DAIMLERCHRYSLER

HYDROGEN TO THE HIGHWAYS

Controlled Hydrogen Fleet and Infrastructure Demonstration and Validation Project

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This presentation does not contain any proprietary or confidential information

Project ID #: TV8

Program Overview

US Dept. of Energy Fuel Cell Vehicle and Infrastructure Cooperative Program

Timeline

- Project Start Date: 01/07/04
- Project End Date: 09/30/09
- Percent Complete: 40%

Partners

- DCX
- MBUSA
- BP America
- DTE Energy
- NextEnergy

Budget

- $88.8M Total Project Funding
  - $44.4M Federal Share
  - $44.4M Industry Share
- $5.1M FY05 Funding
- $7.1M FY06 Funding

Barriers

A. Vehicles
B. Storage
C. Hydrogen Refueling Infrastructure
D. Maintenance and Training Facilities
E. Codes and Standard

Objectives

The main focus of the ongoing DOE Fleet Validation and Demonstration Project is to collect data and evaluate the technology status of

- Fuel cell powered vehicles (OEMs)
- Hydrogen infrastructure (energy companies and suppliers)

Performance Measure	Units	2009 Performance Target	2015 Performance Target
Fuel Cell Stack Durability	Hours	2000	5000
Range	Miles	250	300
Hydrogen Cost at station; On- or Off-site Production	$/GGE (Gasoline Gallon Equivalent)	$3.00	$2.00-$3.00

Approach

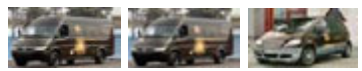
- Deploy 30 Gen I vehicles in three ecosystems to validate current status of
  - Durability of fuel cell stack and system
  - Range of operation with compressed H_2
  - Cost of H_2 from various production methods
  - Performance degradation over life via dynamometer and on-road testing
- Wirelessly and automatically collect data from each vehicle to file servers for customer friendly operation
- Provide hydrogen refueling requirements to fleet customers. Test emerging technology with potential to meet DOE hydrogen cost target while evaluating emerging and renewable technologies to produce hydrogen and testing co-generation technologies (hydrogen and electricity)
- Design and build a cost effective hydrogen safe maintenance facility utilizing Computational Fluid Dynamic Modeling
- Evaluate customer perception of fuel cell technology and F-Cell experiences with partner organizations in California and Michigan. Identify possible opportunities for improvement for the next generation of fuel cell vehicles
- Develop DOE Project Crisis Management Plan, Codes and Standards as well as education and outreach activities
- Provide data from Gen II vehicles under same operating conditions as Gen I vehicles to compare technology maturity over program duration

Accomplishments and Progress

DOE Fleet Customers

Government	Region	Number of Vehicles
Bay Area Air Quality Management District	Northern California	
California Air Resources Board	Northern California	
California Energy Commission	Northern California	
California Fuel Cell Partnership	Northern California	
Caltrans	Northern California	
City of Farmington Hills	Michigan	
Department of General Services	Northern California	
Sacramento Municipal Utility District	Northern California	
DaimlerChrysler	California	

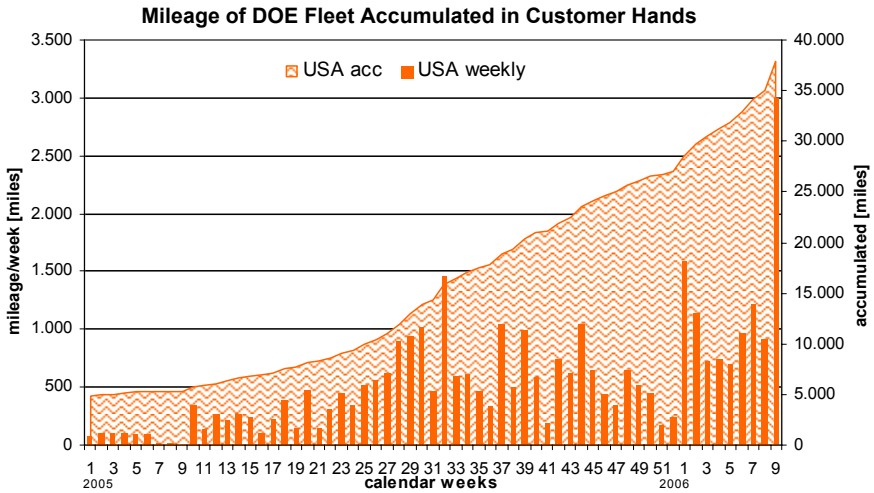
Non-Profit	Region	Number of Vehicles
SRI International	Northern California	
UC Berkeley	Northern California	
UC Los Angeles	Southern California	
Wayne State	Michigan	

For Profit	Region	Number of Vehicles
Inergy Automotive Systems	Michigan	
Los Angeles World Airport	Southern California	
Pacific Gas and Electric Company	Northern California	
Southern California Edison	Southern California	
UPS	Michigan & Southern California	

Accomplishments and Progress

Mileage of DOE Fleet Accumulated in Customer Hands

Over 35,000 miles driven on DOE fleet vehicles



Accomplishments and Progress
Service Facility

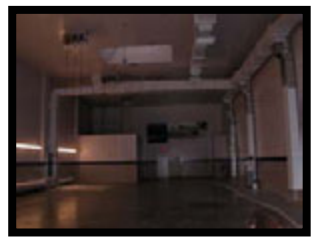
CaFCP West Sacramento

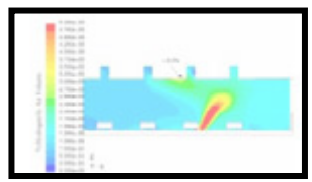
MBUSA Ann Arbor

MBUSA Long Beach

Long Beach Facility addition built specifically for H_2 vehicles:

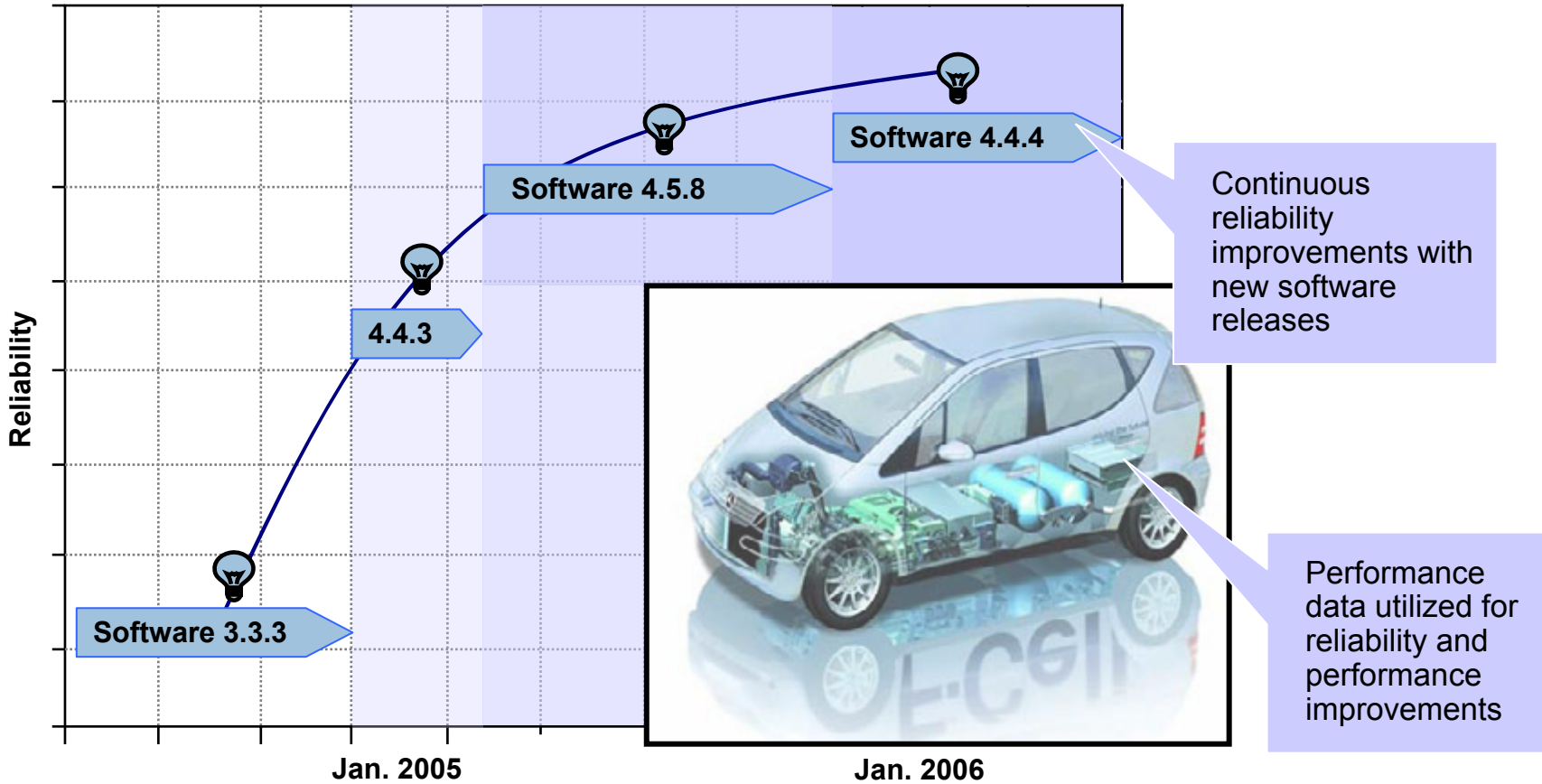
- Four vehicle bays for fuel cell vehicles
- Computational fluid dynamics (CFD) used to determine most probable behavior of potential H_2 leaking
- Ventilation/exhaust to maintain H_2 concentration at or below 1%
- Installation of 9 hydrogen detectors at optimal locations to automatically detect 1% H_2





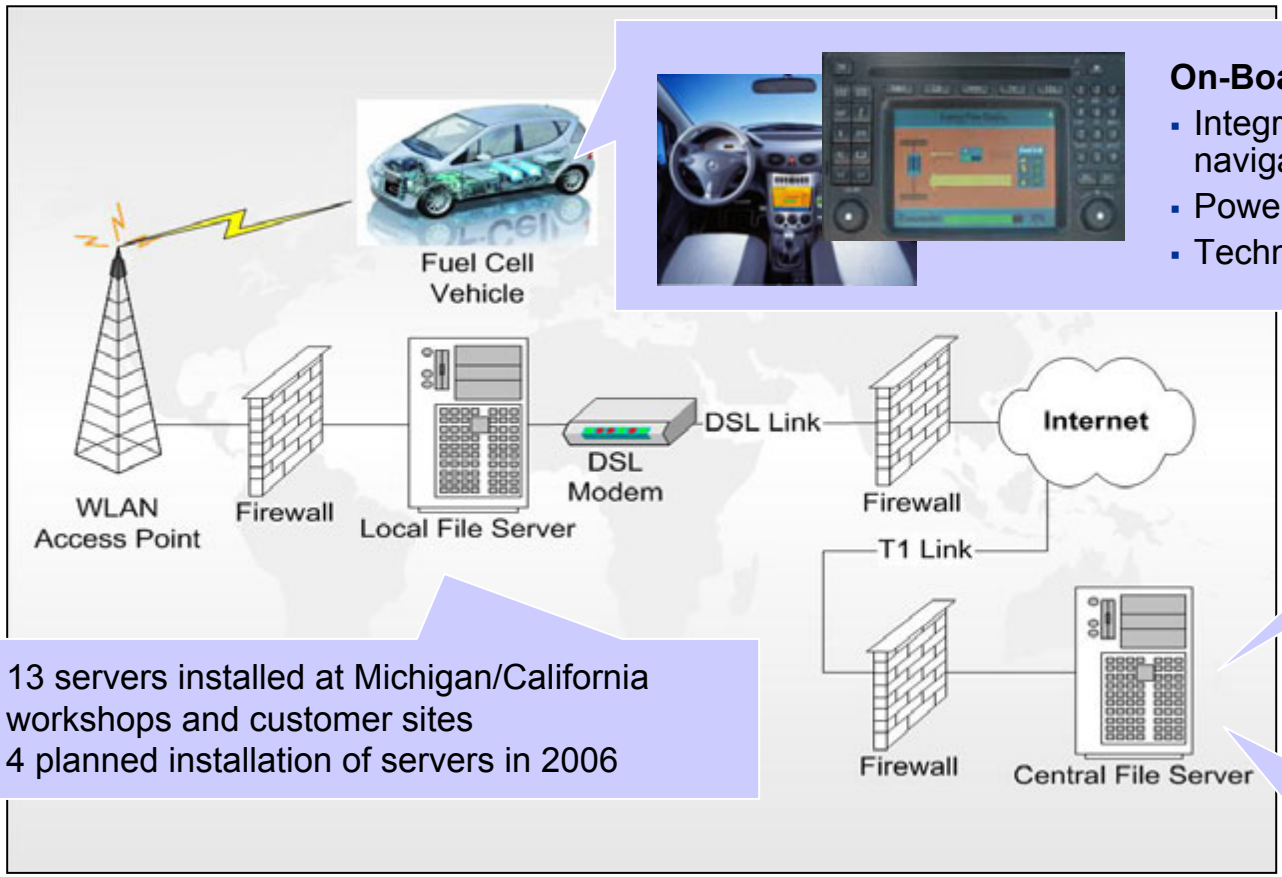
Accomplishments and Progress

Reliability Improvements – Gen I Vehicles



Accomplishments and Progress

FDA Software Installation and Data Collection



On-Board System:

- Integrated with existing navigation unit
- Powerflow display
- Technician displays

- 13 servers installed at Michigan/California workshops and customer sites
- 4 planned installation of servers in 2006

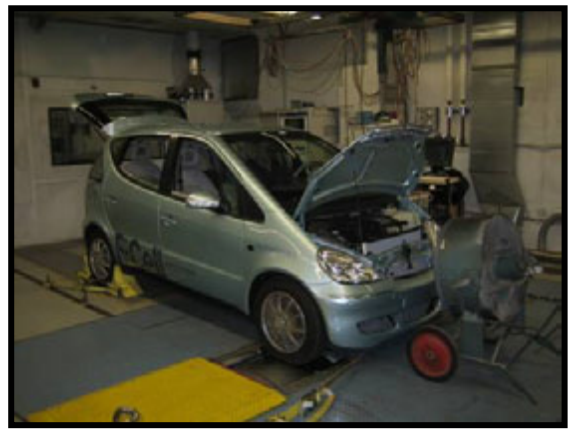
- Central File Server for internal analysis

- Monthly data transmission to NREL (submitted 14 CDs)

Constant discussion between DaimlerChrysler and NREL to improve data analysis

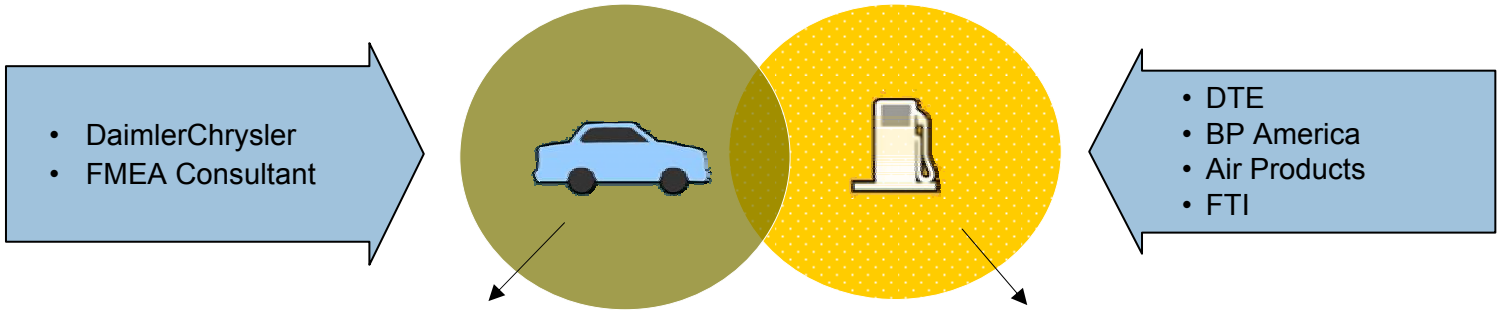
Accomplishments and Progress
Dynamometer Testing

- **Purpose**
  - Test vehicles under various load conditions to determine fuel economy, stack degradation and steady state system efficiency
- **Testing Schedule**
  - Conduct bi-annual dynamometer testing
  - Completed second round of test in 2Q2006
- **Initial Results and Accomplishments**
  - Test procedures agreed with NREL, DOE and DC
  - Reproducible data
  - Results showing expected values
  - Analysis of composite data to be presented by NREL



Accomplishments and Progress

Vehicle/ H_2 Station *Interface* Failure Mode and Effect Analysis (FMEA)



- Safety: Temperature, Pressure, Grounding, Fuel Quality, Flow Rate
- Affects Stack Performance
- Vehicle fuel system Integrity
- Common Interface: **Receptacle**
- **FMEA**

Risk Management

- Various production strategies
- Various H_2 feed stocks
- Various dispenser strategies
- Common Interface: **Nozzle**
- **HAZID**

Key findings and Lessons Learned:

- Use only nozzles/receptacles which are certified to SAE J2600
- H_2 stations need conventional grounding surface in order to ground through tires (API RP 2003)
- Wired Communications connector (Deutsch connector/ CaFCP IO 6) not to be utilized for long term demonstration. Use infrared for future vehicle/station communication

Accomplishments and Progress
Emergency Responder, Customer, Employee Training

- **Developed Training Programs**
  - Service Employee Training
  - Customer Training
  - General Training (F-Cell 101)
  - Infrastructure Training
  - Emergency Response Training

- **Crisis Management Plan**
  - Completed guideline and procedures for crisis management
  - Developed vehicle incident rating classification with corresponding mandatory actions
    - Vehicle
    - Infrastructure
    - Service Facility

Accomplishments and Progress

Fleet Partner Profile

- The fleet partner profiles look at who our partners are in terms of their history, organizational mission and goals, their fleet characteristics and F-Cell related issues
- DaimlerChrysler conducted a series of in-depth intake interviews with each F-cell fleet partner organization to become educated about their ongoing fleet needs, their fleet drivers, and to understand their goals and expectations of the F-cell project. Based on their individual organizational missions and goals, each of our partner has specific goals and expectations running the F-Cell vehicles
- The questionnaire consisted of 30 different questions grouped in 4 main categories:
  - I. General Information
  - II. Fleet Information
  - III. Experience with Alternative Fuel Vehicles
  - IV. F-Cell and Hydrogen Fuel

Accomplishments and Progress
Infrastructure

- Northern California – PG&E Mobile
  - Status: in operation
  - Technical Data: hydrogen produced by SMR; storage capacity of 150kg; 10-15 kg hydrogen dispensed
  - Accomplishments: installed and commissioned at ideal downtown location within 2 months after PG&E reached agreement with DCC, all legal agreements finalized on time (PG&E, BAAQMD, APCI)

- Northern California – Corridor
  - Status: postponed to 2008
  - Technical Data: hydrogen produced by electrolysis
  - Accomplishments: optimal Fairfield site identification and evaluation

- Northern California – SFO
  - Status: postponed to 2008
  - Technical Data: hydrogen produced by SMR
  - Accomplishments: > 10 sites evaluated, optimal location/partner at SFO, began negotiating site and land usage agreements

Accomplishments and Progress
Infrastructure

- Michigan – DTE
  - Status: in operation
  - Technical Data: hydrogen produced by electrolysis, storage capacity of 140kg; 15 kg hydrogen dispensed per day
  - Accomplishments: agreement with DTE to extend operations for 3 years, rigorous safety analysis paid by BP

- Michigan – NextEnergy
  - Status: under construction
  - Technical Data: hydrogen produced by SMR, storage capacity of 50kg; 10-16 kg hydrogen dispensed per day
  - Accomplishments: site identification, legal agreements (APCI/NEC), safety processes coordination with NEC, successful community outreach, on-schedule design and construction, inclusion of DCC in all safety assessment processes

- Southern California – UCLA
  - Status: under development
  - Technical Data: hydrogen produced by SMR
  - Accomplishments: site selection, site evaluation by IGC, legal agreements with UCLA under review

- Southern California – LAX (non-DOE)
  - Status: in operation
  - Technical Data: hydrogen produced by electrolysis, storage capacity of 60kg
  - Accomplishments: open to non-LAX customers, such as UCLA and DaimlerChrysler

Future Work
Plans for 2006

- **Fuel Cell Vehicle**
  - With vehicle handover now complete, 2006 focus will involve:
    - Cultivating customer relations with ongoing service, maintenance, and performance outreach
    - Accumulating more miles in the Michigan and California sites
    - Improving vehicle reliability
- **Hydrogen Infrastructure**
  - Finalize construction and commission the NextEnergy station located in Detroit, Michigan
  - Continue site preparation and permitting process for UCLA
  - Add Linde mobile refueler at Long Beach, California facility
- **Safety**
  - Maintain project safety through continued FMEA updates, vehicle and infrastructure training, education, and emergency response drills, emergency responders training
- **Data Collection**
  - Expand the FDA (Fleet Data Acquisition) infrastructure from 13 to 17 local file servers
  - Continue to generate performance data from daily vehicle operations as well as acceleration, gradeability, and dynamometer testing

Future Work
Customer Perception and Acceptance Study

Hypotheses
H_2 Perception and Acceptance

Vehicle Driver Internet Survey

Conclusions
- Valid Hypotheses
- Invalid Hypotheses

- H_2 exposure correlates with acceptance
- Acceptance/perception differs between for-profit and governmental fleets
- Attitudes towards environment correlates with acceptance
- Position within organization will not affect acceptance
- More F-Cell experience lead to higher expectations of the vehicle
- Positive/negative interactions when driving pushes motivation to drive more/less over time
- Limited range correlates with fewer trips over time
- Type of own car correlates with F-Cell perception

Contents
- Demographics
- Driving Patterns
- Experience with Alternative Fuels/Powertrains
- Attitudes towards innovation and new technologies
- Attitudes towards energy and environment issues
- Experience with the F-Cell

Timeline
- Survey phase 1 (start): Mid April
- Quality Review of 1st Results: Mid May
- Survey phase 2: July
- Survey phase 3: October
- Final report from UCB: Mid Dec.

Outcome
- Contribution to the DOE hydrogen fleet and infrastructure validation and demonstration project by introducing perception and acceptance aspects from a driver perspective

Conclusion

- **All 30 vehicles are operational and equipped with onboard data collection device to wirelessly transmit the collected data to local file servers which then make the data accessible to DC via internet**
- **Over 35,000 miles have been driven on DOE-DaimlerChrysler FCVs which have been delivered to customers in three different ecosystems**
- **Emergency Response Plan and Training Programs have been completed:**
  - Service Employee Training
  - Customer Training
  - General Training (F-Cell 101)
  - Infrastructure Training
  - Emergency Responder Training
  - Crisis Simulations Exercises
- **Hydrogen fueling stations were designed, constructed and operated:**
  - PG&E Mobile - San Francisco
  - DTE Energy - Michigan
- **Following stations are under development/construction:**
  - UCLA
  - NextEnergy - Detroit

Support

Supplemental Slides

Publications and Presentations

Conferences	Date
▪ World Expo, Aichi, Japan	03-09/05
▪ World Environment Day	06/05
▪ Challenge Bibendum Kyoto, Japan	06/05
▪ Frankfurt Motorshow (Germany)	09/05
▪ CaFCP - Mini Road Rally	10/05
▪ Grove Fuel Cell Symposium (London)	10/05
▪ World Hydrogen & Technology Conference	10/05
▪ Fuel Cell Seminar (Palm Springs, CA)	11/05
▪ Tokyo Motor Show	11/05
▪ JHFC Seminar	03/06
▪ NHA Hydrogen Conference	03/06
▪ Auto Mobil International	04/06

Responses to Previous Year Reviewers' Comments

Recommendations Made by Reviewers	DaimlerChrysler's Action Plan
▪ Conduct structured interviews with drivers	▪ DaimlerChrysler is conducting a "Customer Perception and Acceptance Study" to collect and analyze the F-cell vehicle experience of 150 fleet drivers
▪ Prepare a technology transfer plan	▪ Since November 2004, CDs/DVDs containing data files from daily vehicle operations have been sent to the DOE/NREL on a monthly basis
▪ Address efforts to reduce costs	▪ DaimlerChrysler continuously allocates research and development budget to improve performance and reduce costs of fuel cell technology

Critical Assumptions and Issues

- **Fueling Station Locations and Customer Selection**
  - Coordination between OEM and Energy Company crucial for optimal selection of sites/customers
  - Number and type of customers, new customer acquisition
- **Hydrogen Infrastructure Permit**
  - Assistance from local partners who have established relationships with officials (NEC, PG&E)
  - Challenges in certain locations (SF, LA)
- **Infrastructure Legal Contracts**
  - Longer than expected times: customers, suppliers, OEM's
  - Indemnification and liability: BP high risk position (i.e. customers vs. suppliers)
  - Hydrogen sales: reluctance to pay for fuel
- **Station Equipment Acquisition – Design - Construction**
  - Lead times
  - Scope changes (e.g. NFPA 52 at NextEnergy)
  - BP rigorous processes result in unexpected suppliers' delays
  - BP rigorous safety construction processes result in additional efforts to educate third parties
- **Hydrogen Purity**
  - Inadequate set of analytical test methods
  - Significant time and financial commitment to test for/assure extremely tight purity guidelines
- **Community Engagement Prior to Station Construction**
  - Thorough due diligence for local landscape
  - Early buy in from local officials, school superintendents, community members (NEC, PG&E)