The Defense Logistics Agency

Hydrogen & Fuel Cell Activity

USFCC - Matching Federal Government Needs

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The DLA Enterprise

FY02 Sales/Services:	$21.5B
FY03 Sales/Services:	$25B
FY04 Sales/Services:	$28B
FY05 Sales/Services:	$31.8B
FY06 Sales/Services:	$35.5B
FY07 Projected:	$34.6B

- Land/Maritime: $3.4B
- Aviation: $3.4B
- Troop Support: $12.7B
- Energy: $12.5B
- Distribution: $1.5B
- Other: $1.1B
- ~95% of Services' repair parts
- 100% of Services' subsistence, fuels, medical, clothing & textile, construction & barrier materiel

Foreign Military Sales

- Sales: $1.02B
- Shipments: 520K
- Supporting 126 Nations

Scope of Business

- 54,000 Requisitions/Day
- 8,200 Contracts/Day
- #58 Fortune 500 – Above Sprint Nextel
- #3 in Top 50 Distribution Warehouses
- 26 Distribution Depots
- 5.2 Million Items – eight supply chains
- 25M Annual Receipts and Issues
- 1411 Weapon Systems Supported
- 134M Barrels Fuel Sold
- $14.6B Annual Reutilizations/Disposals

People

- 20,805 Civilians
- 519 Active Duty Military
- 754 Reserve Military
- Located in 48 States/28 Countries

DOD's Role: Technology Transition
Historical vs. H2 Potential

Historical DOD Technology Transition

DOD: Basic, Applied, and Developmental R&D + Initial Production Buys

Industry: Leverage DOD Investment Into significant Business Opportunities


NC Tools


Microcircuits


GPS

Internet

Potential H2 DOD Technical Transition Model

DOE: Basic and Applied R&D

Industry: Development

- **ManTech for:**
  - **Infrastructure**
  - **Limited Prod Buys**

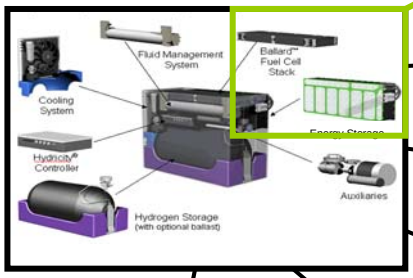
Industry Commercial Industrial Base — Spin Offs

Broad Military Production Base

Fuel Cell Benefit to DOD

Direct benefit to military applications

- **Increased Fuel Efficiency**
- **Quiet, low-heat, zero-emissions**
- **Energy density**
- **Fuel diversity**




Soldier Power


COMBATT APU


UAV


UUV


Micro-grids


Portable Gen-sets


DDX

Fuel Cell Industry View Points

Some of what we heard over the course of a dozen meetings in 2006:

- Fuel Cell volume is key to industry success
- Need to exercise component manufacturers to reduce cost and increase reliability
- Forklift applications are ready for early adopters

Fixed Installation and vehicle efforts can be complementary if properly coordinated

DLA's Hydrogen Logistics Program 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/MRLs)
  - Exercise the supply chain
  - Test under real world conditions
  - Provide feedback to manufacturers
- Highlight the business case for fuel cells

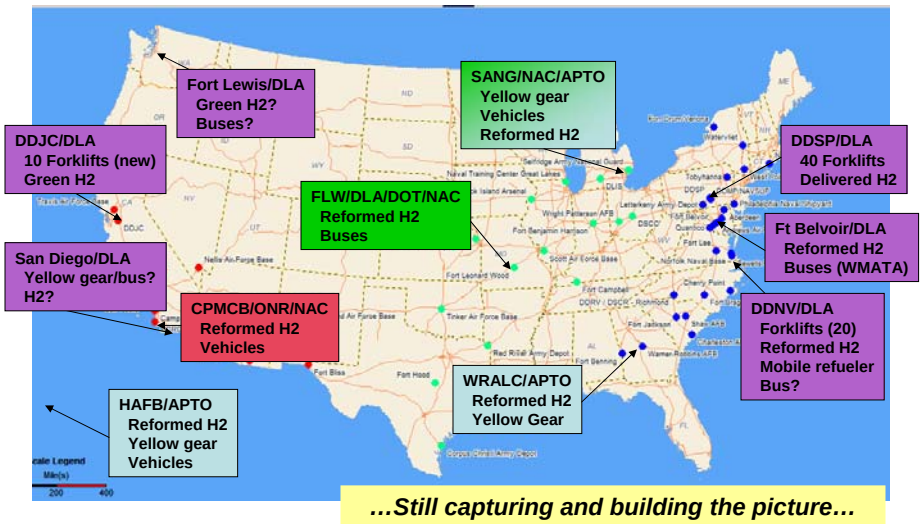
Nurture market momentum toward a tipping point for commercial acceptance

Hydrogen/Fuel Cell Program

- **H2 Fuel Cell Forklift Pilots**
  - Defense Depot Susquehanna, PA
  - Defense Depot San Joaquin, CA
  - Defense Depot Norfolk, VA/FISC Norfolk
  - Potential Sites
    - Naval Station San Diego/MCRD
    - NSWC Crane
- **R&D Program:**
  - Solid Hydrogen Storage Science and Technology Projects
  - Manufacturing Improvements for Man-Portable Fuel Cells
- **H2 Fueling Stations**
  - Fort Leonard Wood, MO (fueling outside gate)
  - Fort Belvoir, VA (WMATA Metro Connection)
  - Fort Lewis, WA (CoGen?)

DOD H2 & FC Activity

(work in progress)



…Still capturing and building the picture…

Manufacturing for the Hydrogen Economy Community of Interest (COI)

- Operates under National Science and Technology Council Interagency Working Group Charter
- Currently chaired by DoD

Goal:

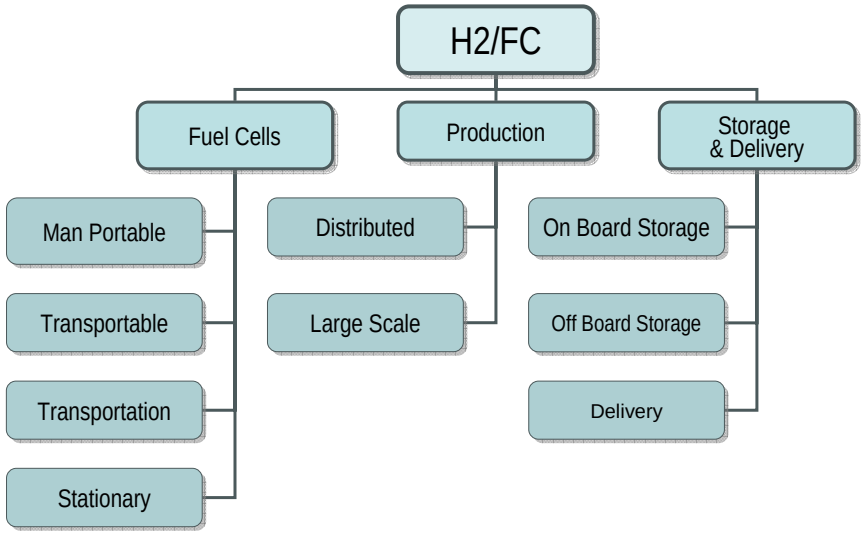
- Serve as a forum for developing consensus and resolving issues associated with H_2 and FC manufacturing R&D policy, programs and budget

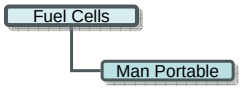
Members include:

✓Commerce (NIST/ITA)
✓Defense
✓Energy (NREL)
✓Transportation
✓Labor

- Health and Human Services/Nat. Inst. of Health
- Environmental Protection Agency
- NASA
- National Science Foundation

Fuel Cell MRL Taxonomy





Taxonomy Detail (an example)

Technology	Component	Subcomponent	Production Process/Function	MRL
PEM/DMFC	MEA	Membrane	Catalyst Deposition	6
	MEA	Membrane	High speed roll production	TBD
	MEA	Diffusion Layer	High speed forming and stamping	6
	MEA	Diffusion Electrode	High speed forming and stamping	6
	FC Stack		Recycling	1-3
	FC Stack		High speed seal	4-5
	FC Stack		Rapid leak detection	1-3
	H2 storage/stack interface			TBD
	Balance of plant			TBD
	Complete Unit		Automated process for assembly	1-3
	Complete Unit		Interim production volumes (5K-50K)	1-3

DoD Investments in MRL Advancement

Project Type	MRL Area of Focus	Current MRL	Funding
Fork Lifts/Infrastructure (at DDSP)	PEM Fuel Cells	4-6	Portion of $ 4.3 M
Fork Lift/Infrastructure (at DDNV)	PEM Fuel Cells	4-6	$ 0.8 M
Fork Lift/Infrastructure (at DDNV)	NG Reformation	5	Portion of $ 2.4 M
Fork Lift/Infrastructure (at DDNV)	Compressed Gas Storage, Composite Tanks	4	Portion of $2.4 M
Fork Lift/Infrastructure (at DDNV)	Delivery, Compressed Gas, Composite Tanks	1-3	$ 150 K
Fork Lift/Infrastructure (at DDJC)	PEM Fuel Cells	4-6	$ 0.7 M
Fork Lift/Infrastructure (at DDJC)	Hydrolysis	5-6	$ 0.4 M
Fork Lift/Infrastructure (at DDJC)	Compressed Gas Storage, Metal Tanks	9-10	$ 0.3 M

DoD Investments in MRL Advancement

Project Type	MRL Area of Focus	Current MRL	Funding
Solid Hydrogen Storage, Rapid material ID	Materials Suitability	TBD	$ 0.5 M
Solid Hydrogen Storage, Subscale prototypes	Reactants, Balance of Plant	TBD	$ 1.0 M
Next Gen. Manufacturing Technology Initiative	Man Portable PEM/DMFC, MEA, Membrane	6	$ 225 K
Next Gen. Manufacturing Technology Initiative	Man Portable PEM/DMFC, MEA, Diffusion Layer and Electrode	6	$ 200 K
Next Gen. Manufacturing Technology Initiative	Man Portable PEM/DMFC, FC Stack	1-3	$ 475 K

How Industry Can Help

To maximize synergies between DoD and Industry efforts, we need Industry to:

- Support progress of MRLs and TRLs
  - Communicate with DoD about key technical roadblocks
  - Identify areas that can be supported through DoD funded projects
- Be aware of DoD funding opportunities/BAAs
  - Visit:
    - http://www.crane.navy.mil/acquisition/homepage.htm
    - http://www.fedbizopps.gov/

Warfighter Support – Where Your Industry Fits

- Address Warfighter needs
- Ensure your product brings a clear advantage to Warfighter
- Warfighter already has enough challenges … don't add to his or her problems … e.g., how do you fuel it?
- Lives depends on products working
- That said … Warfighter always seeks an advantage

DOD Installation Support

- Installations are DOD's communities … power & energy requirements mirror the private sector in community and industrial needs
- Installations needs include watt to megawatt requirements … portable, stationary, remote, & transportation opportunities
- Potential DOD users remain stewards of the nation's environment, and of taxpayer dollars

Summary

- DLA has a strong interest in creating market momentum
- Concurrently advancing hydrogen production and storage as well as fuel cell production efforts
- DLA/Defense Depot Pilots
  - H_2 Fuel Cells have potential to improve DLA Distribution Operations
  - Testing at Defense Depots will provide real data
    - Allows for informed decision making for DoD and others
  - If successful, could extend pilots to other DoD facilities
- Other opportunities being explored
  - Fuel cell MRL Advancement
  - Solid hydrogen storage

Program success will significantly contribute to our nation's energy initiatives.

BACKUPS

Round 1 – Defense Depot Susquehanna, PA

Objectives:
- Explore fuel cell infrastructure and functionality with forklifts
- Develop a business case for fuel cells
- Collect and analyze operational data

Approach:
- Conduct Fly-Off between two fuel cell producers
- Retrofit 40 forklifts with fuel cells
- Set up storage & dispensing systems for delivered H_2

DOD Impacts:
- Develop knowledge of fuel cell powered fork lift capabilities, costs, limitations and benefits
- Improve MRLs and costs

Customers:
- DDC/DDSP

Performers: Air Products/General Hydrogen & East Penn/Nuvera

Milestones:
- Contract award – June 2007
- First Articles – Summer 2007

Budget: $4.3 M

Round - 2a Defense Depot Norfolk, VA

Objectives:
- Expand infrastructure exploration to include on-site reformation and mobile refueling
- Continue to develop a business case for fuel cells
- Collect operational data, including reformation and mobile refueling

Approach:
- Retrofit 20 forklifts with fuel cells
- Set up infrastructure for onsite H_2 reformation
- Test mobile refueling for multiple sites

DOD Impacts:
- Further knowledge of fuel cells, on-site reformation, and mobile refueling
- Improve MRLs and costs for fuel cells and infrastructure

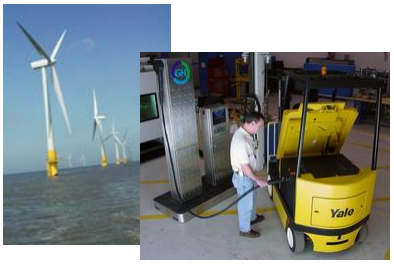
Customers:
- DDC/DDNV/FISC

Performers: CTC/Air Products/Hydrogenics

Milestones:
- BAA – 23 January 2007
- Proposals due – 1 March 2007
- Contract Award – Summer 2007
- First Articles – Late Summer 2007

Budget: $4.15 M

Round - 2b Defense Depot San Joaquin, CA



Objectives:
- Expand project scope to include "green" hydrogen production
- Explore implications of MHE replacement
- Continue to develop business case and collect operational data for forklifts

Approach:
- Replace 10 conventional forklifts
- Set up infrastructure for onsite H2 reformation using "green" energy

DOD Impacts:
- Improve MRLs for fuel cells
- Expanded knowledge of fuel cell costs and benefits
- "Green" hydrogen – reduced CO2 emissions

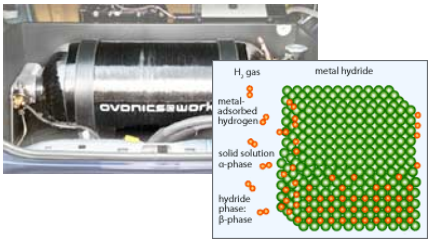
Customers:
- DDC/DDJC

Performers: Hyster, Hydrogenics/General Physics

Milestones:
- RFP – 23 January 2007
- Proposals due – 1 March 2007
- Contract Award – August 2007
- First Articles – Fall 2007

Budget: $2.2 M

Round 3 - Solid Hydrogen Storage



Objective:
- Support the development of efficient and effective H_2 storage for fuel cells
- Develop ability to model and evaluate storage technologies

Approach:
- Demonstrate subscale technologies for solid hydrogen storage systems
- Identify and use novel materials to produce an H_2 storage system.
- Create a system for evaluating potential storage device materials

DOD Impacts:
- Advance TRLs for critical H_2 storage needs
- Expand S&T base for hydrogen fuel cell storage capabilities

Customers:
- DLA/Navy/DOE

Performers: UCF, UC Berkeley, Miami of Ohio, ECD, U of Missouri

Milestones:
- RFP – February 2007
- Proposals due – April 2007
- Contract award – August 2007
- First Articles – TBD

Budget: $1.5M

Round 4 – NGMTI/ATI Fuel Cell ManTech

Objectives:
- Improve fuel cell manufacturing capabilities to meet DOD needs
- Identify and solve key manufacturing issues involved with small scale fuel cells

Approach:
- Determine requirements, develop manufacturing techniques
- Using the results, construct a 100-200 W Polymer Electrolyte Membrane (PEM) powered device suitable for DOD application

DOD Impacts (be specific to military:
- Improved MRLs for small scale fuel cells
- Improve capabilities of manufacturers to meeting DOD needs

Customers:
- DLA/NSWC/?

Performers: TBD

Milestones:
- Contract award – April 2007
- First Articles – June 2007
- Project Completion – April 2008

Budget: $1.2M

Round 5 – Defense Depot San Diego

Objectives:
- Explore various infrastructure configurations and fuel cell functionality
- Develop a business case for fuel cells

Approach:
- TBD, but potential inclusion of forklifts
- Potential focus on non-tactical vehicle use and fueling infrastructure

DOD Impacts:
- Deeper knowledge of fuel cell costs and operational considerations
- Improve MRLs and reduce costs

Customers:
- DDC/DDSC/FISC(?)

Performers:
- TBD

Milestones:
- TBD

Budget: $3-5M

Community of Interest

Activities:

- Charter established
  - Meeting every second Tuesday (1-4 PM)
- Developing a Taxonomy of Hydrogen Fuel Cell and Hydrogen Production Manufacturing
- Apply Manufacturing Readiness Levels to the Taxonomy

Advancing Fuel Cell Readiness

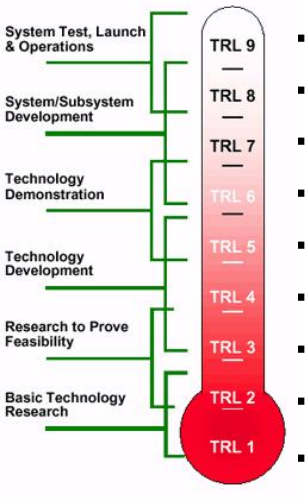
***TRLs* (Technology Readiness Levels)**

- A measure of technological readiness based on a defined set of criteria and standards.
- Used to determine, define and 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 determine, define and quantify manufacturing risk.

TRL Definitions



- **Actual system "proven" through successful mission operations**
- **Actual system completed and "qualified" through test and demonstration**
- **System prototype demonstrated in a relevant environment**
- **System/subsystem model or prototype demonstrated in a relevant environment**
- **Component and/or breadboard validated in a relevant environment**
- **Component and/or breadboard validation in a laboratory environment**
- **Analytical and experimental critical function and/or characteristic proof-of-concept**
- **Technology concept and/or application formulated**
- **Basic principles observed and reported**

MRL Definitions

MRL	Definition	Description
1-3	Manufacturing concepts Identified	Identification of current manufacturing concepts or producibility needs based on laboratory studies.
4	System, component or item validation in laboratory environment.	This is the lowest level of production readiness. Technologies must have matured to at least TRL 4. At this point few requirements have been validated and there are large numbers of engineering/design changes. Component physical and functional interfaces have not been defined. Materials, machines and tooling have been demonstrated in a laboratory environment. Inspection and test equipment have been demonstrated in a laboratory environment. Producibility assessments have not been initiated.
5	System, component or item validation in initial relevant environment. Engineering application/bread board, brass board development.	Technologies must have matured to at least TRL 5. At this point all requirements have not been validated and there are significant engineering/design changes. Component physical and functional interfaces have not been defined. Materials, machines and tooling have been demonstrated in a relevant environment but most manufacturing processes and procedures are in development (or MANTECH initiatives ongoing). Inspection and test equipment have been demonstrated in a laboratory environment. Producibility assessments have not been initiated.
6	System, component or item in prototype demonstration beyond bread board, brass board development.	During the prototype demonstration phase requirements are validated and defined. However, there are still many engineering/design changes and physical and functional interfaces are not yet fully defined. Technologies must have matured to at least TRL 6. Raw materials are initially demonstrated in relevant environment. Similar processes and procedures have been demonstrated in relevant environment. At this point there are likely major investments required for machines and tooling. Inspection and test equipment should be under development. Producibility risk assessments should be initiated.
7	System, component or item in advanced development.	Technologies must have matured to at least TRL 7. At this point engineering/design changes should decrease. Physical and functional interfaces should be clearly defined. All raw materials are in production and available to meet planned LRIP schedule. Pilot line manufacturing processes and procedures set-up and under test. Processes and procedures not yet proven or under control. During this phase initial producibility risk assessments should be started.

MRL Definitions (cont)

MRL	Definition	Description
8	System, component or item in advanced development. Ready for low rate initial production.	Technologies must have matured to at least TRL 8. At this point engineering/design changes should decrease significantly. Physical and functional interfaces should be clearly defined. All raw materials are in production and available to meet planned LRIP schedule. Manufacturing processes and procedures have been proven on the pilot line, under control and ready for low rate initial production. During this phase initial producibility risk assessments should be completed.
9	System, component or item previously produced or in production. Or, the system, component or item is in low rate initial production. Ready for full rate production.	During low rate initial production all systems engineering/design requirements should be met and there should only be minimal system engineering/design changes. Technologies must have matured to at least TRL 9. Materials are in production and available to meet planned production schedules. Manufacturing processes and procedures are established and controlled in production to three-sigma or some other appropriate quality level. Machines, tooling and inspection and test equipment deliver three-sigma or some other appropriate quality level in production. Production risk monitoring is ongoing.
10	System, component or item previously produced or in production. Or, the system, component or item is in full rate production.	This is the highest level of production readiness. There are minimal engineering/design changes. System, component or item is in production or has been produced that meets all engineering, performance, quality and reliability requirements. All materials, manufacturing processes and procedures, inspection and test equipment, controlled in production to six-sigma or some other appropriate quality level in production. A proven, affordable product able to meet required schedule.

MRL Taxonomy

- MRL Mapping exercise conducted 27 February with technical experts from:
  - DLA
  - OSD
  - DOE
  - DRC
  - BMP COE
  - INREL
- We presented the results of that meeting at the March COI
- Based on comments and ongoing modifications, the latest taxonomy: