2019 ANNUAL EVALUATION OF FUEL CELL ELECTRIC VEHICLE DEPLOYMENT & HYDROGEN FUEL STATION NETWORK DEVELOPMENT

Findings and Special Topics

Andrew Martinez, PhD
andrew.martinez@arb.ca.gov
(916) 322-8449
Overview of AB 8

- Signed by Governor Brown in 2013
- Allocates up to $20M annually for hydrogen infrastructure investment

- CARB annually reports to Energy Commission
  - Current and projected FCEV fleet and station progress
  - Assessment of coverage and capacity
  - Recommended station placement
  - Recommended funding level
  - Recommended station technical specifications

- Signed by Governor Brown in 2013
- Allocates up to $20M annually for hydrogen infrastructure investment
Background

- Zero Emission Vehicles vital to addressing air quality & climate change

- Goal to enable industry to scale up to a self-sustained market

- Hydrogen fueling stations are needed ahead of FCEVs to enable market launch
California’s Hydrogen Strategy

- R&D Stations and Vehicles
- Passage of AB 8: funding for 100+ stations
- California’s FCEV market transitions to early market phase
- Adoption of LCFS HRI credit provision
- AB 8 goal of 100+ retail fueling stations
- Executive Order B-48-18 goal of 200 retail fueling stations

- Zero carbon in all sectors

- Hydrogen Blueprint Plan
- California Fuel Cell Partnership Roadmap, 68 stations for market launch
- Pre-Commercial test stations and vehicles
- California Fuel Cell Partnership Revolution, a Vision to 1,000 stations and 1,000,000 FCEVs as early as 2030

Hydrogen Network Self-Sufficiency
California’s Hydrogen Strategy

- Today’s vehicle fleet ~2% ZEV (including PHEVs)
- Completely decarbonized market, relying on ZEV options
- Large-scale fleet turnover in the coming decades

- Success requires ZEVs on the market that meet all possible use cases
- Different drivers have different vehicle needs, usage patterns, and ZEV fueling availability
- FCEV and BEV complement each other; where one faces challenges, the other typically excels
- Multiple technology options provides greater chance of success and potentially faster ramp-up
- Both ZEV fuel pathways offer unique and exciting opportunities to enable greater renewable implementation on the electric grid
California’s Hydrogen Strategy

Larger light-duty market presents greater potential for achieving economies of scale sooner in vehicle technology, especially fuel cell stacks.

Greater per-vehicle hydrogen consumption in the medium and heavy-duty market presents greater potential for achieving economies of scale sooner in hydrogen fuel production and distribution.

These advantages can translate to improvements across markets.
Building on Past Successes

- First retail sale capable station
- Largest FCEV deployment
- World-class fueling station network
- Transition to commercial market
- Reducing station development cost and build time
- Proven growing station utilization
- Leading standards development and implementation

Image courtesy of CaFCP
Positive Momentum since 2018 Annual Evaluation

- LCFS Hydrogen Refueling Infrastructure credit provision adopted
- Energy Commission *Draft Solicitation Concepts* released
  - Adopts strategies to achieve scale
- Hyundai announces FCEV Vision 2030
  - 40,000 fuel cell stacks per year by 2022
- Air Liquide announces 30 ton per day hydrogen production facility
- Air Products announces liquid hydrogen production facility
FINDINGS
Finding 1

Station network development in 2019 has expanded coverage and capacity in core market areas.
Finding 2

Station network development through 2018 and early 2019 has continued to remain largely on schedule.

Latest station status can be found at: [https://cafcp.org/stationmap](https://cafcp.org/stationmap)
Finding 2

Evaluation of station development schedule based on latest available information at time of report writing

- Based on direct communication between public agencies and station developers
- Schedules and future plans are dynamic and sometimes in flux at time of report
- Recent information indicates fewer than 52 stations may be open in 2019
- 2020 total of 64 includes stations that may change plans for future
Finding 3

Auto manufacturer projections for FCEV deployments do not demonstrate sufficient acceleration to support the goals of EO B-48-18 and the California Fuel Cell Partnership’s *Revolution*. 
A station network of 200 stations per EO B-48-18 provides up to three times the fueling capacity of auto manufacturers’ currently projected FCEV deployment plans for 2025.

- Anticipates acceleration in station deployment and capacity growth before 2025, enabled by combination of AB 8 grants and LCFS HRI credits
- Exact match is not required, though similar growth expectation trends in supply and demand were not yet apparent in this year’s data

Finding 4
CARB recommends a streamlined station location evaluation for the next round of Energy Commission grant funding.

**Finding 5**

**Connector or Destination:** An area with long-term potential for local market development, but will likely serve as a long-distance connector or travel destination in the short-term.

**Market Initiation:** An area with high potential for FCEV first adopters, but currently has less than three hydrogen fueling stations open or in construction.

**Coverage Growth:** An area with high potential for FCEV first adopters, that has at least three station open or in construction, and will likely need very large stations further in the future;

**Capacity Growth:** Similar to Coverage Growth, but large stations will be needed sooner.
**Proposed Fueling Position/Capacity Requirements**

Based on 24-hour HySCapE run without additional delivery

Provide flexibility to applicants by allowing proposals with +/- 1 position from table recommendation, with supporting discussion

System as a whole integrates well with LCFS HRI

---

**Table 4: Recommended Station Design Capacity Requirements by Area Classification**

<table>
<thead>
<tr>
<th>Area Classification</th>
<th>Minimum Number of Fueling Positions</th>
<th>Minimum Capacity per Fueling Position (kg/day)</th>
<th>Minimum Station Capacity (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity Growth</td>
<td>3</td>
<td></td>
<td>675</td>
</tr>
<tr>
<td>Coverage Growth</td>
<td>2</td>
<td>225</td>
<td>450</td>
</tr>
<tr>
<td>Market Initiation</td>
<td>2</td>
<td></td>
<td>450</td>
</tr>
<tr>
<td>Connector or Destination</td>
<td>1</td>
<td></td>
<td>225</td>
</tr>
</tbody>
</table>
Finding 6

Infrastructure and vehicle deployments need to continue and significantly accelerate in order to secure State ZEV implementation and emission reduction goals.
CARB and the Energy Commission are continuing to develop a methodology to determine the needs of achieving hydrogen fueling network self-sufficiency.
Finding 8

The open and projected hydrogen fueling network is expected to maintain compliance with the renewable hydrogen requirements of SB 1505.
SELF SUFFICIENCY ANALYSIS
Scenario analysis framework

**Initial Condition**
- Coverage & Capacity of Current AB 8 Funded Stations

**Inputs & Intermediate Data**
- Define FCEV Deployment Scenario
- Translate FCEV to Station Deployment Scenario
- Determine Station Locations through CHIT
- Determine Station Utilization Curve by Local Market Maturity Analysis
- Define Station Capital & Operations & Maintenance Cost Curves
- Define Station Finance Parameters

**Outputs**
- Individual Station & Network-Wide Annual Cash Flows
- Comparison of Modeled Self-Sufficiency to Industry Survey
- Calculated State Investment to Ensure Network Success
- Spatial-Temporal Mapping of Station & Network Financial Performance

Structure
Station and network cash flows
Confirm smaller stations (<400 kg/day) are financially challenged.
Vehicle rollout and station utilization are among largest influencers of financial performance.
Preliminary Insights

Geospatial tracking and visualization may inform future program directions.
LCFS HRI UPDATE
## HRI Crediting Has Begun!

- **31 stations participating**
- **>11,000 kg/day capacity approved**
- **Estimated >55,000 kg/day capacity available in Q2, 2019**

<table>
<thead>
<tr>
<th>Applicant Entity</th>
<th>Station Name</th>
<th>Station Address</th>
<th>City</th>
<th>Number of Dispensing Units</th>
<th>HRI Refueling Capacity (Kg/day)</th>
<th>Effective Date Range for HRI Crediting</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Element Inc.</td>
<td>Truckee</td>
<td>12105 Donner Pass Road</td>
<td>Truckee</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Coalinga</td>
<td>29005 W College Avenue</td>
<td>Coalinga</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Thousand Oaks</td>
<td>5102 E Thousand Oaks Boulevard</td>
<td>Thousand Oaks</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Mill Valley</td>
<td>370 Robwood Highway</td>
<td>Mill Valley</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Playa Del Rey</td>
<td>8126 Lincoln Boulevard</td>
<td>Los Angeles</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Hollywood</td>
<td>3705 Hollywood Boulevard</td>
<td>Los Angeles</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Del Mar</td>
<td>3060 Carmel Valley Road</td>
<td>San Diego</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Fremont (Grimmer)</td>
<td>41700 Grimmer Boulevard</td>
<td>Fremont</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Hayward</td>
<td>591 W A Street</td>
<td>Hayward</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>South San Francisco (Airport)</td>
<td>248 S Airport Boulevard</td>
<td>South San Francisco</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>South Pasadena</td>
<td>1200 Fair Oaks Avenue</td>
<td>South Pasadena</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Campbell (Winchester)</td>
<td>2855 Winchester Boulevard</td>
<td>Campbell</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>La Canada Flintridge</td>
<td>550 Foothill Boulevard</td>
<td>La Canada Flintridge</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Lake Forest</td>
<td>20791 Lake Forest Drive</td>
<td>Lake Forest</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Costa Mesa</td>
<td>2059 Harbor Boulevard</td>
<td>Costa Mesa</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Long Beach</td>
<td>3401 Long Beach Boulevard</td>
<td>Long Beach</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Saratoga</td>
<td>12900 Saratoga Avenue</td>
<td>Saratoga</td>
<td>1</td>
<td>198</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>San Jose</td>
<td>2101 N 1st Street</td>
<td>San Jose</td>
<td>1</td>
<td>266</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>3rd Street</td>
<td>651 3rd Street</td>
<td>San Francisco</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>Bernal Road</td>
<td>101 Bernal Road</td>
<td>San Jose</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>Citrus Heights</td>
<td>8147 Greenback Lane</td>
<td>Citrus Heights</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>Fair Oaks</td>
<td>3510 Fair Oaks Boulevard</td>
<td>Sacramento</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>Harrison</td>
<td>1201 Harrison Street</td>
<td>San Francisco</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>Mission Street</td>
<td>3550 Mission Street</td>
<td>San Francisco</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Shell Inc.</td>
<td>University Berkeley</td>
<td>1250 University Avenue</td>
<td>Berkeley</td>
<td>2</td>
<td>513</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>Air Liquide Hydrogen Energy US LLC</td>
<td>LAX</td>
<td>10400 Aviation Boulevard</td>
<td>Los Angeles</td>
<td>1</td>
<td>200</td>
<td>04/01/2019 - 03/31/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Sherman Oaks</td>
<td>14478 Ventura Boulevard</td>
<td>Sherman Oaks</td>
<td>2</td>
<td>808</td>
<td>07/01/2019 - 06/30/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Oakland</td>
<td>3251 Grand Avenue</td>
<td>Oakland</td>
<td>2</td>
<td>808</td>
<td>07/01/2019 - 06/30/2034</td>
</tr>
<tr>
<td>First Element Inc.</td>
<td>Studio City</td>
<td>3780 Calhoun Avenue</td>
<td>Studio City</td>
<td>2</td>
<td>808</td>
<td>07/01/2019 - 06/30/2034</td>
</tr>
<tr>
<td>Air Liquide Hydrogen Energy US LLC</td>
<td>Palo Alto</td>
<td>3601 Camino De Real Street</td>
<td>Palo Alto</td>
<td>1</td>
<td>136</td>
<td>07/01/2019 - 06/30/2034</td>
</tr>
</tbody>
</table>

**Most recent update**
- 38 stations participating
- 60 total fueling positions
- 18,752 kg/day capacity approved
QUESTIONS