

Advancing Transportation Through Vehicle Electrification - PHEV



Abdullah A. Bazzi
Chrysler Group, LLC
June 9, 2010

Project ID # ARRAVT067

This presentation does not contain any proprietary, confidential, or otherwise restricted information

Timeline

- Project Start: September, 2009
- Project Complete: August, 2013
- 15% Complete

Budget

- Total Project Funding
 - DOE: \$48,000,000
 - Chrysler \$49,408,996
- Funding received FY09: \$0
- Funding for FY10: \$3.3M

Barriers

- Battery performance across extreme ambient conditions
- Thermal management integration
- Charger technology
- Understanding customer usage of the PHEV technology

Development Partners & Key Suppliers

- Behr America • Electrovaya • Hitachi • Delphi • Eetrex • Continental • CASCO Products • EPRI • Austin Energy • ERCOT • Michigan State University • University of Michigan • Sacramento Municipal Utility District (SMUD) • NextEnergy • UC Davis

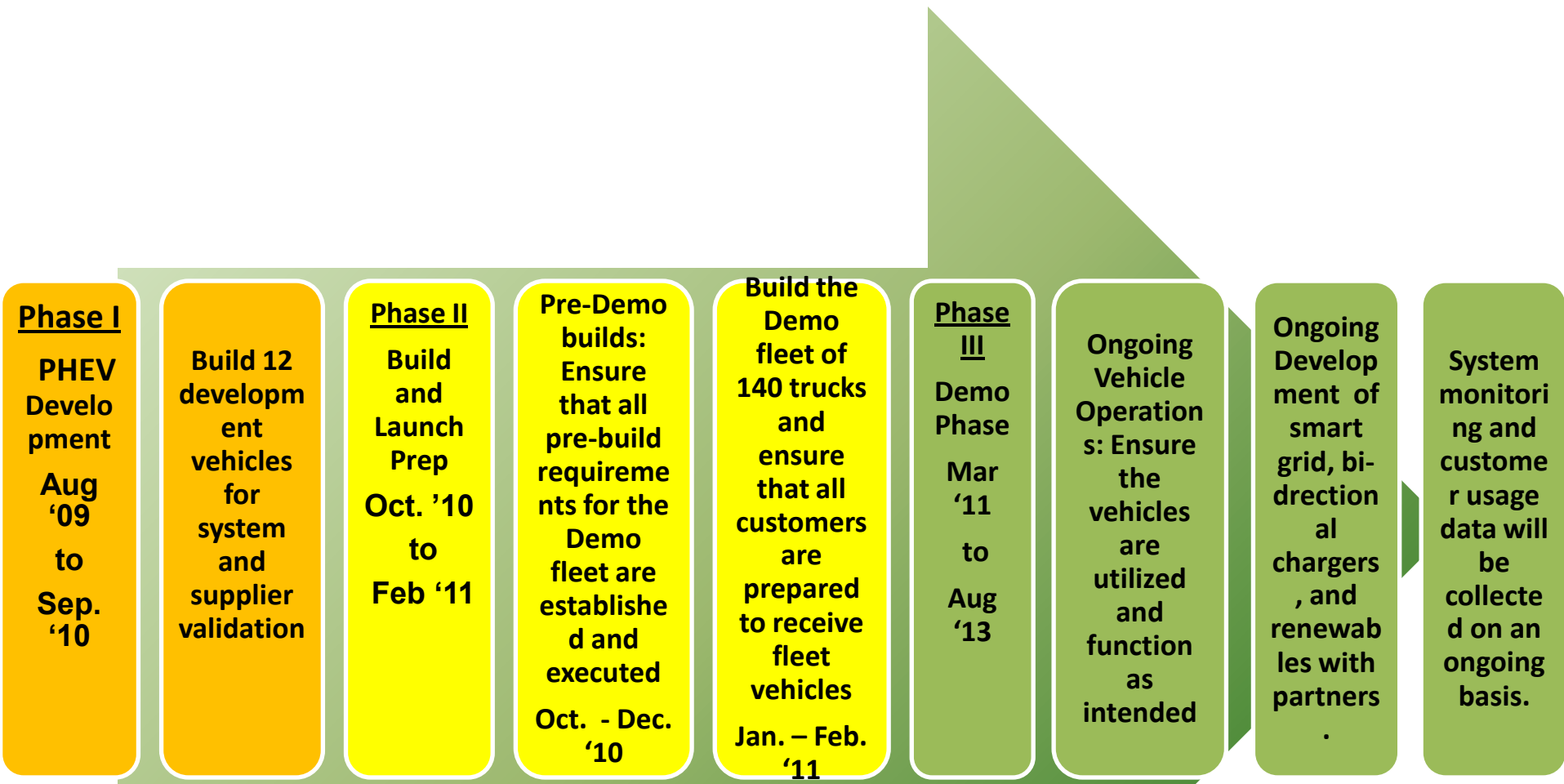
Demonstration Partners

- Sacramento Municipal Utility District (SMUD) • State of Colorado, DOT • State of North Dakota • New York State Energy Research and Development Authority (NYSERDA) • Commonwealth of Massachusetts • Austin Energy • State of Michigan • City of Kansas City, Missouri • Clark Co., NV • City of Yuma, AZ • Hawaii State Energy Office (in cooperation with US Military) • City and County of San Francisco

- Demonstrate 140 pickup trucks in diverse geographies and climates, spanning from North Dakota to Arizona & Hawaii to Massachusetts, and across a range of drive cycles and consumer usage patterns applicable to the entire NAFTA region
- Verify plug-in charging mode performance based on charger and battery model
- Verify AC power generation mode
- Prove product viability in “real-world” conditions
- Develop bi-directional (communication and power) charger interface
- Quantify the benefits to customers and to the nation

Phase I: PHEV Development – 2009/10

- Supplier selection and component sourcing
- Perform Vehicle packaging
- Procure Instrumentation equipment
- Conduct design and performance standardization
- Simulate key systems prior to vehicle builds
- Order carrier vehicles for Ram Truck as well as HV Battery Packs, Chargers and Power Panels for Bench Testing
- Procure all components required for the 12 Development vehicles and build 12 trucks
- Finalize part and tooling costs and lead times for all components
- Kick off tool orders for components and builds
- Determine the material required date (MRD) for the parts

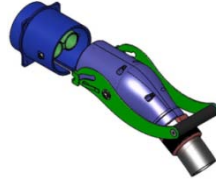


Technical Approach

120V / 240V AC
Power Panel



Charge Port

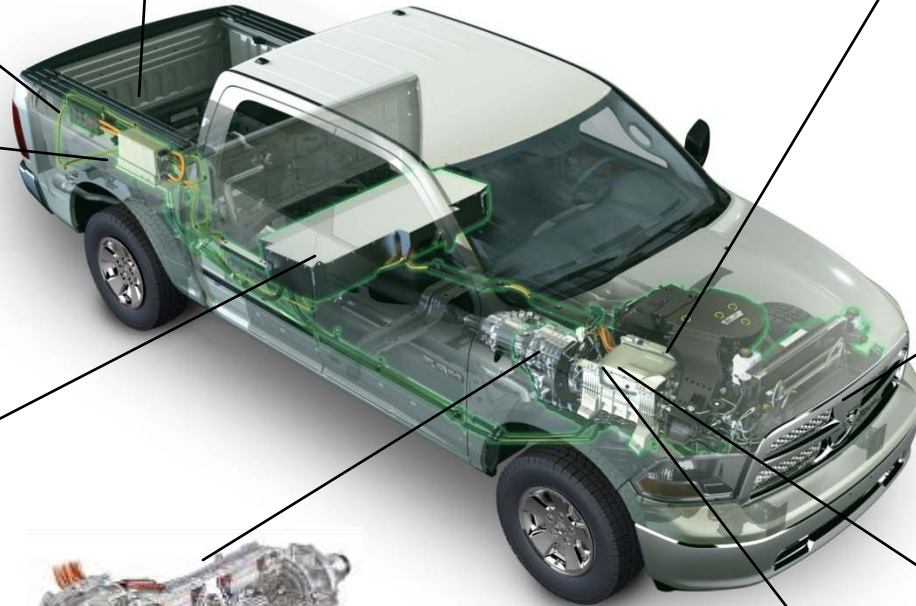


Controls

- E-Motor
- Battery
- Hybrid Vehicle
- Transmission



Charger

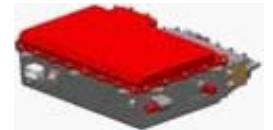


Thermal Systems



HV Battery
Li-Ion

Power
Electronics



Inverter



2-Mode Hybrid
Transmission



Electric Motors

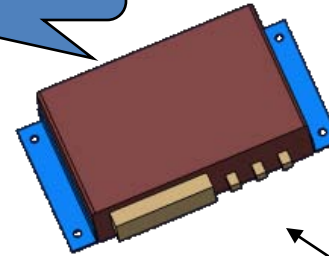


DC/DC

Data Recording Process:



Data Recording Module (DRM)
residing on the vehicle



DRM compresses the data captured from the vehicle. Monitors all CAN buses, has diagnostic capabilities as well as CAN Calibration Protocol (CCP) functionality



DRM will upload the recorded files wirelessly (cell phone or wi-fi) to a server



A secure server stores collected data

Website customer charge input and adjustment. Utility Cost Rate Schedule displayed for optimum charge



Website management to view status of a specific vehicle as well as transmitted data sets to Chrysler and DoE

RAM CREW 1500



- The only plug-in hybrid truck available in the marketplace
- Does not compromise any of the standard pickup volume or utility
- Maintains trailer tow and gradeability advantage of standard truck
- Only full size truck with Advanced Technology Partial Zero Emissions



- Features the unique utility and functionality of on-board AC power
- Is a low cost alternative to aftermarket commercial grade diesel generators
- Eliminates the need for a separate generator fuel supply

Hybrid Drive System

Technology

- Next Generation Lithium Ion Battery

Charge Times

- 2- 4hrs at 220V
- 6 -8 hrs at 110V
- Full Hybrid system function w/o Plug-in

Fuel Economy (City)

- Charge Depleting 32MPG

Electric Drive Range (City)

- 20 miles equivalent

Range

- 655 miles

Transmission

- Advanced Technology Plug-in Hybrid

Brakes

- Regenerative Brake System

Auxiliary Power

- 4.8kW Continuous Through:

Power Panel

- Pickup Bed
- 2 – 120V, 20A duplex
- 1 – 240V, 20A plug

Cabin Receptacle

- Center Console
- 1 – 120v, 20A plug

Power On-The-Fly

- 120V / 240V, 60Hz AC

Silent Mode

- 120V / 240V, 60Hz AC

Exterior Dimensions

Vehicle Length

- 227.5"

Overall Height

- 74.8"

Body Width

- 79.4"

Ground Clearance

- 7.7" @ Curb Weight

Approach / Departure

- 19.2° / 21.9°

Breakover

- 15.2°

Track

- 68.1" Front
- 67.5" Rear

Turning Diameter

- 45.3' Curb to Curb

Wheelbase

- 140"

Powertrain

Engine Size / Type

- 5.7L Hemi V8

Maximum Power

- 399 Horsepower

Maximum Torque

- 390 ft-lb @ 4300 rpm

Transfer Case

- 4x4

Axles

- 3.27 Axle Ratio
- 9.25 Light Duty Rear Axle
- Automatic Front Axle Disconnect (enhances fuel economy)

Capacities / Weights

Curb

- 5,900 lbs

Fuel Tank Capacity

- 26 gallons

GCWR

- 12,100 lbs

GVWR

- 7,200 lbs

Payload

- 1,300 lbs

Towing Capacity

- 6,000 lbs

Cargo Box

- 5'7" with two-tier loading

Wheels / Tires

Wheels

- 17" x 7.0" Aluminum Wheels (Steel Spare)

Tires

- P265/70R17 BSW All Season Tires
- Full Size Spare Tire

Interior Dimensions

Passenger Volume

- 120.9 Cubic Feet

Seating Capacity

- 6 Passenger 3F/3R

Safety

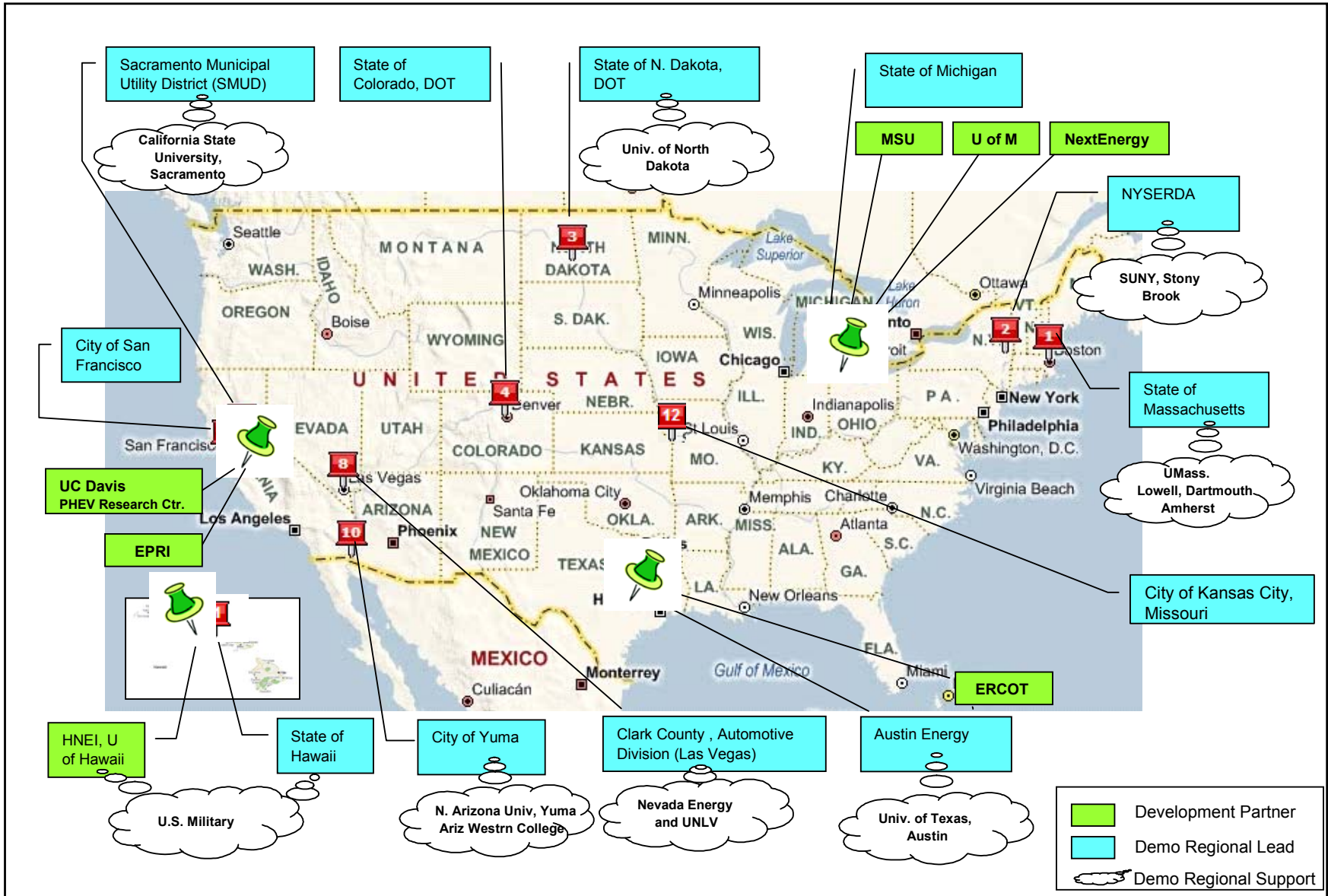
Electronic Stability Program

- Traction Control
- ABS
- Brake Assist
- Electronic Roll Mitigation
- Hill Start Assisted
- Trailer Sway Control

Air Bags

- Advanced Multistage Front
- Supplemental Side Curtain
- Supplemental Front and Rear Curtain

Partner and Vehicle Allocation



PHEV Grant External Stake Holders



Partner and Vehicle Allocation



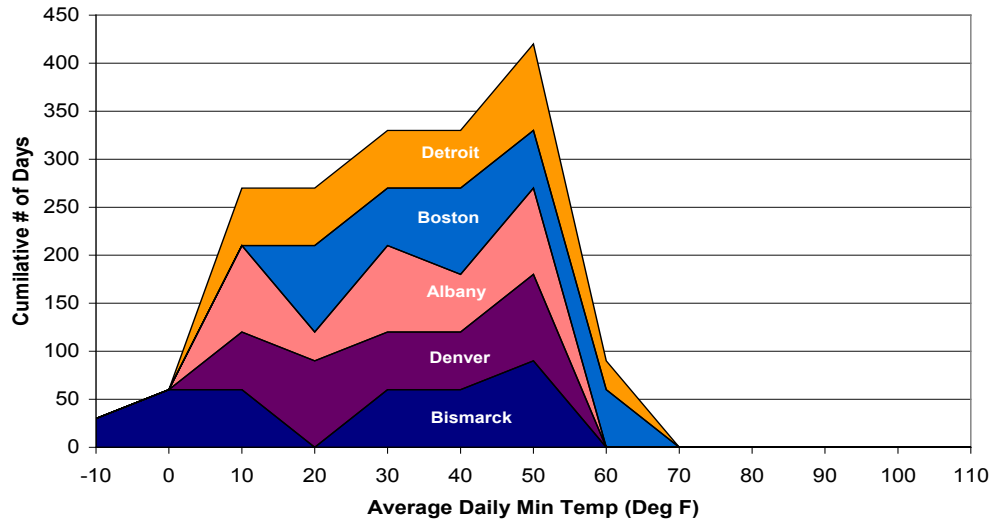
Partner	Central Location	Demonstration Fleet Quantity
Austin Energy - ERCOT - UT Austin	Austin, TX	14
NYSERDA - SUNY, Stony Brook	Albany, NY	14
Clark Co. Automotive Division - Nevada Energy - UNLV	Las Vegas, NV	10
State of Colorado	Denver, CO	14
City of Yuma, Arizona - Univ. of Arizona, Yuma	Yuma, AZ	10
SMUD (Sacramento Municipal Utility District) - Cal State U, Sacramento	Sacramento, CA	14
Commonwealth of Massachusetts - U of Mass, Amherst	Boston, MA	14
State of North Dakota DOT - U of North Dakota	Bismarck, ND	14
State of Michigan	Lansing, MI	4
City of San Francisco - UC Davis	San Francisco, CA	14
State of Hawaii - U.S. Army - HNEI, UofHawaii Manoa	Honolulu, HI	14
Next Energy	Detroit, Mi	1 Development Vehicle
City of Kansas City, Mo	Kansas City, MO	4
	GRNAD TOTAL	140

Partner and Vehicle Allocation



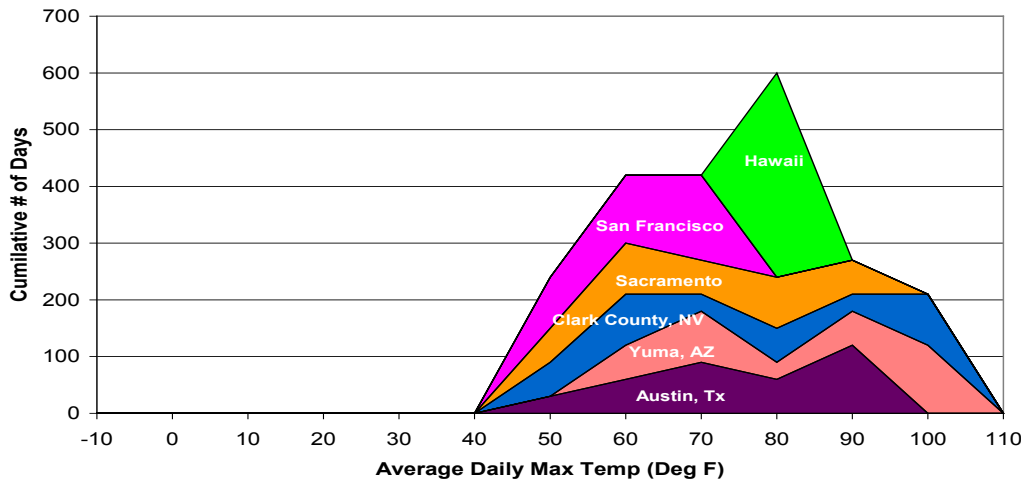
The cumulative mileage for the entire 140 Vehicle fleet is estimated to be 6,525,000 miles.

Annual Ambient Cold Temperature Profiles



Shows the cumulative number of days the demonstration vehicles will be deployed in **Colder** ambient temperature per year. The total estimated mileage accumulation for the cold temperature zone over three years of the demonstration program will be at least 2,925,000 miles. Of the total cold zone miles, approximately 1,023,750 miles will be driven in sub freezing (less than 32 deg F) temperatures.

Annual Ambient Hot Temperature Profiles



Shows the cumulative number of days the demonstration vehicles will be deployed in **Hot** ambient temperatures per year. The total estimated the mileage accumulation for the hot temperature zone over three years of the demonstration program will be at least 3,600,000 miles. Of the total hot zone miles, approximately 800,000 miles will be driven in greater than 90 deg F.

- Program Kick-Off
- Packaged and Designed PHEV Components
- Virtual modeling and simulation of PHEV technology
- Bench Testing of new PHEV components, software and calibrations
- Updated current HEV vehicle with PHEV Technology
 - i. Updated to latest Li-Ion Battery
 - ii. Updated controls for battery thermal module
 - iii. Updated controls and calibration for PHEV
 - iv. Updated thermal system for PHEV
 - v. Instrumented vehicle for PHEV testing & validation

Phase I: PHEV Development

- Complete Hot Weather Validation of vehicle software, calibration and component
- Complete vehicle durability and validation
- Calibration/Controls Development
- Charging system / basic grid interface
- HMI
 - i. Hybrid Human Machine Interface (HMI) Display
 - ii. Plug-In Charging HMI display
 - iii. Power Panel HMI Display
 - iv. Functional objective verification
- Fuel reduction
 - i. Emissions abatement
 - ii. Driveability
 - iii. Towing

Phase II: Build and Launch Prep

- Site preparation
- Customer/Dealer training
- Vehicle Prep and Delivery
- Build the 140 truck demonstration fleet

Phase III: PHEV Vehicle Demonstration

- Successful Kick-Off of DoE PHEV Project
- Management process established
- Virtual modeling and simulation of PHEV technology
- Designs and packaging completed for Development Vehicle Builds
- Built 12 PHEV Vehicles for vehicle validation and testing
- On track to meet program milestones and project deliverables