



DEFENSE LOGISTICS AGENCY

AMERICA'S COMBAT SUPPORT LOGISTICS AGENCY



Powering the Future: DLA's Hydrogen Fuel Cell Pilots

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Presentation Overview

- Fuel cell basics
- DLA's H₂ and Fuel Cell Technologies R&D Program
 - Forklift/H₂ infrastructure pilot projects
 - Program expansion to increase H₂ demand and utilization
- User's lessons learned
 - Safety
 - Stakeholder buy-in
 - Program development and execution
- Industry's lessons learned
 - Permitting
 - Contracting agreements
 - Codes and Standards



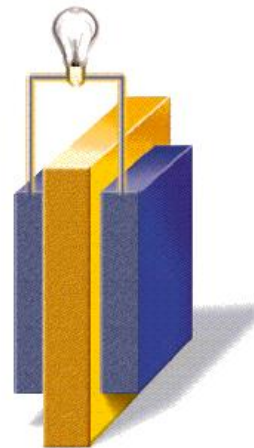
Hydrogen Fuel Cell Basics

Energy production:

- Break H_2 bonds to generate electricity
- Byproducts: water & heat

Potential Applications:

- Electric drive motors
 - Automobiles
 - Material Handling Equipment (MHE)
 - Trains
- Man portable power
- Stationary backup power
- Large power systems





Hydrogen and Fuel Cell Benefits

- Operational benefits over batteries
 - Rapid refueling
 - No battery management (changing, charging, disposing, Hazmat)
 - Constant power
 - Fuel cell forklifts offer most value in three shift operations
- Environmental sustainability:
 - Fuel cells are highly efficient:
 - Capture regenerative braking
 - Hybrid systems using ultra capacitors or small batteries
 - Capture load lowering energy
 - No fuel cell ‘tailpipe’ emissions
 - Potential for “green” hydrogen production pathway – zero GHG emissions





DLA's Hydrogen and Fuel Cell Program

MHE Pilots: Goals

- Be an **early adopter** and **principal demonstrator**
 - Foster competition in the marketplace and provide a market demand
 - Support improved Technology and Manufacturing Readiness Levels (TRLs and MRLs)
 - Exercise the supply chain
 - Test under real world conditions
 - Provide feedback to manufacturers
 - Position fuel cell technology for consumer markets
 - Highlight the business case for fuel cells
 - Further cost reductions through both R&D and volume
- Improve fuel cell readiness by funding R&D efforts in areas that are near commercialization*



DLA's Hydrogen and Fuel Cell Program

4 Fuel cell forklift demonstration projects

Approach:

- Pilot multiple H₂ generation, dispensing and fuel cell technologies to power MHE in warehouse operations
- Analyze operational data to establish an operational business case compared to incumbent technologies

Collaborators:

3 Leading fuel cell mfg, 2 leading hydrogen mfg, DLA/DOE/NSWC
Crane/NREL with multiple prime contractors

Funding (Congressional):

FY07: \$12.7M

FY08: \$13.9M

FY09: \$8M

FY10: \$6M

Locations:

DDSP: 40 forklifts, delivered (cryogenic) H₂, indoor dispensing

DDWG: 20 forklifts, onsite natural gas reformation for H₂, mobile refueling

JBLM: 19 forklifts, 1 bus, wastewater digester gas H₂

DDJC: 20 forklifts, electrolysis for H₂, Power Purchase Agreement (Solar)

Duration: 2 years each

Business case analysis based on performance and cost data collect by NREL



Moving Forward

Extended Range Utility Vehicle

- Beginning Phase II: construct and implement 2 Phase I designs
 - Funding: \$3.5M amongst several awardees
 - Delivery expected Fall 2010



Spiral Development at DDSP & DDWG

- Expand the technical requirements and/or capacity of ongoing DLA demonstration projects
- Stock selectors and “Yard Tractor” source selection in Dec 2010



Ford ICE Bus

- Utilize H₂ capacity and expand interagency partnerships





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DLA H₂ R&D – Users' Lessons Learned

WARFIGHTER SUPPORT ENHANCEMENT

STEWARDSHIP EXCELLENCE

WORKFORCE DEVELOPMENT



Business Case Analysis

Analyzing the business case for fuel cell MHE at 4 sites:

- Teaming with NREL on data collection and analysis
- 99 fuel cell forklifts, 1 bus
- Will take 2-3 years to compile (protecting proprietary info)
- To support transition planning (R&D to operational)

Comparing:

- H₂ fuel cell vs. battery-electric and propane powered MHE
- Delivered liquid H₂ vs. H₂ produced on site vs. H₂ via solar-electrolysis
- Full fleet vs. partial fleet replacement

Cost categories included in analysis

- | | |
|--------------------------------|-----------------------------------|
| • Hydrogen production/delivery | • Refueling time |
| • Hydrogen infrastructure O&M | • Floor space (indoor & outdoor) |
| • Fuel cell O&M | • Power to operate infrastructure |



Lessons Learned: Project Development

- Work closely with host activities to:
 - Identify realistic goals and define program deliverables
 - Generate MOA with participants to establish and document responsibilities
- Track and implement improvements made along the way in future development
- Plan with the end in mind (consider transition from R&D early; consider the business case)





Lessons Learned: Develop Buy-In

Socialize early – instill confidence!

- Hold early and regular informational meetings
 - Command, Users, Union, PAO, Physical Security, **Fire Department**
- Hand out brochures
 - Highlight benefits but recognize safety concerns
- Focus on system safety features
 - Dispel “Hindenburg” misperceptions
- Provide awareness training for all employees
- Heavily promote response procedures





Lessons Learned: Permitting & Site Approval Process

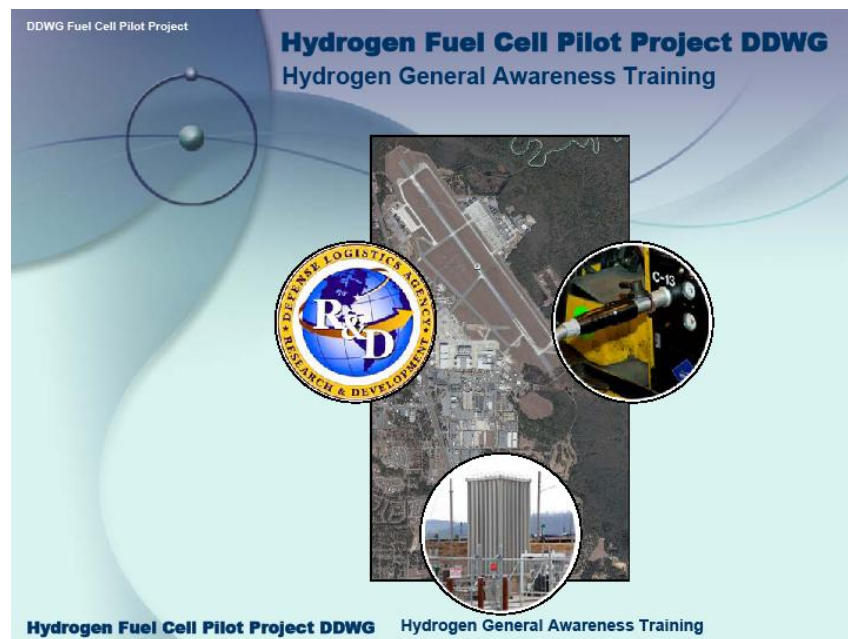
- Early introduction to site safety/environmental team
 - Developing codes/regulations slows approval process for state/Federal/site permitting
 - Uniform Facilities Code: review and analysis by FPE
- Share lessons learned
 - Share permitting process with DoD activities considering hydrogen pilot programs
 - Share permitting process with commercial sector generating codes and standards
 - Harmonize IFC, NFPA and UFC
 - UFC revision in 2009





Lessons Learned: Training

- Content specific to those being trained:
 - General Awareness Training
 - ~2500 trained
 - First responders
 - Refueling personnel
 - Forklift personnel
- Small training group size
 - Size as needed for hands-on interaction
- Complicated with more than one FC type
 - Physical aspects of fuel cells
 - Getting used to refueling
 - Running out of fuel





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DLA H₂ R&D – Industry's Lessons Learned

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Hydrogen and Fuel Cell Challenges

Challenges to widespread use:

- High cost
 - Fuel cells and hydrogen production
 - Even higher for 'green' hydrogen technologies
- Fuel cell durability
- Hydrogen storage
 - Onboard storage capacity for long range capability
- Infrastructure
 - Fueling stations
 - Production
 - Distribution
- Public acceptance
- Switching from production pathways focused on conventional feedstocks





Improved TRLs and MRLs

TRLs (Technology Readiness Levels)

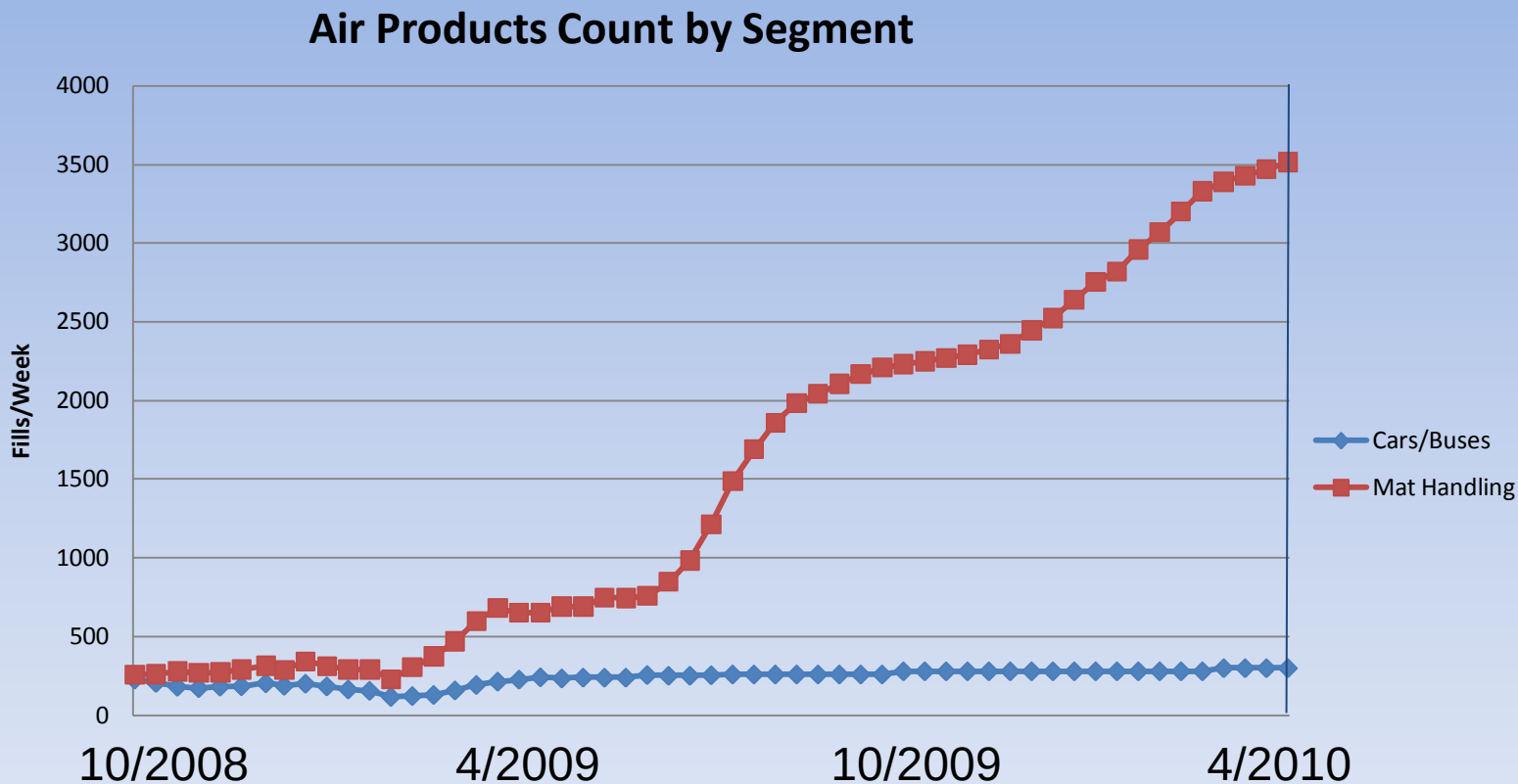
- A measure of technological readiness based on a defined set of criteria and standards.
- Used to quantify technology risk.

MRLs (Manufacturing Readiness Levels)

- A measure of manufacturing readiness or producibility based on a defined set of criteria and standards.
- Used to quantify manufacturing risk.



Hydrogen Dispenser Fills



DDSP: Over 50,000 operating hours, 15,000 refuelings, 10,000 kg of H₂ dispensed

Courtesy Air Products and Chemicals, Inc.



Improved TRLs and MRLs

- Improvements realized:

- High pressure CHC
 - first CHC 7000 at DDSP
 - 16 months operating data
- Cascading manifolds
 - actuated valves/fittings
- Dispenser reliability
 - check valves/nozzle
- Dispensing techniques
 - multiple vehicle logistics
- Dispenser installation codes
 - NFPA 52 2006 edition
 - changes in 2010 edition



- Anticipated

- On-site generation
- Distribution models
- Below grade storage
- MHE/Fuel cell interface



Prime Contractor Challenges

- Fuel Supply Options
 - SOG vs. SOE
 - On-site generation
- Pricing structure
 - Monthly Service Charge vs. Purchase
- Infrastructure equipment
 - demonstration to operation
 - significant change in usage
- OEMs / pack developers
 - Shifting market
- MHE
 - New market





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