



Hydrogen Fuel Cell Vehicle & Infrastructure Demonstration Program Review

Ford Motor Company

Research & Advanced Engineering

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R&A - Research & Advanced Engineering

Project ID #TV10

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This presentation does not contain any proprietary or confidential information

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**

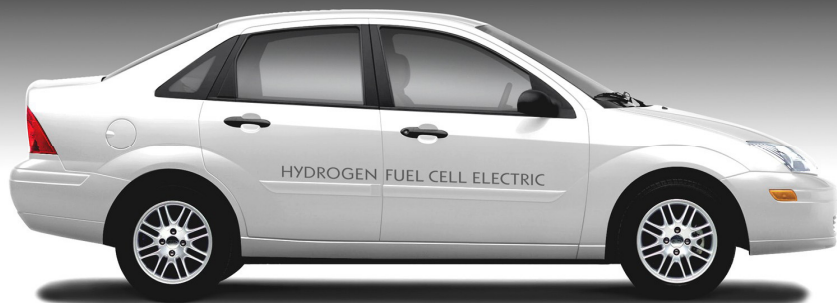


Project Objectives



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

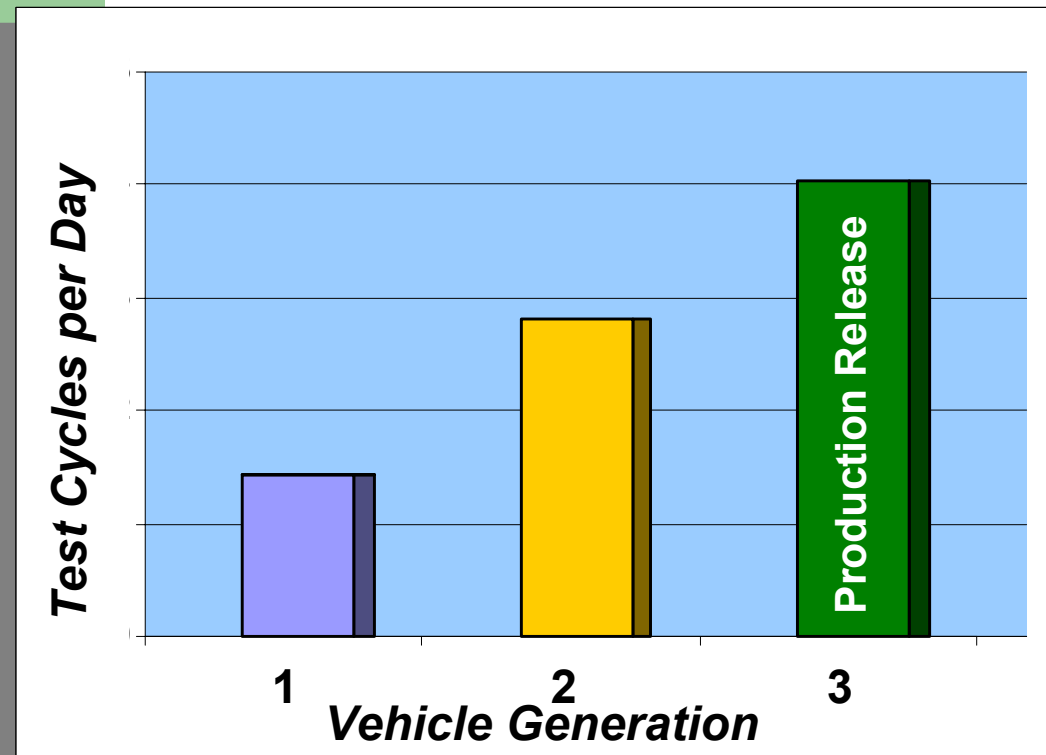
Development

- 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

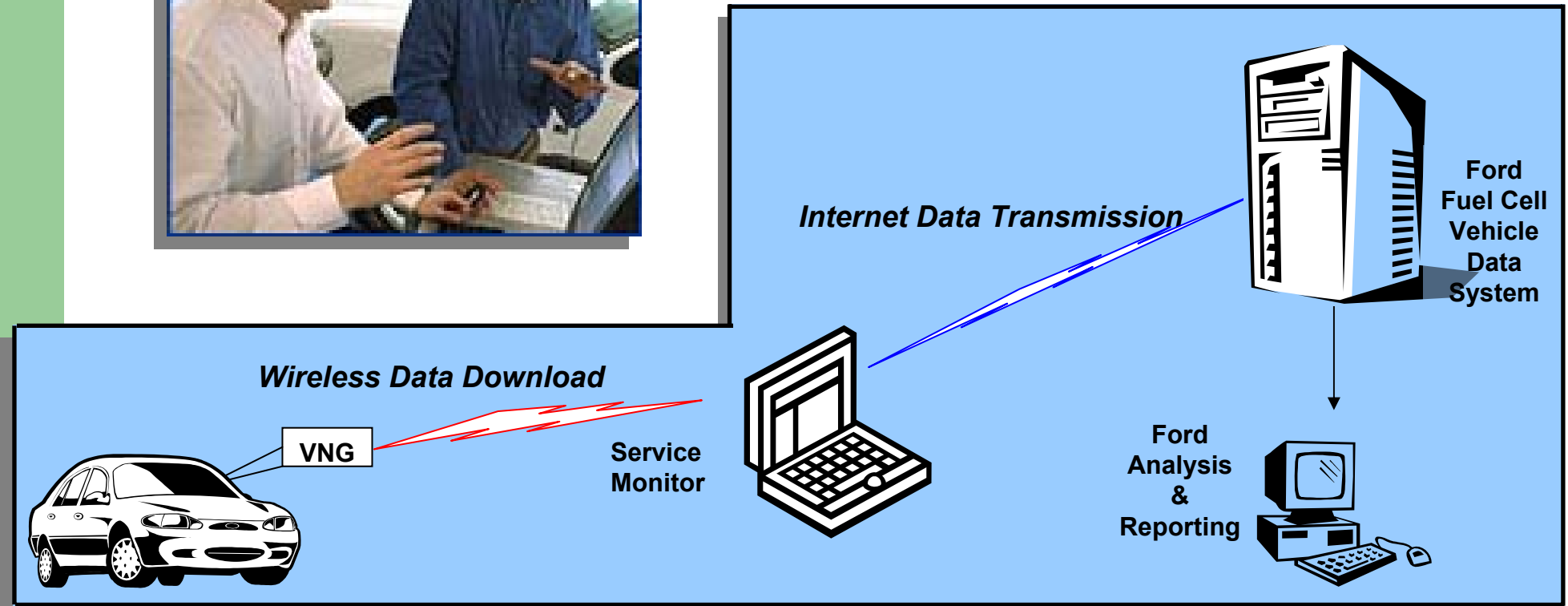


6700 miles of Development

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

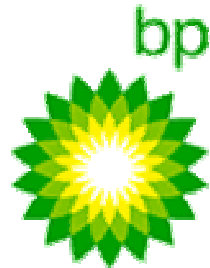
ER Training Conducted

- 110 in Dearborn, MI

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



Approach



•Employ Two Phase Approach

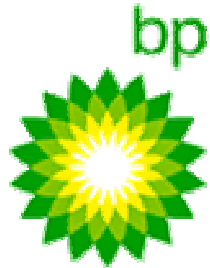
- Phase I: Test Infrastructure Deployment
 - Install H2 Delivered Stations
 - Include electronic data collection for select sites
- Phase II: Meet Cost Targets
 - Install onsite H2 Production and/or 700 bar Fueling at Select Sites

•Station Locations

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



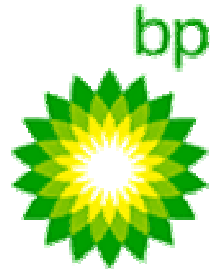
Approach



<i>Location</i>	<i>Phase 1 Delivered H2</i>	<i>Phase 2 Electrolysis</i>	<i>Phase 2 SMR</i>	<i>Phase 2 700 Bar</i>
Orlando				
Sacramento				
<i>Station S1</i>				
<i>Station S2</i>				
<i>SMUD</i>				
Michigan				
<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



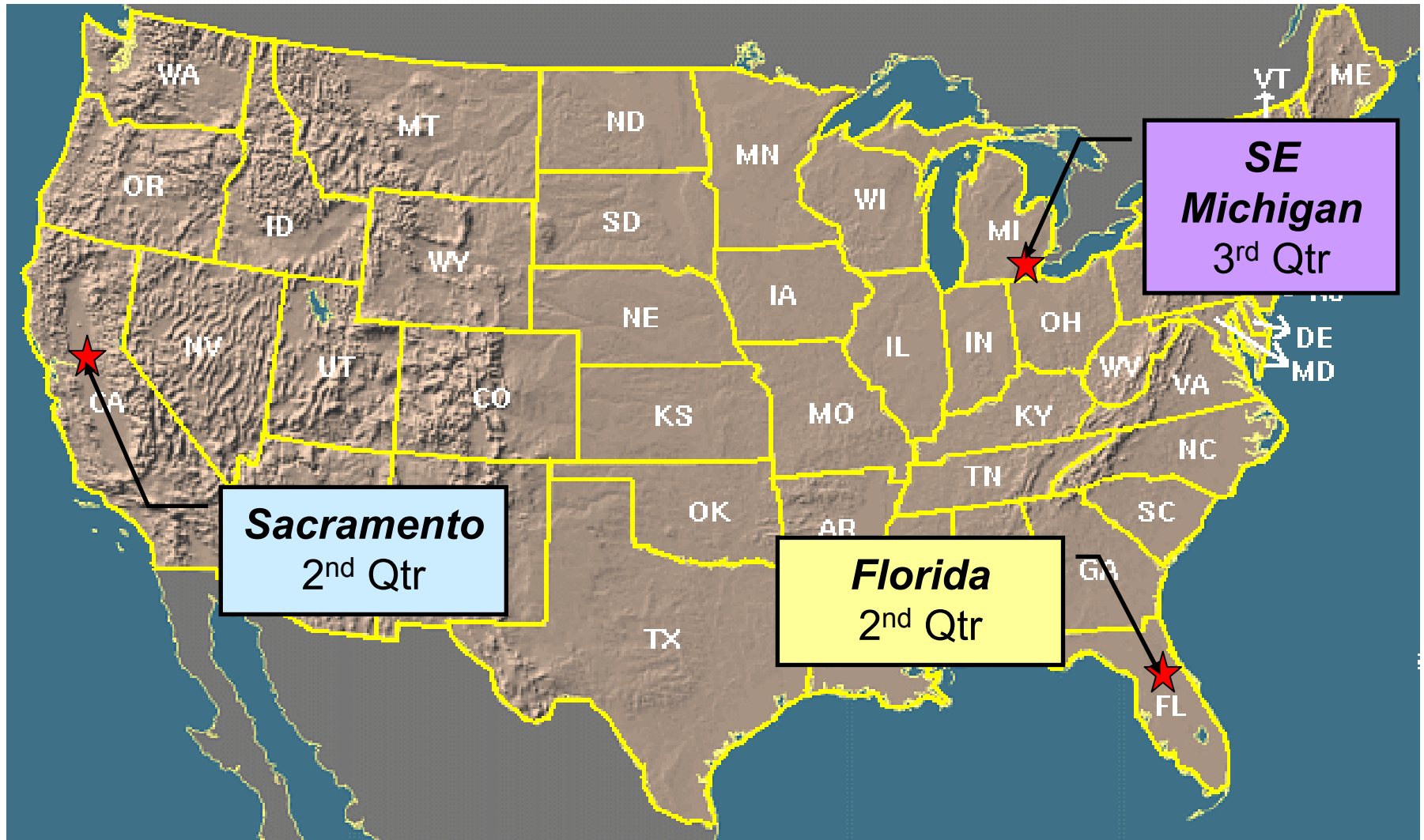
Complete operator, fleet manager training in Michigan

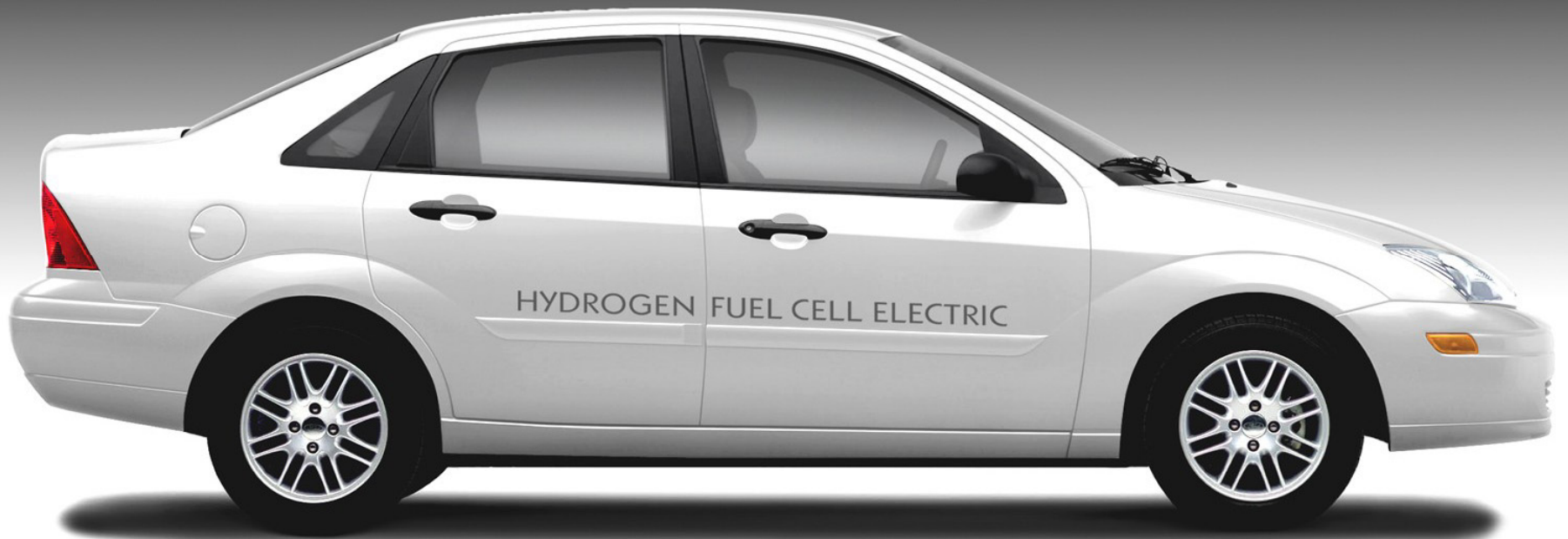


Deliver vehicles in SE Michigan



2005 Vehicle Deployment





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