



Hydrogen Fueling Infrastructure Research and Station Technology

# Hydrogen Contaminant Detector

Danny Terlip\* (NREL), Scott McWhorter (SRNL),  
Bill Buttner (NREL), Chris Ainscough (NREL)

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\*Presenter

Project ID # SCS024

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# The Hydrogen Fueling Infrastructure Research and Station Technology Project



**Objective: Ensure that FCEV customers have a positive fueling experience relative to conventional gasoline/diesel stations as vehicles are introduced (2015-2017), and transition to advanced refueling technology beyond 2017.**

## **Reference Station Design**

- Goal: Develop station designs based on state-of-the-art components and characterize cost, throughput, reliability, and footprint.
- Results: Five detailed reference station designs were published in a report yesterday.
- Impact: Helps station developers evaluate site suitability, encourage interchangeability, cost transparency, inform roll-out scenarios, and AHJ education.

## **Hydrogen Contaminant Detector**

- Goal: Develop requirements for inline fuel quality system for installation at stations
- Results: Report released yesterday identifying the current state of the HCD market, and gaps between that and use requirements.
- Impact: FCEVs will no longer be the “canary in the coal mine” when it comes to contaminants.

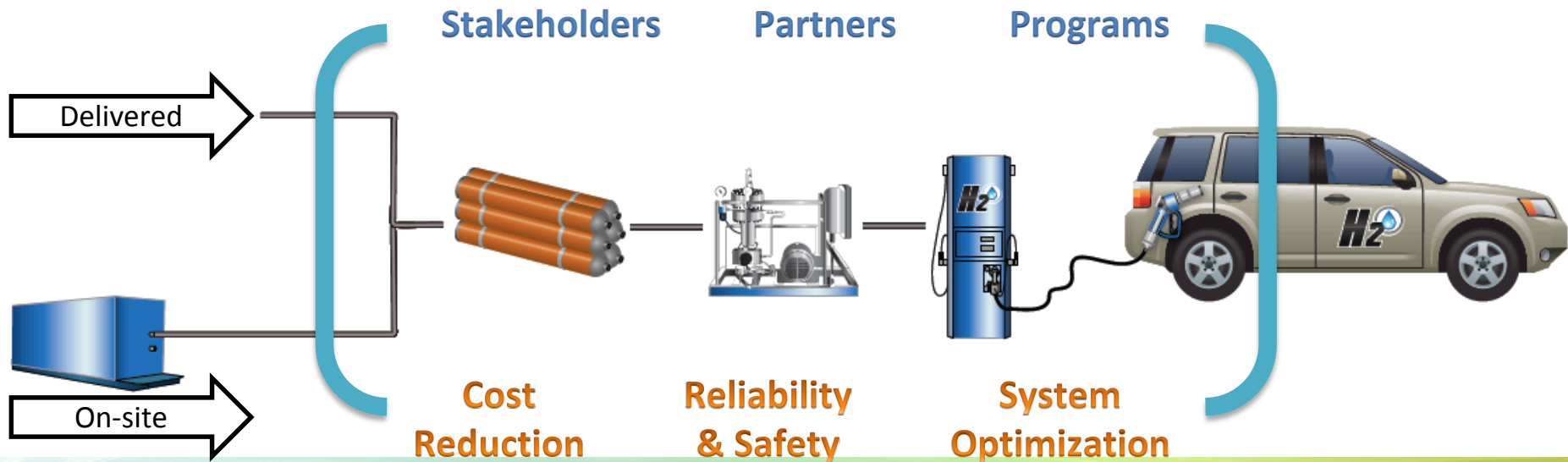
## **Hydrogen Station Equipment Performance (HyStEP) Device**

- Goal: Develop a hydrogen station test device to validate station compliance with SAE J2601/HGV 4.3.
- Results: Device design review is complete
- Impact: HyStEP will allow for safe, effective qualification of stations without using actual vehicles, which is the status quo.

# H2FIRST Long-term Objectives



- Reduce the installation cost of a hydrogen fueling station to be competitive with conventional liquid fuel stations.
- Improve the availability, reliability, and cost while ensuring the safety of high-pressure components.
- Focus a flexible and responsive set of technical experts and facilities to help solve today's urgent challenges and the future unpredicted needs.
- Enable distributed generation of renewable hydrogen in a broader energy ecosystem.



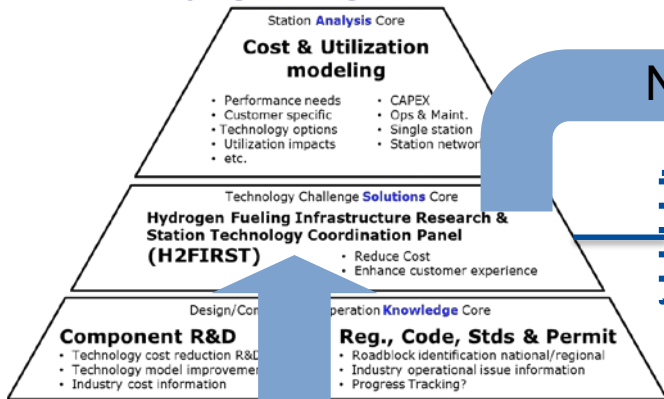
# H2FIRST Project Coordination



DOE FCTO Decision Authority



## Hydrogen Fueling Station WG



Needs, Ideas, Feedback

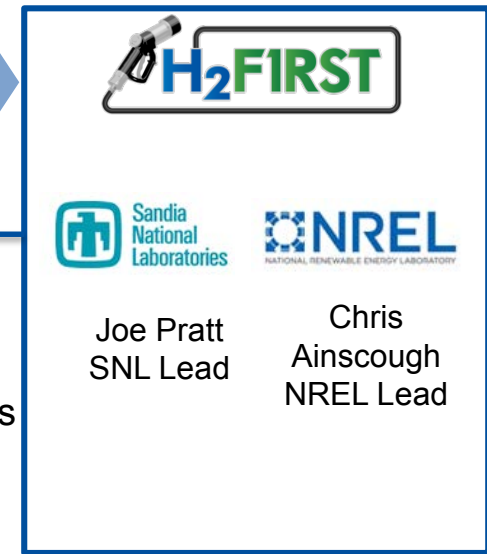
Pre-Proposal

Full Proposal

Add key external partners

Project Status & Results

**H2USA HFSWG  
Coordination Activity**



H2FIRST  
Project(s)

**H2FIRST Project  
Partners Activity**

# Overview



## Timeline

- Task Start Date: Q4 2014
- Task End Date: Q3 2015
- Percent Complete: 95%

## Budget

- Total Task Budget: \$30k
  - DOE Share: \$30k
  - Funds Spent To-date: \$15k

## Barrier – Safety Codes and Standards

- A. Safety Data and Information:  
Limited Access and Availability

## Partners

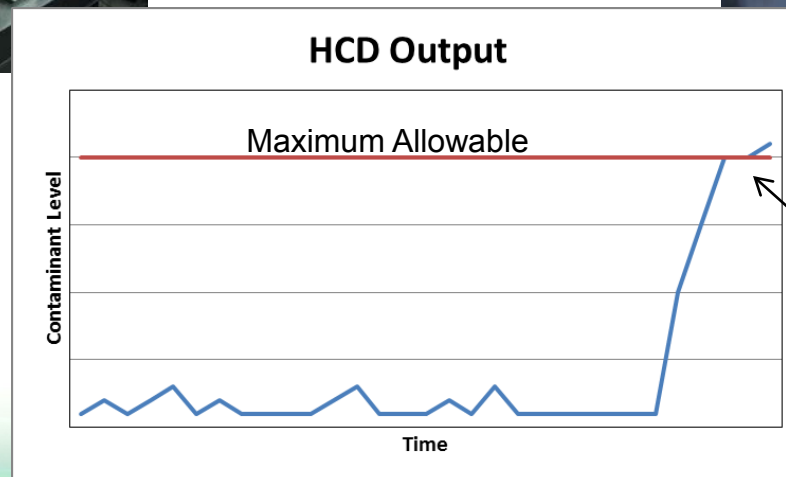
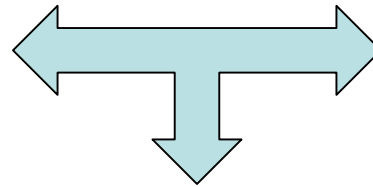
- National Labs: NREL\* and SRNL
- California Air Resources Board
- SAE Fuel Cell Interface Task Force
- DOE-EERE-FCTO

\*Task lead

- **Goal** - Ensure high quality fuel is dispensed to FCEV customers for optimal FC operation by testing for critical contaminants in the fuel before it is dispensed
- **Impact**
  - Educate station operators about contaminants relevant to station type
  - Inform station developers of current status of relevant technology
  - Validate stated performance of analyzers
  - Determine requirements for station integration
  - Provide information for technology developers
    - Define application requirements
    - Provide a gap analysis between requirements and status of current technology



- A hydrogen contaminant detector (HCD) is defined as a gas analyzer and integration apparatus
- An integrated HCD must identify and report poor quality fuel BEFORE it is dispensed to FCEV customers



**Alarm station operator**

# Approach: Identify HCD Challenges



Desired Characteristics	Challenges
Ease of station integration	<ul style="list-style-type: none"><li>• Multiple Station configurations</li><li>• Extreme gas pressure and temperature</li><li>• Hazardous environment rating</li></ul>
Contaminants Detected	<ul style="list-style-type: none"><li>• SAE J2719 identifies large list of contaminants</li><li>• Not all contaminants are probable in stations</li></ul>
Levels of Detection	<ul style="list-style-type: none"><li>• SAE J2719 concentration levels difficult to achieve with current tech</li></ul>
Cost	<ul style="list-style-type: none"><li>• Current technology is laboratory grade<ul style="list-style-type: none"><li>• Expensive</li><li>• Maintenance is frequent and specialized</li></ul></li></ul>

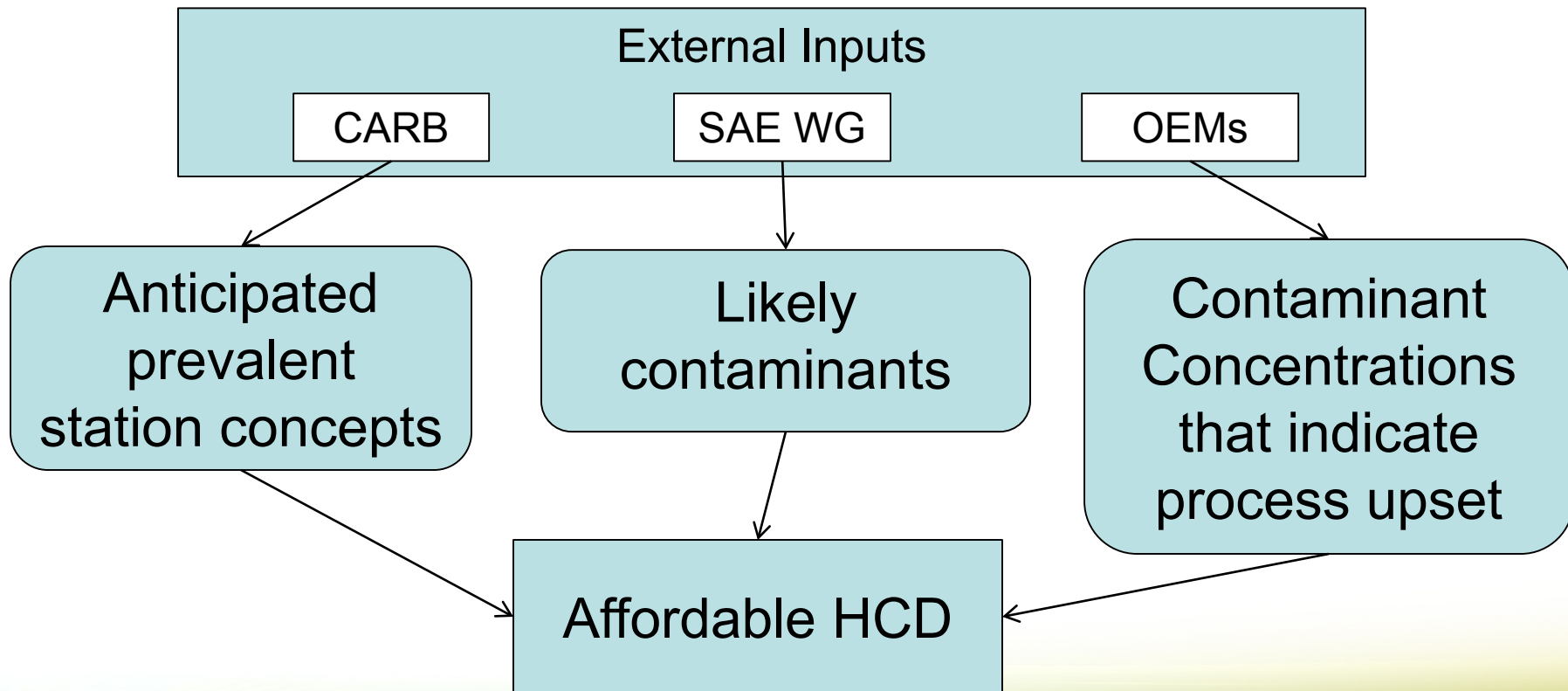
*Near term solution not likely “one size fits all”*



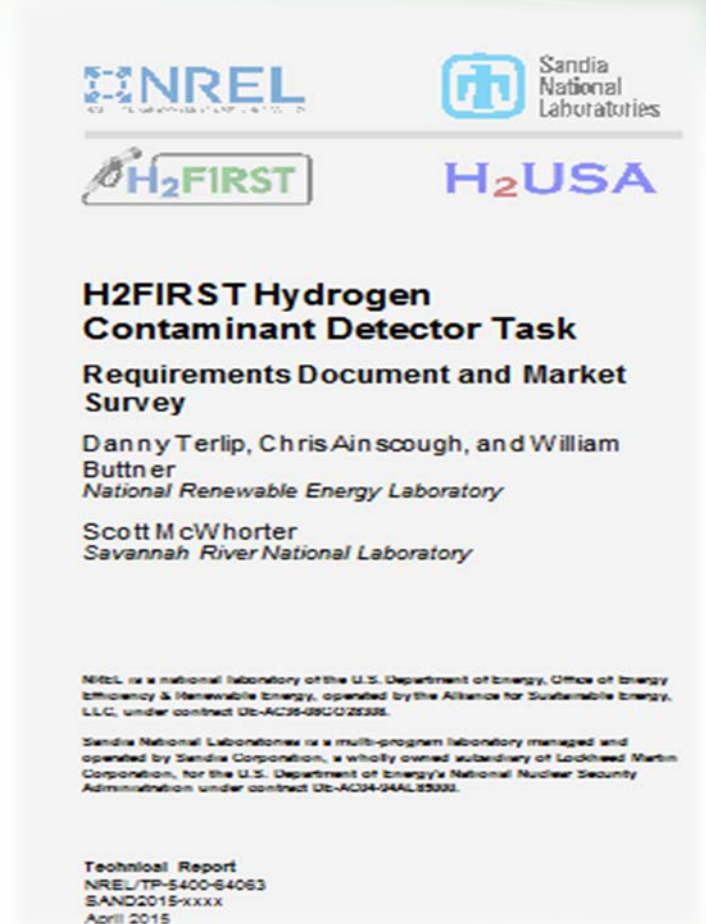
# Approach: Refine the Application



- Unfeasible to detect all contaminants listed in SAE J2719 at required levels
- Not meant to replace regular sampling and laboratory testing
- Target station characteristics to reduce requirements of HCD



- **First deliverable (milestone)**
  - *HCD Requirements Definition*
  - *Market survey of viable HCD technologies*
  - *Report published*
- **Develop proposal for second phase**
  - *Integrate technologies into research and commercial station*
  - *Gather input from DOE, industry and project team*

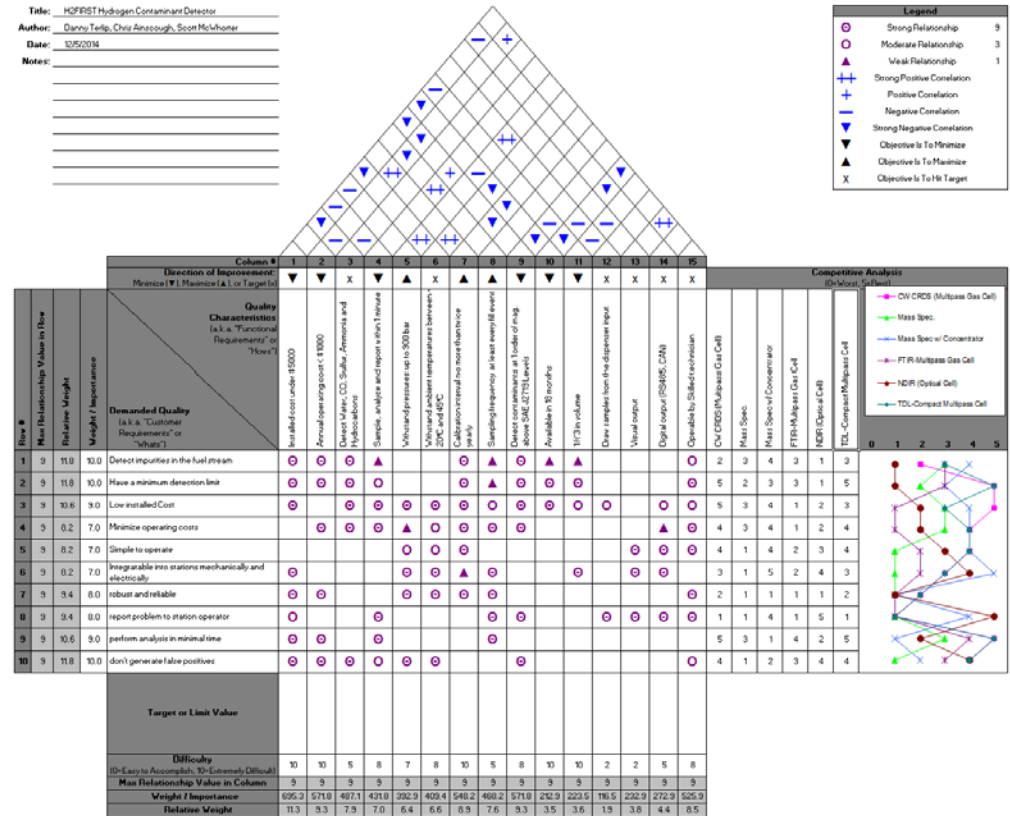


*First phase report published, second phase under proposal*

# Accomplishments: First Deliverable



- **ENGINEERING REQUIREMENTS** – developed with input from industry, state agencies, codes and standards committees
  - Detection abilities
    - Types
    - Concentrations
  - Cost
  - Availability
  - Ambient environmental
  - Gas sampling
    - Pressure
    - Temperature
    - Volume



*Customer and functional requirements determined and compared*

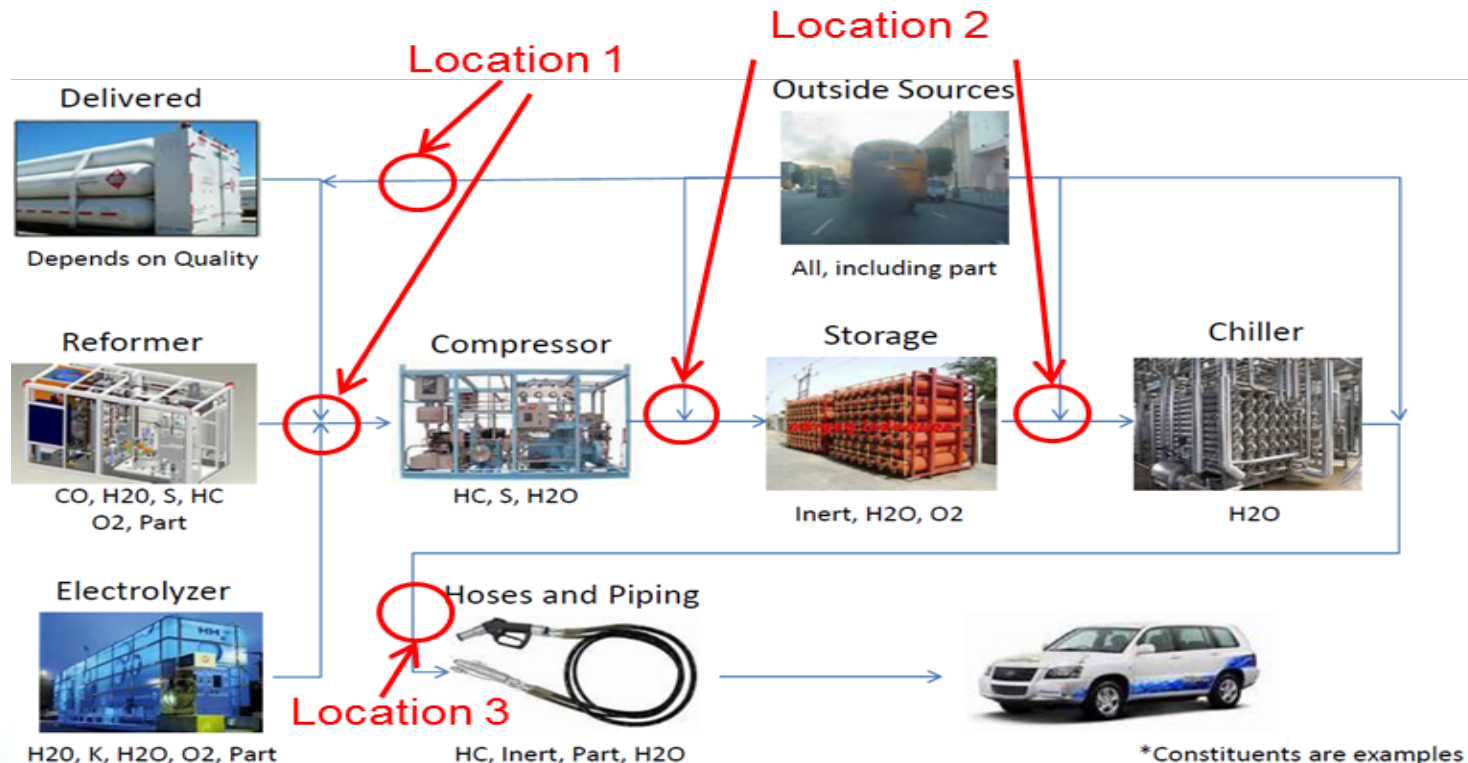


# Accomplishments: First Deliverable



- ENGINEERING REQUIREMENTS – station integration

○ Possible HCD Location



# Accomplishments: First Deliverable



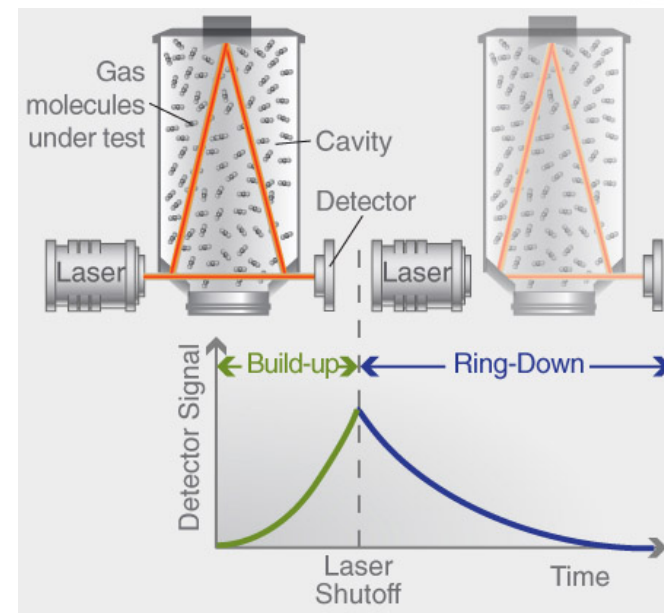
- ENGINEERING REQUIREMENTS

Contaminant	Detection Level Requirements (ppmv)	
	HCD 1 (SMR)	HCD 2 (H <sub>2</sub> O electrolysis)
Water	50	50
Carbon Monoxide	2	-
Total Sulfur	0.04	-
Ammonia	1	-
Total Hydrocarbons (as C <sub>1</sub> )	20	20

Parameter	Nominal Specification		
	Location 1	Location 2	Location 3
Process Pressure (bar)	< 300	< 900	< 900
Process Temperature (°C)	-20 < T < 100	-20 < T < 100	-40 < T
Ambient Temperature (°C)	-35 < T < 45		

*Device requirements defined for different stations*

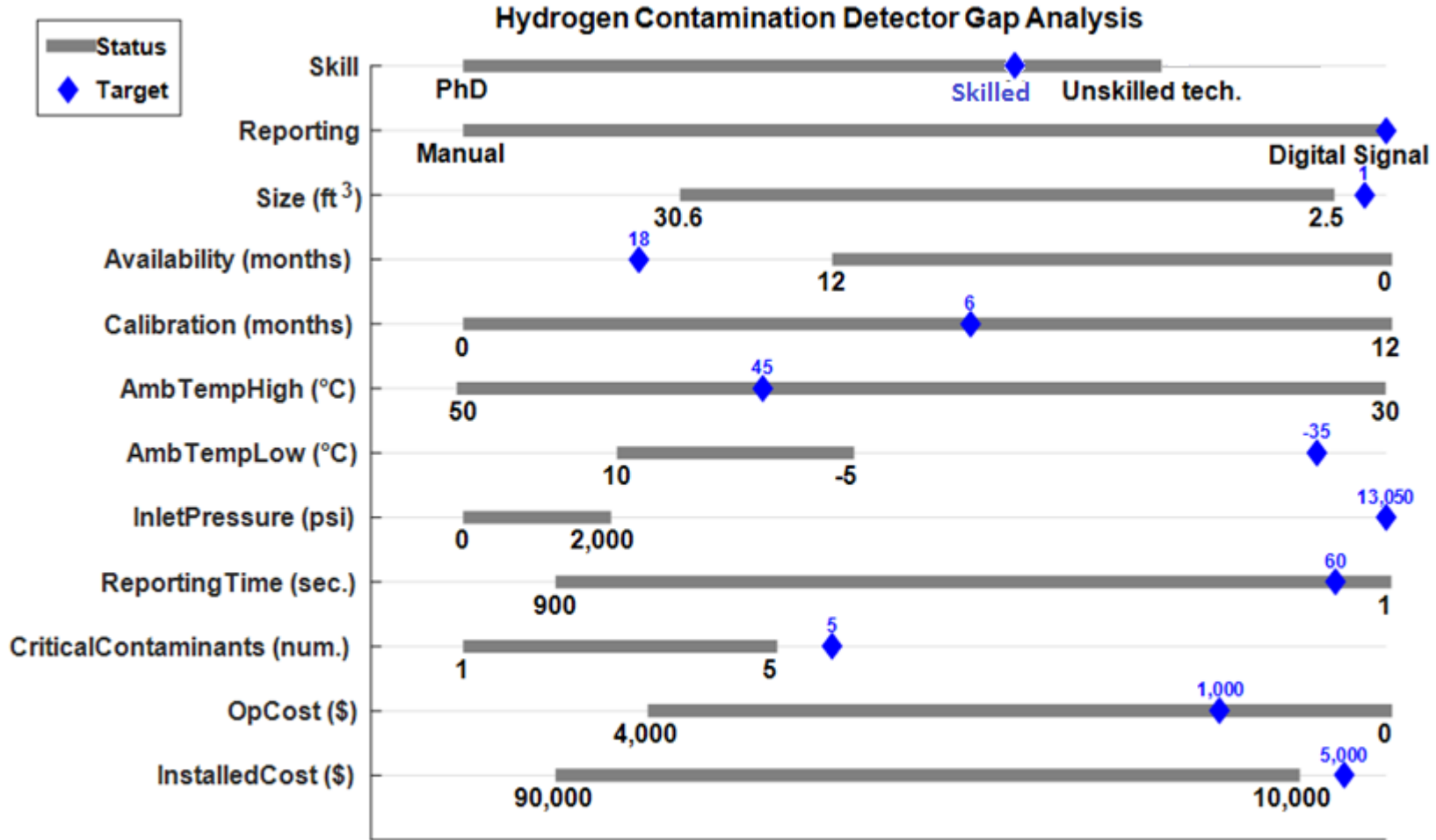
- **MARKET SURVEY** - 8 week study into currently available, potential hydrogen contaminant detectors
  - Survey responses from 10 companies
  - Multiple technologies explored
    - Gas chromatograph, mass spectroscopy, Fourier transform infrared spectroscopy, non-dispersive infrared spectroscopy, laser absorption continuous wave cavity ring down spectroscopy and concentrator technologies
  - Gap analysis on state of technology versus engineering requirements



Credit: [www.picarro.com](http://www.picarro.com)

*Current state of the market compared with device requirements*

# Accomplishments: HCD Gaps



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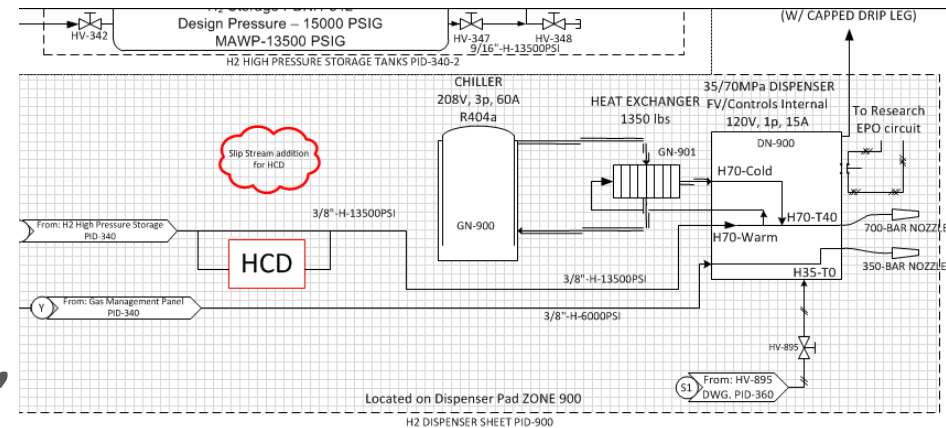


The **gray bars** indicate the current state of the market  
 The **blue diamond** indicates engineering requirements

# HCD Next Steps – Proposal Highlights



- Work with HCD manufacturers to obtain units for testing
  - Anticipate devices will be ready by June 2015 or sooner
- Design and build integration and sampling apparatus
  - 70MPa capable near the dispenser
- Communicate with project team to identify most important aspects of testing
- Develop test plan for bench-top testing and station integration
  - Verify performance in lab first
- Generate report on performance, maintenance and costs



DESCRIPTION  
ENERGY SYSTEMS INTEGRATION LABORATORY P&ID  
H<sub>2</sub> MED/HIGH PRESSURE OVERVIEW

*Phase 2 proposal for component testing submitted*



- Accomplishments
  - A hydrogen contaminant detector was defined
  - Challenges were presented for installation at commercial stations
  - A set of engineering requirements was developed
  - A market survey was performed on applicable technologies
  - An analysis was conducted to highlight the gaps between HCD requirements and the current state of technology
- Stakeholders who benefit
  - Station developers
  - Station operators
  - Legislative bodies
  - Technology developers
  - Automotive OEMS
  - FCEV customers