

Idaho National Laboratory

U.S. Department of Energy - Vehicle Technologies Program

Advanced Vehicle Testing Activity - PHEV Testing Results and Fleet Demonstrations

Jim Francfort

**Power UP 2008 Summit
Wenatchee, Washington – May 2008**

This presentation does not contain any proprietary or sensitive information

INL/CON-08-14229

Idaho National Laboratory

- Eastern Idaho based U.S. Department of Energy (DOE) multi-program laboratory
- 890 square mile site with 3,600 staff
- Support DOE's strategic goal:
 - Increase U.S. energy security and reduce the nation's dependence on foreign oil

AVTA Background & Goal

- The Advanced Vehicle Testing Activity (AVTA) is part of the U.S. Department of Energy's Vehicle Technologies Program
- The AVTA is primarily conducted by the Idaho National Laboratory (INL) and Electric Transportation Applications (ETA - Phoenix, AZ), with Argonne National Laboratory performing dynamometer testing
- AVTA Goal
 - 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

AVTA Testing History

- Hybrid electric vehicles
 - 14 models, 3.7 million test miles
- Hydrogen ICE (internal combustion engine) vehicles
 - 6 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



PHEV Testing Objectives

- Perform independent testing of PHEVs in track, laboratory and onroad environments
- Document battery life, charging patterns and demand profiles, vehicle operations, and fuel use (both gasoline and electricity)
- Document PHEV infrastructure requirements and costs in real-world environments
- Document life-cycle costs

PHEV Baseline Performance Testing

- Initial track testing conducted by ETA near Phoenix
 - Testing includes coastdown (determination of dynamometer coefficients), acceleration, top speed, charging, & durability
- Five day dynamometer testing regime performed at Argonne
 - Testing includes at least 26 drive cycle tests
 - Charge depleting & sustaining test cycles
 - UDDS, HWFEDs & US06 cycles
 - Includes air conditioning (AC) off & on cycles

Baseline Performance Testing Results

 U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY

Base Vehicle Description

Make: Toyota
Model: Prius Year: 2006
VIN: JTOKB20U7508841
Number of Passengers: 5
Hybrid Configuration: Series/Parallel

Energy CS Plug-in Hybrid

VEHICLE SPECIFICATIONS

Weights	Electric Drive System
Design Curb Weight: 3160	Battery Manufacturer: Valence
Vehicle Test Weight: 3400 lbs	Battery Type: Li-Ion
(GVWR: 3795 lbs)	Number of Cells: 2376
GAWR/F/R: 2335/2236	Nominal Cell Voltage: 3.7V
Distribution: 54.2%/45.8%	Nominal System Voltage: 230.4V
Payload: 675 lbs	Maximun Pack Capacity: 10 kWh
Performance Goal: 400 lbs	Measured Usable Capacity: 4.88 kWh
Engine	Charge Sustaining ¹
Model: 1.5L FXE	Acceleration 0-60 MPH: 12.0V
Output: 76 HP @ 5000 RPM	Required Breaker Currents: 1.5 Amp
Configuration: 4 Cylinder In-line	Charger Power Output: 1.2 kW
Displacement: 1.5L	Charger Plug Type: NEMA 5-15
Fuel Tank Capacity: 11.9 gal	Estimated 0% Charge Time: 6.5 Hrs
Fuel Types: Unleaded	Estimated 100% Charge Time: 8 Hrs

VEHICLE TEST RESULTS

Charge Depleting: Acceleration 0-60 MPH: Time: 12.96 seconds	Fuel Economy with A/C Off ² Cold Start Charge Depleting ³ : Fuel Economy: 108.2 MPG A/C KWh Consumed ⁴ : .369 kWh/mi
Acceleration 1/4 Mile: Time: 20.09 seconds	Charge Depleting ⁵ : Average Fuel Economy: 149.1 MPG A/C KWh Consumed ⁶ : .351 kWh/mi
Acceleration 1 Mile: Maximum Speed: 104.9 MPH	Charge Sustaining ⁷ : Fuel Economy: 60.0 MPG
Charge System: Input: Voltages: 120V	Fuel Economy with A/C On ⁸ Cold Start Charge Depleting ⁹ : Fuel Economy: 101.7 MPG A/C KWh Consumed ¹⁰ : .361 kWh/mi
Output: 76 HP @ 5000 RPM	Acceleration 1/4 Mile: Time: 19.98 seconds
Configuration: 4 Cylinder In-line	Charge Power Output: 1.2 kW
Displacement: 1.5L	Charger Plug Type: NEMA 5-15
Fuel Tank Capacity: 11.9 gal	Estimated 0% Charge Time: 4.4 Hrs
Fuel Types: Unleaded	Estimated 100% Charge Time: 5.3 Hrs

UDDS Fuel Economy¹¹

Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	118.0	1.83
20	137.6	3.65
40	124.7	5.52
60	105.9	5.65
80	94.7	5.65
100	89.18	5.65
200	77.9	5.65

HWFET Fuel Economy¹²

Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	106.6	1.77
20	116.4	3.45
40	99.9	5.46
60	86.7	5.94
80	79.5	5.93
100	75.2	5.93
200	66.6	5.93

TEST NOTES:

1. Based on one EPA standard drive cycle.
2. Value measured at ambient temperature while off for a minimum of 12 hours prior to testing.
3. Average non-cold start charge depleting fuel economy.
4. Value determined from average charge depleting fuel economy test with appropriate energy conversion calculation.
5. Cold start charge depleting fuel economy.
6. Calculated cumulative fuel economy values, includes cold start.
7. A/C energy based on measured charge efficiency.

This vehicle meets all HEV and PHEV 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.

 U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY

Base Vehicle Description

Make: Toyota
Model: Prius Year: 2007
VIN: JTDKB20U7577558820
Number of Passengers: 5
Hybrid Configuration: Series/Parallel

Hymotion Plug-in Hybrid

VEHICLE SPECIFICATIONS

Weights	Electric Drive System
Design Curb Weight: 3037	Battery Manufacturer: A123
Vehicle Test Weight: 3337 lbs	Battery Type: Li-ion
(GVWR: 3795 lbs)	Number of Cells: 656
GAWR/F/R: 2335/2236	Nominal Cell Voltage: 3.7V
Distribution: 54.2%/45.8%	Nominal System Voltage: 194.8V
Payload: 758 lbs	Maximun Pack Capacity: 4.7 kWh
Performance Goal: 400 lbs	Measured Usable Capacity: 2.96 kWh
Engine	Charge Sustaining ¹
Model: 1.5L FXE	Acceleration 0-60 MPH: 12.0V
Output: 76 HP @ 5000 RPM	Required Breaker Currents: 1.5 Amp
Configuration: 4 Cylinder In-line	Charger Power Output: 1.2 kW
Displacement: 1.5L	Charger Plug Type: NEMA 5-15
Fuel Tank Capacity: 11.9 gal	Estimated 0% Charge Time: 4.4 Hrs
Fuel Types: Unleaded	Estimated 100% Charge Time: 5.3 Hrs

VEHICLE TEST RESULTS

Charge Depleting: Acceleration 0-60 MPH: Time: 13.28 seconds	Fuel Economy with A/C Off ² Cold Start Charge Depleting ³ : Fuel Economy: 146.72 MPG A/C KWh Consumed ⁴ : .347 kWh/mi
Acceleration 1/4 Mile: Time: 20.27 seconds	Charge Depleting ⁵ : Average Fuel Economy: 167.2 MPG A/C KWh Consumed ⁶ : .348 kWh/mi
Acceleration 1 Mile: Maximum Speed: 103.4 MPH	Charge Sustaining ⁷ : Fuel Economy: 60.0 MPG
Charge System: Input: Voltages: 120V	Fuel Economy with A/C On ⁸ Cold Start Charge Depleting ⁹ : Fuel Economy: 128.9 MPG A/C KWh Consumed ¹⁰ : .399 kWh/mi
Output: 76 HP @ 5000 RPM	Acceleration 1/4 Mile: Time: 17.01 seconds
Configuration: 4 Cylinder In-line	Charge Power Output: 1.2 kW
Displacement: 1.5L	Charger Plug Type: NEMA 5-15
Fuel Tank Capacity: 11.9 gal	Estimated 0% Charge Time: 74.02 Hrs
Fuel Types: Unleaded	Estimated 100% Charge Time: 104.0 Hrs

UDDS Fuel Economy¹¹

Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	154.8	1.65
20	160.3	3.31
40	117.4	3.58
60	99.40	3.58
80	88.88	3.58
100	83.71	3.58
200	72.26	3.58

HWFET Fuel Economy¹²

Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	87.48	1.30
20	95.27	2.64
40	86.11	3.92
60	75.79	3.92
80	70.52	3.92
100	67.36	3.92
200	61.05	3.92

TEST NOTES:

1. Cumulative fuel economy over EPA standard drive cycle.
2. Value measured at ambient temperature while off for a minimum of 12 hours prior to testing.
3. Average non-cold start charge depleting fuel economy.
4. Value determined from average charge depleting fuel economy test with appropriate energy conversion calculation.
5. Cold start charge depleting fuel economy.
6. A/C-on/cold start setting with full factory pressure.
7. A/C-off/cold start setting with full factory pressure.
8. A/C-off/cold start setting with full factory pressure.
9. A/C energy based on measured charge efficiency.
10. A/C energy based on measured charge efficiency.

This vehicle meets all HEV and PHEV 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.

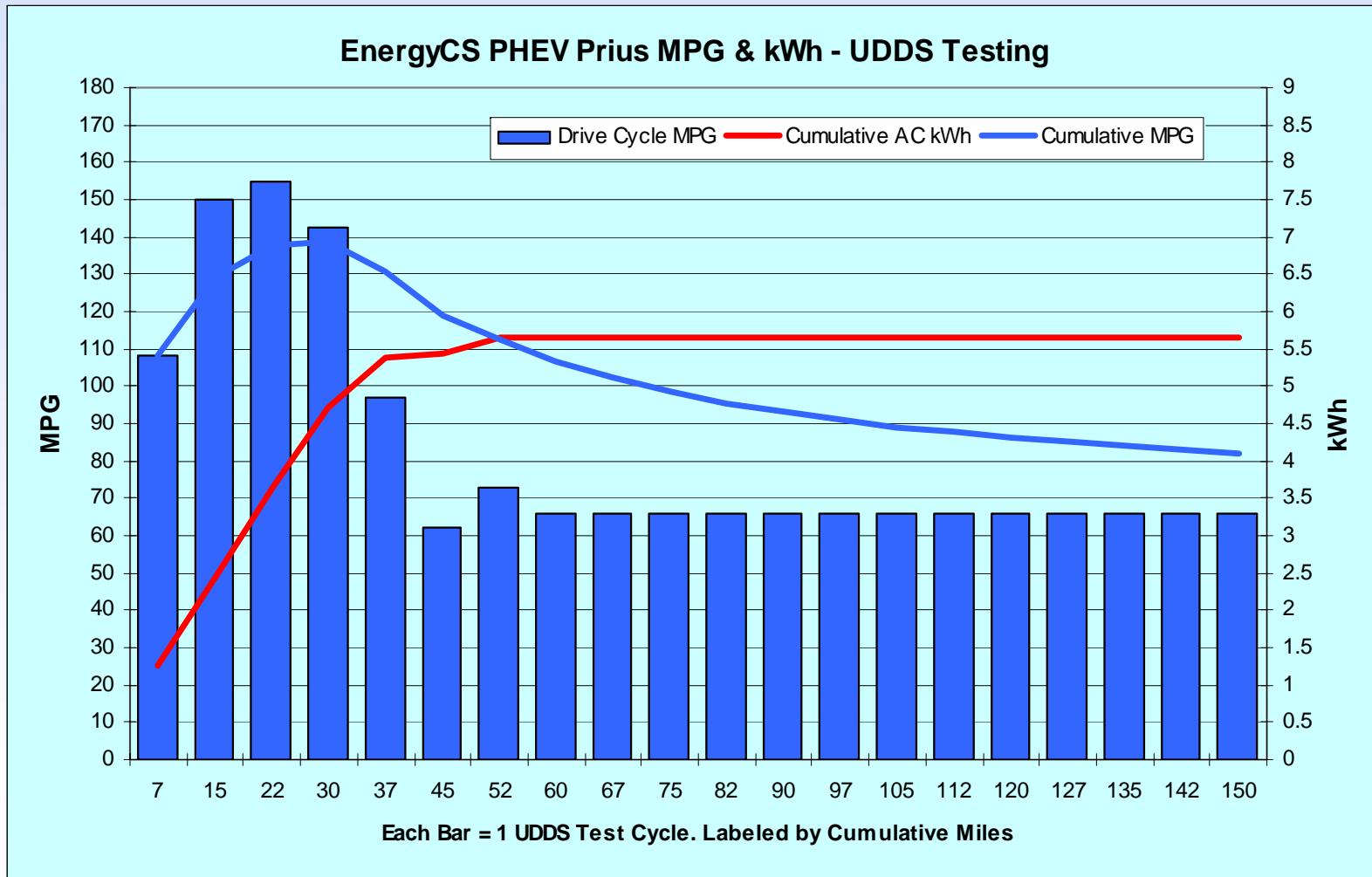
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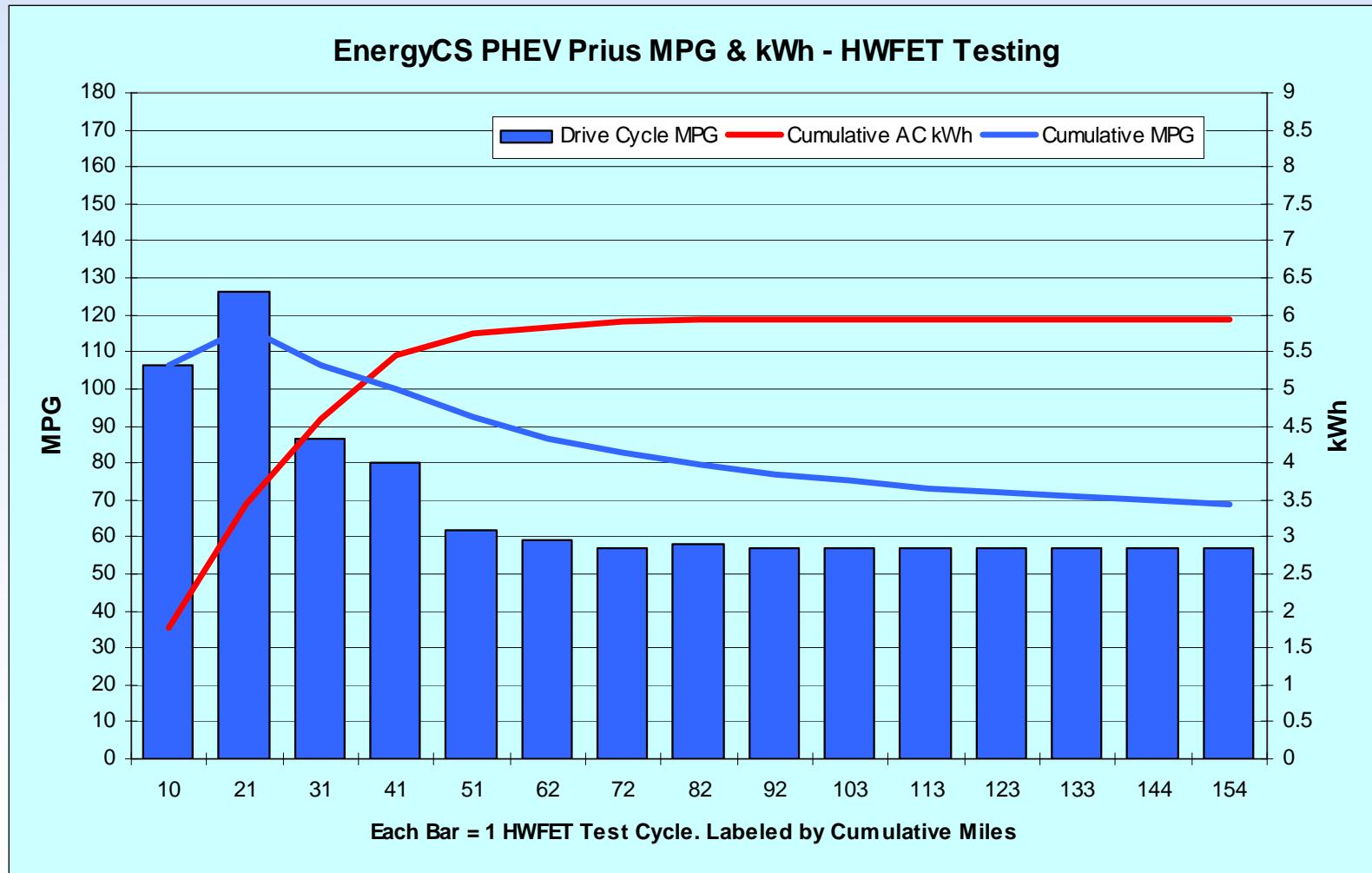
EnergyCS Prius – UDDS Fuel Use

- 9 kWh Valence lithium pack – AC kWh



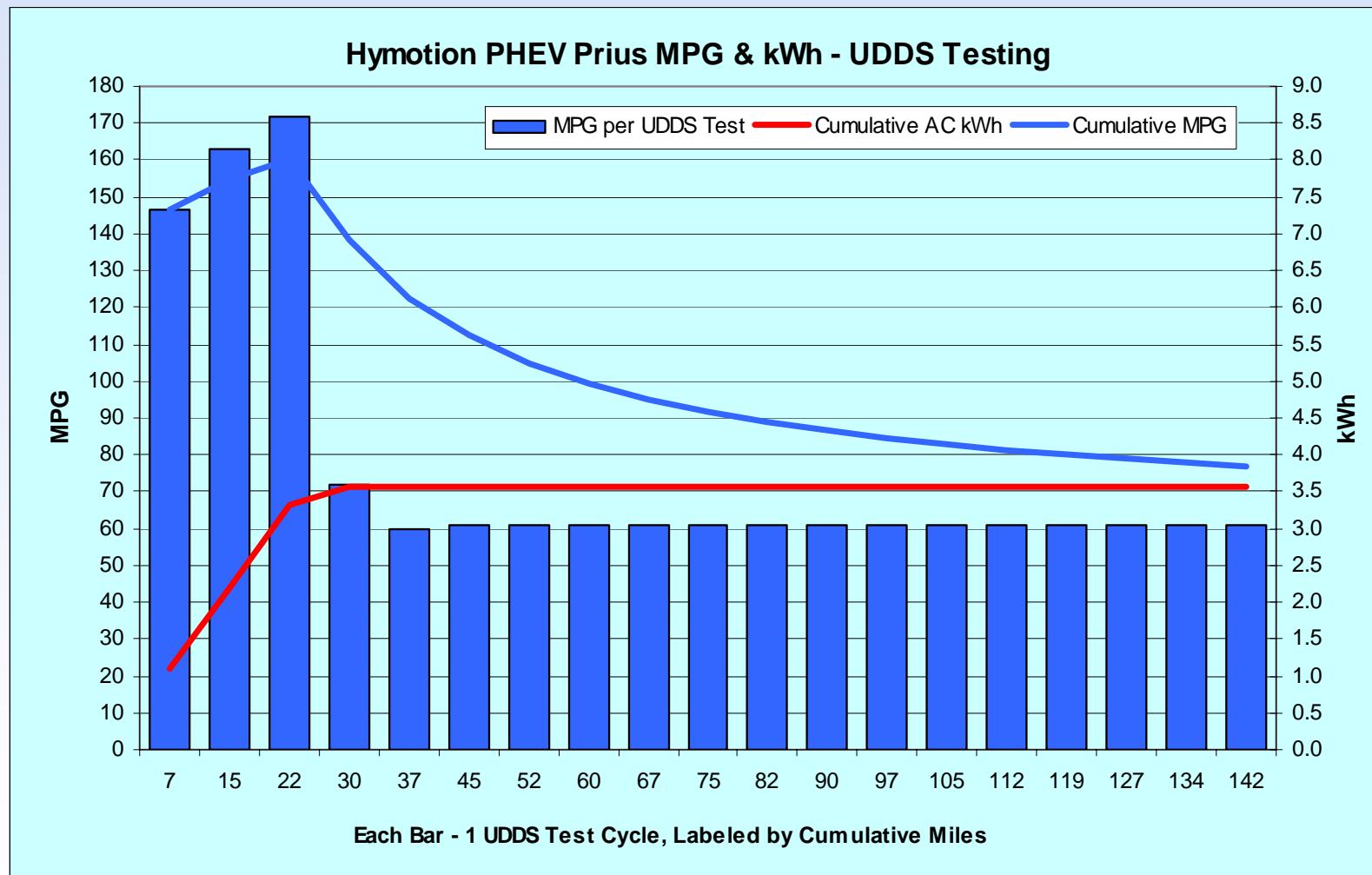
EnergyCS Prius – HWFET Fuel Use

- 9 kWh Valence lithium pack – AC kWh



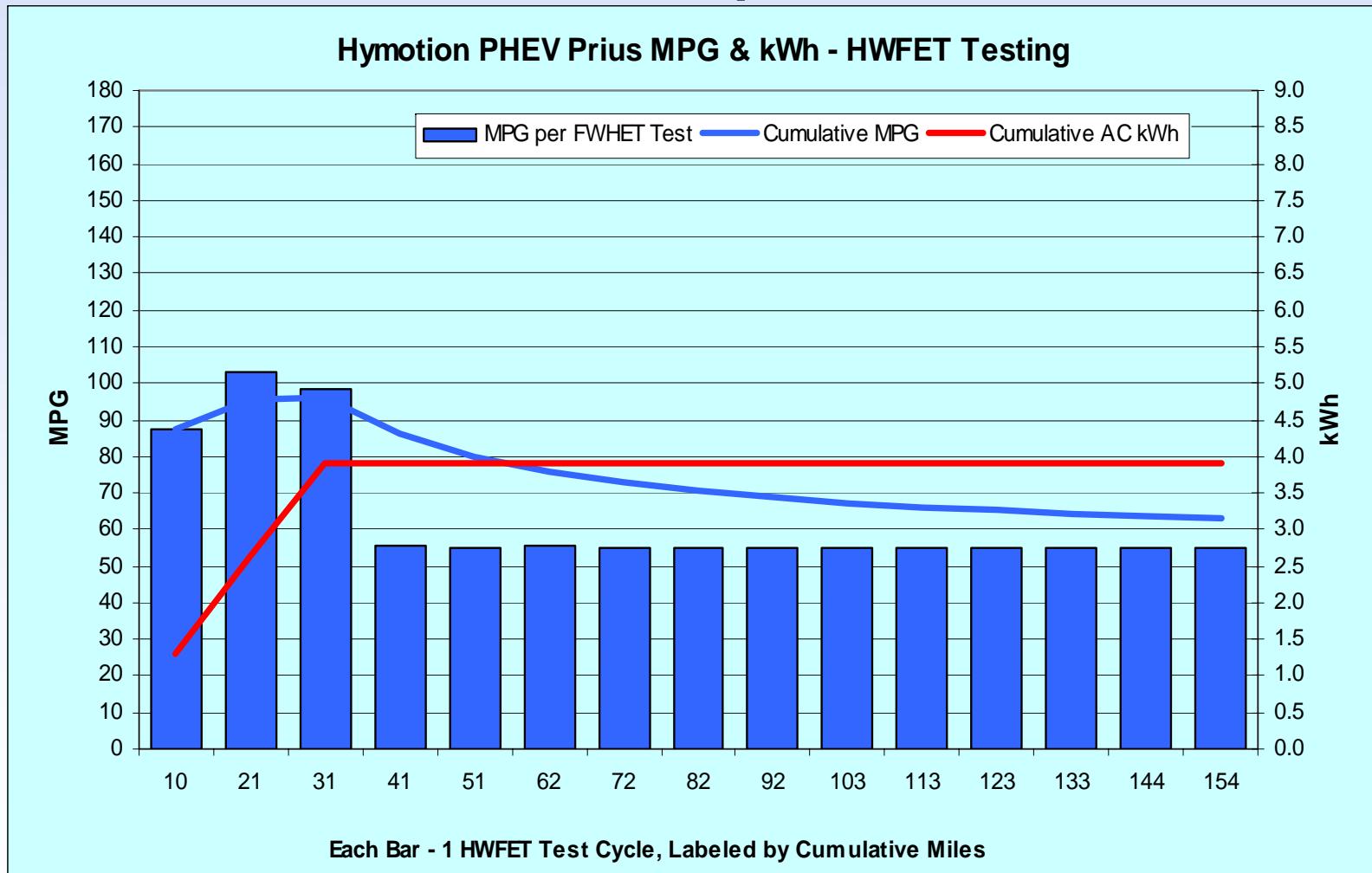
Hymotion Prius – UDDS Fuel Use

- 5 kWh A123 lithium & Prius packs – AC kWh



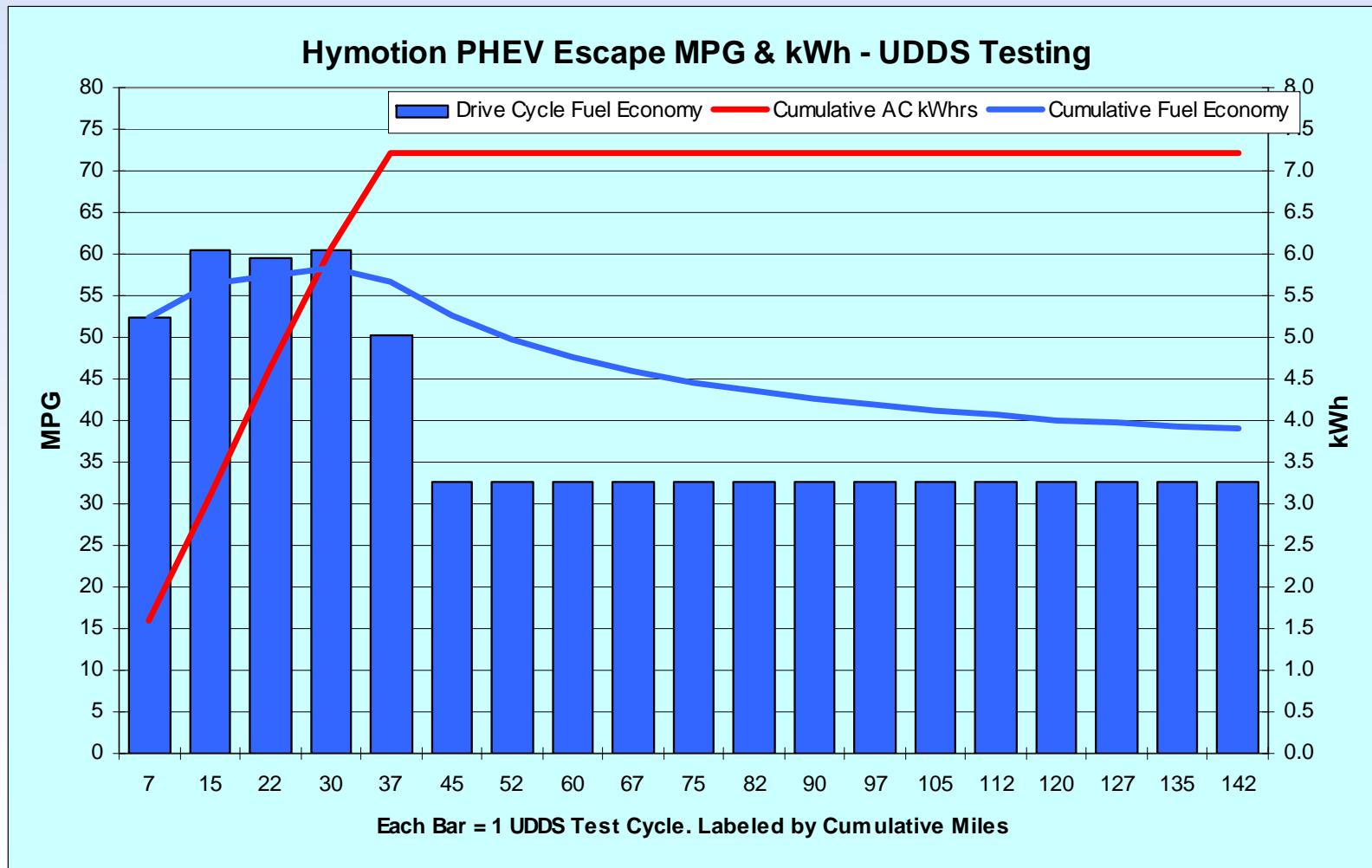
Hymotion Prius – HWFET Fuel Use

- 5 kWh A123 lithium & Prius packs – AC kWh



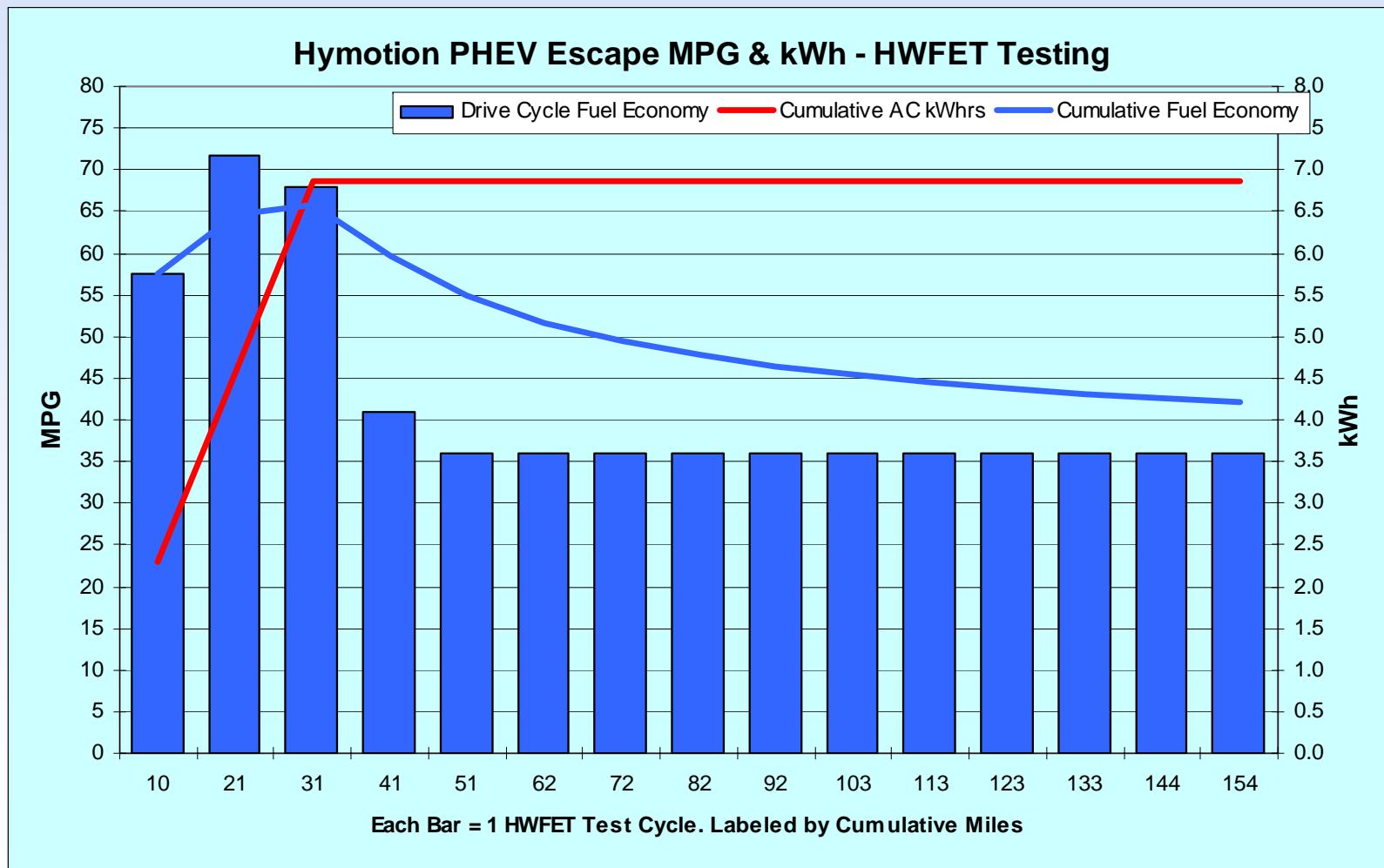
Hymotion Escape – UDDS Fuel Use

- 8.5 kWh A123 lithium & Escape packs – AC kWh



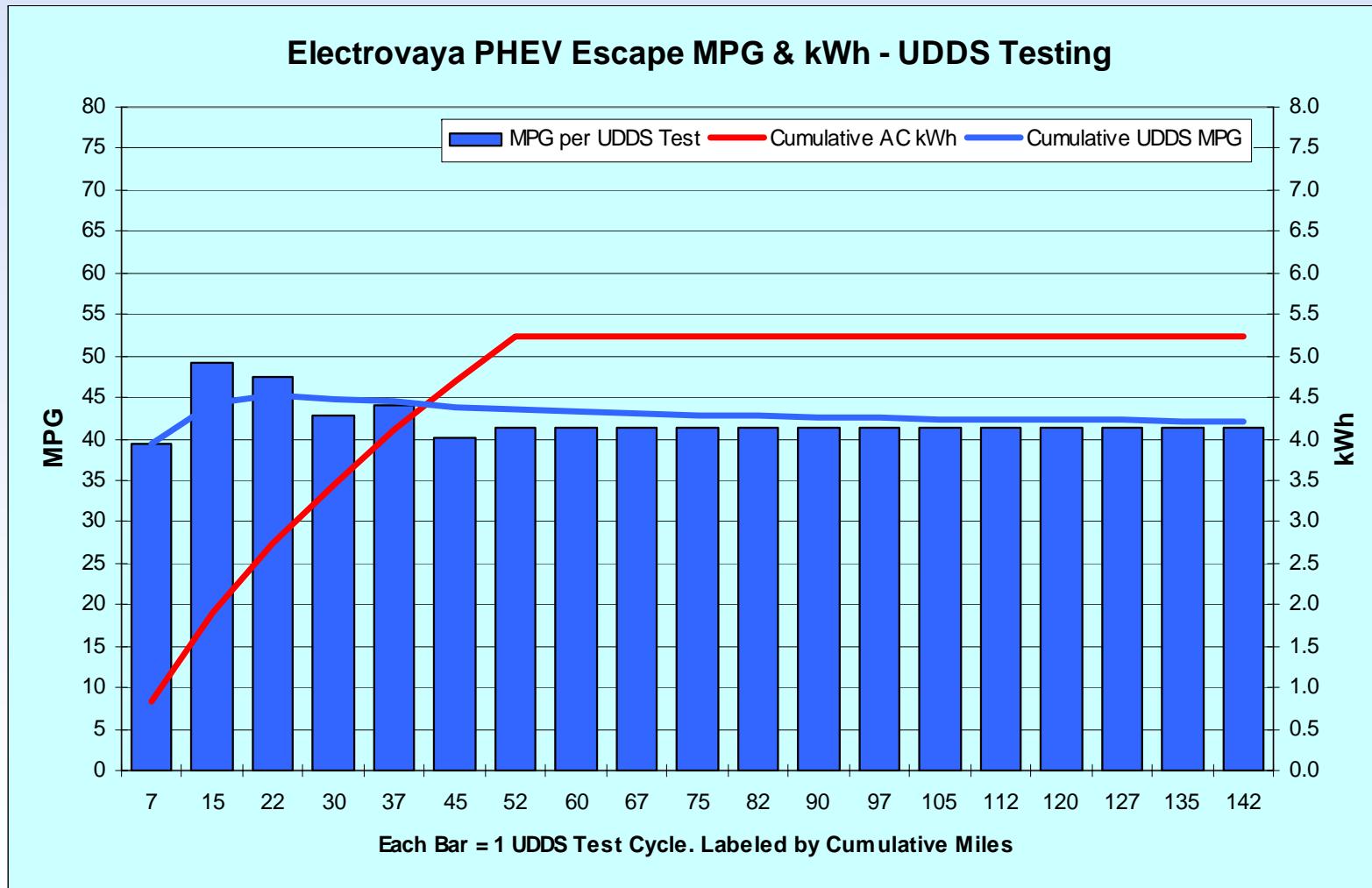
Hymotion Escape – HWFET Fuel Use

- 8.5 kWh A123 lithium & Escape packs – AC kWh



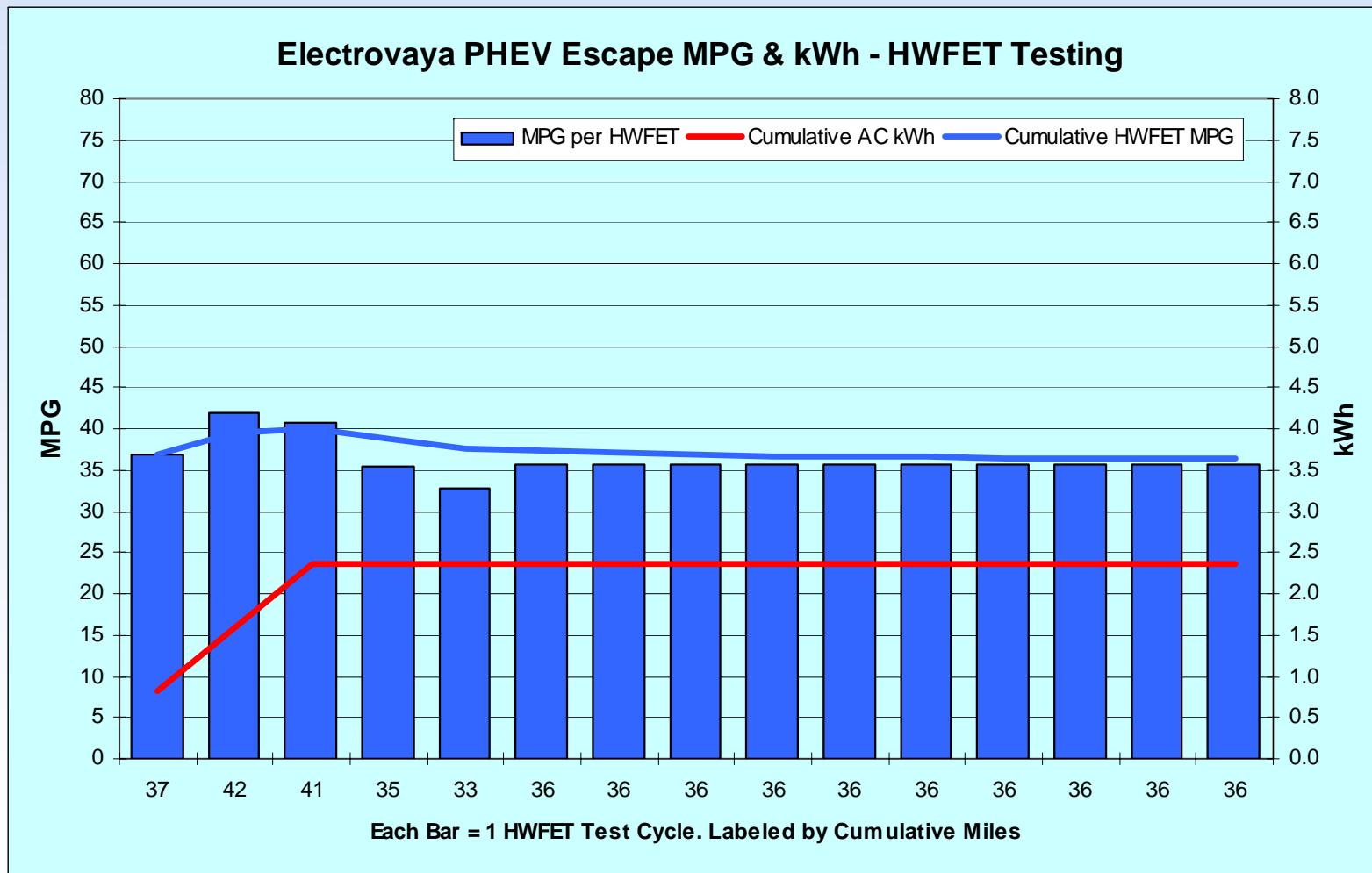
Electrovaya Escape – UDDS Fuel Use

- 12 kWh Electrovaya lithium & Prius packs – A/C kWh

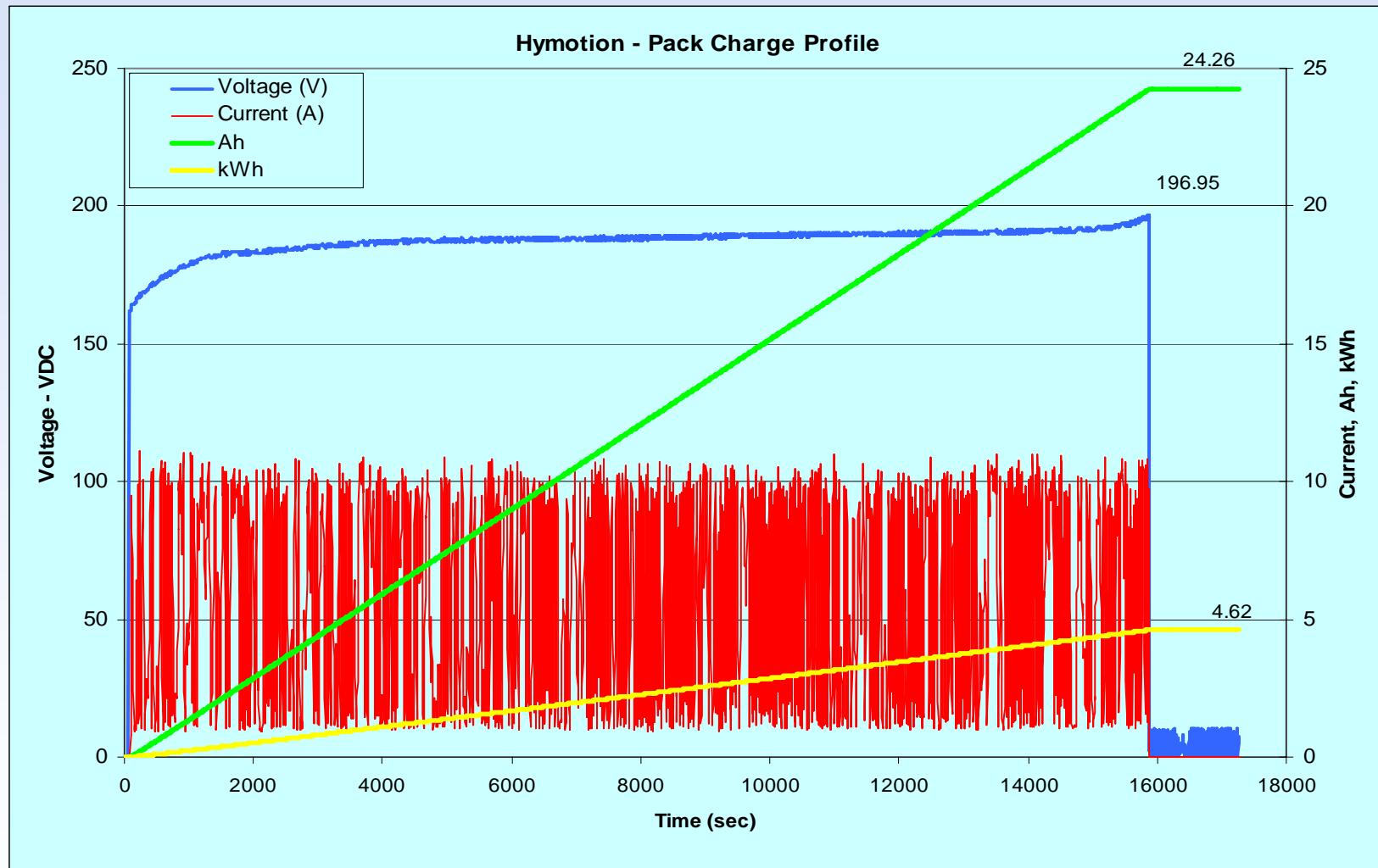


Electrovaya Escape – HWFET Fuel Use

- 12 kWh Electrovaya lithium & Prius packs – A/C kWh

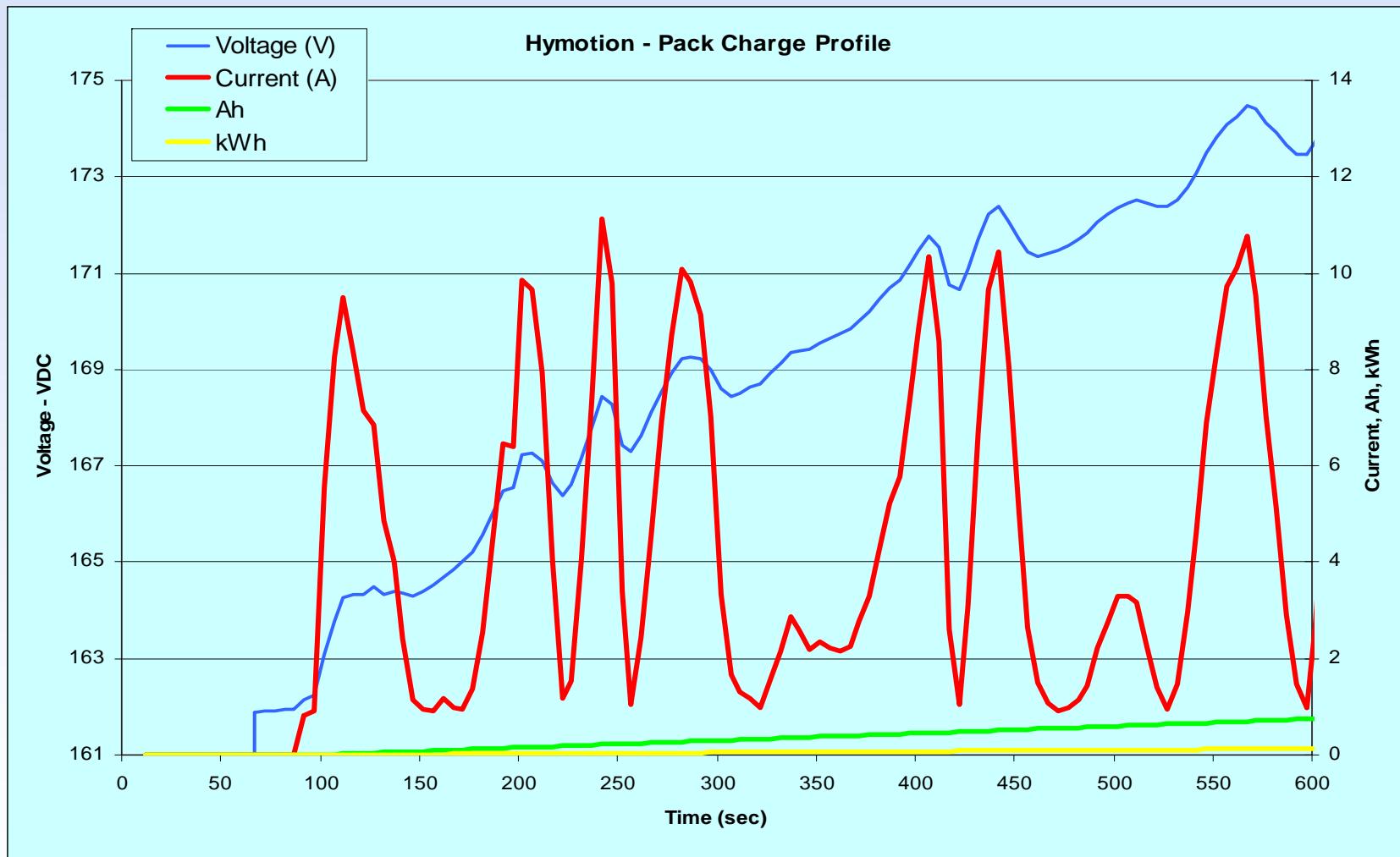


Hymotion Battery Charge Profile



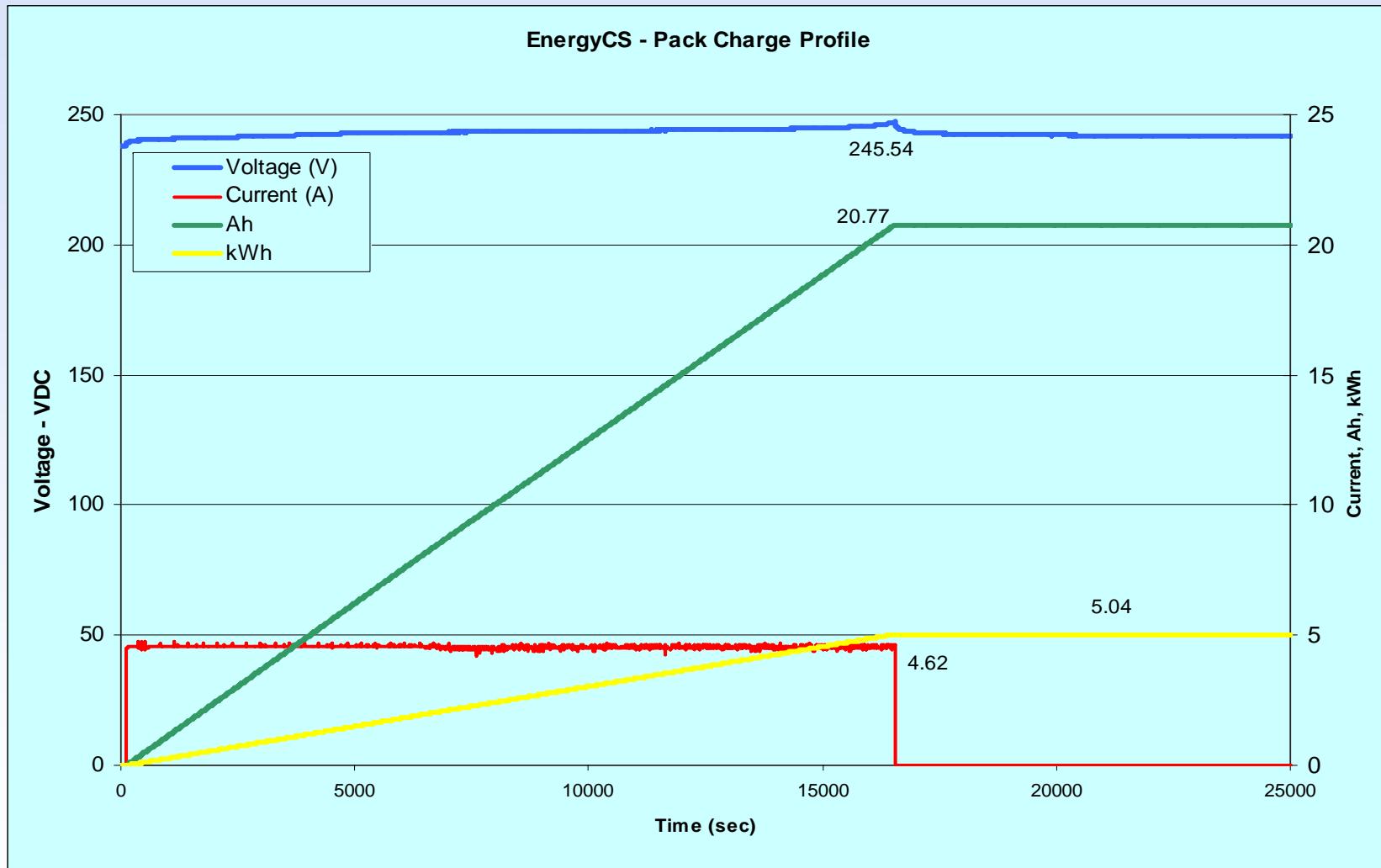
A123 Systems Lithium Ion Battery - DC kWh

Hymotion Cell Charge Profile



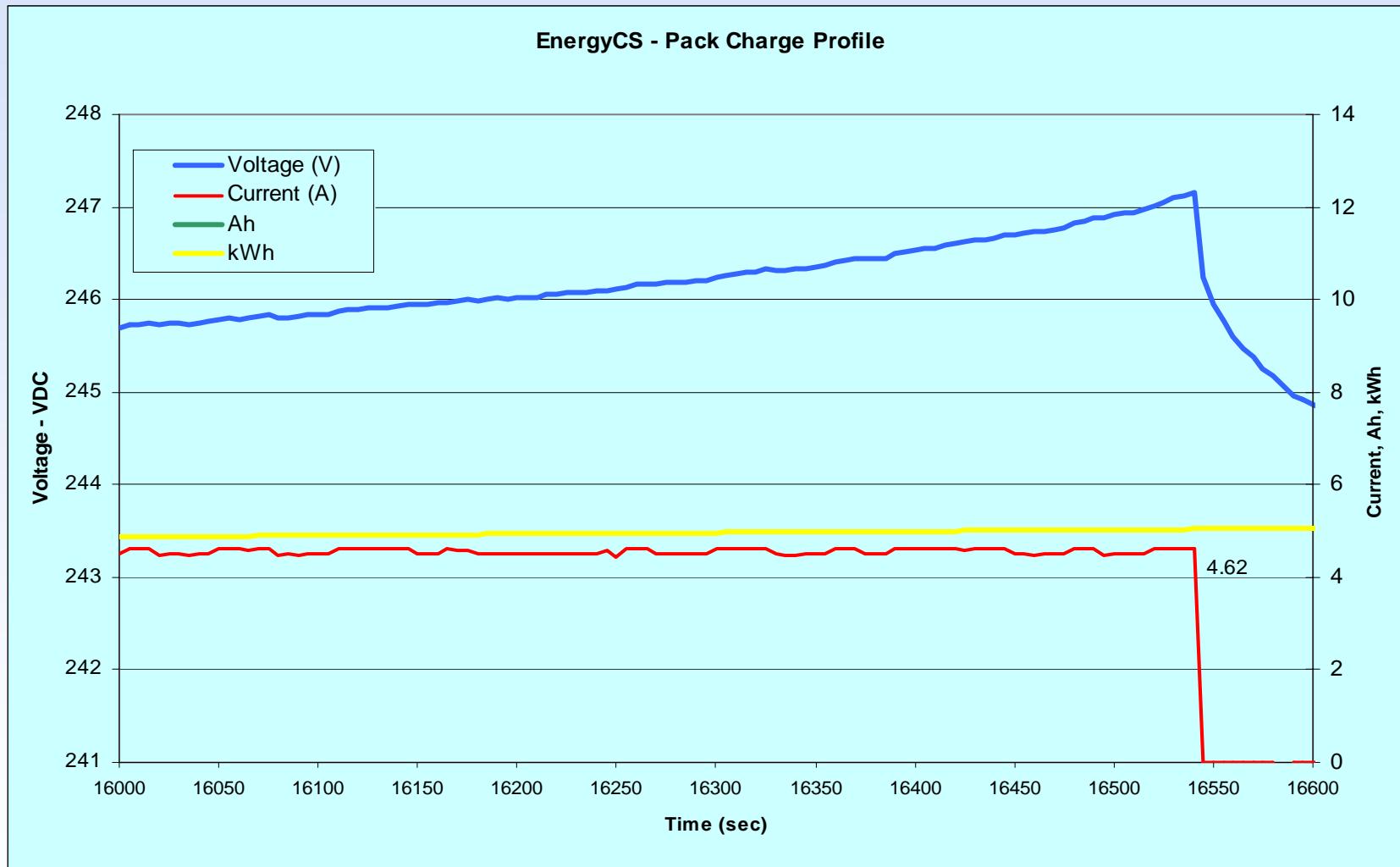
A123 Systems Lithium Ion Battery – DC kWh

EnergyCS Battery Charge Profile



Valence Lithium Ion Battery – DC kWh

EnergyCS Cell Charge Profile



Valence Lithium Ion Battery – DC kWh

Kangoo Test Results

- Renault Kangoo – Series PHEV with 9.6 kWh (usable) Saft NiCad pack & 650cc gasoline engine

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



Accelerated Onroad Testing

- Uses dedicated drivers
- Predetermined and repeatable drive cycles
- Combinations of urban and highway loops
- 5,440 total onroad test miles per PHEV model
- 162 drive and charging cycles that include a minimum of 1,344 hours of charging
- Complements dynamometer testing by allowing a broader view of fuel use over many more miles and charging events
- Test PHEV batteries at completion of accelerated testing and at 25k, 50k and ? miles

PHEV Accelerated Testing

- Accelerated testing in Phoenix over 5,440 miles
- GPS units track distance, average & 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			

EnergyCS Prius – Accelerated Testing

Cycle	Urban (mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity kWh	Gasoline Gals	Gasoline 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	984	147	4840	Weighted Average		84.5

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

Hymotion Prius – Accelerated Testing

Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gasoline	
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	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	86.4	

Each total distance slightly greater than 600
and 640 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)	kWh	Mi/kWh	Gals	MPG
10	1	0	4	60	600	359.60	1.67	0	-
20	1	1	8	30	600	131.96	4.55	0	-
40	4	0	12	5	200	35.18	5.59	0	-
40	2	2	12	5	200	33.22	6.02	0	-
40	0	4	12	5	200	28.60	6.99	0	-
60	2	4	12	10	600	57.96	10.35	13.3	45.1
80	2	6	12	8	640	44.62	14.34	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	Weighted Average		101.7	

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

Hymotion Escape – Accelerated Testing

Cycle	Urban (mi)	Highway (mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity kWh	Gasoline Gals	Gasoline 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			
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			
200	2	18	12	3	600			
Total	2340	3100	1344	162	5440	Weighted Average		

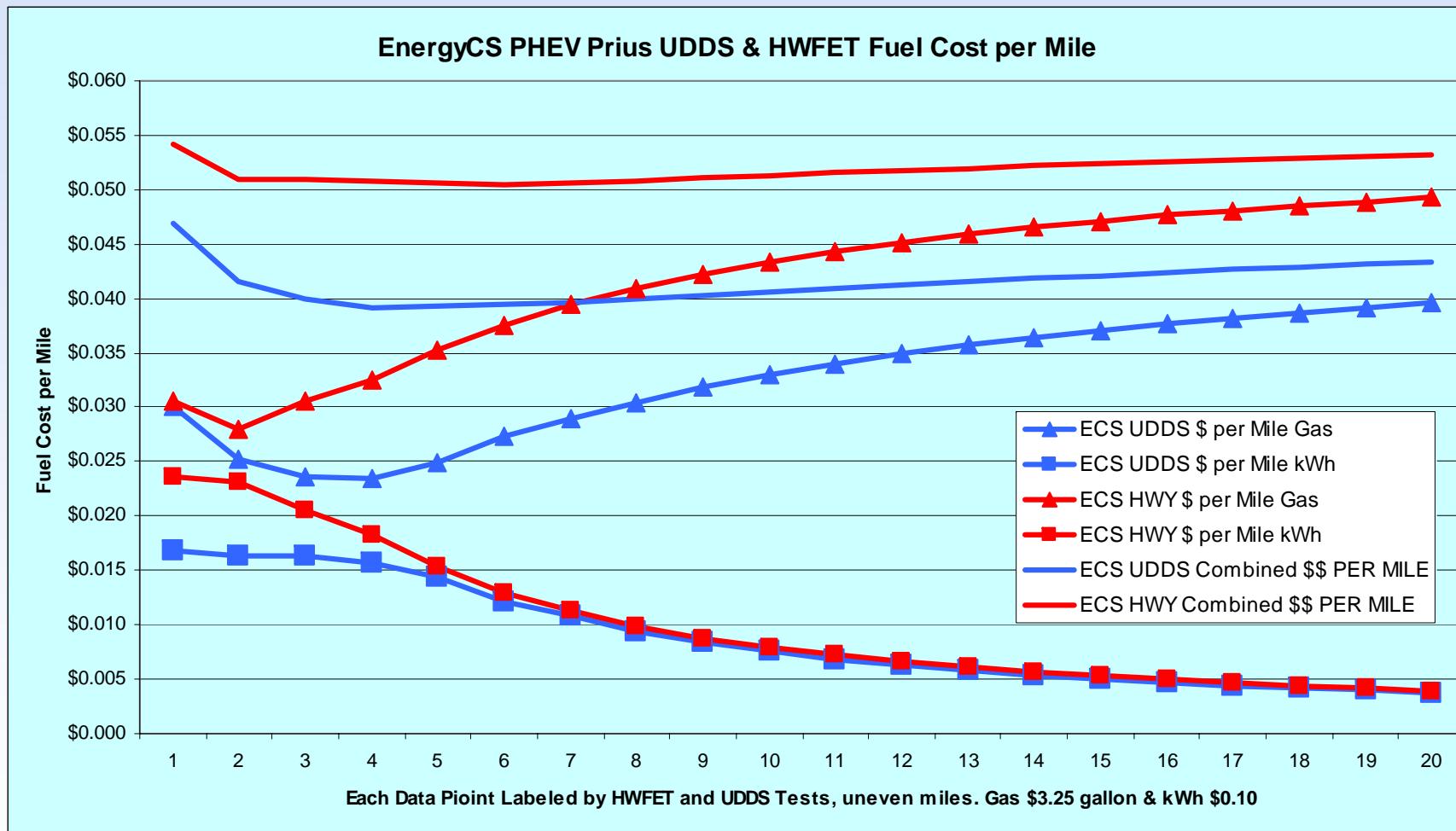
Each total distance slightly greater than 600 miles. HEV version = 27 mpg

HybridsPlus Escape – Accelerated Testing

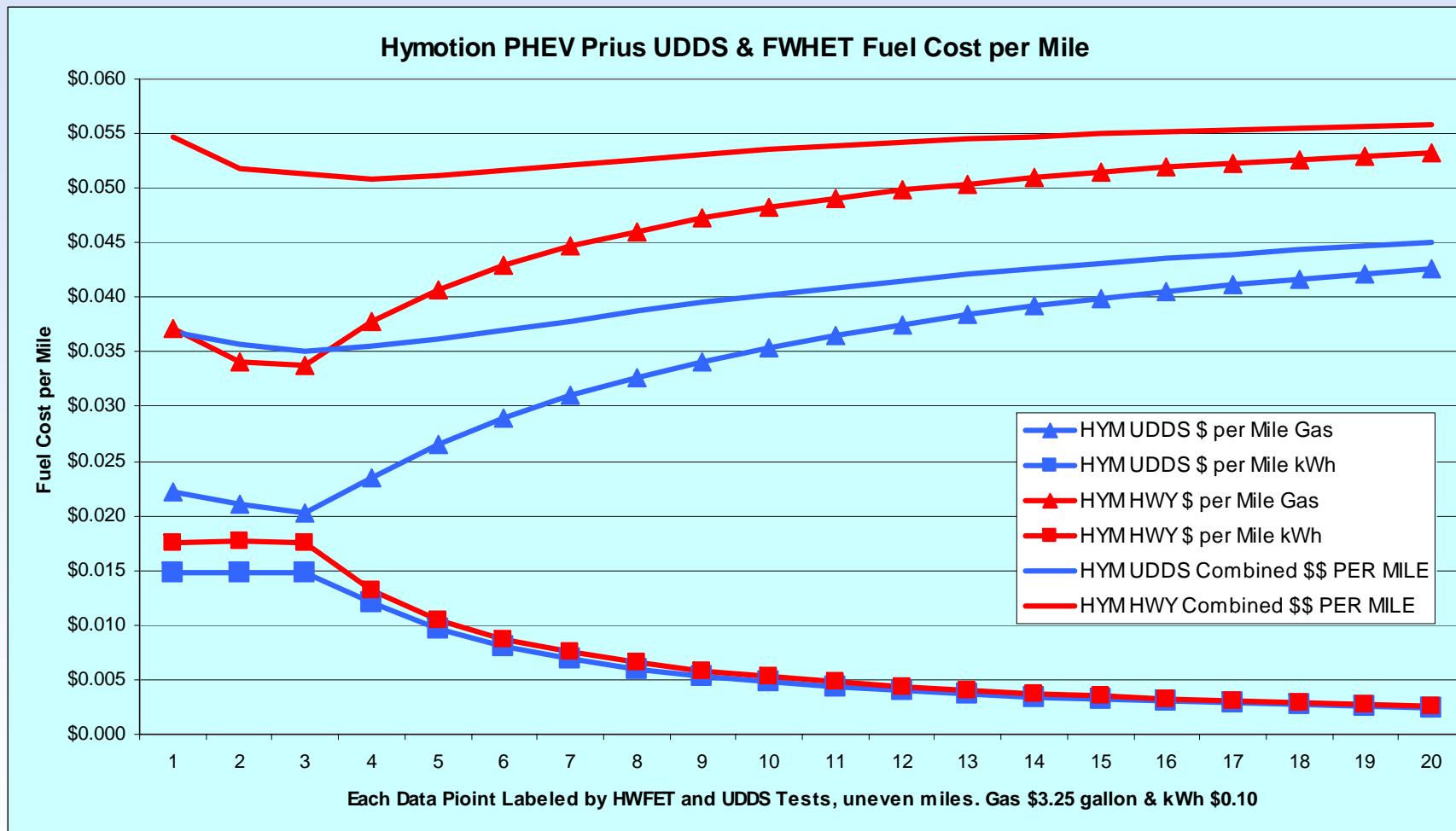
Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gasoline	
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	kWh	Gals	MPG
10	1	0	4	60	600		In progress	
20	1	1	8	30	600			
40	4	0	12	15	600			
40	2	2	12	15	600			
40	0	4	12	15	600			
60	2	4	12	10	600			
80	2	6	12	8	640			
100	2	8	12	6	600			
200	2	18	12	3	600			
Total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

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

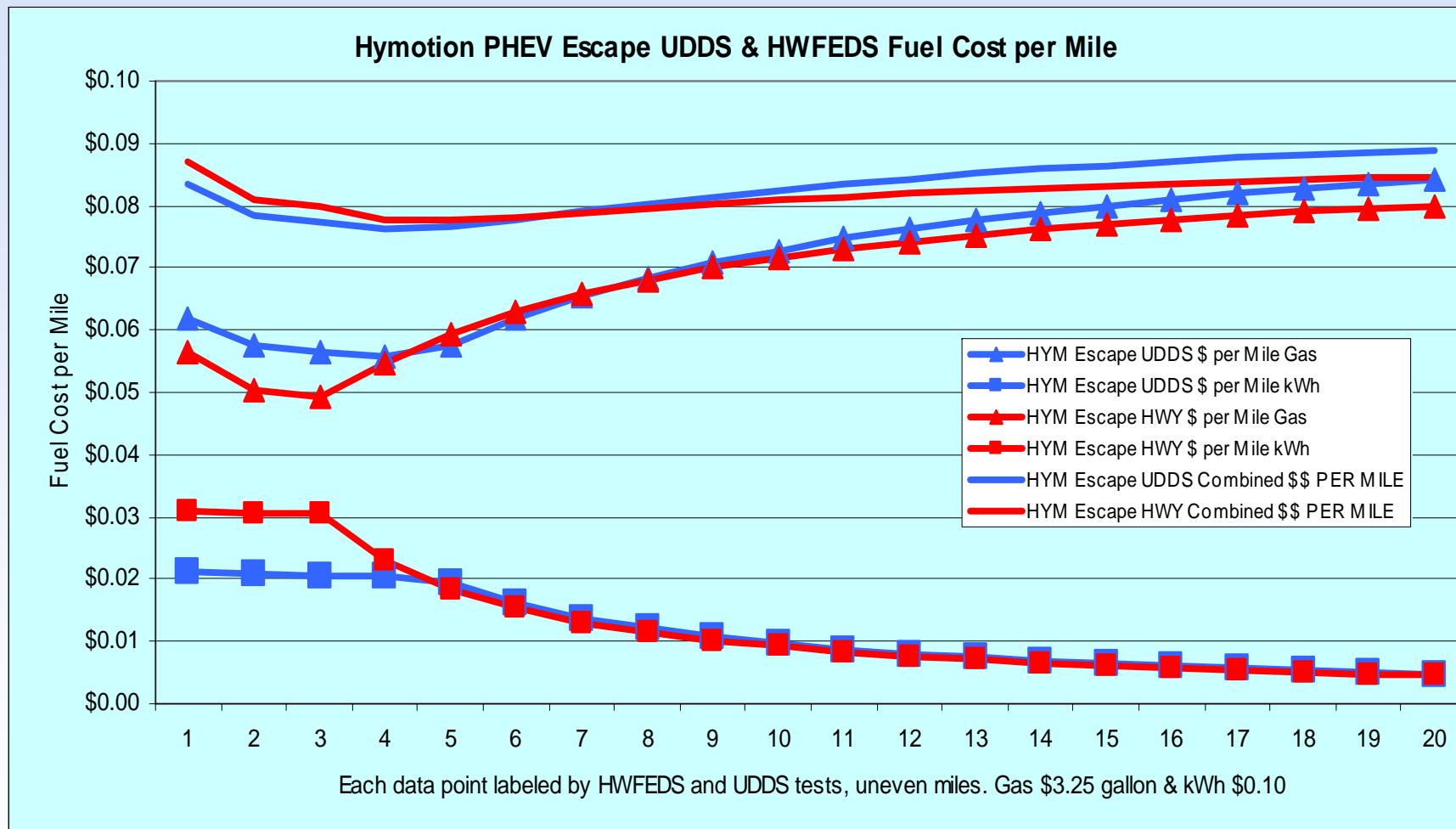
EnergyCS Prius – Fuel Costs



Hymotion Prius – Fuel Costs

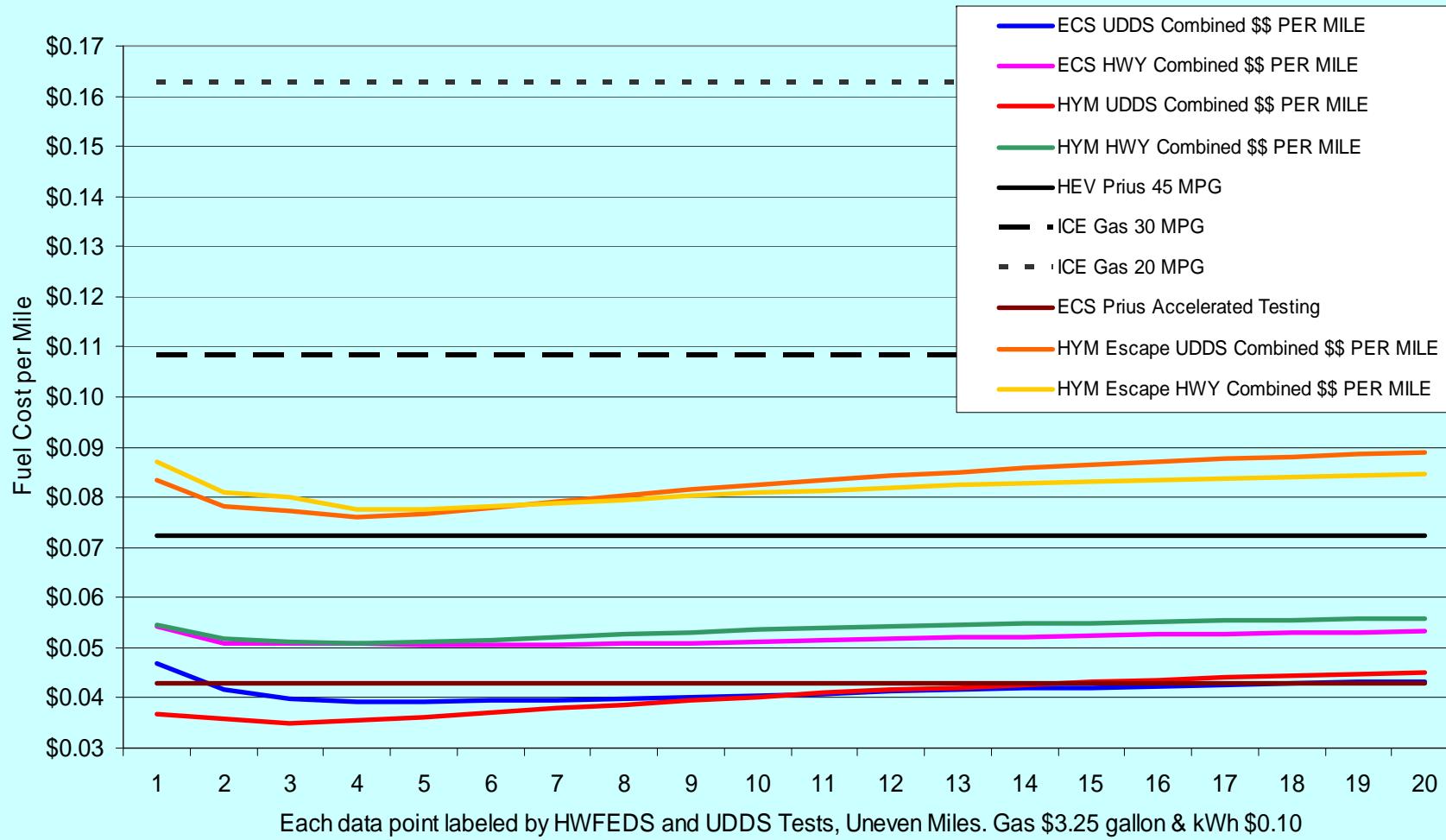


Hymotion Escape – Fuel Costs



PHEV Fuel Costs per Mile

2 Hymotions, EnergyCS, & Electrovaya PHEVs (UDDS & HWFEDS) & Other Vehicles



Onroad Demonstration Partners and Fleet Data Collection Activities

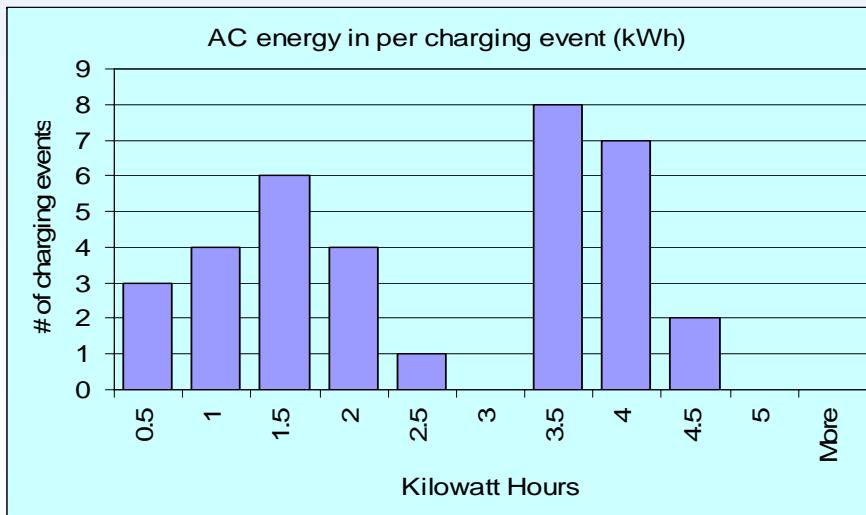
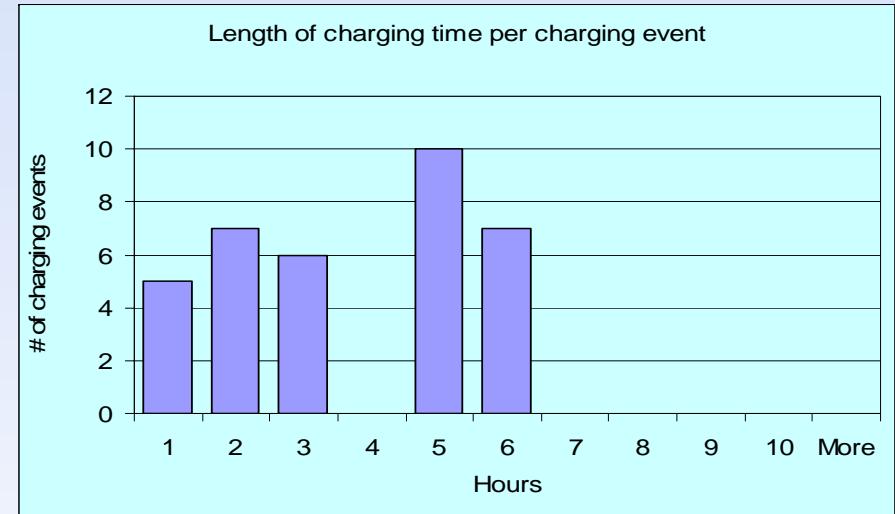
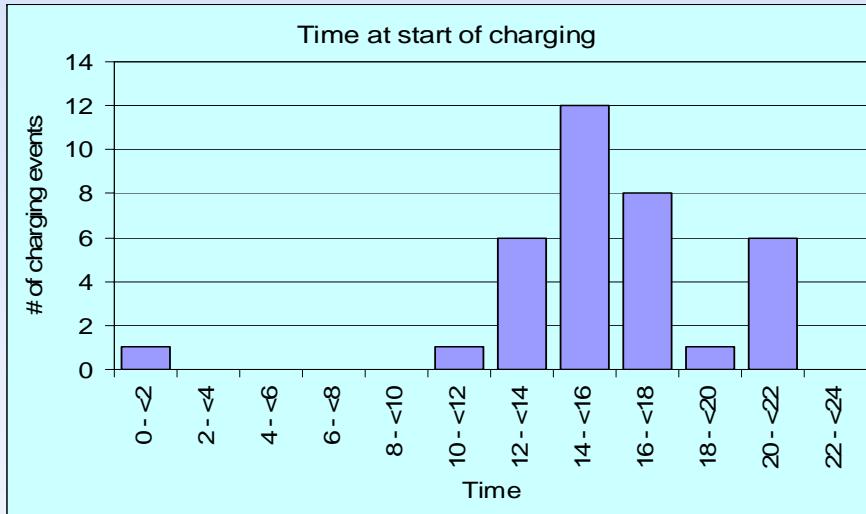
Hymotion Joint Data Collection

- Kvaser data loggers installed 50 PHEVs in US & Canada
- Onboard data includes vehicle performance, fuel use, and charging and driving profiles
- Offboard data - fuel use and maintenance data
- INL provides reports to fleets, DOE and Hymotion
- 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



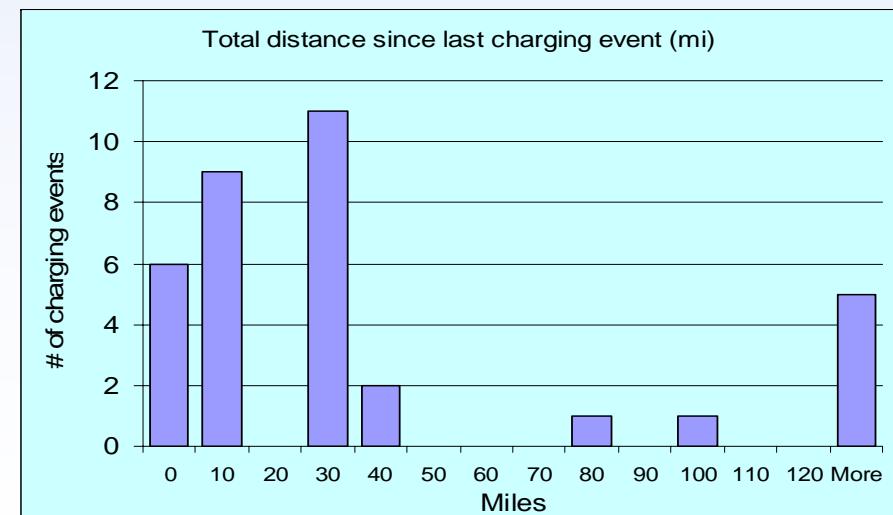
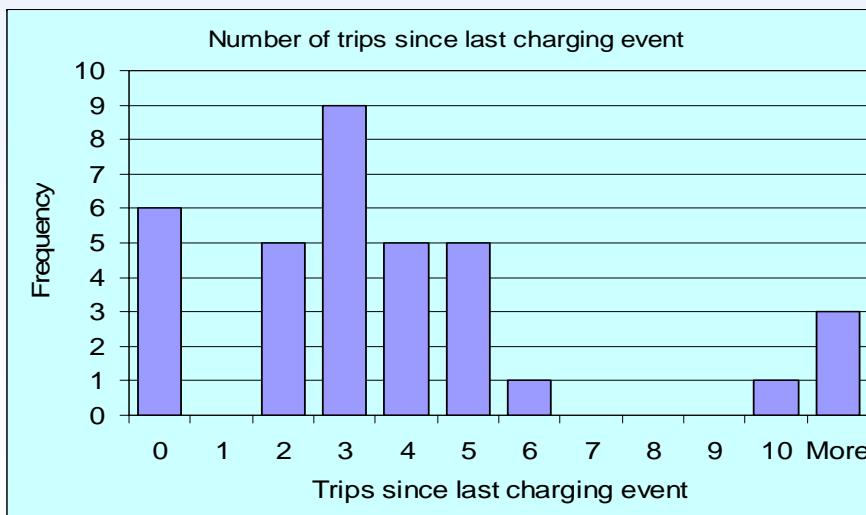
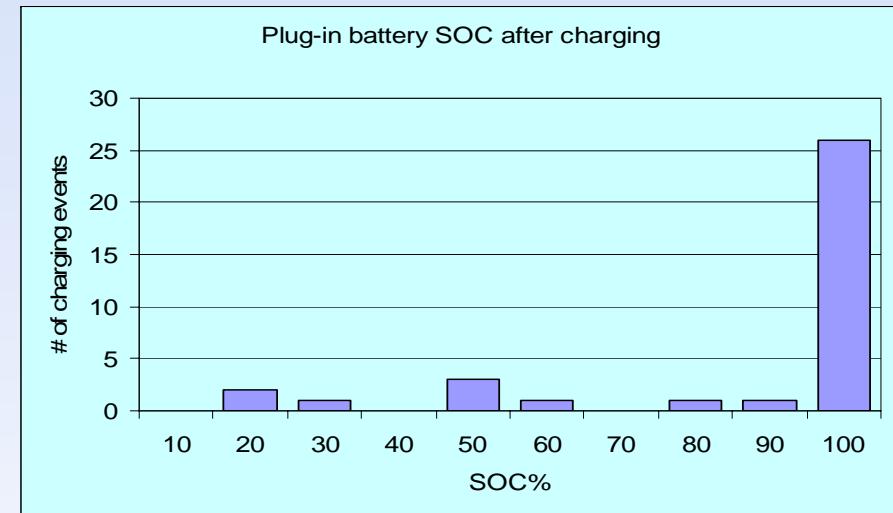
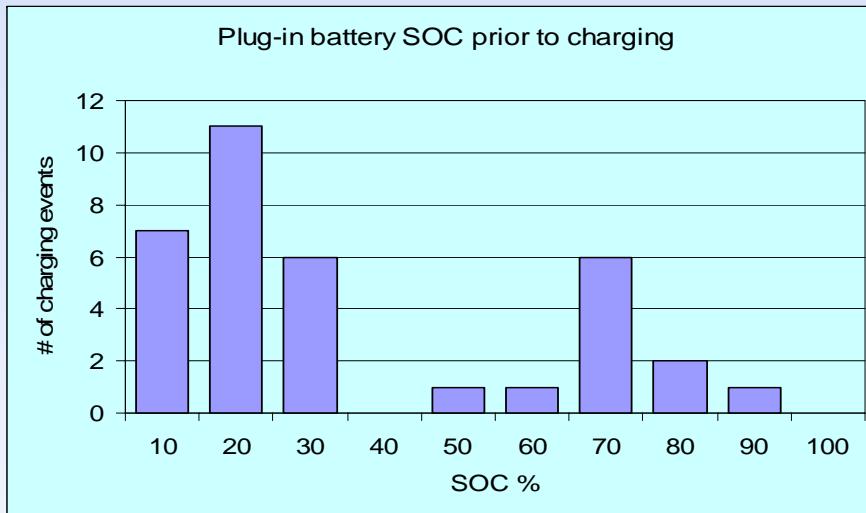
Hymotion Prius Charging Profiles

- 3 months, 2212 miles, 35 charges (single PHEV)



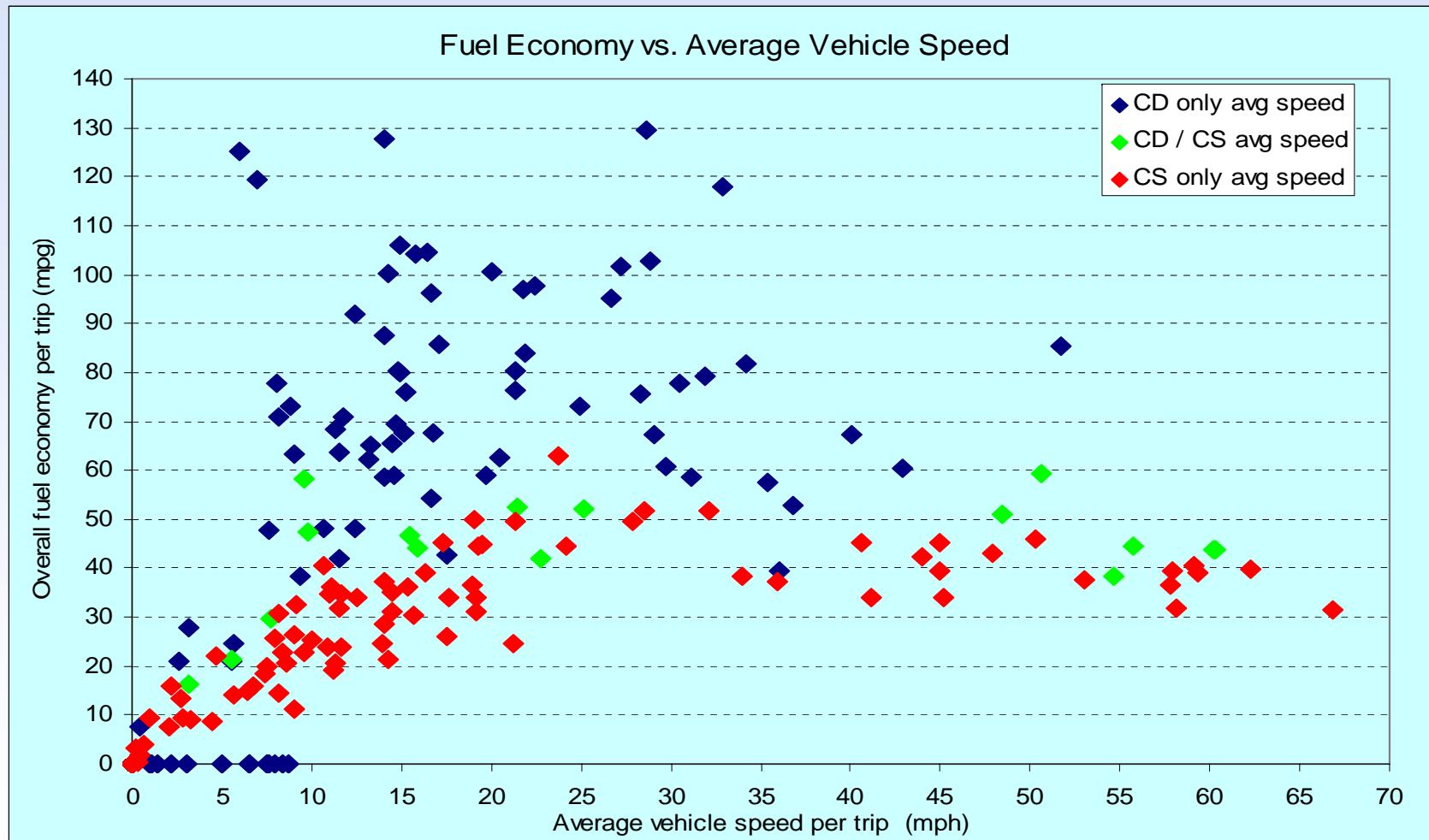
Hymotion Prius Charging Profiles

- 3 months, 2212 miles, 35 charges (single PHEV)



Hymotion Prius MPG Vs. Average Trip Speed

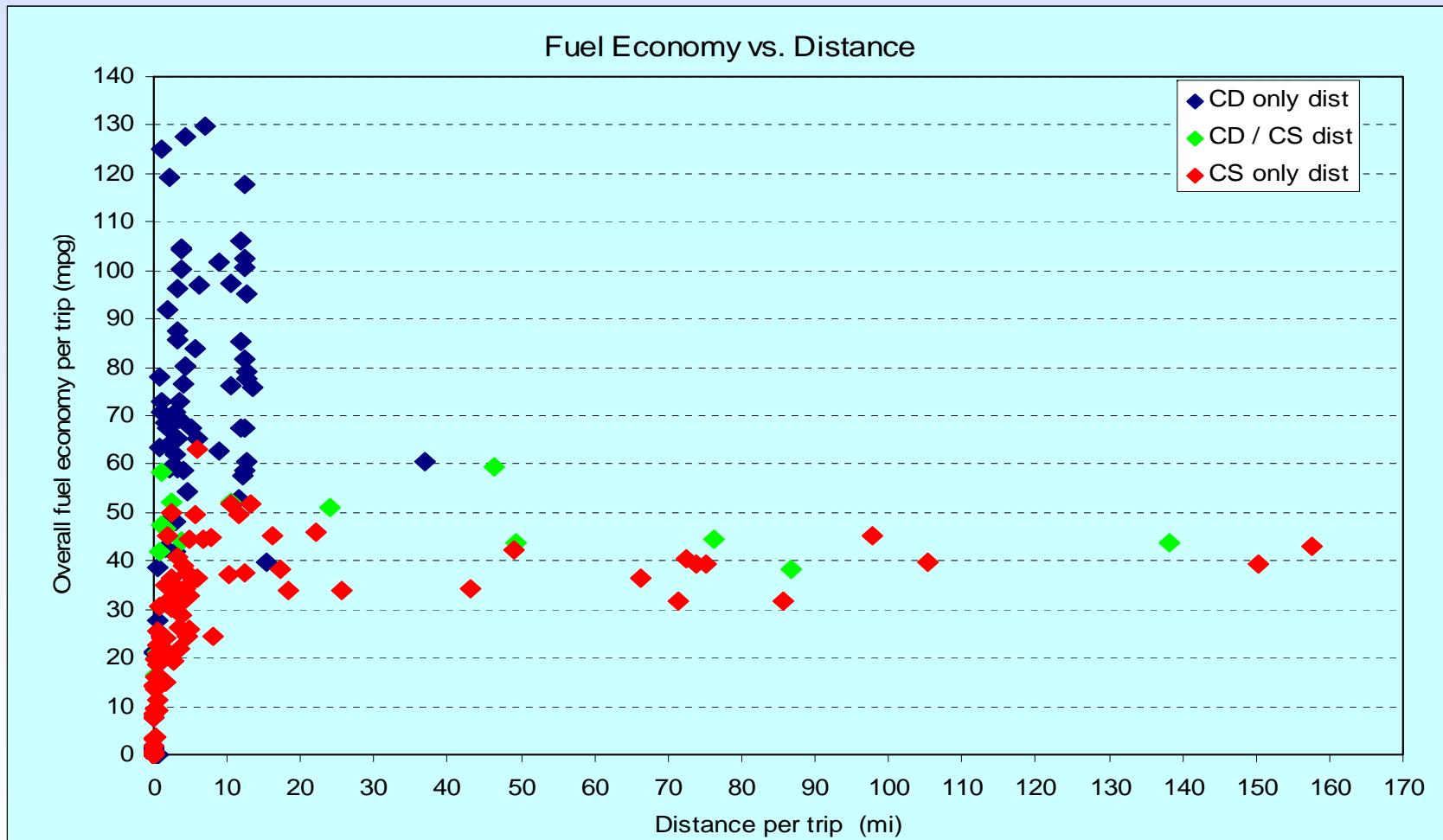
- 3 months, 2212 miles, 35 charges (single PHEV)



CD – charge depleting, S - sustaining

Hymotion Prius MPG Vs. Trip Distance

- 3 months, 2212 miles, 35 charges (single PHEV)



CD – charge depleting, S - sustaining

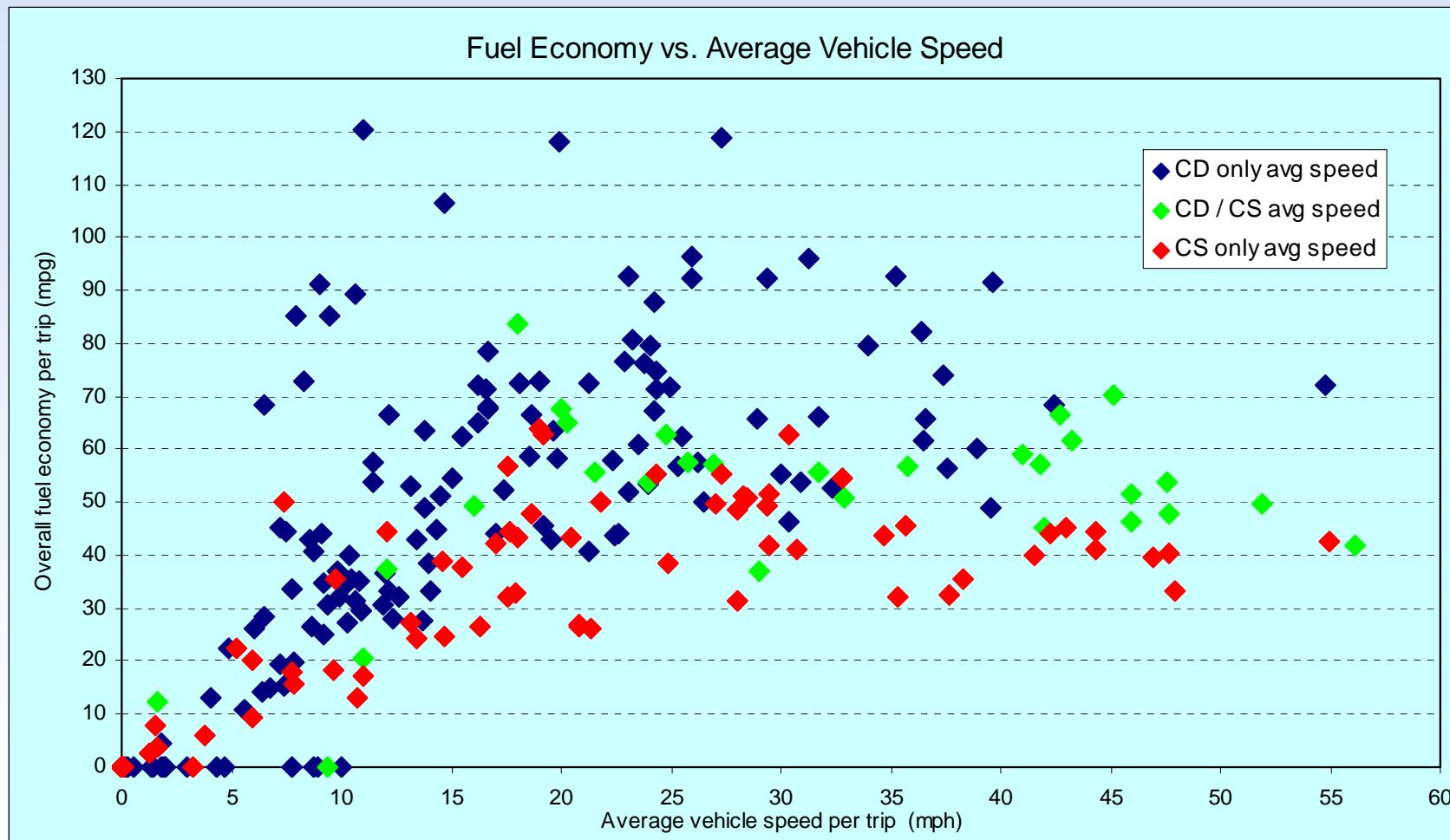
Hymotion Prius – Different Fleet

- 1/2/08 – 1/31/08, 12 charging events, single vehicle

	All Trips	CD-only mode	Combined modes	CS-only mode
Average MPG	43	76	45	40
# of Trips	77	12	12	53
% Total Trips	-	16%	16%	69%
Miles	1,999	86	1,047	866
Average Miles / Trip	26	7	87	16
% Total Miles	-	4%	52%	43%

Hymotion Prius 5 PHEVs MPG Vs. Speed

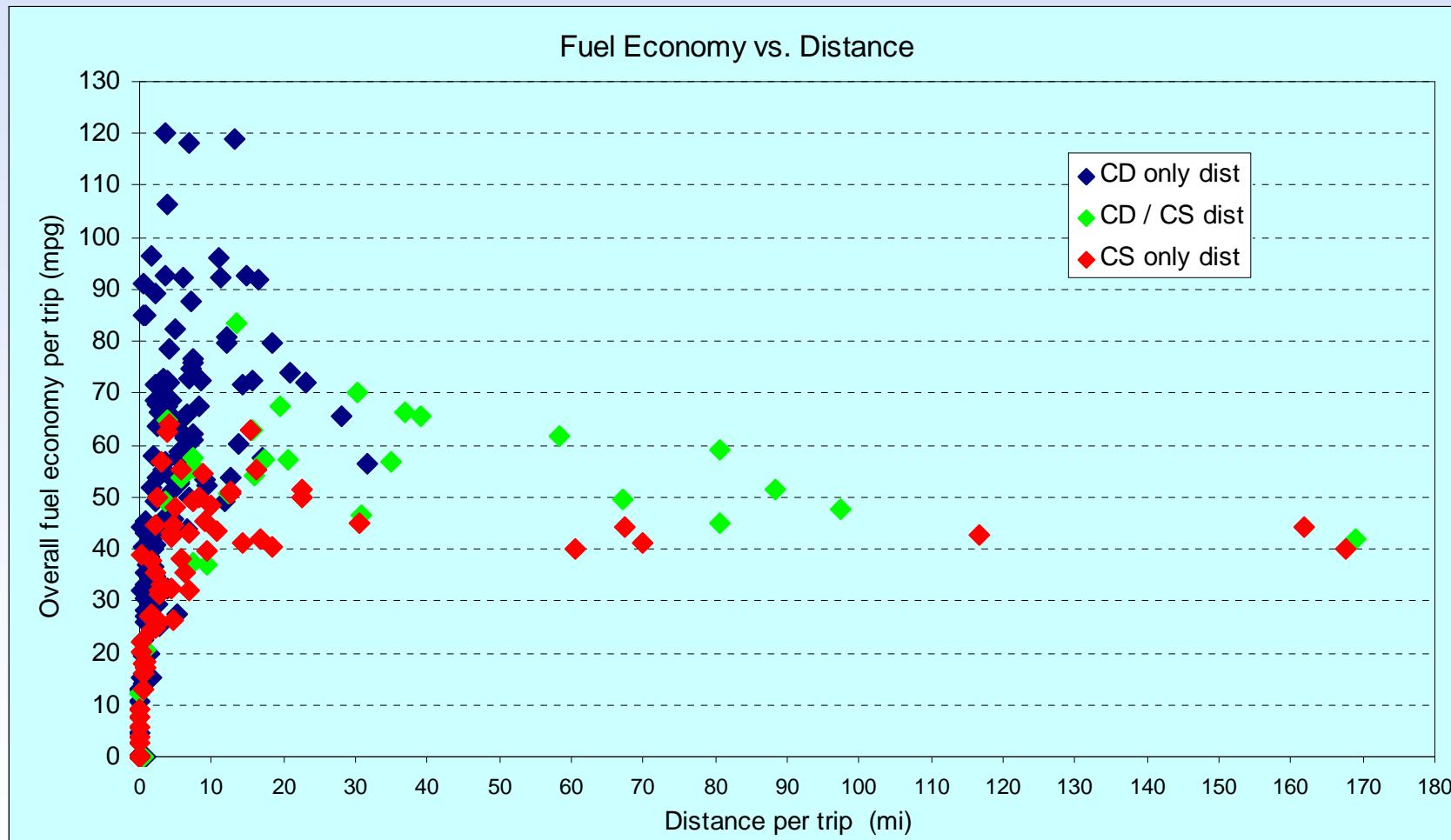
- TX, VT, and CA, 2800 miles, 206 trips, January 2008



CD – charge depleting, S - sustaining

Hymotion Prius 5 PHEVs MPG Vs. Distance

- TX, VT, and CA, 2800 miles, 206 trips, January 2008



CD – charge depleting, S - sustaining

EnergyCS Joint Data Collection

- EnergyCS provided onboard data for seven vehicles operating in fleets in Canada, Arizona, and California
- Modifying data collection to allow EnergyCS & INL server-to-server interface and wireless communication
- Some reduction in battery performance due to software and pack problems
- EnergyCS using different battery manufacturers
- 36 vehicles deployed (16 North America and 20 Europe)



NYSERDA

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

Model	Baseline Testing	Accelerated Testing	Delivery Status
EnergyCS Prius	Completed	Near completion	1 delivery
Hymotion Prius	Completed	Near completion	1 delivery
Hymotion Escape	Completed	Started	1 delivery
Electrovaya Escape	Problems	Waiting	4 deliveries required
HybridsPlus Escape	Waiting	Started	3 deliveries required



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Tacoma Power

- Two lead acid battery Prius PHEVs from the Green Car Company
- Two Hymotion Prius on order
- Testing includes charging and driving profiles as well as charging infrastructure analysis
- Using V2Green cellular data loggers and GPS units
- Started 1st quarter CY08



Tacoma Power



Vehicle Technologies Program

North American PHEV Demonstration

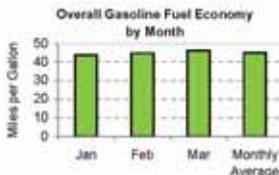
Monthly report for Tacoma Power Utilities

Vehicle conversion make/model: Manzanita Micro Prius

Vehicle ID: 5311

Reporting period: January – March 2008

All trips combined	Jan	Feb	Mar	Monthly Average	YTD Total
Overall gasoline fuel economy (mpg)	43.8	45.0	46.4	45.1	–
Total number of trips	89	74	87	83	250
Total gasoline fuel consumption (gal)	9.4	10.5	21.6	13.8	41.5
Total distance traveled (mi)	410	474	1004	629	1888
Number of days when the vehicle was driven	16	17	20	18	53



Manually recorded mileage	Mar
Beginning odometer	7176
Ending odometer	8682
Distance traveled (mi)	1506
Gasoline use (gal)	19.2
Fuel economy (mpg)	78.3

Plug-in charging	Jan	Feb	Mar	Monthly Average	YTD Total
Number of charging events	105	29	29	54	163
Number of charging events per day vehicle driven	6.6	1.7	1.5	3.2	–
Average length of charging event (hr) *	2.9	20.4	17.3	13.5	–
Average energy per charging event (kWh)	0.3	0.8	1.1	0.7	–
Total charging energy (kWh)	28.4	24.5	30.5	28	83

* Length of time when vehicle is plugged in per charging event.

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Tacoma Power



U.S. Department of Energy
Energy Efficiency and Renewable Energy
Energy and transportation data visualization by your electric utility choices

Seattle-Area Demonstration

- 13 Hymotion Prius PHEV demonstration with:
 - The City of Seattle (4)
 - King County (4)
 - Port of Seattle (2)
 - Puget Sound Clean Air Agency (3)
- 1 Green Car Company lead acid Prius at King County
- Using V2Green cellular data loggers and GPS units
- Offboard fuel use and maintenance requirements
- Started April 2008
- AVTA partner in time-of-day charge demand study



National Rural Electric Cooperative Association (NRECA)

- Total of ten Prius and Escape PHEVs from Hymotion, EnergyCS, and HybridsPlus will be / are operated by rural electric coop (4 delivered)
- Collect and process onboard data from the fleets, and provide individual vehicle and fleet operations data to NRECA and fleets



University of California Davis

- **UCDavis will use 13 Hymotion Prius for public fleet demonstration**
- **Demonstration will include up to 100 drivers that are identified by AAA of California**
- **Each public driver will operate a vehicle for ~2 months**
- **Use V2Green cellular data loggers and GPS units**
- **AVTA provides data collection, handling, analysis and dissemination support**
- **AVTA, UCDavis and AAA partnering to capture first study of public use of PHEVs, including charging practices and locations**
- **Started April 2008**

Washington State PHEV Demonstration

- Demonstrate 14 Hymotion Prius in coastal, desert, and island areas
- Testing partners include:
 - Port of Chelan (lead)
 - State of Washington
 - Five utilities and three colleges
 - Port agencies, cities and counties
 - Private company
- Will include daily solar (photovoltaic array) charging of up to three PHEVs
- Electricity costs as low as 2.5 cents/kWh (hydropower)
- Started April of 2008
- Using V2Green cellular data loggers and GPS units



Hawaii PHEV Demonstration

- Demonstrate six Hymotion Prius on Maui and Oahu
- Testing partners:
 - State of Hawaii
 - University of Hawaii
 - Hawaiian Electric Company
 - Maui Electric Company
 - Maui County
 - U.S. Air Force
- Will use V2Green cellular data loggers and GPS units
- Start late summer 2008



Charging Infrastructure



Charging Infrastructure



Other PHEV Testing

- Status of End of Life Battery Studies
 - EnergyCS Valance battery repaired and finishing accelerated testing
 - Hymotion Prius pack near completion of accelerated testing
- Charging demand study awaiting critical mass of PHEVs at one location
- Testing data loggers
- Defining bi-directional charging study
 - Likely at ~6 kW and ~20 kW levels
 - Includes V2Grid on two lithium battery PHEVs
 - Includes cellular modem charging control

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Vehicle Technologies Program

Tien Duong, Lee Slezak and Ro Sullivan

Additional Information

<http://avt.inl.gov>

or

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

INL/CON-08-14229

