The California Fuel Cell Revolution: Activating the Commercial Market

The National Academies of Sciences, Engineering & Medicine

Bill Elrick, Executive Director
California Fuel Cell Partnership
California Emissions Challenge
California’s Advanced Clean Cars (ACC) Program

• Approved as an integrated regulatory package in 2012
  o Comprehensive approach of carrots and sticks

• LEV III Criteria and GHG standards
  o 75% reduction in fleet avg NMOG + NOx emissions
  o 90% reduction in PM emission standards
  o 34% reduction in GHG emissions

• ZEV Regulation
  o More ZEVs and PHEVs

• Additional programs and activities
  o Low Carbon Fuel Standard
  o Cap and Trade program
  o Renewable Portfolio Standards
ZEV Regulation and Future of Light-duty Mobility

• Complimentary nature of BEVs and FCEVs
  – Hydrogen and electricity system enables larger decarbonized energy transition in all sectors
• Provides consumer choice
• Analysis = both are necessary!
  – Acknowledges the magnitude of the reductions needed
  – Acknowledges highly segmented vehicle market and wide array of use cases
  – Acknowledges 50% or greater GHG reductions WTW with today’s hydrogen; more in future
Heavy Duty Regulations – Electric Drive Everywhere

Suite of Mobile Source Measures

Zero-Emission (ZE) Operation
- Innovative Clean Transit
- ZE Airport Shuttle
- ZE truck certification
- Advanced Clean Trucks
- ZE ships at berth
- Rail yard idling
- ZE TRUs
- ZE forklifts
- ZE truck fleets
- ZE drayage trucks
- ZE cargo equipment

Lower Emissions
- CA GHG Phase 2
- Truck OBD
- Truck Smoke Tests
- Handbook-1 Warehouses
- Heavy-duty Omnibus
- Heavy-duty I/M
- Harbor craft
- Handbook-2 Ports, Rail
- Low-emission diesel fuel
- Non-preempted locomotives

CARB
California Fuel Cell Partnership (CaFCP)

– 20 years of collaboration –
Launching California’s Retail Market

2012 Roadmap – *how to start the market*
- Stations come first
- Establish initial network coverage
- Clusters in big cities
- “Connectors” and “destination” stations
- Consensus vision for commercial launch

2013 AB8 – ARFVTP Support
- $20M annually through 2023
- Co-funding for first 100 stations
- Annual survey, evaluation and reporting
- Government responsibility and leadership
<table>
<thead>
<tr>
<th>Number Description</th>
<th>Total</th>
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<tbody>
<tr>
<td>Fuel cell cars sold and leased</td>
<td>6,830</td>
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<tr>
<td>Fuel cell buses in operation in California</td>
<td>31</td>
</tr>
<tr>
<td>Retail hydrogen stations open in California</td>
<td>40</td>
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<tr>
<td>Fuel cell buses &amp; shuttles in development in California</td>
<td>25</td>
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<tr>
<td>Fuel cell trucks in development in California</td>
<td>35+</td>
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<tr>
<td>Retail hydrogen stations in development in California</td>
<td>24</td>
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</tbody>
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https://cafcp.org/by_the_numbers
California’s Experience – Customer Focus!

- The technology works – customers are coming!
- Need to know where, when and if hydrogen is available
- Tools for customers & stakeholders; quarterly webinars, Station Status (SOSS), reports

http://m.cafcp.org
California’s Experience – Stakeholder Progress

- “Normalization” of HRS process
- HRS development time >18 months
- Greater industry investment and building larger stations
- ER and permit peer support

Fig 8: Average Station Development Time (days)
California Activities

- Executive Order B-48-18 targets 200 HRS by 2025 and 5MM ZEVs by 2030
- New H2 production facilities
- New heavy duty fuel cell truck projects
- Innovative Clean Transit regulation
- Low Carbon Fuel Standard Amendments
- CaFCP publishes new 2030 vision for a self-sustaining California market

http://cafcp.org/stationmap
Bending the ZEV Curve

California Vehicle Population vs. Years After Market Introduction

- HEV
- BEV
- PHEV
- FCEV

BEV Proj., PHEV Proj., FCEV Vision
MISSION

Accelerate commercialization of hydrogen and fuel cell vehicles
Customer Adoption = Sustainability

INNOVATORS
Tech Adventurous

EARLY ADOPTERS
Visionary

EARLY MAJORITY
Pragmatic

Development
fuel cell cars

Retail
fuel cell cars

Retail H2
stations

Statewide
H2 Network

Early
H2 stations

Sparse
H2 network

Customer adapts
to technology

Transition to
mainstream

Traditional customer
interactions

VALUE PROPOSITION

Vehicle Cost
Same as gasoline cars

Vehicle Performance
Better than gasoline cars

Vehicle Range
Same as gasoline cars

Fuel Cost
Less than gasoline

H2 Network Coverage
Same as gasoline

http://cafcp.org/sites/default/files/CAFCR.pdf
California Fuel Cell Revolution

Enable market conditions to support:

1,000 hydrogen stations
and
1,000,000 fuel cell vehicles
by 2030
Image of a Successful Self-Sustaining Market

8,000 retail gas stations

1,000 retail H2 stations

HD Truck Infrastructure

- Potential Corridor Co-Location
- Funded Stations
- Signage Ready
- Signage Pending
- Additional Routes
- Truck Activity
  - High
  - Low
✓ Enable the market by attracting capital investment in infrastructure
✓ Establish the market with a competitive value proposition to increase consumer demand
Expand the fuel cell and hydrogen market across the transportation and energy spectrum
Transforming California’s Transportation and Energy Systems

MISSION
Accelerate commercialization of hydrogen and fuel cell vehicles

OUTCOMES
Economic, Social, & Environmental Benefits

SELF-SUSTAINING MARKET
Private investment
Growing market

FOSTER H2 INFRASTRUCTURE
Market Policies
Economies of Scale

BUILD CONSUMER DEMAND
Customer Incentives
Hydrogen Network
Dedicated Supply

AMPLIFY INNOVATION
Trucks
Diversify
Grid Integration

Costs parity
Renewable H₂
A Vision for 2030 in California

Governor’s goal of 5,000,000 ZEVs in California by 2030.


200 hydrogen stations by 2025, pursuant to the Governor’s 2018 ZEV infrastructure Proposal.

1000 hydrogen stations by 2030 with favorable market conditions and state policies pursuant to the CAFCP 2030 vision. Will support 1,000,000 fuel cell electric vehicles.
Scale Creates Cost-Competitiveness & Consumer Adoption

Joan Ogden, UC Davis – Transitioning to Electric Drive Vehicles
Next for California

- **Policies** that encourage **investment**
- Addressing **cost challenges**
- **Renewable** production pathways
- **Expanding Stations** across and beyond CA
- **Sustainable freight**