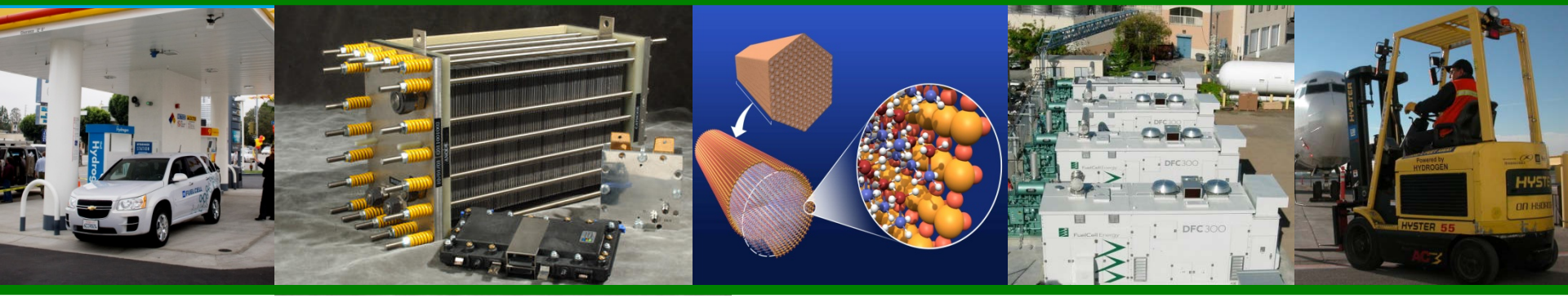
U.S. DEPARTMENT OF ENERGY



Market Transformation
- Plenary Presentation -

Pete Devlin

2017 Annual Merit Review and Peer Evaluation Meeting

June 5 - 9, 2017

Goals and Objectives for Market Transformation

Objectives

- Catalyze key program activities and partnerships with federal, state, and local governments
- Develop technical-economic analysis associated with user applications and fuel infrastructure
- Provide technical assistance to increase hydrogen fuel use

GOALS: Accelerate technology viability for domestically produced hydrogen and fuel cell systems. Lower fuel cell and fuel costs by reducing deployment barriers.

Challenges

To test new technology applications in user operating conditions to establish baseline energy efficiency and reliability performance

Examples:

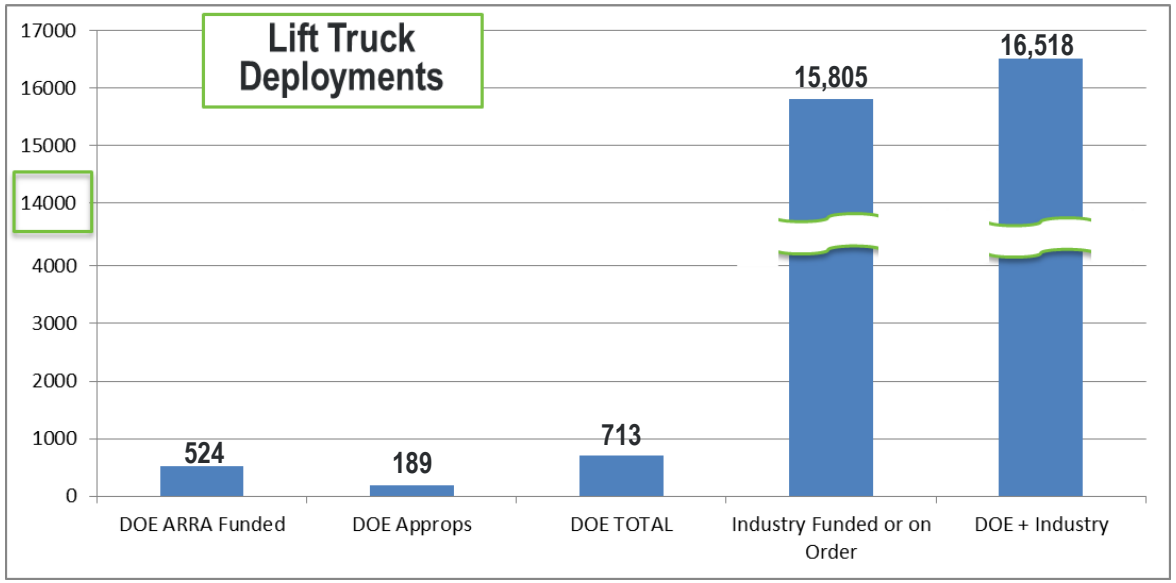
First fuel cell cargo tow trucks at U.S. airport

APU for truck refrigeration

BEV-FC parcel delivery truck

Maritime fuel cell 100 kW generator

Market Transformation Deployments

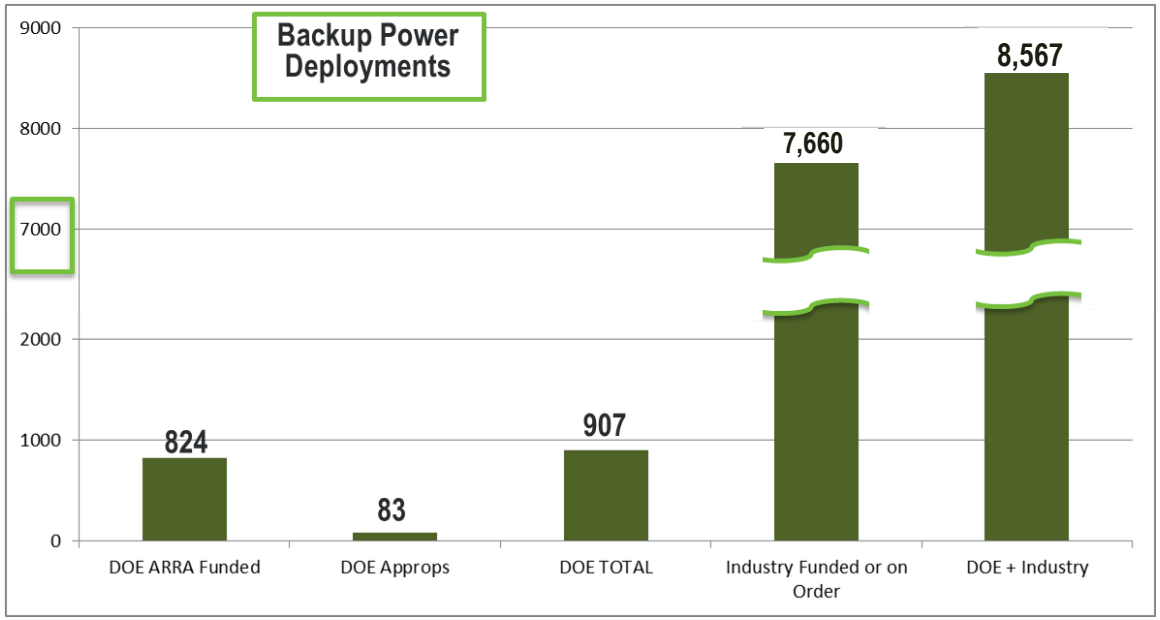


The successful deployment of 713 DOE fuel cell material handling units has led to over **16,500 industry purchased** and on order units with no DOE funding.

41% increase from prior total

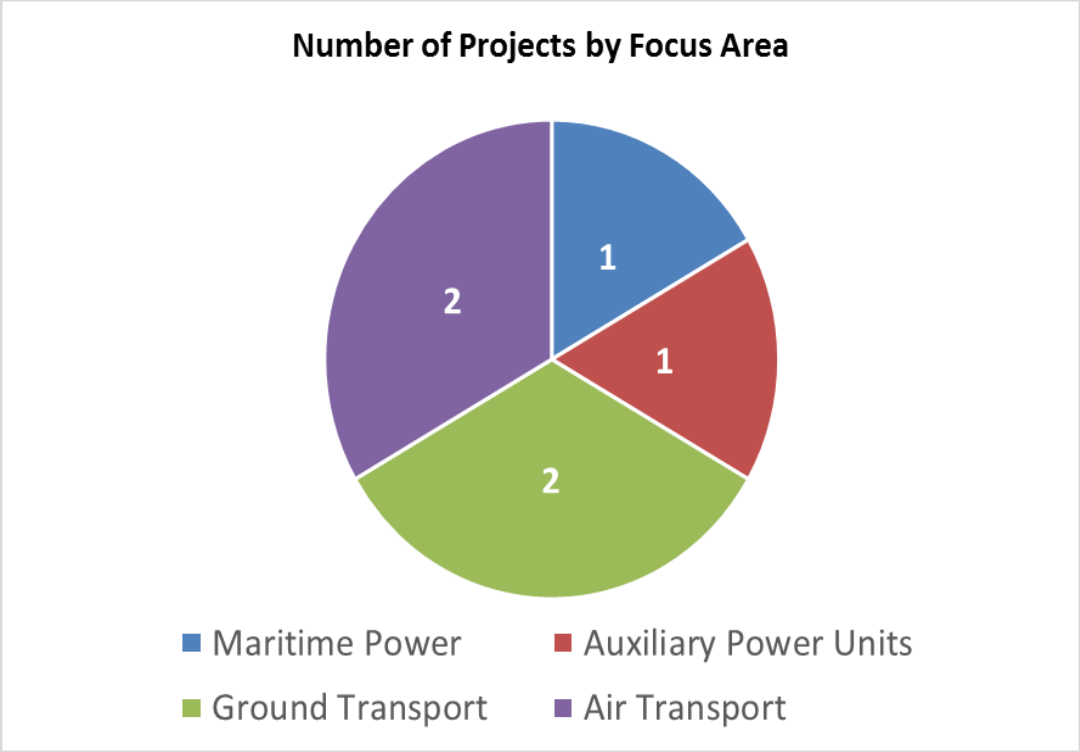
The funding of 907 DOE fuel cell backup power systems has led to over **8,500 industry installations** and on-order backup power units with no DOE funding.

9% increase from prior year total



Market Transformation Projects

FY 2017 Appropriation = $0M*



EMPHASIS

- Conduct airport cargo tow tractor evaluation (prior year)
- Conduct LDV range extenders and truck APU evaluations (prior year)
- Conduct infrastructure technology support activities
- Evaluate advanced UAV research concepts

***$1 Million in CR Funds**

Light Duty Range Extended Cargo Vans

Project Background:

- Concept: ***Fuel cell hybrid drivetrain significantly extends zero-emission driving range vs. battery only***
- Project Team: US Hybrid (prime), Nissan, ANL, and National Grid (fleet operator)

Project Scope:

- Phase 1: development phase to build & test prototype range-extended delivery van
- Phase 2: two-year demo of multi-unit fleets at host site under "real world" operating environments.

Accomplishments:

- Completed first prototype cell stack assembly for validation testing
- Initiated power plant packaging design

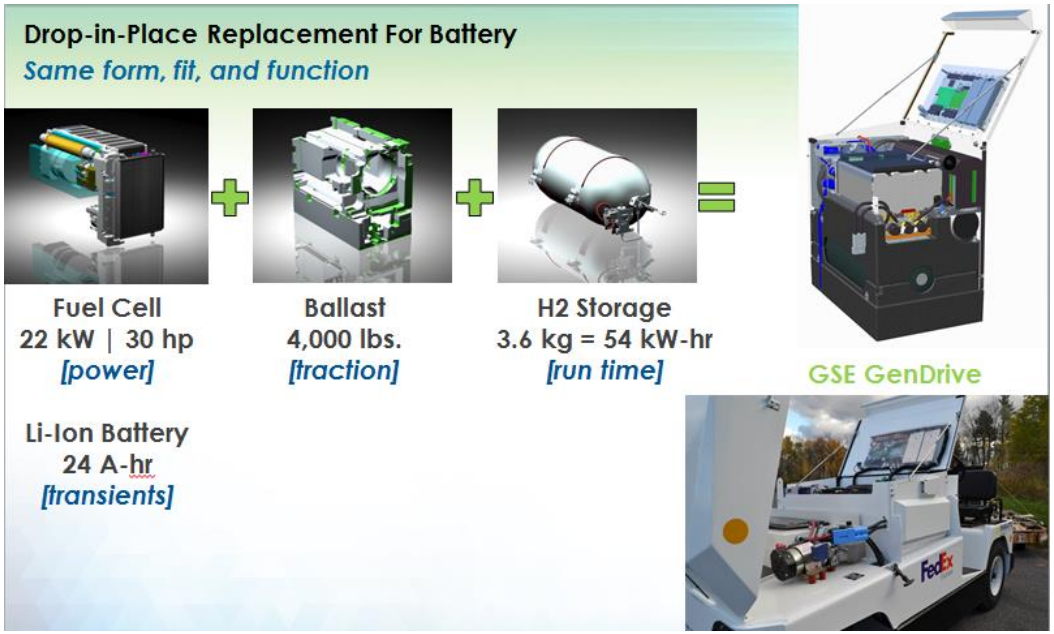
Airport Cargo Tow Tractors

Project Background:

- Concept: *Fuel cells can operate as cargo haulers in airport environments*
- Project Team: FedEx (prime), Plug Power, Charlatte

Accomplishments:

- Completed fleet re-build and commissioning of cargo tractors at Memphis Airport
- > 90% availability vs. 80% target



FC Auxiliary Power Unit Powering Truck Refrigeration Units (TRU)

Background:

- Concept: ***Demonstrate the viability of fuel cell-based Transport Refrigeration Units (TRUs) for refrigerated Class 8 trucks using demonstrations and business case development***
- Team I (multi-temp): Nuvera, ThermoKing
- Team II (Single-Temp): Ballard, Carrier, Walmart

Project Scope:

- Phase I (completed): Assembly and test of 1st prototype unit; Evaluated business cases – "go" decision for multi-temp and "no go" decision on single-temp
- Phase II : complete system build and perform functional testing.
- Phase III: evaluate system roadworthiness, integrate with TRU, and complete the 800 hours of demonstration.

Accomplishments:

- Successfully demonstrated integration.
- Next will integrate inverter and TRU into system for full 8 hour lab demonstration

BEV-FC Parcel Delivery Trucks

Project Background:

- Concept: *Incumbent urban "last mile delivery" trucks (Class 4-6) typically powered by engines not designed for low emissions – significant impact on NOx, PM, and GHG emissions*
- 150-mile driving range
- Project Team: FedEx (Prime), Plug Power, Workhorse
- Drivetrain Specifications:
  - 80 kWh Li-On battery pack
  - 20 kW PEM fuel cell
  - 11.6 kg On-board H2 storage (11 kg usable)
  - TM4 motor, driveshaft
  - 430V battery bus

Accomplishments:

- Completed first prototype truck detailed design
- Completed FC system Factory Acceptance
- Completed chassis build and body fitting

Accomplishments

Maritime Fuel Cell Generator Project:

- **Lower the technology risk of future port fuel cell deployments by providing:**
  - **performance data of H2-PEMFC technology in this environment**
  - **a validated economic assessment for this and future potential projects**
- **Enable easier permitting and acceptance of H2-FC technology in maritime applications by assisting USCG and ABS develop H2+FC codes and standards**
- **Complete Phase 1 operations**

Accomplishments

North East States Infrastructure Technical Assistance:

- Conducted education webinar for NYC Department of Citywide Administrative Services
- Conducted market transformation and safety classes in New York City, Long Island, and Boston for state and local fire and building code officials
- Educated safety fire marshals and code officials in CT, MA, NJ, NY, and RI

Private Investor Outreach:

- Held 2 investor seminars in Fall and Spring with 10 to 12 investors in attendance
- Anglo American Platinum invested $4m in United Hydrogen Group to reopen the JFK station and build additional Northeast hydrogen infrastructure
- The Massachusetts Clean Energy Center awarded SimpleFuel a grant funding to install a station in Somerville, MA

Station Ground Breaking – Stations have broken ground in CT and RI. MA station ground breaking is imminent.

Accomplishments

Hawai'i Project Highlights

- Fleet of 3 fuel cell buses
- Fleet of 3 hydrogen tube trailers
- Setting up "Hydrogen Hub" on NELHA campus to leverage hydrogen infrastructure.
- Developed novel system to reduce H2 delivery costs by 50%
- $1.2 million from state of Hawaii for NELHA site infrastructure.
- Executed MOA with Hawaii Volcanoes National Park

1 County of Hawaii Bus

2 HAVO Buses

3 Tube Trailers

New Compression Post

Collaboration - Project Highlights

Collaboration with ARMY Tank Automotive Research, Development and Engineering Center (TARDEC)

January 2107 workshop with military on multi-feedstock reformers and APUs for armored vehicles – main findings:

- **Saves petroleum**
- **Makes potable water**
- **Extremely quiet - Warfighter lives saved within logistics and tactical protection vehicle**

R & D needs:

1) **Small SMR system that reforms JP8**
2) **5 kW APU for armored vehicles**

GM ZH_2

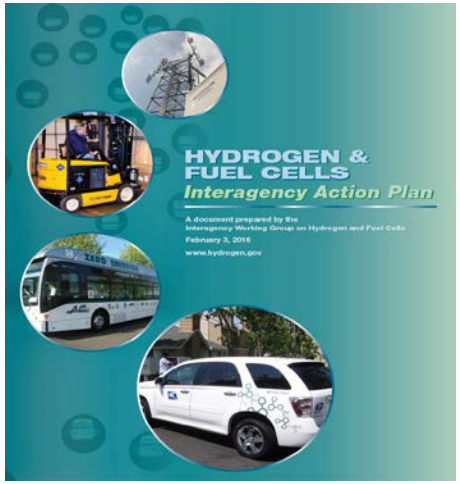
Dr. Paul Rogers Presenting at Jan 2017 Workshop

Interagency Working Group (IWG) on H2 and Fuel Cells

IWG Members: DOD, DOE, DOL, DOT, EPA, FAA, GSA, HCATT, HUD, NASA, NIST, NPS, NREL, NSF, PNNL, USDA, USPS, VA

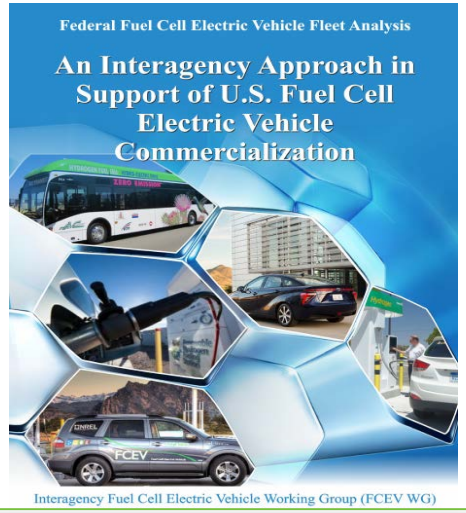
Interagency Action Plan:

- Published December 2011, updated in 2015
- Agencies came together to delineate responsibilities and explore leveraging opportunities
- New version coming online this year



Federal FCEV Fleet Analysis:

- Completed IWG report that describes a Federal fleet program strategy
- Strategies show locations and quantities for near term deployment



Bringing FCEVs into Federal Fleets:

- Developed SoCal Fed pilot fleet of ~10 vehicles

Facilitating Supply:

- Led development of coordinated effort (GSA Schedule 751)

RESULT:

GSA now has FCEVs available for lease

Collaborations

INDUSTRY

- Plug Power
- Nuvera
- US Hybrid
- Hydrogenics
- Proton OnSite
- FedEx
- Workhorse
- UPS
- Air Liquide
- General Motors
- Nissan North America
- Toyota
- Hyundai
- Honda

National Collaborations (inter- and intra-agency efforts)

- EPA
- SCRA
- DOT:
  - MARAD
  - FTA
- NPS
- GSA
- H2USA
- DOD:
  - ARMY
  - NAVY
  - USMC
  - USAF
- HCATT
- CCAT

Applied R&D is coordinated among national and international organizations

Ongoing Activities

Early Markets:

- Up-take in fuel cell-based forklifts and backup power systems continues strong annual growth -- 41% for forklifts and 9% for backup power since 2016.
- Commercial introduction in emerging applications such as cargo tractors and truck APUs in target regions is underway.

Road Vehicles:

- Develop and demonstrate both medium and light duty EV range extender trucks in commercial operations such as parcel delivery and dispatchable services

Refueling Infrastructure:

- Collaborating with industry and other federal agencies on site-specific analyses and novel refueling technologies

Contacts

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Backup Slides

Accomplishments: Hawaii "Hydrogen Hub"

H2wai'i

NELHA "Hydrogen Hub" Co-Located with Small Business Development Center

Setting up "Hydrogen Hub" on NELHA campus to leverage hydrogen infrastructure