Hydrogen Technology Validation as a "Learning Demonstration" that Feeds the R&D Process

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Outline

- Technology Validation Strategy and Targets
- Role of Technology Validation in DOE's Hydrogen, Fuel Cells, & Infrastructure Technologies Program
- Competitive Solicitation Background
- Summary of Winners Announced
- Data to Be Collected by Industry
- Planned Data Analysis
- Future Work

Technology Validation Strategy

- To conduct learning demonstrations that emphasize co-developing hydrogen infrastructure in parallel with hydrogen fuel cell-powered vehicles to **allow a commercialization decision by 2015**.
  - Test, demonstrate, and validate optimum system solutions
  - Refocus Hydrogen R&D Program as appropriate

Controlled Fleet Performance Targets
(From solicitation RFP, Appendix C)

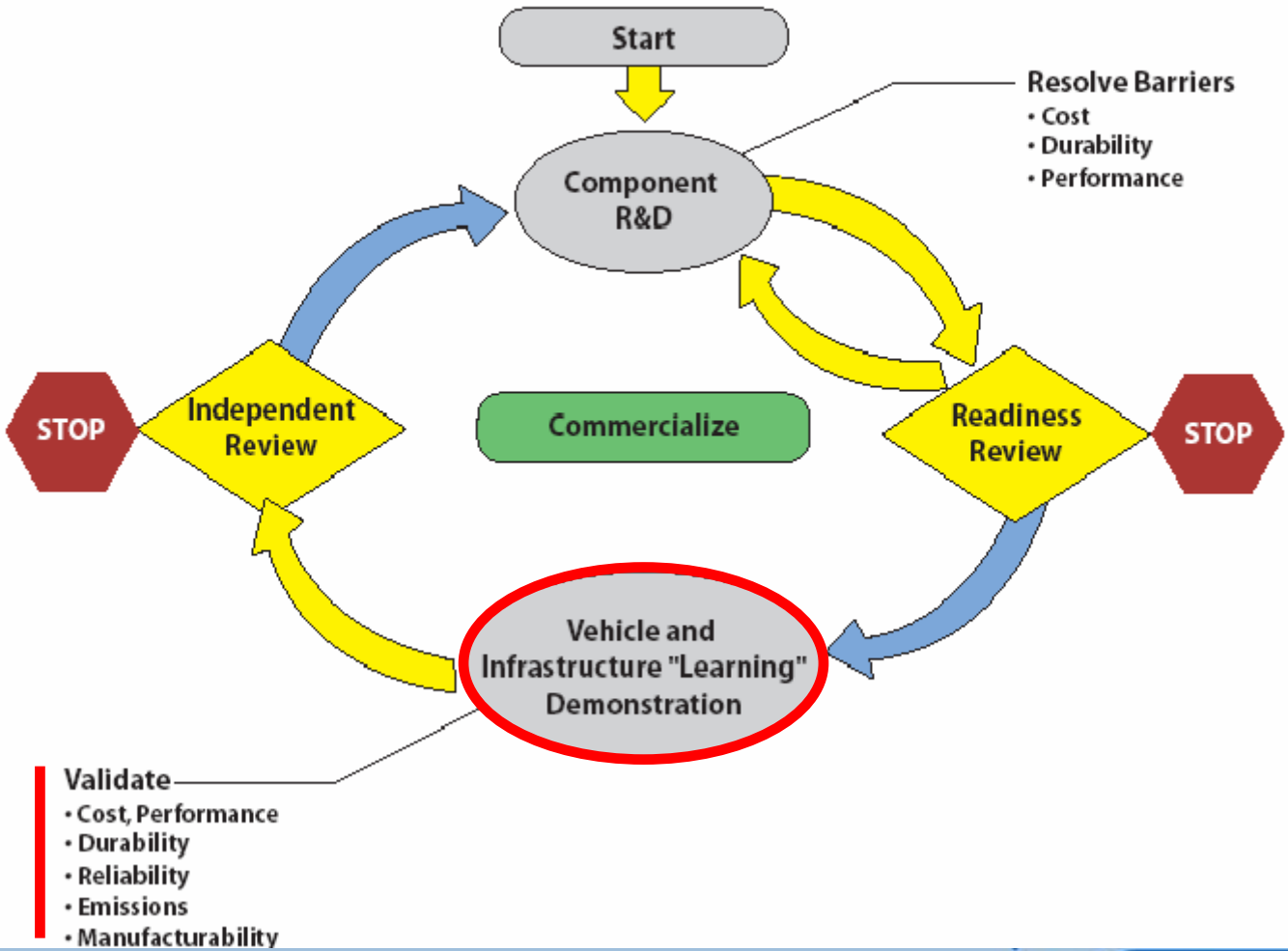
- 2008 Performance Targets
  - FC Stack Durability: 2000 hours
  - Vehicle Range: 250+ miles
  - H2 cost at station: $3.00/kg
- 2015 Performance Targets
  - FC Stack Durability: 5000 hours
  - Vehicle Range: 300+ miles
  - H2 cost at station: $1.50/kg

To verify progress toward 2015 targets

Subject of subsequent projects to validate 2015 targets

Role of Technology Validation in the DOE's Hydrogen R&D Process

Figure 3.5.1. The Role of Technology Validation—
"Learning demonstration activity with clearly defined objectives, milestones, and go/no-go decisions"



Controlled H2 Fleet & Infrastructure Solicitation: General Information

- Five year project 2004 – 2009
- Government/industry cost shared co-operative agreement
- $150M –$240M Government share subject to the appropriations process
  - $190M announced this week
- Data from project to help refocus R&D projects
- 2 Generations of vehicles
- Cold climates to be included by 2nd generation
- Must include renewable feedstock for H2 generation
- Codes, Standards and Education integral to the success of the project
- Stationary facilities that co-produce electricity and hydrogen are encouraged

SOLICITATION FOR SUBMISSION OF FINANCIAL ASSISTANCE APPLICATIONS

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

SOLICITATION NUMBER DE-PS36-03GO93030

CONTROLLED HYDROGEN FLEET AND INFRASTRUCTURE DEMONSTRATION AND VALIDATION PROJECT

Project Safety – Key Part of Project

- Solicitation bidders required to include in their proposal:
  - Preliminary Failure Modes and Effects Analysis (FMEA) on the project
  - Brief example of safety assessment
  - Detailed outline of Risk Mitigation Plan
  - Description of how safety performance will be measured and monitored
  - Detailed outline for Communication Plan, including reportable accidents, management response, and independent reviews
- Safety accounted for 20% of proposal evaluation score
- RFP included “Guidance for Safety Aspects of Hydrogen Projects” for reference

Controlled H2 Fleet & Infrastructure Solicitation: Teaming

- An automobile manufacturer and an energy company;
- A hydrogen supplier;
- A fuel cell supplier;
- Utility and/or gas company
- A fleet operator of vehicles (private, local, state, or federal fleets);
- System and component suppliers;
- Small businesses;
- Universities, educational, and outreach organizations;
- State, local, and federal governments.

The automobile manufacturer or the energy company will be the prime

Successful Teams Announced

- Ford Motor Co./BP
- FC: Ballard
- Stations in
  - Detroit, MI
  - Orlando, FL
  - Sacramento, CA

- General Motors/Shell
- FC: GM
- Stations in
  - Washington, DC/Fort Belvoir, VA
  - Detroit, MI
  - New York, NY
  - Los Angeles, CA

- DaimlerChrysler/BP
- FC: Ballard
- Stations in
  - Los Angeles, CA
  - Detroit, MI
  - Sacramento, CA

- Texaco Energy Systems/Hyundai
- FC: UTC Fuel Cells
- Stations in
  - Chino, CA
  - Pomona, CA
  - UC Davis

- Air Products, Conoco-Phillips, Toyota, Honda, Nissan, BMW
- FC: UTC, others
- Stations in
  - Northern CA
  - Southern CA
  - Las Vegas, NV

Data Collection
Details Specified in RFP Statement of Objectives

- 8 tables
- Footnotes to clarify

DRAFT
FINAL CONTENT SUBJECT TO CHANGE

APPENDIX A

Statement of Objectives
Controlled Hydrogen Fleet and Infrastructure Demonstration

A.1.0 Background

The use of fuel cell technology with hydrogen as the energy carrier offers a viable option to reduce dependence on imported petroleum, develop domestic improve fuel efficiency while reducing greenhouse gas emissions, and provide a diverse source of energy feedstocks. It also offers the opportunity to embrace both transportation and electric generation sectors.

In November of 2002, Energy Secretary, Spencer Abraham, announced the *Energy Roadmap*, a document designed to ensure a more secure and cleaner energy future for America. The Roadmap provides a blueprint for the coordinated, long-term, public and private efforts required for hydrogen energy development. These requirements include:

- Improved fuel cell durability
- Decreased cost of fuel cell stack
- Enhanced infrastructure/vehicle systems integration
- Focused demonstrations to showcase vehicle/infrastructure capabilities
- Accelerated development of codes and standards
- Public policies to educate the public about hydrogen as a fuel

A.3.0 Project performance measures

Applicants shall provide summaries of the vehicle, site, and energy parameters, as well as energy production (optional) test plans. Tables 1 - 6 below and the accompanying narrative summarize the performance measures.

A.3.1 Performance Measures

Table 1. Vehicle Performance Measures

Category	Performance Measure	Units	Baseline Benchmark (Current)	2006 Performance Targets	2008 Performance Targets	Comments
Operations	Fuel Economy (a)	MPGGE *	50 (fuel cell vehicle)	50	60	Use draft SAE J2572 and draft EPA fuel economy test procedures. Overall testing may include FTP75, HWYFE,
	R					

Table 6. –Data for Modeling and Evaluation of Component Development Program at DOE

Vehicle Component	Required Data	Comments
Dynamometer Testing (a)		
Fuel Cell Stack	1. Stack voltage, current 2. Anode inlet and outlet temperature and pressure 3. Cathode inlet and outlet temperature and pressure 4. Hydrogen feed and recirculation rates 5. Cathode air feed rate 6. Humidification levels for cathode and anode feed gases	Data to be obtained on a continuous basis.
Fuel Cell System Balance-of-Plant	1. Power consumption by – air compressor or blower – radiator/condenser fan(s) – hydrogen recirculator – coolant / water pump(s) – any other electrical components 2. Make-up water (if any)	Same as above
Major Components	1. Traction Inverter Motor (TIM) – current, voltage, power in – motor voltage, current, power in – motor shaft power out	Same as above

Performance Measures
Data Collected

- **Vehicle Performance Measures**
  - **Operations**
    - Fuel economy
    - Range
    - Vehicle refueling time
  - **Vehicle Fuel Cell Systems and Components**
    - Durability
    - Efficiency
    - H2 tank cycle life
  - **Performance**
    - Top speed, Acceleration
    - Gradeability
    - Minimum/maximum temperature
    - Cold drive-away
    - Emissions
  - **Safety**
    - Unplanned failures,
    - Fuel tank release,
    - Grounding, sensor, and passenger compartment alarm

Performance Measures Data Collected

- Infrastructure Performance Measures
  - **Site**
    - Purity of hydrogen from storage tank
  - **Fueling System**
    - Durability
    - Hydrogen production and delivery, refueling rate
  - **Safety**
    - Release of hydrogen from fueling connector

- Fuel cell co-generation facility (Optional)
    - Cost of co-generation
    - Fuel cell durability
    - Electrical efficiency of fuel cell
  - **Safety**
    - Electrical overload
    - Ground short
    - Alarms

Data Analysis Approach (Fuel Cell Vehicles)

A. Identify significant factors affecting vehicle performance from collected data
B. Provide processed data for development/verification of codes and standards
C. Measure progress compared to research technical targets (MYPP, solicitation targets)
D. Identify possible technical areas of future research within Program from results -- *technology gaps and research opportunities*

Overview of Technology Validation Hydrogen Fuel Cell Vehicle Performance Analysis

Performance at multiple temperatures

Performance at multiple elevations

Acceleration & Gradeability

FC Component Efficiencies

Dyno Fuel Economy

On-Road Fuel Economy

Driving Range

In-Use Data Acquisition System

Data Collected by Auto Teams

Compare Results from Multiple Climates & Technologies

Performance measures include vehicle fuel economy, driving range, acceleration, gradeability, etc.

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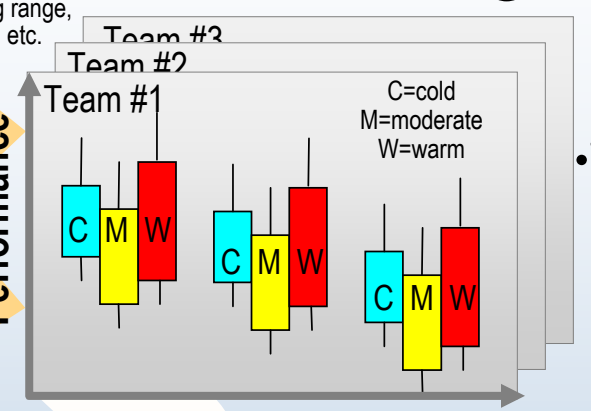


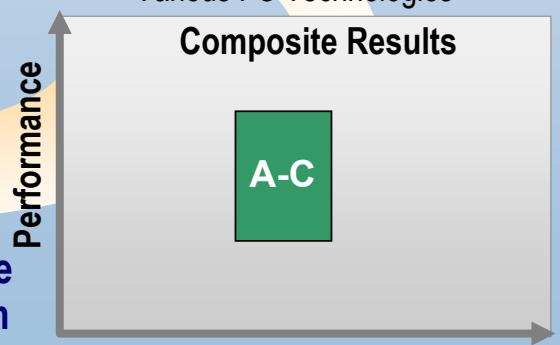
Firewall

B

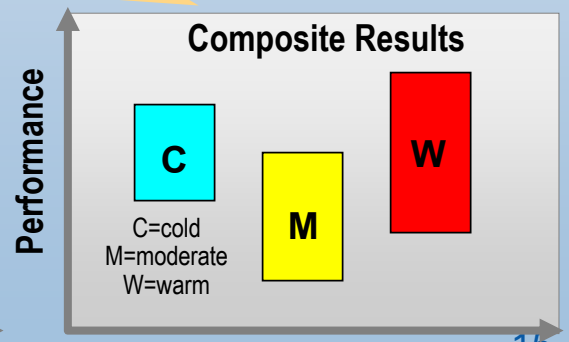
Results to Codes & Standards Groups

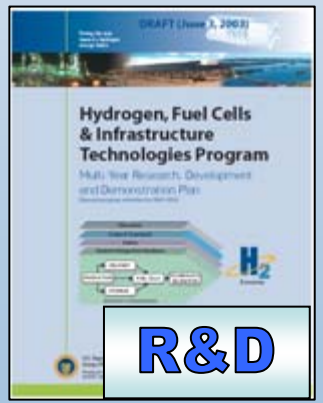
Summarize Results by Technology & Climate

Range of Performance for Various FC Technologies



Range of Performance for 3 climates





Re-Focus R&D as Appropriate

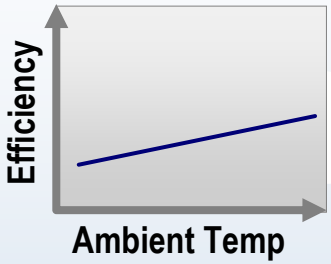
D

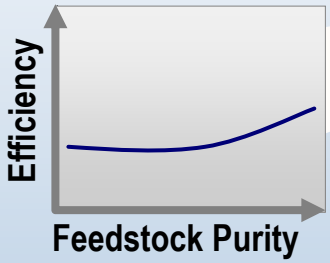
ADVISOR 2003

Compare Performance Against DOE Program Technical Targets

C

Overview of Technology Validation Hydrogen Production Analysis





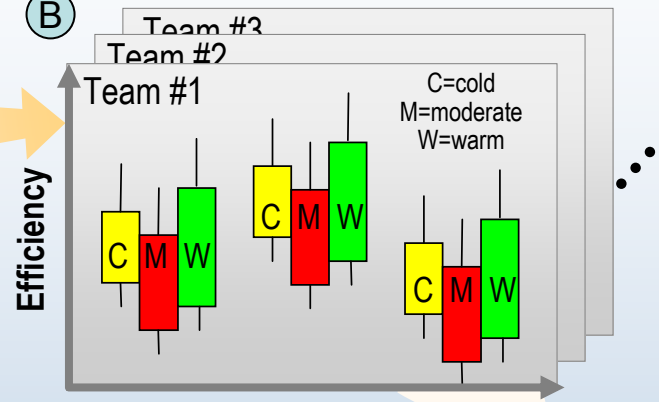
Detailed analyses of production data determine what factors affect productive efficiencies

A

Identify Factors Affecting Performance

Compare Results from Multiple Sites and Methods

B

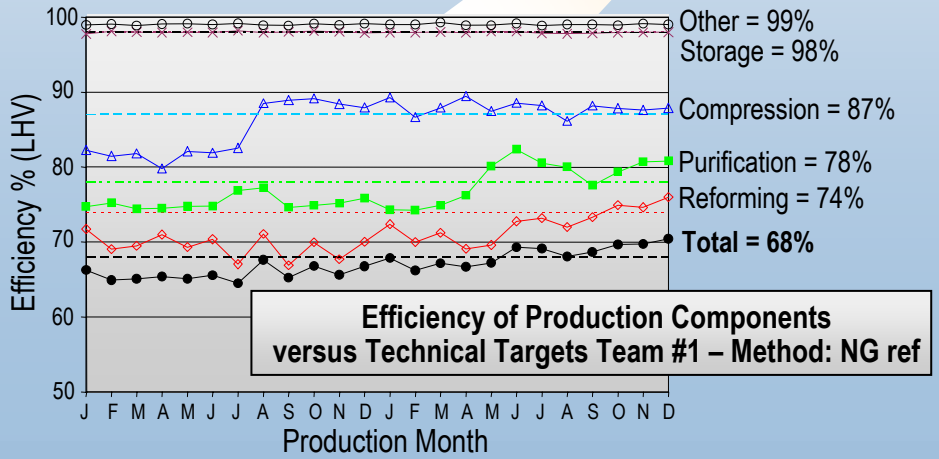


Map Performance Against Program Technical Targets

C

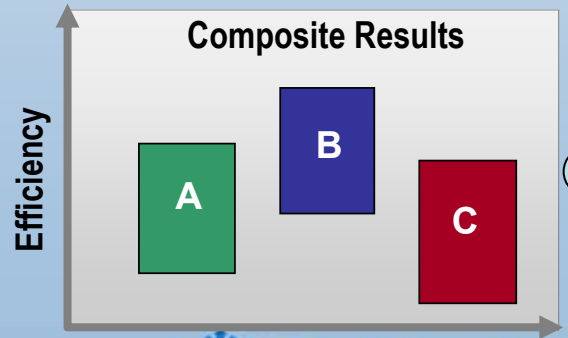
Firewall

Summarize Results by Method



Efficiency of Production Components versus Technical Targets Team #1 – Method: NG ref

Range of Efficiency Achieved by Different Productive Methods



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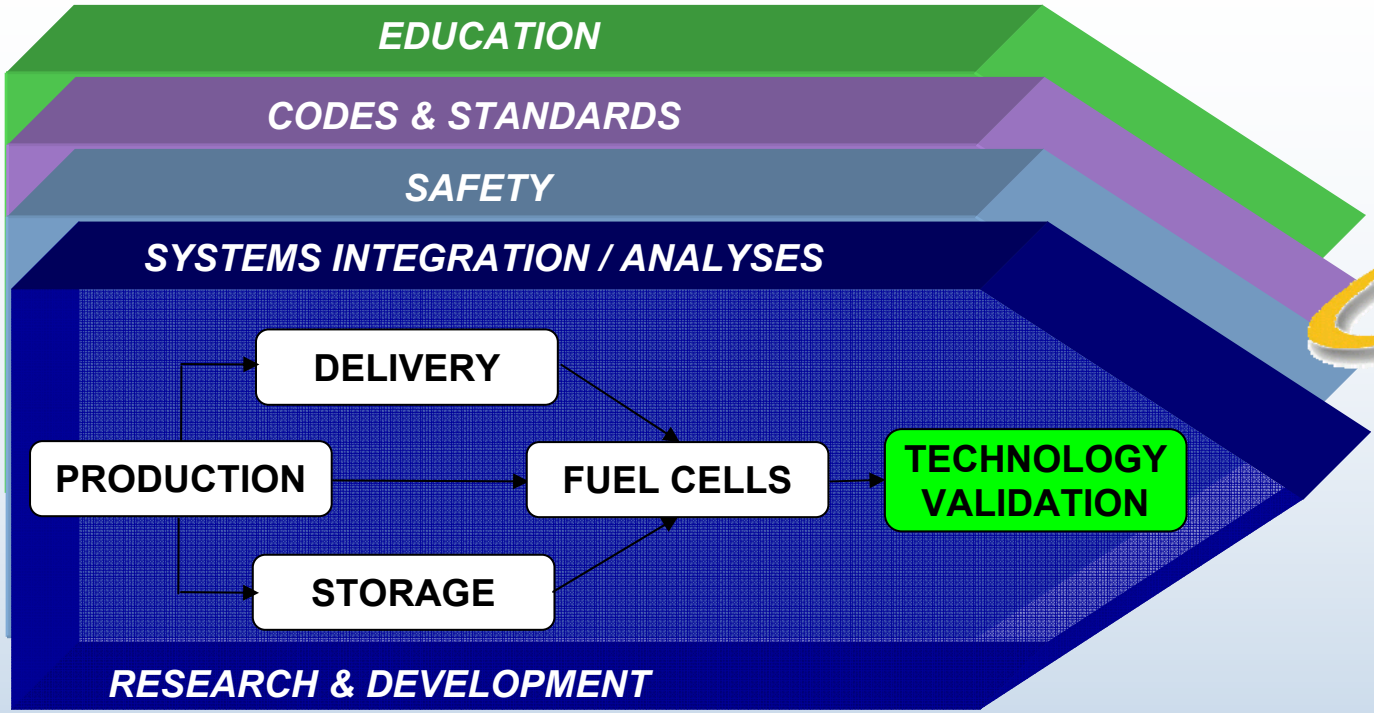
Future Work
Controlled H2 Fleet & Infrastructure Project

- Remainder 2004
  - Industry/government kick-off meetings
  - Discussions on data collection methods, codes and standards, and education
  - Begin quarterly Validation Assessment Reports
- 2005 and beyond
  - Complete *first generation* vehicle & infrastructure demonstration
  - Compare technical progress to program objectives
  - Actively feed findings from project back into HFCIT program R&D activities (“learning demonstration”)
  - Implement *second generation* systems to meet 2008 targets



Economy

Questions?