



Idaho National Laboratory

U.S. DOE Advanced Vehicle Testing Activity

PHEV Testing Activities and Fleet Demonstrations

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Portland, Oregon
July 2008**

Presentation Outline

- **Background - Idaho National Laboratory and DOE's Advanced Vehicle Testing Activity**
- **AVTA testing history**
- **PHEV baseline performance and accelerated onroad testing methods and results**
- **PHEV demonstration partners and data collection**
- **PHEV charging infrastructure examples**
- **Other PHEV testing studies**
- **Unofficial market status of PHEVs by converter and OEM**

Idaho National Laboratory

- **Eastern Idaho based U.S. Department of Energy (DOE) multi-program laboratory**
- **890 square-mile site with 3,600 staff**
- **Support implementation of DOE's strategic goals, both nationally and regionally, including**
 - **Diversity of supply and use**
 - **Reduced environmental impact**
 - **Flexible, reliable energy infrastructure**
 - **Energy security**

AVTA Background

- **The Advanced Vehicle Testing Activity (AVTA) is part of The U.S. Department of Energy's Vehicle Technologies Program**
- **The Idaho National Laboratory (INL) and Electric Transportation Engineering Corporation (ETEC) conduct the AVTA light-duty vehicle testing; Argonne National Laboratory provides dynamometer testing support**

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 Test History

- PHEVs - 8 different models in testing / demonstrations
- Hybrid electric vehicles
 - 14 models, 42 vehicles, 3.7 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
 - 20 models, 200,000 test miles
- Urban electric vehicles
 - 3 models, 1 million test miles



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**
- **Document battery life, charging patterns and demand profiles**
- **Document vehicle operations, fuel use (both gasoline and electricity) and infrastructure requirements**
- **Document PHEV life-cycle costs**

PHEV Baseline Performance Testing


- **EETEC 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 charge sustaining test cycles
 - At least 26 UDDS (Urban Dynamometer Driving Schedule) and HWFEDS (Highway Fuel Economy Driving Schedule) dynamometer test cycles
 - Includes hot and cold test starts



Baseline Performance Testing Results



PHEV AMERICA
U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY



Energy CS Plug-In Hybrid

Base Vehicle Description
 Make: Toyota
 Model: Prius Year: 2006
 VIN: JTDKB20U767508841
 Number of Passengers: 5
 Hybrid Configuration: Series/Parallel

VEHICLE SPECIFICATIONS

Weights
 Design Curb Weight: 3160
 Vehicle Test Weight: 3400 lbs
 GVWR: 3795 lbs
 GAWR F/R: 2335/2250
 Distribution: 54.2%/45.8%
 Payload: 635 lbs
 Performance Goal: 400 lbs

Engine
 Model: 1NZ-FXE
 Output: 76 HP @ 5000 RPM
 Configuration: 4 Cylinder In-line
 Displacement: 1.5L
 Fuel Tank Capacity: 11.9 gal
 Fuel Types: Unleaded

Electric Drive System
 Battery Manufacturer: Valence
 Battery Type: Li-Ion
 Number of Cells: 2376
 Nominal Cell Voltage: 3.2V
 Nominal System Voltage: 230.4V
 Nominal Pack Capacity: 10 kWh
 Measured Useable Capacity: 4.88 kWh

Charge Systems:
 Input Voltages: 120V
 Required Breaker Currents: 15-Amp
 Charger Power Output: 1.2 kW
 Charger Plug Type: NEMA 5-15
 Estimated 80% Charge Time: 6.5 Hrs
 Estimated 100% Charge Time: 8 Hrs

Charge Depleting:
 Acceleration 0-60 MPH
 Time: 12.96 seconds
Acceleration 1/4 Mile
 Time: 20.09 seconds
 Maximum Speed: 75.7 MPH
Acceleration 1 Mile
 Maximum Speed: 104.9 MPH
Charge Sustaining:
Acceleration 0-60 MPH
 Time: 12.82 seconds
Acceleration 1/4 Mile
 Time: 19.98 seconds
 Maximum Speed: 75.7 MPH
Acceleration 1 Mile
 Maximum Speed: 105.0 MPH

Brake Test @ 60 MPH
 Distance Required: 1.26.8 ft

VEHICLE TEST RESULTS

Fuel Economy with A/C Off:
 Cold Start Charge Depleting:¹
 Fuel Economy: 108.2 MPG
 A/C kWh Consumed:⁷ .169 kWh/mi
Charge Depleting:
 Average Fuel Economy: 149.1 MPG
 A/C kWh Consumed:⁷ .153 kWh/mi
Charge Sustaining:
 Fuel Economy: 60 MPG

Fuel Economy with A/C On^{1,5}
Cold Start Charge Depleting:²
 Fuel Economy: 101.7 MPG
 A/C kWh Consumed:⁷ .201 kWh/mi
Charge Depleting:
 Average Fuel Economy: 138.4 MPG
 A/C kWh Consumed:⁷ .194 kWh/mi
Charge Sustaining:
 Fuel Economy: 43 MPG

UDDS Fuel Economy ⁶			HWFET Fuel Economy ⁶		
Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)	Distance (miles)	Fuel Economy (mpg)	A/C Energy Consumed (kWh)
10	118.0	1.83	10	106.6	1.77
20	137.6	3.65	20	116.4	3.45
40	124.7	5.52	40	99.9	5.46
60	105.9	5.65	60	85.7	5.84
80	94.7	5.65	80	79.5	5.93
100	89.18	5.65	100	75.2	5.93
200	77.9	5.65	200	66.6	5.93

UDDS Fuel Economy ⁶			HWFET Fuel Economy ⁶		
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:

- Cumulative fuel economy over EPA standard urban drive cycle.
- Vehicle soaked at ambient temperature while off for a minimum of 12 hours prior to testing.
- Average non-cold start charge depleting fuel economy.
- Value determined from average charge sustaining fuel economy tests with appropriate energy correction calculations.
- A/C on coldest setting with full blower power.
- Calculated cumulative fuel economy values, includes cold start.
- A/C energy based on measured charge efficiency.

This 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.

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PHEV AMERICA
U.S. DEPARTMENT OF ENERGY ADVANCED VEHICLE TESTING ACTIVITY



Hymotion Plug-In Hybrid

Base Vehicle Description
 Make: Toyota
 Model: Prius Year: 2007
 VIN: JTDKB20U577558820
 Number of Passengers: 5
 Hybrid Configuration: Series/Parallel

VEHICLE SPECIFICATIONS

Weights
 Design Curb Weight: 3037
 Vehicle Test Weight: 3337 lbs
 GVWR: 3795 lbs
 GAWR F/R: 2335/2250
 Distribution: 54.2%/45.8%
 Payload: 758 lbs
 Performance Goal: 400 lbs

Engine
 Model: 1NZ-FXE
 Output: 76 HP @ 5000 RPM
 Configuration: 4 Cylinder In-line
 Displacement: 1.5L
 Fuel Tank Capacity: 11.9 gal
 Fuel Types: Unleaded

Electric Drive System
 Battery Manufacturer: A123
 Battery Type: Li-Ion
 Number of Cells: 616
 Nominal Cell Voltage: 3.3V
 Nominal System Voltage: 184.8V
 Nominal Pack Capacity: 4.7 kWh
 Measured Useable Capacity: 2.96 kWh

Charge Systems:
 Input Voltages: 120V
 Required Breaker Currents: 15-Amp
 Charger Power Output: 1.2 kW
 Charger Plug Type: NEMA 5-15
 Estimated 80% Charge Time: 4.4 Hrs
 Estimated 100% Charge Time: 5.5 Hrs

Charge Depleting:
 Acceleration 0-60 MPH
 Time: 13.28 seconds
Acceleration 1/4 Mile
 Time: 20.27 seconds
 Maximum Speed: 74.34 MPH
Acceleration 1 Mile
 Maximum Speed: 103.4 MPH
Charge Sustaining:
Acceleration 0-60 MPH
 Time: 13.41 seconds
Acceleration 1/4 Mile
 Time: 20.42 seconds
 Maximum Speed: 74.82 MPH
Acceleration 1 Mile
 Maximum Speed: 104.0 MPH

Brake Test @ 60 MPH
 Distance Required: 153.0 ft

VEHICLE TEST RESULTS

Fuel Economy with A/C Off:
 Cold Start Charge Depleting:¹
 Fuel Economy: 146.72 MPG
 A/C kWh Consumed:⁷ .147 kWh/mi
Charge Depleting:
 Average Fuel Economy: 167.2 MPG
 A/C kWh Consumed:⁷ .148 kWh/mi
Charge Sustaining:
 Fuel Economy: 60.8 MPG

Fuel Economy with A/C On^{1,5}
Cold Start Charge Depleting:²
 Fuel Economy: 126.9 MPG
 A/C kWh Consumed:⁷ .199 kWh/mi
Charge Depleting:
 Average Fuel Economy: 153.2 MPG
 A/C kWh Consumed:⁷ .197 kWh/mi
Charge Sustaining:
 Fuel Economy: 46.3 MPG

UDDS Fuel Economy ⁶			HWFET Fuel Economy ⁶		
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
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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:

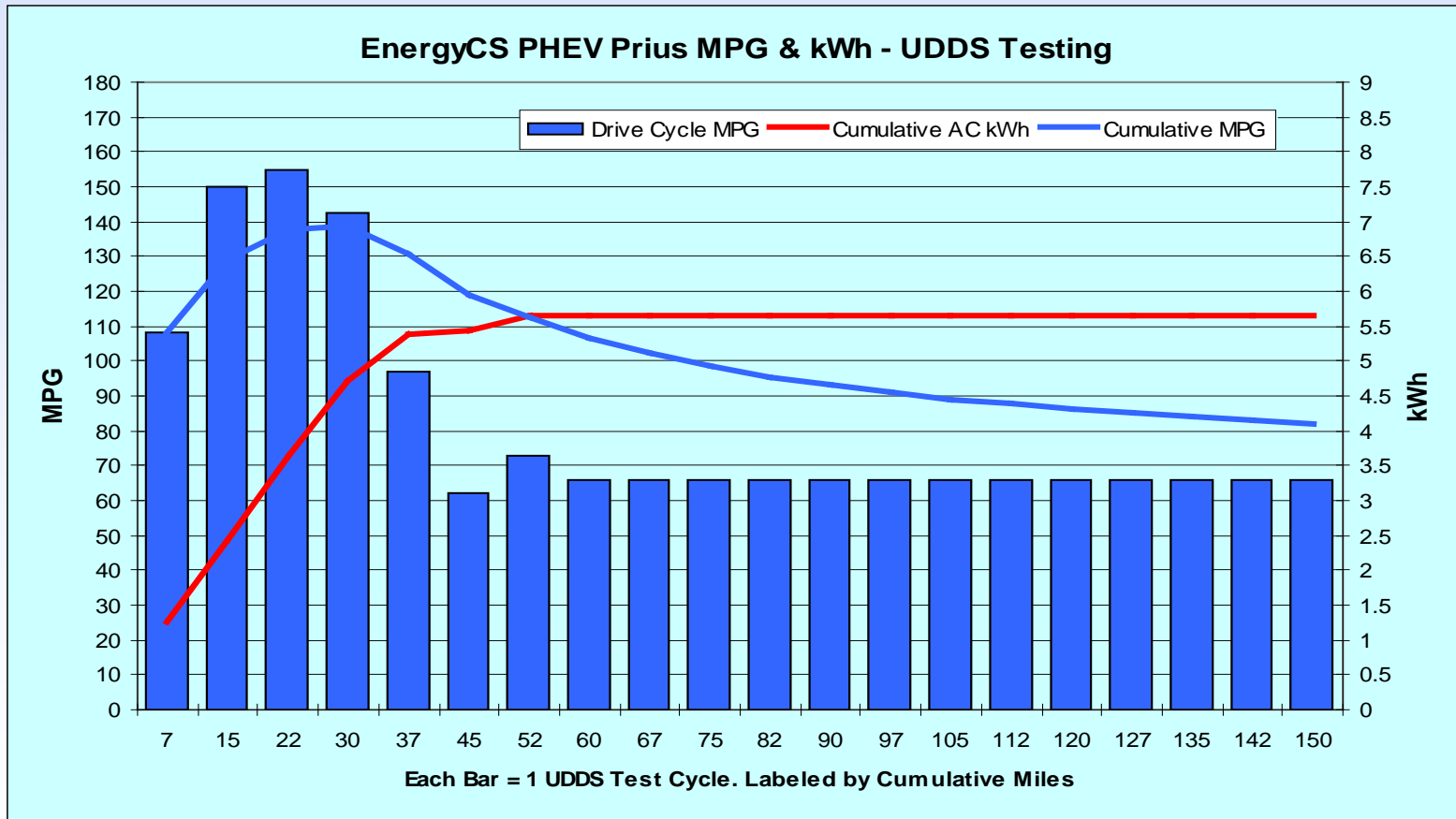
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- Average non-cold start charge depleting fuel economy.
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- A/C on coldest setting with full blower power.
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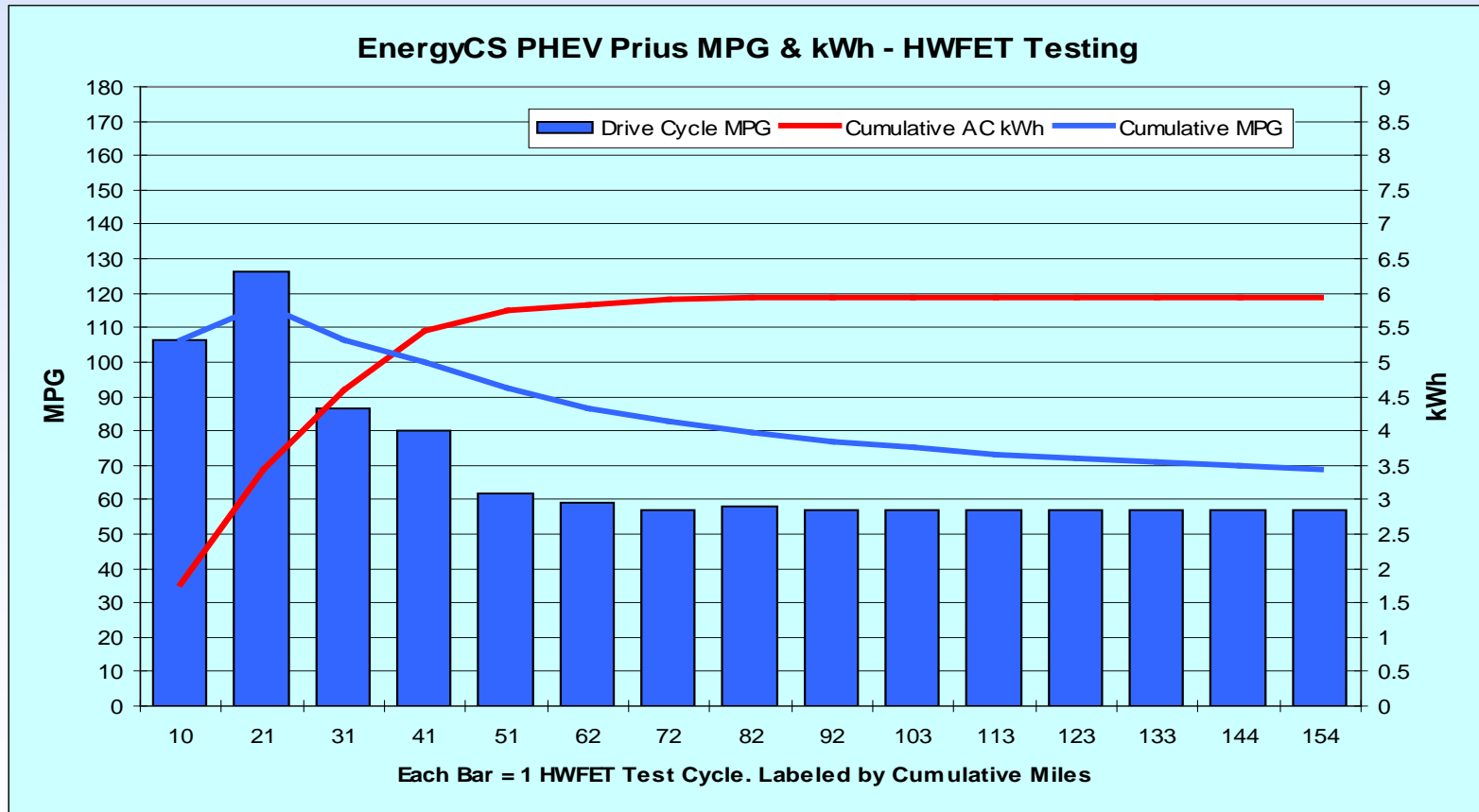
EnergyCS Prius – UDDS Fuel Use

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



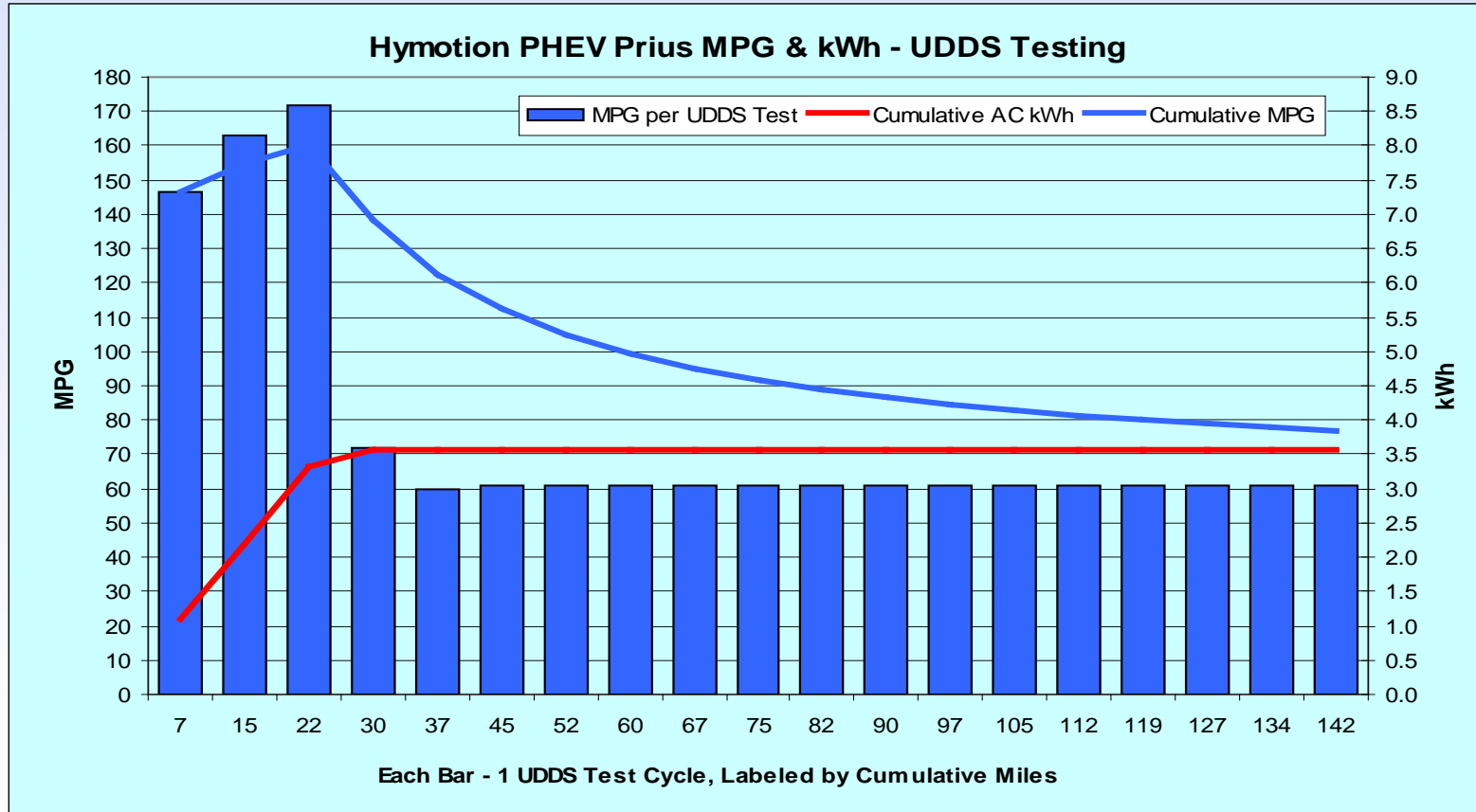
EnergyCS Prius – HWFETS Fuel Use

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



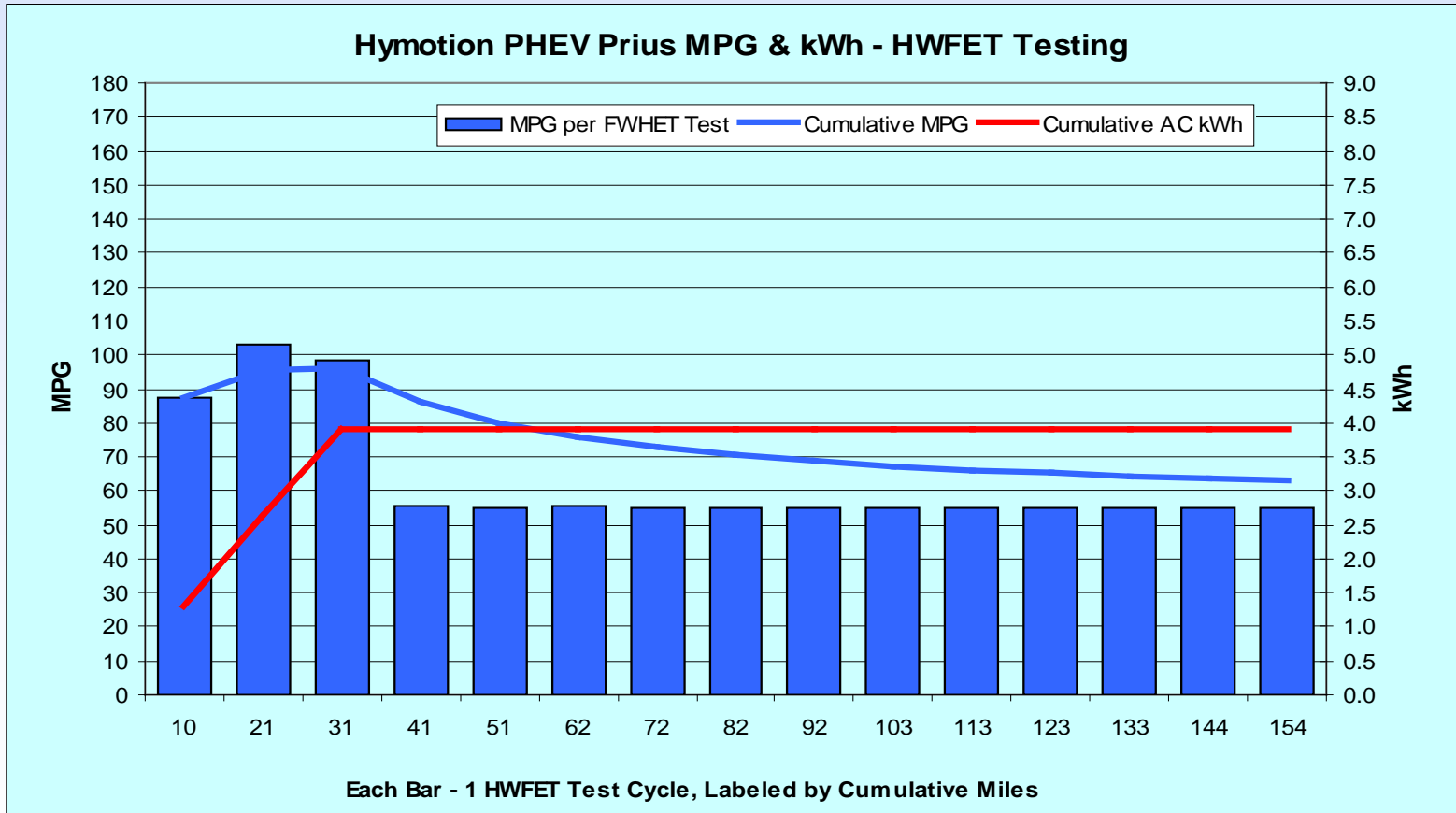
Hymotion Prius – UDDS Fuel Use

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



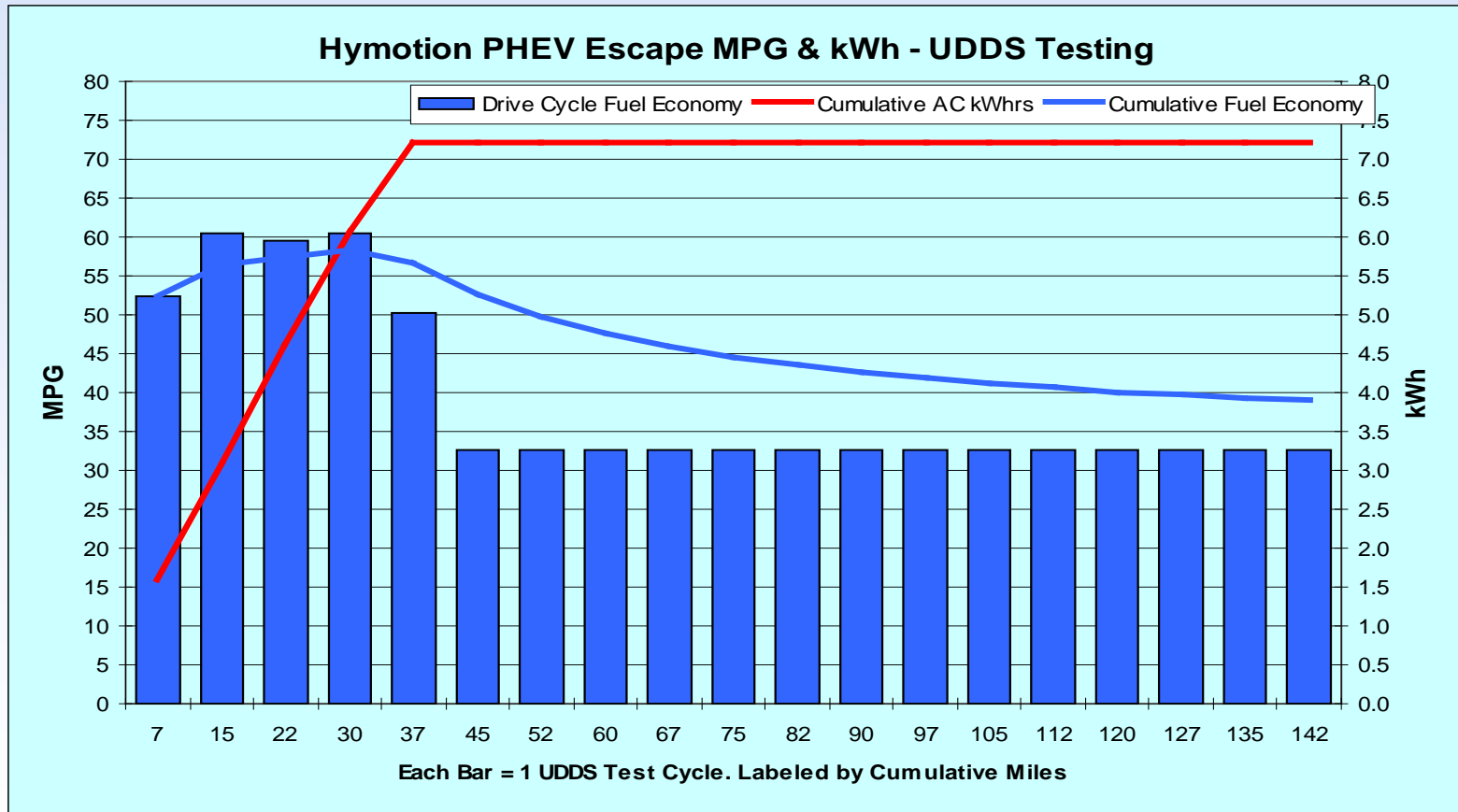
Hymotion Prius – HWFETS Fuel Use

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



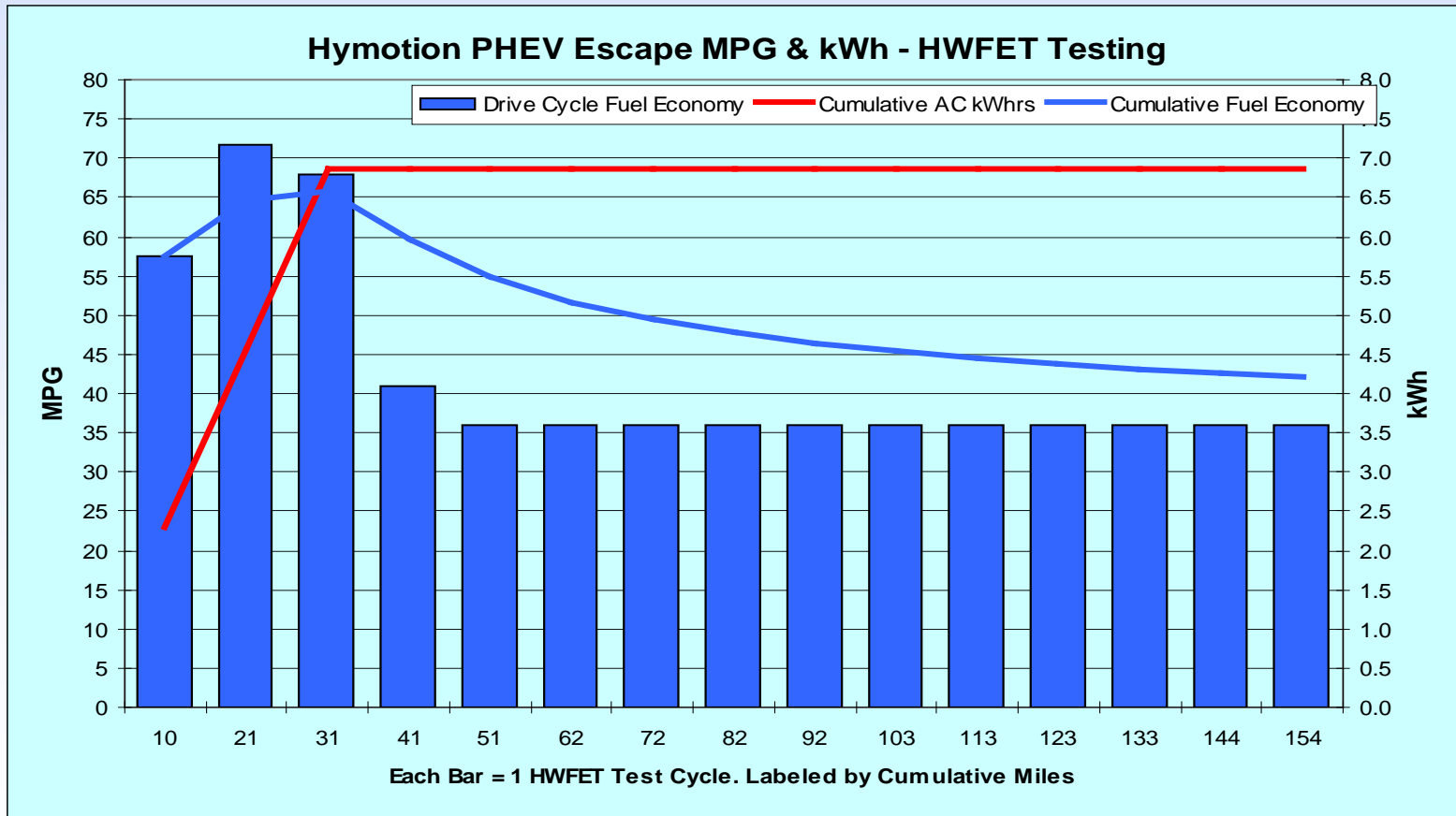
Hymotion Escape – UDDS Fuel Use

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



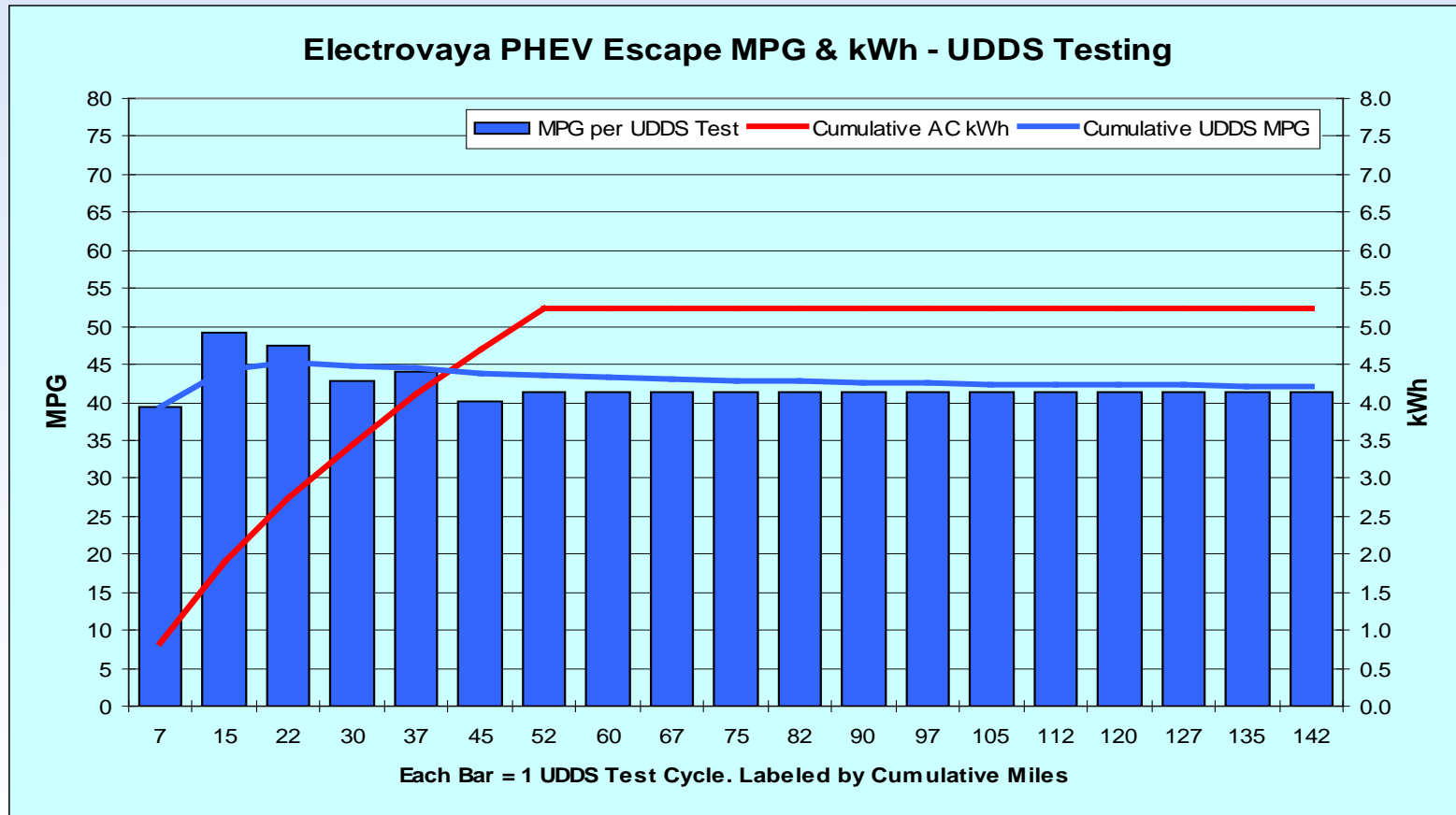
Hymotion Escape – HWFETS Fuel Use

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



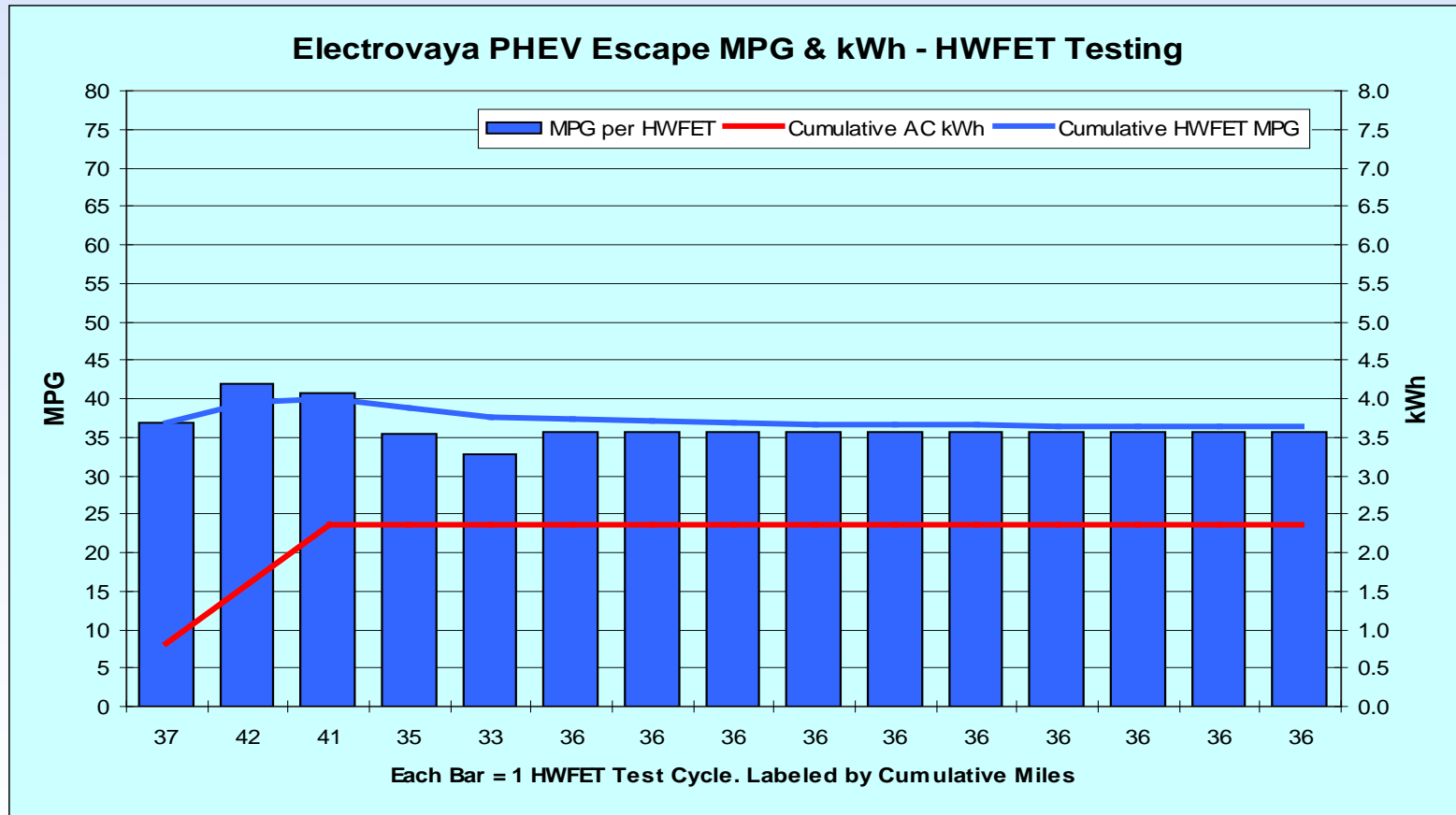
Electrovaya Escape – UDDS Fuel Use

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



Electrovaya Escape – HWFETS Fuel Use

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



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			

EnergyCS 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	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 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 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

Renault Kangoo – Accelerated Testing

Cycle	Urban (mi)	Highway (10 mi)	Charge (hr)	Reps (N)	Total (mi)	Electricity		Gasoline	
						AC kWh	Mi/kWh	Gals	MPG
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	Highway	Charge	Reps	Total	Electricity	Gasoline	
(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			
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			
Total	2340	3100	1344	162	5440	Weighted Average		

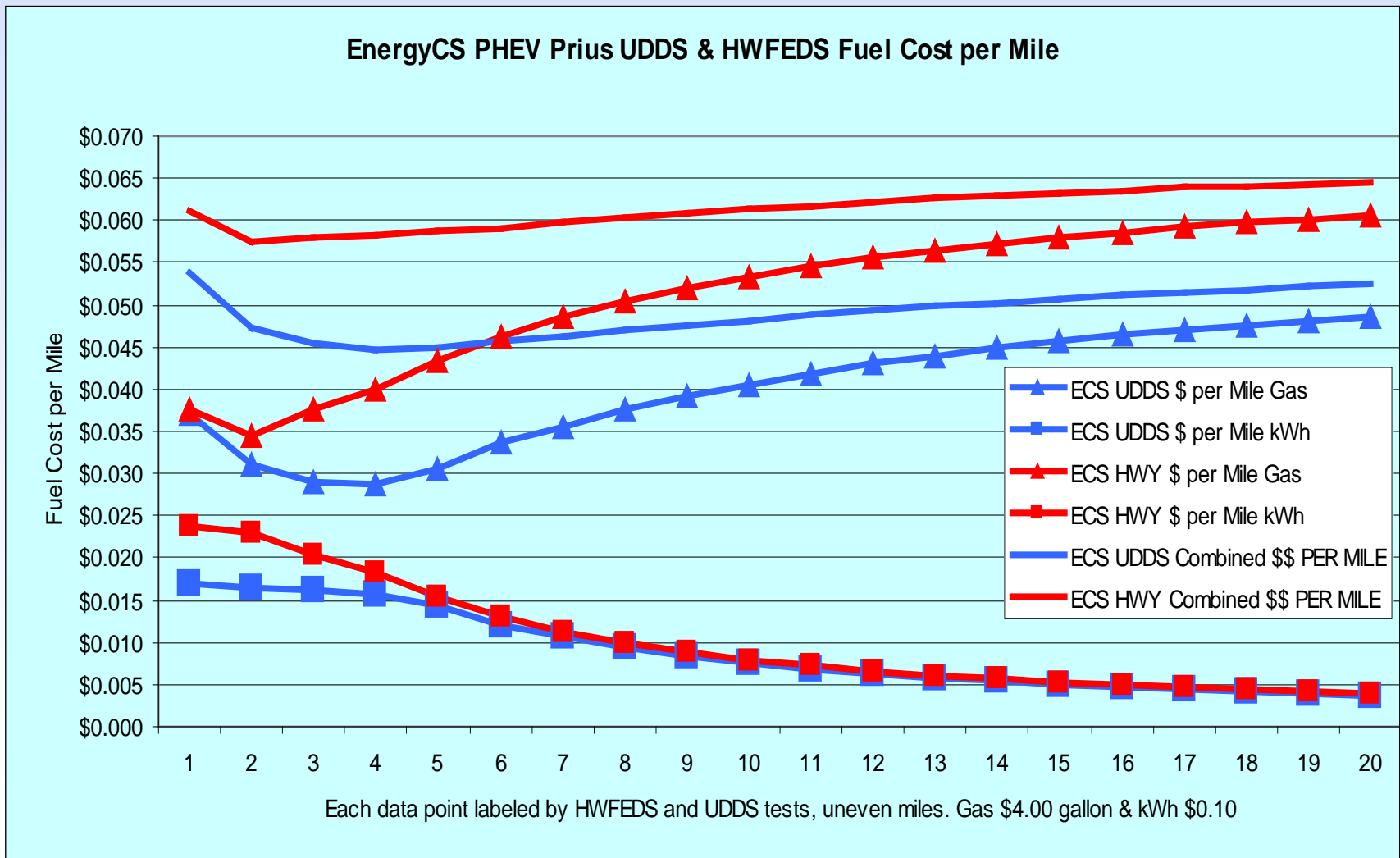
Each total distance slightly greater than 600 miles. HEV version = 27 mpg

Electrovaya Escape – Accelerated Testing

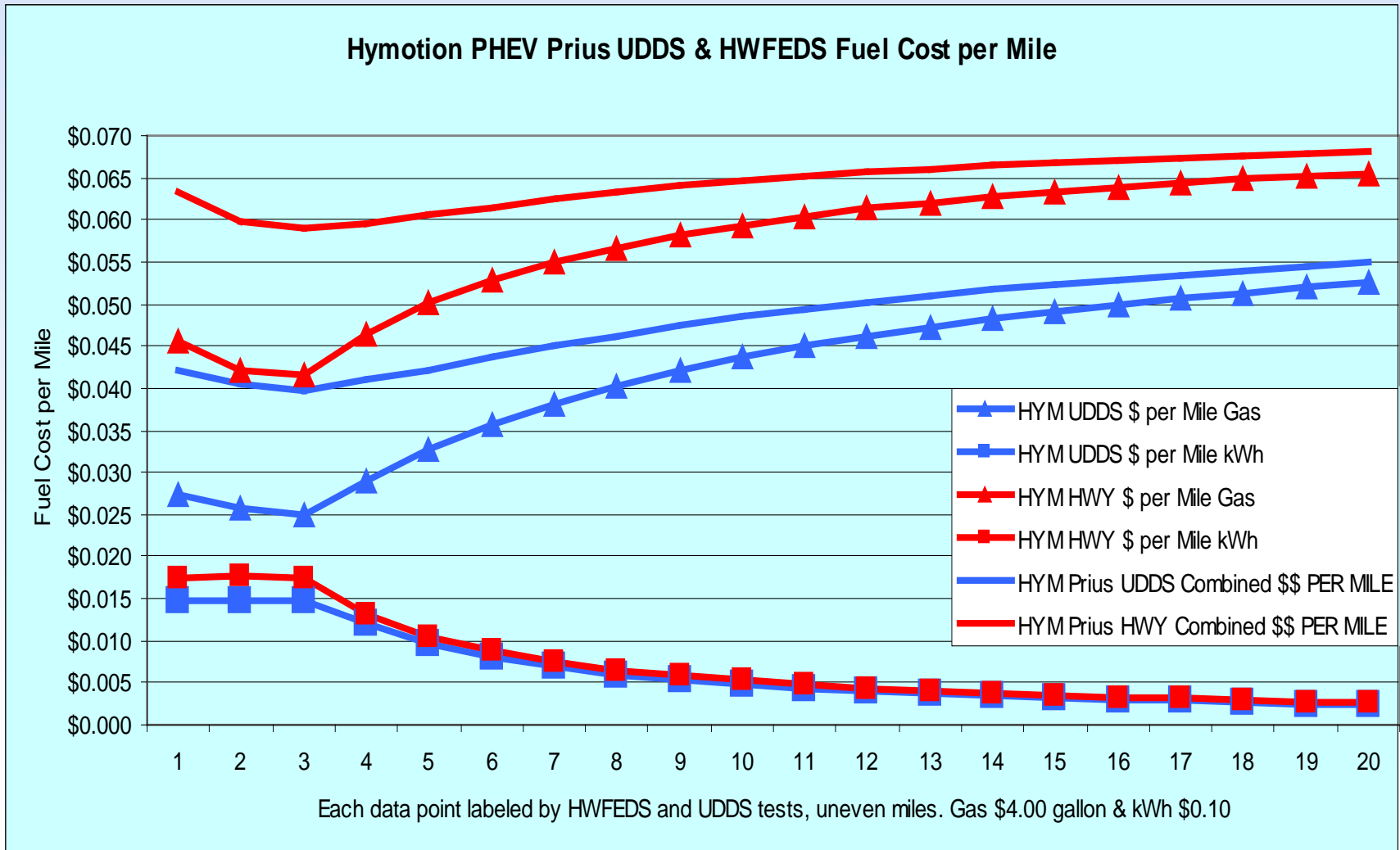
Cycle	Urban	Highway	Charge	Reps	Total	Electricity	Gasoline	
(mi)	(10 mi)	(10 mi)	(hr)	(N)	(mi)	AC kWh	Gals	MPG
10	1	0	4	60	600			
20	1	1	8	30	600			
40	4	0	12	15	600	71.3	16.42	37.3
40	2	2	12	15	600	69.8	14.34	43.1
40	0	4	12	15	600			
60	2	4	12	10	600	44.8	16.64	37.3
80	2	6	12	8	640			
100	2	8	12	6	600			
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

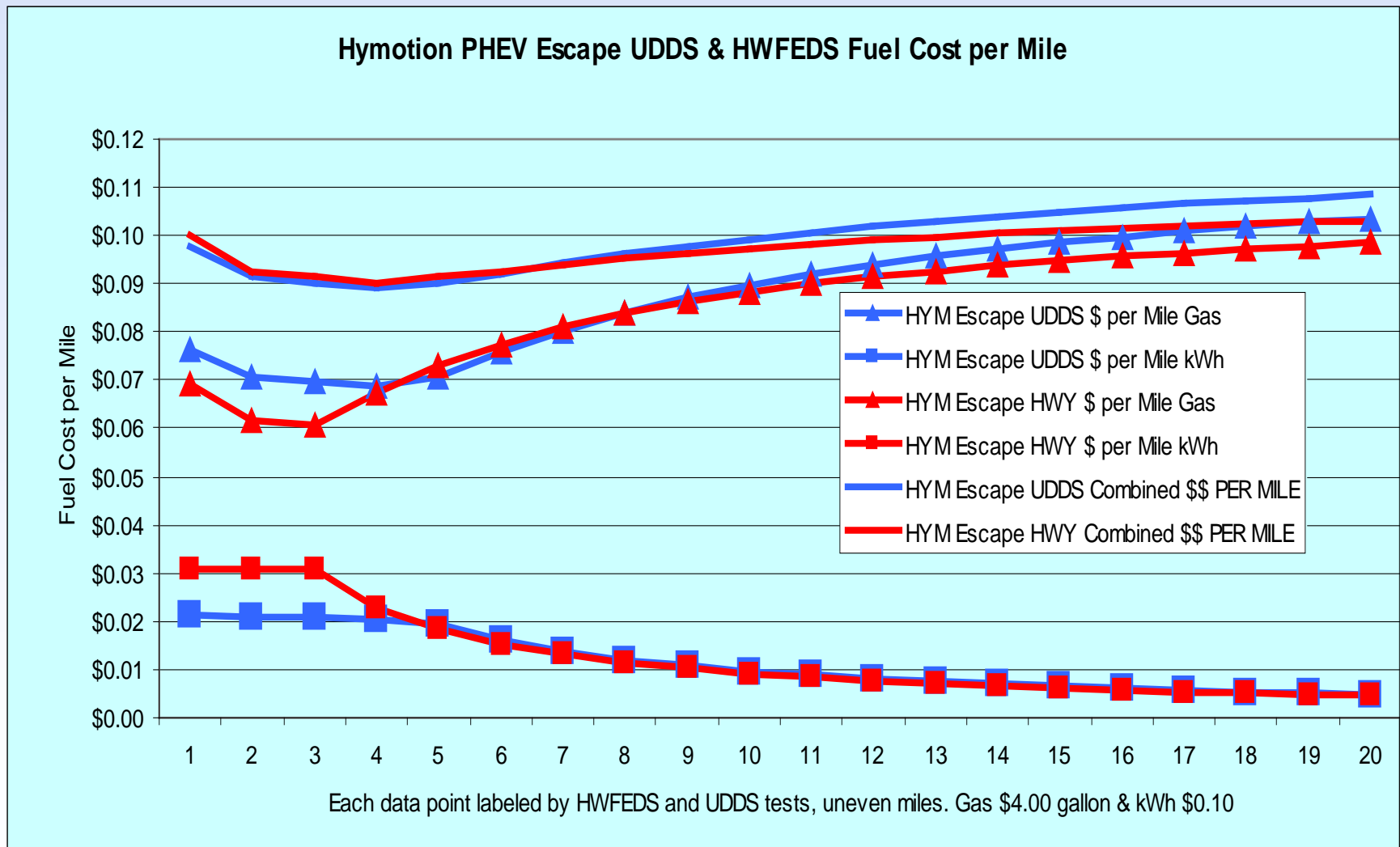
EnergyCS Prius – Fuel Costs



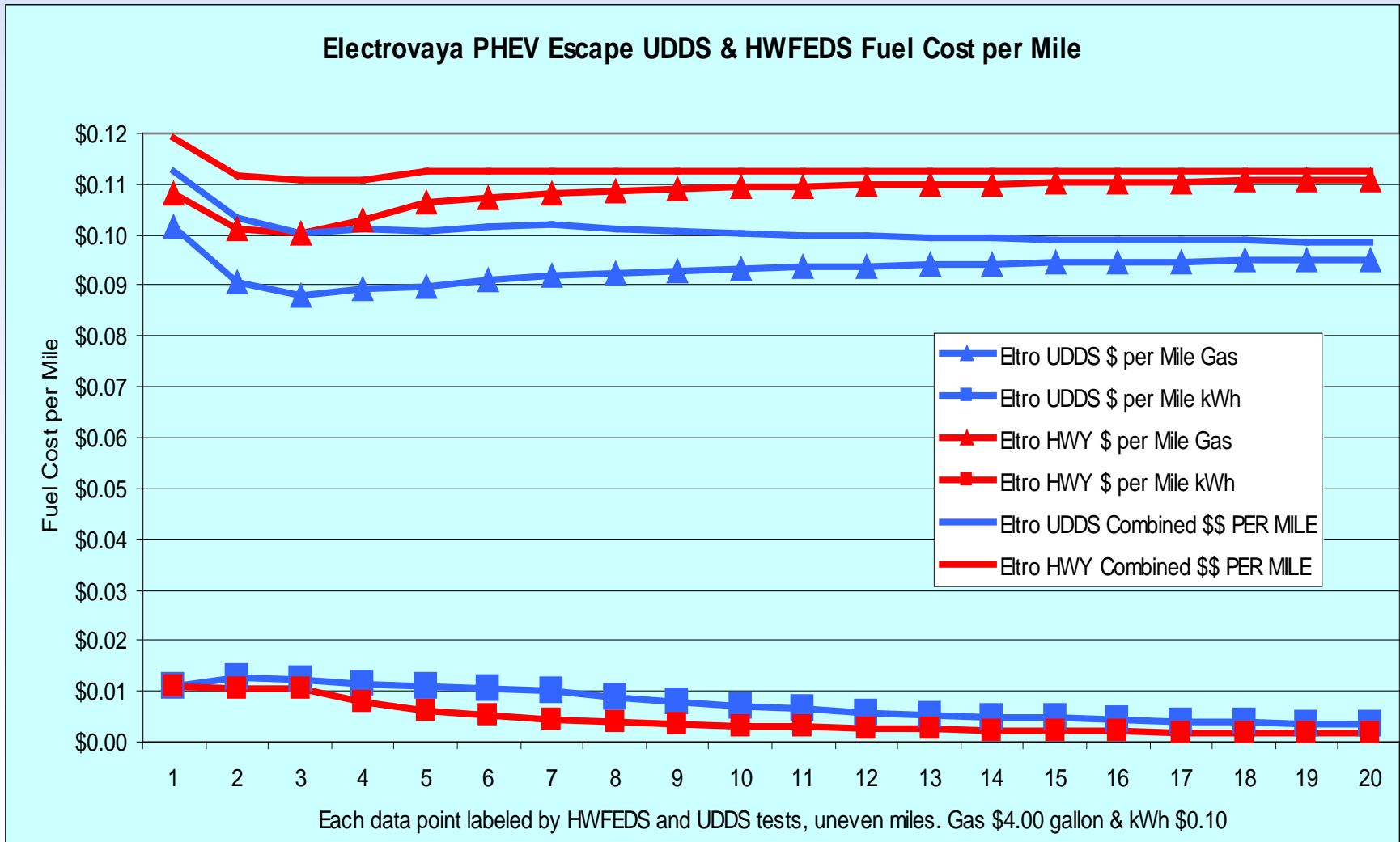
Hymotion Prius – Fuel Costs



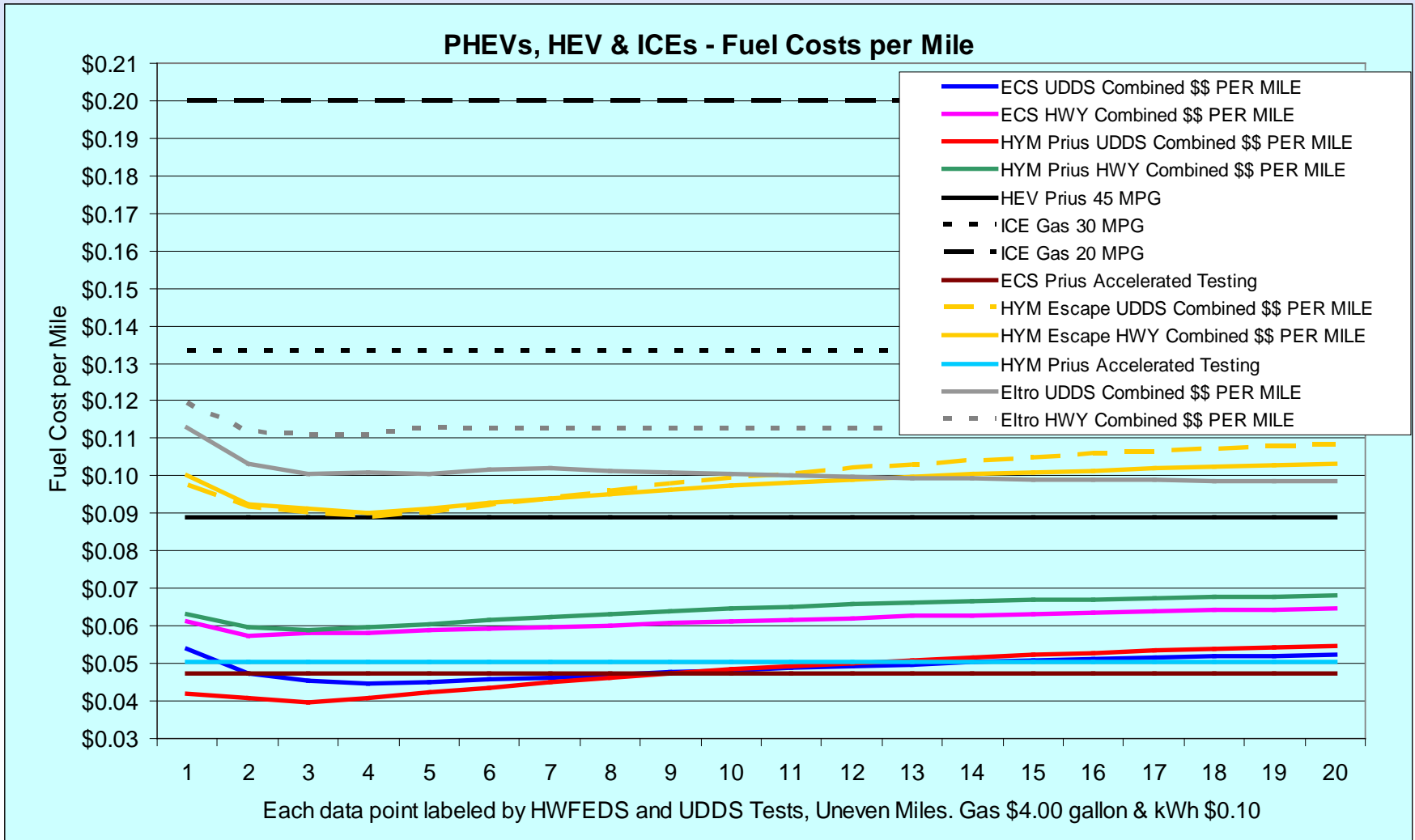
Hymotion Escape – Fuel Costs



Electrovaya Escape – Fuel Costs



PHEV Vs. HEV and ICE Fuel Costs per Mile



Onroad Demonstration Partners and Fleet Data Collection Activities



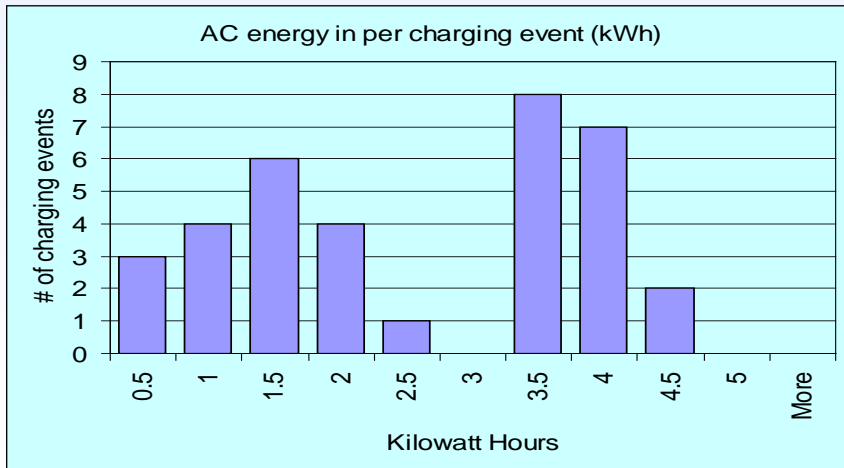
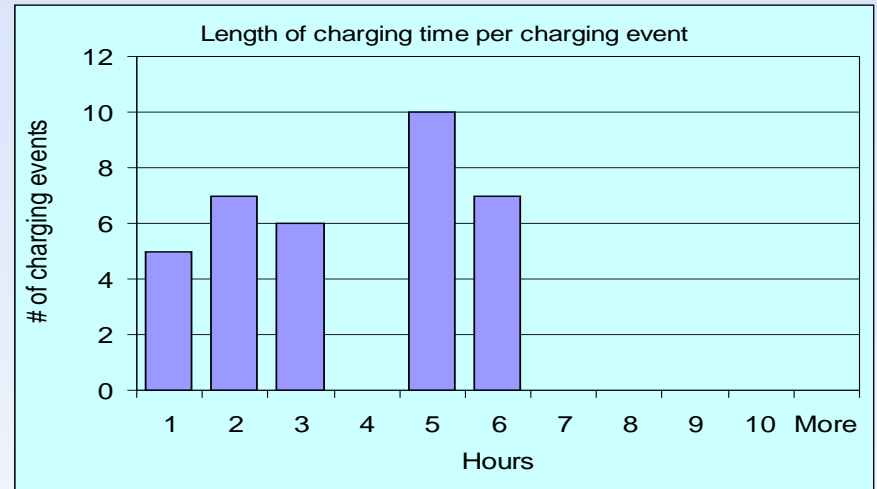
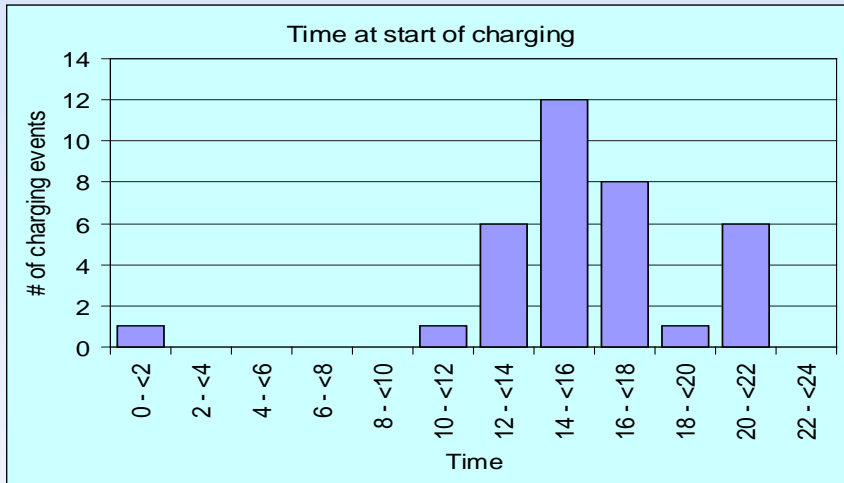
Hymotion Joint Data Collection

- 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



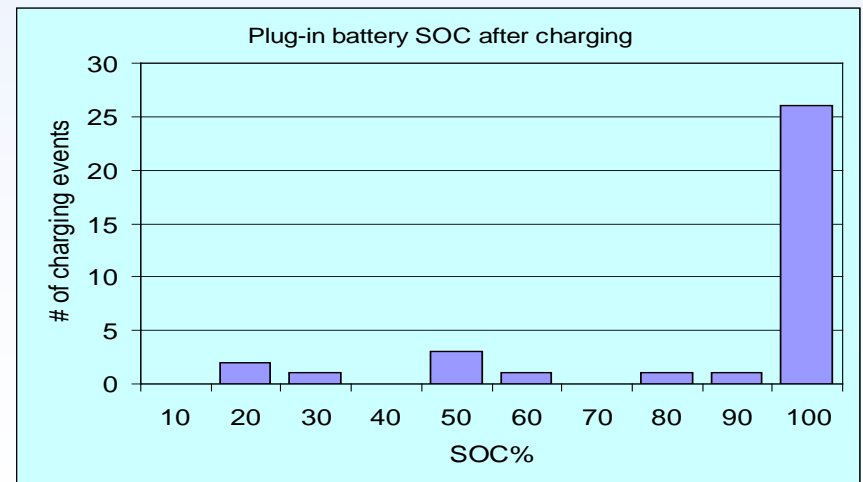
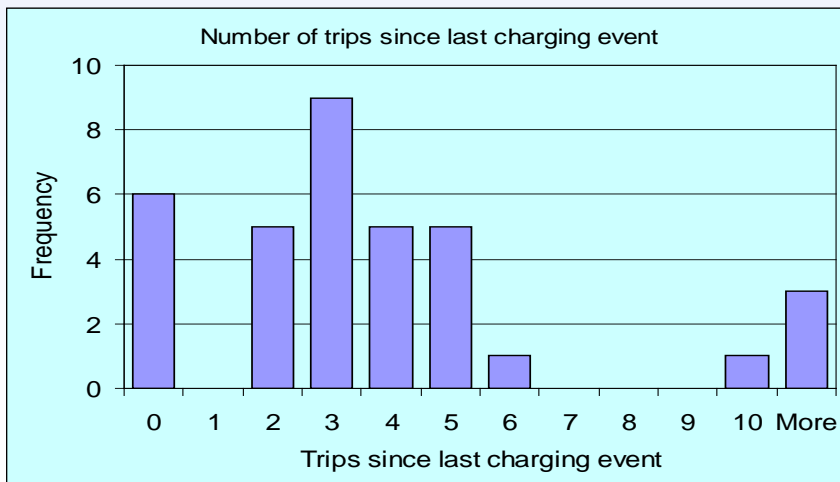
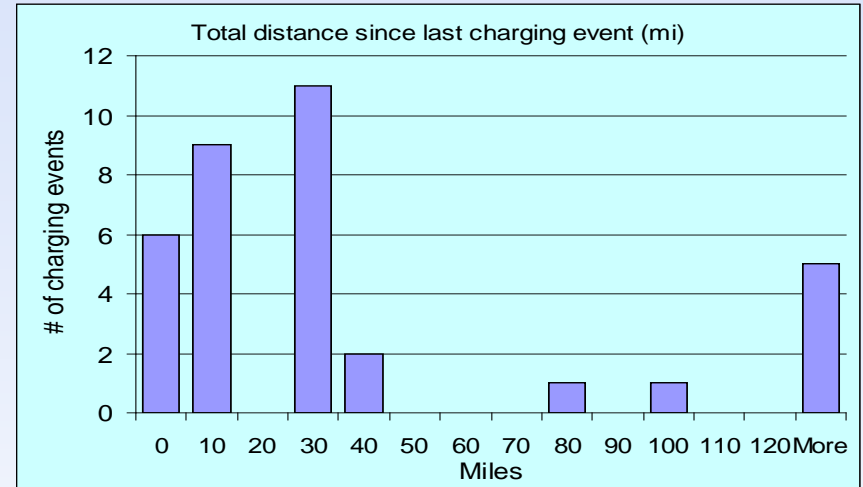
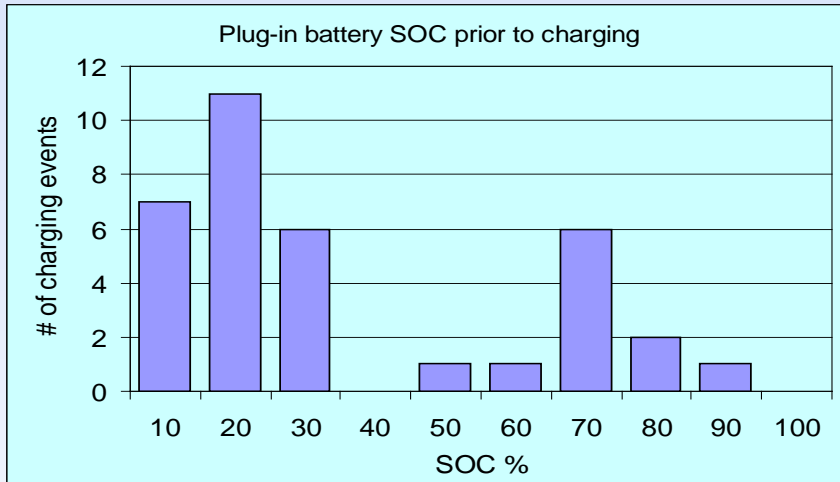
Single Hymotion Prius Charging Profiles

- 3 months, 2212 miles, 35 charges



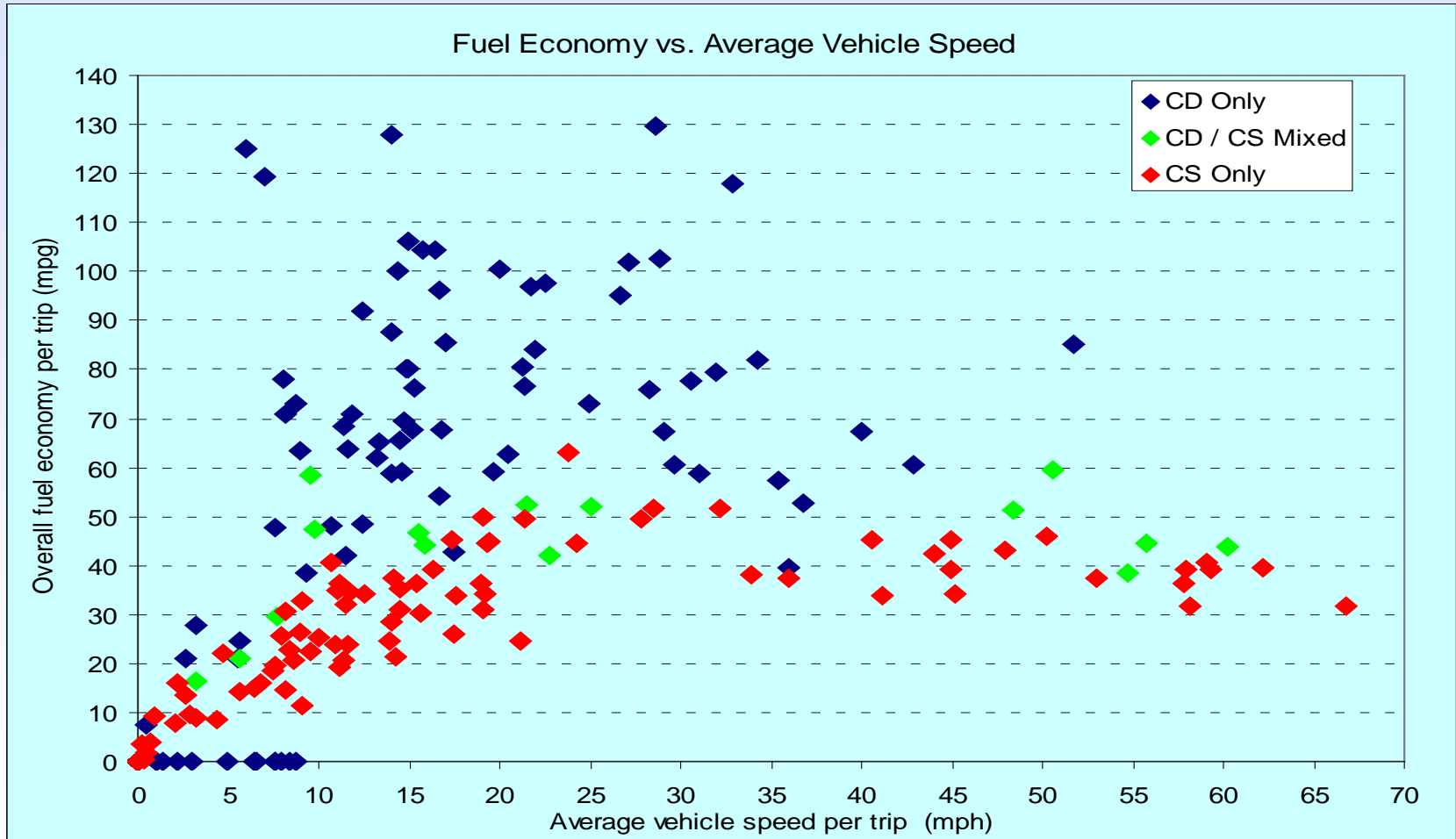
Single Hymotion Prius Charging Profiles

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Single Hymotion Prius MPG Vs. Speed

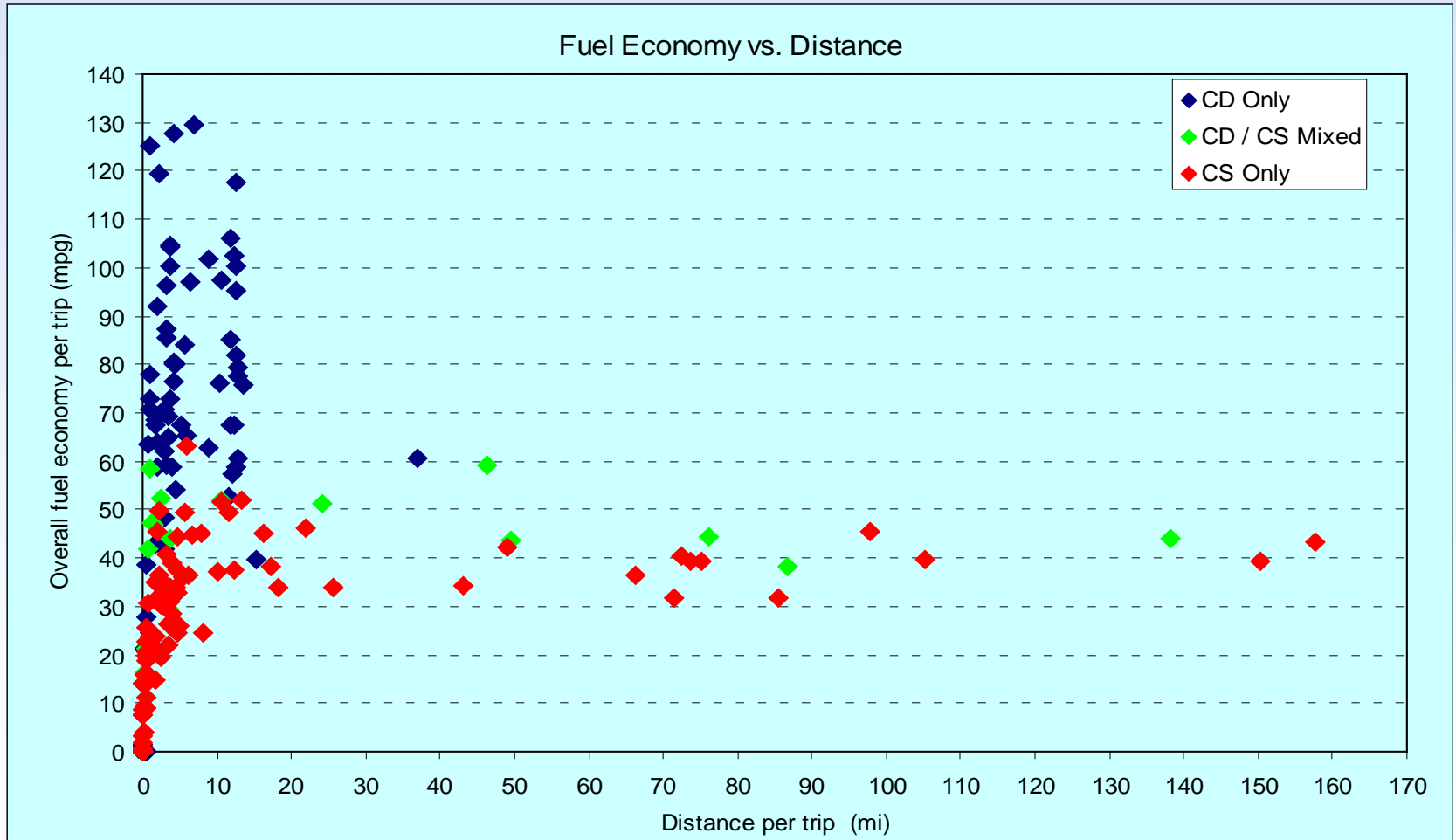
- 3 months, 2212 miles



CD – charge depleting, S - sustaining

Single Hymotion Prius MPG Vs. Distance

- 3 months, 2212 miles



CD – charge depleting, S - sustaining

26 Hymotion Prius - January thru May 2008

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

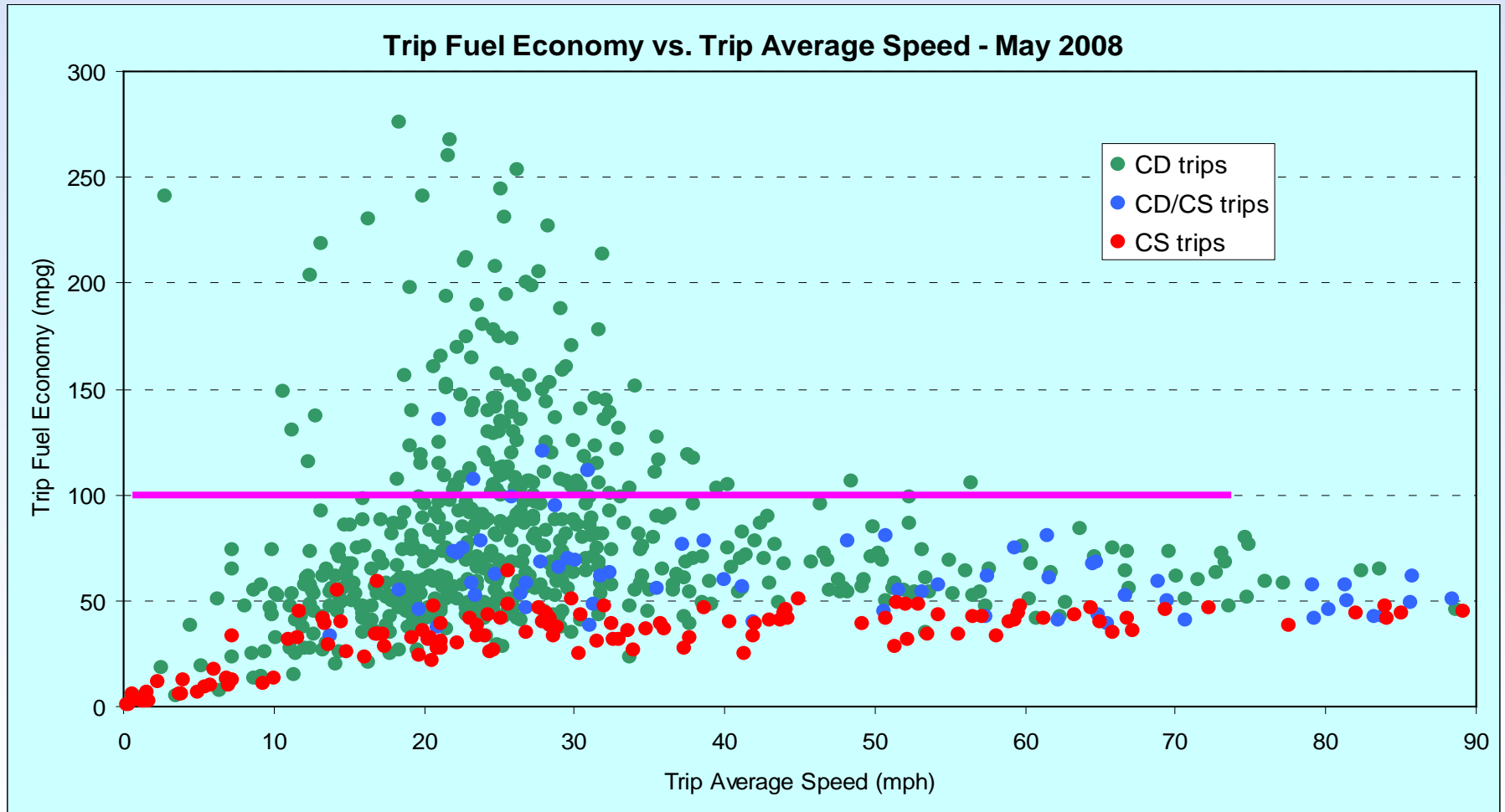


13 Hymotion Prius in May 2008 - MPG

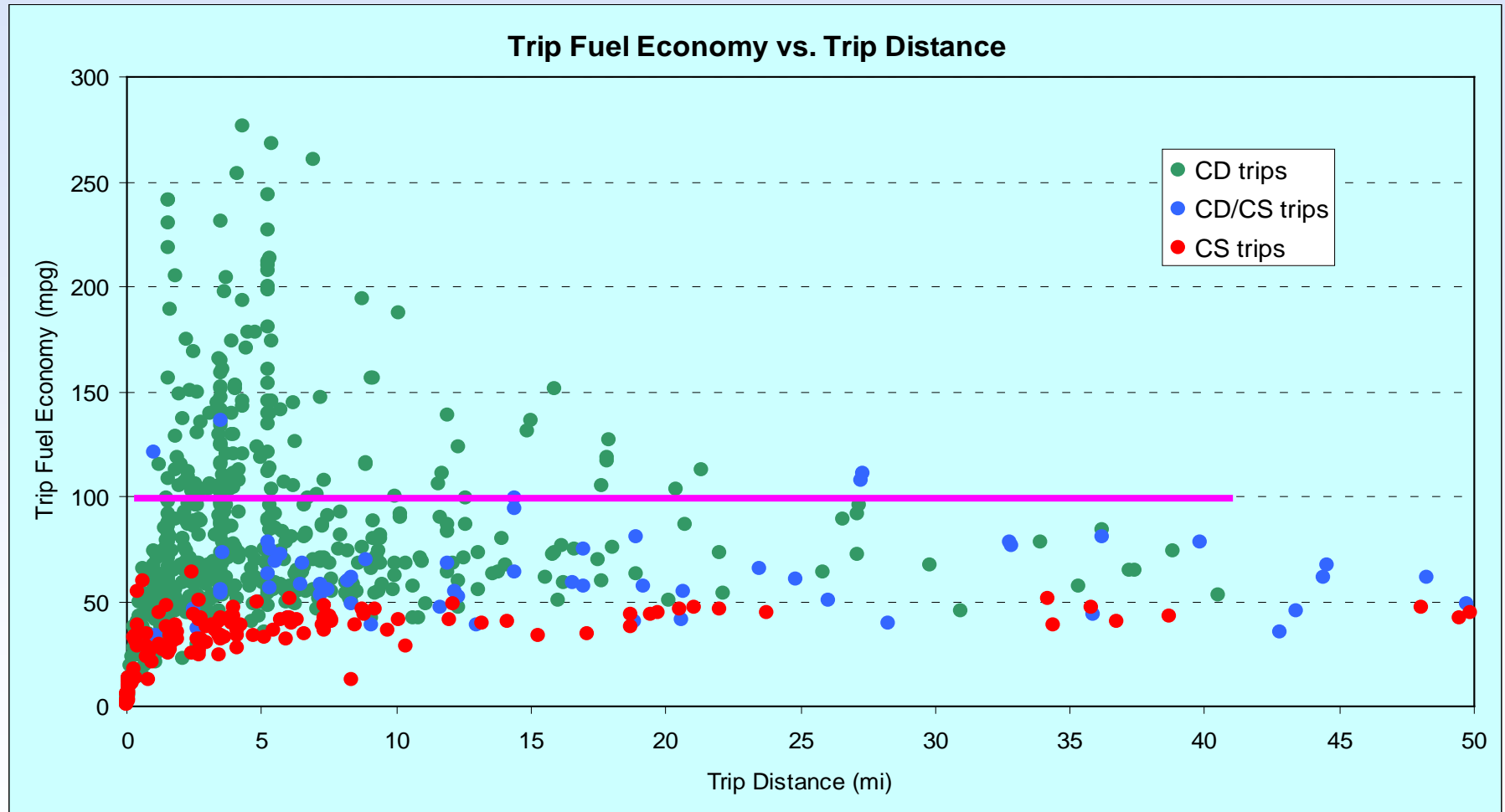
- Below averages do NOT tell the whole PHEV energy use potential – see next 3 slides

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	

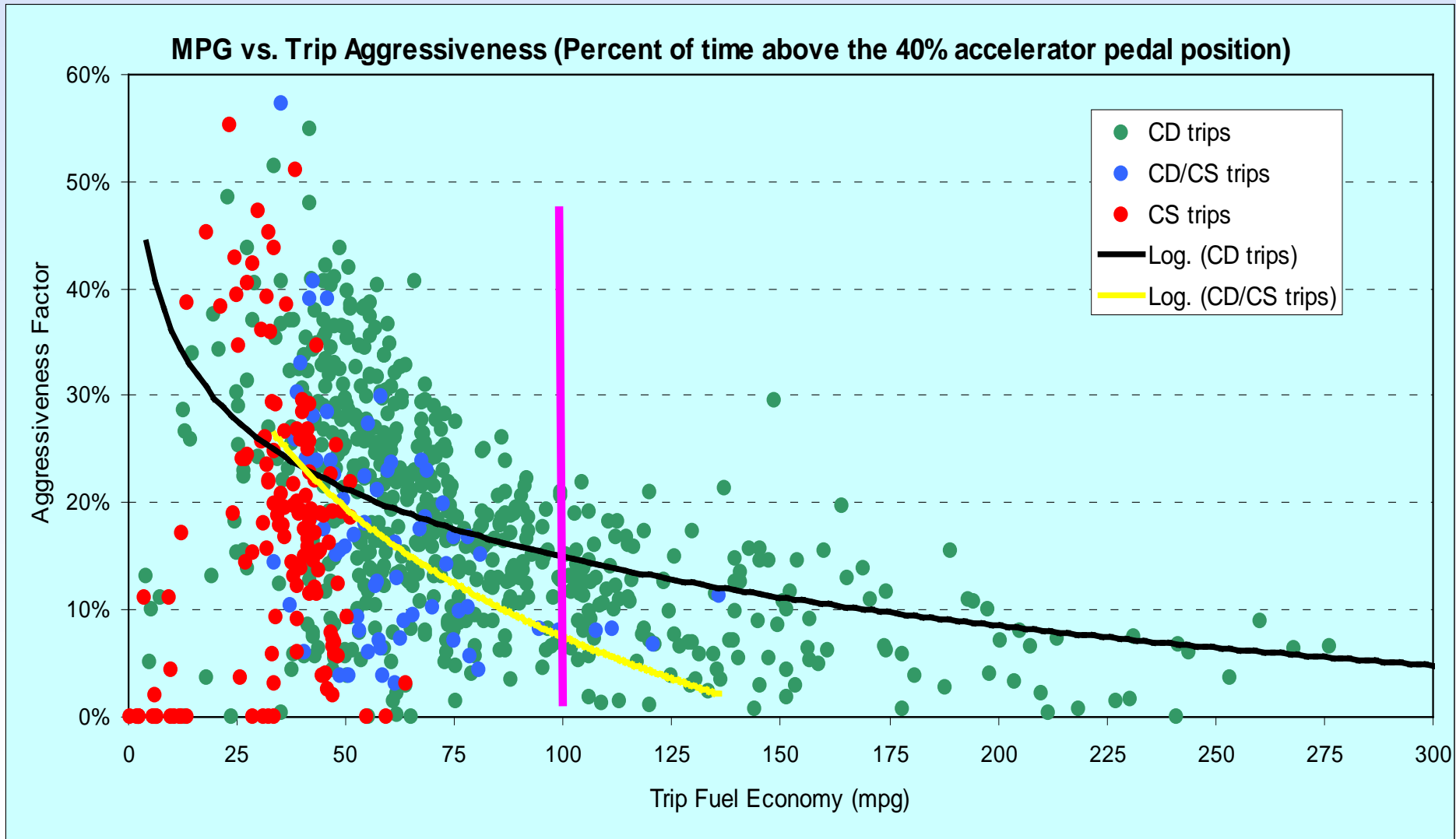
13 Hymotion Prius MPG Vs. Speed



13 Hymotion Prius MPG Vs. Distance



13 Hymotion Prius and Aggressive Driving



NYSERDA Testing Partnership

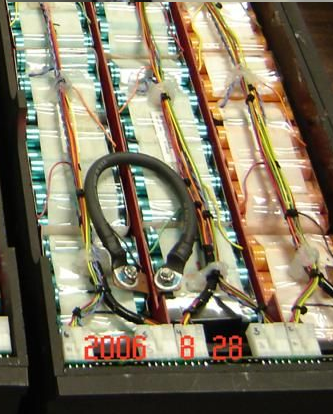
- AVTA is testing New York State Energy Research and Development Agency's PHEV conversions, stated 2007
- Fleet testing of ~20 PHEVs later CY08

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



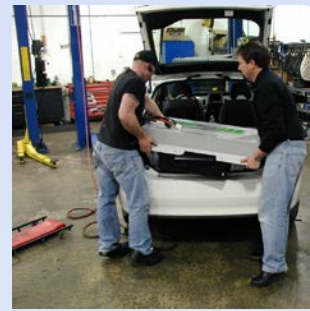
EnergyCS Prius Joint Data Collection

- Provided AVTA onboard data for 11 vehicles operating in fleets in Canada, Arizona, Georgia and California
- Going forward, EnergyCS is using lithium batteries from various manufacturers
- ~ 30 vehicles deployed (~15 North America and ~15 Europe)



Fleet Demonstration Partners

- **Seattle-area, using 13 Hymotion Prius with:**
 - City of Seattle (4)
 - King County (4)
 - Port of Seattle (2)
 - Puget Sound Clean Air Agency (3)
 - Started 4/2008, 1 converted to date, more 8/2008
- **Tacoma Power**
 - 2 current Green Car Company lead acid Prius – potential battery problems
 - 2 Hymotion Prius adding 11/2008
- **These and all future demonstration PHEVs are using V2Green onboard data loggers with cellular data transfer and GPS**



Fleet Demonstration Partners – cont'd

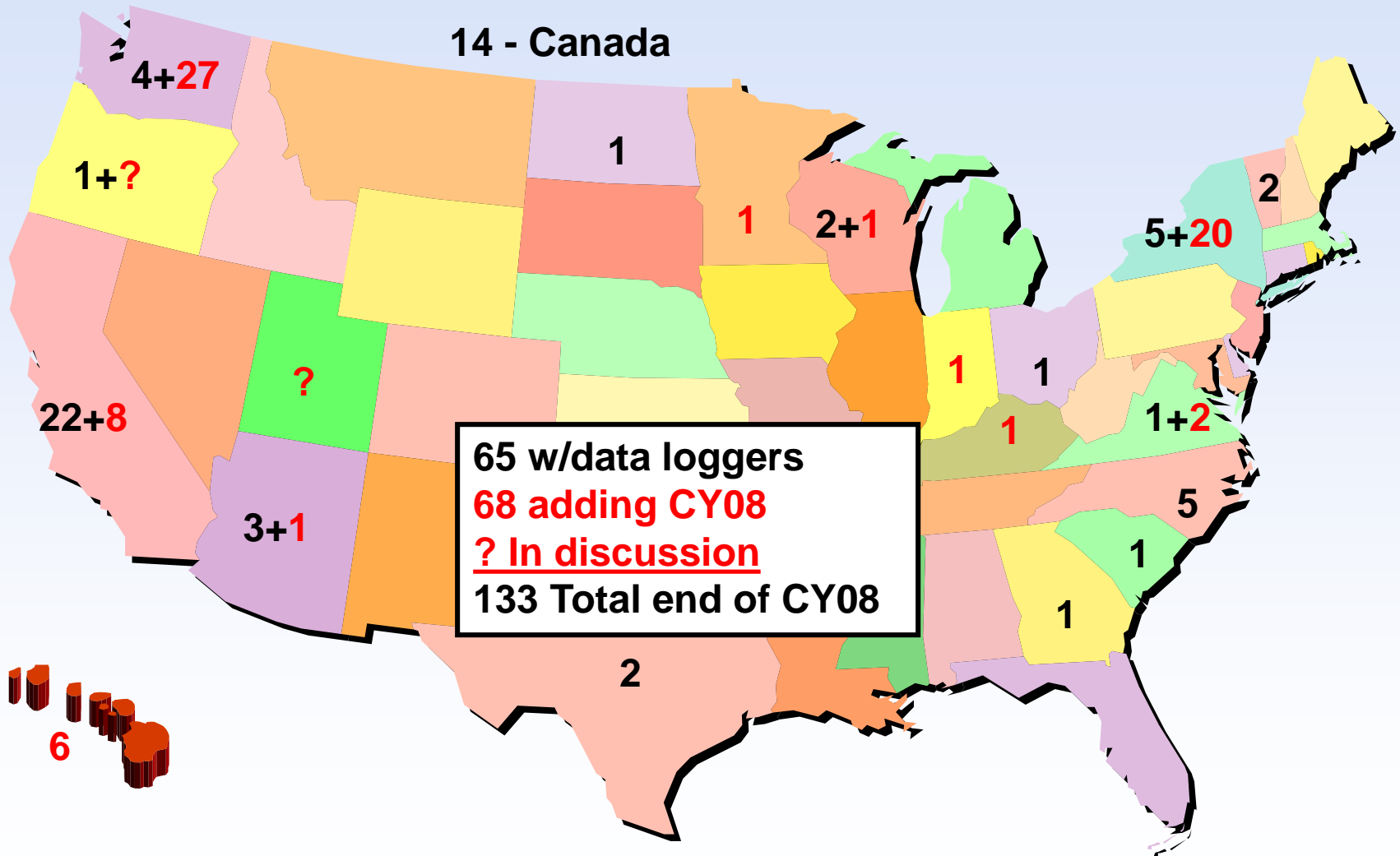
- **Washington State-wide, Port of Chelan leading, with 14 Hymotion Prius with:**
 - **Benton County PUD, Chelan County Public Works, City of Wenatchee, Douglas County PUD, Energy Northwest, Green IT Alliance, McKinstry, Port of Chelan, University of Washington, Walla Walla Community College and Wenatchee Valley College**
 - **Started 4/2008, 1 converted to date, more 8/2008**
- **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**
 - **7 vehicles converted**

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



Charging Infrastructure

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



Other PHEV Testing

- **Ford E85 Escape PHEV demonstration, started 6/2008**
- **Hymotion Prius with A123Systems V2 battery – conduct vehicle/battery testing, summer 2008**
- **PHEV charging at commercial facility studies - collecting data on PHEVs and commercial facilities to document energy profiles of recharging PHEVs as portion of facility profiles. Started 5/2008**
- **Defining time-of-day demand charging demonstration and battery analysis impacts on 13 PHEVs in Seattle**



Other PHEV Testing – cont'd

- **Defining bidirectional vehicle-to-grid (V2G) charging study with electric utilities participating**
 - **6 kW and 20 kW levels, using two lithium battery PHEVs, cellular charging control, documenting infrastructure requirements and costs**
- **Daimler PHEV Sprinter – conduct vehicle/battery testing, start winter 2008/2009**
- **Conduct vehicle/battery testing on PHEVs when received via DOE's original equipment manufacturer's PHEV solicitation**
- **Consider other PHEV conversions for vehicle/battery testing**

PHEV Market Status - Converters

- **Hymotion: About 85 Prius (\$9995) and 5 Escapes**
 - Prius only battery production ramp-up now, replacing all 67 Version 1 batteries. Recall Escapes
 - Prius crash-tested and obtaining CARB certification
 - Conversions and warranty work in Boston, Los Angeles, Minneapolis, San Francisco, and Seattle
- **Hybrids Plus: 26 Prius and Escapes, (\$21,600 to \$36,150). Some operational issues**
- **EnergyCS: ~30 Prius (~\$40,000). Some operational issues, only doing custom conversions in future**
- **Cal Cars: 8 Pius, believed to be all lead acid**
- **Green Car Company: 3(?) lead acid conversions (\$12,000). Some operational issues. May do Hymotion conversions**
- **Electrovaya: 2 Escapes. Some operational issues**
- **Various single conversion “companies”**

PHEV Market Status - OEMs

- **Daimler Benz – 6 Sprinters late 2008, 1 to AVTA**
- **Ford: 20 Escapes in 2008/2009. 1 at AVTA for 6 months**
- **General Motors: Volt late 2010. Maybe Vue earlier**
- **Renault Kangoo: ~1,200 NiCad range-extenders in Europe (was 1 in U.S.), but shipped AVTA's to Brussels for repair and sale**
- **Toyota: 20 Prius NiMH PHEVs in U.S., France and Japan, gaining operational knowledge. Maybe available in 2009**
- **Volvo and other OEMs have made various announcements**
- **DOE PHEV solicitation: Ford, GE/Chrysler and GM. AVTA to test products**
- **Note that OEM and converter statuses not necessarily “official” versions**

Acknowledgement

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Additional Information

<http://avt.inl.gov>

or

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

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