California Hydrogen Refueling Infrastructure: Present Activities and Future Plans

Alternative and Renewable Fuel and Vehicle Technology Program (ARFVTP)

HTAC
April 6, 2016
Jean Baronas
ARFVTP Origins in Statute

Established by Assembly Bill 118 (Nunez, 2007)
✓ $100 million per year

Funding extended through January 1, 2024 by Assembly Bill 8 (Perea, 2013)

“…develop and deploy innovative technologies that transform California’s fuel and vehicle types to help attain the state’s climate change policies.”
(Health and Safety Code Section 44272(a))
## ARFVTP Funding: 2009-2015

<table>
<thead>
<tr>
<th>Investment Areas</th>
<th>Funding Amount (millions)</th>
<th>Percent of Total (%)</th>
<th>Number of Awards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Vehicle Serv. Equip.</td>
<td>$199</td>
<td>33</td>
<td>153</td>
</tr>
<tr>
<td>Biofuels</td>
<td>$158</td>
<td>26</td>
<td>61</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>$113</td>
<td>19</td>
<td>72</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$95</td>
<td>16</td>
<td>185</td>
</tr>
<tr>
<td>Workforce Development</td>
<td>$28</td>
<td>4</td>
<td>58</td>
</tr>
<tr>
<td>Market &amp; Program Develop.</td>
<td>$13</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$606</strong></td>
<td><strong>100</strong></td>
<td><strong>545</strong></td>
</tr>
</tbody>
</table>

Through Q4 2015
H2 USA Participation

- Codes and Standards: Larry Vettraino
- Infrastructure and Station Acceptance: Chris Jenks and Jean Baronas
- Roadmap: Phil Cazel

- Stations: Larry Vettraino, Esther Odufuwa, Chris Jenks, and Jean Baronas
- Market Support: Miki Crowell and Chris Jenks
- Investment: Brad Cole
NREL Technology Validation Participation

CDP-INFR

• 10, Cumulative Number of Stations
• 11, Hydrogen Stations by Type
• 27, Hydrogen Station Timeline
• 40 Stations Costs by Daily Capacity
• 41, Station Costs (Budget v. Actual)
• 42, Station Costs (State Funding v. Cost Share)
• 43, Station Cost by Type
Quarterly Submission to NREL

- Hydrogen feedstocks,
- Pathways (station configurations),
- Station capacities,
- Equipment, labor, and materials costs,
- Durations of major project implementation milestones,
- Invoiced expenditures, and
- Match funding.

- Organizational safety policies and procedures
- Hydrogen and fuel cell experience
- Safety vulnerabilities
- Risk reduction
- Equipment and mechanical integrity
- Change procedures

- Communications plan
- Training
- Safety reviews
- Safety events and lessons learned
- Emergency Response
- Self-audits

AB 8 Joint Agency Report

• “Assessment of Time and Cost Needed to Attain 100 Hydrogen Refueling Stations in California”

• Energy Commission and California Air Resources Board joint report to California Legislature
  – December 2015
  – Technical support from NREL
Station Costs  
(Source: AB 8 Joint Report)
Network Over Time
Source: AB 8 Report

Maximum Average Utilization 75%

Average Network Utilization (Group 1 & 2 Stations)

- Expected
- Robust
- Delayed
Ongoing and Future Project Development

• Human-centered user interface: dispenser
• Third party component and station certification
• Regulations for fueling protocols (adopt voluntary standards)
• Mobile refueling critical pathway
• “Fueling Plaza” (multi-fuels, Interstate 5, State Route 99 and U.S. Highway 101)
Hydrogen Network
Statewide Retail

SOSS Weighting - 14 Retail Stations
2 = Online (95% SOC)
1 = Limited (Less than 95% SOC and compression down)
0 = Offline

March 2016

Statewide score of 28 = 100% online
So. California score of 18 = 100% online
N. California score of 10 = 100% online

North 700
North 350
South 700
South 350
700 Statewide
350 Statewide
Ongoing and Future Project Development

• State-wide coordination: biofuels for hydrogen delivery trucks and biogas for renewable hydrogen production
• NFPA 2 implementation
• Inline fuel quality testing capabilities
• Adjacent stations
  – Coordinate planned maintenance
  – Provide redundancy/backup fueling
  – Provide backup parts
Ongoing and Future Projects

• Upgrades through “bridge” standards
• HyStEP “use on the rise”
• Medium duty (MD) fueling protocols
• Standards that support > 0.75 nameplate capacity
• Airport locations (in proximity)
First Element: Long Beach, Costa Mesa, Coalinga
Linde’s West Sacramento Station Opening
December 2014
Commissioner Janea Scott
For further information:

Jean Baronas  
California Energy Commission  
1516 Ninth Street  
Sacramento, CA 95814  
Jean.baronas@energy.ca.gov  

916-654-4526
Backup Slides
California Transportation: Nation-State Statistics

- Population: 38 million
- GDP: $2.0 trillion - 8th largest global economy
  - Transportation accounts for 37% of all GHG emissions
- Air Pollution: Severe Non-Attainment for Ozone
  - San Joaquin and South Coast Air Basins
- Vehicles: 28.1 million cars + 0.9 million trucks
- Annual Fuel Consumption: 18.1 billion gallons
  - 14.5 billion gallons gasoline + 3.6 billion gallons diesel
- Primary Roadways: 170,000 miles
Existing Agreements: 2009-2015

Current through Q4, 2015
Hydrogen Station Funding
To Date = $103 million

Public Station Funding
45 New Stations = $72.7 million
4 Station Upgrades = $6.7 million
44 Station O&M Grants = $12.5 million
1 Mobile Refueler = $0.9 million

Other Funding Activities
5 H2 Regional Readiness Plans = $1.4 million
AC Transit Fuel Cell Bus Station = $3 million
CDFA Div of Weights and Measures = $4 million
Retail Dispensing Fuel Standards
HyStEP Test Device = $0.1 million
UC Irvine STREET Model = $1.5 million
GoBiz ZEV Infrastructure Manager
## Energy Commission Solicitations and Award Dates

<table>
<thead>
<tr>
<th>Solicitation No.</th>
<th>Notice of Proposed Award</th>
<th>Total Capital Funding ($ millions)</th>
<th>Number of HRS Developers Awarded</th>
<th>Number of Stations Funded</th>
</tr>
</thead>
<tbody>
<tr>
<td>PON-09-608</td>
<td>November 2010</td>
<td>15.7</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>PON-12-606</td>
<td>April 2013</td>
<td>11.9</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>PON-13-607</td>
<td>May 2014</td>
<td>46.6</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td>South Coast Upgrades</td>
<td>August 2013</td>
<td>6.7</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>80.9</td>
<td></td>
<td>49</td>
</tr>
</tbody>
</table>
# Energy Commission Solicitations

<table>
<thead>
<tr>
<th>Solicitation No.</th>
<th>CEC Capital Grant Share</th>
<th>Total Funding Available ($ million)</th>
<th>Incentive Funding</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>PON-09-608</td>
<td>40% to 70%</td>
<td>19</td>
<td>Accelerated Completion Upon Permit Receipt</td>
<td>11 stations funded</td>
</tr>
<tr>
<td>PON-12-606</td>
<td>65% or $1.5 M</td>
<td>28.6</td>
<td>No</td>
<td>Undersubscribed by $6.7 M 5 stations funded</td>
</tr>
<tr>
<td>PON-13-607</td>
<td>70% to 85% or $1.75 to $2.1 M</td>
<td>46.6</td>
<td>For Speed of Development</td>
<td>Oversubscribed 28 stations funded</td>
</tr>
</tbody>
</table>
## Representative Costs for 3 Station Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Equipment Costs ($ million)</th>
<th>Installation Costs ($ million)</th>
<th>Total Cost (All-In) ($ million)</th>
<th>Levelized Costs ($/kg)</th>
<th>No. of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delivered Gaseous (180 kg/day)</td>
<td>1.6</td>
<td>0.4</td>
<td>2.0</td>
<td>$13.00</td>
<td>31</td>
</tr>
<tr>
<td>Delivered Liquid (350 kg/day)</td>
<td>1.9</td>
<td>0.8</td>
<td>2.8</td>
<td>$9.90</td>
<td>7</td>
</tr>
<tr>
<td>Electrolysis (130 kg/day)</td>
<td>2.3</td>
<td>0.8</td>
<td>3.2</td>
<td>$24.00</td>
<td>8</td>
</tr>
</tbody>
</table>

- CEC solicitation and proposal files
- Represents most recent bid costs to CEC. Final costs may vary.
- Source: AB 8 Joint Report
Stations, Capacity, Demand
Source: AB 8 Joint Report

50 hydrogen refueling stations: 2016
• With fueling capacity for 10,000 FCEVs
• Demand could outpace capacity in 2020-21 (CARB survey results include 10,500 FCEVs by 2018 and 34,300 FCEVs by the end of 2021)
Station Development Times
Source: AB8 Joint Report

Hydrogen Station Development Times Decreasing from Nearly 5 Years (2009 funding) to 1.6 Years
Targets: 20 Operational Stations: 2015
49 Operational Stations: 2016

Status of 49 Energy Commission Funded Hydrogen Stations

- Operational: 13
- Construction: 12
- Approval to Build: 4
- Planning Approval: 5
- In Permitting: 6
- Planning: 9