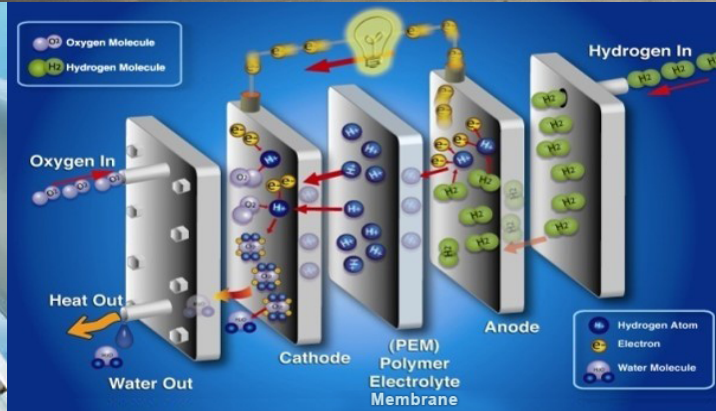


# U.S. Department of Energy Fuel Cell Technologies Office

U.S. DEPARTMENT OF  
**ENERGY** | Energy Efficiency &  
Renewable Energy



## Hydrogen and Fuel Cell Technical Advisory Committee

Livermore, CA

April 6, 2016

Dr. Sunita Satyapal

Director  
Fuel Cell Technologies Office  
U.S. Department of Energy

- **HTAC Scope**
  - Energy Policy Act (EPACT) 2005 Title VIII
  - Membership
- **Program Updates**
- **Overview 2014-2015 HTAC Recommendations**
  - Program Plan Feedback
  - Examples of Responses
- **Next Steps**

## To advise the Secretary of Energy on:

- 1. The implementation of programs and activities under Title VIII of EPACK**
- 2. The safety, economical, and environmental consequences of technologies to produce, distribute, deliver, store or use hydrogen energy and fuel cells**
- 3. The DOE Hydrogen & Fuel Cells Program Plan**

1. Enable and promote comprehensive **development, demonstration, and commercialization** of H<sub>2</sub> and fuel cells with industry
2. Make **critical public investments** in building strong links to private industry, universities and National Labs to expand innovation and industrial growth
3. Build a mature H<sub>2</sub> economy for **fuel diversity** in the U.S.
4. Decrease the **dependency on foreign oil & emissions** and enhance energy security
5. Create, strengthen, and protect a **sustainable national energy economy**

HTAC Member and Affiliation	Expertise
<b>Ayers, Katherine</b> Proton OnSite	<b>Hydrogen Production R&amp;D</b>
<b>Bond, Peter</b> Brookhaven National Laboratory	<b>Government</b>
<b>Carlin, Richard (indicated departure FY17)</b> Sea Warfare and Weapons Department, Office of Naval Research	<b>Government</b>
<b>Clay, Kathryn</b> American Gas Association	<b>Associations / Non-profits</b>
<b>Dunwoody, Catherine</b> California Air Resources Board	<b>Government</b>
<b>Freese, Charles F.</b> General Motors Company	<b>Transportation</b>
<b>Gobin, Anne</b> Bureau of Air Management, Connecticut Department of Energy & Environmental Protection	<b>Government</b>
<b>Hofmeister, John (indicated departure 3/16)</b> Citizens for Affordable Energy; President & U.S. Country Chair (retired), Shell Oil Company	<b>Fuels Production</b>
<b>Kaya, Maurice</b> Pacific International Center for High Technology; Chief Technology Officer (retired), Hawaii Dept. of Business, Economic Development, and Tourism	<b>Government</b>

HTAC Member Name and Affiliation	Expertise
<b>Kodjak, Drew</b> International Council on Clean Transportation (ICCT)	<b>Transportation</b>
<b>Koyama, Harol</b> H2 PowerTech	<b>Stationary Power</b>
<b>Leggett, Paul</b> Morgan Stanley, Investment Banking Division	<b>Venture Capital / Investment</b>
<b>Lipman, Timothy</b> Transportation Sustainability Research Center, UC Berkeley; Director, DOE Pacific Region Clean Energy Application Center	<b>Academia</b>
<b>Markowitz, Morry</b> Fuel Cell and Hydrogen Energy Association (FCHEA)	<b>Associations / Non-profits</b>
<b>Novachek, Frank (Chair)</b> Xcel Energy	<b>Utilities (Electricity and Natural Gas)</b>
<b>Ogden, Joan</b> Dept. of Environmental Science & Policy, UC Davis	<b>Academia</b>
<b>Oge, Margo</b> Office of Transportation and Air Quality, Environmental Protection Agency	<b>Environmental</b>
<b>Scott, Janea</b> California Energy Commission	<b>Government</b>
<b>Thompson, Levi</b> University of Michigan	<b>Academia</b>



Indicates new members as of Aug. 2015

# Fuel Cell Technologies Office (FCTO) Overview

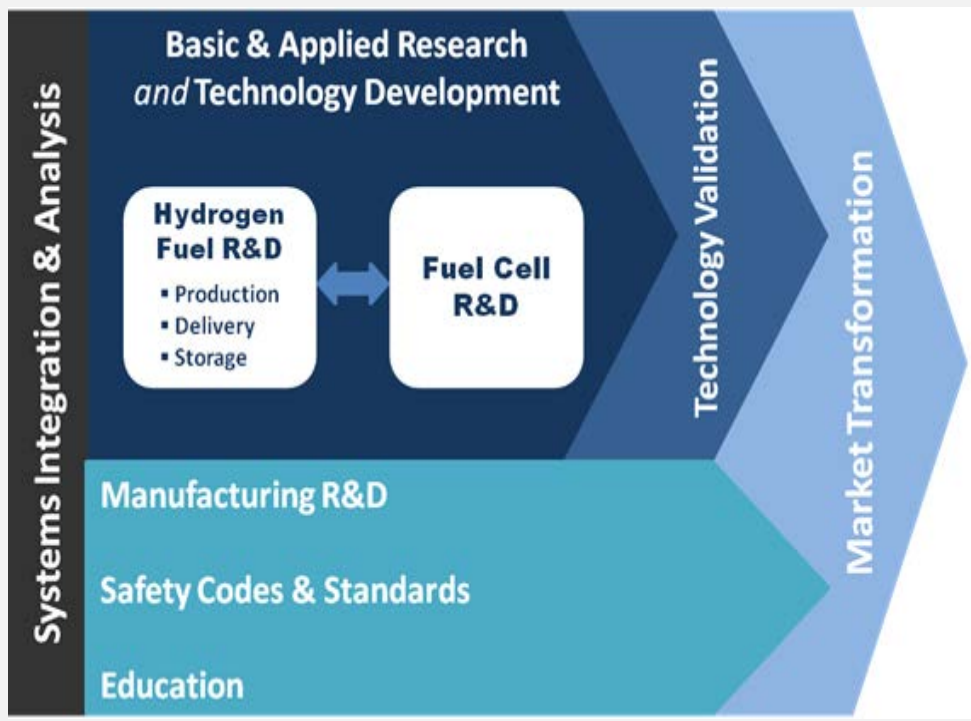
## Mission

To enable the **widespread commercialization** of hydrogen and fuel cell technologies, which will reduce petroleum use, greenhouse gas (GHG) emissions, and criteria air pollutants, and will contribute to a more diverse energy supply and more efficient use of energy.

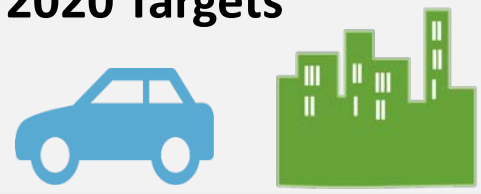
## Impact

**2-4 million** barrels per day petroleum reduction by 2050  
**200- 450 million** metric tons/year GHG emissions reduction by 2050

## Strategy and Approach



## 2020 Targets



Fuel Cell Cost	<b>\$40/ kW</b>	<b>\$1,000/kW*</b> <b>\$1,500/kW**</b>
Durability	<b>5,000 hrs</b>	<b>80,000 hrs</b>
H <sub>2</sub> Storage Cost (On-Board)	<b>\$10/kWh</b>	
H <sub>2</sub> Cost at Pump	<b>&lt;\$4/gge</b> <b>&lt;\$7/gge</b> (early market)	

\*For Natural Gas  
 \*\*For Biogas

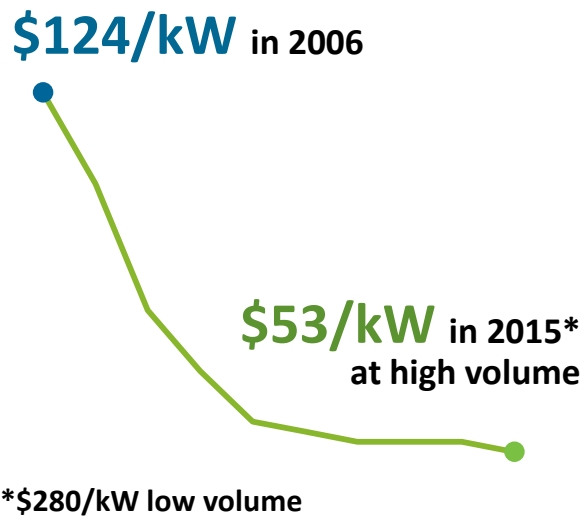
# DOE Activities Span from R&D to Deployment



## 1. Research & Development

### Fuel Cells

- >50% decrease in cost since 2006
- 5X less platinum used
- >4X increase in durability



## 2. Demonstration

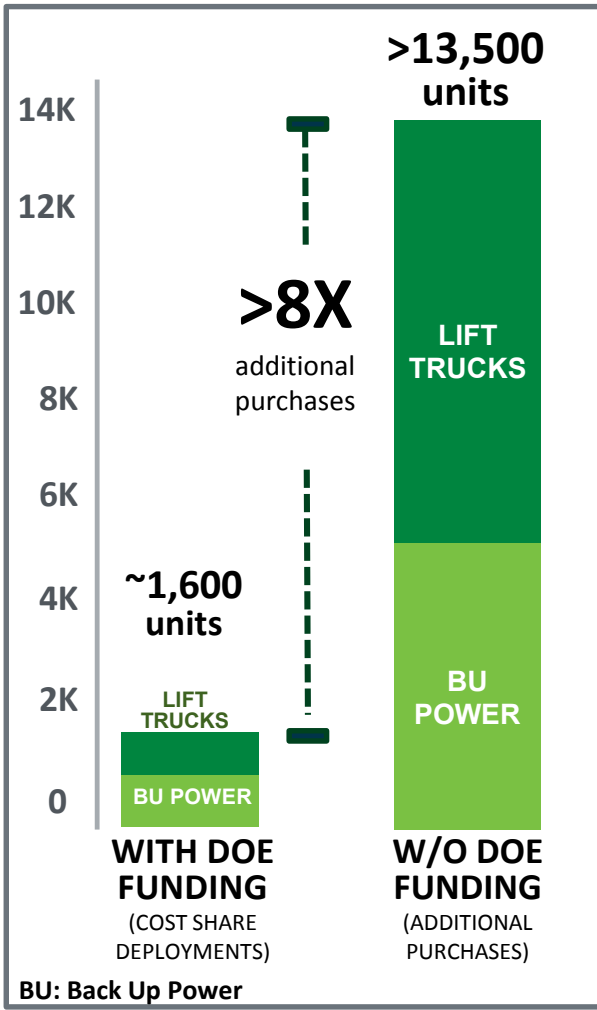
Forklifts, back-up power, airport cargo trucks, parcel delivery vans, marine APUs, buses, mobile lighting, refuse trucks

>220 FCEVs, 30 stations, 6M miles traveled

World's first tri-gen station



## 3. Deployment

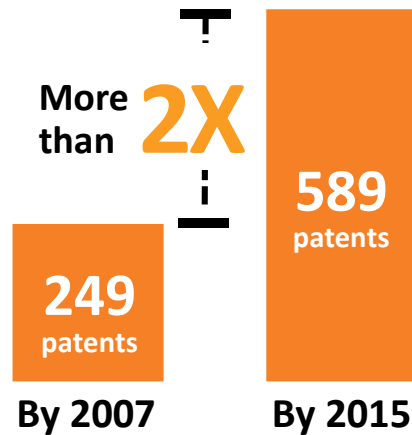


# DOE Impact - H<sub>2</sub> and Fuel Cells



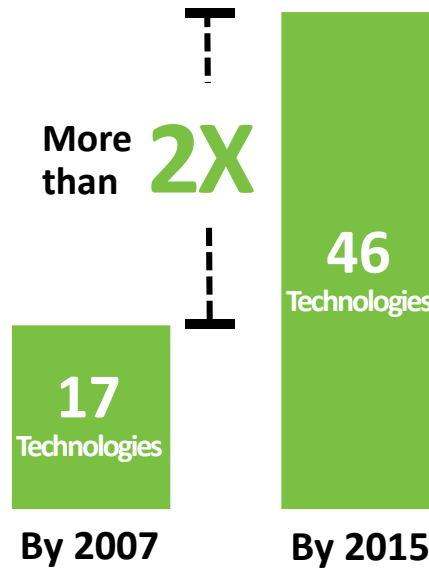
## Innovation

### Cumulative Number of Patents



## Commercialization

### Cumulative Number of Commercial Technologies Entering the Market



## Jobs

### From DOE-supported Commercial Technologies:

**450 jobs** average per year

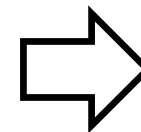
### From ARRA-supported Technology Deployments

**1,400 jobs** created or sustained

ARRA: American Recovery and Reinvestment Act



**Savings from Active Project Management & Downselects**



**More than last \$40M 7 yrs**



# DOE H<sub>2</sub> and Fuel Cells Strategy

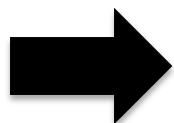
## BARRIERS

## NEAR TO MID-TERM

## LONG-TERM

**R&D**

- Fuel Cell Cost and Durability
- Hydrogen Storage
- Hydrogen Production and Delivery



**ADDITIONAL**

- Infrastructure Development
- Manufacturing and Supply Chain
- Safety, Codes and Standards (SCS)
- Public Acceptance and Awareness



Low PGM catalysts, MEAs, durability, components	PGM-free catalysts, advanced membranes, AEMs, MEAs
700 bar tanks, composites	Materials R&D for low P storage, cold/cryo-compressed
H <sub>2</sub> from NG/electrolysis; delivered H <sub>2</sub> , high P, compression	H <sub>2</sub> from renewables (PEC, biological, etc.), pipelines, low P option

Enablers: H2FIRST-station validation, metering, sensors, etc.	Materials compatibility, station innovation, cost reduction- H-Prize
Catalyst, MEA and tank manufacturing; QC; cost & reliability; supply chain	Mfg. processes and scale up; strong supply base- H <sub>2</sub> and fuel cells
Set back distances, fueling protocols; safety dissemination	Risk mitigation; National and International harmonization of SCS
H <sub>2</sub> Tools, code officials, responders; early markets; H <sub>2</sub> USA	Widespread Outreach, Education & Social Acceptance

Level of Difficulty

- High
- Medium
- Low to Medium

# Hydrogen & Fuel Cells Budget

Key Activity	FY15	FY16	FY17
	(\$ in thousands)		
	Approp.	Approp.	Request
Fuel Cell R&D	33,000	35,000	35,000
Hydrogen Fuel R&D <sup>1</sup>	35,200	41,050	44,500
Manufacturing R&D	3,000	3,000	3,000
Systems Analysis	3,000	3,000	3,000
Technology Validation	11,000	7,000	7,000
Safety, Codes and Standards	7,000	7,000	10,000
Market Transformation	3,000	3,000	3,000
Technology Acceleration	0	0	13,000 <sup>2</sup>
NREL Site-wide Facilities Support	1,800	1,900	N/A
<b>Total</b>	<b>97,000</b>	<b>100,950</b>	<b>105,500</b>

Office	FY15
EERE	\$97.0M
Basic Science	\$18.5M
Fossil Energy, SOFC	\$30.0M

**FY 2015 DOE Total: ~\$150M**

Number of Recipients funded from 2008-2015	
Industry	>110
Universities	>100
Laboratories	12

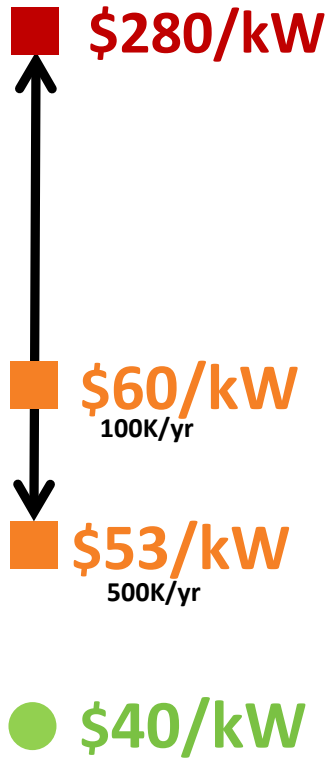
<sup>1</sup>Hydrogen Fuel R&D includes Hydrogen Production & Delivery R&D and Hydrogen Storage R&D

<sup>2</sup>Combines Manufacturing R&D, Technology Validation, Market Transformation.

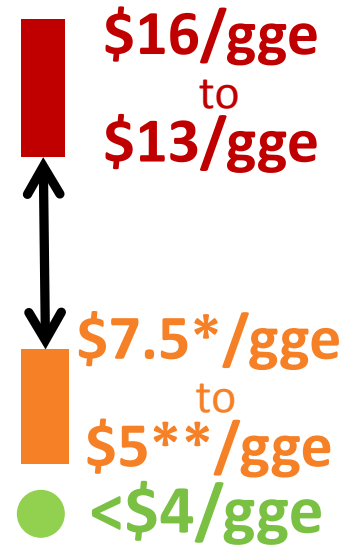
*Sustained, stable funding requests and appropriations*

# DOE Cost Targets and Status

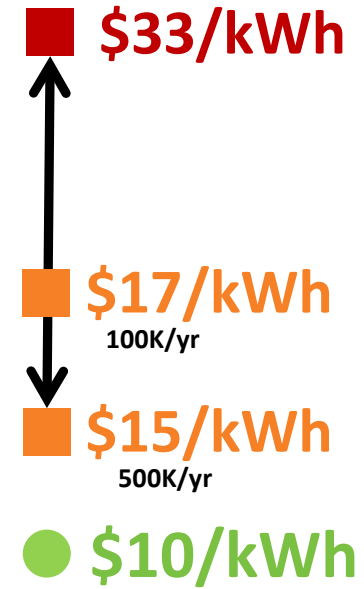
## Fuel Cell System



## H<sub>2</sub> Production, Delivery & Dispensing



## On-board H<sub>2</sub> Storage (700-bar compressed system)



● 2020 Targets

■ High-Volume Projection

■ Low-Volume Estimate

## Key Challenges- Examples

- PGM loading
- Catalyst and membrane durability
- Electrode performance and durability

- Efficiency and Reliability
- Feedstock and Capital Costs
- Compression, Storage and Dispensing (CSD) Costs

- Carbon fiber precursors and conversion
- Composite/resin materials
- BOP and assembly costs



**Response to Findings and  
Recommendations of the  
Hydrogen and Fuel Cell  
Technical Advisory  
Committee during Fiscal  
Years 2012 and 2013**

Fourth Biennial Report to Congress  
May 2014

United States Department of Energy  
Washington, DC 20585

**4<sup>th</sup> Biennial Report addresses HTAC  
recommendations during 2012-2013**

## 2014-2015 HTAC Recommendations

**13 recommendations** made since 2013






### Delivered through:

- **HTAC Hydrogen Enabling Renewables WG summary report** (Oct, 2013)
- **Letter on state of H<sub>2</sub> infrastructure** (Nov, 2013)
- **Two annual reports** (June, 2014 and May, 2015)

### Two mechanisms to respond:

- **Formal - 5<sup>th</sup> Biennial report** (underway)
- **Informal - FCTO update presentations at HTAC meetings** (Oct. & Apr., 2015 & Apr. and Nov., 2014)

# Themes- HTAC Recommendations (FY14- FY15) and DOE & FCTO Responses

Recommendation Theme	Examples of DOE and FCTO Responses
 <p><b>Public Support Visibility</b></p>	<p><b>Events:</b> H<sub>2</sub> Station opening in Washington D.C., Sustainable Transportation Summit, 1<sup>st</sup> ever National H<sub>2</sub> and Fuel Cell (FC) day, upcoming IPHE education workshop in CA, ride &amp; drives with DOE senior level participation, etc.</p> <p><b>Communications:</b> ~100 articles, blogs, social media posts/year reaching &gt;11,800 readers.</p> <p><b>Examples:</b> H-Prize; H2Tools, HyTEST, H<sub>2</sub> Student Design Contest, etc.</p>
 <p><b>Collaboration &amp; Coordination (national &amp; int'l)</b></p>	<p><b>Events:</b> IPHE workshop on role of major cities in the world; H<sub>2</sub> refueling summit in IN; joint int'l safety workshops in Japan, Germany, etc.</p> <p><b>Communications:</b> Request for information (RFIs) open to public (i.e. H<sub>2</sub> infrastructure concepts, innovative research, etc.), inter-agency workshop reports, ongoing stakeholder engagement meetings, etc.</p> <p><b>Examples:</b> H2USA, H2FIRST, IPHE, IWG, established consortia (HyMARC and FC-PAD) allowing lab, industry and university collaboration, etc.</p>
 <p><b>Global Competitiveness and Leadership</b></p>	<p><b>Events:</b> Lab Impact initiative, Tech-to-Market (T2M) lab showcase events, supply-chain events, investor forum, small business voucher (SVB) program</p> <p><b>Communications:</b> Market and business case reports tracking and assessing state of industry published annually (2015 Market Report showing consistent 30% growth in FC shipments), etc.</p> <p><b>Examples:</b> Global competitiveness analysis, HFC nexus-- a national online supply chain database, etc.</p>
 <p><b>Support for Renewable H2 Storage and Grid</b></p>	<p><b>Events:</b> Workshop on H<sub>2</sub> energy storage/grid with Canada in 2014, planned 2016 workshop on H<sub>2</sub> storage applications for grid, electricity generation and FCEVs, etc.</p> <p><b>Communications:</b> DOE's major deliverable - the Quadrennial Technology Review (QTR) report-- includes chapters addressing H<sub>2</sub> energy storage systems and grid applications, etc.</p> <p><b>Examples:</b> DOE-wide crosscut effort on grid modernization includes H<sub>2</sub>; NREL/INL joint project on real-time grid simulation of electrolyzers, H<sub>2</sub> at Scale Lab big idea; 2016 H<sub>2</sub> Student Design Contest topic focused on H<sub>2</sub> and grid systems, etc.</p>
 <p><b>Budgetary Support</b></p>	<p><b>FY17 request (\$105.5M) higher than FY16 request (\$103M) and &gt;10% higher than 2015 request (\$93M)</b>, awards to 7 fuel cell companies for DOE's SVB voucher round 1, \$40M EMN initiative which includes consortium on electrocatalysis (ElectroCat), strong support for lab impact initiatives including incubator concept (focused on fuel cells and H<sub>2</sub> IP) and related activities transitioning IP and technologies to commercialization phase (i.e. DetecTape<sup>TM</sup> success story).</p>

# Examples of DOE Responses to HTAC Recommendations

## Recommendation Theme




**Public Support & Visibility**



**Collaboration & Coordination (national & int'l)**



**Global Competitiveness and Leadership**



**Support for Renewable H2 Storage and Grid**



**Budgetary Support**

## Examples:



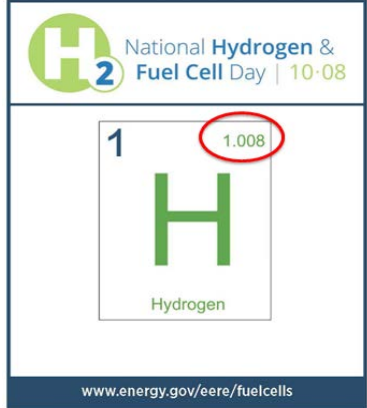
FCEV Ride & Drives at DOE HQ with DOE Secretary Moniz and EERE Assistant Secretary David Danielson



EERE Deputy Assistant Secretary Reuben Sarkar at Ribbon Cutting Ceremony for world's first fuel cell airport cargo trucks



Open house in Fall 2016 will allow public and press to get a look at the designed system



U.S. celebrated first ever H<sub>2</sub> and Fuel Cell Day

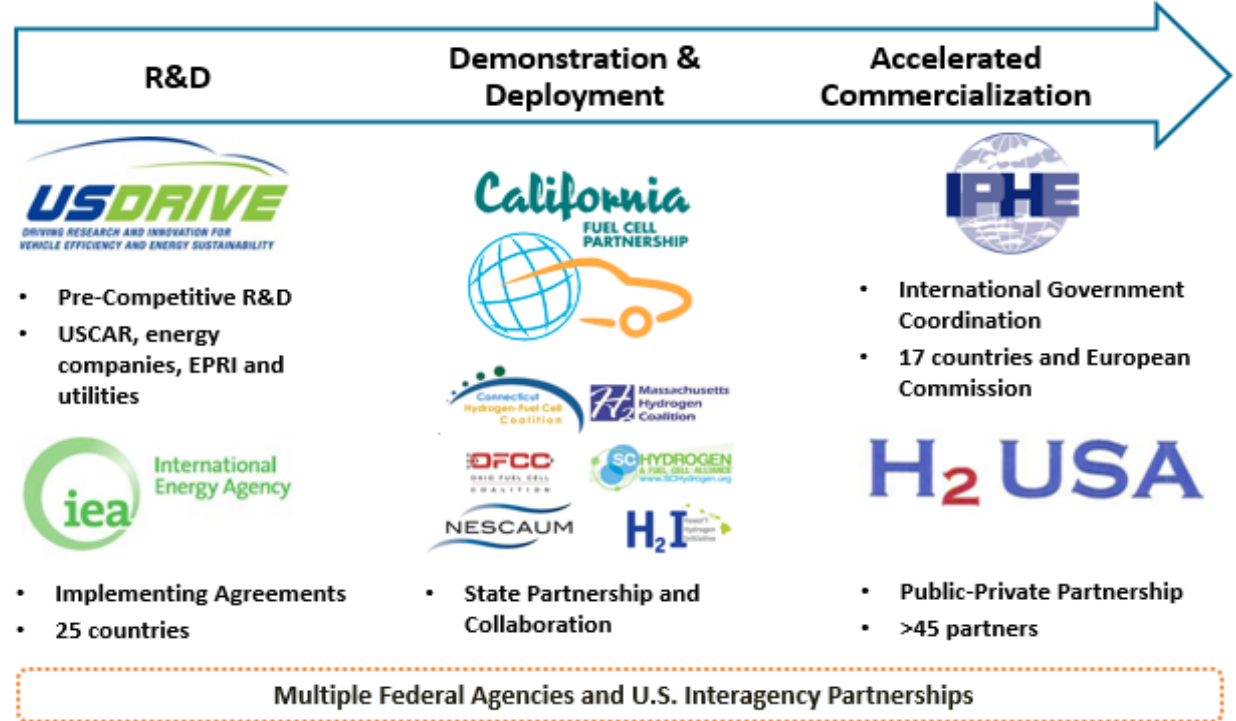
## Upcoming Events with High Visibility:

- **Sustainable Transportation Summit - July 11-12**
- **H<sub>2</sub> Station Opening in Washington DC (Brentwood)** with senior official participation from DOE and DOI
- **IPHE Outreach and policy stakeholder events** May 17 & May 20 in CA

# Examples of DOE Responses to HTAC Recommendations

Recommendation Theme	
	Public Support & Visibility
	Collaboration & Coordination (national & int'l)
	Global Competitiveness and Leadership
	Support for Renewable H2 Storage and Grid
	Budgetary Support

## Continued Collaboration with Multiple Stakeholders at each Technology Stage:



## Upcoming IPHE Event on May 20<sup>th</sup> in Berkeley, CA

- Stakeholder feedback on policies, actions and opportunities for H2/FC in sustainable cities
- **Diverse participation** from govt. (US and other countries) private sector stakeholders, thought leaders
- **IPHE background:** [www.iphe.net](http://www.iphe.net)

## H<sub>2</sub>USA

### Partners

### Mission



~ 45 Partners in 2015

To address hurdles to establishing hydrogen fueling infrastructure, enabling the large scale adoption of fuel cell electric vehicles

### Structure

4 Working Groups coordinated by the Operations Steering Committee

### H<sub>2</sub>USA's Working Groups

H<sub>2</sub>FIRST  
Coordination  
panel



Hydrogen  
Fueling Station



Locations  
Roadmap



Financing  
Infrastructure



Market Support &  
Acceleration





Leveraging Expertise of National Labs



In support of

**H<sub>2</sub>USA** and tasked to deliver:

## Reference Station Design

- ✓ Report Delivered with Detailed Station Designs and Cost Estimates

## HyStEP (H<sub>2</sub> Station Equipment Performance Device)

- ✓ Design Complete
- ✓ Testing Complete



## Outstanding Partnership Award

By the Federal Laboratory Consortium (FLC) for efforts toward deployment of hydrogen fueling infrastructure

## Fuel Contaminant Detection

- ✓ Market Survey and Gap Analysis Complete

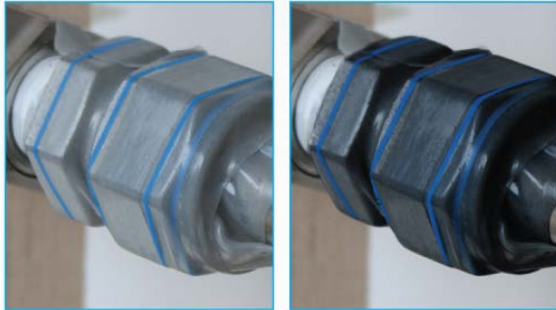


Trailer that will house HyStEP, and the control panel.

*DOE's H<sub>2</sub>FIRST project supports H2USA goals to address infrastructure*

# Example Success Story: Hydrogen Detection Tape

## R&D Results



No leak detected

H<sub>2</sub> leak detected

Photo Credit: Detecttape.com

## Innovation

### Detects small hydrogen leaks

Based on transition metal oxide color change in silicone tape



Multiple  
Applications

## Primary Use

- Fuel Cell Plants
- Fueling Stations
- Gas Refineries
- Research Laboratories
- Storage Facilities

## Others

- Dissolved H<sub>2</sub> in transformer oil
- H<sub>2</sub>S and natural gas leaks
- Manufacturing and power plants
- Pharmaceutical applications

## DOE, Industry and National Lab Collaboration to Enable Innovation & Impact

DOE FCTO  
Support


Element One  
Technology  
Development

MSP Inc.  
Manufacturing and  
Distribution

NREL  
Field Validation

*DOE support and field validation at NREL has enabled commercialization of technology*

## Recommendation Theme




**Public Support & Visibility**




**Collaboration & Coordination (national & int'l)**



**Global Competitiveness and Leadership**



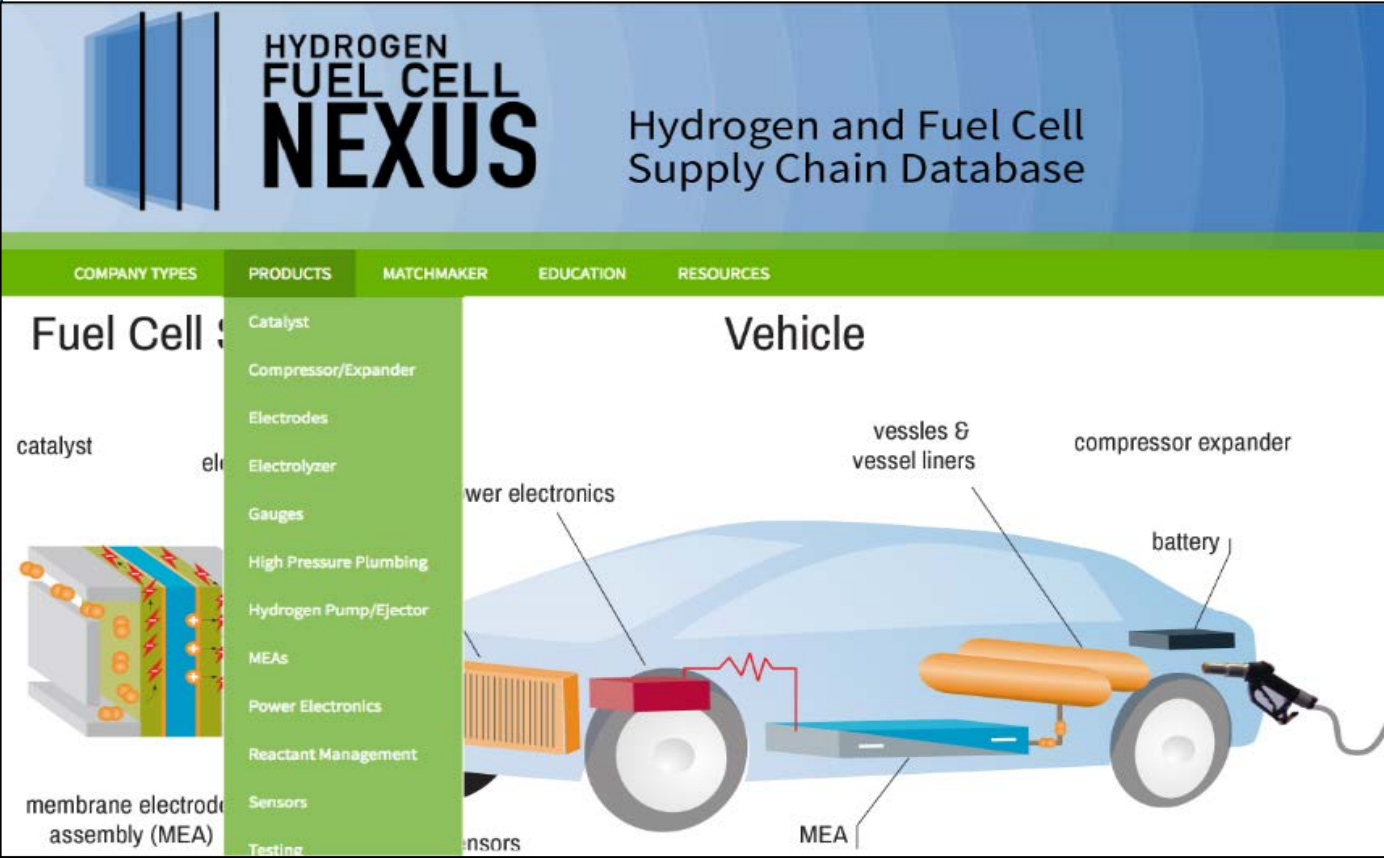
**Support for Renewable H2 Storage and Grid**



**Budgetary Support**

## Hydrogen Fuel Cell (HFC) Nexus: the U.S. Fuel Cell Directory

- **Goal:** To encourage supplier engagement & collaboration while having information readily and publicly accessible



**HYDROGEN FUEL CELL NEXUS**  
 Hydrogen and Fuel Cell Supply Chain Database

COMPANY TYPES | PRODUCTS | MATCHMAKER | EDUCATION | RESOURCES

**Fuel Cell** | Catalyst | Compressor/Expander | Electrodes | Electrolyzer | Gauges | High Pressure Plumbing | Hydrogen Pump/Ejector | MEAs | Power Electronics | Reactant Management | Sensors | Testing

**Vehicle**

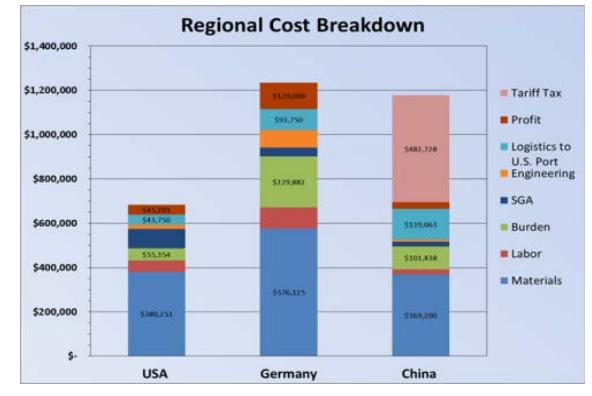
Labels in diagram: catalyst, membrane electrode assembly (MEA), power electronics, vessels & vessel liners, compressor expander, battery, MEA, sensors.

- **Upcoming Event:** Supply Chain Exchange and Partnership Development Workshop- May 5<sup>th</sup>, Long Beach, CA

## Global Competitiveness Analysis including:

- Global Cost Breakdown
- Design for Manufacturing & Assembly
- Value Stream Mapping

GLWN.org



## Integrated Network of Regional Technical Centers



### Located at

1. East Coast (CCAT)
2. Midwest at the OFCC
3. Central States at NREL's National Fuel Cell Technology Evaluation Center
4. West Coast (UC Irvine)

### Activities (Examples)

- Hold supply chain exchanges
- Promote cooperation between suppliers & standardization of component specs



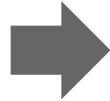
## Fuel Cell and H<sub>2</sub> Opportunity Center

- Comprehensive **online database**
- **Project activities include:**
  - Encourage **supplier engagement**
  - Release and maintain **public directory**
  - Conduct **outreach campaign** (social media, etc.)



# DOE Small Business Vouchers Pilot- Round 1

Approximately  
**\$6.7 million**  
 in DOE investment



**33** small  
 businesses  
 selected



Including  
**7 fuel cell**  
 related businesses



Company	Location	Working with	Focus
Altery Systems	Folsom, CA	SNL	PEM design modelling
Amsen Technologies	Tucson, AZ	LANL	PEM characterization
Sustainable Innovations	East Hartford, CT	LANL	H <sub>2</sub> fuel quality testing
Element One	Boulder, CO	NREL	H <sub>2</sub> sensor performance
Midwest Energy Group	Carbondale, IL	NREL	Membrane performance and stability testing
KWJ Engineering	Newark, CA	LANL/NREL	Gas-sensor characterization
Treadstone Technologies	Princeton, NJ	ORNL/LANL	Coating and processing for electrolyzers

*Access to national lab resources to move innovative ideas and technologies to market*

# Lab Consortia Approach

## Activities

### Consortia Core

- **Fuel Cells: FC-PAD** (Fuel Cell Performance and Durability)
- **Storage: HyMARC** (Hydrogen Storage Materials Advanced Research Consortium)
- **ElectroCat – Just Launched!**
- **Renewable H<sub>2</sub> Production (planned)**

### Projects added through FOAs

- Companies, universities, labs
- 2-4 yrs/project
- May include seedling projects

\* Subject to appropriations

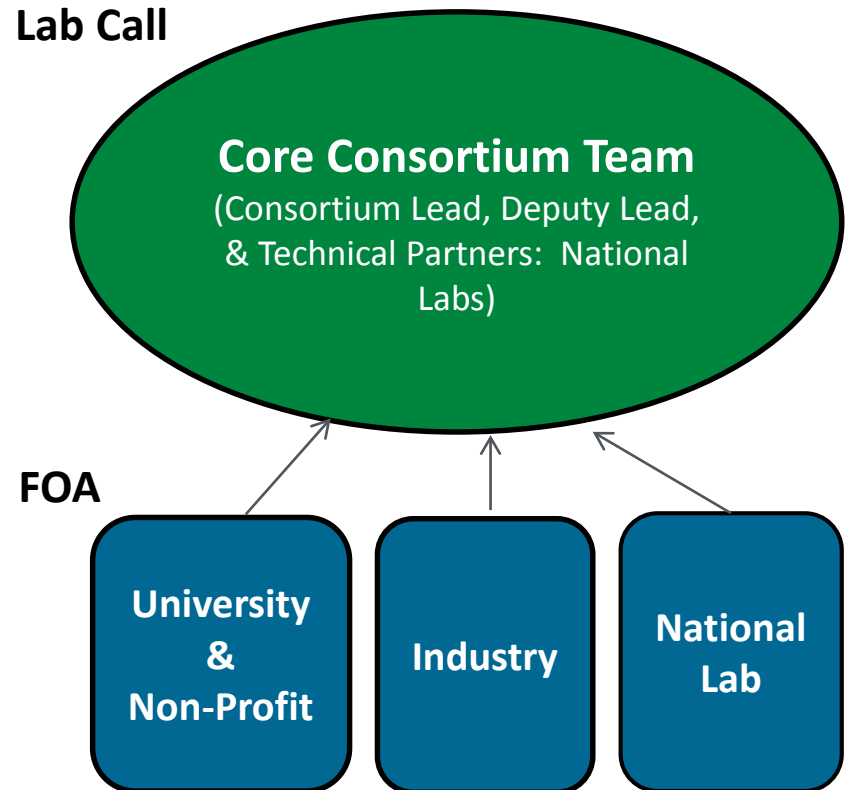
### Potential Future Collaborations

Relevant Offices and other Agencies (e.g. Office of Science, Advanced Manufacturing Office, etc.)


## Strategy and Structure

Multi-Lab team with Lab Call to competitively select core team

### Lab Call




## Recommendation Theme

 **Public Support & Visibility**

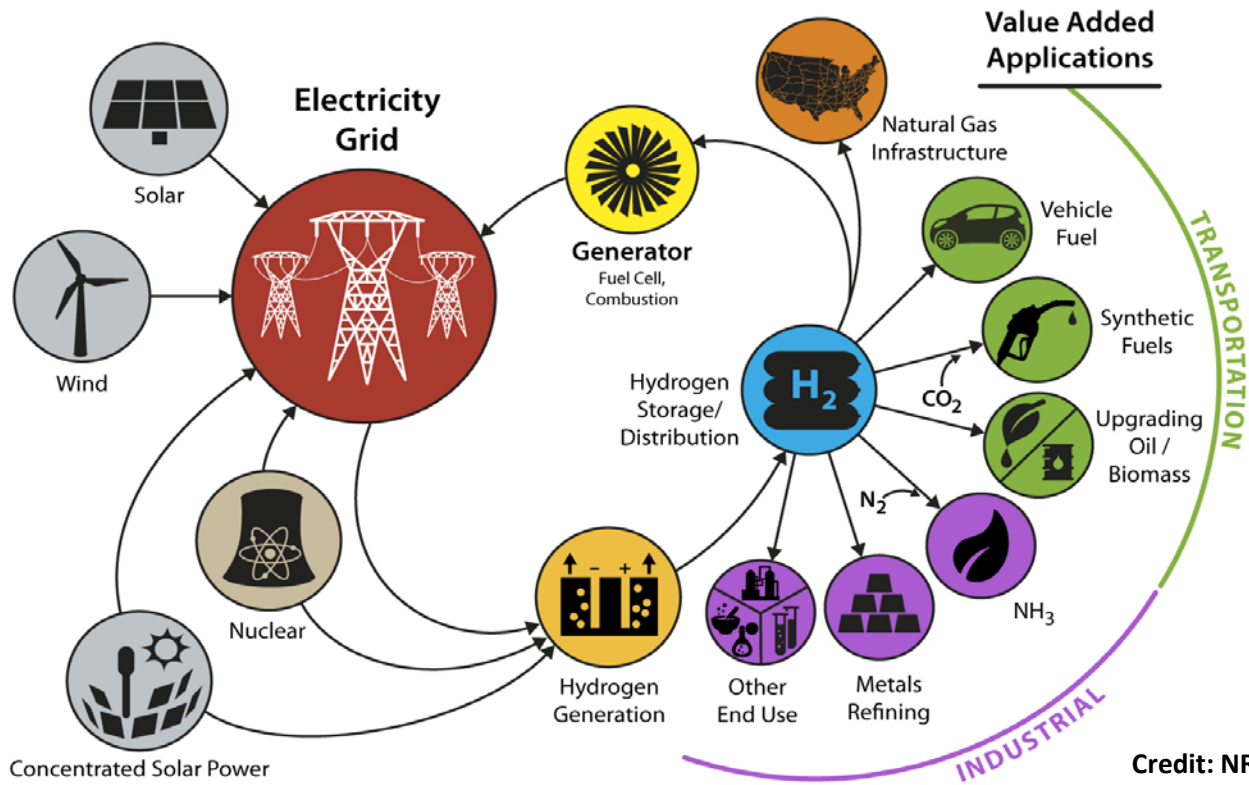
 **Collaboration & Coordination (national & int'l)**

 **Global Competitiveness and Leadership**

 **Support for Renewable H2 Storage and Grid**

 **Budgetary Support**

## H2 at Scale- Lab Big Idea Initiative



### 3 H<sub>2</sub> Focus Areas

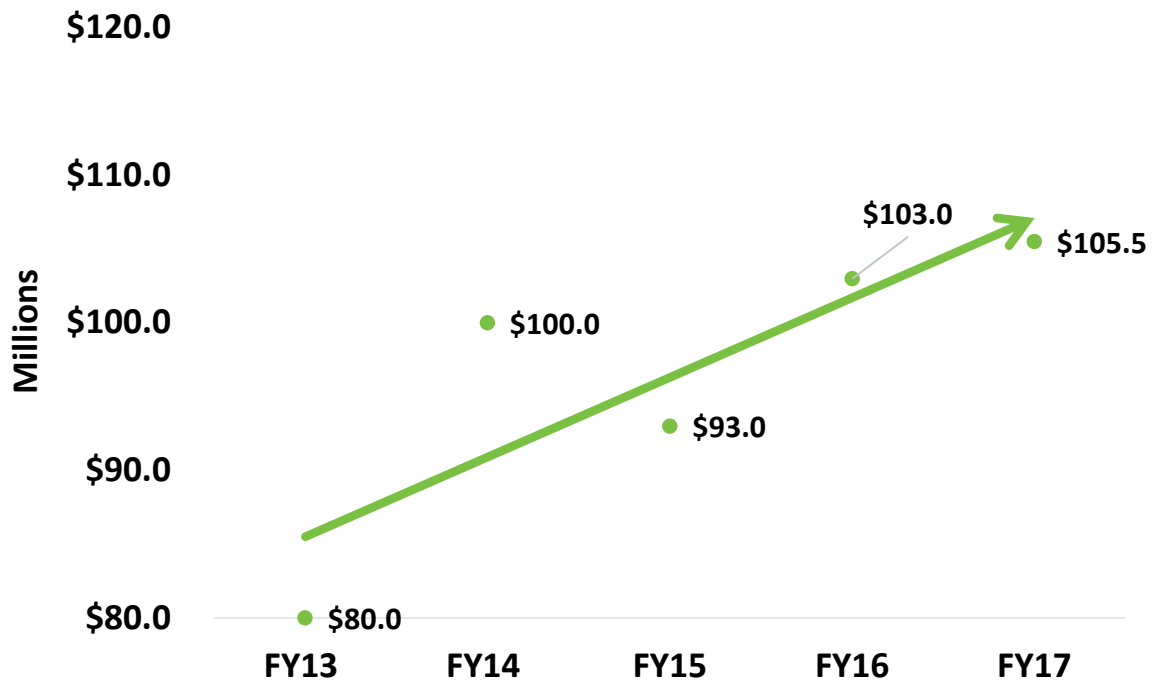
- Advanced **Generation**
- **Storage and Distribution**
- End use market transformation and **systems integration**

### Partners

- **National Labs** (NREL-Lead)
- **EERE** with the Sustainable Transportation Office (including engagement with other DOE offices)

Recommendation Theme	
	Public Support & Visibility
	Collaboration & Coordination (national & int'l)
	Global Competitiveness and Leadership
	Support for Renewable H2 Storage and Grid
	Budgetary Support

## Hydrogen & Fuel Cells (FCTO) Budget Requests Showing Upward Trend



**FY17 request (\$105.5M) higher than FY16 request (\$103M) and >10% higher than 2015 request (\$93M)**



- **Strengthen linkage to Title VIII goals for FCEVs and infrastructure**
- **Discuss multi-value attributes of hydrogen and fuel cells**
  - H2@Scale- discuss benefits- e.g. energy security, energy storage, including FCEV fuel, production of renewable carbon-based fuels, methanation, augmentation and “greening” of natural gas, and general electric grid support
- **Show all-of-the-above portfolio** (discuss BEVs, etc., not just FCEVs)
- **Update infrastructure accomplishments & needs**
  - e.g., H2FIRST, HySTEP, contaminant detection, etc.

## Additional Feedback

- **HTAC Q: Should there be additional sections on the challenges of public acceptance and enabling commercialization?**
- **Tighten Executive Summary**
- **Reiterate importance of supply chain development and manufacturing (e.g. not R&D in isolation)**

- **Continue to strengthen R&D activities and accelerate Tech to Market (Lab impact)**
  - H<sub>2</sub>, fuel cells, safety, manufacturing, etc.
  - Cost, performance, durability need to be addressed
- **Conduct strategic, selective demonstrations**
  - Industry cost share and potential to accelerate market transformation
- **Continue to conduct key analyses to guide RD&D and path forward**
  - Life cycle cost; infrastructure, economic & environmental analyses, etc. (e.g. Medium/heavy duty vehicle target setting underway)
- **Leverage activities to maximize impact**
  - U.S. and global partnerships, H2USA, States

**Save the date: Annual Merit Review (AMR)**  
**June 6-10, 2016- Washington DC**

- Annual Report
- Prior input on Program Requests
  - H<sub>2</sub> cost target revision ✓
  - H<sub>2</sub> Production Expert Panel ✓
  - Feedback on H-Prize ✓
  - Manufacturing subcommittee ✓
  - Program Plan revision (previous update 2011) ✓

## Specific Requests to HTAC for Future Areas of Input:

- Safety (response planning, etc.)
- H<sub>2</sub> Energy Storage (Enabling Renewables) Subcommittee
  - H2@Scale Feedback
- IPHE upcoming event input
- Increasing outreach/awareness and state collaboration

# Thank You

**Dr. Sunita Satyapal**

**Director**

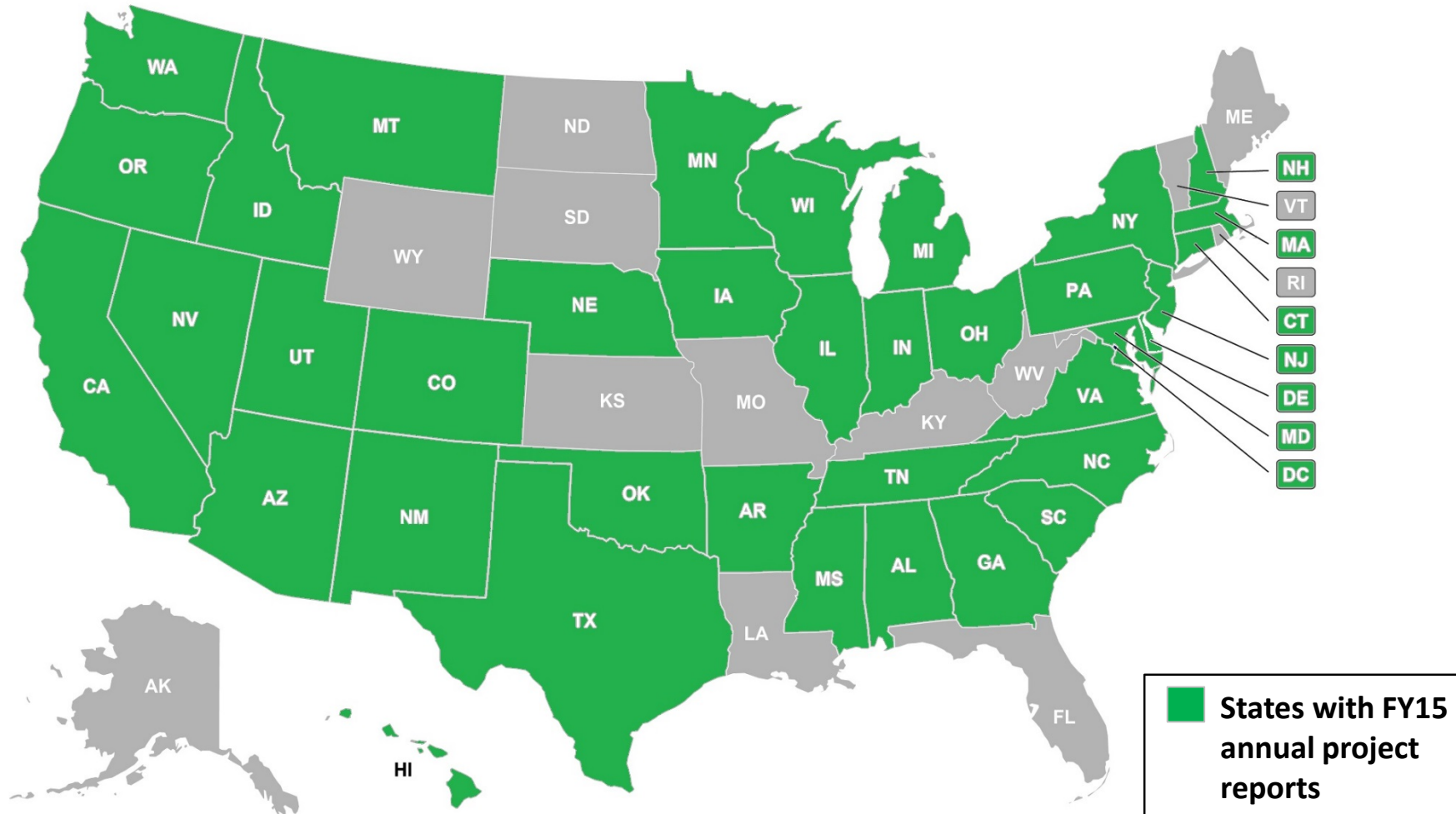
**Fuel Cell Technologies Office**

**[Sunita.Satyapal@ee.doe.gov](mailto:Sunita.Satyapal@ee.doe.gov)**

**[hydrogenandfuelcells.energy.gov](https://hydrogenandfuelcells.energy.gov)**

# ADDITIONAL INFORMATION

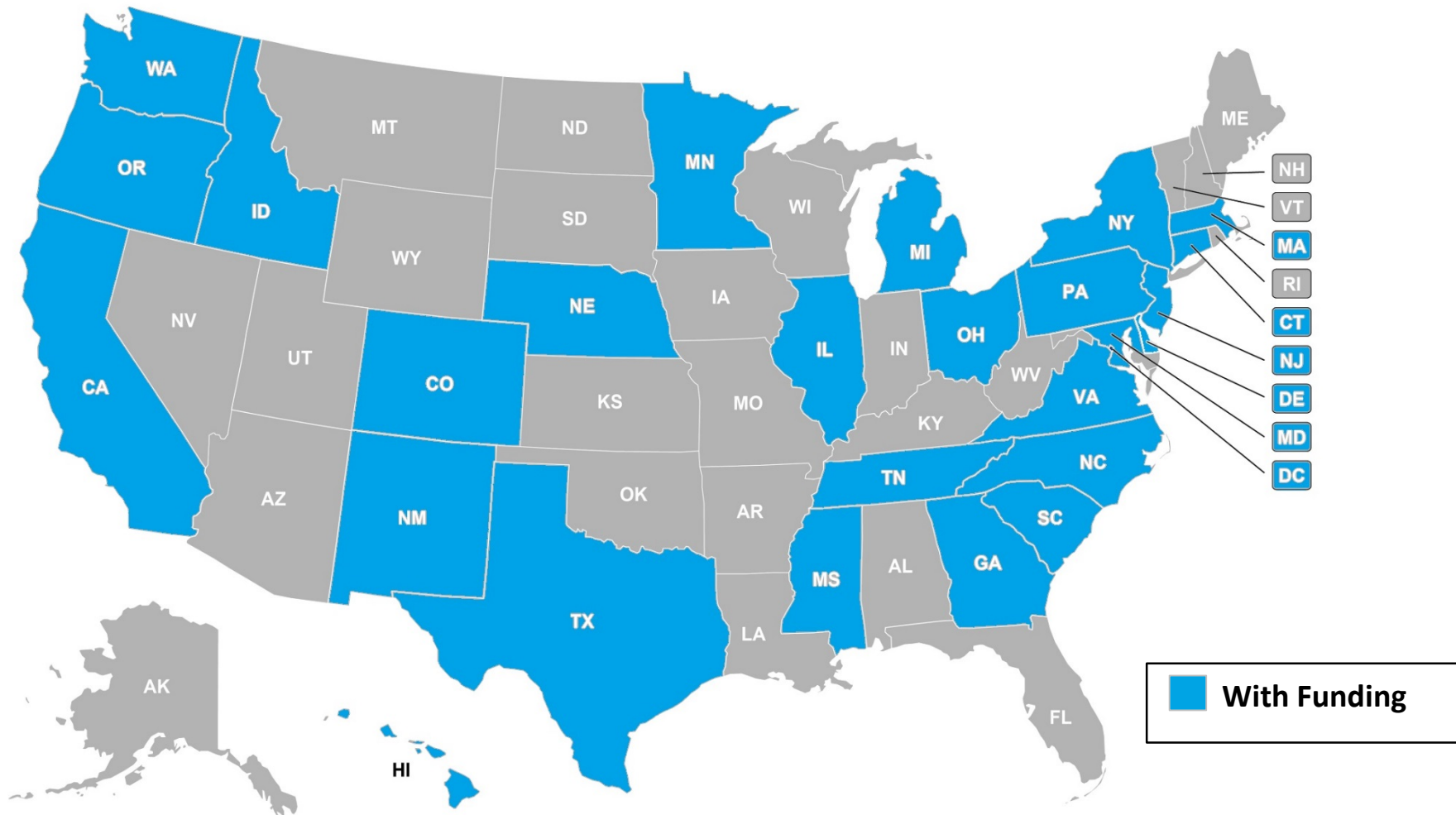
## Fuel Cell Technologies Office Activities By State *Prime and Subcontract Recipients*



Source: [FY 2015 Annual Progress Report- Project Listings by State](https://www.hydrogen.energy.gov/pdfs/progress15/xv_project_listing_by_state_2015.pdf)  
([https://www.hydrogen.energy.gov/pdfs/progress15/xv\\_project\\_listing\\_by\\_state\\_2015.pdf](https://www.hydrogen.energy.gov/pdfs/progress15/xv_project_listing_by_state_2015.pdf))

# States involved in FCTO activities- FY13-FY15 Funding

## Competitively Selected Projects and National Lab Core Capabilities- *Prime Recipients Only* FY 2013, FY 2014, and FY 2015



Source: [Fuel Cell Technologies Office Funding by State: FY 2013, FY 2014, and FY 2015](#)

(<http://energy.gov/eere/fuelcells/downloads/fuel-cell-technologies-office-funding-state-fy-2013-fy-2014-and-fy-2015>)

## Workshops

### 2016 Examples/plans

- ElectroCat
- Sustainability Metrics
- H2VETS
- Water splitting materials for renewable H<sub>2</sub>
- Energy Storage
- Low-cost, improved performance high-pressure H<sub>2</sub> storage systems
- Market Transformation and Safety
- Alkaline Membranes

### 2014-2015 Examples

- Early Market Fuel Cell Showcase and Project Review- 2013
- Clean Energy Technology Showcase Review- 2014
- Hydrogen Transmission and Distribution Workshop held- 2014
- Electrolytic Hydrogen Production Workshop- 2014
- DOE Materials-Based Hydrogen Storage Summit: Defining pathways for onboard automotive applications- 2015

## Requests for Information (RFIs)

### 2016 Examples/plans

- **Open:** H<sub>2</sub> infrastructure concepts & innovative research ideas- *Closes on Apr. 10*
- High pressure H<sub>2</sub> storage systems
- Truck Targets
- Manufacturing Topics
- Water splitting materials for renewable H<sub>2</sub>

### 2014-2015 Examples

- Strategies for a robust market introduction of hydrogen supply, infrastructure, and FCEVs- 2014
- Hydrogen contamination detectors- 2014
- Feasibility of commercializing fuel cell range extenders as onboard power generators for electric vehicles- 2014
- Advanced Thermal Insulation of Composite Materials for Long-term Cold and Cryogenic H<sub>2</sub> Storage On-Board FCEVs- (October, 2015)

## Ongoing Collaboration and Coordination

- USDRIVE Tech Teams
- HTAC
- H<sub>2</sub>USA & H<sub>2</sub>FIRST
- CaFCP and State Agencies



## 6 Areas of Work

1. **Devices and Integrated Systems Testing\***
2. Sensing and Measurements
3. System Operations, Power Flow, and Control
4. **Design and Planning Tools\***
5. Security and Resilience
6. Institutional Support

*\* FCTO emphasis areas*

## 2025 Targets

- **33% decrease in cost** of reserve margins while maintaining reliability
- **10% reduction** in the economic costs of power outages
- **50% decrease in the net integration costs** of distributed energy resources

## Examples of FCTO Projects Portfolio under DOE Grid Modernization Effort

- **Electrolyzer test bed at NREL (FY14)**
- **Electrolyzers in real-time grid simulation; INL & NREL (FY15)**

### Grid Modernization Lab Call Projects (FY15/16)

- **DER Siting and Optimization Tool\*** (LBNL)
- **Smart Reconfiguration of Idaho Falls Power Grid\*** (INL)
- **Integrated Systems Modeling of H<sub>2</sub>-Vehicle-Grid Interactions\*\*** (LBNL)
- **Optimal Stationary Fuel Cell Integration and Control\*\*** (NREL)

\*Foundational \*\* Program-related topics

## T2M Strategy

### Increase Industry Contact

- Business-to-Business Product Theater at conferences
- Manufacturing Road Show
- Small Business Vouchers

### Listen to the Voice of the Customer

- Key Staff Exchange with industry and national labs
- Site visits, Feedback sessions

### Develop Technology Transfer Skills

- Business Plan Development Training
- Lab Corps

## Activities

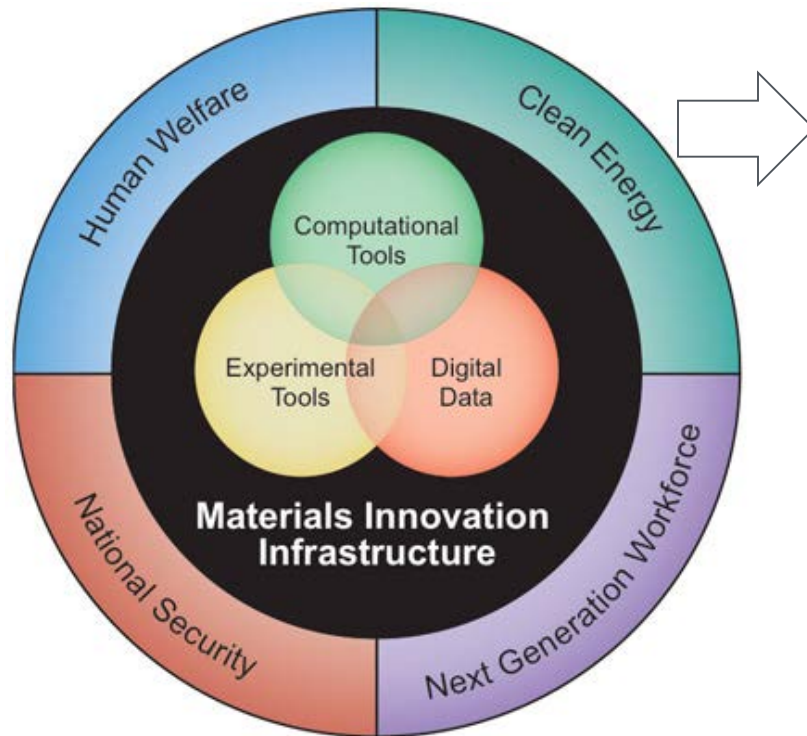
## Goals

Increase Market Understanding

Improve Private Sector and National Lab Relationships

*Improving technology transfer and targeted impact from lab to market*

# The Energy Materials Network: In Support of the Materials Genome Initiative (MGI)



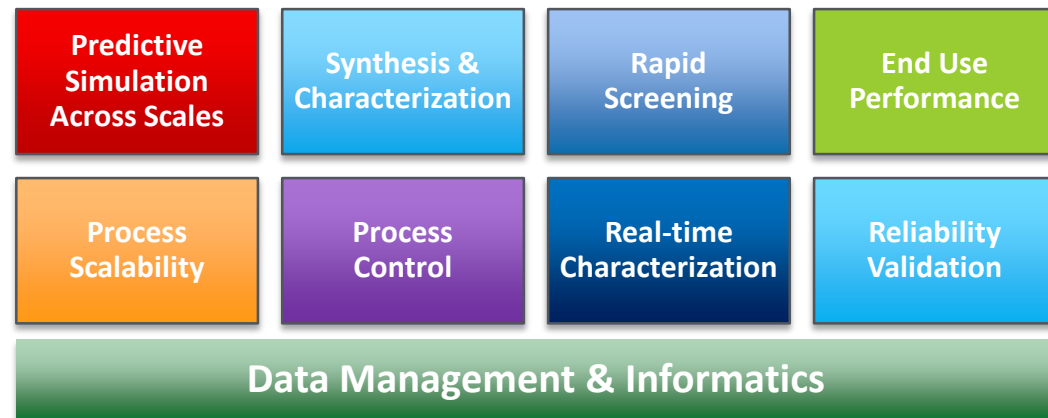
## MGI - Framework



## Energy Materials Network

U.S. Department of Energy

*Coordinated resource network with a suite of capabilities for advanced materials R&D*



*New Material Innovations for Clean Energy 2X Faster and 2X Cheaper*

# ElectroCat (Electrocatalysis Consortium)

## Goal

Accelerate the deployment of fuel cell systems by **eliminating the use of PGM catalysts**

## Mission

Develop and implement PGM-free catalysts by:

- **streamlining access** to unique synthesis and characterization tools across national labs
- **developing missing strategic capabilities**
- **curating a public database** of information

## Partners



**High-throughput materials discovery, characterization, and testing**



**Design and synthesis of PGM-free catalysts and electrodes**

## The Bigger Picture



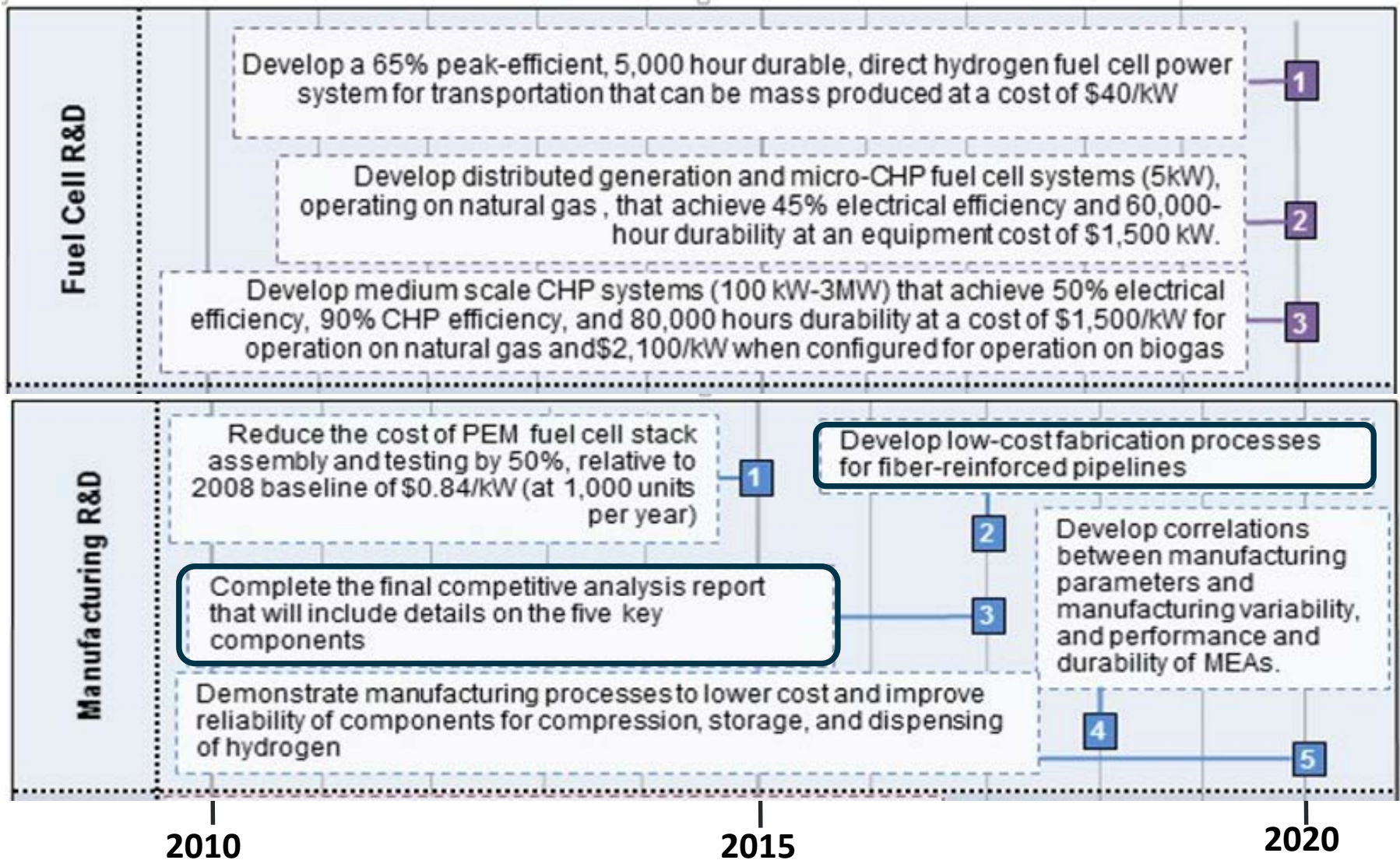
Part of



**Energy Materials Network**  
U.S. Department of Energy

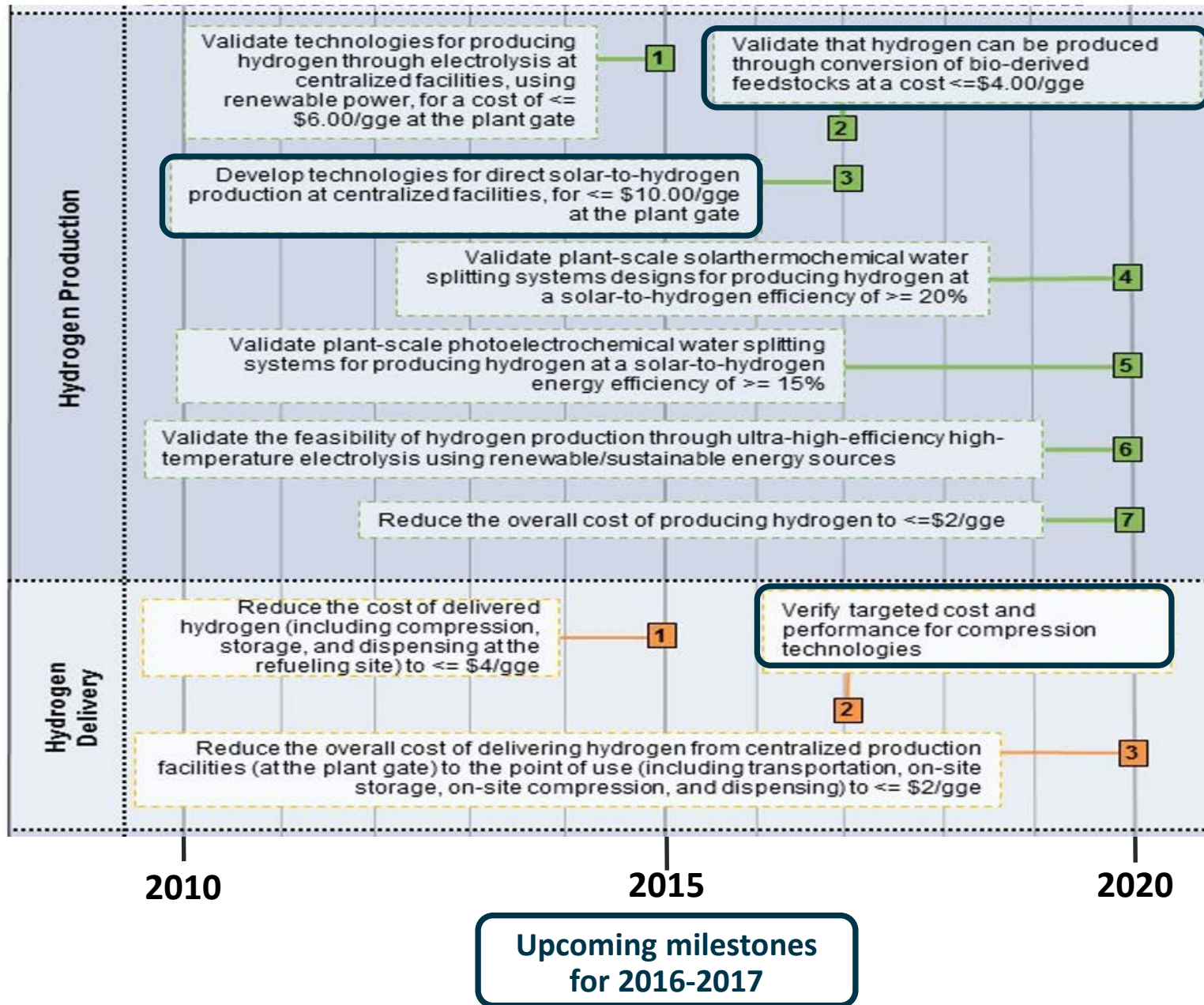
# UPDATED PROGRAM PLAN MILESTONES

# Updated Program Plan Milestones (FC and MN)

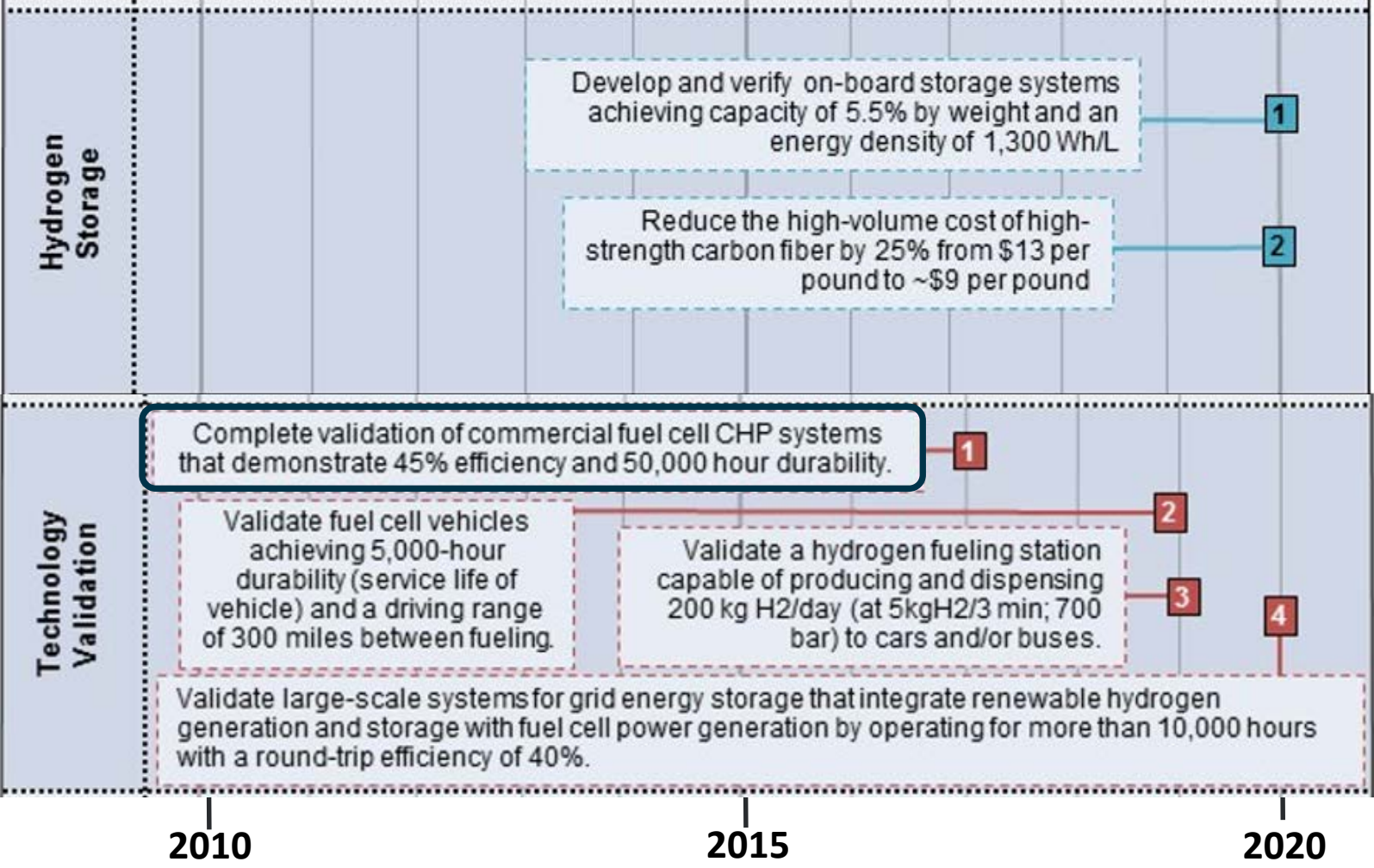


Upcoming milestones  
for 2016-2017

# Updated Program Plan Milestones (PD)



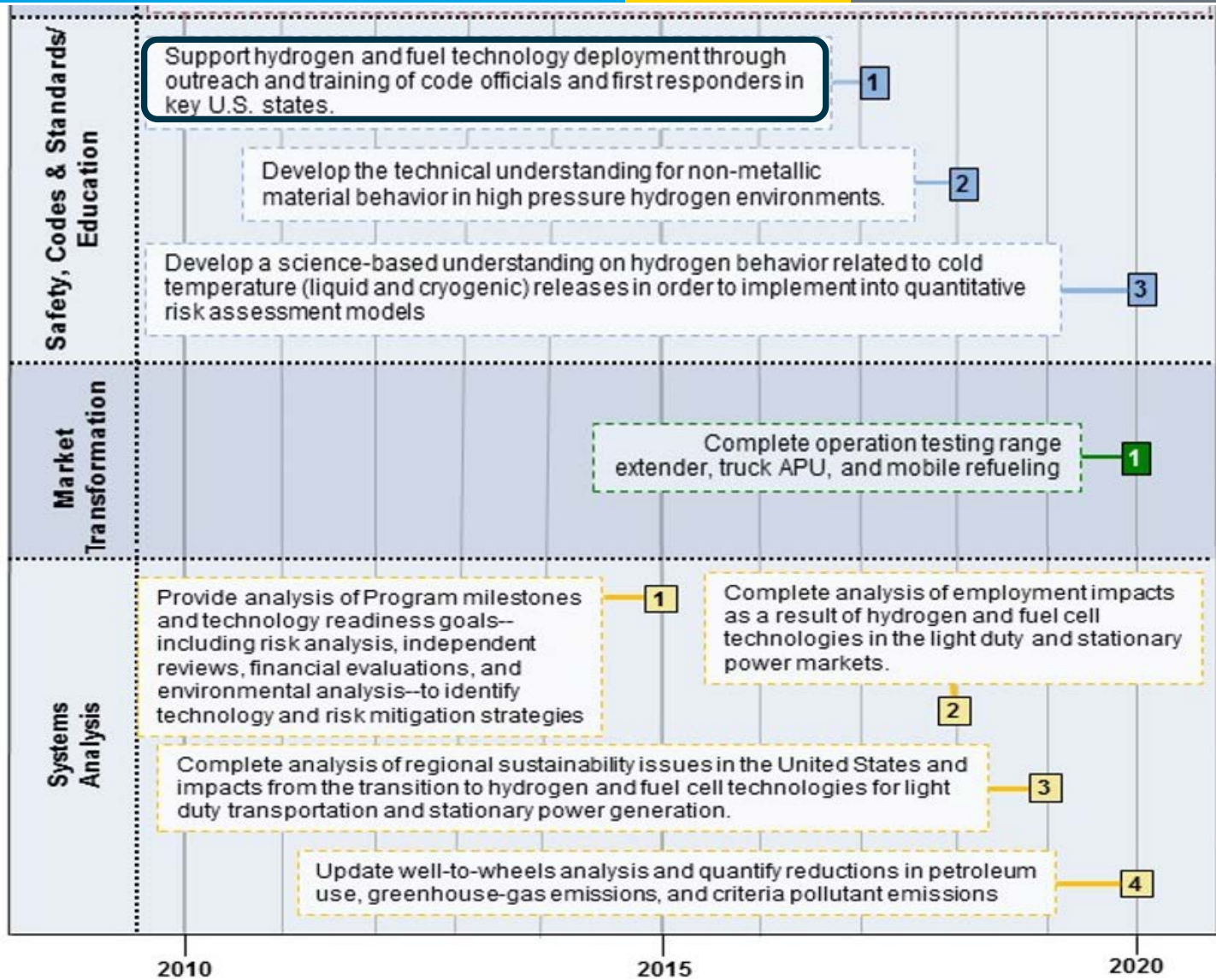
# Updated Program Plan Milestones (ST and TV)



**Upcoming milestones for 2016-2017**



# Updated Program Plan Milestones (SCS, MT and SA)



**Upcoming milestones  
for 2016-2017**