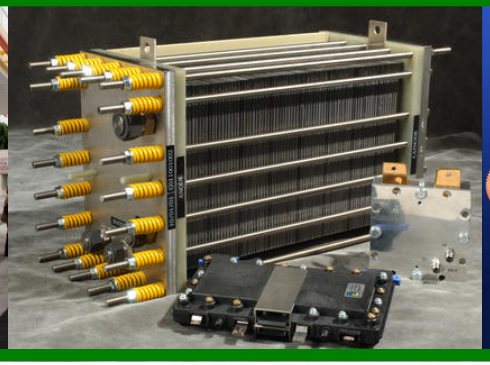
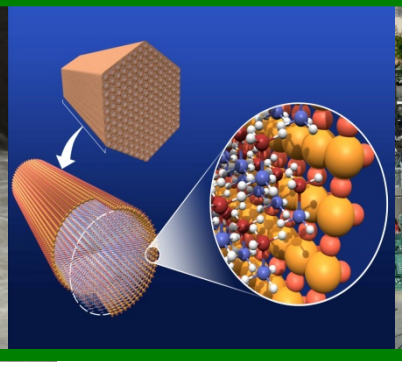
U.S. DEPARTMENT OF ENERGY

# Technology Validation
# - Session Introduction -

*Jason Marcinkoski*

*2012 Annual Merit Review and Peer Evaluation Meeting*

*May 17, 2012*

# Technology Validation Activities

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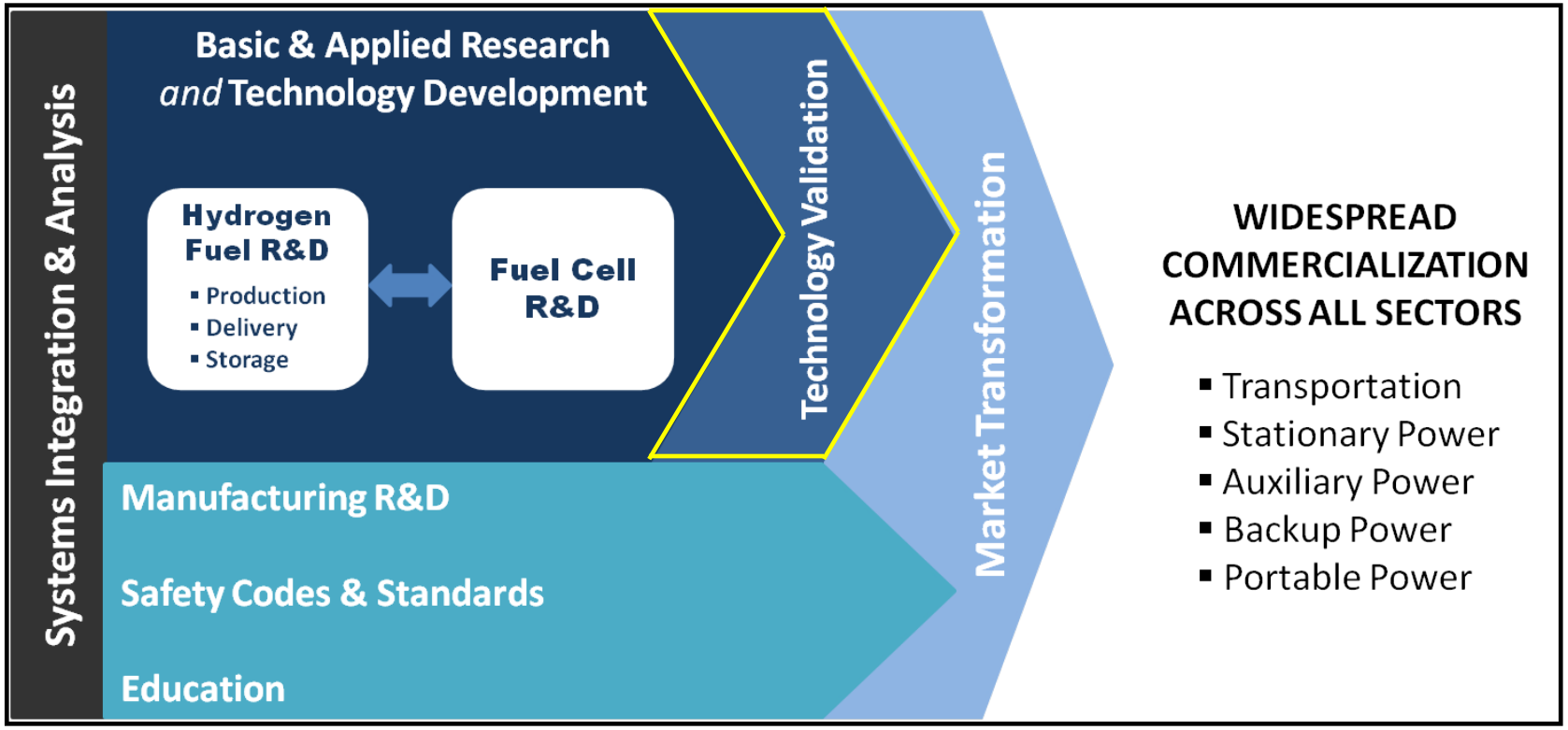
*Technology Validation assesses the performance and durability of new technologies to provide feedback to the R&D sub-programs and confirm readiness for commercialization.*

## DOE Program Structure



# Goal & Objectives

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*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 2012, publish the final report on the National Hydrogen Fuel Cell Electric Vehicle and Infrastructure Learning Demonstration.
- 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 $H_2$ to cars and/or buses.

# Technology Validation - Plans

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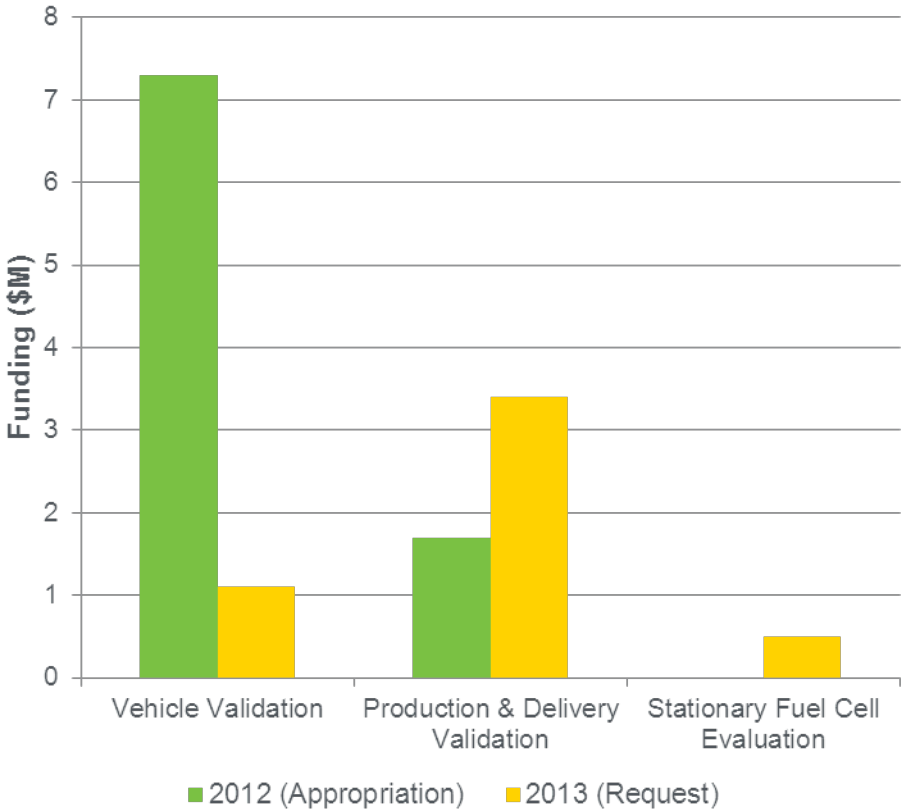
***Includes real-world data collection from fuel cell vehicles and hydrogen stations, evaluation of innovative hydrogen fueling and delivery components, and production and storage of hydrogen from renewable sources***

**FY 2013 Request = $5.0M**

**FY 2012 Appropriation = $9.0M**




Subject to appropriations, project go/no go decisions and competitive selections

## 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

# Funding Opportunity Announcement

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## Light-Duty Fuel Cell Electric Vehicle Validation Data

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.

$6M ($500k to $2M per award, up to 5 year period)

Applications Due 4/30 (Issue Date 2/29)

## Validation of Hydrogen Refueling Station Performance and Advanced Refueling Components

### Hydrogen Refueling Station Data Collection

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)

### Validation of Advanced Refueling Components

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.

~$3M, $1M (max) per award (up to 5 year period)

Applications Due 5/21 (Issue Date 3/13)

# Progress

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***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)
- $H_2$ cost**- onsite reformation: $7.7 - $10.3/gge
- $H_2$ 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

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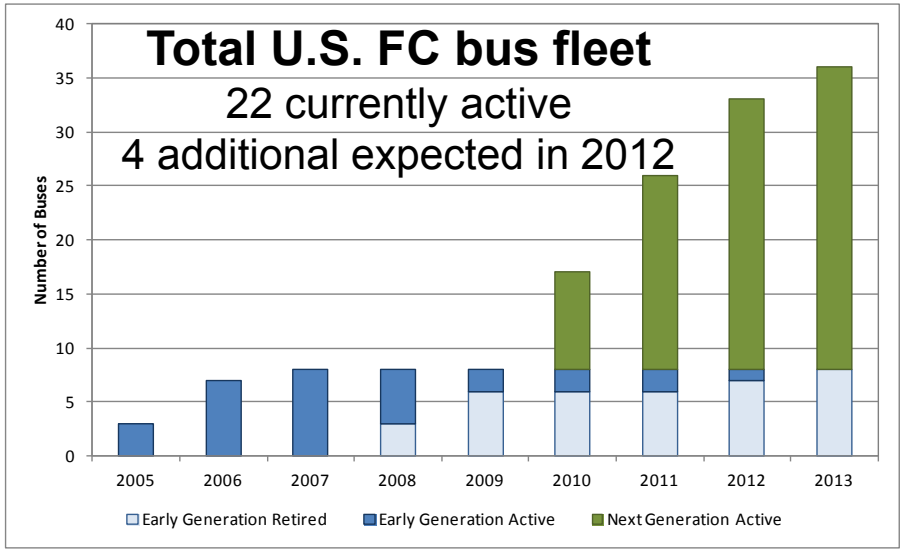
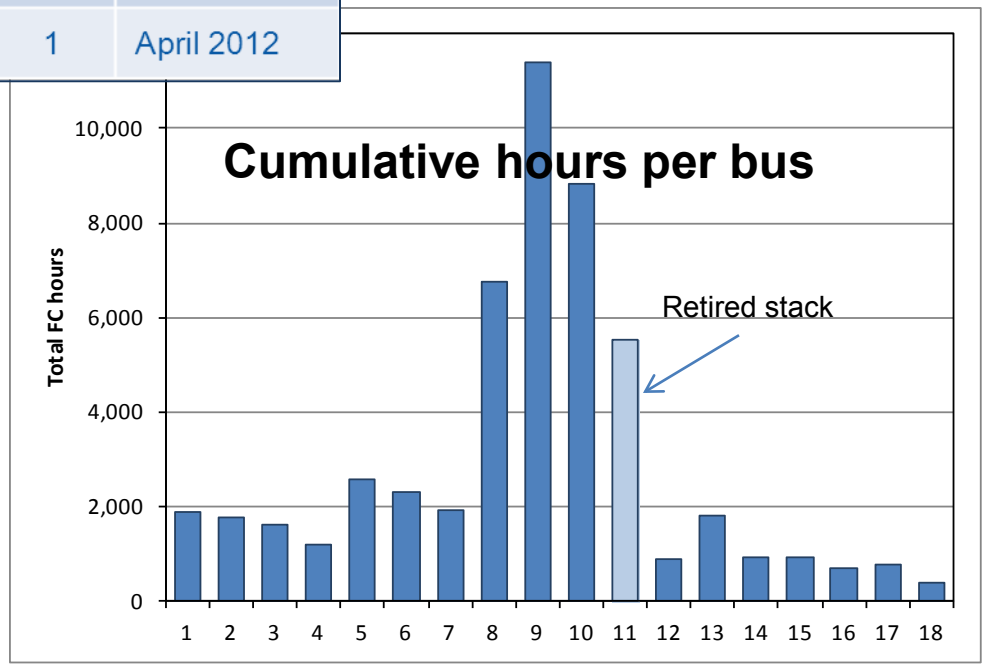
| Transit Agency | Project | Location | No. buses | Start-up date |
|---|---|---|---|---|
| SunLine | Adv. Tech FCEB | Thousand Palms, CA | 1 | May 2010 * |
| AC Transit | ZEBA | Emeryville, CA | 12 | June 2010 * |
| CTTRANSIT | NFCBP: Nutmeg | Hartford, CT | 4 | Aug 2010 * |
| SunLine | NFCBP: AFCB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

* Data analyzed to date

**Bus fleet leaders**

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




**Fuel Cell Buses have 2 X Fuel Economy, Meeting 8 mpdge Target**

www.nrel.gov/hydrogen/proj_tech_validation.html

# Validation of an Integrated Energy Station

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

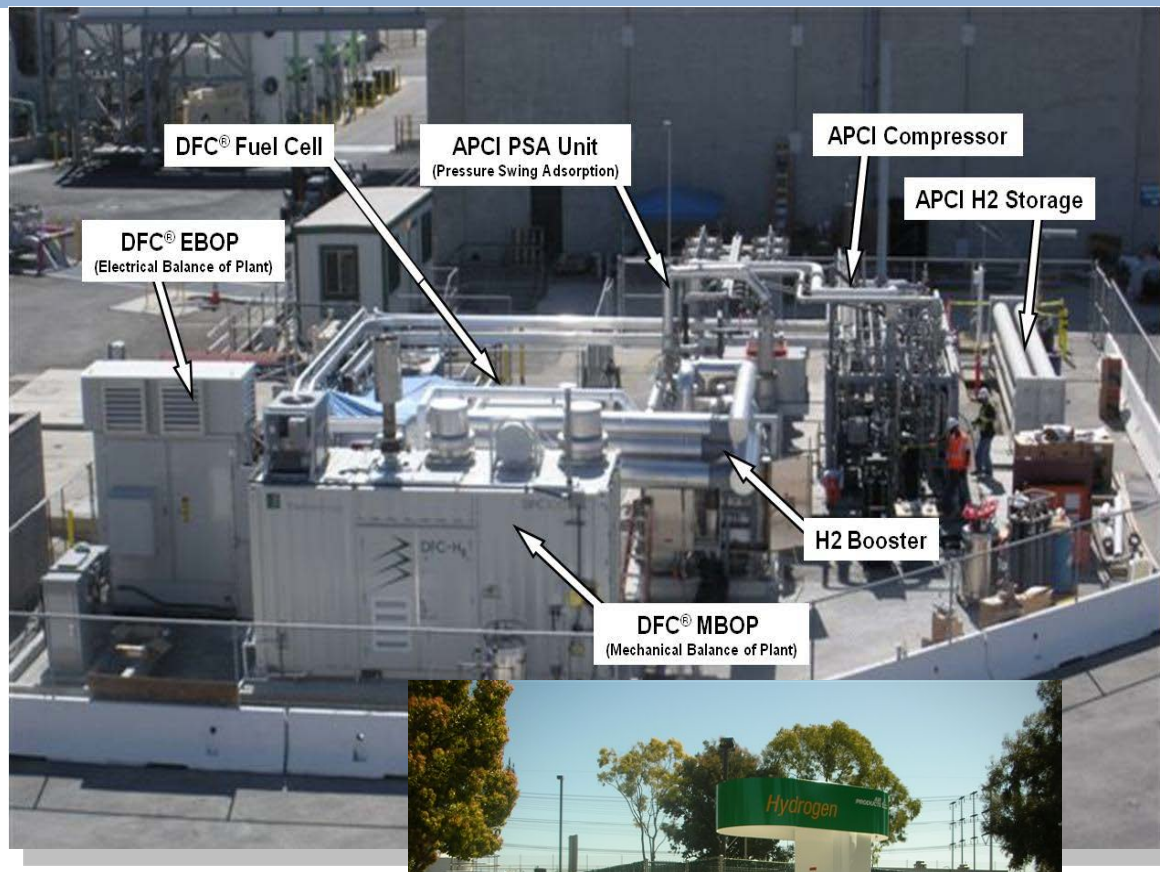
AIR PRODUCTS

FuelCell Energy

- March 2011- first vehicle refueling
- June 2011- began operation on ADG (anaerobic digester gas)

- Exported > 1 GWh electricity
- Used /mitigated > 5M SCF ADG
- Produced > 5,700 kg H2

- To operate 3 years (31 May 2014)



- Fueled with Orange County municipal wastewater gas
- Produces 100 kg/day $H_2$ (350 and 700 bar)
- Generates approximately 250 kW
- 54% efficiency coproducing $H_2$ and electricity

Funding Partners: CARB, SCAQMD and DOE

# Technology Validation Projects

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***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 $H_2$ infrastructure and fuel

# Technology Validation Plan

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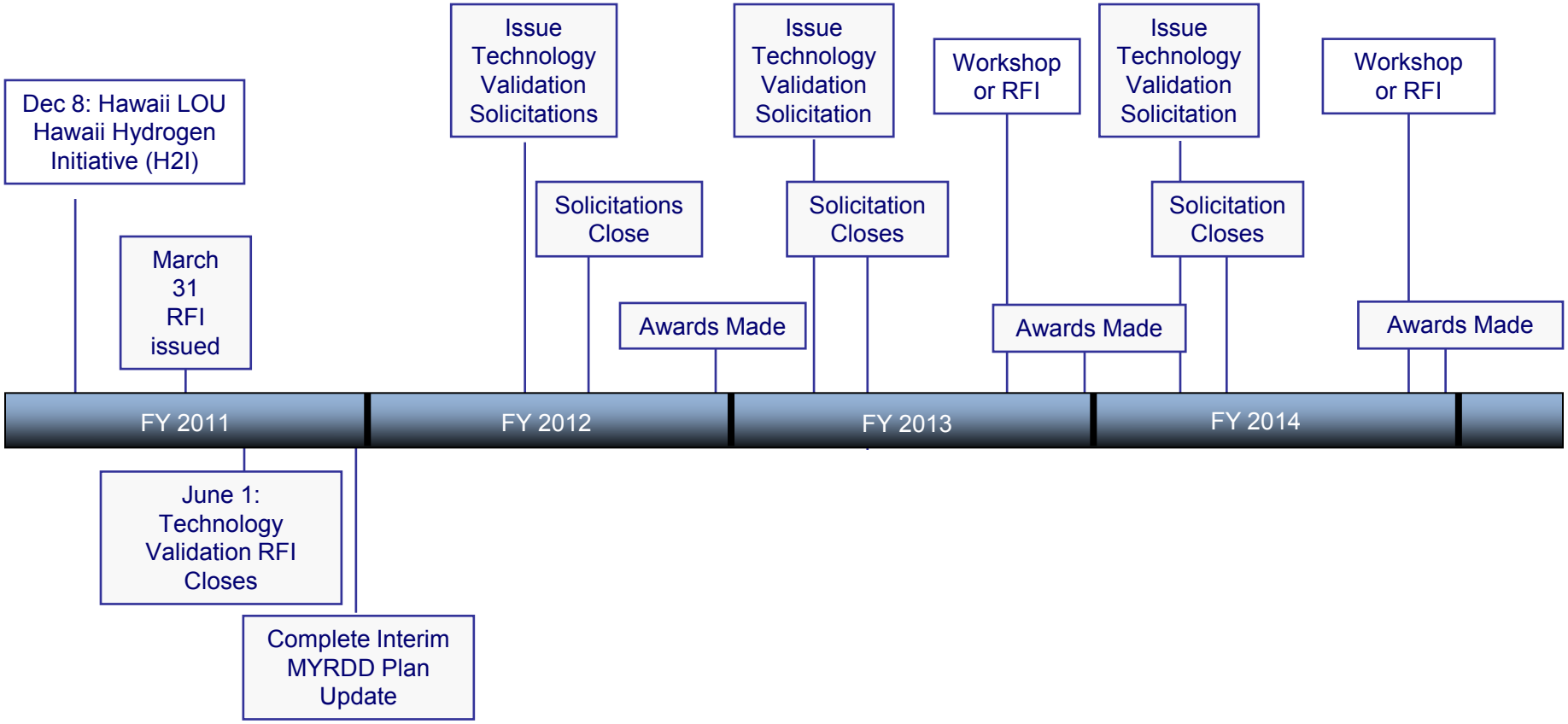
## *Major milestones & future solicitations**




*Subject to appropriations

# Session Instructions

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- 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

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- 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.

# For More Information

U.S. DEPARTMENT OF ENERGY

## *Technology Validation*


Jason Marcinkoski
Technology Validation
Acting Team Leader
202-586-7466
jason.marcinkoski@ee.doe.gov

Jim Alkire
Technology Validation Team
720-356-1426
james.alkire@go.doe.gov


**National Renewable Energy Laboratory Support:**

Keith Wipke
Sam Sprik
Jennifer Kurtz
Todd Ramsden
Leslie Eudy
Chris Ainscough
Genevieve Saur

# Participating Organizations

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## 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

**CT**TRANSIT

SunLine

City of Burbank

Ballard Power Systems, Inc.

Hydrogenics Corporation