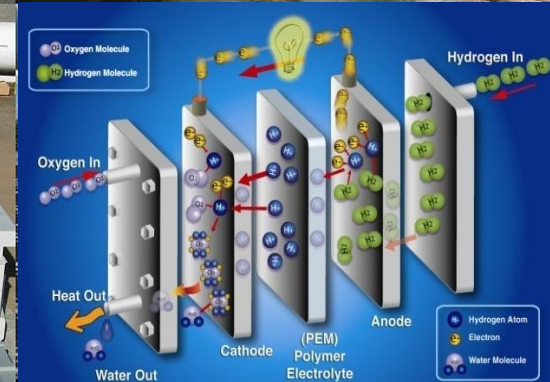


H2 Refuel: An Opportunity to Win \$1 Million & Provide Momentum for FCEV Market Entry



General Information Webinar

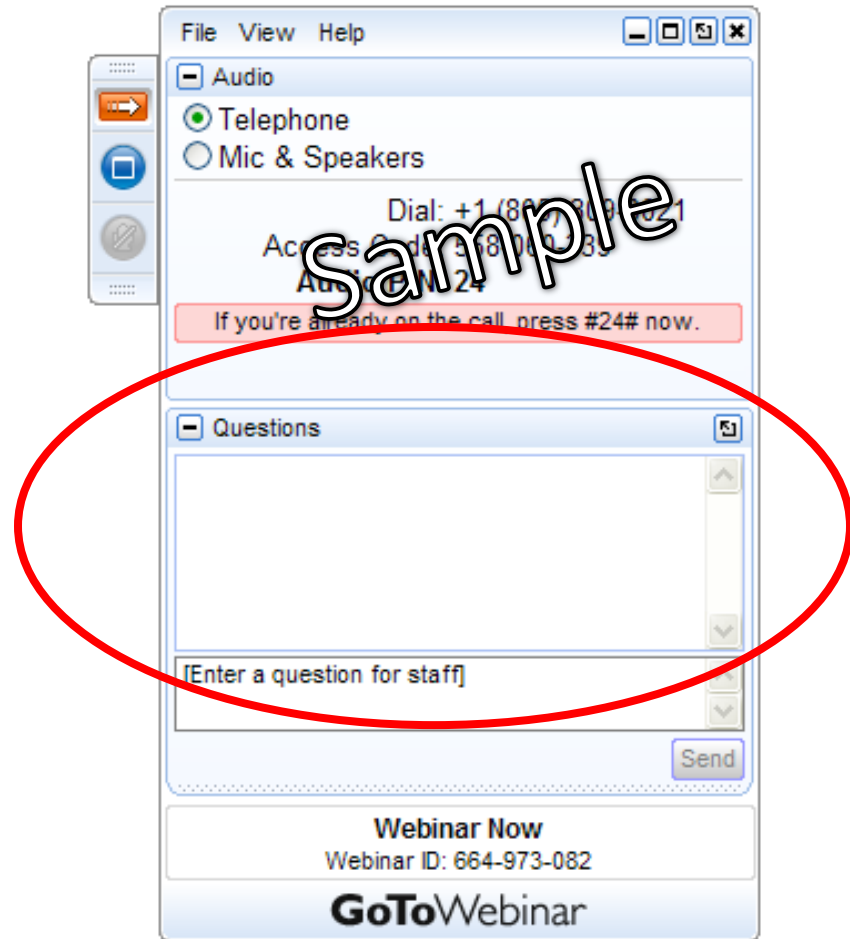
June 25, 2015

Katie Randolph
Sarah Studer

Fuel Cell Technologies Office
U.S. Department of Energy

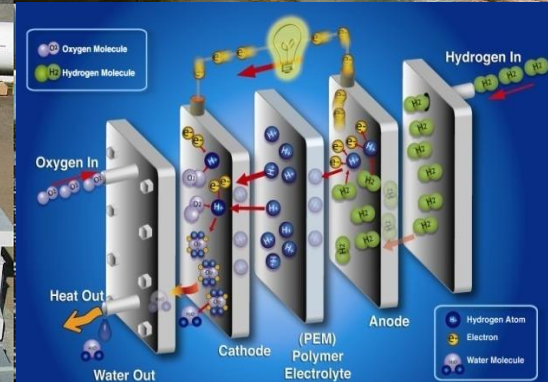
Question and Answer

- Please type your question into the question box



hydrogenandfuelcells.energy.gov

H2 Refuel: An Opportunity to Win \$1 Million & Provide Momentum for FCEV Market Entry



General Information Webinar

June 25, 2015

Katie Randolph
Sarah Studer

Fuel Cell Technologies Office
U.S. Department of Energy

FCEVs are on U.S. Roads Now!

Announced for commercial sale in the U.S.



Now Leasing...



In Auto Shows...



Click to see
video of
Secretary Moniz
driving an FCEV

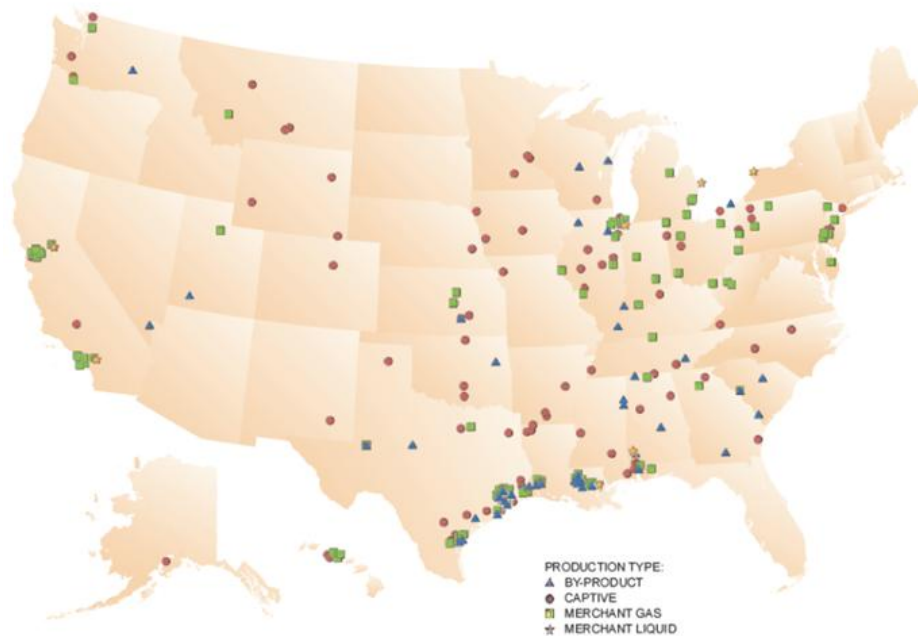


<http://energy.gov/eere/fuelcells/articles/watch-energy-secretary-moniz-test-drive-toyota-mirai>

Status of H₂ Infrastructure

Nationwide

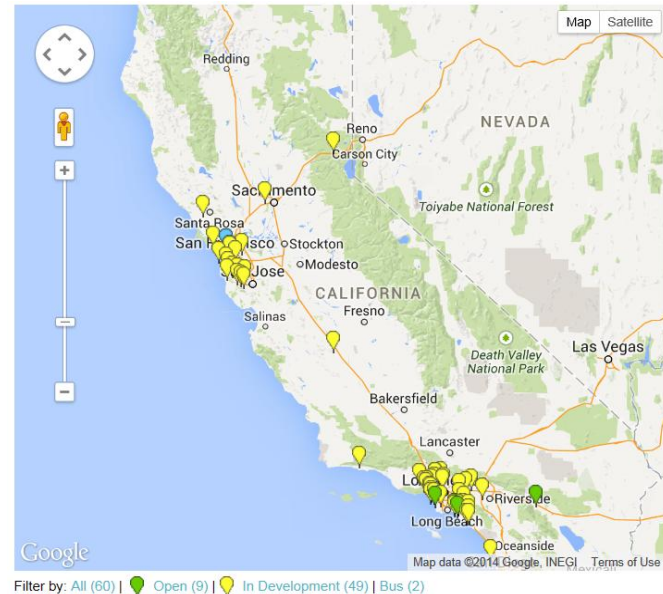
- **1500 mi.** of H₂ pipeline
- **>9M** metric tons produced/yr
- **~50 stations** (~10 public)



Centralized H₂ Production Facilities (source: NREL)

States

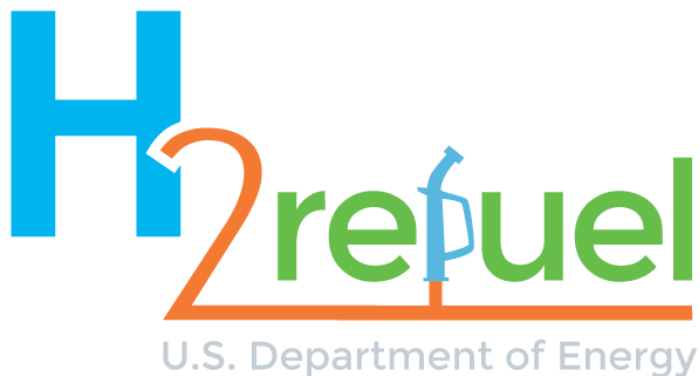
- **CA- 100 stations, ~\$100M** planned through 2023
- **8 State MOU- 3.3M ZEVs** by 2025
- **Northeast states, Hawaii**



H₂ stations in CA (source: CAFCP)

NE states, California and Hawaii have H₂ infrastructure efforts underway

2014-2016 H-Prize competition



Challenging America's innovators to develop on-site systems to generate and dispense hydrogen to fuel vehicles at homes, community centers or small businesses.

The Winning Entry Gets \$1 Million!

Year One

Teams form, develop plans, and submit designs by October 29, 2015.

Year Two

Finalists are announced in December 2015, and will prepare their entries, and start testing in early Summer 2016. Open houses will let the public get a peek!

Beyond

The competition closes October 31, 2016. Technical and cost data will be analyzed to select the \$1 million winner.

Want to compete? Interested in seeing what teams are doing? Looking to join a team? For more information, to sign up for updates, or register, visit <http://hydrogenprize.org/>

The Goal:

Deploy an on-site hydrogen generation system that uses electricity or natural gas and can be used in homes, community centers, retail sites or similar locations to fuel hydrogen vehicles. The best entry, based on technical and cost criteria, wins \$1 million!



The Competition:

2014

October

- Competition opens: Contestants have one year to find partners, design a system, test components, find a place to install the system, and register for the prize

2015

October

- Contestants submit data and designs, and a team of independent judges selects finalists to enter the testing phase

December

- Finalists are announced and they have 7 months to build, install, and prepare systems for testing

2016

June-
October

- Remote and on-site testing data collection for the technical criteria
- Independent financial experts evaluate the cost criteria
- Open house to let the public get a peek at the entries!

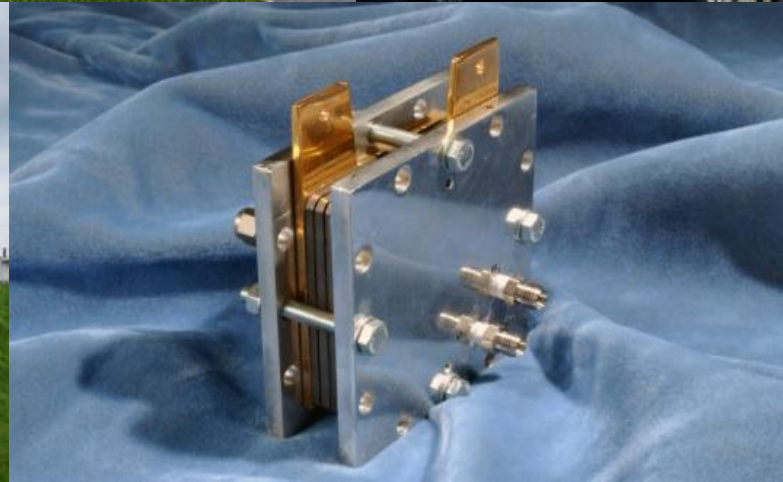
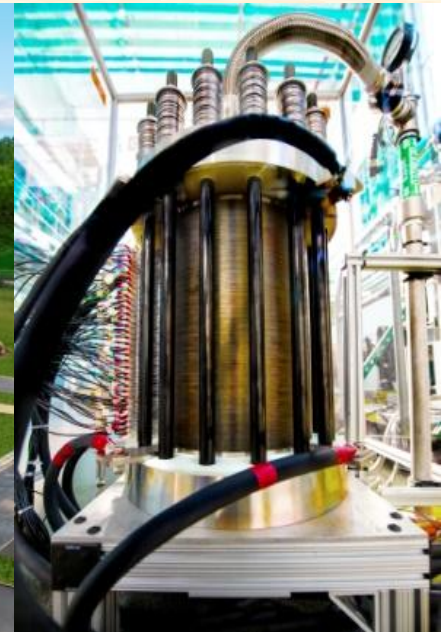
December

- Data analyzed and H-Prize winner announced

H2 Refuel H-Prize



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Rules and Guidelines



- Complete set of official rules and guidelines at:
<http://www.hydrogenprize.org/how-to-compete/rules-and-guidelines/>
- Includes information pertaining to:
 - Design submission
 - Base criteria
 - Finalist competition information
 - Safety requirements
 - System location requirements
 - Data collection
 - Finalist scoring criteria
 - System evaluation

Disclaimer: if anything said or shown in this presentation contradicts the rules and guidelines, the rules and guidelines take precedence over this presentation

Design Submission

- The design submission needs to include information demonstrating the system's ability to meet the base criteria
- All contestants are required to submit their design by October 29, 2015

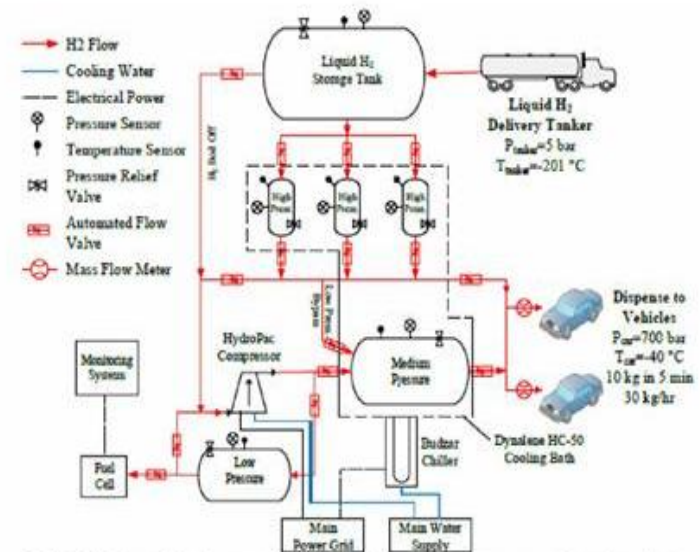


FIGURE 3. Hydrogen fuel station system diagram. Note that medium and low pressure tanks are shown here as single volumes for clarity.

Example system process diagram

Base Criteria



- Entries must meet the initial selection criteria defined below.
- The top teams providing convincing evidence that entry can satisfy the min/max criteria will be selected for testing

Criteria	Home	Community
Min. dispensing pressure	350 bar	
Max dispensing time (standard fill)	10 hours	60 minutes
Min. H ₂ dispensed per day	1 kg	5 kg
H ₂ purity	Meets SAE J2719 (Hydrogen Fuel Quality for Fuel Cell Vehicles)	
Fill method	Compliant with relevant codes (for automobiles, SAE J2601 Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles) and ensures that delivered hydrogen does not exceed the pressure and temperature limits of the vehicle storage tank.	
Safety	Meets relevant safety codes and standards for installation in target location and design parameters	

Finalists

- Finalists selected based upon submitted documentation
- Expert panel will determine whether the system is likely to meet reasonable usability, cost, and safety criteria
- Finalists will be announced December 2015 and have 7 months to build their systems



Example of hydrogen refueling station

Safety

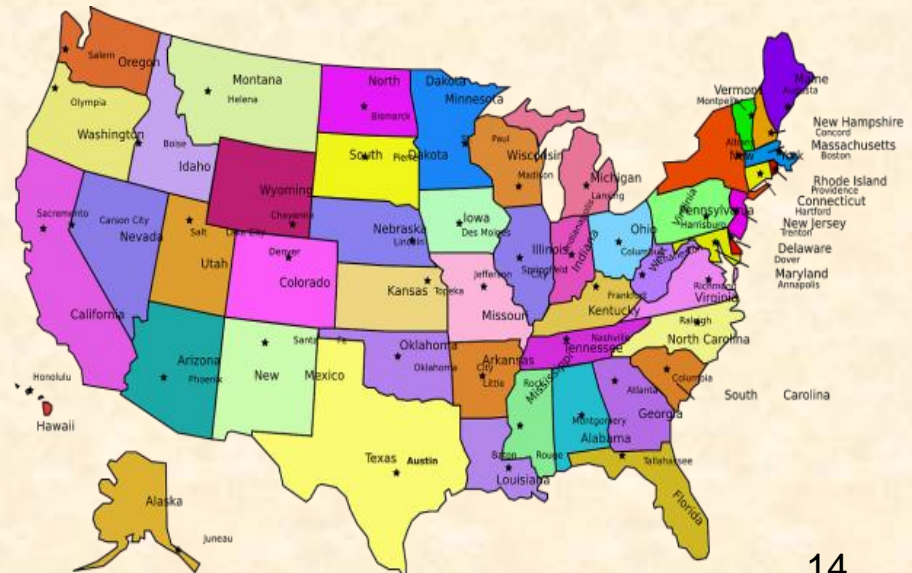


- Safety is of highest priority
- All systems must meet the relevant safety codes and standards
- A particular system (depending on the location and design) may have different safety requirements
- Information on safety issues can be found here: <http://www.hydrogenprize.org/how-to-compete/safety/>
- Details on Safety will be provided in an upcoming webinar in August

System Location



- An appropriate site for a system is:
 - Within one of the 50 U.S. states or District of Columbia
 - Adequate access for data collection teams and remote monitoring equipment
 - Site allows for press and public access for at least a one day open house



Data Collection

- System data will be collected over a period of 2-3 months
- At least one on-site test
- More info on data collection:
 - <http://www.hydrogenprize.org/wp-content/uploads/2015-03-26-Data-requirements-v5.pdf>
- Data requirements:
 - <http://www.hydrogenprize.org/how-to-compete/h2-refuel-h-prize-data-collection/>
- Data collection webinar
 - <http://www.hydrogenprize.org/how-to-compete/h2-refuel-h-prize-data-collection/>



Data Collection



Performance Metric	System Type	Signal Range	Units	Physical Measurement	Logging Period (s)	Location	Minimum Accuracy	Signal Type	Scaling for Modbus Signals	Modbus Data Type	Modbus Data Location	Preferred Modbus Address*	
Required Data Collection													
Due to the potential variation among possible system configurations, additional measurements, at the candidate team's expense, may be required to measure H-Prize criteria													
Time	All	n/a	UTC	Real time, 24-hour clock, UTC, reported as Epoch time (elapsed seconds since midnight Jan 1, 1970)	30 sec	n/a	precision to seconds	Modbus TCP/IP	n/a	32-bit unsigned int, straight endian	Holding Register	4x00015-4x00016	
Dispensing Pressure		125% of system design maximum dispensing pressure	bar	Pressure		As close to the dispensing nozzle as practical	0.25% of span	4-20mA					
Dispensing Time		Binary	on/off	Open/closed dry contacts (one of each) on dispenser valve		n/a	Dry contacts						
Hydrogen Dispensed	Home	1	kg dispensed**	Mass total for each fill	30 sec	As appropriate	10% of fill amount	Modbus TCP/IP	kg*1000	16-bit unsigned int	Holding Register	4x00001	
		0.03 to 1.5	grams/min**	Mass flow rate averaged over 30 seconds			10% of max flow rate		grams/min*10000			4x00002	
	Community	1	kg dispensed**	Mass total for each fill, at least 5 fills per day			10% of fill amount		kg*1000			4x00003	
		15 to 350	grams/min**	Mass flow rate averaged over 30 seconds			10% of max flow rate		grams/min*1000			4x00004	
Ambient Temperature	All	-40 to 50	°C	Ambient temperature	Shaded area out of direct sunlight/precipitation.	+/- 1 °C	See RTD Spec	transmit as Kelvin				4x00006	
Hydrogen Gas Temperature		-40 to 80		Gas temperature	As close to the dispensing nozzle as practical							4x00007	
Availability		Whether the system is up and ready to fill.	Yes/No	Binary Yes/No	n/a	n/a	Modbus TCP/IP	n/a	1-bit	Status Coil	1x00000		
Volume of the Tank Being Filled	as appropriate	L	Water filled volume of tank being filled for each fill	manual	n/a	in accordance with tank manufacturer's manufacturing tolerances	manual collection						

* Because Modbus slaves may differ in their address space allocation, other addresses are acceptable if communicated in writing in the design package. However, if possible please use the specified addresses to reduce data transmission issues.

** Both values are required, but one may be calculated from a physical sensor measuring the other

RTD Spec: RTD Pt ($\alpha = 0.00385, 0.00392$), Ni ($\alpha = 0.005001$), Cu ($\alpha = 0.0039$) 10 Ohm to 10 kOhm. 2.5mA Max

For more info on data requirements, visit:

<http://www.hydrogenprize.org/wp-content/uploads/2015-03-26-Data-requirements-v5.pdf>

Data Collection



Performance Metric	System Type	Signal Range	Units	Physical Measurement	Logging Period (s)	Location	Minimum Accuracy	Signal Type	Scaling for Modbus Signals	Modbus Data Type	Modbus Data Location	Preferred Modbus Address*	
Optional Bonus Points													
Due to the potential variation among possible system configurations, additional measurements, at the candidate team's expense, may be required to measure H-Prize criteria													
Hot Water	Optional	35	gallons per day	Water volume	30 sec	At point of delivery to the thermal load	+/- 1% of reading	Modbus TCP/IP	gal/day*10	16-bit unsigned int	Holding Register	4x00008	
		1.5	gallons/hour	Water flow rate gph averaged over 30 seconds				gal/hour*100	4x00009				
1 to 250		°C	Water Temperature	+/- 1 °C			See RTD Spec						
Space Heating		25,000	SCFH	Air flowrate SCFH*** averaged over 30 seconds			+/- 1% of reading	Modbus TCP/IP	no scaling, transmit directly	16-bit unsigned int	Holding Register	4x00010	
		1 to 250	°C	Air Temperature			+/- 1 °C	See RTD Spec					
Electricity		10 kWh/day		Hz			Power Frequency	At the point of delivery to the electrical load	+/- 1% of reading	Modbus TCP/IP	Hz*10	16-bit unsigned int	Holding Register
				n/a		Power factor	power factor *100				4x00012		
				V (RMS)		Line-line Voltage (RMS)	Voltage (RMS) * 100				4x00013		
						Line-neutral voltage (RMS)					Voltage (RMS) * 100		
				A (RMS)		Current (RMS)	4-20 mA						

* Because Modbus slaves may differ in their address space allocation, other addresses are acceptable if communicated in writing in the design package. However, if possible please use the specified addresses to reduce data transmission issues.

*** SCFH = standard cubic feet per hour of dry air at 20°C and 1 atm

RTD Spec: RTD Pt ($\alpha = 0.00385, 0.00392$), Ni ($\alpha = 0.005001$), Cu ($\alpha = 0.0039$) 10 Ohm to 10 kOhm. 2.5mA Max

For more info on data requirements, visit:

<http://www.hydrogenprize.org/wp-content/uploads/2015-03-26-Data-requirements-v5.pdf>

Scoring Criteria Weighting



- Because some of the criteria are considered more critical, the criteria have different weights adding up to a total of 50 points

Criteria	Weight
Dispensing pressure	3
Dispensing time	1
Standard fills per day	1
Tested availability	2
Installed system cost	2
Direct user cost per kg	1

Technical and Cost Criteria



Cost	Score	Installed system cost (Includes capital costs)		Direct user cost per kg (Does not include capital costs)
		Home	Community	Home & Community
	1	\$25k/kg or less	\$15k/kg or less	\$20 or less
	2	\$20k/kg or less	\$12.5k/kg or less	\$17 or less
	3	\$15k/kg or less	\$10k/kg or less	\$14 or less
	4	\$10k/kg or less	\$7.5k/kg or less	\$11 or less
	5	\$5k/kg or less	\$5k/kg or less	\$8 or less

Technical	Score	Dispensing pressure	Dispensing time		Standard fills per day		Tested availability
		Home & Community	Home	Community	Home	Community	Home & Community
	1	350 bar or higher	10 hours or less	60 minutes or less	1 or more	5 or more	80% or higher
	2	400 bar or higher	8 hours or less	30 minutes or less	2 or more	10 or more	85% or higher
	3	500 bar or higher	5 hours or less	15 minutes or less	3 or more	20 or more	90% or higher
	4	600 bar or higher	2 hours or less	10 minutes or less	4 or more	40 or more	95% or higher
	5	700 bar or higher (ultimate target)	30 minutes or less	3 minutes or less	5 or more	50 or more	98% or higher

Bonus Criteria



- Integrated systems providing heat and/or power in addition to H₂ for refueling will be awarded bonus points

Points	Heat or power supplied
1	Supply at least 35 gallons of hot water per day
1	Supply at least 25,000 BTU/hr of space heating
1	Supply at least 10 kWh electricity per day

Scoring Examples



Home System

Criteria Category	Result	Category Score	Score Multiplier	Total Scores
Dispensing pressure	475 bar	2	3	6
Dispensing time	3 hours	3	1	3
Standard fills per day	3	3	1	3
Tested availability	88%	2	2	4
System installation cost	\$18k/kg	2	2	4
Direct user cost per kg	\$11/kg	4	1	4
Bonus categories	Supplies hot water	1	–	1
Total	–	–	–	25

Scoring Examples



Home System

Criteria Category	Result	Category Score	Score multiplier	Total scores
Dispensing pressure	360 bar	1	3	3
Dispensing time	8 hours	1	1	1
Standard fills per day	1	1	1	1
Tested availability	81%	1	2	2
System installation cost	\$23k/kg	1	2	2
Direct user cost per kg	\$19/kg	1	1	1
Bonus categories	None	0	0	0
Total	–	–	–	10

System Evaluation

- An independent panel of judges will be assembled by the DOE and HEF
- Judges will be selected from relevant organizations and agencies
- Technical data collection will be done by NREL
- An independent auditing entity will determine costs associated with the systems



How To Participate



The 2014-2016 H-Prize Competition



U.S. Department of Energy

Home News About the H-Prize For Competitors Contestants Media / Contact Us Mailing List

Get Involved
Registration
Rules and Guidelines
Safety Planning and Codes & Standards
H2 Refuel H-Prize Data Collection

The H2 Refuel H-Prize is challenging America's in- hydrogen genera-
tion system, using electricity or natural gas, to fi- be used in homes,
tion system, using electricity or natural gas, to fi- be used in homes,
community centers, retail sites or similar locati- technical and cost cri-
teria, will win \$1 million!

2015 **2016** **Award**

Contestants develop & submit designs **October 2015** Finalist selection & testing **October 2016** Technical & cost analysis to select winner **\$1M**

Interested in competing? Review the [guidelines](#), [timeline](#), [evaluation criteria](#) and [registration process](#). Interested in following along with the H2 Refuel progress? Sign up for our [mailing list](#).

Time left to register - October 22, 2015:

03 Months 03 Weeks 06 Days 14 Hours 56 Minutes

RECENT POSTS

DOE Hosts Public Webinar on \$1M Competition for Home or Community Hydrogen Refueling System on June 25, 1 PM ET

H2 Refuel H-Prize Technical Data Collection Requirements Webinar May 14, 1 PM - Your Questions, Answered

Hydrogen Education Foundation Publishes H2 Refuel H-Prize Technical Data Collection Requirements

HOSTING ORGANIZATIONS

U.S. DEPARTMENT OF

Go to: <http://hydrogenprize.org/how-to-compete/registration>

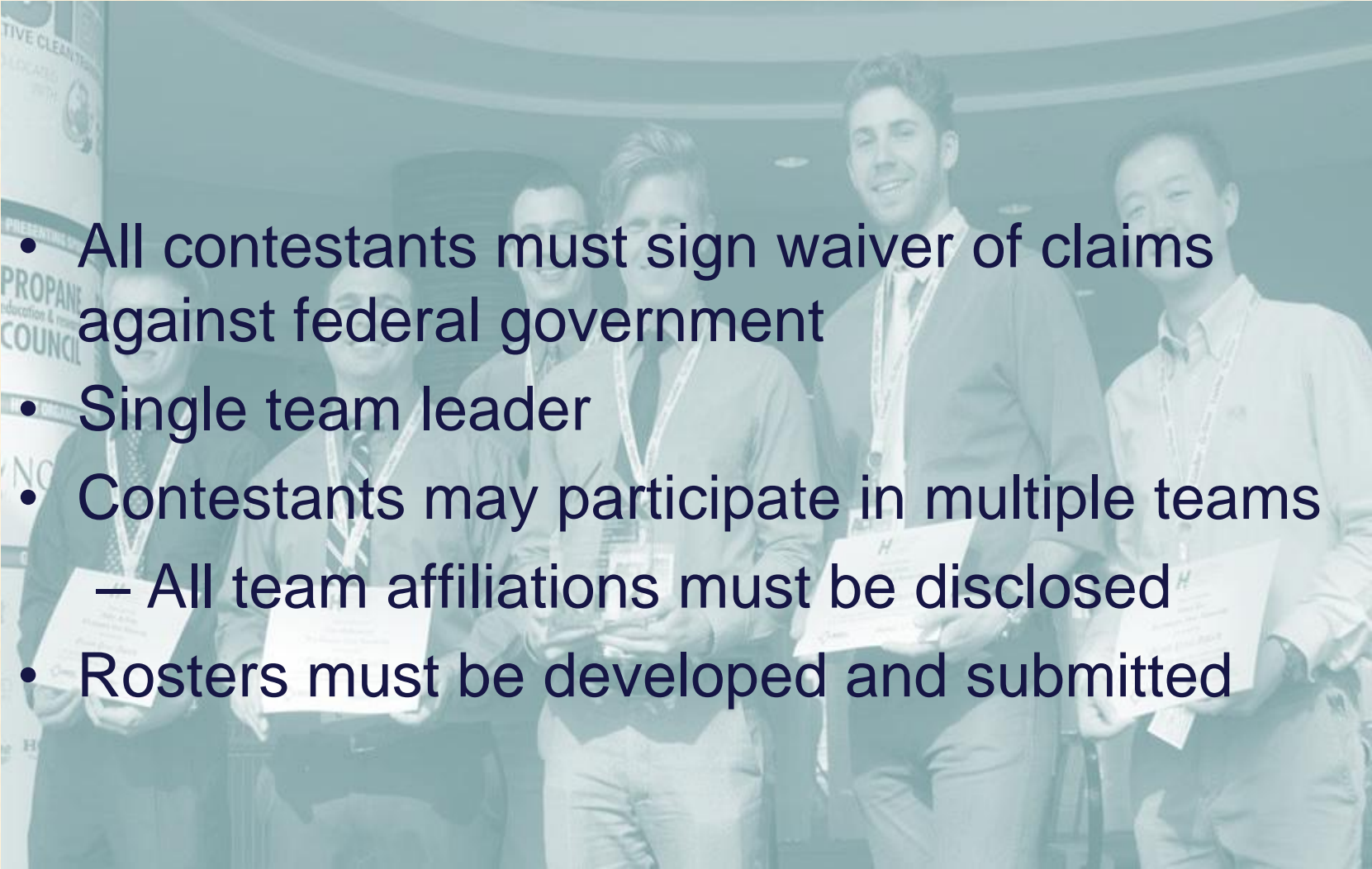
Who Can Participate?



HYDROGEN
EDUCATION
FOUNDATION

- A contestant may be an individual, an entity, or a team
 - A team may consist of two or more individuals or entities or any combination of the two
- Individuals who are permanent residents or citizens of the US
- Any entity that is organized or incorporated in the US with a primary place of business located in the US
- Above statuses must be maintained for duration of contest
- Relevant documentation needed:
 - <http://www.hydrogenprize.org/how-to-compete/registration/>
- A contestant may not be a Federal entity, or a Federal or National Laboratory employee acting within the scope of his or her employment

Contestants

- 
- All contestants must sign waiver of claims against federal government
 - Single team leader
 - Contestants may participate in multiple teams
 - All team affiliations must be disclosed
 - Rosters must be developed and submitted

Looking for a Team?



<http://www.hydrogenprize.org/how-to-compete/join-a-team/>

Get Involved

If you are interested in joining a team, you can fill out the form to the right. Submissions for people or groups looking to join a team appear below.

Please note that neither the Hydrogen Education Foundation (HEF) nor the U.S. Department of Energy (DOE) endorses any member of the list, or provides guarantees about their suitability. This information is only provided as a resource to facilitate potential contestants to find other possible team members and resources. This website is operated and maintained by the Hydrogen Education Foundation (HEF) under a cooperative agreement with DOE. It is not a government website. DOE's Privacy Policy does not apply to HEF.

If you want to keep up on any news and updates, you can sign up for the [mailing list](#).

FULLNAME	SPECIALTY	EMAIL
Milan Krupa	We can build one of our three ultra-efficient rotary compressor/pump concepts to cost effectively compress hydrogen to any pressure. We are developing the designs for use as detonation cycle engines.	memilan@yahoo.com

INTERESTED IN JOINING A TEAM?

Fill out the form below to let others know your areas of expertise. Submissions will be listed in a table to the left.

Full Name (required)

Email (required)

Phone number (required)

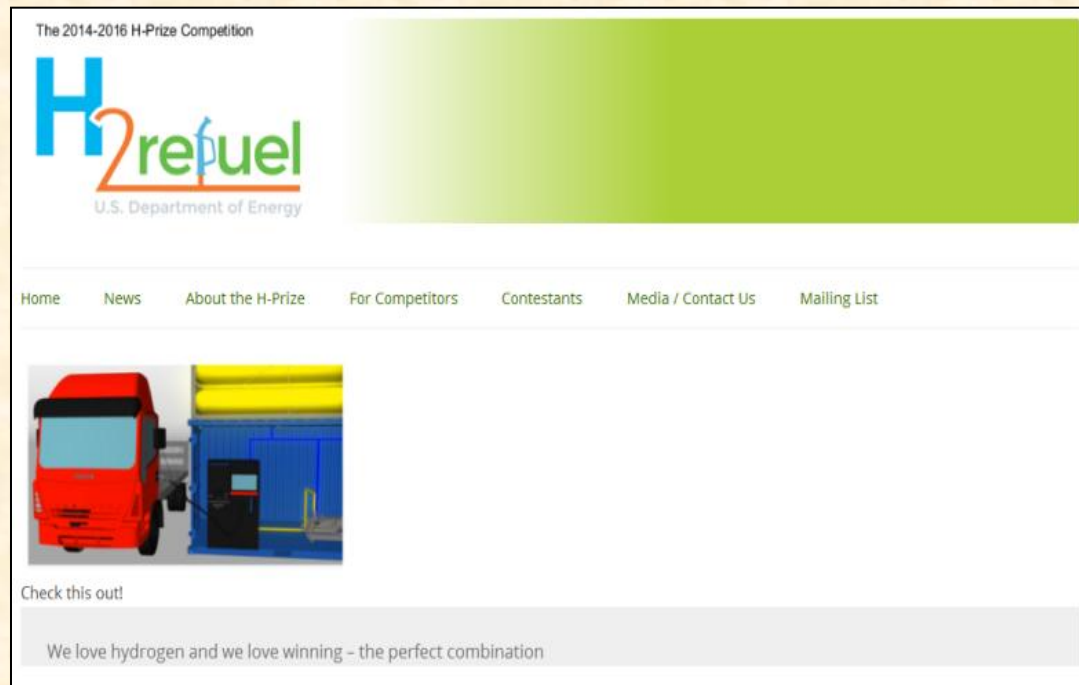
Affiliation

Website

Registration Benefits



- Devoted web page
- Allows for status updates and RSS feeds (social media)
- H-Prize updates will be directly available



*Registration must be approved to receive benefits

IP/Liability



- All IP rights belong solely to the contestants following the completion of the competition. The DOE, HEF, supporting organizations, the US government, H-Prize officials, and judges will make no claims to any system IP rights
- Contestants are responsible for all costs associated with competing
- The Department of Energy, H-Prize, the Hydrogen Education Foundation and any sponsoring or supporting organization assume no liability or responsibility for accidents or injuries incurred as a result of competing in the H-Prize Contest

Additional Information

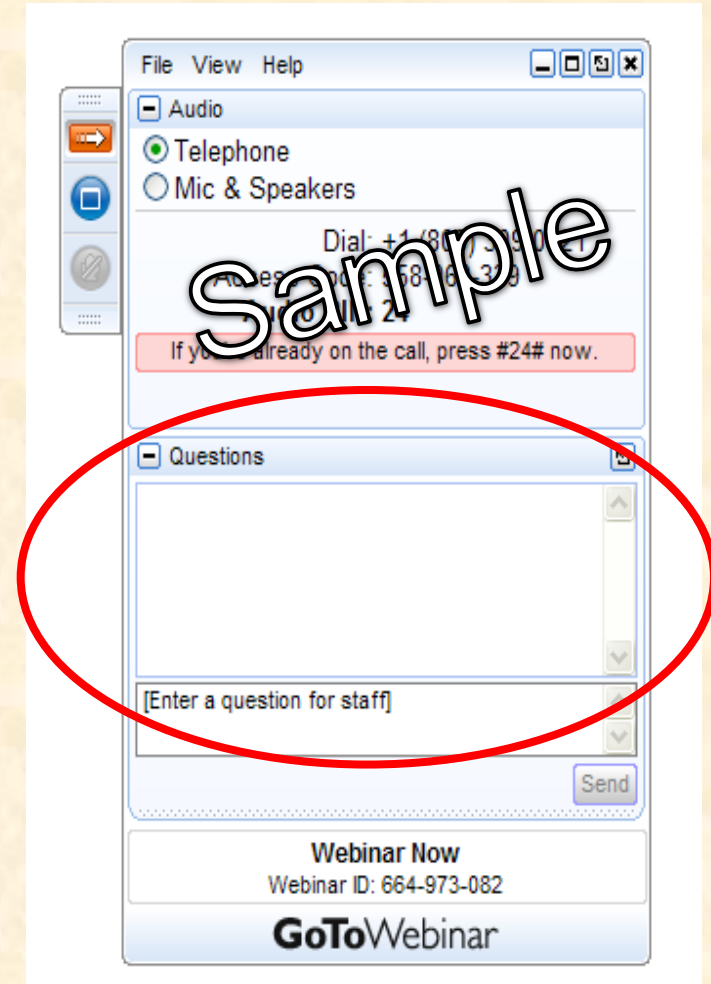


- All this information and more is located on the H-Prize website!
 - <http://www.hydrogenprize.org/>
- Take a look at the FAQ!
 - <http://www.hydrogenprize.org/about-the-h-prize/faqs/>
- Sign up for the H-Prize mailing list!
 - <http://www.hydrogenprize.org/mailling-list/>
- Follow us on Twitter!
 - [@H2Refuel](https://twitter.com/H2Refuel)
- Like HEF on Facebook!
 - <https://www.facebook.com/Hydrogen.Education.Foundation>



Q&A

- Please type your question into the question box



Additional Information



- Slides will be posted on the website later this week
 - <http://www.hydrogenprize.org/>
- Have questions you want answered directly, or think of one later?
 - Send an email to: HPrize@ee.doe.gov
 - Check out the H-Prize FAQ webpage:
<http://www.hydrogenprize.org/about-the-h-prize/faqs/>

Thank you for your attention!