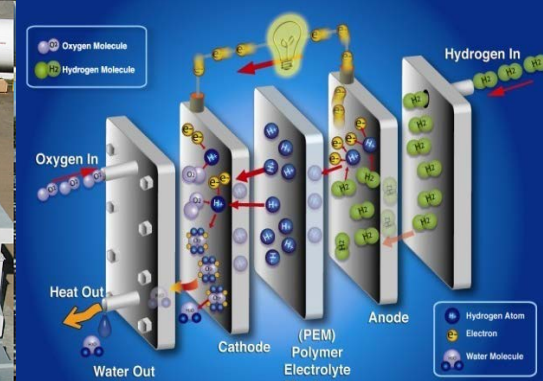


# U.S. DEPARTMENT OF ENERGY FUEL CELL TECHNOLOGIES OFFICE

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



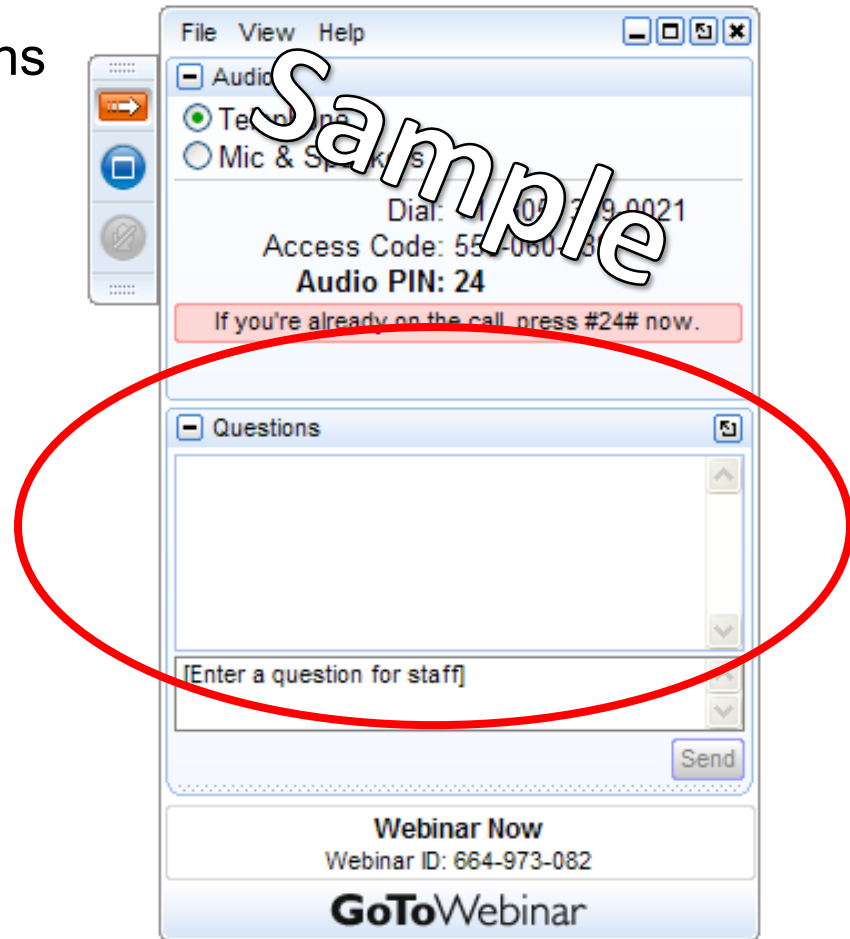
## National Hydrogen Safety Training Resource for Emergency Responders

3/24/15

Presenter(s):  
Nick Barilo  
Jennifer Hamilton

# Question and Answer

- Please type your questions into the question box



[hydrogenandfuelcells.energy.gov](http://hydrogenandfuelcells.energy.gov)



HYDROGEN  
Emergency Response  
Training Resources



Pacific Northwest  
NATIONAL LABORATORY

Proudly Operated by **Battelle** Since 1965

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



# Hydrogen and Fuel Cell First Responder Training Resources

Nick Barilo (PNNL) and Jennifer Hamilton (CaFCP)

Pacific Northwest National Laboratory and the California Fuel  
Cell Partnership

March 24, 2015, 12:00 PM – 1:00 PM EDT



# DOE First Responder H<sub>2</sub> Safety Training

## ► National Goal

- Support the successful implementation of hydrogen and fuel cell technologies by providing technically accurate hydrogen safety and emergency response information to first responders

## ► Integrated Activities

- Online, awareness-level training
- Classroom and hands-on operations-level training
- National training resource (enabling trainers)

## ► Collaboration and Partnerships

- Pacific Northwest National Laboratory (PNNL)
- California Fuel Cell Partnership (CaFCP)
- National Fire Academy



*A properly trained first responder community is critical to the successful introduction of hydrogen fuel cell applications and their transformation in how we use energy.*

# Supporting the Mission of H<sub>2</sub>USA

- The mission of H<sub>2</sub>USA is to promote the commercial introduction and widespread adoption of FCEVs across America through creation of a public-private collaboration to overcome the hurdle of establishing hydrogen infrastructure.
- Having properly trained first responders will address a key barrier, ensure a safe transition to fuel cell vehicles and H<sub>2</sub> infrastructure, and pave the way for broader public acceptance.

## H<sub>2</sub>USA's public-private partnership



# Key Early Market Challenges Addressed by H2USA



Photo Credits Top: NREL, Middle: NREL, Bottom: Hexagon Lincoln

## ➤ Station Cost Reduction

- Fueling resources & delivery
- State and local regulations

## ➤ Station Locations

- Identify and prioritize markets
- Regulatory barriers (zoning)
- Station rollout timing

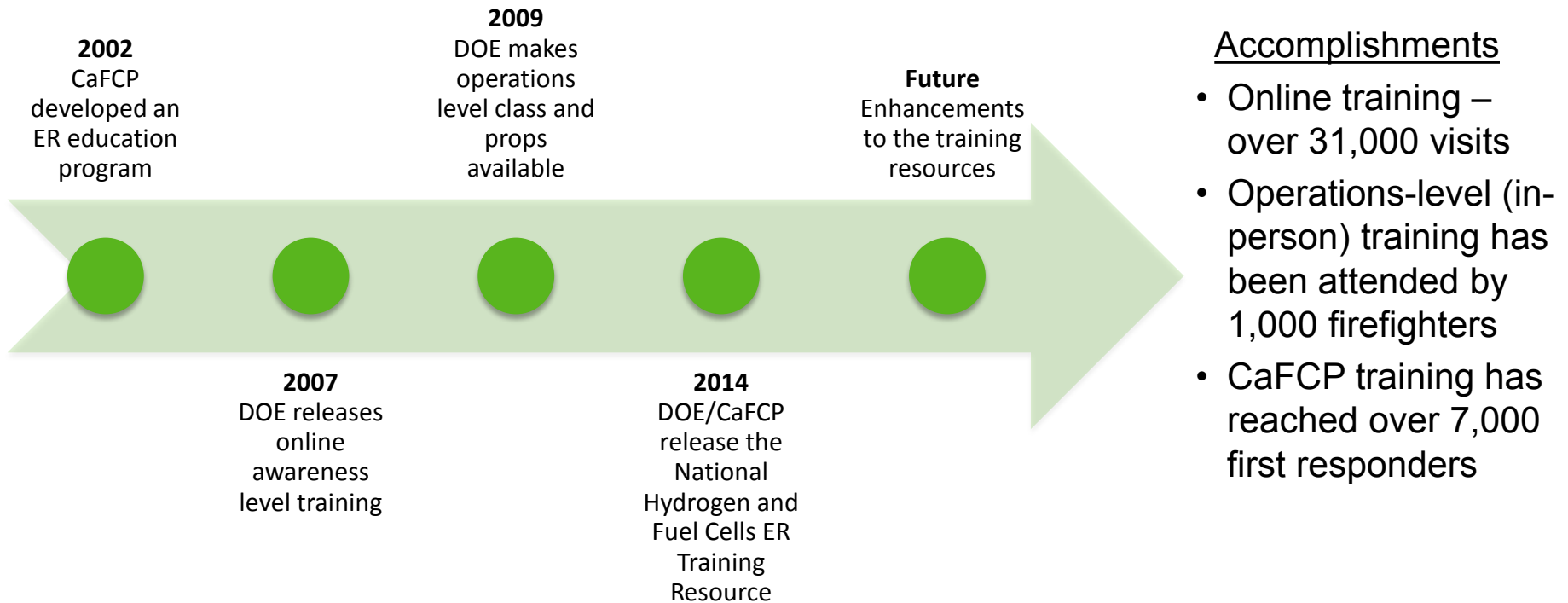
## ➤ Investment and Finance

- Private sector financing
- Government support

## ➤ Market Support and Acceleration

- Product launch and timeline
- Codes and standards (non-vehicle related)
- Public education

# Training Resources Timeline and Accomplishments



# Online Training

## Introduction to Hydrogen Safety for First Responders

U.S. Department of Energy  
**Hydrogen Program**  
[www.hydrogen.energy.gov/firstresponders](http://www.hydrogen.energy.gov/firstresponders)

**COURSE MATERIALS** | **LIBRARY** | EXIT ▶

Hydrogen Basics    Transport & Storage    Hydrogen Vehicles    Hydrogen Dispensing    Stationary Facilities    Codes & Standards    Emergency Response    Summary & Quiz

### Hydrogen Safety Course Contents



The Course Materials cover the following topics:

- Hydrogen Basics
- Hydrogen Vehicles
- Stationary Facilities
- Emergency Response
- Transport & Storage
- Hydrogen Dispensing
- Codes & Standards

You can view the topic modules in sequence or select them in random order using the top navigation bar.

A short quiz follows at the end of the course.

You can mute the narration by clicking on the mute button in the navigation bar.

[Begin the Course ▶](#)

Slide 1 of 1      [Submit Comment](#)

<http://hydrogen.pnl.gov/FirstResponders/>



# Online Training Example Slide

## Introduction to Hydrogen Safety for First Responders



U.S. Department of Energy  
**Hydrogen Program**  
[www.hydrogen.energy.gov/firstresponders](http://www.hydrogen.energy.gov/firstresponders)

COURSE MATERIALS

LIBRARY

EXIT ►

Hydrogen Basics  Transport & Storage  Hydrogen Vehicles  Hydrogen Dispensing  Stationary Facilities  Codes & Standards  Emergency Response  Summary & Quiz

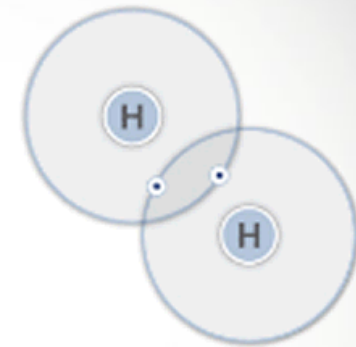
### Hydrogen Properties and Behaviors

Like gasoline or natural gas, hydrogen is a fuel that must be handled properly; it can be used as safely as other common fuels when simple guidelines are followed.

Hydrogen is colorless, odorless, and tasteless. It's non-toxic and non-poisonous; it's non-corrosive, but can embrittle some metals. Hydrogen is the lightest and smallest element, and a gas under ambient conditions. It's 14 times lighter than air, which means that when it's released, it typically rises and diffuses quickly.

The volume ratio of liquid to gas is 1:848. So, if you picture a gallon of liquid hydrogen, that same amount of hydrogen, existing as a gas, would, theoretically, occupy 848 gallon containers (without compression).

- Colorless, odorless, tasteless, non-toxic, non-corrosive and non-poisonous
- Lightest and smallest element
- A gas at ambient conditions
- Fourteen times lighter than air, it rises and disperses rapidly
- Exists as a liquid at -423°F (-253°C)
- Volume ratio of liquid to gas is 1:848



Molecular Hydrogen

Slide 4 of 13

# Operations Training

## ► Classroom Content

- Hydrogen and Fuel Cell Basics
- Hydrogen Vehicles
- Stationary Facilities
- Emergency Response
- Incident Scenarios

## ► Demonstrations/Hands-on Exercise with FCEV Prop

- Demonstration of Hydrogen Flame Characteristics
- Student Participation in Rescue Evolutions



*Multiple instructors for classroom training*



*A "rescue" at Sunnyvale (CA) Department of Public Safety*

# Course Content and Hands-on Activities

## Hydrogen Emergency Response

### Table of Contents

Instructor Manual

Module 1: Introduction and Course Overview

Module 2: Hydrogen and Fuel Cell Basics

Module 3: Hydrogen-Fueled Vehicles

Module 4: Stationary Facilities

Module 5: Managing Hydrogen-Related Emergencies

Module 6: Practical Exercise

Module 7: Quiz

Module 8: Hands-On Exercise With FCV Prop



Presented by



# What and Why – National Hydrogen and Fuel Cell Emergency Response Training Resource

- ▶ Hydrogen and fuel cell-related first responder training utilizing a national emergency response education program as a **consistent source of accurate information and current knowledge**.
- ▶ A resource **adaptable to the specific needs** of first responders and presentation styles of training organizations and meant to complement extensive training programs already in place.
- ▶ The nationally-focused training template intended to serve as a resource and guide for the delivery of a variety of training regimens to various audiences.
- ▶ The template delineates this concept as L1-Overview, L2-Short Course and L3-Full Course and suggests training materials accordingly.
- ▶ Feedback from presenters and audiences to the developers of the National Hydrogen and Fuel Cells Emergency Response Education Program will help ensure that the development of new and updated training content and techniques serves to continually enhance the value of this resource.

# History of the National Program's Development

- ▶ Used existing materials from DOE and CaFCP programs
  - Approved, vetted information
  - Made updates as necessary
- ▶ Three 'levels' of information in 130 slides
  - Accompanying template document with guidance on use
  - Slides suggested for three levels of information:
    - Introductory course
    - Short course
    - Extended course
- ▶ Not prescriptive; trainer can select any/all of the slides that are appropriate for the audience

# Hierarchy of the Training Template Approach

An outline was developed to topically to cover the following:



# Illustrating the use of the template

## First Responder Training Template

- Slide #1 National Hydrogen Emergency Response Education Program
- Slide #2 What and Why

	Level 1 Overview	Level 2 Short Course	Level 3 Full Course
<b>1. Introduction and Background (Slide #3)</b>			
• Slide #4 Fuel cells overview and benefits	✓	✓	✓
• Slide #5 Fuel cells – Where are we today?		✓	✓
• Slide #6 Diverse fuel cell transportation applications		✓	✓
<b>2. Hydrogen and Fuel Cell Basics (Slide #7)</b>			
2.1 Hydrogen – Where does it come from and how do we use it today?			
2.2 Properties of hydrogen and its safe use			

# Managing Hydrogen-related Emergencies

FR Template

- 1. Introduction and Background +
- 2. Hydrogen and Fuel Cell Basics +
- 3. Hydrogen-Fueled Vehicles (light duty and transit) +
- 4. Stationary Facilities +
- 5. Managing Hydrogen-Related Emergencies -
- 6. Practical Exercises +

Examples of slides covering a few topics/subtopics

- 5.1 Vehicle incidents
  - 5.1.1 Size up
  - 5.1.2 Plan (Identify)
  - 5.1.3 Act
- 5.2 Stationary Systems/Facility Incidents
- 5.3 Vehicle and Stationary Facility Responses

### National Fire Academy (NFA) Command Sequence

1. Size Up (Think) **SIZE UP**
2. Identify Strategy/Tactics **PLAN**
3. Assign Tasks **ACT**
4. Review Results of Actions/Critique **EVALUATE**




Photo: Volpertest HAMMER Training and Education Center

Follow SOPs for vehicle response, paying particular attention to unique systems and characteristics for hydrogen-powered fuel cell vehicles

July 23, 2014 / 14

### Stationary facilities **SIZE UP**

Stationary hydrogen facilities will have hazards similar to facilities with other compressed and/or cryogenic gas processing or storage systems

- Gas or liquid storage?
  - High-pressure cylinder storage
  - Cryogenic liquid storage
- Is there a leak or flame present?
  - Gaseous hydrogen: use CGI/hydrogen detector and thermal-imaging cameras
  - Liquid hydrogen: look for ice crystals/frozen water vapor
- Is the leak confined by a structure? Ventilation adequate?
- Onsite reforming? Is a methane source present?
- Presence of other fuels (e.g., CNG, propane, gasoline)
- Identify potential ignition sources

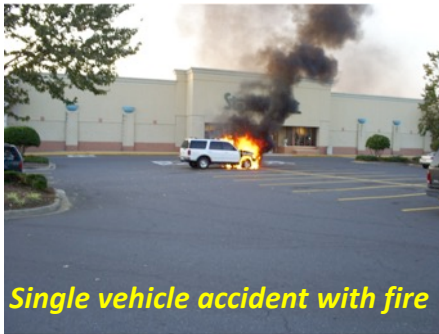
July 23, 2014 / 110



# Accident Scenarios Provided for Group Discussion

FR Template

1. Introduction and Background +
2. Hydrogen and Fuel Cell Basics +
3. Hydrogen-Fueled Vehicles (light duty and transit) +
4. Stationary Facilities +
5. Managing Hydrogen-Related Emergencies +
6. Practical Exercises +



# Let's Take a Look at How the Material Could Be Used

HYDROGEN Emergency Response Training Resources

Pacific Northwest NATIONAL LABORATORY  
Proudly Operated by Battelle Since 1951

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

California  
ADVANCING THE FUTURE

National Hydrogen and Fuel Cells Emergency Response  
**TRAINING**

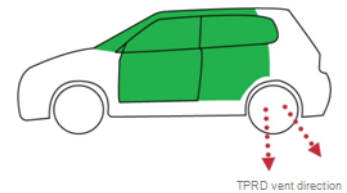
HYDROGEN  
FLAMMABLE GAS  
NO SMOKING  
NO OPEN FLAME

This presentation does not contain any proprietary, confidential, or otherwise restricted information. October

Our example will be a “short course” awareness level training session

## Hydrogen Vehicle Safety Systems

- When a leak is detected by hydrogen sensors, solenoid valves close, shutting off the flow of hydrogen, and the vehicle safely shuts down
- When collision sensors activate:
  - Tank solenoid valves close so that hydrogen remains locked in the tank.
  - In FCVs, high-voltage relays open so that the high-voltage battery/capacitors are isolated from the system
- Tank solenoid valves also close when the vehicle is turned off or the power is disrupted
- Tanks have thermally activated pressure relief devices (TPRDs)



# What and Why?

## National Hydrogen and Fuel Cell Emergency Response Training

A properly trained first responder community is critical to the successful introduction of hydrogen fuel cell applications and their transformation in how we use energy. We envision that hydrogen and fuel cell-related first responder training will be delivered locally to serve missions to protect life and preserve property, utilizing this national emergency response training resource as a consistent source of accurate information and current knowledge. These training materials are adaptable to the specific needs of first responders and training organizations and are meant to complement the extensive training programs already in place to serve their missions. **The note pages format of these slides provides more details for the instructor to conduct the training. Instructors should share this information when presenting the slides.**

The nationally-focused training template that accompanies these materials is intended to serve as a resource and guide for the delivery of a variety of training regimens to various audiences. These materials are adaptable for different presentation styles, ranging from higher level overview formats to more comprehensive classroom training. Three example uses of the slides are provided in the companion Word file.

Feedback from presenters and audiences to the developers of the National Hydrogen and Fuel Cells Emergency Response Training will help ensure that the development of new and updated training content and techniques serves to continually enhance the value of this resource.

This material was prepared as an account of work sponsored by an agency of the United States Government. NEITHER THE UNITED STATES GOVERNMENT NOR THE UNITED STATES DEPARTMENT OF ENERGY, NOR ANY OF THEIR EMPLOYEES, NOR ANY OF THEIR CONTRACTORS, SUBCONTRACTORS OR THEIR EMPLOYEES, MAKES ANY WARRANTY, EXPRESS OR IMPLIED, OR ASSUMES ANY LEGAL LIABILITY OR RESPONSIBILITY FOR THE ACCURACY, COMPLETENESS, OR USEFULNESS OR ANY INFORMATION, APPARATUS, PRODUCT, OR PROCESS DISCLOSED, OR REPRESENTS THAT ITS USE WOULD NOT INFRINGE PRIVATELY OWNED RIGHTS.

Revision Date: January 8, 2015



HYDROGEN  
Emergency Response  
Training Resources



Pacific Northwest  
NATIONAL LABORATORY

Proudly Operated by **Battelle** Since 1965

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



# National Hydrogen and Fuel Cells Emergency Response TRAINING



## SECTION 1:

# Introduction and Background

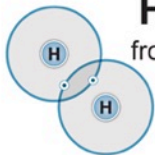
## This section introduces the user to:

- An overview of the role of fuel cells and their benefits
- A picture of today's hydrogen production and delivery, current markets for fuel cells
- A diverse set of fuel cell transportation applications

# Fuel Cells Overview

## DIVERSE ENERGY SOURCES & FUELS

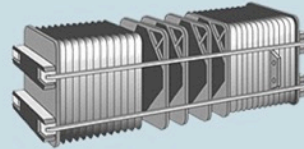
Biomass  
Natural Gas  
Propane  
Diesel  
Other Hydrocarbons  
Methane  
Methanol



**Hydrogen**  
from renewables  
or low carbon  
resources

## CLEAN, EFFICIENT ENERGY CONVERSION

### Fuel Cells



- Alkaline
- Direct Methanol
- Molten Carbonate
- Polymer Electrolyte Membrane (PEM)
- Phosphoric Acid
- Solid Oxide

## DIVERSE APPLICATIONS



### Stationary Power



### Transportation



### Portable Power

# Why Hydrogen?

- Excellent energy carrier
- Nonpolluting
- Economically competitive
- As safe as gasoline
- Used safely for over 50 years
- Produced from a variety of sources



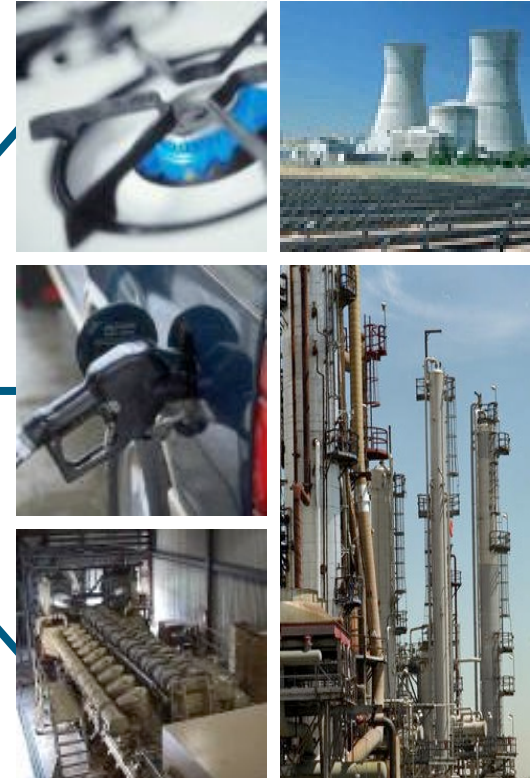
# Where Do We Get Hydrogen?

## Renewable Sources



*Solar, wind, geothermal,  
hydro, biomass, algae*

## Traditional Sources



*Natural gas, gasoline,  
nuclear, coal*



# Hydrogen Uses

The use of hydrogen is not new; private industry has used it safely for many decades. Nine million tons of hydrogen are safely produced and used in the United States every year. 56 billion kg/yr are produced globally. For example, H<sub>2</sub> is used for:

- Petroleum refining
- Glass purification
- Aerospace applications
- Fertilizers
- Annealing and heat treating metals
- Pharmaceutical products

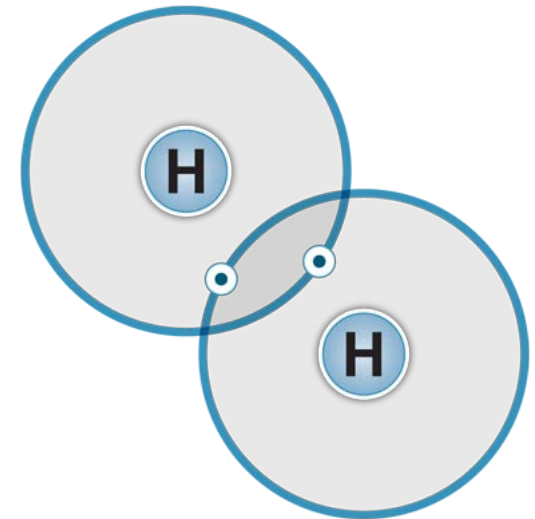


The Air Products and Chemicals hydrogen production facilities in Port Arthur, Texas, is funded by the Energy Department through the 2009 Recovery Act. | Photo credit Air Products and Chemicals hydrogen production facilities.

- Petrochemical manufacturing
- Semiconductor industry
- Hydrogenation of unsaturated fatty acids in vegetable oil
- Welding
- Coolant in power generators

# Hydrogen Properties and Behavior

- A gas at ambient conditions
- Hydrogen is a cryogen: exists as a liquid at  $-423^{\circ}\text{F}$  ( $-253^{\circ}\text{C}$ ).
  - Compressing the gas does not liquefy it
  - No liquid phase in a compressed gaseous hydrogen storage tanks
- LH2 storage at relatively low pressure (50 psi)
- Double walled, vacuum insulated tanks with burst disks, vents, and pressure relief devices
- Volumetric ratio of liquid to gas is 1:848
  - Compare water to steam (1:1700)
- Energy content of 1kg of  $\text{H}_2$  is approximately equal to 1 gal of gasoline (in BTUs)



Molecular Hydrogen

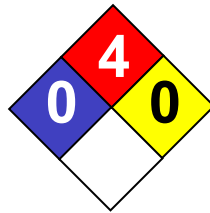
# Hydrogen Properties: A Comparison

	Hydrogen	Natural Gas	Gasoline
Color	No	No	Yes
Toxicity	None	Some	High
Odor	Odorless	Mercaptan	Yes
Buoyancy Relative to Air	14X Lighter	2X Lighter	3.75X Heavier
Energy by Weight	2.8X > Gasoline	~1.2X > Gasoline	43 MJ/kg
Energy by Volume	4X < Gasoline	1.5X < Gasoline	120 MJ/Gallon

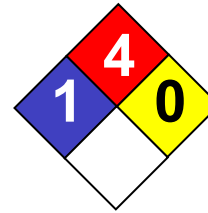
Source: California Fuel Cell Partnership

# Comparison of Flammability

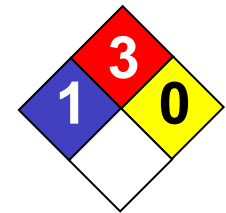
## Hydrogen



## Natural Gas



## Gasoline



Flammability in air  
(LFL – UFL)

4.1% - 74%

5.3% - 15%

1.4% - 7.6%

Explosive limits in air  
(LEL – UEL)

18.3% - 59%

5.7% - 14%

1.4% - 3.3%

Most easily ignited  
mixture in air

29%

9%

2%

Flame temperature (°F)

4010

3562

3591

# Fuel Cell Basics

- The type of electrolyte determines the kind of fuel cell
  - The polymer electrolyte membrane fuel cell is the most promising for light-duty transportation
  - Other fuel-cell types, such as solid oxide, molten carbonate, and phosphoric acid fuel cells, use different electrolytes
- To increase the amount of electricity generated, individual fuel cells are combined into a fuel-cell “stack,” which may consist of hundreds of individual fuel cells

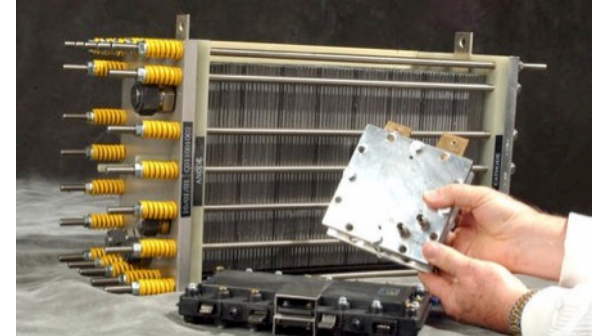
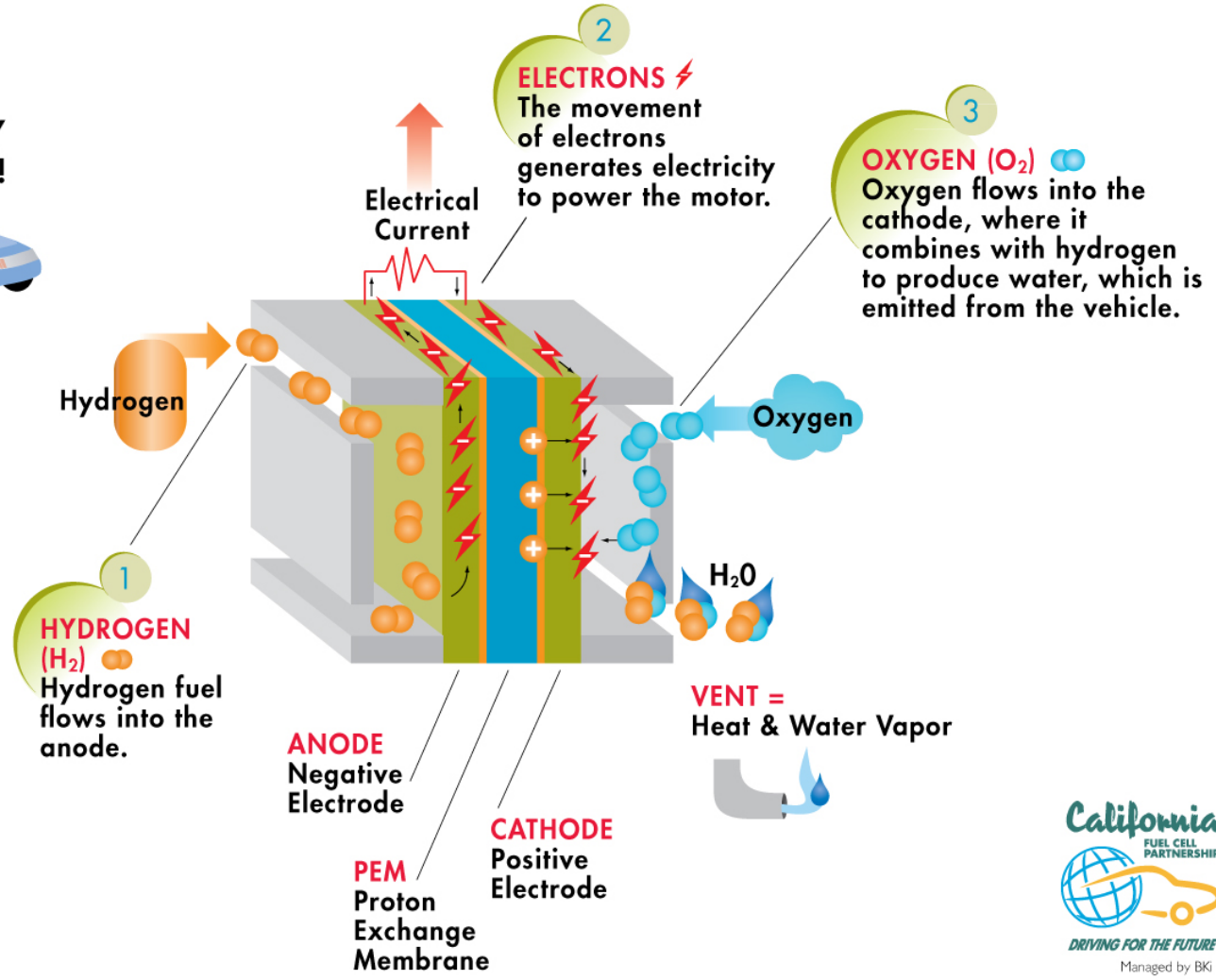
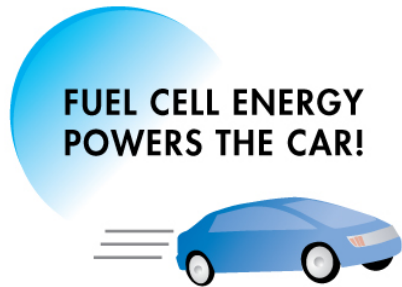


Photo: National Renewable Energy Laboratory



Photo: California Hydrogen Business Council

# How a Fuel Cell Works



# Fuel Cell Electric Vehicles (FCEV)

- Run on hydrogen
- Use a fuel cell and electric motor, no engine
- Quiet, mostly air compressor and valves
- Emit zero pollutants



**Mercedes-Benz**



**Nissan**



**General Motors**



**Hyundai / Kia**



**Honda**



**AC Transit**



**Volkswagen / Audi**



**Toyota**

# Public Vehicles



Photos provided by equipment providers

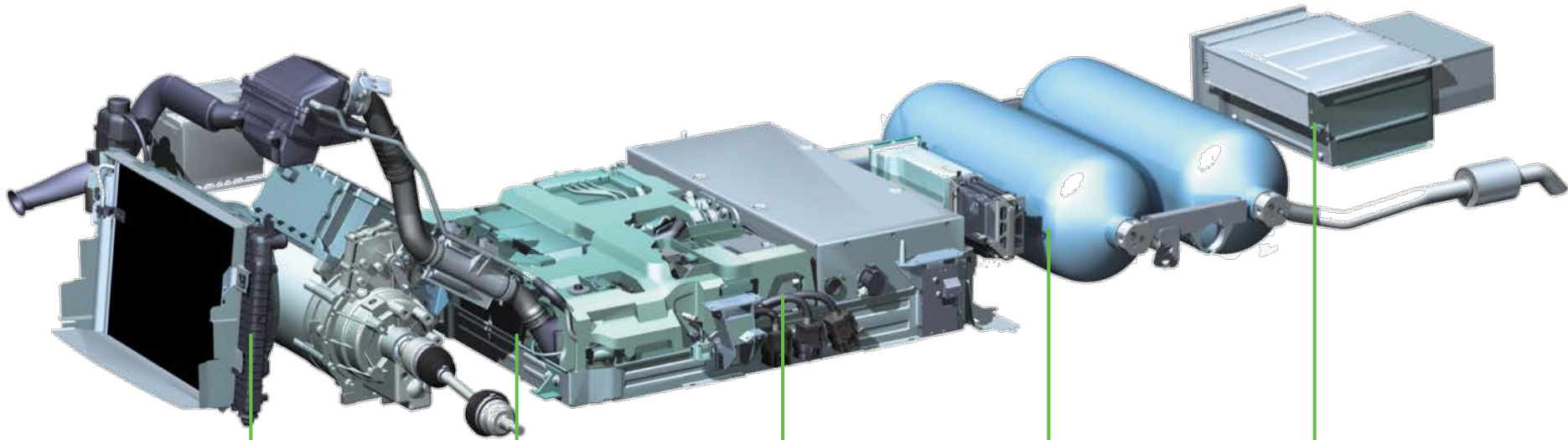


# FCEV Concepts



Image courtesy of Honda

# FCEV System Layout



## Cooling System

Typically, slightly larger radiators than conventional

## Electric Motor

Electrical component; drives vehicle by electricity

## Power Electronics

Electrical component; distributes electricity

## Fuel Cell

Electrical component; generates electricity from hydrogen

## Hydrogen Tanks

Compressed, gaseous fuel; vehicle fueled with hydrogen

## High Voltage Battery

Electrical component; captures regen braking, supports acceleration

Source: California Fuel Cell Partnership

# High Voltage System

- Same technology as other alt fuel vehicles (gas/electric hybrids)
- Orange high-voltage wiring per SAE
- Isolated + and – sides (not grounded to the chassis)
- Automatic high voltage system disconnect
  - Inertia switch
  - Ground fault monitoring



Light Duty Vehicle



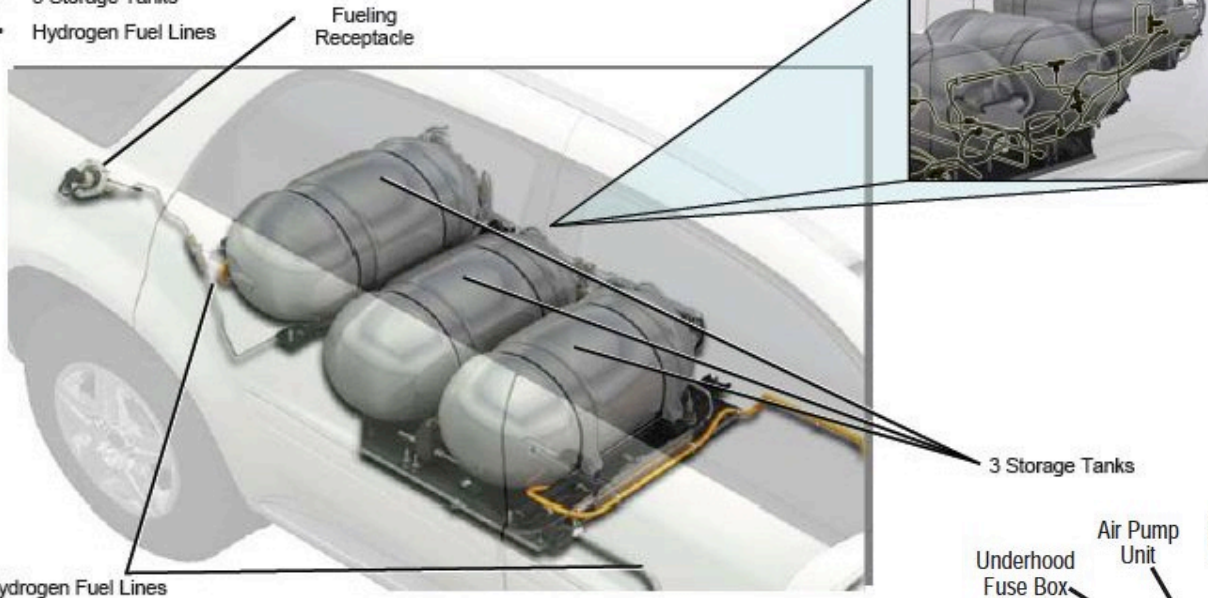
Transit Bus

# Hydrogen Delivery System

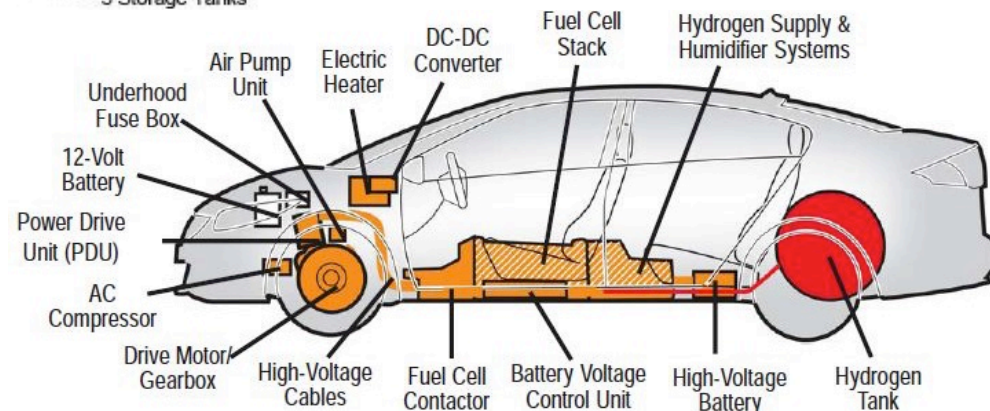
## Equinox Fuel Cell Components (cont.)

The Hydrogen Storage System, located in the rear underbody area, stores compressed hydrogen for use in the Fuel Cell Stack. This system consists of:

- Fueling Receptacle
- 3 Storage Tanks
- Hydrogen Fuel Lines

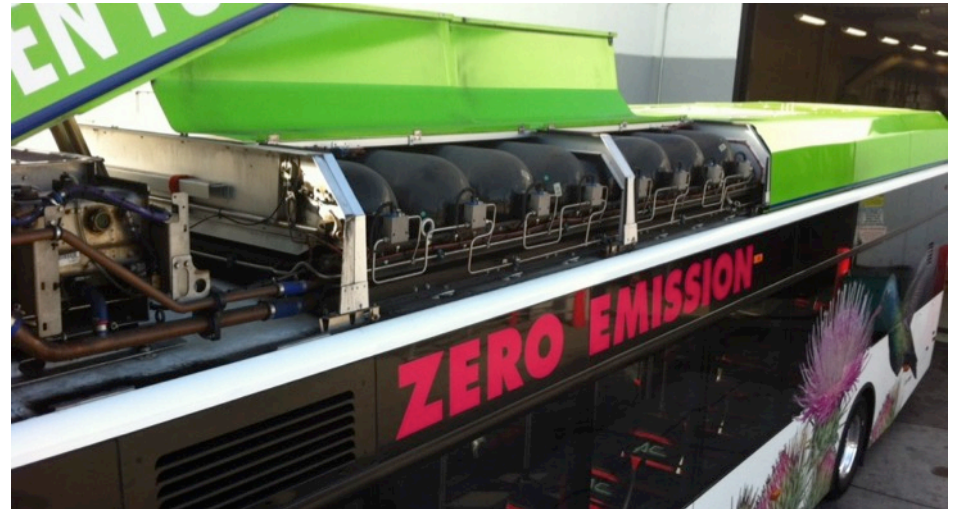


- Single tank and multi-tank set-ups
- Distribution lines contain lower pressures than tanks
- Tank TPRDs vent directly or are connected to fuel vent line(s)



# Hydrogen Delivery System – Bus

- Bus fuel tanks on roof
- All equipped with thermally activated pressure relief devices and vent lines
- Larger capacity storage



# Compressed Hydrogen Storage Systems

- Carbon fiber wrapped, metal or polymer lined tanks
- Equipped with temperature activated pressure relief devices (TPRD)
- Stronger than conventional gasoline tanks
  - Absorb 5X crash energy of steel



Wall thickness comparison:  
35 MPa vs. 70 MPa cylinders

(Photo courtesy of Powertech)

# Compressed Hydrogen Tank Testing

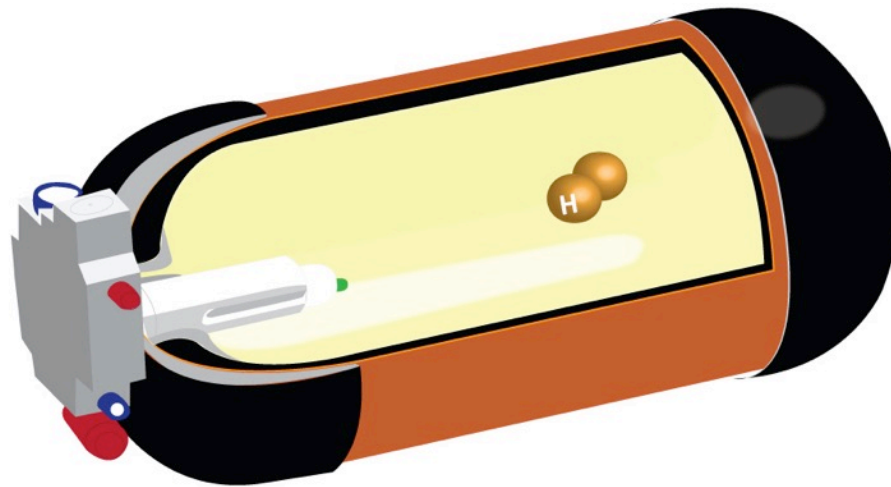
Tank testing is on a national (SAE International/FMVSS) and international scale (Global Technical Regulation) for the types of tests and tank lifetimes (15 years is typical, but could qualify for 20+ years with additional testing).

- Bonfire
- Drop
- Gun fire
- Pressure cycling
- Overpressure
- Temperature
- Impact
- Permeation
- “Tank life” – at least 15 years
- Rated for 2.25x service pressure



# Compressed Hydrogen Tank Testing

- In accordance with latest proposed hydrogen vehicle tank standards (SAE J2579, CSA HGV2)
- Tests conducted as part of the design qualification testing for new tanks
- The tank should only vent and not rupture





# Types of Stationary Facilities

Stationary facilities include:

- Stationary fuel cells
- Bulk hydrogen storage
- Hydrogen fueling stations



Photo: Air Products and Chemicals, Inc.



Photo: Plug Power, Inc.

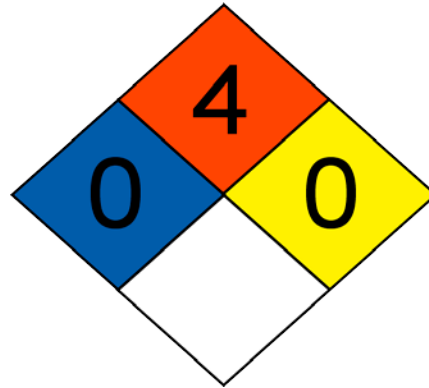


Photo: California Fuel Cell Partnership

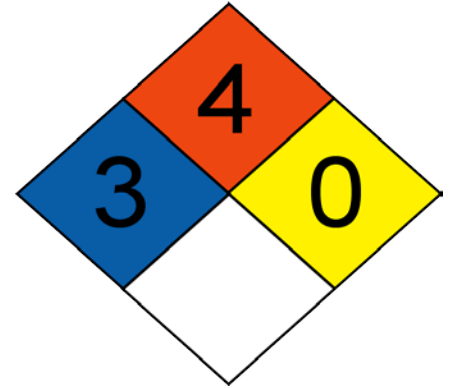
# Identifying Stationary Facilities

## NFPA 704 Hazard Placards

- Red = Flammability
- Blue = Health
- Yellow = Reactivity
- White = Special Precautions



Gaseous Hydrogen



Liquid Hydrogen

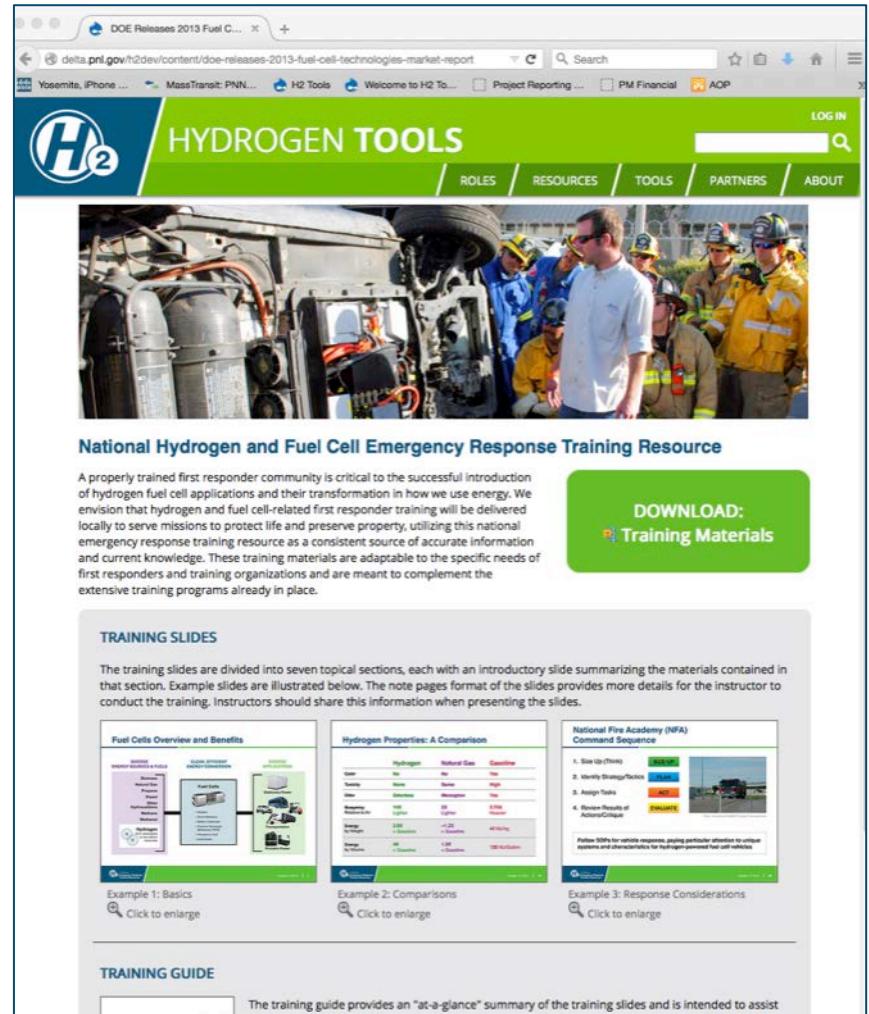
# Hydrogen Fueling Stations



Pictures provided by CaFCP

# Downloading the Resource...

- ▶ The National Hydrogen and Fuel Cell Emergency Response Training Resource is one of many resources available from the Hydrogen Tools Portal at <http://h2tools.org/fr/nt/>.
- ▶ The Hydrogen Tools Portal brings together and enhances the utility of a variety of tools and web-based content on the safety aspects of hydrogen and fuel cell technologies. It is intended to help inform those tasked with designing, approving, or using systems and facilities, as well as those responding to incidents.



The screenshot shows a web browser displaying the Hydrogen Tools website. The page features a green header with the H<sub>2</sub> logo and the text "HYDROGEN TOOLS". Below the header is a navigation menu with links for "ROLES", "RESOURCES", "TOOLS", "PARTNERS", and "ABOUT". A search bar is located on the right side of the header. The main content area includes a large image of a hydrogen fuel cell vehicle with several people in safety gear. Below the image is the title "National Hydrogen and Fuel Cell Emergency Response Training Resource" and a short introductory paragraph. A prominent green button labeled "DOWNLOAD: Training Materials" is visible. Underneath, there is a section titled "TRAINING SLIDES" which contains three example slide thumbnails: "Fuel Cells Overview and Benefits", "Hydrogen Properties: A Comparison", and "National Fire Academy (NFA) Command Sequence". Each slide has a "Click to enlarge" link. At the bottom, there is a "TRAINING GUIDE" section with a brief description.

**National Hydrogen and Fuel Cell Emergency Response Training Resource**

A properly trained first responder community is critical to the successful introduction of hydrogen fuel cell applications and their transformation in how we use energy. We envision that hydrogen and fuel cell-related first responder training will be delivered locally to serve missions to protect life and preserve property, utilizing this national emergency response training resource as a consistent source of accurate information and current knowledge. These training materials are adaptable to the specific needs of first responders and training organizations and are meant to complement the extensive training programs already in place.

**DOWNLOAD:**  
Training Materials

**TRAINING SLIDES**

The training slides are divided into seven topical sections, each with an introductory slide summarizing the materials contained in that section. Example slides are illustrated below. The note pages format of the slides provides more details for the instructor to conduct the training. Instructors should share this information when presenting the slides.

**Fuel Cells Overview and Benefits**  
Example 1: Basics  
Click to enlarge

**Hydrogen Properties: A Comparison**  
Example 2: Comparisons  
Click to enlarge

**National Fire Academy (NFA) Command Sequence**  
Example 3: Response Considerations  
Click to enlarge

**TRAINING GUIDE**  
The training guide provides an "at-a-glance" summary of the training slides and is intended to assist

# Hydrogen Tools

## A Transformative Step Towards Hydrogen Adoption

### CENTRALIZED LOCATION

organizes current H<sub>2</sub> resources in one robust location—including more than 20 existing tools, with plans for adding future content

### FOCUSED CONTENT

tailored to the specialized needs of H<sub>2</sub> user groups

### CUSTOMIZABLE INTERFACE

allows content to display based on the H<sub>2</sub> user's role or interests

### RESPONSIVE DESIGN

enables H<sub>2</sub> safety work across both desktop and mobile devices

### TRUSTED COMMUNITIES

fostered through social networking around H<sub>2</sub> subject matter expertise

### EXPANDABLE FORMAT

built with frequently requested future feature sets in mind

http://www.h2tools.org

## HYDROGEN TOOLS

Focusing on Safety Knowledge

SOURCES COMMUNITY PARTNERS TOOLS ABOUT

Articles

Resources  
Best Practices  
Bibliographic Database  
Compatibility of Materials  
Lessons Learned  
State-specific Info

Role-Based Content

Tools  
Codes & Standards Wizard  
Permitting Hydrogen Facilities

Training

Username: \_\_\_\_\_  
Password: \_\_\_\_\_  
New user? [CREATE AN ACCOUNT](#) [Log In](#)

Facebook LinkedIn  
Twitter Google Plus  
YouTube RSS  
FlipIt Subscribe

### New Codes & Standards Wizard Enables Better H<sub>2</sub> Understanding

A new hydrogen safety tool helps code officials and project engineers better under the established codes and standards involved in the design, review, and implementation of safe hydrogen facilities.

[READ MORE](#)

**ALERT** The International Code Council has passed changes to the International Fire Code that require retrofit activities to be designed, constructed, and maintained in accordance with NFPA 2, Hydrogen Technologies Code. [Read the Full Story](#)

[Subscribe to Alerts](#)

#### NEWS

MAY 20, 2014  
**Radically New Technique to Produce Hydrogen Fuel from Water**  
A radically new way of producing hydrogen fuel from water — one that wasn't even thought to be possible — has been developed by researchers at the University of Colorado Boulder. The assessors think that this new technology/system could pave the way for the mainstream use of hydrogen as a fuel.  
[Read the Full Story](#)

MAY 27, 2014  
**A New Solution for Storing Hydrogen Fuel for Alternative Energy**  
Turning the "hydrogen economy" concept into a reality, even on a small scale, has been a bumpy road, but scientists are developing a novel way to store hydrogen to smooth out the long-awaited transition away from fossil fuels. Their report on a new solid, stable material that can pack in a large amount of hydrogen that can be used as a fuel appears in the ACS journal Chemistry of Materials.  
[Read the Full Story](#)

#### RECENTLY VIEWED

NREL announces new initiatives  
SERA Scenarios of Early Market Fuel Cell Electric Vehicle Production: Modeling Framework (2014)

#### COMMUNITY

Kelly Heaz posted an article to the Hydrogen Summit 2014 Forum  
Like (0) Comment (0) | Share 14h ago

Kim McNeil shared a link with the Hydrogen Safety Group  
Like (0) Comment (0) | Share 32 ago

Lauren Wing updated her profile with new contact information  
Like (0) Comment (0) | Share 32 ago

Karen Thompson Bess a journal article in the International Journal of Hydrogen Energy  
Like (0) Comment (0) | Share 32 ago

NREL reveals DOE Analysis Related to Hydrogen  
Like (0) Comment (0) | Share 32 ago

+ Mobile Friendly



> Credible and reliable safety information from a trustworthy source

# Planning for Future Activities

- ▶ Updating and maintaining information and media in the National Hydrogen and Fuel Cell Emergency Response Training Resource is critical
- ▶ Developing new, smaller props and prop kits can help address the tactile needs of the participants
- ▶ Giving preference to videos and enhanced videos when updating or developing new materials
- ▶ Updating and providing new photographs can provide significant value
- ▶ Considering new virtual reality tools for immersing students in real-world scenarios

# Reiterating the Vision for the National Hydrogen and Fuel Cell Emergency Response Training Resource

*Hydrogen and fuel cell-related first responder training is delivered locally to serve missions to protect life and preserve property, utilizing a national emergency response education program as a consistent source of accurate information and current knowledge.*

A training template approach is utilized to achieve this vision by facilitating

- ▶ delivery of a variety of training regimens to various audiences,
- ▶ development of new and updated training content and techniques and
- ▶ encouragement of collaborations among various stakeholders to achieve purposeful results.

# Acknowledgements

The National Hydrogen and Fuel Cells Emergency Response Training Resource was developed by PNNL and the CaFCP with funding from the US DOE Office of Energy Efficiency and Renewable Energy's Fuel Cell Technologies Office.

The following individuals are gratefully acknowledged for their contributions to developing and reviewing this training resource:

## U.S. Department of Energy

- Sunita Satyapal, Director, Fuel Cell Technologies Office
- Will James, Laura Hill and Kristen Nawoj

## Development and review

- Nick Barilo, Steven Weiner and Monte Elmore – Pacific Northwest National Laboratory
- Jennifer Hamilton and Bill Elrick – California Fuel Cell Partnership

## Reviewers

- Aaron Harris – Air Liquide
- Larry Moulthrop – ProtonOnsite
- Rodney Slaughter, – Cal Fire, Office of the State Fire Marshal
- Colin Armstrong – HTEC
- Brian Ladds – Calgary Fire Department
- John Frala – Rio Hondo College
- Spencer Quong – Quong Associates



# Contact Information

Please let us know if you have any questions or comments!

## Nick Barilo, P.E.



Hydrogen Safety Program Manager  
Pacific Northwest National Laboratory  
509-371-7894  
[nick.barilo@pnl.gov](mailto:nick.barilo@pnl.gov)

## Jennifer Hamilton



Safety and Education Specialist  
California Fuel Cell Partnership  
(916) 375-4914  
[jjhamilton@cafcp.org](mailto:jjhamilton@cafcp.org)

# Thank You

[Chris.Werth@ee.doe.gov](mailto:Chris.Werth@ee.doe.gov)

**Presenter:** Jennifer Hamilton ([jjhamilton@cafcp.org](mailto:jjhamilton@cafcp.org))  
Nick Barilo ([nick.barilo@pnnl.gov](mailto:nick.barilo@pnnl.gov))

**DOE Host:** Will James Jr. ([Charles.James@EE.Doe.Gov](mailto:Charles.James@EE.Doe.Gov))

[hydrogenandfuelcells.energy.gov](http://hydrogenandfuelcells.energy.gov)