Technology Validation assesses the performance and durability of new technologies to provide feedback to the R&D sub-programs and confirm readiness for commercialization.

DOE Program Structure

Technology Validation Activities

Basic & Applied Research and Technology Development

- Hydrogen Fuel R&D
  - Production
  - Delivery
  - Storage

Fuel Cell R&D

Technology Validation

Market Transformation

WIDESPREAD COMMERCIALIZATION ACROSS ALL SECTORS

- Transportation
- Stationary Power
- Auxiliary Power
- Backup Power
- Portable Power

Systems Integration & Analysis

Manufacturing R&D

Safety Codes & Standards

Education
Goal & Objectives

Goal: Validate the state-of-the-art of fuel cell systems in transportation and stationary applications as well as hydrogen production, delivery and storage systems. Assess technology status and progress to determine when technologies should be moved to the market transformation phase.

Objectives:

- By 2017, validate commercial fuel cells (100 kW to 3 MW) against 2015 system targets (50,000 h, 45% electrical efficiency).
- By 2017, validate durability of auxiliary power units (APUs) against 2015 fuel cell system target (15,000 h, 35% electrical efficiency).
- By 2019, validate hydrogen fuel cell electric vehicles with greater than 300-mile range and 5,000 hours fuel cell durability.
- By 2019, validate a hydrogen fueling station capable of producing and dispensing 200 kg/day H₂ to cars and/or buses.
EMPHASIS

- Data collection, analysis and evaluation. (leverages equipment funded outside the Program)
  - Light-duty vehicles, buses and hydrogen refueling stations. (Collaboration on buses with DOT)
  - Forklifts and Backup Power
  - Stationary Fuel Cells

- Real-world demonstration / evaluations (small number of units for validation purposes)
  - Wind to Hydrogen
  - Innovative refueling components
  - Advanced hydrogen delivery

Subject to appropriations, project go/no go decisions and competitive selections
<table>
<thead>
<tr>
<th>Funding Opportunity Announcement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Light-Duty Fuel Cell Electric Vehicle Validation Data</strong></td>
</tr>
<tr>
<td>Supply dynamometer and real-world vehicle data to the Hydrogen Secure Data Center (HSDC) at the National Renewable Energy Laboratory (NREL) for analysis and aggregation into composite data products for a minimum of five vehicles of the same model.</td>
</tr>
<tr>
<td>~$6M ($500k to $2M per award, up to 5 year period)</td>
</tr>
<tr>
<td>Applications Due 4/30 (Issue Date 2/29)</td>
</tr>
<tr>
<td><strong>Validation of Hydrogen Refueling Station Performance and Advanced Refueling Components</strong></td>
</tr>
<tr>
<td><strong>Hydrogen Refueling Station Data Collection</strong></td>
</tr>
<tr>
<td>Supply hydrogen refueling station data to the Hydrogen Secure Data Center (HSDC) at the National Renewable Energy Laboratory (NREL) for analysis and aggregation into composite data products. ~$1.2M, $400k (max) per award (up to 5 year period)</td>
</tr>
<tr>
<td><strong>Validation of Advanced Refueling Components</strong></td>
</tr>
<tr>
<td>Advanced components to be validated may include, but are not limited to, compressors, electrolyzers, hydrogen delivery, hydrogen storage systems, and dispenser systems or components, such as flow meters, nozzles or communications systems.</td>
</tr>
<tr>
<td>~$3M, $1M (max) per award (up to 5 year period)</td>
</tr>
<tr>
<td>Applications Due 5/21 (Issue Date 3/13)</td>
</tr>
</tbody>
</table>
Learning Demonstration has provided valuable real-world data from fuel cell vehicles and hydrogen infrastructure.

- Data has been collected on 183 fuel cell vehicles and 25 hydrogen fueling stations during the Learning Demonstration
- 3.6 million miles traveled
- Over 151,000 kg of hydrogen produced or dispensed*
- Fuel cell efficiency 53-59%
- Range 196 - 254 miles
  - separately validated 430 mile range
- Fuel cell durability
  - 2,521 hours projected (~75k miles)
- 5-minute refueling time (4 kg of hydrogen)
- H₂ cost**- onsite reformation: $7.7 - $10.3/gge
- H₂ cost**- onsite electrolysis: $10 - $12.9/gge

* Not all of the hydrogen was used in Learning Demonstration vehicles.
**cost will reduce dramatically with increased number of stations
## Second-Generation Fuel Cell Buses

### Bus fleet leaders
- 3 FCPPs over 6,000 hours without repair or cell replacements
- Top FCPP now over 11,000 hours

### Total U.S. FC bus fleet
- 22 currently active
- 4 additional expected in 2012

### Cumulative hours per bus

<table>
<thead>
<tr>
<th>Transit Agency</th>
<th>Project</th>
<th>Location</th>
<th>No. buses</th>
<th>Start-up date</th>
</tr>
</thead>
<tbody>
<tr>
<td>SunLine</td>
<td>Adv. Tech FCEB</td>
<td>Thousand Palms, CA</td>
<td>1</td>
<td>May 2010 *</td>
</tr>
<tr>
<td>AC Transit</td>
<td>ZEBA</td>
<td>Emeryville, CA</td>
<td>12</td>
<td>June 2010 *</td>
</tr>
<tr>
<td>CTTRANSIT</td>
<td>NFCBP: Nutmeg</td>
<td>Hartford, CT</td>
<td>4</td>
<td>Aug 2010 *</td>
</tr>
<tr>
<td>SunLine</td>
<td>NFCBP: AFCB</td>
<td>Thousand Palms, CA</td>
<td>1</td>
<td>Jan 2012</td>
</tr>
<tr>
<td>SFMTA</td>
<td>NFCBP: Bus 2010</td>
<td>San Francisco, CA</td>
<td>1</td>
<td>Jun 2012</td>
</tr>
<tr>
<td>Cap Metro</td>
<td>NFCBP: Proterra</td>
<td>Austin, TX</td>
<td>1</td>
<td>April 2012</td>
</tr>
</tbody>
</table>

* Data analyzed to date

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Fuel Cell Buses have 2X Fuel Economy, Meeting 8 mdpge Target

Validation of an Integrated Energy Station

System produces hydrogen and electricity from wastewater gas—mitigating treatment plant emissions while producing high-grade, high-value energy products.

FuelCell Energy

- Fueled with Orange County municipal wastewater gas
- Produces 100 kg/day H₂ (350 and 700 bar)
- Generates approximately 250 kW
- 54% efficiency coproducing H₂ and electricity

Funding Partners: CARB, SCAQMD and DOE
Technology Validation Projects

Technology validation projects follow R&D portfolio and leverage ARRA activities.

Wind 2 Hydrogen (Harrison/Ainscough, NREL)
- Electrolyzers (both alkaline & PEM) provide grid frequency regulation support, eliminating frequency disturbances up to 4x faster than the control with no electrolyzers
- 5500 hours of electrolyzer stack operation on variable wind power
- Designed, built and now validating hydrogen flow from electrolyzers and hydrogen dispensers with volumetric-based mass flow device

Next Generation H2 Fueling and Component Analysis (Sprik, NREL)
- Updated infrastructure data collection templates
- Developed First Set of CDPs from four stations providing data (Spring 2012)

Stationary Fuel Cell Evaluation (Kurtz, NREL)
- Partner with end users, state collaborations, and fuel cell developers to create data sets of stationary fuel cell systems operating in real-world conditions
- Collecting data from collaborators NFCRC and CaSFCC to publish first set of composite data products Fall 2012

Fuel Cell Forklift and Backup Power Evaluations (Kurtz, NREL)
- Operating reliably in 15 states with 99.7% successful starts
- 29 hours maximum continuous run-time due to a grid outage
- >98% FC Material Handling Equipment (MHE) availability
- Majority of MHE systems operate > 6 hours/day
- Significant savings in refueling labor and space, greater cost for H2 infrastructure and fuel
Technology Validation Plan

Major milestones & future solicitations*

Dec 8: Hawaii LOU Hawaii Hydrogen Initiative (H2I)

March 31 RFI issued

June 1: Technology Validation RFI Closes

Complete Interim MYRDD Plan Update

Issue Technology Validation Solicitations

Solicitations Close

Awards Made

Issue Technology Validation Solicitation

Solicitation Closes

Awards Made

Workshop or RFI

Solicitation Closes

Awards Made

Workshop or RFI

FY 2011

FY 2012

FY 2013

FY 2014

*Subject to appropriations
Session Instructions

• This is a review, not a conference.
• Presentations will begin precisely at scheduled times.
• Talks will be 20 minutes and Q&A 10 minutes.
• Reviewers have priority for questions over the general audience.
• Reviewers should be seated in front of the room for convenient access by the microphone attendants during the Q&A.
• Please mute all cell phones and other portable devices.
• Photography and audio and video recording are not permitted.
Reviewer Reminders

• Deadline to submit your reviews is **May 25th at 5:00 pm EDT.**

• ORISE personnel are available on-site for assistance.
  
  • **Reviewer Lab Hours:** Tuesday – Thursday, 7:30 am – 8:30 pm; Friday 7:30 am – 1:00 pm.

  • **Reviewer Lab Locations:**
    
    • Crystal Gateway Hotel—Rosslyn Room (downstairs, on Lobby level)
    • Crystal City Hotel—the Roosevelt Boardroom (next to Salon A)

• Reviewers are invited to a brief feedback session – at 5:30 pm today, in this room.
### Technology Validation

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
<th>Email</th>
</tr>
</thead>
<tbody>
<tr>
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<tr>
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<td><a href="mailto:james.alkire@go.doe.gov">james.alkire@go.doe.gov</a></td>
</tr>
</tbody>
</table>

**National Renewable Energy**

**Laboratory Support:**
- Keith Wipke
- Sam Sprik
- Jennifer Kurtz
- Todd Ramsden
- Leslie Eudy
- Chris Ainscough
- Genevieve Saur
Participating Organizations

Technology Validation

Air Products & Chemicals, Inc.
General Motors Corporation
Mercedes Benz R&D, North America
Ford Motor Company
National Renewable Energy Laboratory
CA Fuel Cell Partnership
BP America Inc.
Chevron Technology Ventures, LLC
Hyundai-Kia
UTC Power
Shell Hydrogen
National Fuel Cell Research Center, U.C. Irvine
Hydrogen Frontier, Inc.
U.S. Department of Transportation
AC Transit
CTTRANSIT
SunLine
City of Burbank
Ballard Power Systems, Inc.
Hydrogenics Corporation