward

- Finalize partnerships and deployments for remaining undeployed vehicles
- Continue V2G/G2V Communications demonstration
- HV Battery software adjustments to improve charge, cell balance and robust vehicle operation
- Service and maintain fleet
- Collect, analyze and report vehicle/fleet data
- Use lessons learned and field data to support production PHEV and BEV vehicle designs

Summary

- DOE-sponsored program leads to the announcement of a 2012 mass production PHEV program
- Engineering development continues to drive production vehicle designs
- Strong interest from public
- Fleet customers are very satisfied with battery charging and driving experience