



# ***Hydrogen Fuel Cell Vehicle & Infrastructure Demonstration Program Review***

Ford Motor Company

Research & Advanced Engineering

May 25, 2005



***R&A - Research & Advanced Engineering***

This presentation does not contain any proprietary or confidential information

Project ID #TV10

# Overview



## Timeline

- Project start:  
Nov. 17, 2004
- Project end:  
Jun. 2009
- 5 % complete

## Budget

- \$88 mil project
  - DOE \$44 mil
  - Ford \$44 mil
- FY04: \$0.4 mil
- FY05: \$34.2 mil

## Barriers Addressed

- Vehicles
- Storage
- Hydrogen Refueling Infrastructure
- Maintenance and Training Facilities
- Codes & Standards

## Partners

- BP America
- Ballard
- States of California & Florida
- Cities Ann Arbor & Taylor
- SMUD, Progress Energy & NextEnergy



# Project Objectives



*To gain FCV operational data in differing climate conditions to direct and augment future design efforts*



- **Complete Program Management Documentation**
  - **Plans for Safety, Risk Mitigation, Communication, Training, Facility Preparation, Test & Data, Vehicle Delivery and Program Plan**
- **Begin Vehicle Build Process**
- **Design Data Collection Architecture**
- **Prepare Service Facilities**
- **Train Emergency Responders**
- **Train Service Technicians**
- **Prepare & Deliver Training Material for Drivers & Fleet Managers**



# Project Objectives



*Provide safe, reliable user friendly hydrogen infrastructure for vehicles, install technology to meet cost targets and establish an initial infrastructure network to fuel small fleets across a metropolitan area*

- Stations in Florida, Sacramento, California and SE Michigan
- Implement data collection system
- Commence community engagement
- Complete Program Management Documentation
  - Plans for Safety, Risk Mitigation, Communication, Training, Facility Preparation, Test & Data, and Program Plan



# Vehicle Approach



- Two demonstration components
  - Component 1: developed technology installed in contemporary vehicles for real world use
  - Component 2: controlled in-house demonstration of extended range, durability and operating temperature
- Fleet vehicles in three differing geographic/climatic regions
- Automated data collection methodologies for effective data analysis



# Vehicle Approach

| <i>Program Elements</i>      | <i>Component 1</i>  | <i>Component 2</i>                  |
|------------------------------|---|-------------------------------------|
| Real World Data              | <input checked="" type="checkbox"/>   |                                     |
| Maintenance & Training       | <input checked="" type="checkbox"/>   |                                     |
| Hydrogen Storage & Interface | <input checked="" type="checkbox"/>   | <input checked="" type="checkbox"/> |
| Durability                   |  | <input checked="" type="checkbox"/> |
| Economy                      |   | <input checked="" type="checkbox"/> |
| Weight                       |   | <input checked="" type="checkbox"/> |
| Cost                         |   | <input checked="" type="checkbox"/> |



# Component 1:

## Focus Model Implementations

Designed for a customer life of 3yr/ 45,000 miles (73,000 km)



- Ford Focus 4 Door
- Weight: 1600 kg (3520 lbs)
- Fuel Cell: Ballard Mark 902 fuel cell stack
- Power: 67kW (87hp)
- Power train: Integrated--combines inverter module with AC electric motor transaxle
- Hybridized – 216 volt Battery Pack
- Regenerative Braking System
- Range: 260 - 320 km (160 - 200 miles)
- Max speed: 128+ kph (80+ mph)
- Fuel: 5000 psi Compressed Gaseous Hydrogen
- Emissions: Zero



# ***Technical Accomplishments/ Progress/Results***

- **Developed systems control improvements to enhance reliability**
- **Established Fuel Economy**
- **Implemented Data collection architecture using Vehicle Network Gateway at one second intervals**
- **Developed Training Material**
- **Conducted Emergency Responder Training**



# Technical Accomplishments/ Progress/Results

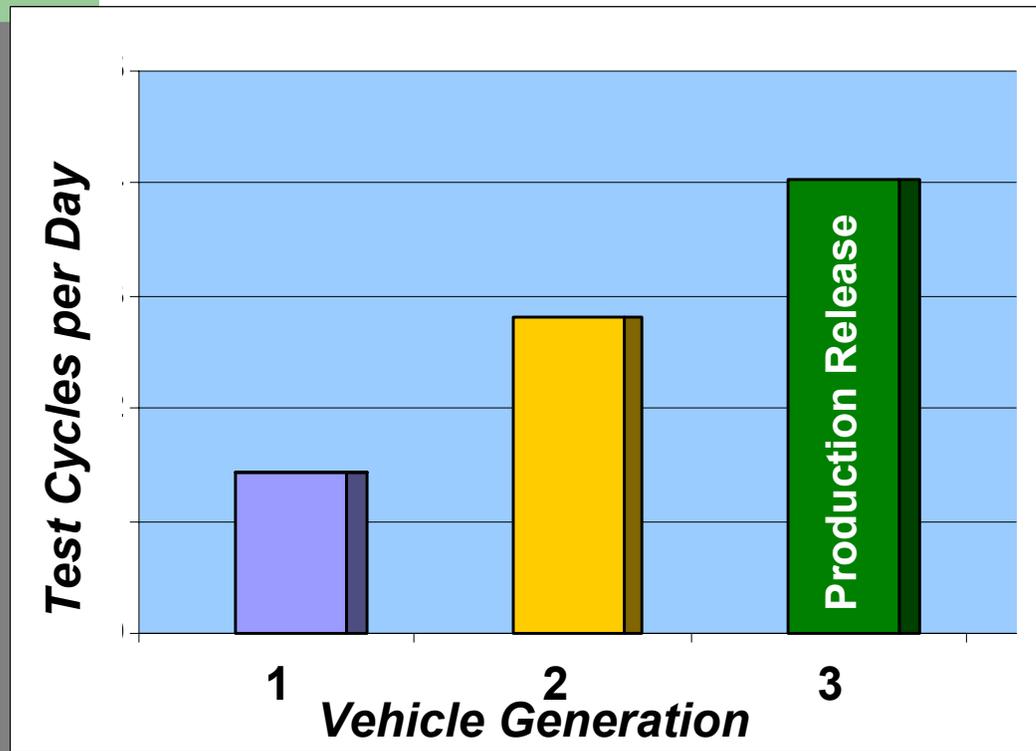
## Development

- Tested to 4.5 yr/  
65,000 miles  
(109,000 km) target
- Over 165,000 miles  
(275,000 km)  
accumulated on our  
FCV fleet to date
- Production  
validation testing  
completed



# Robustness Improvement

## Significant Reliability Improvements



- Systems Control Software enhanced
- Improved robustness of interfacing vehicle systems

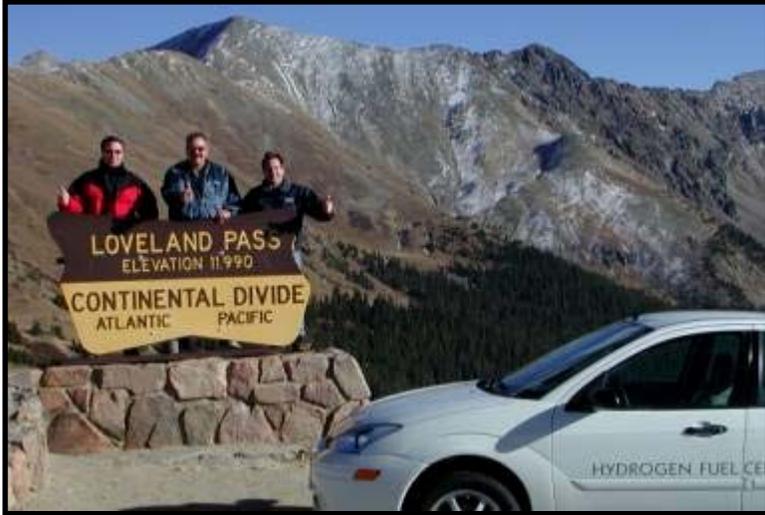


# Vehicle Durability

*Completed Proving Grounds tests of three vehicles to equivalent of 150% of program duration (4.5 years)*



# Vehicles Robustness and Durability Testing



14,000 Ft Altitude Testing



Mud Bath / Salt Water Fording



Brake Testing -18 C



Hot Weather Thermal / Durability Tests



# Impact Safety Tests Complete



90° 30 MPH Front Fixed  
Barrier Impact

90° 30 MPH Rear  
Moving Barrier  
Impact



# Vehicle Development – Fuel Economy

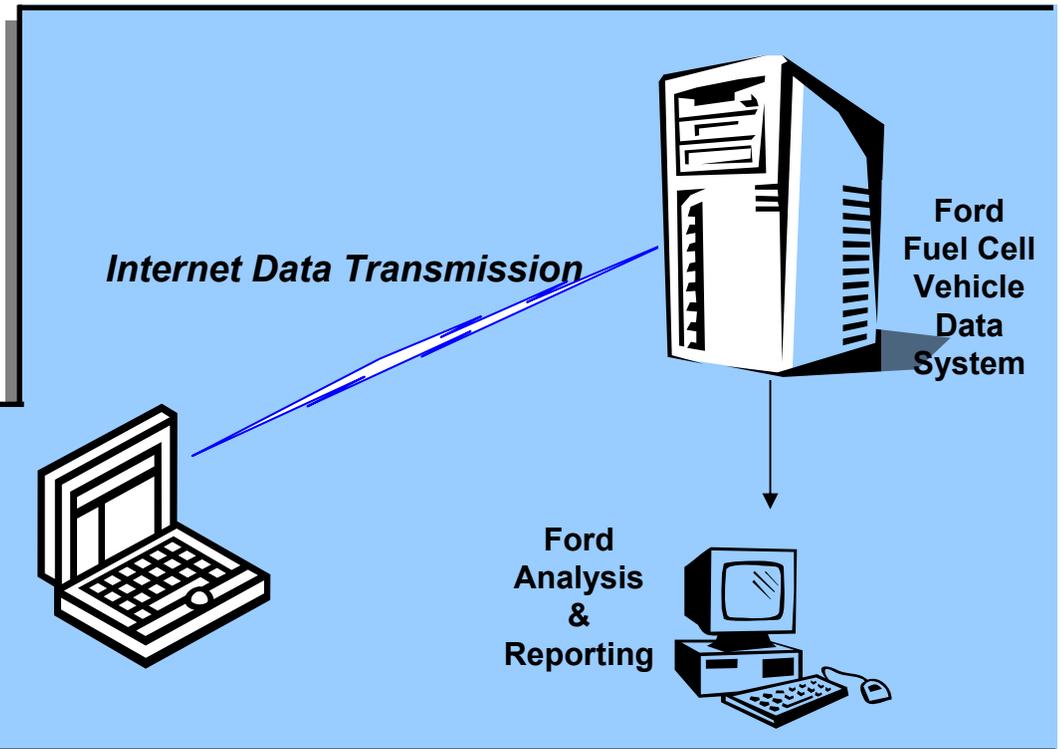


**6700 miles of Development**

**Result:**  
**Achieved 50 mpg M-H Target**



# Vehicle Data Collection



*Data acquisition, transfer, and analysis capability is piloted and ready to deploy*



# Vehicle Placements Activities

## Training Material Developed

- Service Manuals
- Operator Training
- ER Training

## ER Training Conducted

- 110 in Dearborn, MI

**8 Vehicles  
already in  
service provide  
model for DOE  
launch**



# Approach



## •Employ Two Phase Approach

- Phase I: Test Infrastructure Deployment
  - Install H2 Delivered Stations
  - Include electronic data collection for select sites
- Phase II: Meet Cost Targets
  - Install onsite H2 Production and/or 700 bar Fueling at Select Sites

## •Station Locations

- Orlando Florida (1)
- Sacramento (up to 4)
- Taylor, Michigan (up to 2)



# Approach



| <b>Location</b>   | <b>Phase 1<br/>Delivered<br/>H2</b> | <b>Phase 2<br/>Electrolysis</b> | <b>Phase 2<br/>SMR</b> | <b>Phase 2<br/>700 Bar</b> |
|-------------------|-------------------------------------|---------------------------------|------------------------|----------------------------|
| <b>Orlando</b>    |                                     |                                 |                        |                            |
| <b>Sacramento</b> |                                     |                                 |                        |                            |
| <i>Station S1</i> |                                     |                                 |                        |                            |
| <i>Station S2</i> |                                     |                                 |                        |                            |
| <i>SMUD</i>       |                                     |                                 |                        |                            |
| <b>Michigan</b>   |                                     |                                 |                        |                            |
| <i>Taylor</i>     |                                     |                                 |                        |                            |
| <i>Station M2</i> |                                     |                                 |                        |                            |



# Technical Accomplishments



- Initiated Permanent Station Permitting Process
  - Florida
  - Sacramento
  - Michigan
- Leasing Mobile Refueler to meet immediate vehicle fueling needs
- Selected Turn Key Infrastructure Suppliers for 2005 Projects
- Evaluated reformer and electrolysis options
- Completed Hydrogen Fire Marshal Workshops
  - Florida
  - Sacramento



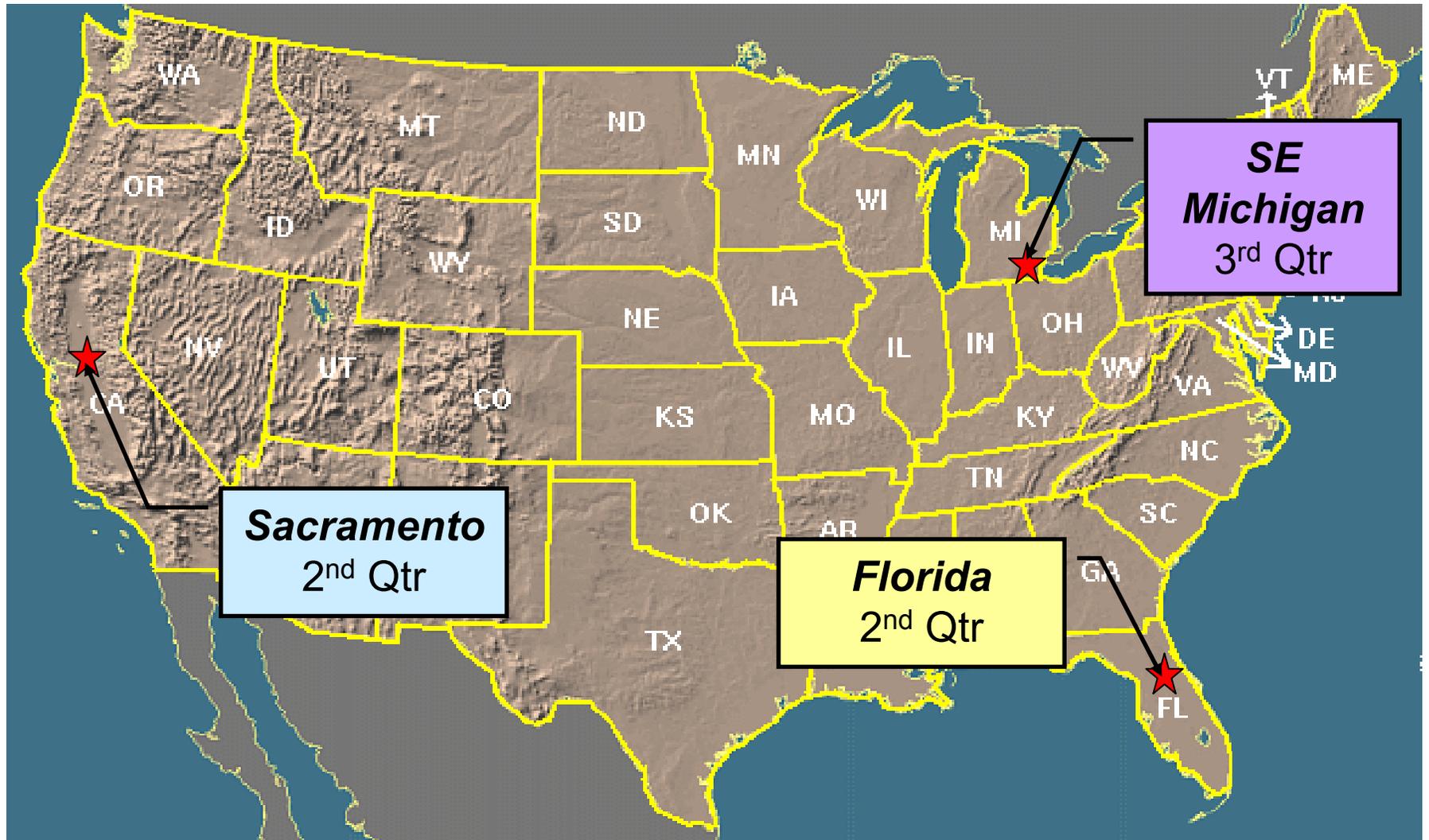
# 2005 Work Plan

- **Upcoming Events:**

-  Install fueling capability in California
-  Complete operator, fleet manager & technician training in Sacramento
-  Deliver vehicles to Sacramento
-  Install fueling capability in Orlando
-  Complete operator, fleet manager & technician training in Orlando
-  Deliver vehicles to Orlando
-  Install fueling capability in SE Michigan
-  Complete operator, fleet manager training in Michigan
-  Deliver vehicles in SE Michigan



# 2005 Vehicle Deployment





# Research and Advanced Engineering

