

Data Collection and Validation of Newport Beach Hydrogen Station Performance

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Overview

Timeline

- Project Start Date: October 2012
- Project End Date:
 - Phase A: March 2014
 - Phase B: March 2015 (TBD, Subject to approval)
- Percent complete: 10%

Budget

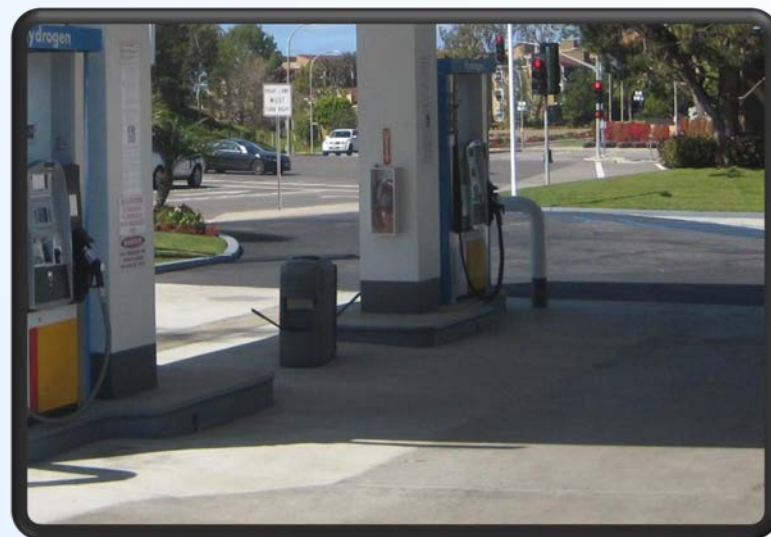
- Total project funding
 - DOE share: \$156,392
 - Contractor share: \$157,758
- Funding received in FY12: \$0
- Planned Funding for FY13: \$92,000

Partners

- California Air Resources Board – Co-funder
- Hydrogenics Corporation – Operation/Maintenance

Barriers

- Overall high station operation costs
 - High utility costs
- Maximize SMR efficiency using measured inputs/outputs vs. calculated



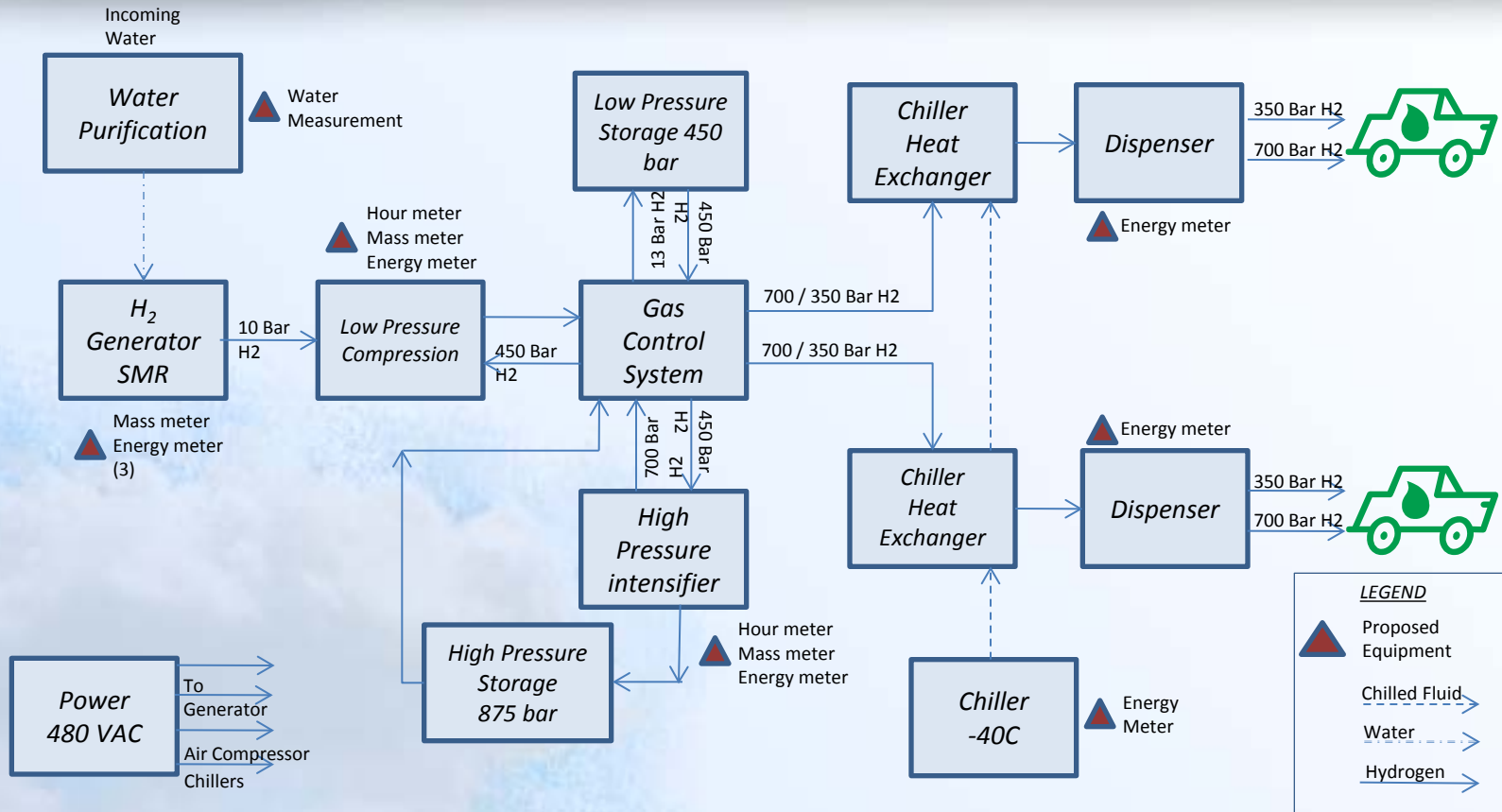
Relevance

Project Objective – Phase A:

Instrumentation and Data Collection

- Specify & install correct instrumentation to increase the amount of data collected
 - (3) Mass flow meters
 - (2) Hour meters
 - (9) Power meters
 - (2) Water flow meters
- Validate new data and conduct initial analysis

Project Objective – Phase A



Relevance

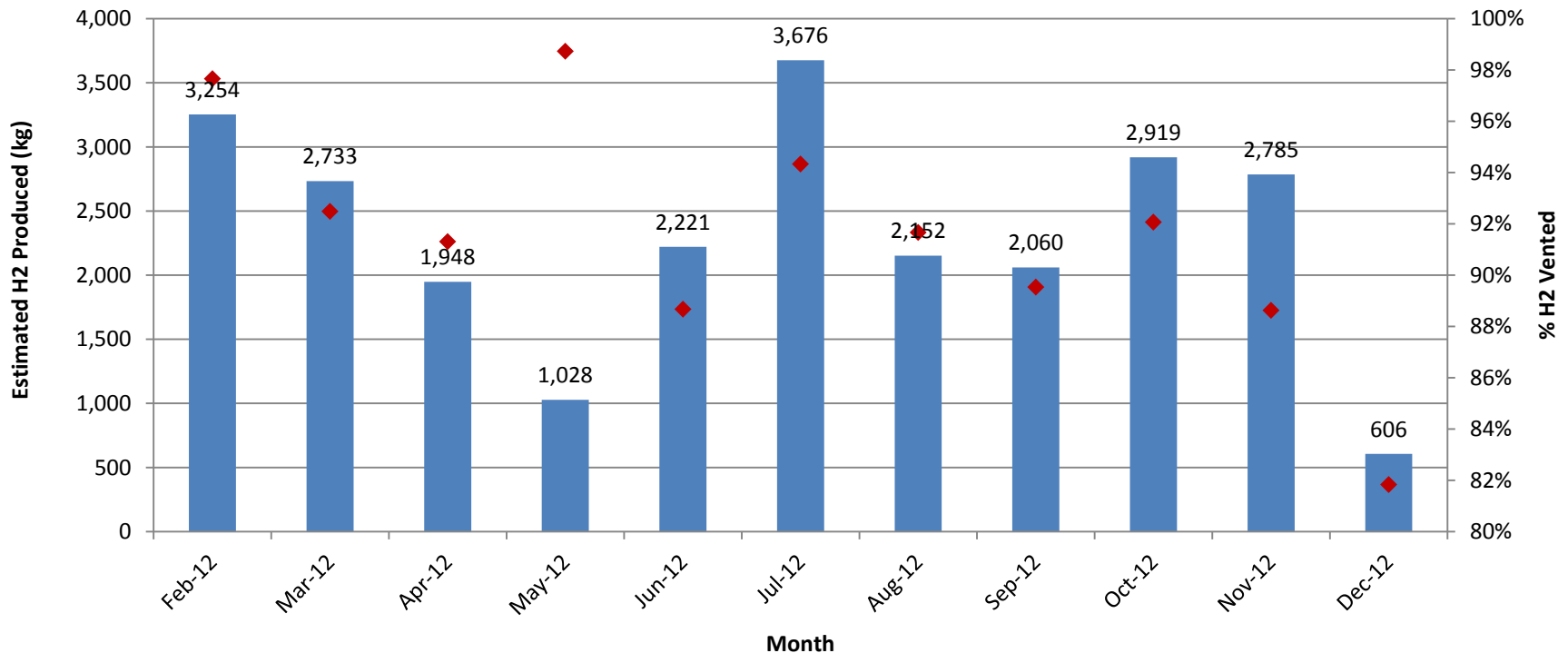
Project Objective – Phase B:

Improve Efficiency

- Increase overall station/equipment up time
- Reduce non-scheduled maintenance visits
- Make recommendations on how to optimize components
- Act on recommendations/continue to monitor and check/validate station optimization

Project Objective – Phase B

Current H2 Gas Vented



■ Estimated (Calculated)
H2 Produced (kg)
(Includes Downtime) ◆ % H2 Vented

Approach

Budget Period 1 – Installation and Data Validation

- Task 1.0 – Specify, Procure and Verify Instrumentation
 - Flow meters for the appropriate medium, temperature and pressure
 - Power meters to measure electrical energy consumption for the specific components listed
 - Timers to measure the number of run hours on some select equipment

Approach

Budget Period 1 – Installation and Data Validation

- Task 2.0 – Installation, Test and Calibration of Equipment
Install equipment at site. Site owner and operator will manage and supervise the installation of all new equipment under existing Management of Change (MOC) program.
- Task 3.0 – Commissioning Equipment, Data Verification and Reporting Procedures
After completion of the installation, all equipment will be validated to ensure proper operation and data accuracy.

Approach

Budget Period 1 – Installation and Data Validation

- Task 4.0 – Start Data Collection

Data will be collected on a monthly basis. After being reviewed for accuracy and discrepancies, the data will be reported to appropriate personal at the National Energy Renewable Laboratory (NREL) on a quarterly basis.

Approach

Budget Period 1 – Installation and Data Validation

- Task 5.0 – Data Submission

Data will be reported no later than six weeks after the end of each calendar quarter.

- Task 6.0 – Go/No Go

Based on the effectiveness of the sensors installed and analysis of data collected, a determination will be made on whether further instrumentation/collection is needed. It is expected that due to anticipated increases in OEM vehicle releases, additional learnings could be obtained by lengthening the data capture period.

Technical Accomplishments and Progress

Template Number	Data Point Description	Status	Proposed Action
1 – Site Summary	Simplified Process Diagram	Complete	None
	General Information	Missing portions of the Storage section	To be completed with funding.
2 – Delivery	N/A Onsite Generation		
3 – Compression	Mass of Hydrogen Compressed	Not Recorded	Install mass flow meters: -Measure the mass of H2 from reformer to compressor 1 to low pressure storage (SB 1); -Measure the mass flow from SB1 to compressor 2 to high pressure storage (SB2).
	Operation Time	Not Recorded	Install hour meter on both compressors
	Electricity Used	Not Recorded	Install power meter on both compressors
	Total Energy Consumed	Not Recorded	To be calculated with the information above
	Specific Energy	Not Recorded	Will calculate based on information above

Technical Accomplishments and Progress

Template Number	Data Point Description	Status	Proposed Action
4 – Dispensing	Hydrogen 350	Recorded	None
	350 bar Energy Cost	Not Recorded	-Install power meter on each of the two dispensers. Single meter for each dispenser.
	Energy Consumed 350	Not Recorded	-Will be recorded based on above.
	Hydrogen 700 bar	Recorded	None
	700 bar Energy Cost	Not Recorded	-Install power meter on each of the two dispensers. Single meter for each dispenser.
	Energy Consumed 700	Not Recorded	-Will be recorded based on above.
	Energy Consumed in Pre Cooling	Not Recorded	-Will install power meter to record amount of energy for pre cooling (chiller only).
	Pre Cooling Pump	Not Recorded	-Will install power meter on pre cooling pump.
	Specific Energy	Not Recorded	-Will calculate based on information above.

Technical Accomplishments and Progress

Template Number	Data Point Description	Status	Proposed Action
5 – Fuel Log	Date and Time; Fuel Price; Dispenser ID; H2 Filled; Fill time; Pressure; Communication type	Recorded	None
	Ambient Temperature	Not Recorded	-Instrumentation exists but data not collected. Add to data collection.
	Pre cooling Temperature	Not Recorded	-Instrumentation exists but data not collected. Add to data collection.
	Fill Description	Not Recorded	-Instrumentation exists but data not collected. Add to data collection.
	Vehicle Name or Type	Recorded	None
	Comments	Recorded	None
	Fill Rate	Recorded	None

Technical Accomplishments and Progress

Template Number	Data Point Description	Status	Proposed Action
6 – Maintenance	Date; Component Name; Category; Fail Mode; Maintenance Type; Labor Hours	Recorded	None
	Labor Cost	Not Recorded	To be added to templates.
	Parts Cost	Not Recorded	To be added to templates.
	Stations OP hours at Repair	Not Recorded	To be added to templates.
	Event Safety Issue	Recorded	None
7 – H2 Cost	Labor Non Maintenance	Not Recorded	To be added to templates.
	Site Power	Recorded	None
	Site Rent	Recorded	None
	Tax	N/A	N/A
	License Permit Fees	Not Recorded	To be added to templates.
	Insurance	N/A	N/A
	Nitrogen Deliveries	Not Recorded	To be added to templates.
	Natural Gas Costs	Recorded	None
	\$/H2 dispensed	Not Recorded	To be added based above

Technical Accomplishments and Progress

Template Number	Data Point Description	Status	Proposed Action
8 – Safety	All items	Recorded	None
9 – H2 Quality	All items	Recorded	None
10 – Reformer	Operating Time	Recorded	None
	Hydrogen Produced	Currently Calculated	- Add flow meter to determine the exact amount of H2 produced
	Water Consumed	Not Recorded	-Add 2 water flow meters one to record the water consumed, the other to record water rejection from RO system.
	Feed Stock Consumed	Recorded	None
	Feed Stock Bill	Recorded	None
	Total Energy Consumed	Not Recorded	-Add power meter to reformer; chiller; blower.
	Specific Energy Consumed in Conversion	Not Recorded	-Calculated based on above.

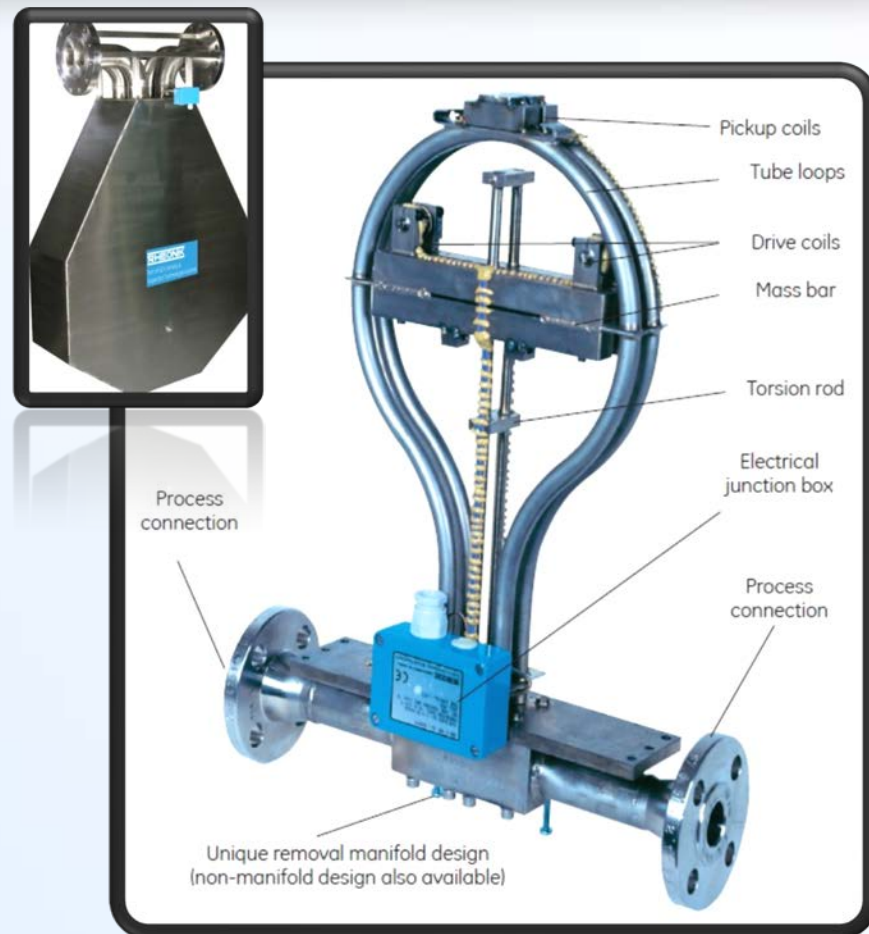
Technical Accomplishments and Progress

Equipment Selection

•High Pressure

Mass Flow Meter (1)

- Rheonik Coriolis mass flow meters
- Pressure ratings up to 875 bar / 12,700 psig
- Temperature ratings from -255°C to 400°C / -425°F to 750°F
- Unaffected by viscosity, density or pressure changes



Technical Accomplishments and Progress

Equipment Selection

- Low Pressure

Mass Flow Meters (2)

- Sage Rio industrial thermal mass flow meters
- Pressure ratings up to 34.5 bar / 500 psig
- Temperature ratings from -40°C to 93°C / -40°F to 200°F
- Continuous diagnostics checks sensor performance and verifies that sensor is clean



Technical Accomplishments and Progress

Equipment Selection

- Power Meters (9)
 - Accuenergy Acuvim-L series power meter
 - Economical yet highly functional
 - Monitored data is available via standard digital RS485 communication port running the Modbus RTU protocol



Collaborations

- Station co-funded by the California Air Resources Board
 - Support infrastructure for rollout of Fuel Cell Electric Vehicles
 - Collect data to help meet ambient air quality standards and to reduce GHG emissions
- Station maintained and serviced by Hydrogenics Inc.
 - Manufacturer of fuel cells & electrolyzers
 - Involved in over 30 H2 Fueling Stations worldwide

Future Work

Budget Period 2 – Feasibility and Data Evaluation

- Task 7.0 – Improve and Continue

With increased fueling throughput at the station, the possibility exists that the station could recover operating costs and in time be theoretically profitable. With this increased monitoring, further optimization can take place to reduce the feedstock consumption/expense and demonstrate how to maximize operations of a station using this technology. It is expected that the amount of hydrogen vented through the reformer will be reduced and operation optimized to minimize waste. This can be achieved by tuning the system with the known variables that will be collected. The improvements will be evident through the collected data and will be highlighted at the end of the project.

Future Work

Budget Period 2 – Feasibility and Data Evaluation

- Task 8.0 – Meeting with DOE in Washington, D.C.
Peer review meeting as requested by DOE.

Future Work

- More comprehensive data templates

New data

Total Fills		931		Fueling & Dispenser Uptime					
Total H2 Dispensed		2,193							
Month/Year	Days per month	Dispenser Availability		H2 Fuelings (month)	H2 Dispensed (kg/month)	TOTAL H2 Fuelings	TOTAL H2 Dispensed (kg)	Avg. Fuelings (per day)	Energy Consumed
		Total Life %	Month %						
January-12	31	-----	-----	11	33	11	33	0.4	
February-12	29	82	82	46	124	57	157	1.6	
March-12	31	85	97	84	235	141	392	2.7	
April-12	30	83	80	80	220	221	612	2.7	
May-12	31	61	6	12	31	233	643	0.4	
June-12	30	67	87	99	248	332	891	3.3	
July-12	31	73	100	88	207	420	1098	2.8	
August-12	31	74	77	73	179	493	1277	2.4	
September-12	30	74	77	95	218	588	1495	3.2	
October-12	31	77	94	151	271	739	1766	4.9	
November-12	30	78	93	148	317	887	2083	5	
December-12	31	78	71	44	110	931	2193	1	
2012				931	2,193				
January-13	31	78	74	64	150	995	2343	2	
February-13	29								
March-13	31								
April-13	30								

- Example template

Future Work

- New data will be collected to analyze energy use

Compressor data

Month	Mass of H ₂ - Reformer to Comp 1 to SB1	Mass of H ₂ - SB1 to Comp 2 to SB2	Operation Time	Electricity Used	Total Energy Consumed	Specific Energy
Jan-14						
Feb-14						
Mar-14						
Apr-14						
May-14						
Jun-14						
Jul-14						
Aug-14						
Sep-14						
Oct-14						
Nov-14						
Dec-14						

- *Example template*

Project Summary

- **Relevance** – Optimize operation of an on-site SMR station
- **Approach** – Install 16 various meters for increased data collection allowing improved analysis
- **Technical accomplishments and progress** – Proposed actions have been determined
- **Collaborations** – California Air Resources Board, Hydrogenics Inc.
- **Proposed future work** – Increased data and analysis should lead to further optimization and reduced feedstock expense maximizing operations of an SMR station