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

Findings and Special Topics

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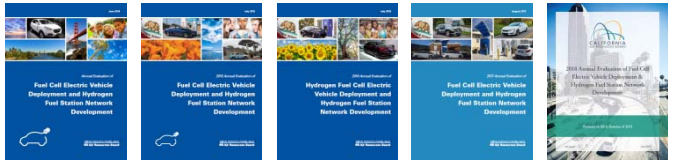
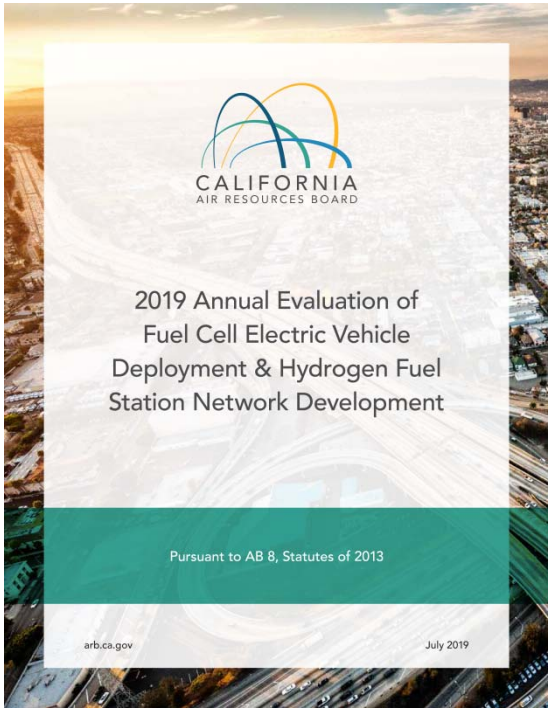
CALIFORNIA
AIR RESOURCES BOARD

# 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





# 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

**2005** — R&D Stations and Vehicles

**2013** — Passage of AB 8: funding for 100+ stations

**2017** — California's FCEV market transitions to early market phase

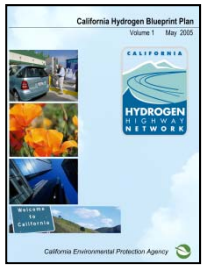
**2018** — Adoption of LCFS HRI credit provision

**2024** — AB 8 goal of 100+ retail fueling stations

**2025** — Executive Order B-48-18 goal of 200 retail fueling stations

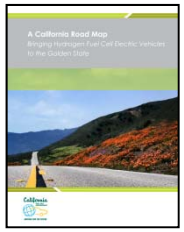

**2045** — Zero carbon in all sectors

Hydrogen Blueprint Plan



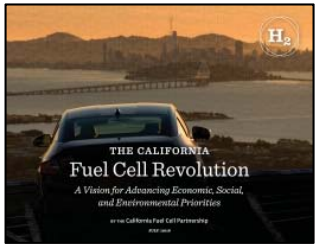

California Fuel Cell Partnership *Roadmap* , 68 stations for market launch

Pre-Commercial test stations and vehicles

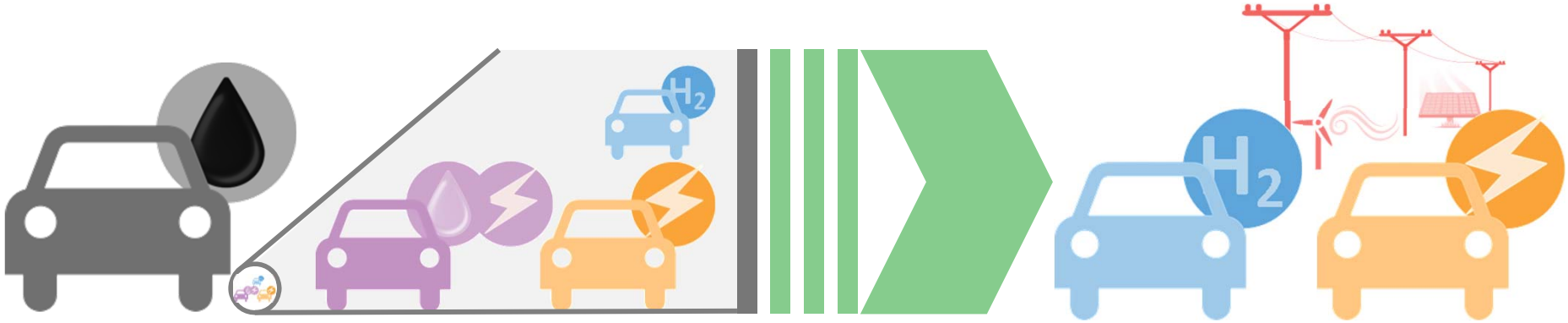



California Fuel Cell Partnership *Revolution*, a Vision to 1,000 stations and 1,000,000 FCEVs as early as 2030

Hydrogen Network Self-Sufficiency



# California's Hydrogen Strategy




Today's vehicle fleet ~2% ZEV (including PHEVs)

Large-scale fleet turnover in the coming decades

Completely decarbonized market, relying on ZEV options

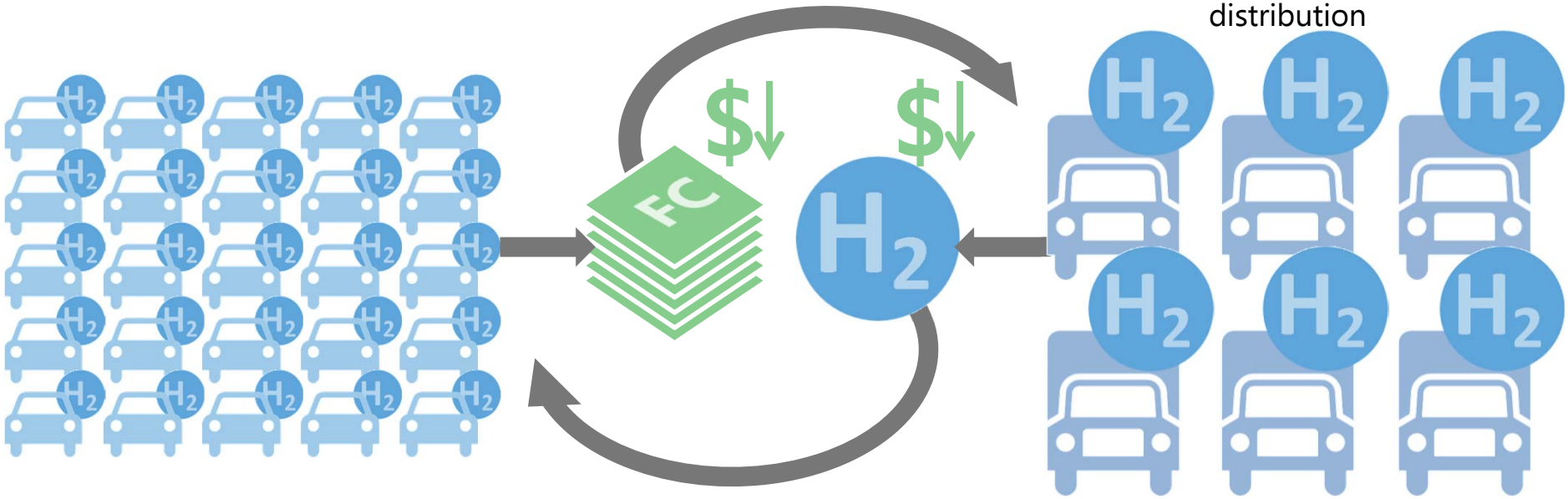
- Success requires ZEVs on the market that meet all possible use cases
- Different drivers have different vehicle needs, usage patterns, and ZEV fueling availability
- FCEV and BEV complement each other; where one faces challenges, the other typically excels
- Multiple technology options provides greater 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

These advantages can translate to improvements across markets

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



# 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

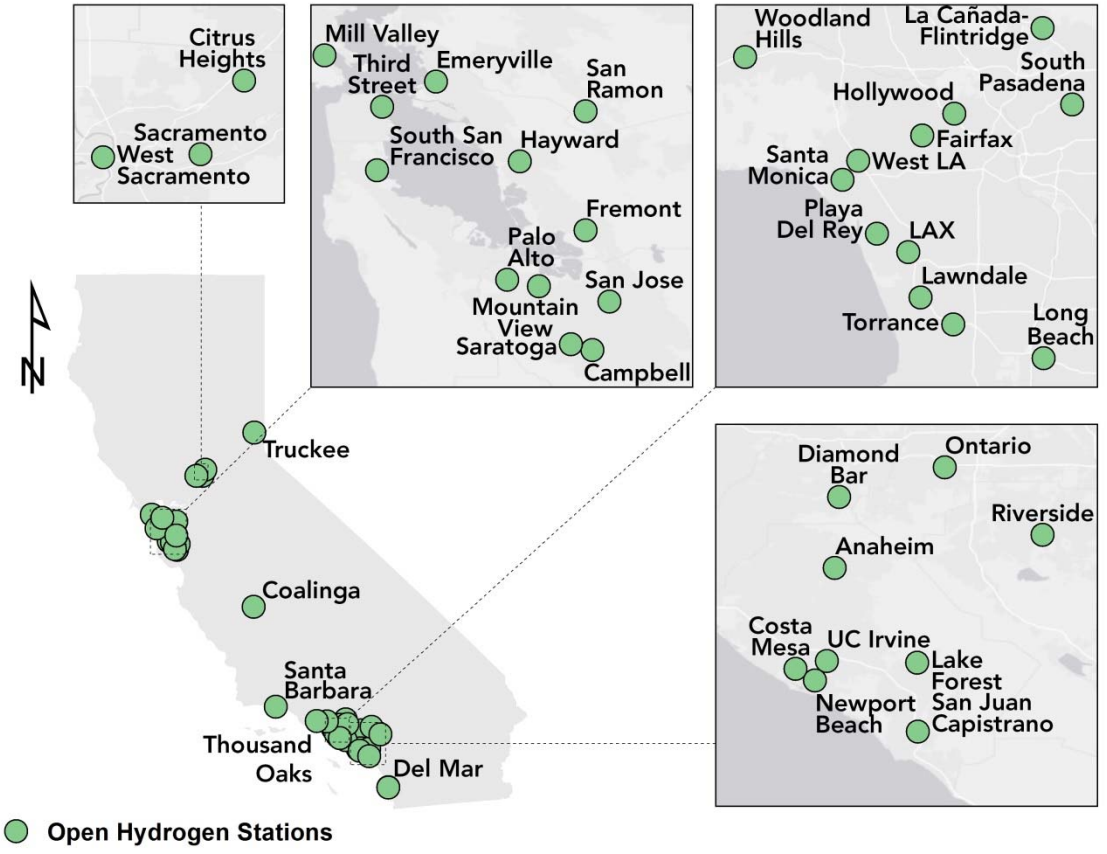
*Image from Hyundai Australia*


- Air Liquide announces 30 ton per day hydrogen production facility
- Air Products announces liquid hydrogen production facility

# FINDINGS

# Finding 1

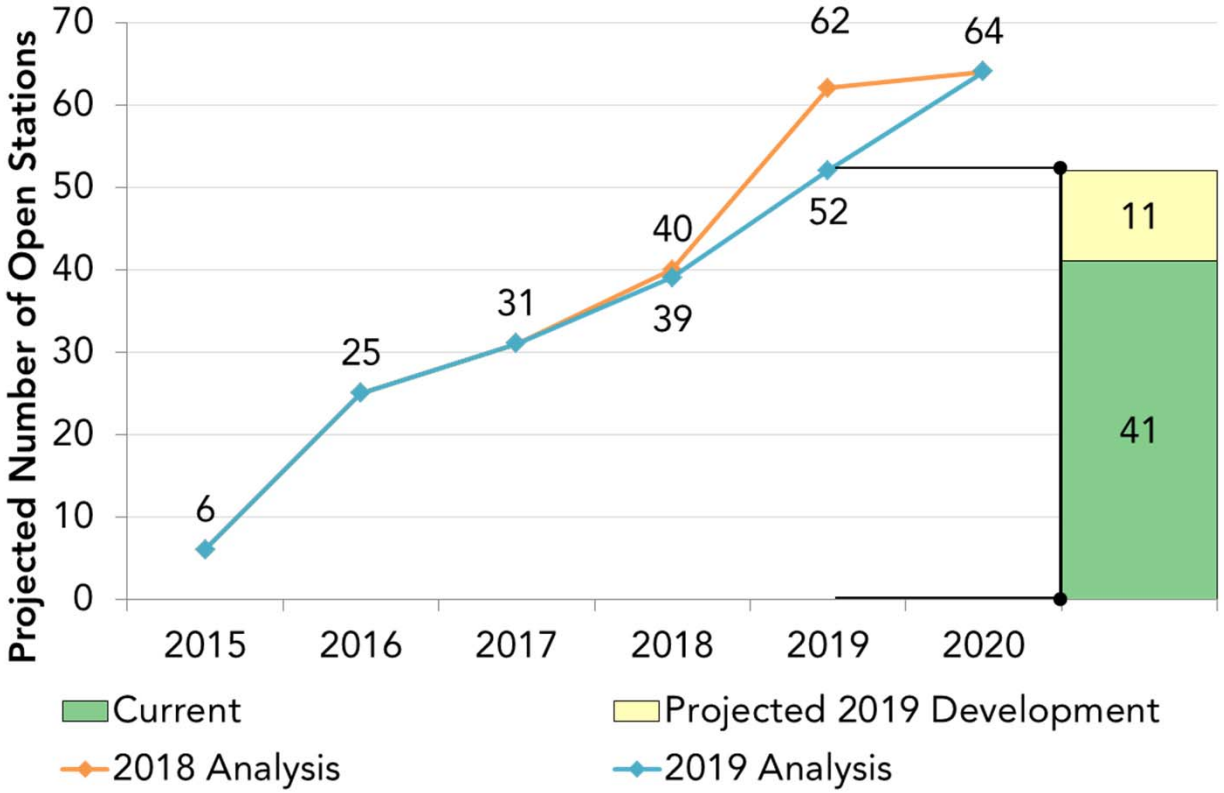
Station network development in 2019 has expanded coverage and capacity in core market areas



# Finding 2

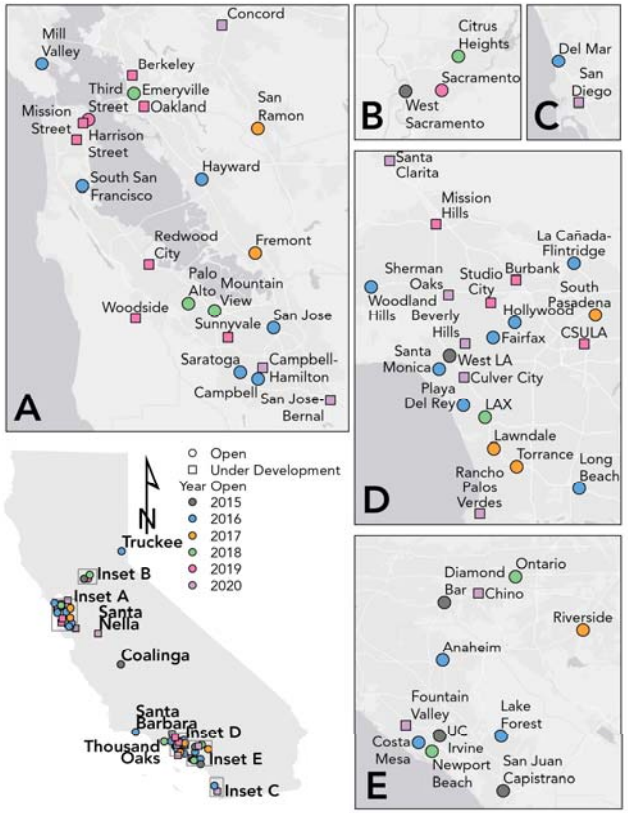
Station network development through 2018 and early 2019 has continued to remain largely on schedule

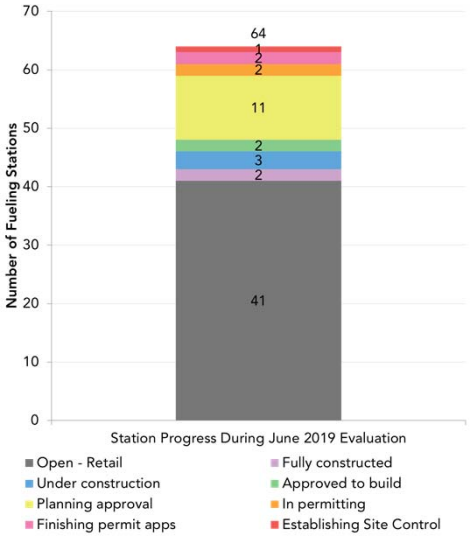
Latest station status can be found at: https://cafcp.org/stationmap



# Finding 2

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

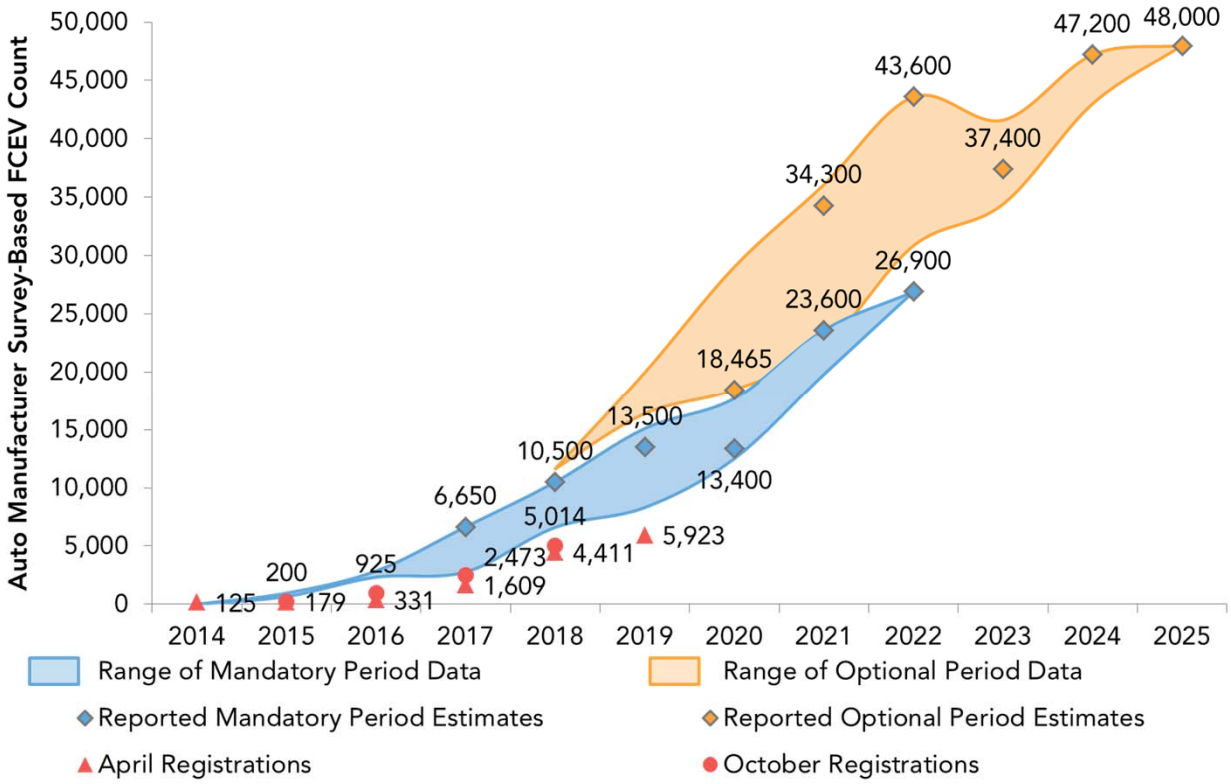



- Based on direct communication between public agencies and station developers
- Schedules and future plans are dynamic and sometimes in flux at time of report
- Recent information indicates fewer than 52 stations may be open in 2019
- 2020 total of 64 includes stations that may change plans for future

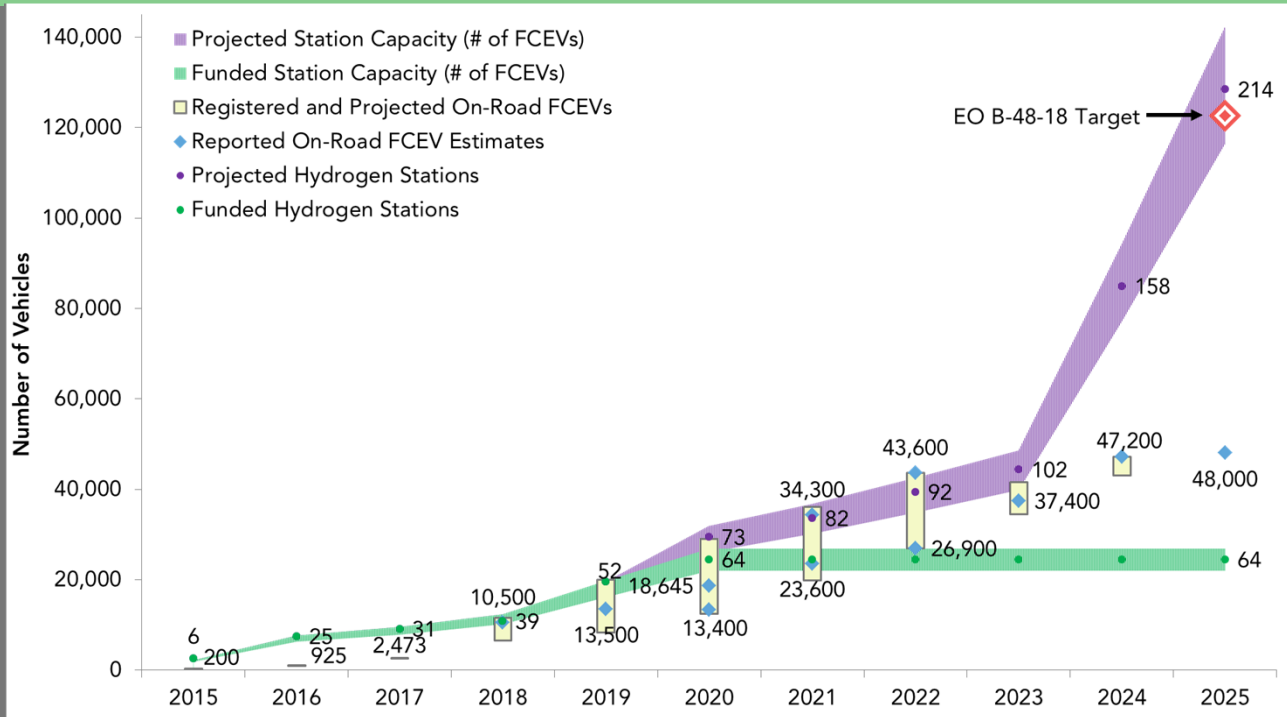
# Finding 3

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*



# Finding 4

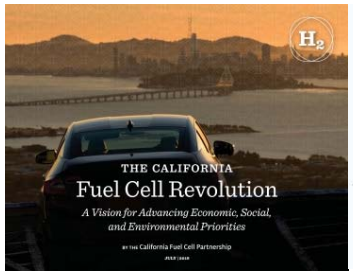
A station network of 200 stations per EO B-48-18 provides up to three times the fueling capacity of auto manufacturers' currently projected FCEV deployment plans for 2025

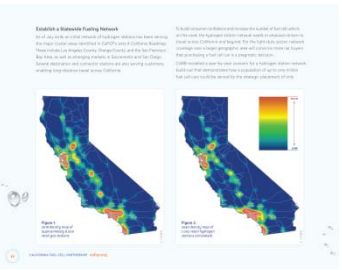


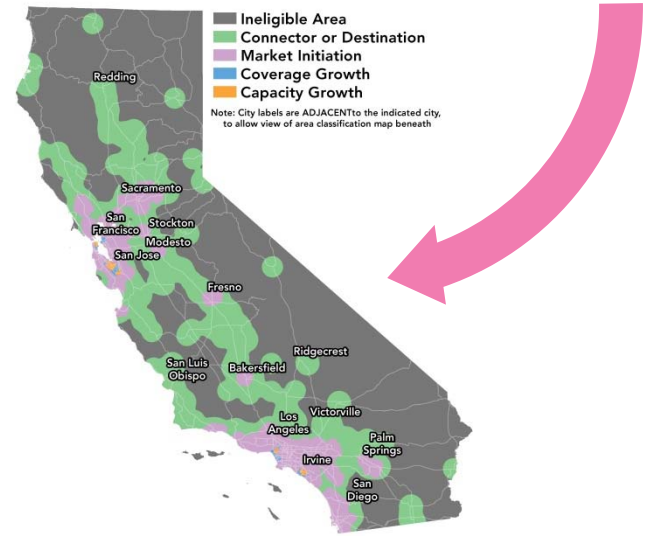

- Anticipates acceleration in station deployment and capacity growth before 2025, enabled by combination of AB 8 grants and LCFS HRI credits
- Exact match is not required, though similar growth expectation trends in supply and demand were not yet apparent in this year's data

# Finding 5

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






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

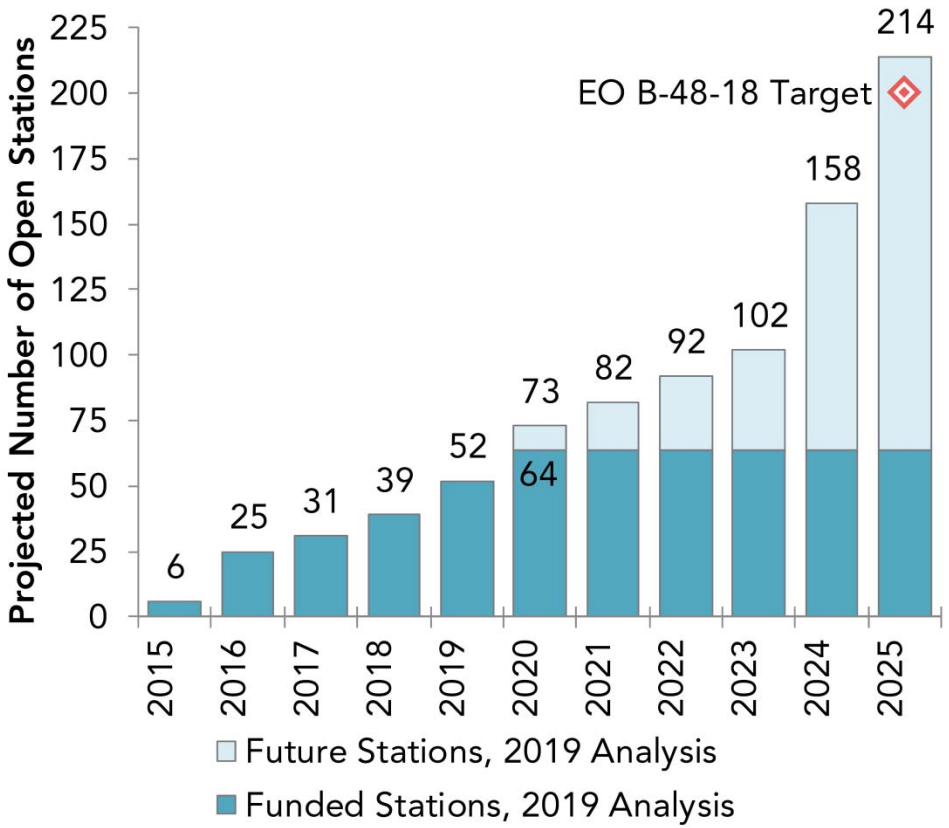
**Table 4: Recommended Station Design Capacity Requirements by Area Classification**

| Area Classification | Minimum Number of Fueling Positions | Minimum Capacity per Fueling Position (kg/day) | Minimum Station Capacity (kg/day) |
|---|---|---|---|
| Capacity Growth | 3 | 225 | 675 |
| Coverage Growth | 2 | | 450 |
| Market Initiation | 2 | | 450 |
| Connector or Destination | 1 | | 225 |

- 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

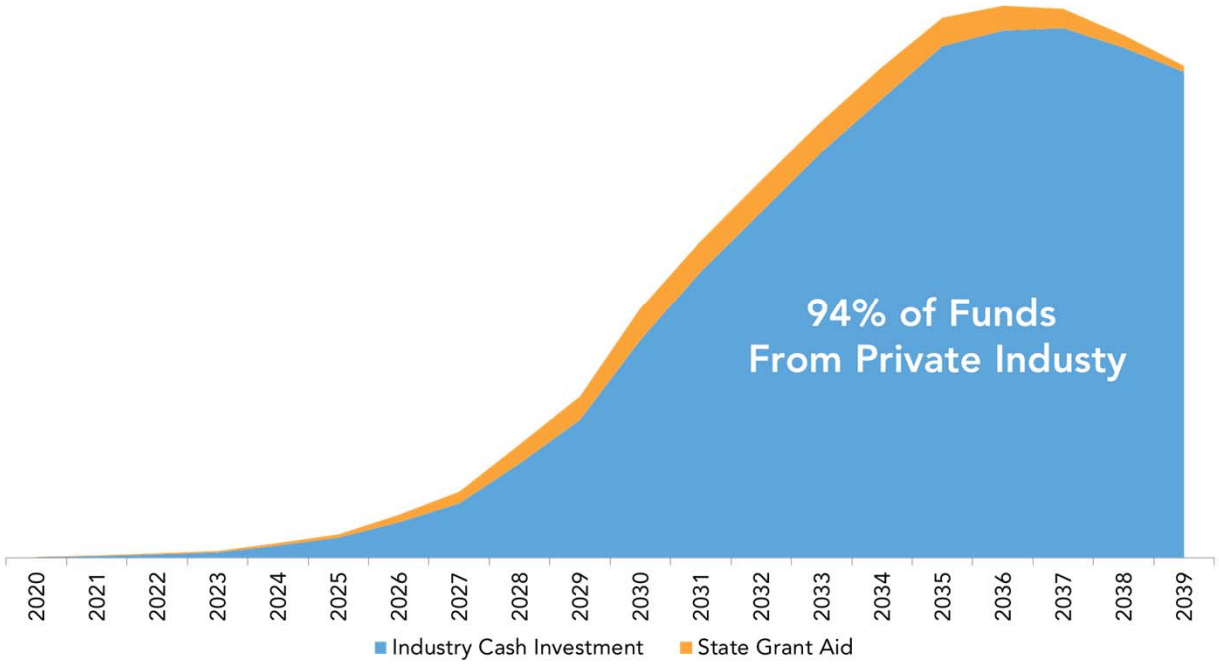
# Finding 6

Infrastructure and vehicle deployments need to continue and significantly accelerate in order to secure State ZEV implementation and emission reduction goals



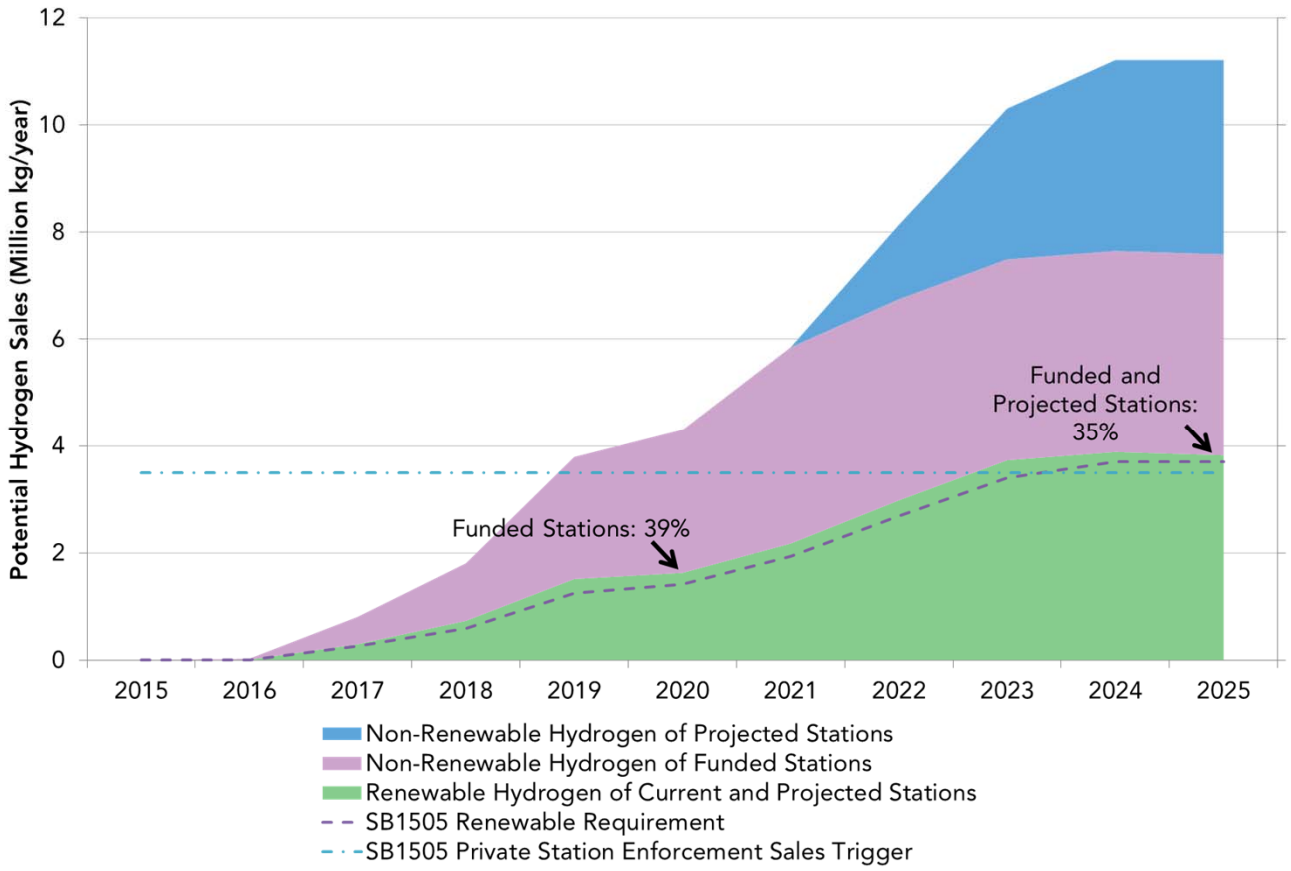
# Finding 7

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

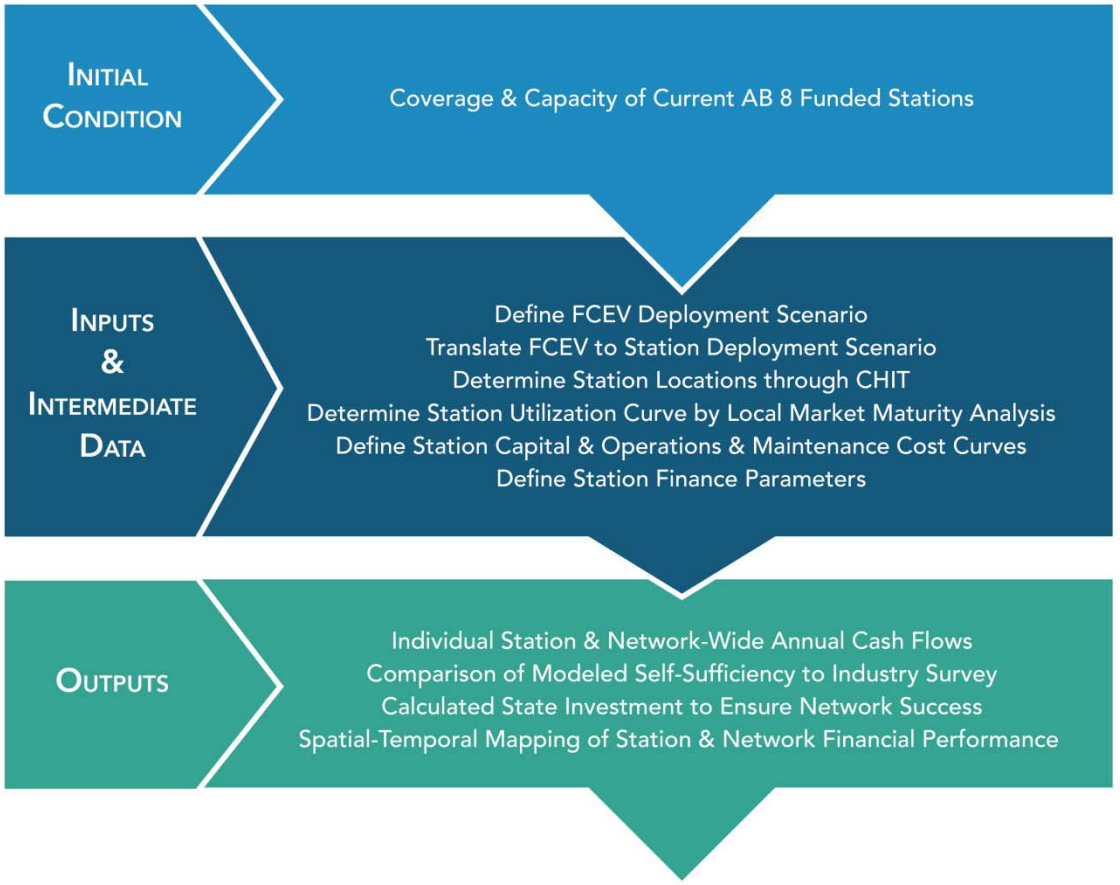


# SELF SUFFICIENCY ANALYSIS

*Image courtesy of CaFCP*

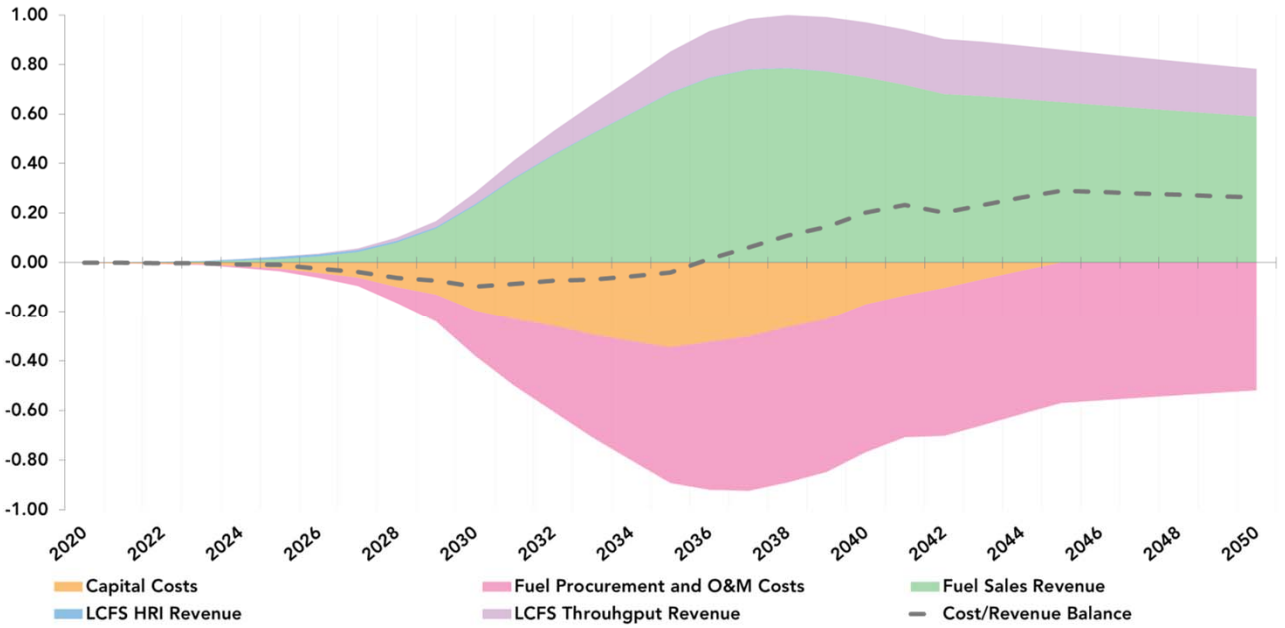
# Structure

## Scenario analysis framework



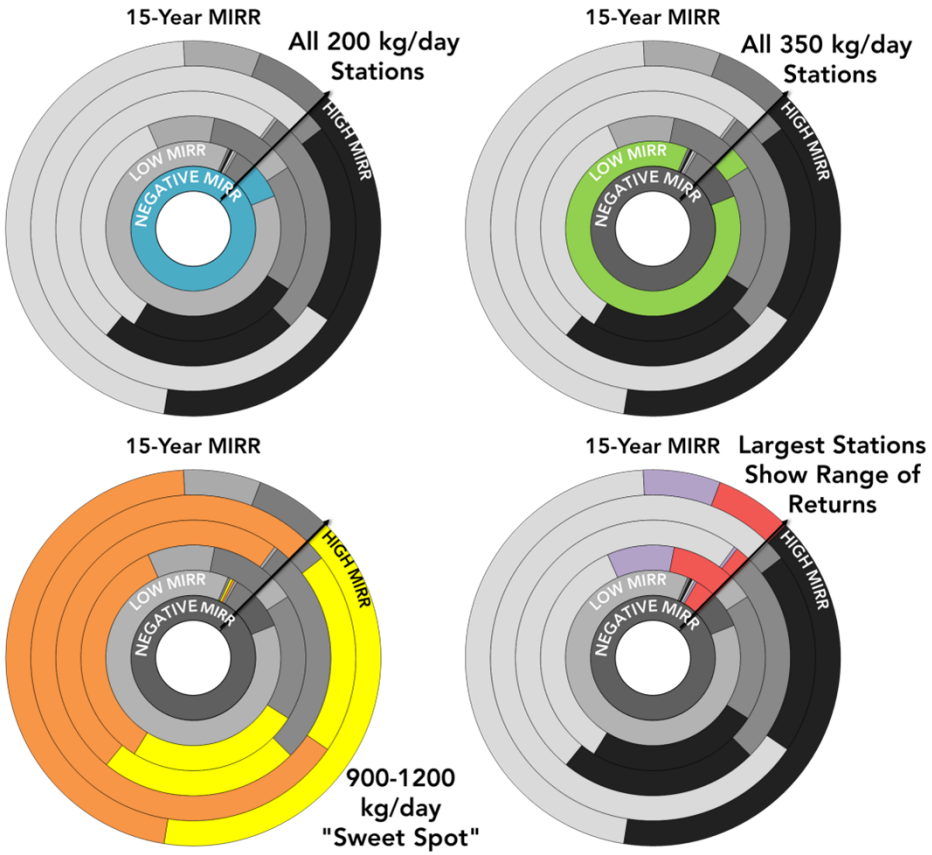
# Structure

## Station and network cash flows



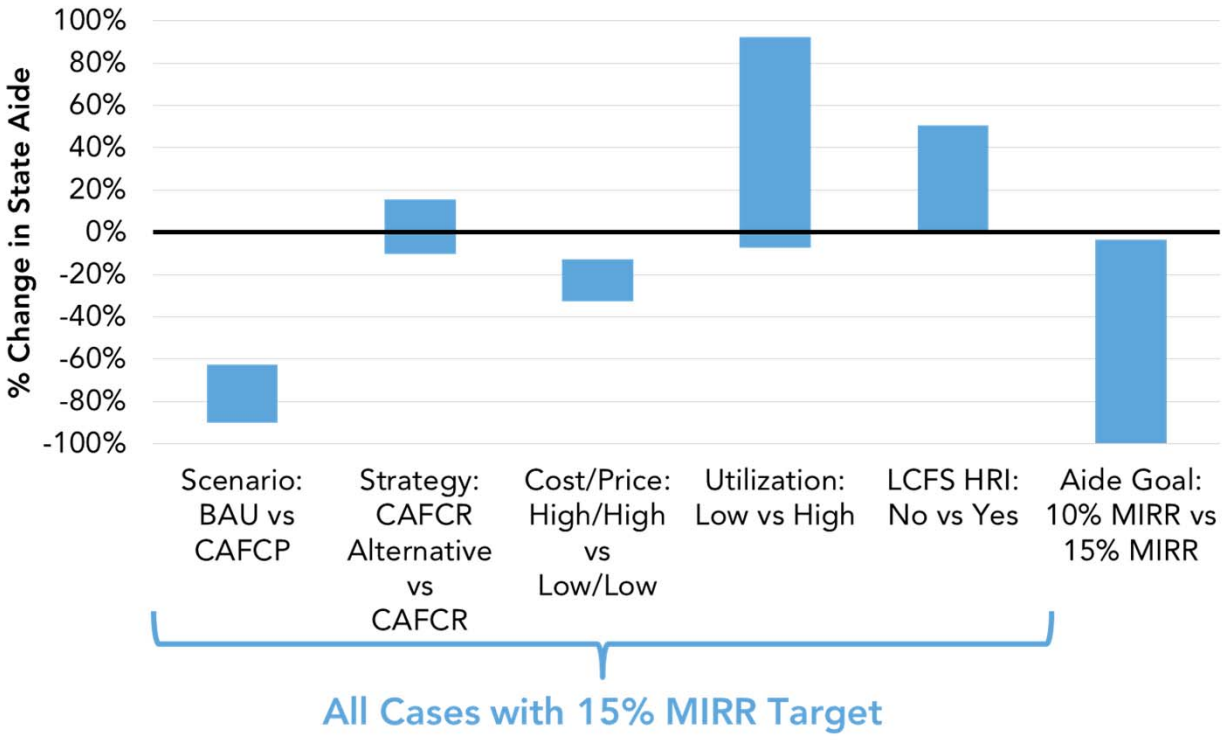
# Preliminary Insights

Confirm smaller stations (<400 kg/day) are financially challenged



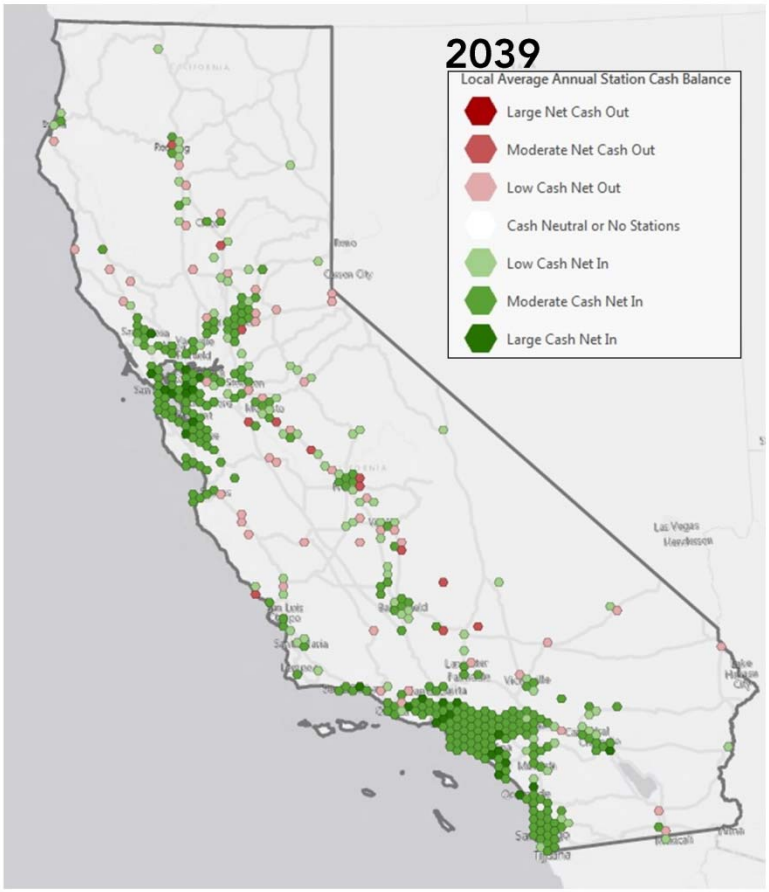
# Preliminary Insights

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

*Image courtesy of FirstElement*

# HRI Crediting Has Begun!

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

| Applicant Entity | Station Name | Station Address | City | Number of Dispensing Units | HRI Refueling Capacity (Kg/day) | Effective Date Range for HRI Crediting |
|---|---|---|---|---|---|---|
| First Element Inc. | Truckee | 12105 Donner Pass Road | Truckee | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Coalinga | 24505 W Dorris Avenue | Coalinga | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Santa Barbara | 150 South La Cumbre Road | Santa Barbara | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Thousand Oaks | 3102 E Thousand Oaks Boulevard | Thousand Oaks | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Mill Valley | 570 Redwood Highway | Mill Valley | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Playa Del Rey | 8126 Lincoln Boulevard | Los Angeles | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Hollywood | 5700 Hollywood Boulevard | Los Angeles | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Del Mar | 3060 Carmel Valley Road | San Diego | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Fremont (Grimmer) | 41700 Grimmer Boulevard | Fremont | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Hayward | 391 W A Street | Hayward | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | South San Francisco (Airport) | 248 S Airport Boulevard | South San Francisco | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | South Pasadena | 1200 Fair Oaks Avenue | South Pasadena | 1 | 206 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Campbell (Winchester) | 2855 Winchester Boulevard | Campbell | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | La Canada Flintridge | 550 Foothill Boulevard | La Cañada Flintridge | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Lake Forest | 20731 Lake Forest Drive | Lake Forest | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Costa Mesa | 2050 Harbor Boulevard | Costa Mesa | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Long Beach | 3401 Long Beach Boulevard | Long Beach | 1 | 266 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Saratoga | 12600 Saratoga Avenue | Saratoga | 1 | 198 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | San Jose | 2101 N 1st Street | San Jose | 1 | 266 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | 3rd Street | 551 3rd Street | San Francisco | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | Bernal Road | 101 Bernal Road | San Jose | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | Citrus Heights | 6141 Greenback Lane | Citrus Heights | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | Fair Oaks | 3510 Fair Oaks Boulevard | Sacramento | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | Harrison | 1201 Harrison Street | San Francisco | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | Mission Street | 3550 Mission Street | San Francisco | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Shell Inc. | University Berkeley | 1250 University Avenue | Berkeley | 2 | 513 | 04/01/2019 - 03/31/2034 |
| Air Liquide Hydrogen Energy US LLC | LAX | 10400 Aviation Boulevard | Los Angeles | 1 | 200 | 04/01/2019 - 03/31/2034 |
| First Element Inc. | Sherman Oaks | 14478 Ventura Boulevard | Sherman Oaks | 2 | 808 | 07/01/2019 - 06/30/2034 |
| First Element Inc. | Oakland | 350 Grand Avenue | Oakland | 2 | 808 | 07/01/2019 - 06/30/2034 |
| First Element Inc. | Studio City | 3780 Cahuenga Boulevard | Studio City | 2 | 808 | 07/01/2019 - 06/30/2034 |
| Air Liquide Hydrogen Energy US LLC | Palo Alto | 3601 Camino De Real Street | Palo Alto | 1 | 136 | 07/01/2019 - 06/30/2034 |
| **Total** | | | | **41** | **11,277** | |

**Most recent update**

38 stations participating
60 total fueling positions
18,752 kg/day capacity approved

# QUESTIONS

*Image courtesy of CaFCP*