

Idaho National Laboratory

U.S. Department of Energy, Vehicle Technologies Program, Advanced Vehicle Testing Activity (AVTA)

EPRI/IWC – AVTA's PHEV Testing and Demonstration Activities

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Georgia Power Company, Atlanta, GA.
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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). Argonne National Laboratory performs dynamometer testing
- AVTA Goal
 - Provide benchmark data to technology modelers, research and development programs, vehicle manufacturers (via VSATT), and target and goal setters
 - Assist fleet managers in making informed vehicle purchase, deployment and operating decisions

AVTA Testing History

- **Plug-in hybrid electric vehicles (PHEV)**
 - 9 models, ~75 vehicles
- **Hybrid electric vehicles (HEV)**
 - 14 models, 4 million test miles
- **Hydrogen ICE (internal combustion engine) vehicles**
 - 7 models, 400,000 test miles
- **Full-size electric vehicles**
 - 40 EV models, 5+ million test miles
- **Neighborhood electric vehicles**
 - 16 models, 200,000 test miles
- **Urban electric vehicles**
 - 3 models, 1 million test miles



9 PHEVs Models in Testing/Demonstrations

- Hymotion Prius
- Hymotion Escape
- EnergyCS Prius
- Electrovaya Escape
- Hybrids Plus Escape
- Hybrids Plus Prius
- Manzanita Prius (lead acid)
- Ford Escape
- Renault Kangoo (NiCad)
- (Vehicles equipped with lithium traction batteries unless noted)

PHEV Testing Objectives

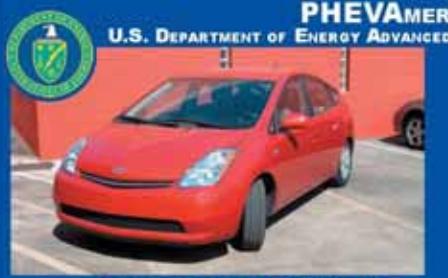
- Perform independent testing of PHEVs, using:
 - Baseline performance testing – closed test tracks and dynamometers
 - Accelerated testing – dedicated drivers operating on defined onroad loops
 - Fleet testing – everyday unstructured use, with onboard data loggers
- Document battery life, charging patterns and demand profiles
- Document vehicle operations, fuel use (both gasoline and electricity) and infrastructure requirements (110 versus 220, offpeak and V2Grid charging)
- Document driver influences on fuel use
- Document PHEV life-cycle costs

PHEV Baseline Performance Testing

- ETEC conducts initial track testing near Phoenix, AZ
 - Includes coastdown (determination of dynamometer coefficients), acceleration, top speed, braking, charging, and durability testing
- Argonne 5-day dynamometer testing regime includes:
 - Charge depleting and sustaining test cycles, as well as hot and cold starts
 - At least 26 UDDS (Urban Dynamometer Driving Schedule) and HWFEDS (Highway Fuel Economy Driving Schedule) dynamometer test cycles



Baseline Performance Testing Results



PHEVAMERICA
U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY

Base Vehicle Description
Make: Toyota
Model: Prius Year: 2007
VIN: JTDKB20U57755820
Number of Passengers: 5
Hybrid Configuration: Series/Parallel

Hymotion Plug-in Hybrid

VEHICLE SPECIFICATIONS			VEHICLE TEST RESULTS		
Weights	Electric Drive System	Charge Depleting:	Fuel Economy with A/C OFF ¹		
Design Curb Weight: 3037	Battery Manufacturer: A123	Acceleration 0-60 MPH	Cold Start Charge Depleting ² :		
Vehicle Test Weight: 3337 lbs	Battery Type: Li-Ion	Time: 13.26 seconds	Fuel Economy: 146.72 MPG		
GWR: 3795 lbs	Number of Cells: 616	Acceleration 1/4 Mile	A/C kWh Consumed: .147 kWh/mi		
GAWR/FRC: 2335/2230	Nominal Cell Voltage: 3.7V	Time: 20.27 seconds	Charge Depleting ³ :		
Distribution: 54.2%/45.8%	Nominal System Voltage: 184.8V	Maximum Speed: 74.34 MPH	Average Fuel Economy: 167.2 MPG		
Perchad: 738 lbs	Nominal Pack Capacity: 4.7 kWhs	Acceleration 1 Mile	A/C kWh Consumed: .188 kWh/mi		
Performance Goal: 400 lbs	Measured Usable Capacity: 2.96 kWhs	Maximum Speed: 103.4 MPH	Charge Sustaining ⁴ :		
Engine	Charge System:	Acceleration 0-60 MPH	Fuel Economy: 60.8 MPG		
Model: 1N4Z-FXE	Input Voltages: 120V	Time: 13.41 seconds	Fuel Economy with A/C On ⁵		
Output: 76 HP @ 5000 RPM	Required Breaker Currents: 15-Amp	Acceleration 1/4 Mile	Cold Start Charge Depleting ⁶ :		
Configuration: 4 Cylinder In-Line	Charger Power Output: 1.2 kW	Time: 20.42 seconds	Fuel Economy: 128.9 MPG		
Displacement: 1.5L	Charger Plug Type: NEMA 3-15	Maximum Speed: 74.82 MPH	A/C kWh Consumed: .199 kWh/mi		
Fuel Tank Capacity: 11.9 gal.	Estimated 80% Charge Time: 4.4 Hrs	Acceleration 1 Mile	Charge Depleting ⁷ :		
Fuel Types: Unleaded	Estimated 100% Charge Time: 5.5 Hrs	Maximum Speed: 104.0 MPH	Average Fuel Economy: 153.2 MPG		
		Brake Test @ 60 MPH	A/C kWh Consumed: .197 kWh/mi		
		Distance Required: 153.0 ft	Charge Sustaining ⁸ :		
			Fuel Economy: 46.5 MPG		
UDDS Fuel Economy ⁹			HWFET Fuel Economy ¹⁰		
Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)	Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	154.8	1.65	10	87.48	1.30
20	160.3	3.31	20	95.27	2.64
40	117.4	3.58	40	86.11	3.92
60	99.40	3.58	60	75.79	3.92
80	88.88	3.58	80	70.52	3.92
100	83.71	3.58	100	67.36	3.92
200	72.26	3.58	200	61.05	3.92

TEST NOTES:

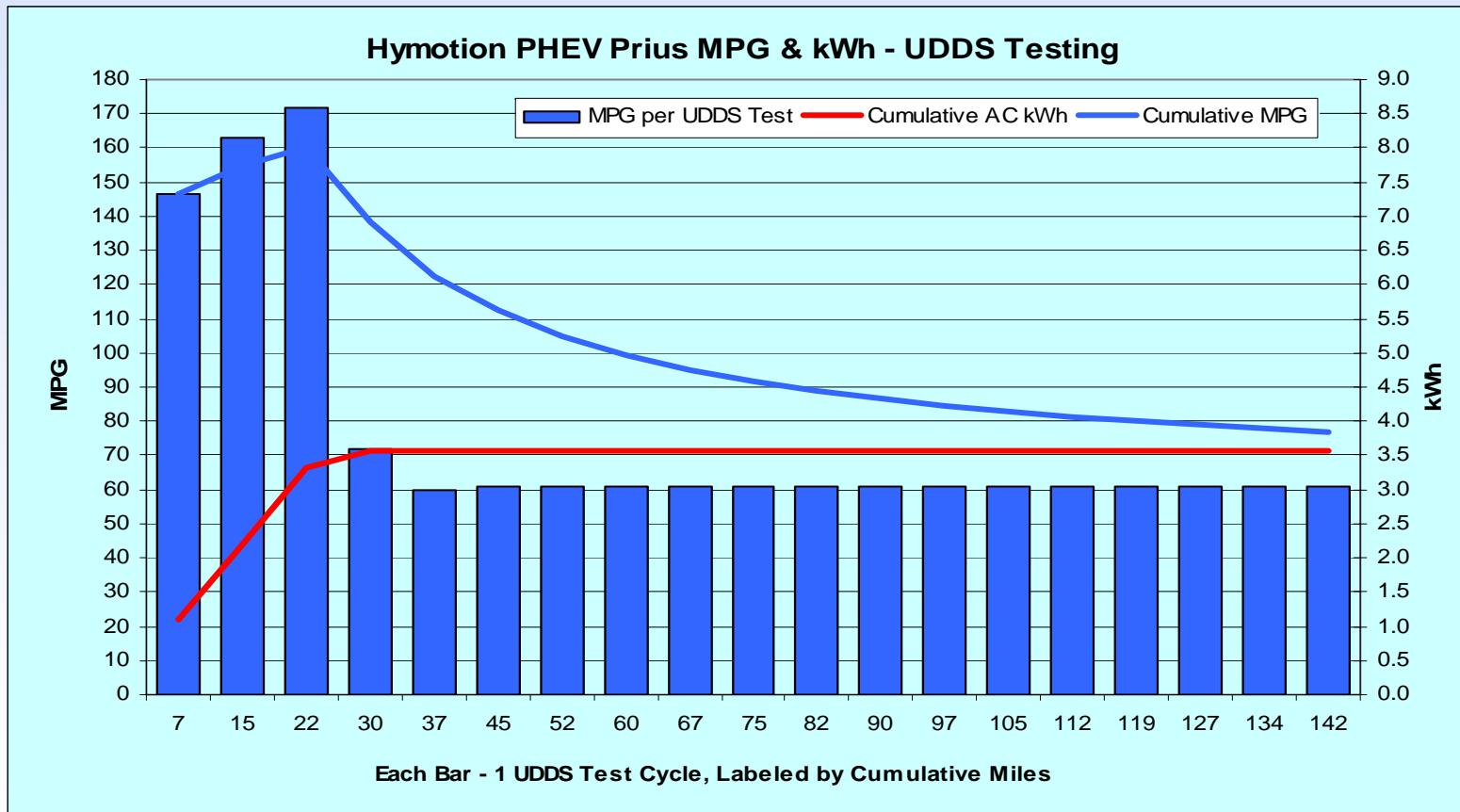
1. Constant fuel economy over E20 standard urban driving cycle.
2. Vehicle tested at ambient temperature with A/C off for a minimum of 12 hours prior to testing.
3. Average charge depleting fuel economy test with appropriate energy correction calculation.
4. Value determined from average charge depleting fuel economy test with appropriate energy correction calculation.
5. A/C on coldest setting with full blower power.
6. Cold-start contributes fuel economy values, include cold start.
7. A/C energy used to determine charge efficiency.

The vehicle meets all HEV America Minimum Requirements listed on back of this sheet.
Values in red indicate the Performance Goal was not met. All Power and Energy Values are DC unless otherwise specified.

- MPG with A/C off and on
- MPG in charge depleting and sustaining modes
- MPG cold and hot starts
- Acceleration 0-60 mph, and at ¼- and ½-mile, in charge sustaining and depleting modes
- Brake test at 60 mph
- 80% and 100% recharging times
- Vehicle specifications

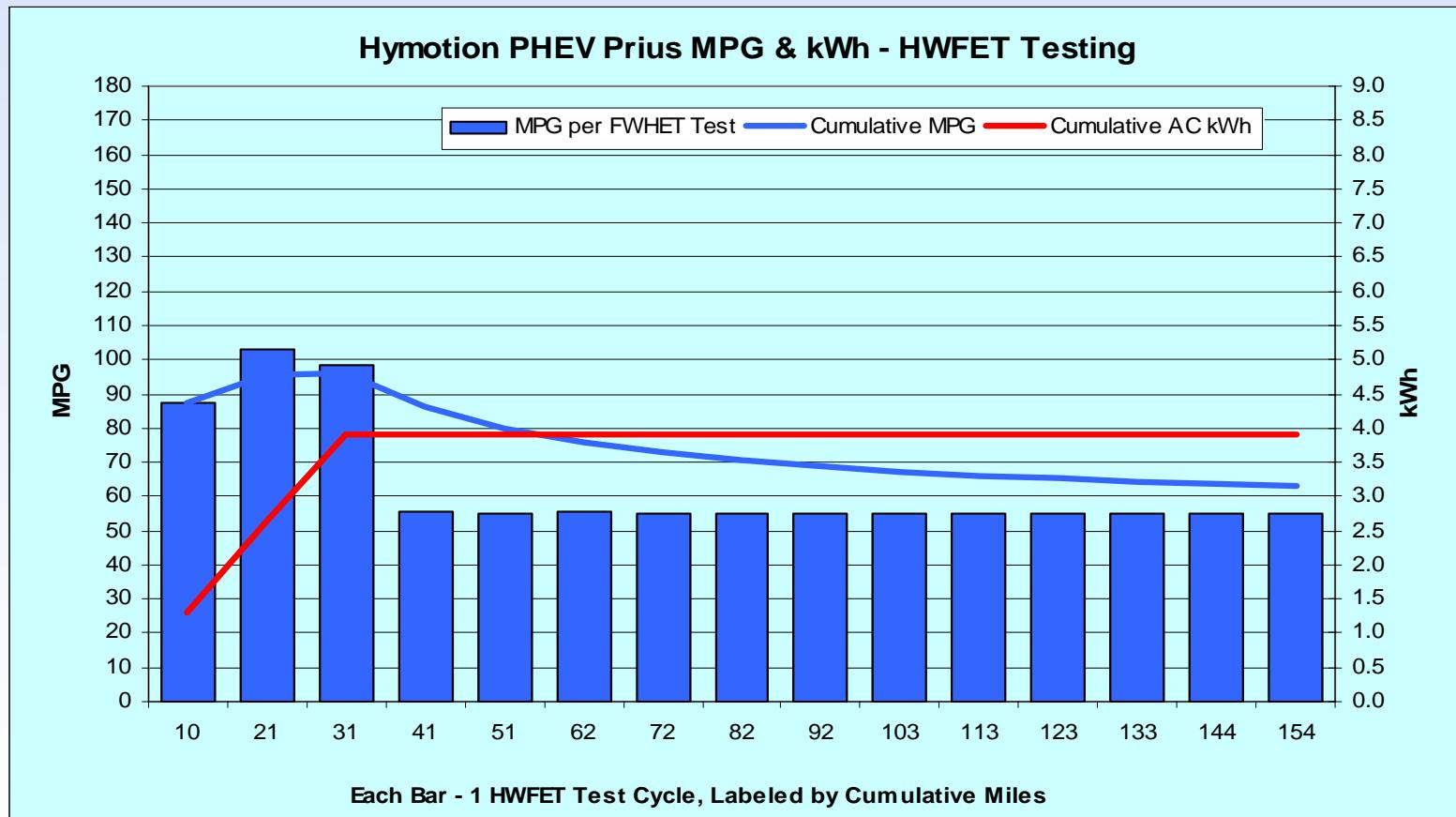
Hymotion Prius – UDDS Fuel Use

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



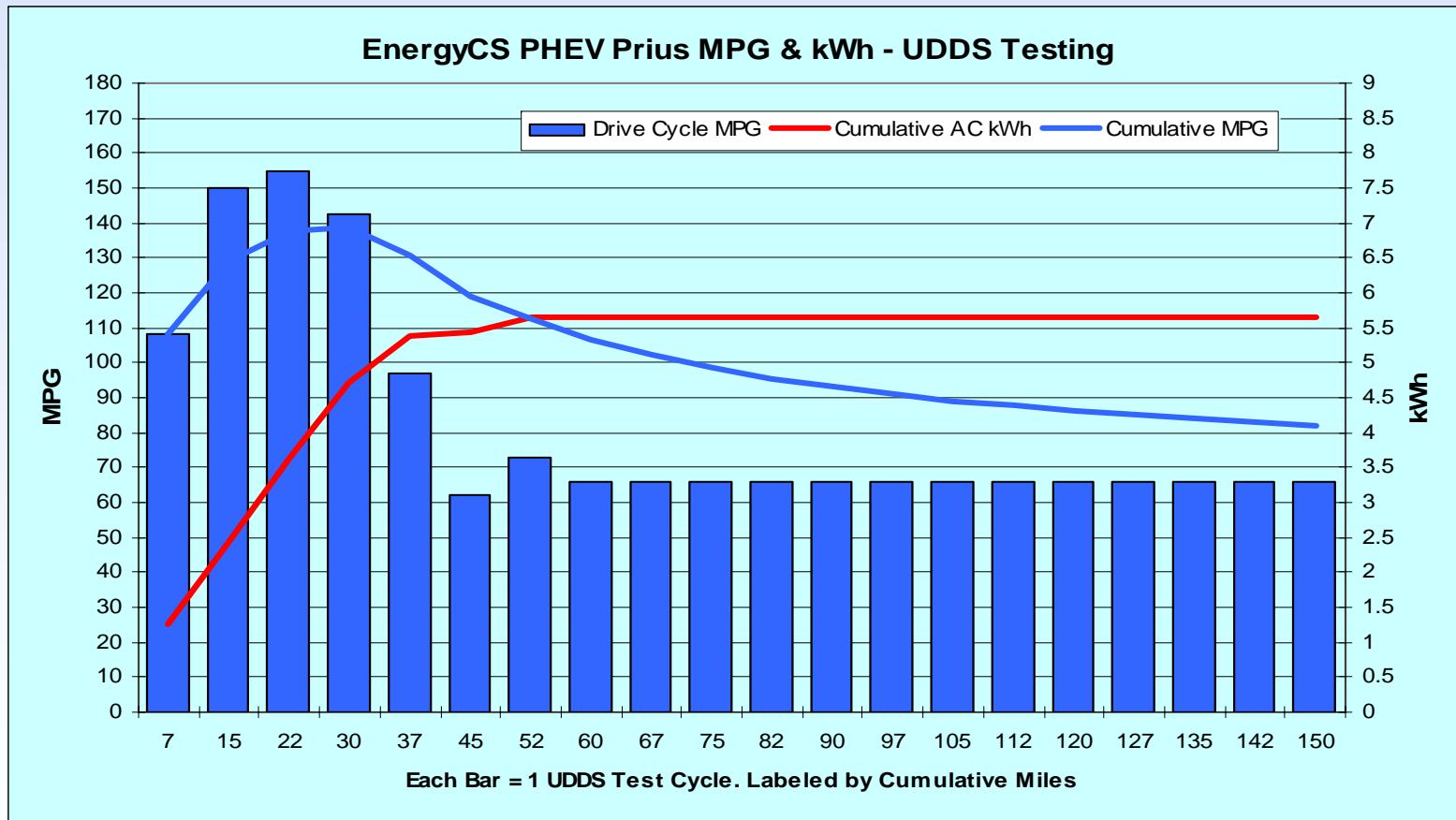
Hymotion Prius – HWFETS Fuel Use

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



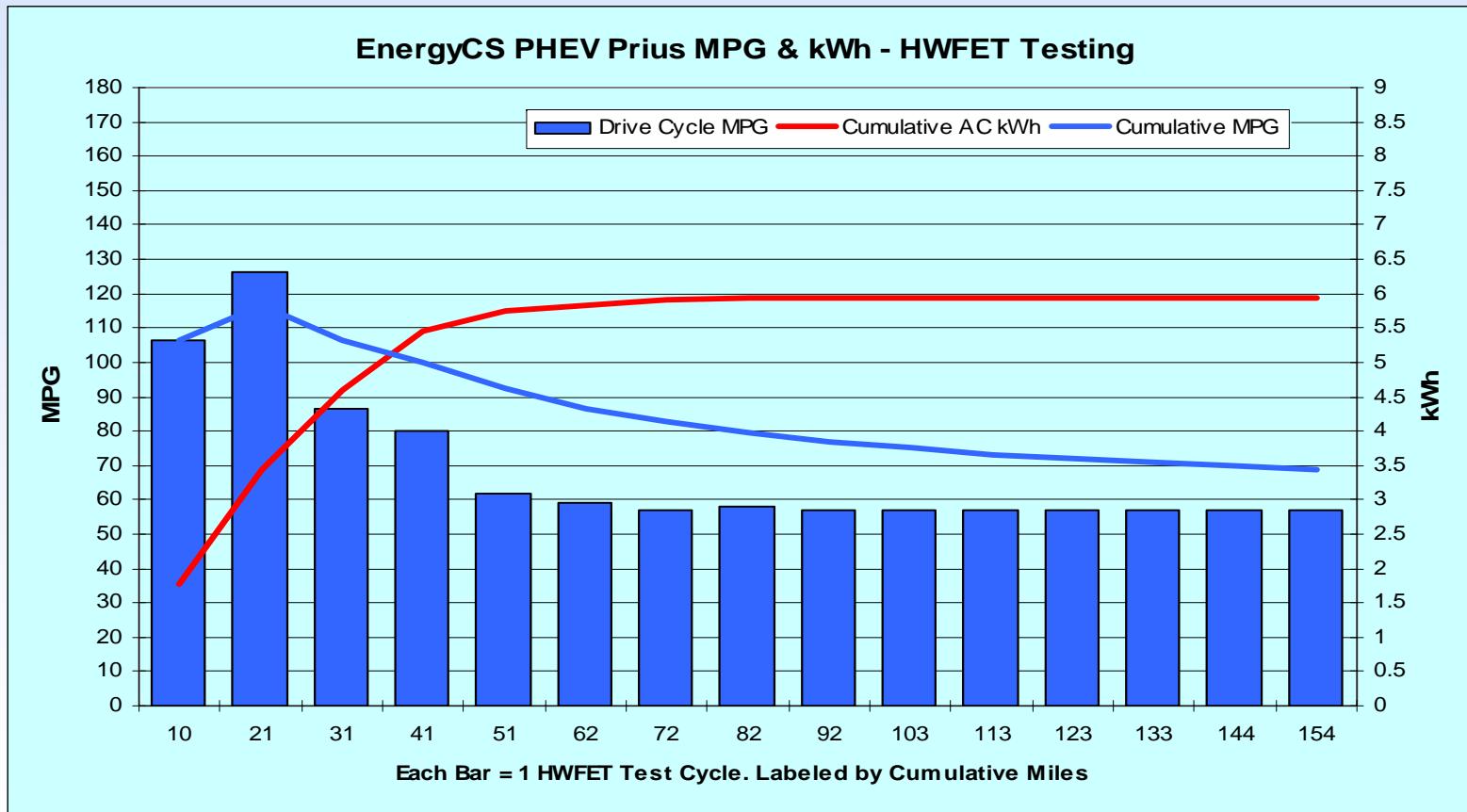
EnergyCS Prius – UDDS Fuel Use

- 9 kWh Valence (Li) pack only (AC kWh)



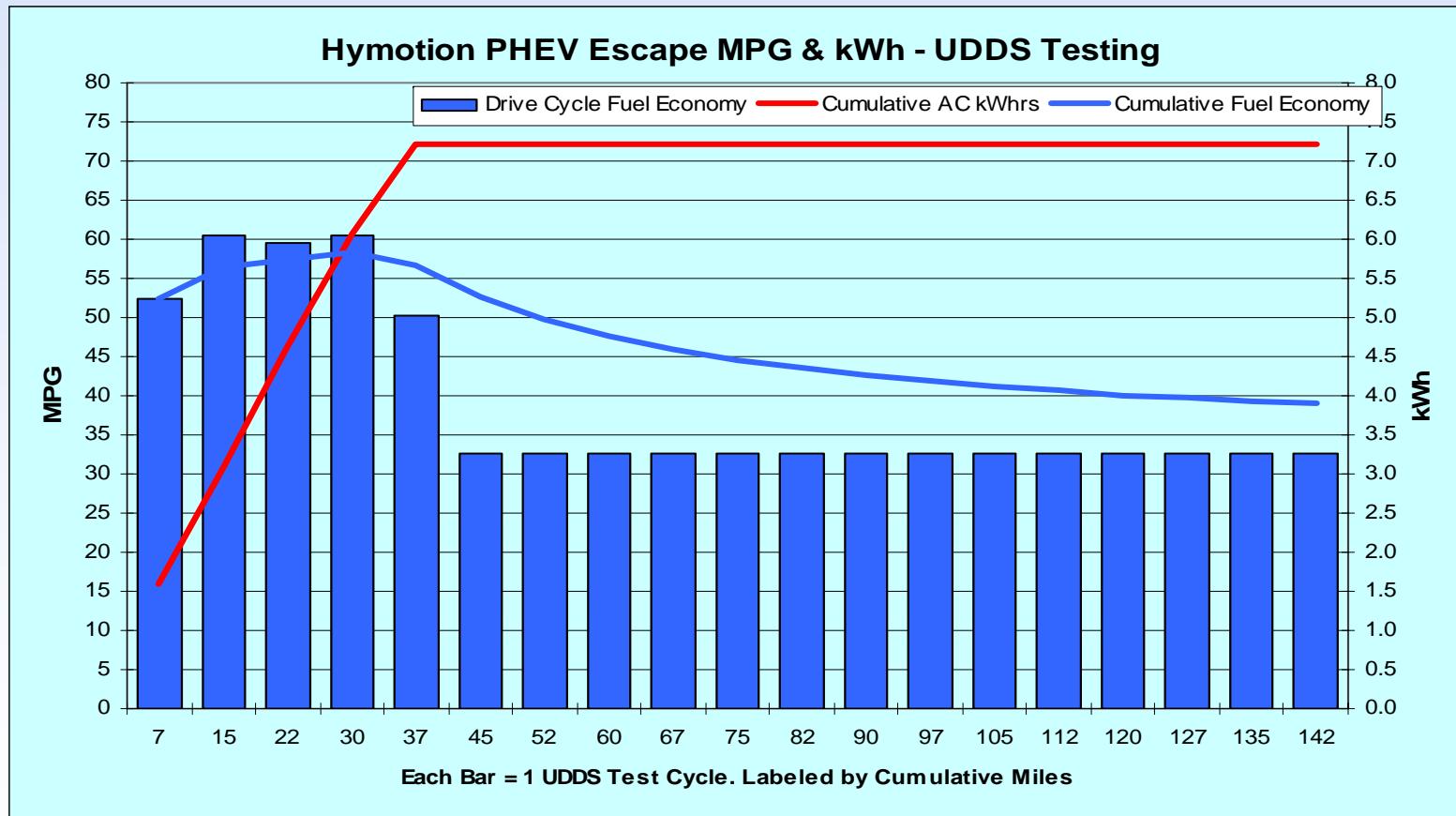
EnergyCS Prius – HWFETS Fuel Use

- 9 kWh Valence (Li) pack only (AC kWh)



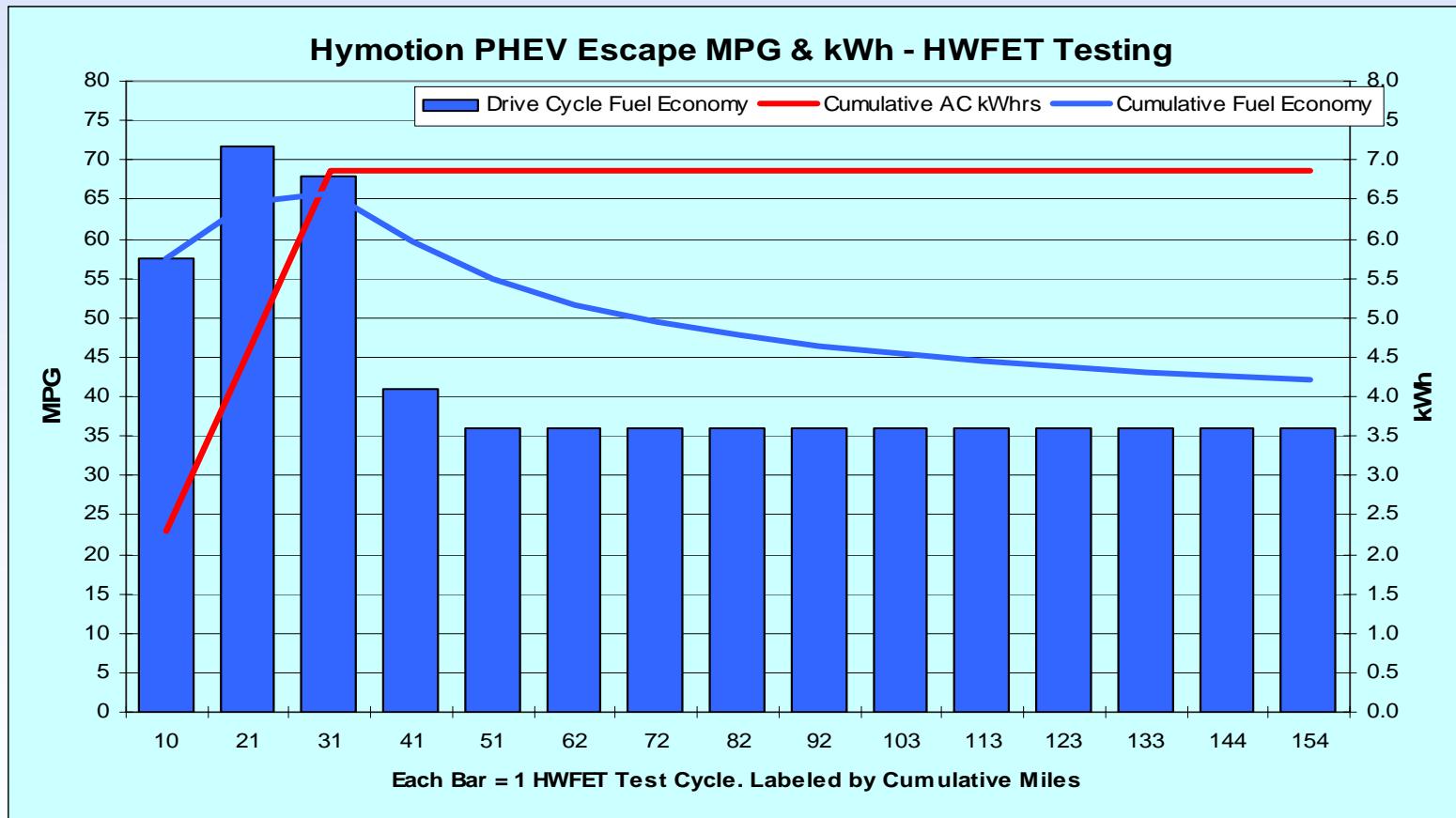
Hymotion Escape – UDDS Fuel Use

- 8.5 kWh A123Systems (Li) and Escape packs (AC kWh)



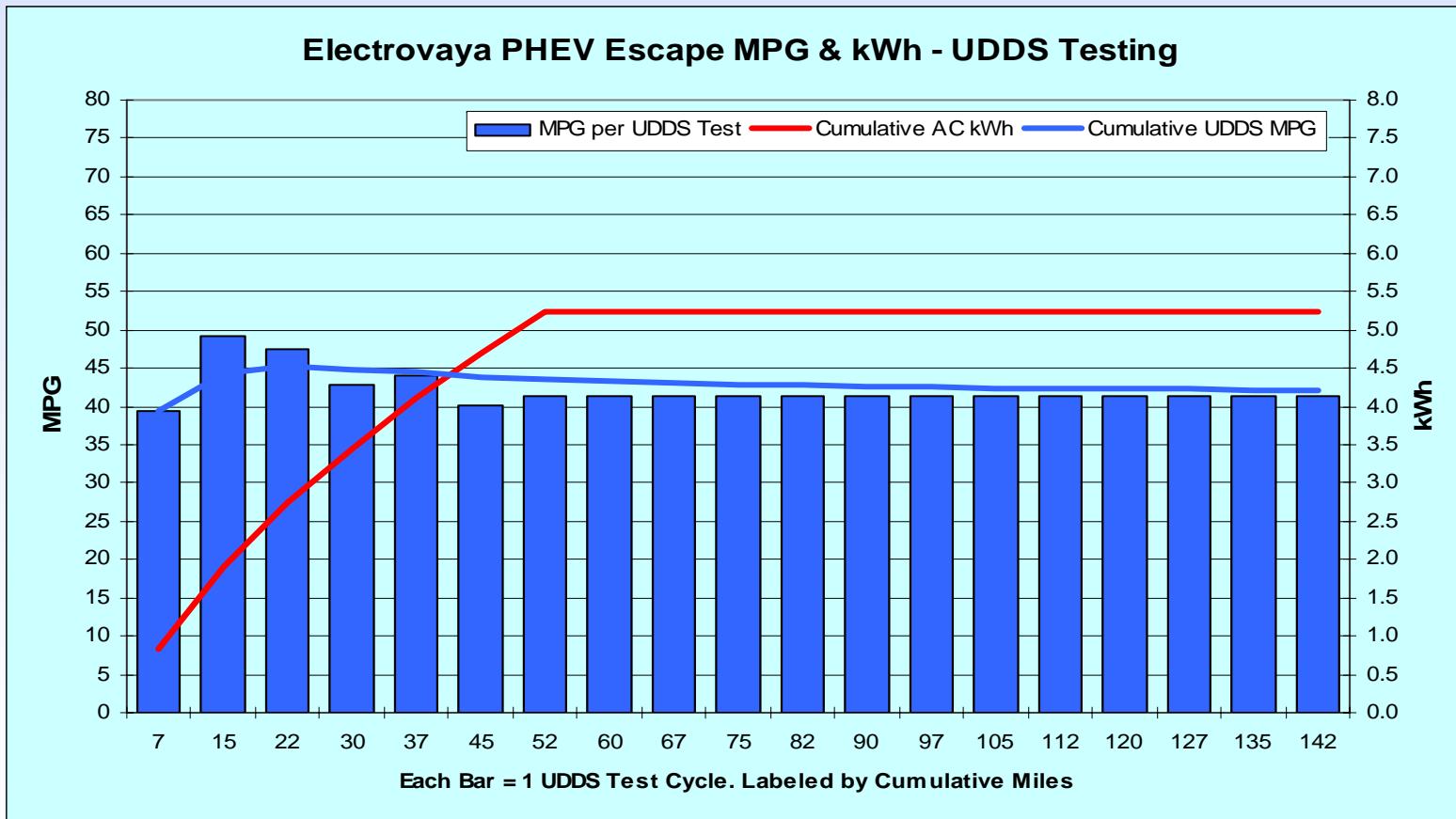
Hymotion Escape – HWFETS Fuel Use

- 8.5 kWh A123Systems (Li) and Escape packs (AC kWh)



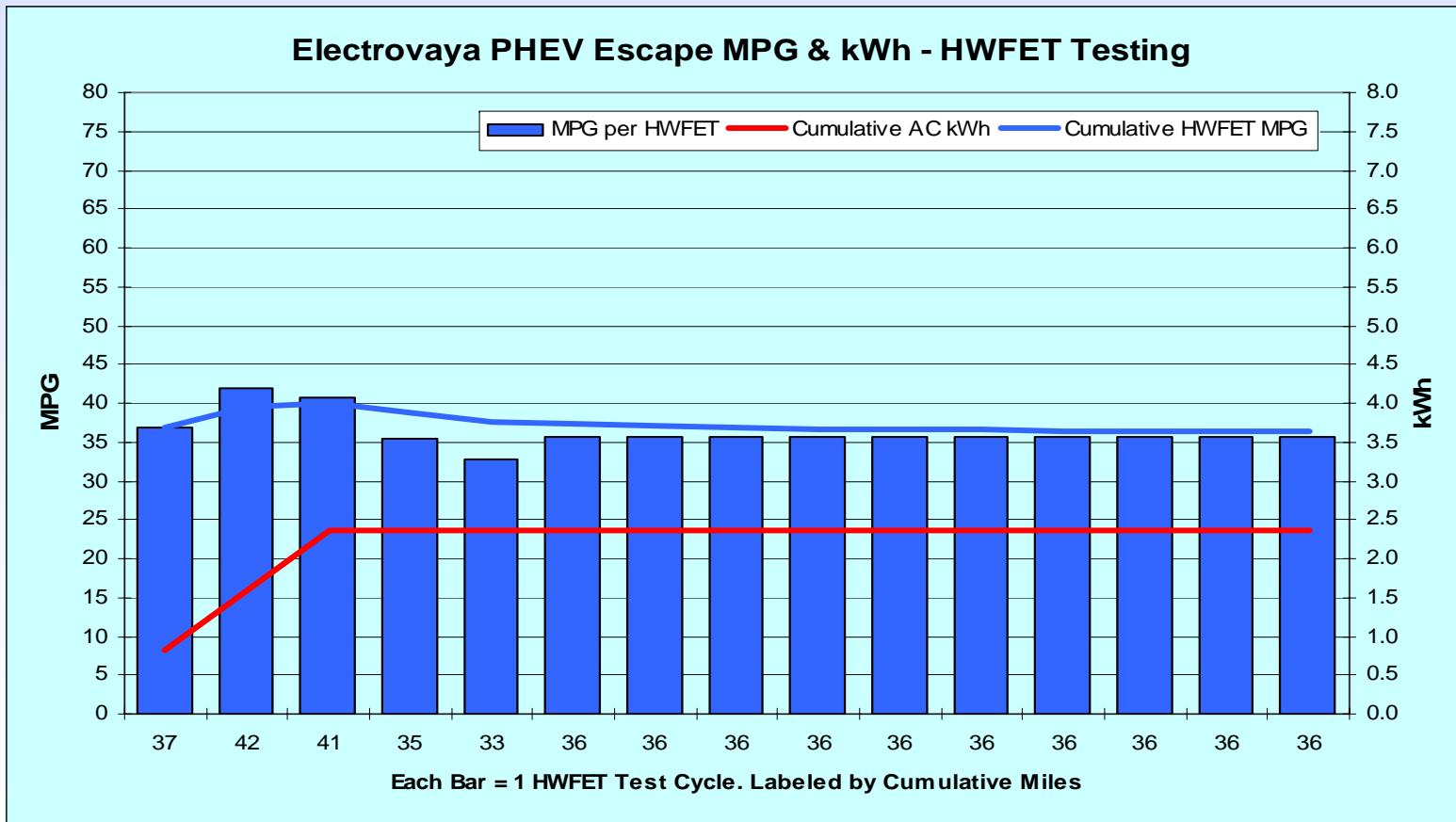
Electrovaya Escape – UDDS Fuel Use

- 12 kWh Electrovaya (Li) and Escape packs (AC kWh)

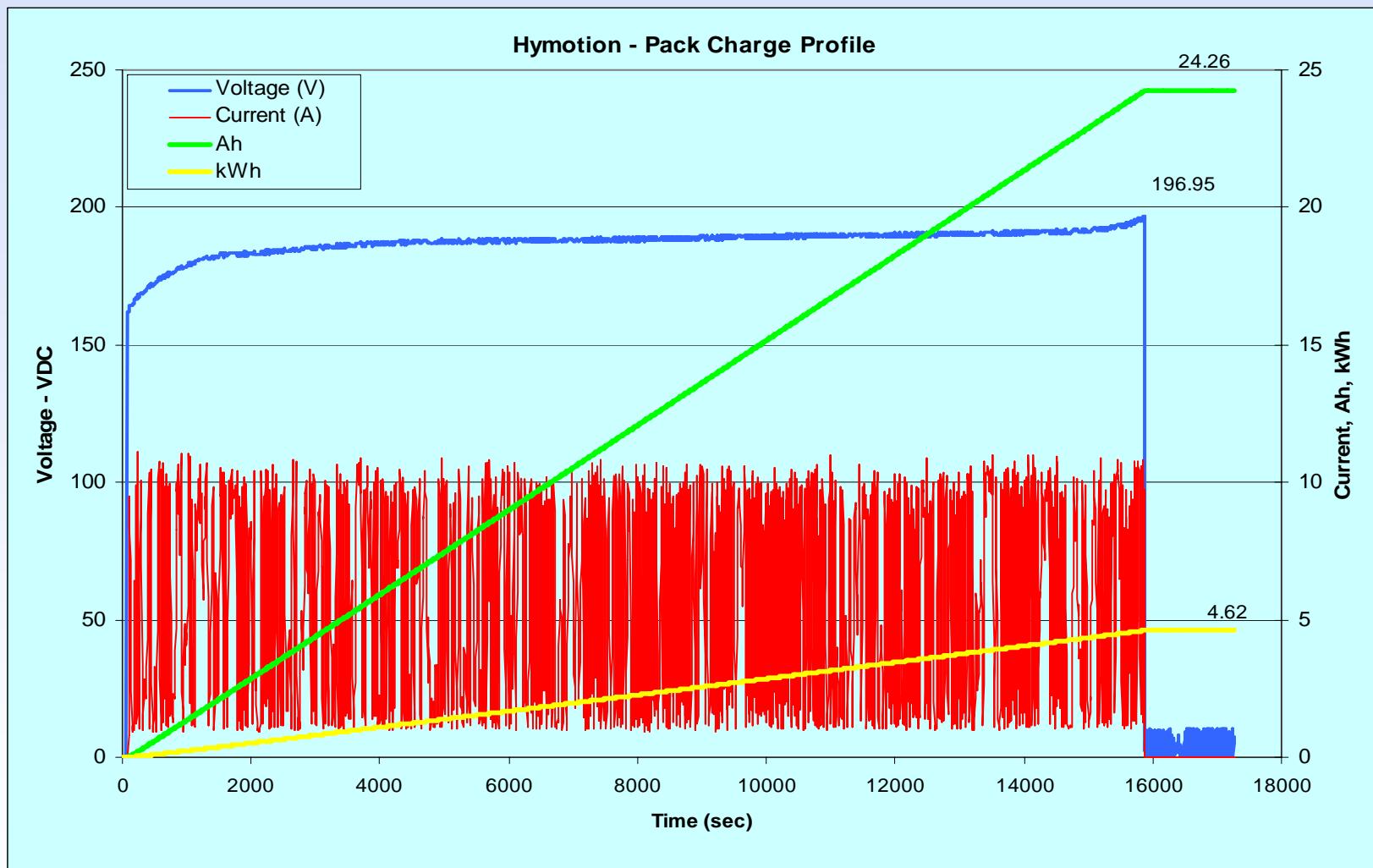


Electrovaya Escape – HWFETS Fuel Use

- 12 kWh Electrovaya (Li) and Escape packs – (AC kWh)

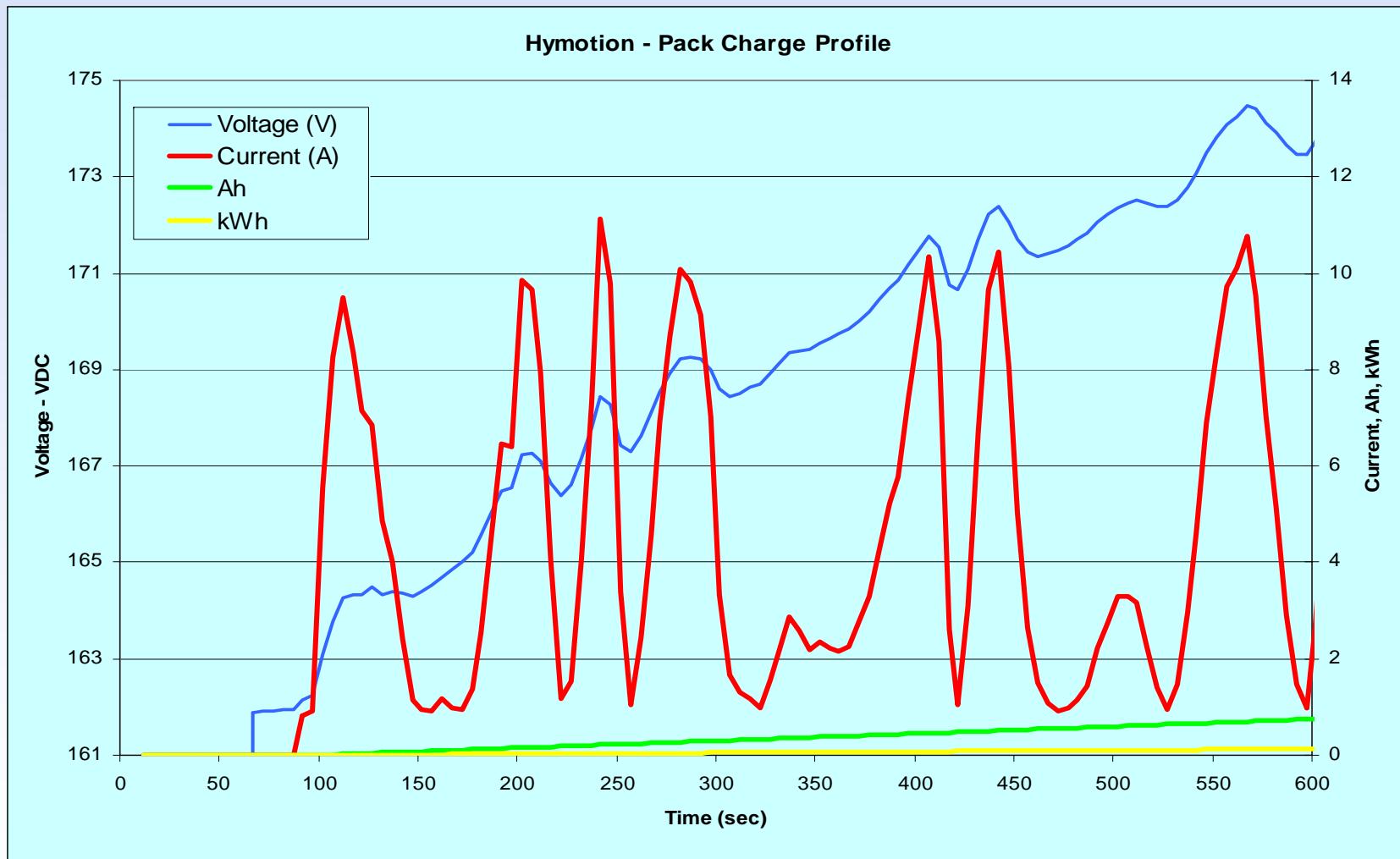


Hymotion A123Systems Pack Charge Profile



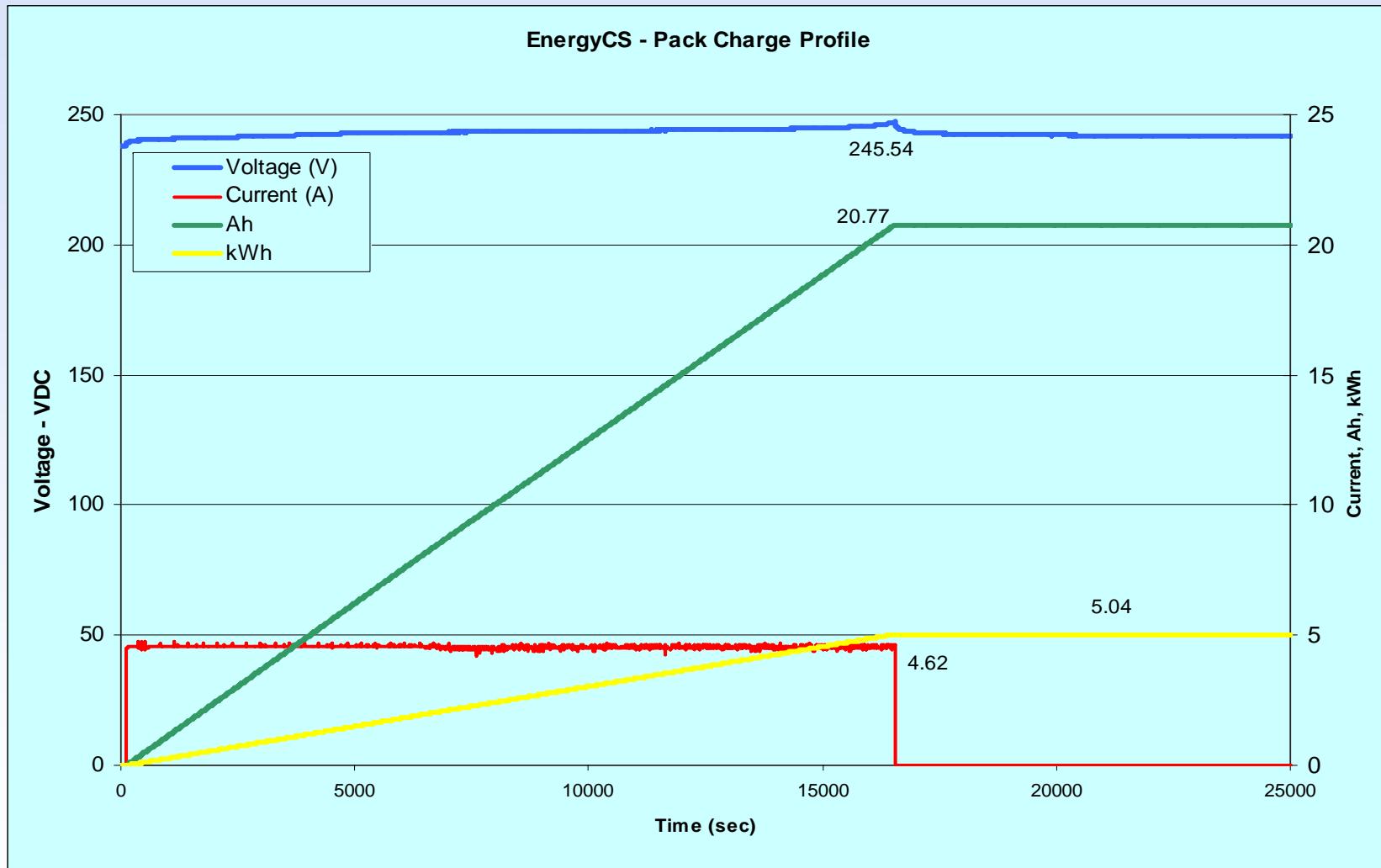
A123 Systems Lithium Ion Battery - DC kWh

Hymotion A123Systems Pack Charge Profile



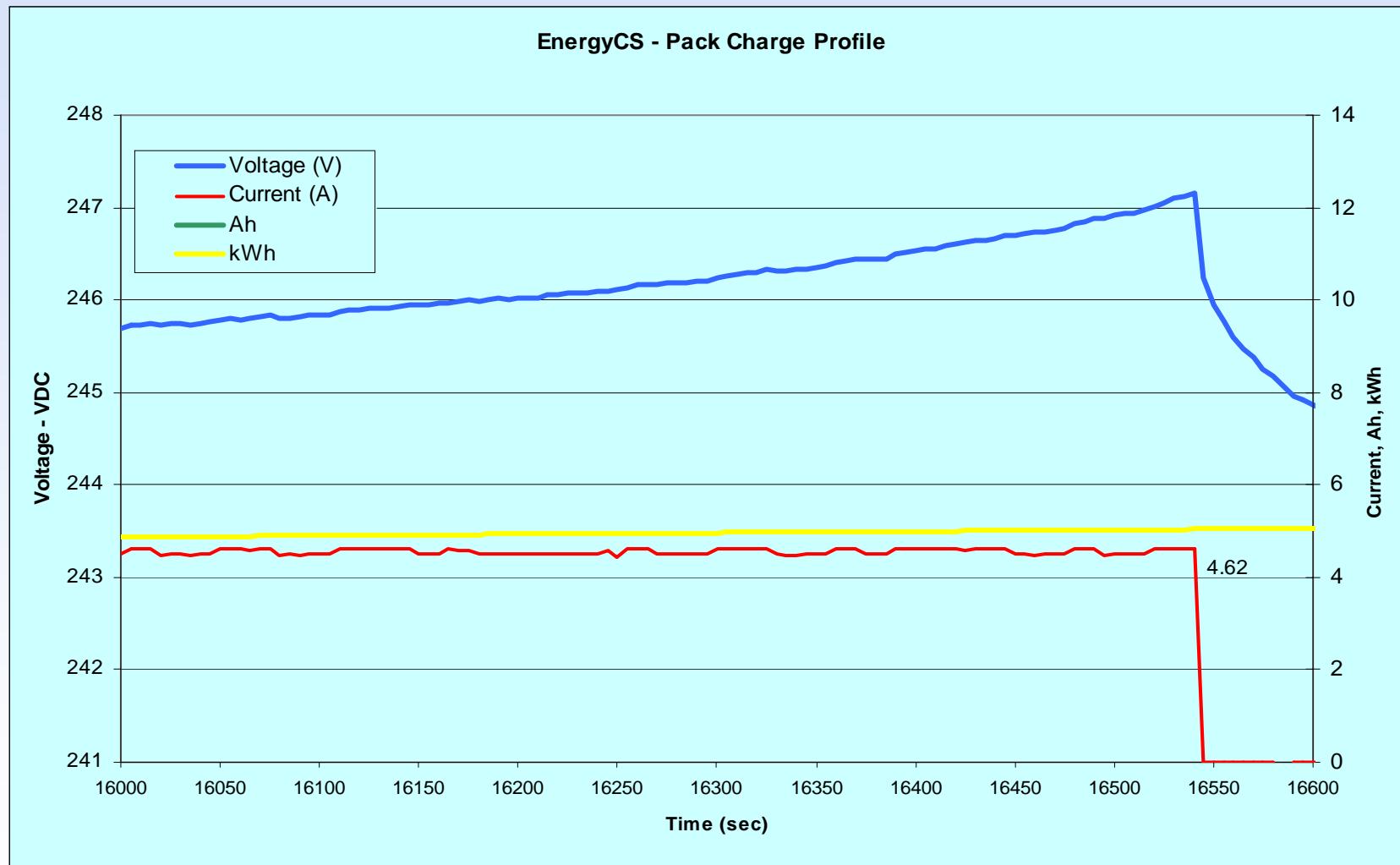
A123 Systems Lithium Ion Battery – DC kWh

EnergyCS Valence Pack Charge Profile



Valence Lithium Ion Battery – DC kWh

EnergyCS Valence Pack Charge Profile



Valence Lithium Ion Battery – DC kWh

Renault Kangoo Test Results

- First OEM series PHEV with 9.6 kWh (usable) Saft NiCad pack and 650cc gasoline engine

Test Cycle	AC kWh per Mile	Miles per Gallon
Battery Only – UDDS	0.268	
Battery Only - HWFETS	0.155	
Battery Only @ Constant 45 mpg	0.271	
Battery and Gas Cold UDDS	0.144	42.3
Battery and Gas Hot UDDS	0.110	39.4
Battery and Gas Hot HWFETS	0.042	40.9



PHEV Accelerated Testing

- Accelerated testing in Phoenix over 5,440 miles
- GPS units track distance, average and maximum speeds

Cycle (mi)	Urban (10 mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Reps (%)	Miles (%)
10	1	0	4	60	600	37%	11%
20	1	1	8	30	600	19%	11%
40	4	0	12	15	600	9%	11%
40	2	2	12	15	600	9%	11%
40	0	4	12	15	600	9%	11%
60	2	4	12	10	600	6%	11%
80	2	6	12	8	640	5%	12%
100	2	8	12	6	600	4%	11%
200	2	18	12	3	600	2%	11%
Total	2,340	3,100	1,344	162	5,440		
Average	43%	57%	8.3	18			

Hymotion Prius – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gasoline	
(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 Average	79.5	

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

EnergyCS Prius – Accelerated Testing

Cycle	Urban (mi)	Highway (mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity kWh	Gasoline	
	(10 mi)	(10 mi)	(hr)	(N)	(mi)		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	15	600*	25.00	14.29	42.7
40	2	2	12	5	600*	Testing		
40	0	4	12	5	600*	32.44	11.36	55.5
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	984	147	4840	Weighted Average		

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

Renault Kangoo – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity		Gasoline	
	(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Mi/kWh	Gals
10	1	0	4	60	600	359.60	1.7	0	
20	1	1	8	30	600	131.96	4.6	0	
40	4	0	12	5	200	35.18	5.6	0	
40	2	2	12	5	200	33.22	6.0	0	
40	0	4	12	5	200	28.60	7.0	0	
60	2	4	12	10	600	57.96	10.4	13.3	45.1
80	2	6	12	8	640	44.62	14.4	16.6	38.6
100	2	8	12	6	600	Deleted*			
200	2	18	12	3	600	Deleted*			
Total	1560	1480	876	123	3,040				

* Testing ended when gasoline engine and inverter failed. Each total distance slightly greater than 600 miles.

Hymotion Escape – Accelerated Testing

Cycle	Urban (mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity AC kWh	Gasoline Gals	Gasoline MPG
10	1	0	4	60	600	Testing		
20	1	1	8	30	600	163.29	13.51	45.7
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 Average		

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

Electrovaya Escape – Accelerated Testing

Cycle	Urban (mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity AC kWh	Gasoline Gals	Gasoline 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	55.84	20.73	29.8
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 Average		

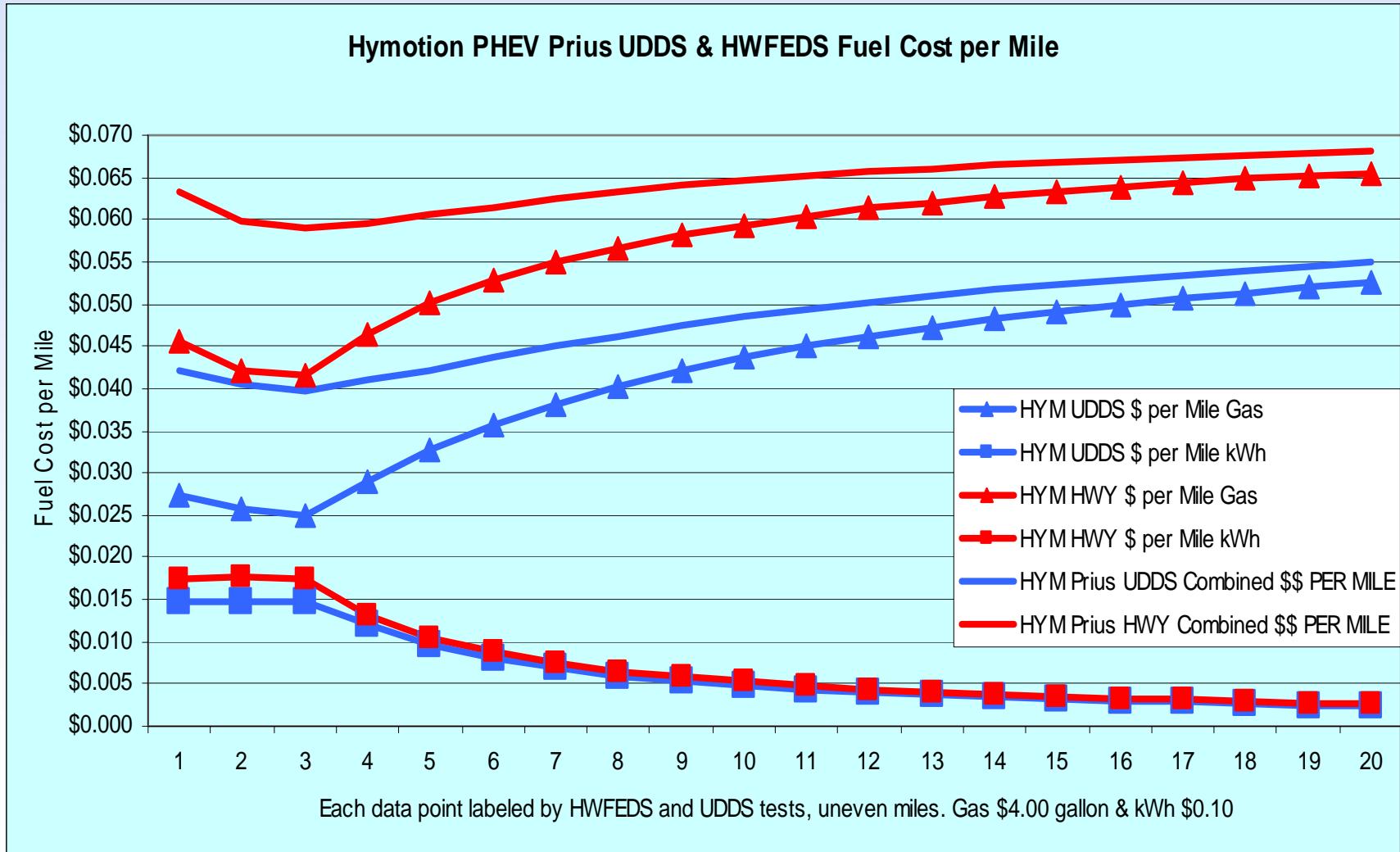
Each total distance slightly greater than 600 miles. HEV version = 27 mpg

Hybrids Plus Escape – Accelerated Testing

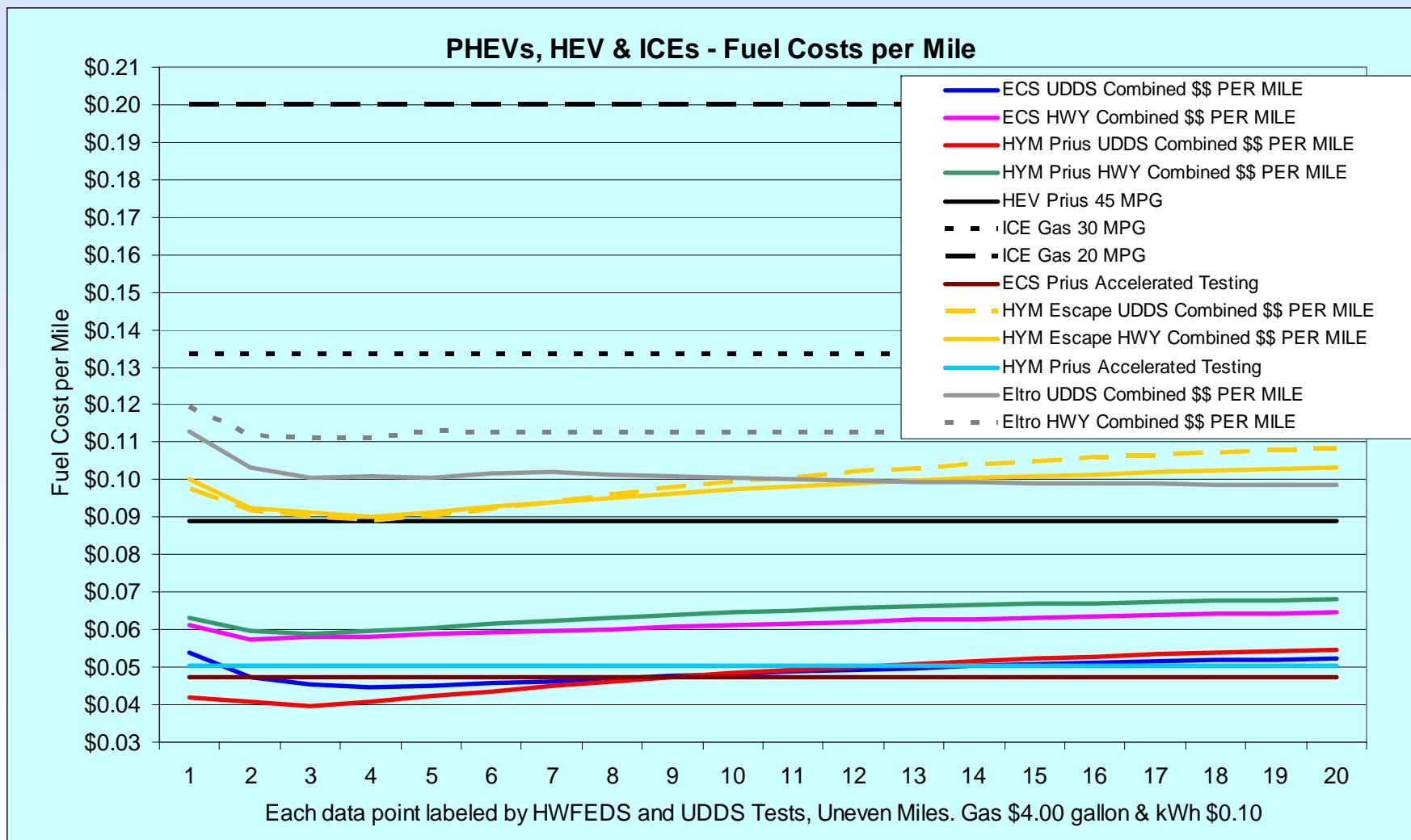
Cycle	Urban (mi)	Highway (mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity AC kWh	Gasoline	
	(10 mi)	(10 mi)					Gals	MPG
10	1	0	4	60	600			
20	1	1	8	30	600			
40	4	0	12	15	600			
40	2	2	12	15	600			
40	0	4	12	15	600		Suspended	
60	2	4	12	10	600			
80	2	6	12	8	640			
100	2	8	12	6	600			
200	2	18	12	3	600			
Total	2340	3100	1344	162	5440	Weighted Average		

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

Hymotion Prius – Fuel Costs



PHEV Vs. HEV and ICE Fuel Costs per Mile



Onroad Demonstration and Data Collection Partners

- ~75 Testing partners in the U.S. and Canada, including:
 - 36 electric utilities (some via NRECA)
 - 6 City governments
 - 2 County governments
 - 2 State governments
 - 8 Universities and colleges
 - 2 Clean air agencies
 - 7 private companies and advocacy organizations
 - 3 Province governments
 - 4 Port, clean air district and U.S. military organizations
 - 2 PHEV conversion companies



Hymotion Joint Data Collection

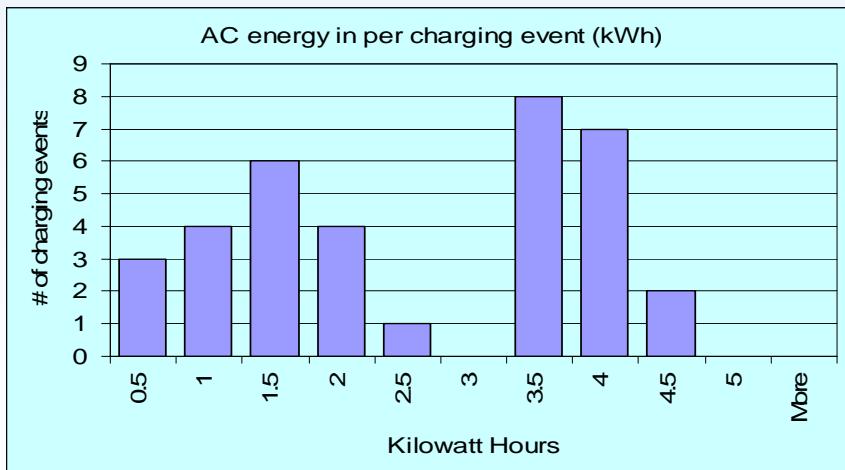
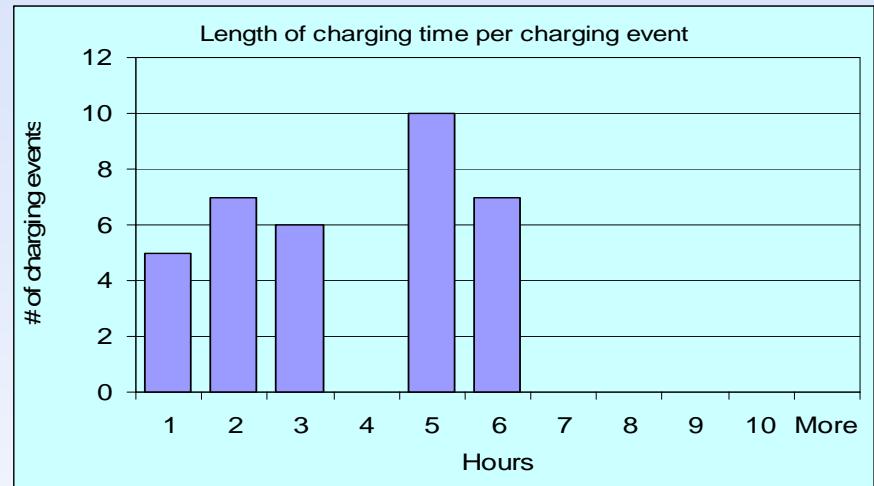
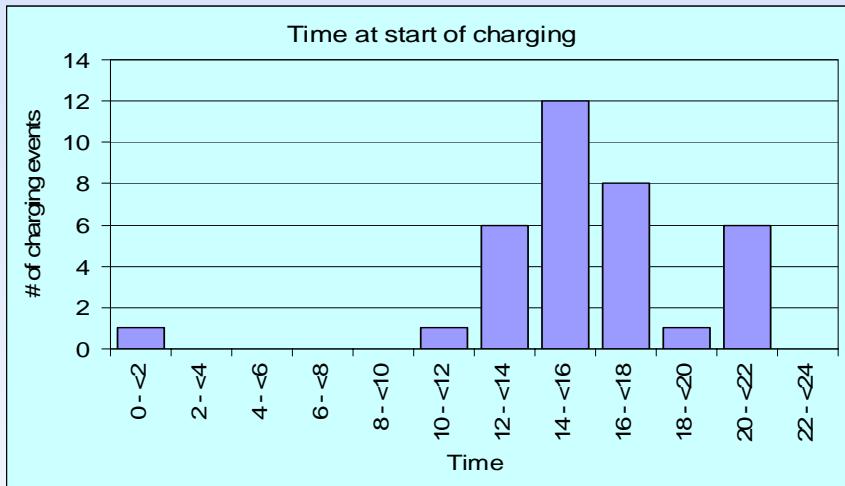
- Kvaser data loggers installed 50 PHEVs North America
- Onboard data includes vehicle performance, fuel use, and charging and driving profiles
- Participants include electric utilities, water agencies, universities, county and provincial governments:
 - Northeast: Vermont, New Hampshire, New York
 - 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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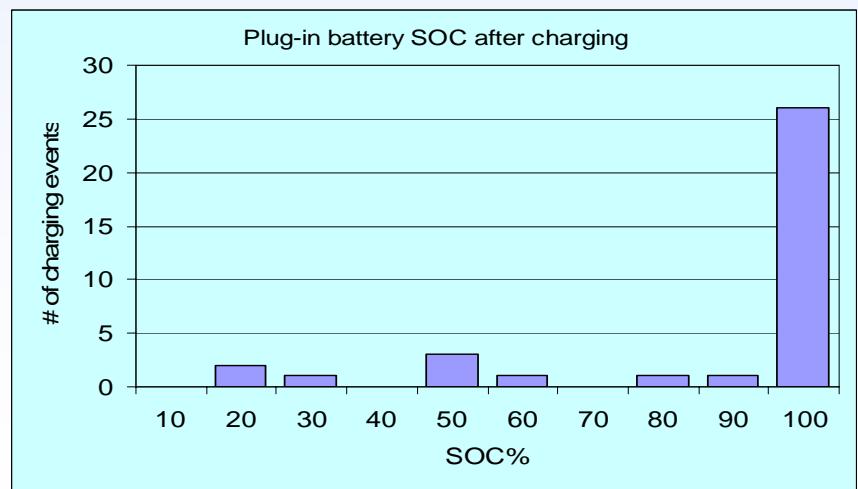
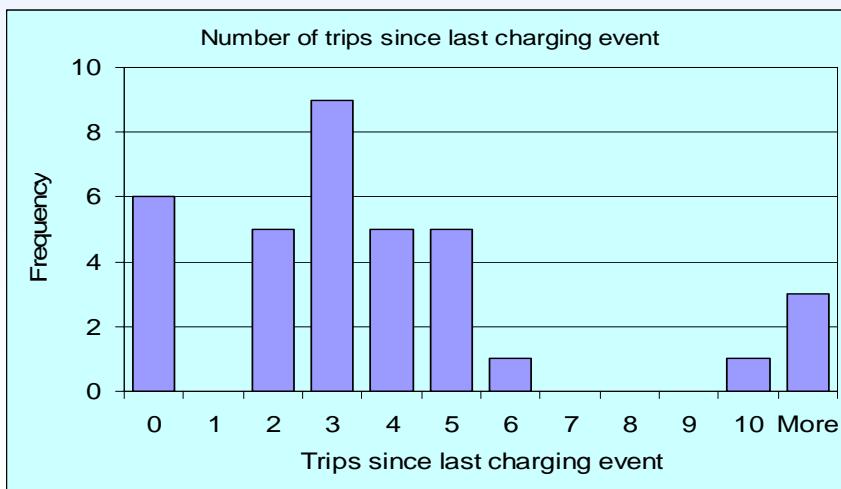
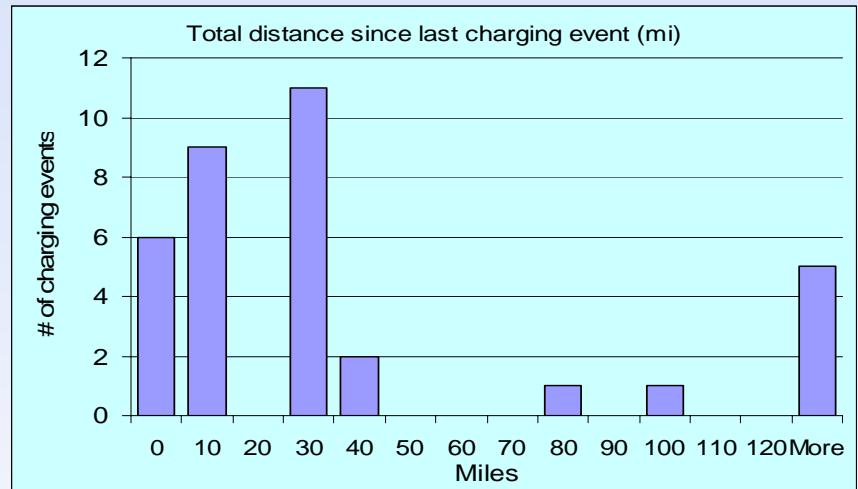
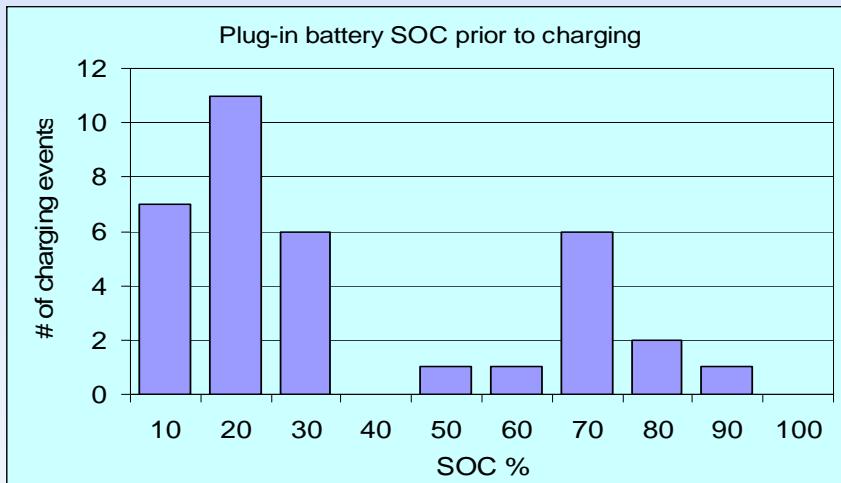
Single Hymotion Prius Charging Profiles

- 3 months, 2212 miles, 35 charges



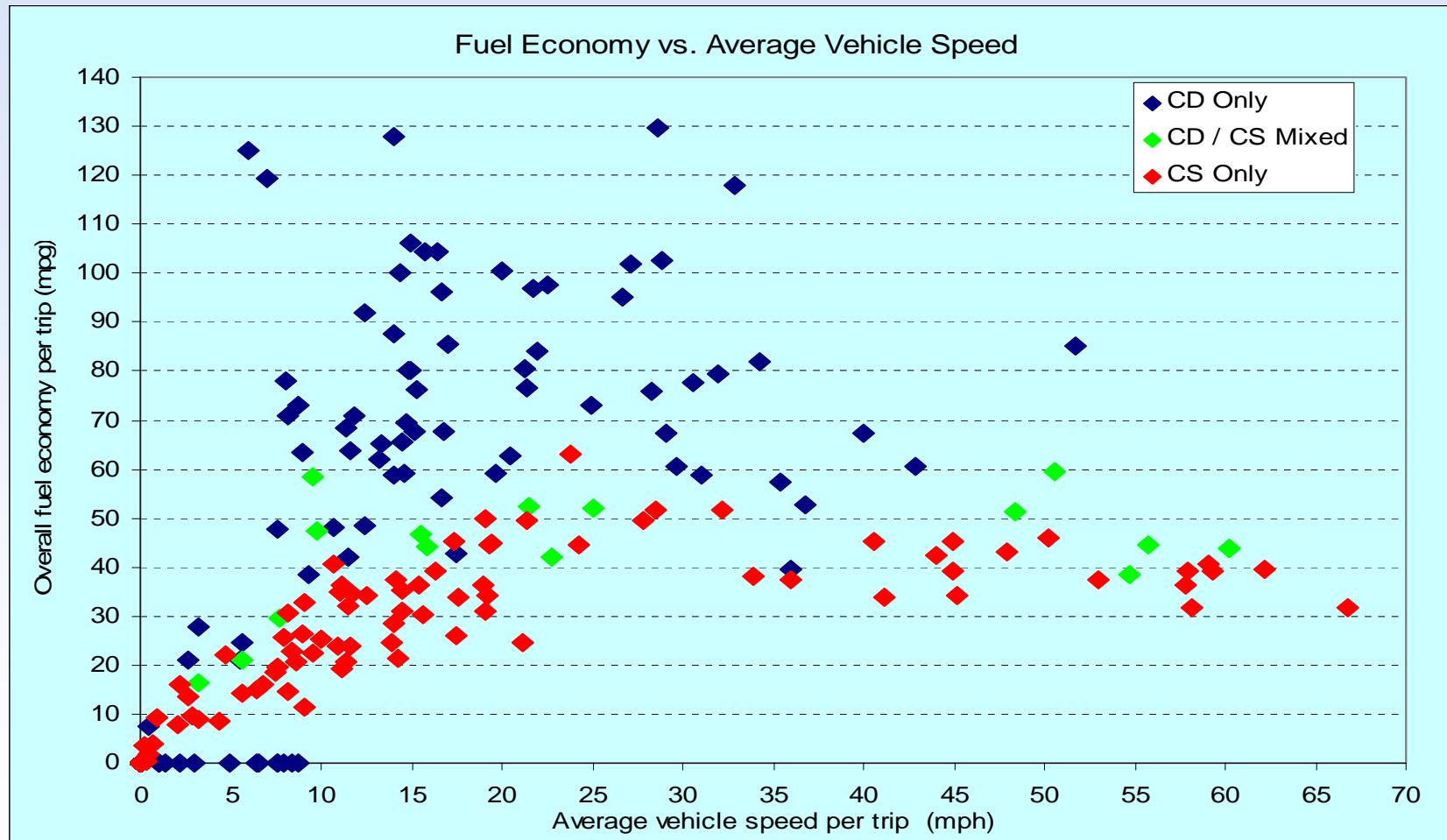
Single Hymotion Prius Charging Profiles

- 3 months, 2212 miles, 35 charges



Single Hymotion Prius MPG Vs. Speed

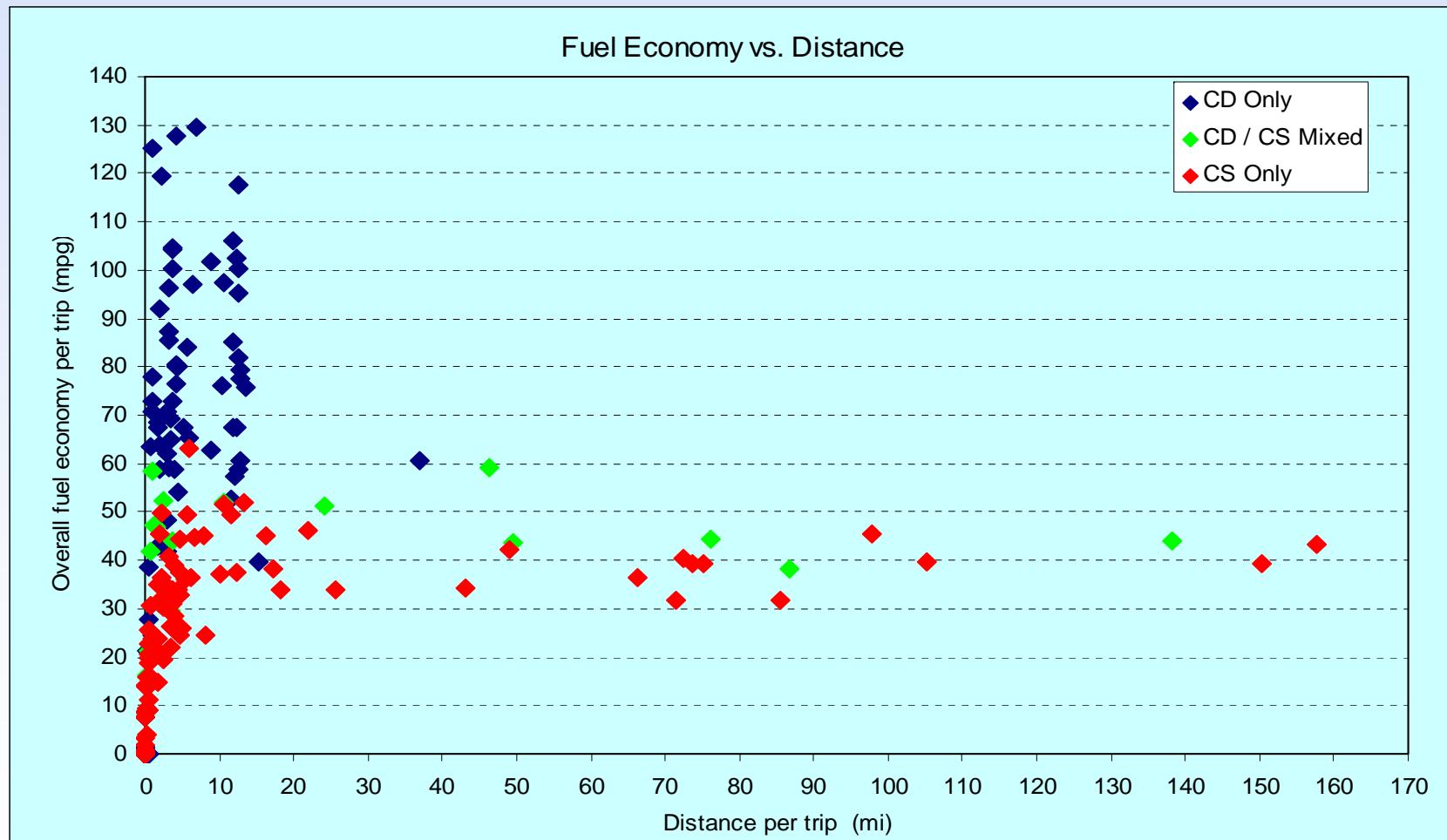
- 3 months, 2212 miles



CD – charge depleting, S - sustaining

Single Hymotion Prius MPG Vs. Distance

- 3 months, 2212 miles



CD – charge depleting, S - sustaining



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Vehicle Technologies Program

North American PHEV Demonstration

Monthly report for:
Vehicle ID: 6321

Reporting Period: June 2008

Date range of data received:
6/2/2008 to 6/30/2008

Number of days when the vehicle was driven: 22

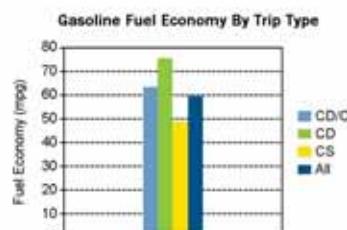
All Trips Combined

Overall gasoline fuel economy (mpg)	59
Total number of trips	154
Total distance traveled (mi)	1467

Trips in Charge Depleting (CD) mode *

Gasoline fuel economy (mpg)	75
Number of trips	68
Percent of trips city / highway	63.20% / 36.80%
Distance traveled (mi)	605

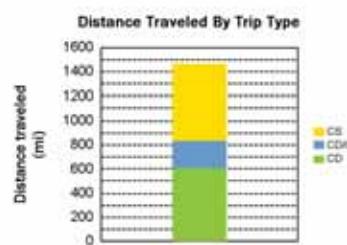
Percent of total distance traveled: 41.28%



Trips in combined Charge Depleting and Charge Sustaining (CD/CS) modes**

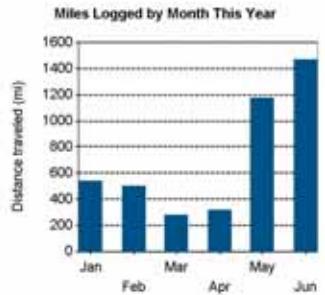
Gasoline fuel economy (mpg)	63
Number of trips	10
Percent of trips city / highway	30.00% / 70.00%
Distance traveled (mi)	223

Percent of total distance traveled: 15.20%



Trips in Charge Sustaining (CS) mode***

Gasoline fuel economy (mpg)	49
Number of trips	76
Percent of trips city / highway	63.20% / 36.80%
Distance traveled (mi)	638
Percent of total distance traveled	43.53%
Number of trips when the plug-in battery pack was turned off†	6
Distance traveled with plug-in battery pack turned off (mi)‡	62



* Trips when the plug-in battery pack charge is depleted to propel the vehicle throughout entire trip.

** Trips when the plug-in battery pack is depleted to propel the vehicle for a portion of the trip, but is fully depleted prior to the end of the trip.

*** Trips when the plug-in battery pack is not used to propel the vehicle - either the plug-in battery is fully depleted before the beginning of the trip, or the plug-in battery pack is turned off.

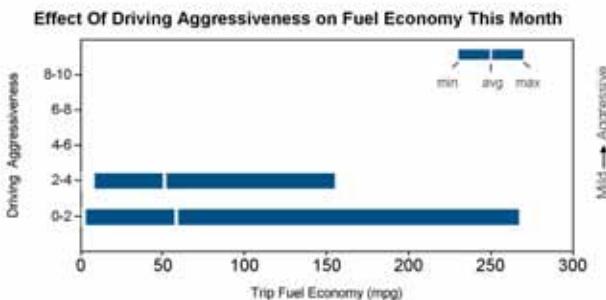
† Number of trips with plug-in battery pack turned off is a subset of number of trips in combined CD/CS and CS mode.

‡ Distance traveled with plug-in battery pack turned off is a subset of distance traveled in combined CD/CS and CS modes.

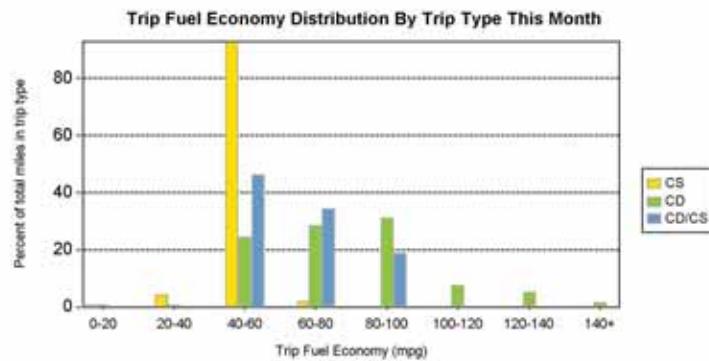
Sample Single Vehicle Monthly Report – page 1

Sample Single Vehicle Monthly Report – page 2

	City	Highway
Trips in Charge Depleting (CD) mode		
Gasoline fuel economy (mpg)	82	75
Percent of miles in electric-only mode	8.00%	3.00%
Average trip aggressiveness (on scale 0 - 10)	1.0	1.6
Average trip distance (mi)	1.9	20.9
Trips in combined Charge Depleting and Charge Sustaining (CD/CS) modes		
Gasoline fuel economy (mpg)	52	64
Percent of miles in electric-only mode	8.00%	2.00%
Average trip aggressiveness (on scale 0 - 10)	1.7	1.2
Average trip distance (mi)	6.7	29.0
Trips in Charge Sustaining (CS) mode		
Gasoline fuel economy (mpg)	44	50
Percent of miles in electric-only mode	3.00%	1.00%
Average trip aggressiveness (on scale 0 - 10)	1.0	1.2
Average trip distance (mi)	2.5	18.5
Average ambient temperature this month:	71 deg F	

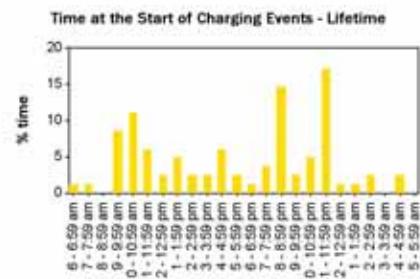
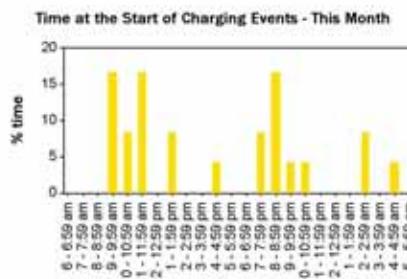
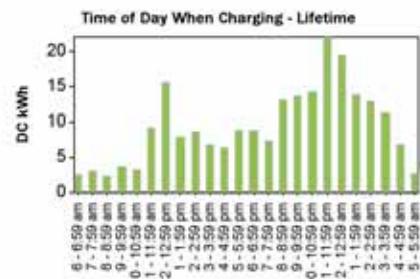


Aggressiveness factor is based on accelerator pedal position. The more time spent during a trip at higher accelerator pedal position, the higher the trip aggressiveness.



Plug-in charging

Number of charging events	24
Average number of charging events per day when vehicle driven	1.1
Average number of trips between charging events	6.4
Average duration of charging event (hr)	3.2
Average energy per charging event (DC kWh)	3.4
Total charging energy (DC kWh)	82.4



Sample Single Vehicle Monthly Report – page 3

26 Hymotion Prius - January thru May 2008

- Below averages do NOT tell the whole PHEV energy-use potential – see following slides

Charge / Operating Mode	Number of Trips	Distance Traveled (Miles)	Miles per Gallon
Charge Depleting (CD)	3,073	14,820	59
Mixed CD / CS	404	11,121	49
Charge Sustaining (CS)	1,358	16,059	40
All trips combined	4,835	42,000	48

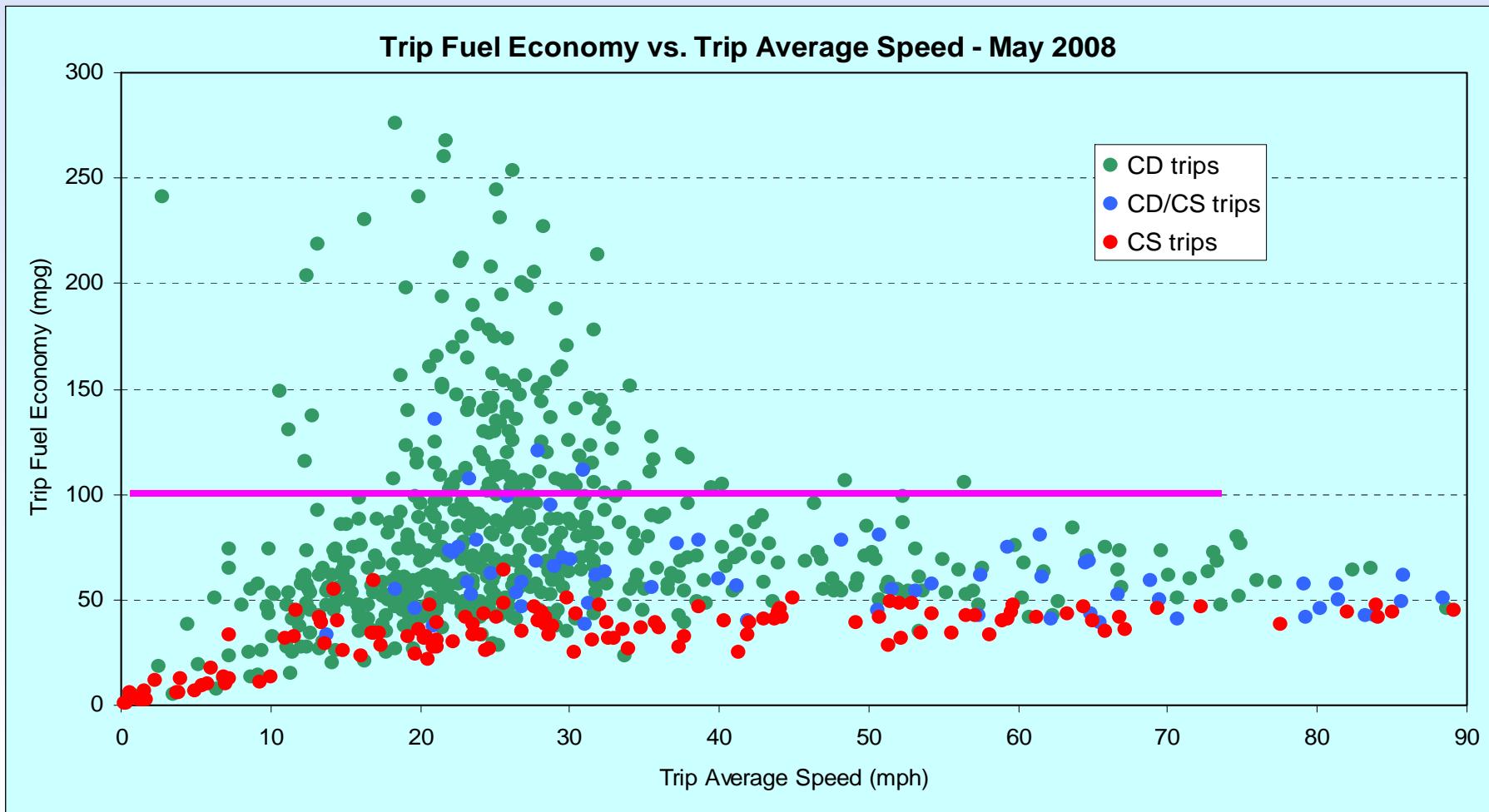


13 Hymotion Prius in May 2008 - MPG

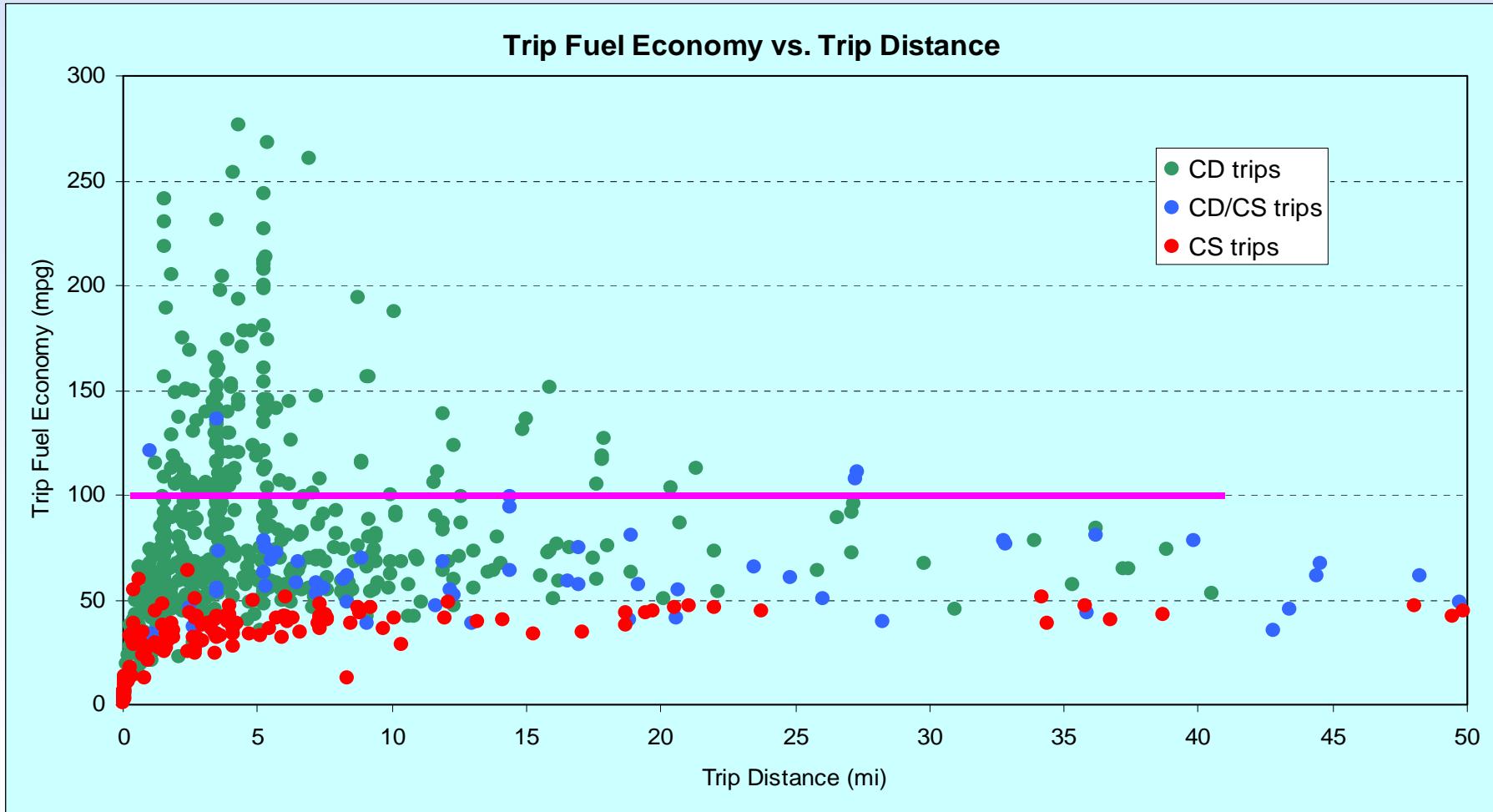
- Below averages do NOT tell the whole PHEV energy use potential – see following slides

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	

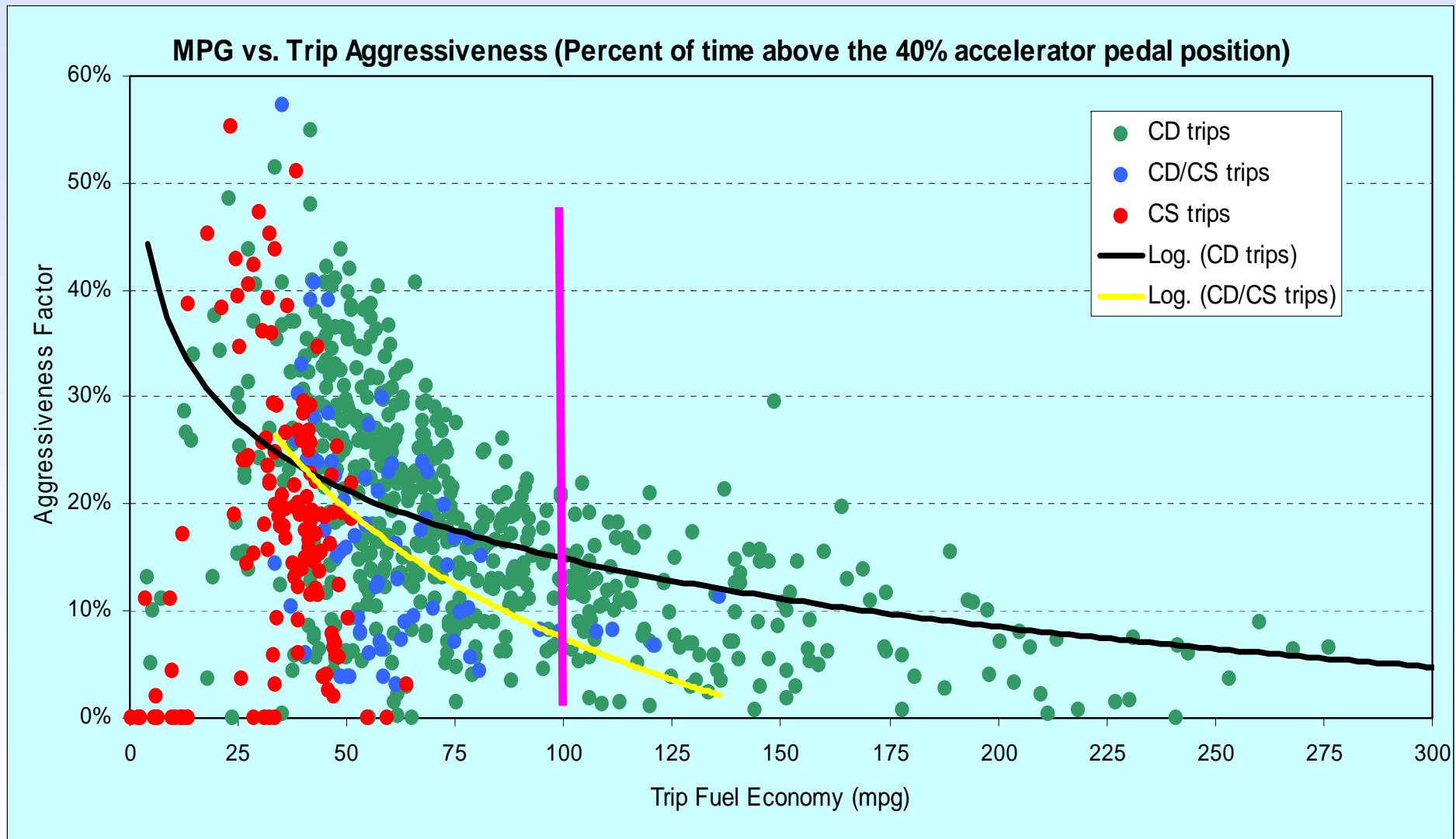
13 Hymotion Prius MPG Vs. Speed



13 Hymotion Prius MPG Vs. Distance



13 Hymotion Prius and Aggressive Driving



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
Electrovaya Escape	Completed (problems)	Restarted
HybridsPlus Escape	Not started	Suspended



EnergyCS Prius Data Collection

- Provided AVTA onboard data for 12 vehicles operating in fleets in the U.S. and Canada
- Going forward, EnergyCS is using lithium batteries from various manufacturers
- ~ 30 vehicles deployed (~15 North America and ~15 Europe)



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, nine vehicles converted to date, remainder October 2008
- 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 demonstrations are using V2Green onboard data loggers with cellular data transfer and GPS



Tacoma Power Demonstration

- Vehicle demonstration 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

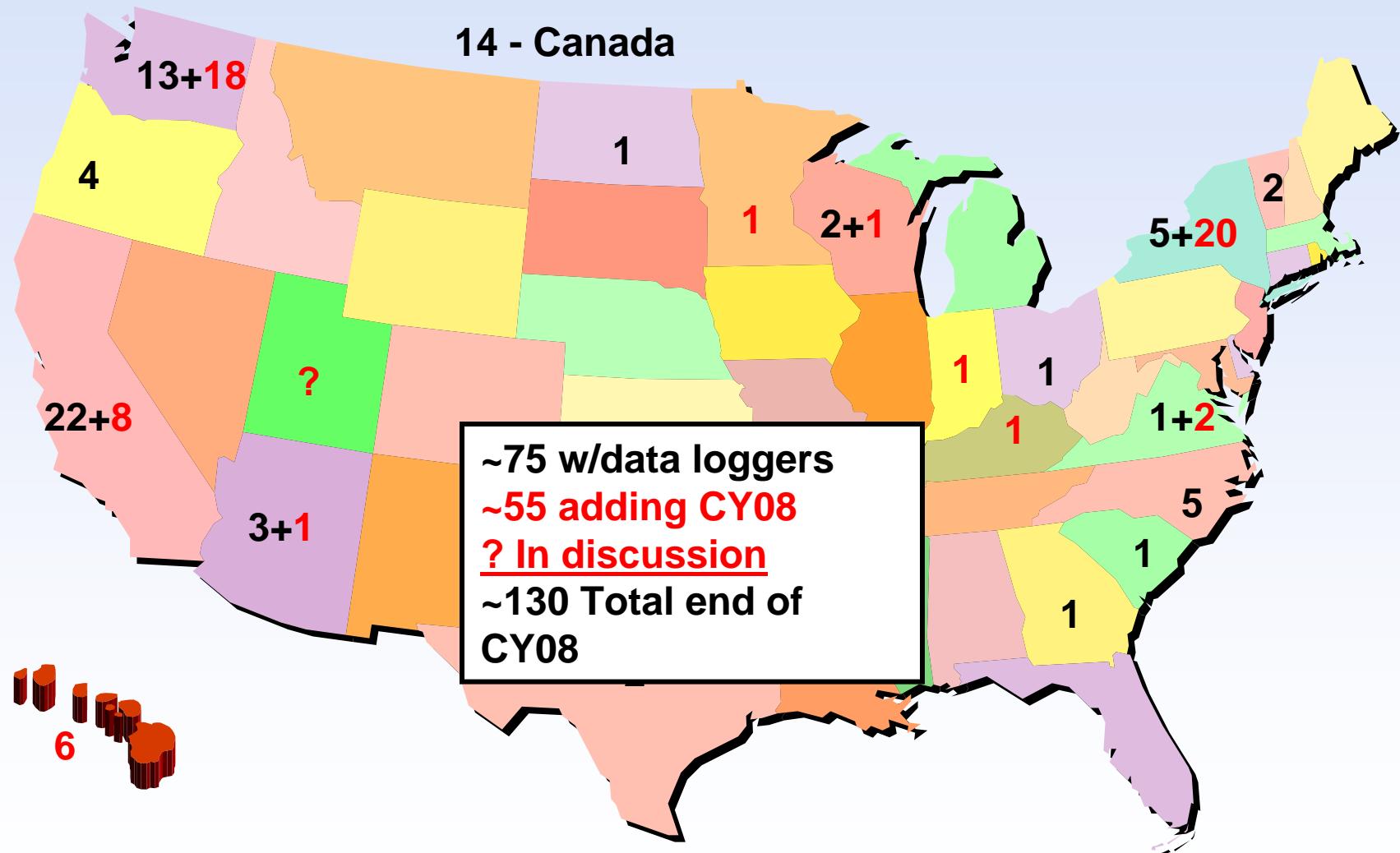
- Washington State-wide, Port of Chelan leading, with 14 Hymotion Prius with:
 - Benton County PUD, Chelan County Public Works, City of Wenatchee, Douglas County PUD, Energy Northwest, Green IT Alliance, McKinstry, Port of Chelan, University of Washington, Walla Walla Community College and Wenatchee Valley College
 - Started 4/2008, 1 converted to date, more Oct. 2008
- University of California Davis, with 13 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
 - 13 vehicles recently completed conversions

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



Total PHEV Demonstrations



Other PHEV Testing

- Hymotion/A123Systems V2 Prius battery hot weather vehicle/battery testing, summer 2008
- PHEV charging studies at three commercial facilities (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
- Conduct vehicle/battery testing on PHEVs when received via DOE's OEM TADA PHEV solicitation
- Will consider other suitable PHEV conversions for vehicle/battery testing

Charging Infrastructure

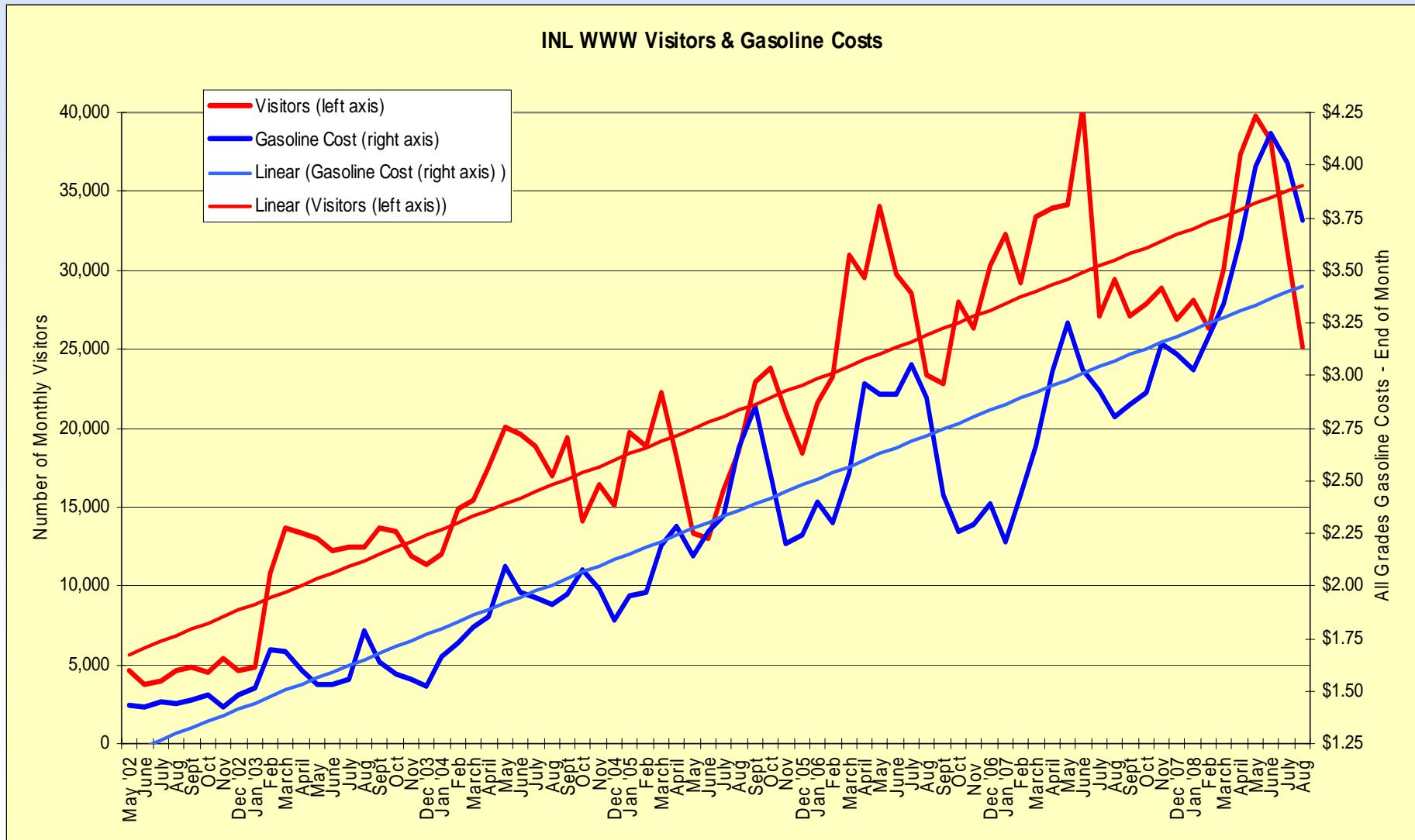
- National Electric Code requires
 - Dedicated branch circuit
 - GFCI (ground fault circuit interrupt)
 - “EV” extension cord
 - Unique connector “plug”
- NEC being updated



PHEV Market Status - Converters

- Hymotion: ~125 Prius (\$9995) and 5 Escapes
 - Prius only battery production ramp-up now, replacing all 67 Version 1 batteries. Recall most Escapes
 - Prius crash-tested and obtaining CARB certification
 - Conversions and warranty work in Boston, D.C., L.A., Minneapolis, San Francisco and Seattle
- Hybrids Plus: ~35 Prius and Escapes, (\$21,600 to \$36,150). Some operational issues
- EnergyCS: ~30 Prius (~\$40,000). Some operational issues with early batteries
- Cal Cars: 8 Pius, believed to be all lead acid
- Green Car Company: 3(?) Manzanita lead acid Prius conversions (\$12,000). Some operational issues. Doing Hymotion conversions
- Electrovaya: 2(?) Escapes. Some operational issues
- Various single conversion “companies”

AVTA Webpage Use and Gasoline Costs



Acknowledgement

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Additional Information

**<http://avt.inl.gov>
or**

<http://www1.eere.energy.gov/vehiclesandfuels/avta/>

INL/CON-08-14887

