Idaho National Laboratory

U.S. DOE Advanced Vehicle Testing Activity

National PHEV Fleet Testing and Demonstration Activities

Jim Francfort Beyond Oil: Transforming Transportation Redmond, Washington September 2008

This presentation does not contain any proprietary or sensitive information

AVTA Background and Goal

- The Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program
- The AVTA is primarily conducted by the Idaho National Laboratory (INL) and Electric Transportation Engineering Corporation (ETEC - Phoenix, AZ), and Argonne National Laboratory performs dynamometer testing
- AVTA Goal / Data Audience
 - Provide benchmark data to technology modelers, research and development programs, and target and goal setters
 - Assist fleet managers in making informed vehicle purchase, deployment and operating decisions



PHEV Questions

- Are PHEVs technically and economically feasible as a transportation option?
- What are the petroleum savings and electricity demands?
- Will fleets and the public adapt to plugging in (charging) PHEVs to maximize mpg?
- Is a two-fuel scenario a difficult transition?
- What are the charging infrastructure needs, including 110V versus 220V? Fast charging?
- V2Grid economic benefit or liability to the vehicle operator?
- Are there societal and economic issues and benefits?
- To answer these questions, the AVTA is testing and field demonstrating nine different PHEV models and charging infrastructure

Hymotion Prius – UDDS Fuel Use

• 5 kWh A123Systems (Li) V1 and Prius packs (AC kWh)



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Hymotion Prius – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gas	oline
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Gals	MPG
10	1	0	4	60	600	136.33	4.81	127.2
20	1	1	8	30	600	122.02	5.37	115.9
40	4	0	12	15	600	84.10	6.05	101.1
40	2	2	12	15	600	87.22	5.78	106.9
40	0	4	12	15	600	79.82	8.54	73.1
60	2	4	12	10	600	55.33	8.98	68.9
80	2	6	12	8	640	43.99	11.36	58.3
100	2	8	12	6	600	35.98	8.43	73.2
200	2	18	12	3	600	15.0	11.02	54.8
Total	2540	3100	1404	167	5,440	Weighted A	Average	79.5

Each total distance slightly greater than 600 and 640 miles. HEV version = 44 mpg



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EnergyCS Prius – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gas	oline
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Gals	MPG
10	1	0	4	60	600	115.58	4.78	128.1
20	1	1	8	30	600	86.21	7.95	77.9
40	4	0	12	5	200*	17.37	1.61	126.4
40	4	0	12	15	600**	26.48	11.31	54.1
40	2	2	12	5	200*	29.00	1.42	145.1
40	0	4	12	5	200*	30.00	2.43	85.5
60	2	4	12	10	600	65.00	5.90	103.7
80	2	6	12	8	640	39.04	10.09	65.8
100	2	8	12	6	600	22.67	8.81	70.8
200	2	18	12	3	600	12.98	10.46	57.8
Total	2340	2500	9.84	147	4840	Weighted A	Average	84.5

*Rerun to 600 miles. **Software updated and cells replaced. May rerun. Each total distance slightly greater than 600 miles. HEV version = 44 mpg

Hymotion Escape – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gas	oline
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Gals	MPG
10	1	0	4	60	600			
20	1	1	8	30	600	In	testing	
40	4	0	12	15	600	57.51	14.91	41.1
40	2	2	12	15	600	76.29	15.99	38.7
40	0	4	12	15	600	114.14	11.92	51.5
60	2	4	12	10	600	97.18	13.70	45.3
80	2	6	12	8	640	77.69	16.05	41.3
100	2	8	12	6	600	58.64	15.69	39.8
200	2	18	12	3	600	26.09	17.72	33.5
Total	2340	3100	1344	162	5440	Weighted A	Average	

Each total distance slightly greater than 600 miles. HEV version = 27 mpg



Electrovaya Escape – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gas	oline
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Gals	MPG
10	1	0	4	60	600			
20	1	1	8	30	600			
40	4	0	12	15	600	71.3	16.42	37.3
40	2	2	12	15	600	69.8	14.34	43.1
40	0	4	12	15	600	In	testing	
60	2	4	12	10	600	44.79	16.64	37.3
80	2	6	12	8	640	42.72	16.30	40.8
100	2	8	12	6	600	20.85	21.17	29.2
200	2	18	12	3	600			
Total	2340	3100	1344	162	5440	Weighted A	Average	

Each total distance slightly greater than 600 miles. HEV version = 27 mpg





Hymotion/A123Systems Joint Data Collection

- Kvaser data loggers installed on 50 PHEVs North America
- Onboard data includes vehicle performance, fuel use, and charging and driving profiles
- Participants include electric utilities, water agencies, universities, county and provincial governments:
 - Northeast: Vermont, New Hampshire, New York
 - East / South East: Toronto, Virginia, South Carolina, North Carolina, Kentucky, Florida
 - North / Central: Wisconsin, North Dakota, Indiana, Manitoba
 - Southwest: Arizona, Texas
 - West Coast: California, Oregon
- Started 2007



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Single Hymotion Prius Charging Profiles

• 3 months, 2212 miles, 35 charges











Single Hymotion Prius Charging Profiles

• 3 months, 2212 miles, 35 charges









ENERGY

13 Hymotion Prius in May 2008 - MPG

 Below averages do NOT tell the whole PHEV energy use potential – see next slide

Charge / Operating Mode	Number of Trips	Total Distance (Miles)	Average Trip Distance (miles)	MPG	DC kWh per Mile
Charge Depleting (CD)	575	3,040	5.3	72.0	0.138
Mixed CD / CS	67	1,840	27.5	52.1	0.050
Charge Sustaining (CS)	133	1,411	10.6	40.2	
Electric vehicle only (EV)	137	127	0.9		0.236
Total	912	6,417	7.0		
CD, CS, CD/CS results (excludes EV results)	775	6,291	8.1	55.9	



13 Hymotion Prius and Aggressive Driving



ENERGY

NYSERDA Testing Partnership

- AVTA is testing New York State Energy Research and **Development Agency's PHEV conversions, stated 2007**
- Fleet testing of ~20 PHEVs later CY08

Model	Baseline Testing	Accelerated Testing	
EnergyCS Prius	Completed	Near completion, restarted	
Hymotion Prius	Completed	Completed	
Hymotion Escape	Completed	Ongoing	
Electovaya Escape	Completed (problems)	Restarted	
HybridsPlus Escape	Not started	Suspended	





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Seattle Area Demonstration



- 13 Hymotion Prius operations in partnership with:
 - City of Seattle (4)
 - King County (4)
 - Port of Seattle (2)



- Puget Sound Clean Air Agency (3)
- Started 4/2008, five vehicles converted to date
- City of Seattle lead time-of-day charging demonstration on above 13 Seattle area PHEVs. Includes INL battery impact analysis. Uses V2Green wireless charging control
- These and all future demonstration PHEVs are using V2Green onboard data loggers with cellular data transfer and GPS



Tacoma Power Demonstration

- Vehicle demonstration with data loggers using:
 - 2 Manzanita lead acid Prius, 1st quarter 2008
 - 2 Hymotion Prius adding late 2008
- Charging infrastructure study
 - After 4 PHEVs in operation, collect data on one section of administration building (800 amp, 480 volt, 3 phase load) and PHEV charging infrastructure
 - Document demand and energy profiles of PHEV charging as portion of facility profiles
 - WiFi local energy meter (LEM) data collection system





Fleet Demonstration Partners – cont'd

- Washington State-wide, Port of Chelan leading, with 14 Hymotion Prius with:
 - Benton County PUD, Chelan County Public Works, City of Wenatchee, Douglas County PUD, Energy Northwest, Green IT Alliance, McKinstry, Port of Chelan, University of Washington, Walla Walla Community College and Wenatchee Valley College
 - Started 4/2008, 1 converted to date, more Sept. 2008
- University of California Davis, with 12 Hymotion Prius
 - Up to 70 AAA of California public drivers will each operate a vehicle for ~2 months
 - First study of public use of PHEVs, charging practices and locations, started April 2008
 - 7 vehicles converted to date

Fleet Demonstration Partners – cont'd

- National Rural Electric Cooperative Association
 - Total of ten Prius and Escape PHEVs from Hymotion, EnergyCS, and Hybrids Plus operated by rural electric coop utilities, 6 converted to date, started 2007
 - Includes: Jackson Electric Membership Coop (GA), Salem Electric (OR), Four County Electric Membership Corp. (NC), Central Electric Power Coop (SC), Great River Electric (MN), and Buckeye Rural Electric Coop (OH)
- Hawaii, with 6 Hymotion Prius on Maui and Oahu
 - State of Hawaii, University of Hawaii, Hawaiian Electric Company, Maui Electric Company, Maui County, U.S. Air Force
 - Planned start 11/2008

PHEV Demonstrations: 20 States/Provinces



Other PHEV Testing

- Hymotion/A123Systems V2 Prius battery hot weather vehicle/battery testing, summer 2008
- PHEV charging studies at three commercial facilities with PHEV charging (Tacoma Power is one). Started 5/2008
- Bidirectional vehicle-to-grid (V2G) charging study with electric utilities participating. Fall 2008
 - 6 kW and 20 kW levels, using two lithium battery PHEVs, V2Green cellular charging control, documenting infrastructure requirements and costs
- Ford E85 Escape PHEV demonstration, started 6/2008
- Daimler PHEV Sprinter testing. Start spring 2009
- Conduct vehicle/battery testing on PHEVs when received via DOE's OEM PHEV solicitation
- Will consider other suitable PHEV conversions for vehicle/battery testing



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Additional Information

http://avt.inl.gov or http://www1.eere.energy.gov/vehiclesandfuels/avta/

INL/CON-08-14724



