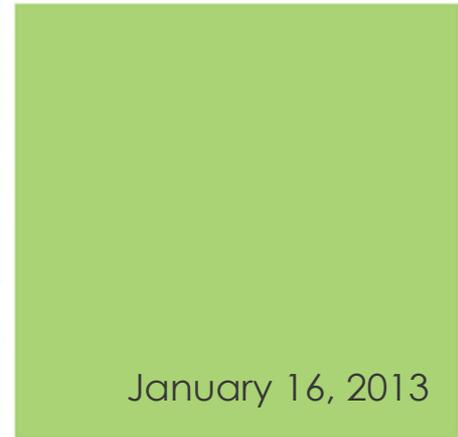
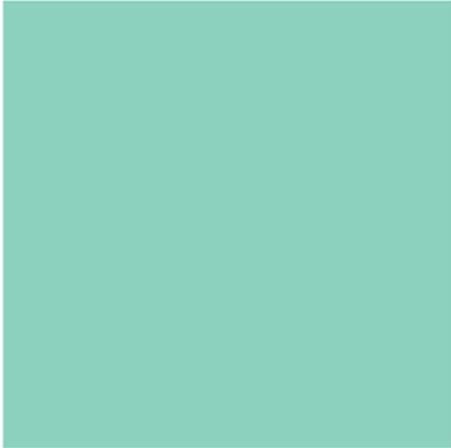


A California Roadmap: Lessons learned and the path to commercialization

Bill Elrick
California Fuel Cell Partnership



January 16, 2013

Progress to date

California

- ▶ >230 FCEVs & FCEBs today
- ▶ Over 5 million road miles
- ▶ 8 public H₂ stations
- ▶ 12 new/upgraded stations in development
- ▶ On track to have 20 public H₂ stations by end of 2013



Public H₂ stations in California

Open today:

- ▶ Emeryville
- ▶ Irvine
- ▶ West LA
- ▶ Torrance
- ▶ Fountain Valley
- ▶ Newport Beach
- ▶ Thousand Palms
- ▶ Burbank



In development:

- ▶ Beverly Hills
- ▶ Diamond Bar*
- ▶ Harbor City
- ▶ Hawthorne
- ▶ Hermosa Beach
- ▶ Irvine*
- ▶ Irvine North
- ▶ Laguna Niguel
- ▶ Los Angeles
- ▶ Santa Monica
- ▶ W. Sacramento
- ▶ Westwood

We've learned

- ▶ Stations must come before vehicles
- ▶ People want fuel near home, work and in weekend destinations
- ▶ Stations must be customer friendly
- ▶ Six minutes is the target maximum travel time
 - For early market clusters



A California Road Map

- ▶ Develop 68 station network by 2016
 - 45 stations in cluster communities
 - 23 connector and destinations that seed new clusters
 - Supports 20,000 FCEVs
- ▶ Promote hydrogen readiness
 - Communities, businesses, consumers
- ▶ Accelerate station implementation
 - Timeliness, performance, path to profitability

www.cafcp.org/roadmap

A CALIFORNIA ROAD MAP
Bringing Hydrogen Fuel Cell Electric Vehicles to the Golden State

COMMERCIAL LAUNCH OF FCEVS
EXPECTED AROUND 2015

Zero-emissions → 250-400 mile range
Minutes to refuel
Domestically produced hydrogen

THE NETWORK:
CLUSTERS
CONNECTORS
DESTINATIONS

"Consumers need CONFIDENCE in a hydrogen fueling network"
Initial station deployments will focus on geographic clusters in key markets with additional stations connecting these clusters into a regional network.

68 STATIONS
NEEDED TO LAUNCH THE EARLY FCEV MARKET

\$65 MILLION
IN ADDITIONAL FUNDING NEEDED!

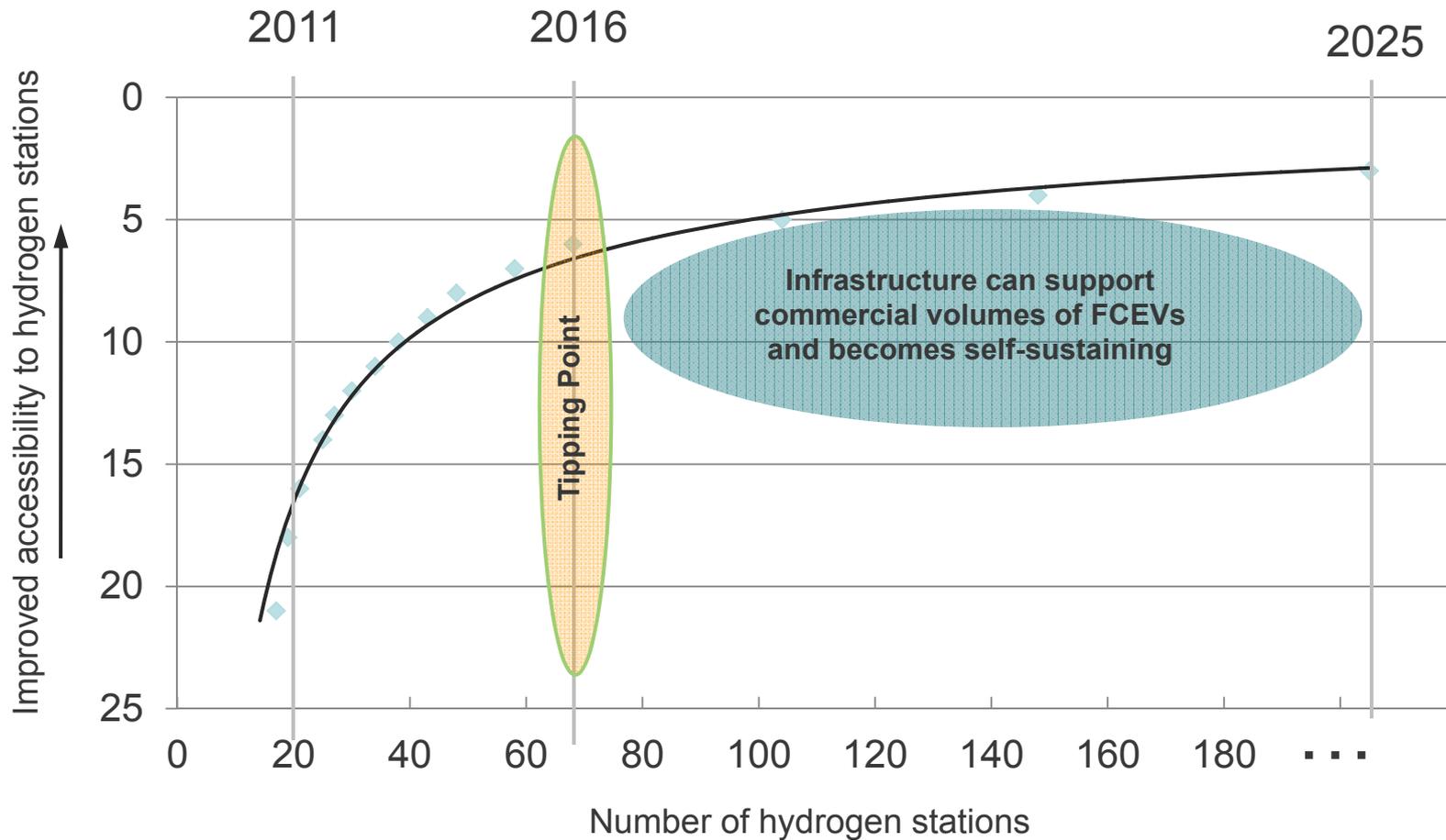
Download A California Road Map at www.cafcp.org/roadmap

The California Fuel Cell Partnership is a collaboration of organizations that work together to promote the commercialization of hydrogen fuel cell electric vehicles.

By working together, we help ensure that vehicles, stations, regulations and people are in step with each other as the technology comes to market.

www.cafcp.org

Access to stations



Source: National Fuel Cell Research Center at UC Irvine

Locations based on



- ▶ Demographic information
- ▶ Individual OEM market assessments
- ▶ California Energy Commission/ Air Resources Board Vehicle Survey
- ▶ Hybrid and alt fuel vehicles registrations
- ▶ Geographic distribution of Clean Vehicle Rebate Program

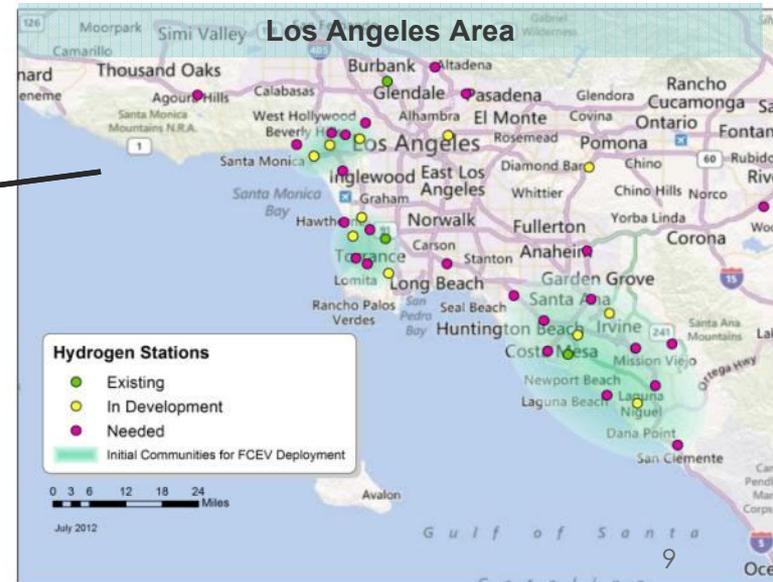
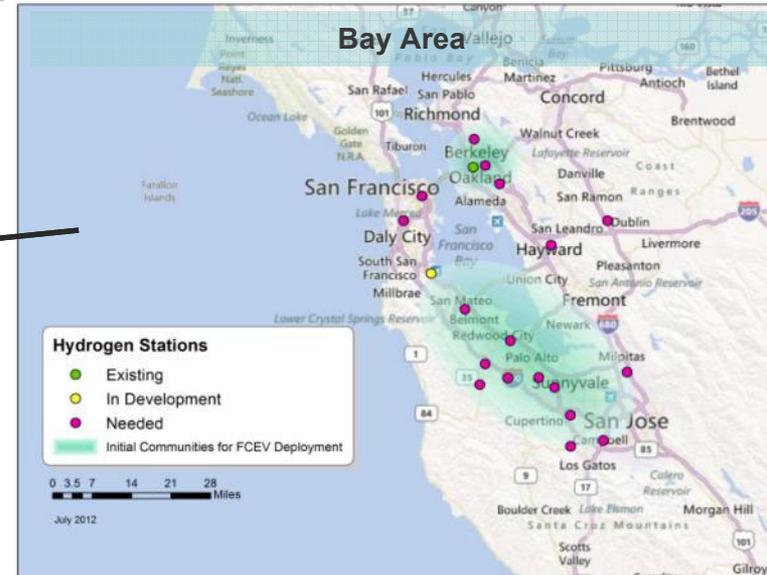
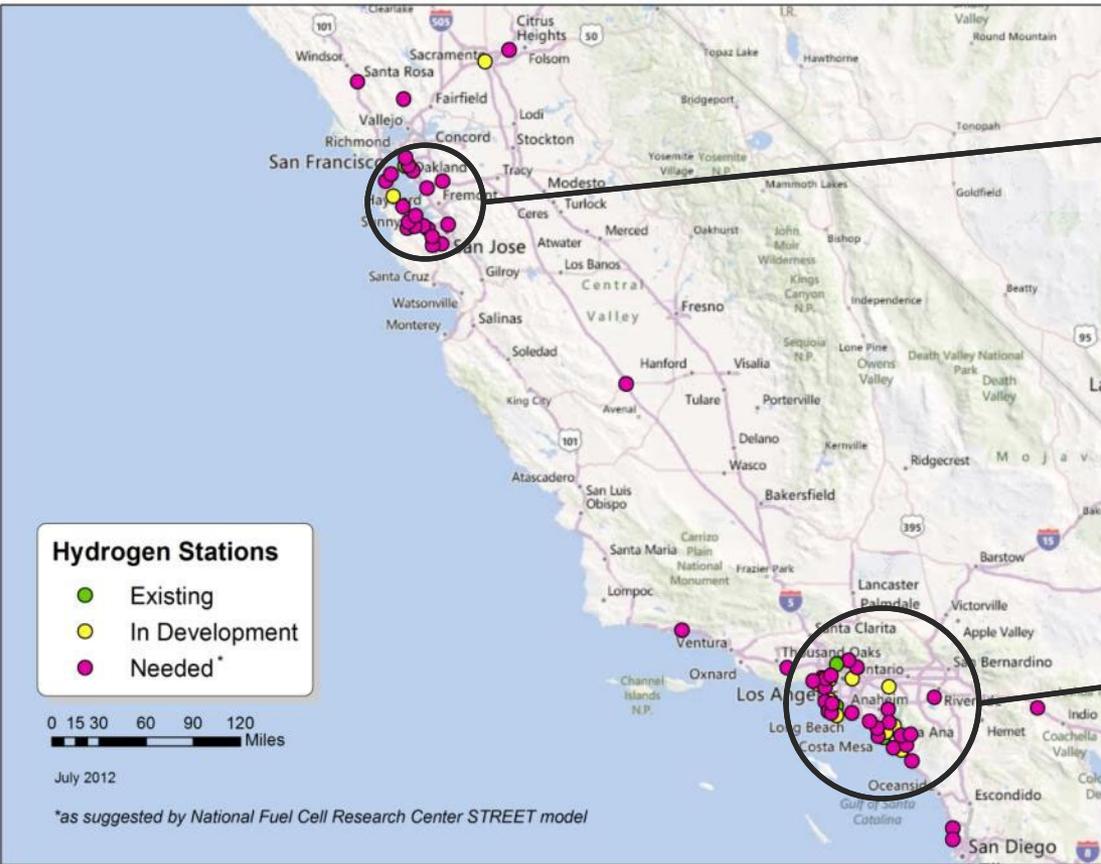
Five clusters to launch market

- ▶ Santa Monica and West Los Angeles
- ▶ Torrance and nearby coastal cities
- ▶ Southern coastal area of Orange County
- ▶ South San Francisco Bay area (Silicon Valley)
- ▶ Berkeley



Building a statewide network

Map of 68 Hydrogen Fueling Stations: Existing, In Development and Needed



Projected deployment



Year	Start of Year (Station Total)	Added Stations	Number of FCEVs in CA	Expected Station Design Capacity [kg/day]
2012	4	9	312	Up to 100
2013	13	7	430	100
2014	20	17	1389	100-500
2015	37	31	<i>5,000-15,000</i>	100-500
2016	68	<i>Market Needs</i>	<i>10,000-30,000</i>	500
2017	>84	<i>Market Needs</i>	53,000	500
2018	>100	<i>Market Needs</i>	>53,000	>500

Note: The OEM Survey only requested years 2015-2017 as a single entry. While the numbers of FCEVs in 2015 and 2016 are not generated in the survey, an estimate value has been used based on a likely roll-out scenario. Based on questions during the CEC Workshop, this table has been adjusted to illustrate an estimated range.

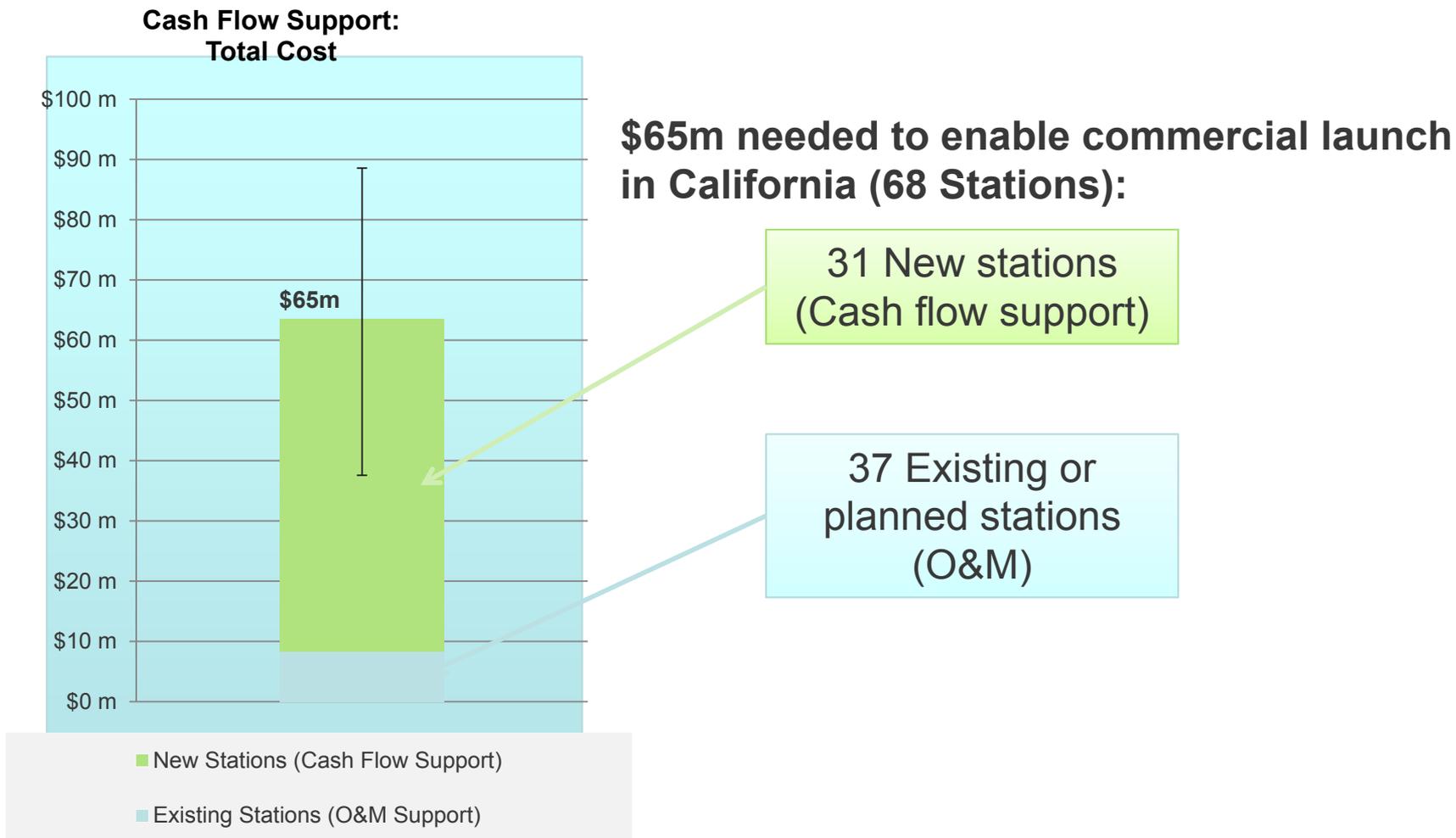
Funding goals

- ▶ Ensure we can build out the 68 station network
 - 37 stations already in process or expected to be funded
 - 31 more stations needed by January 2016
- ▶ Keep stations operating as vehicle volume grows
- ▶ EIN analysis shows additional \$65M funding need



How much does it cost?

Incentives cover negative cash flow as market grows



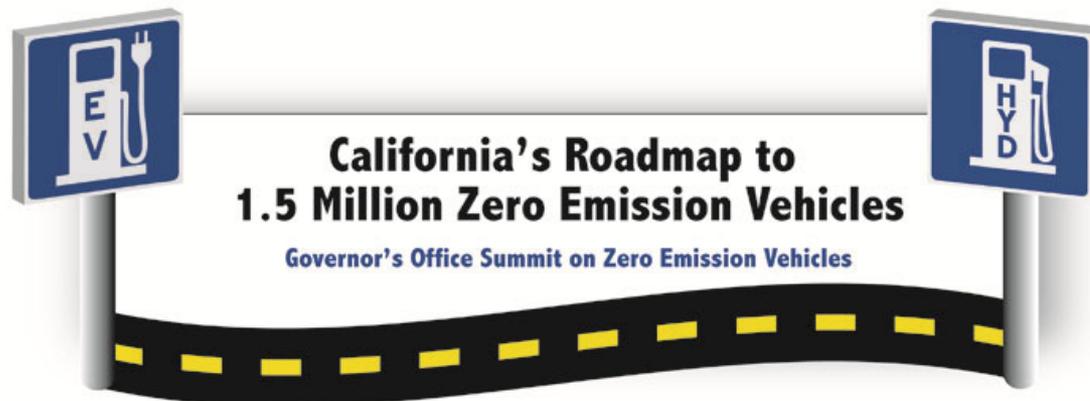
Update on H2 station funding



- ▶ California legislators introduced SB11 and AB8
 - Extends funding for air quality and alternative fuel programs
 - Guarantees \$20M annually for hydrogen for three years (\$60M total)
 - Additional funding may be allocated to match market demand for H2 stations until California has 100 stations
 - Removes Clean Fuels Outlet regulation
- ▶ Diverse stakeholder groups are in support

California ZEV Action Plan

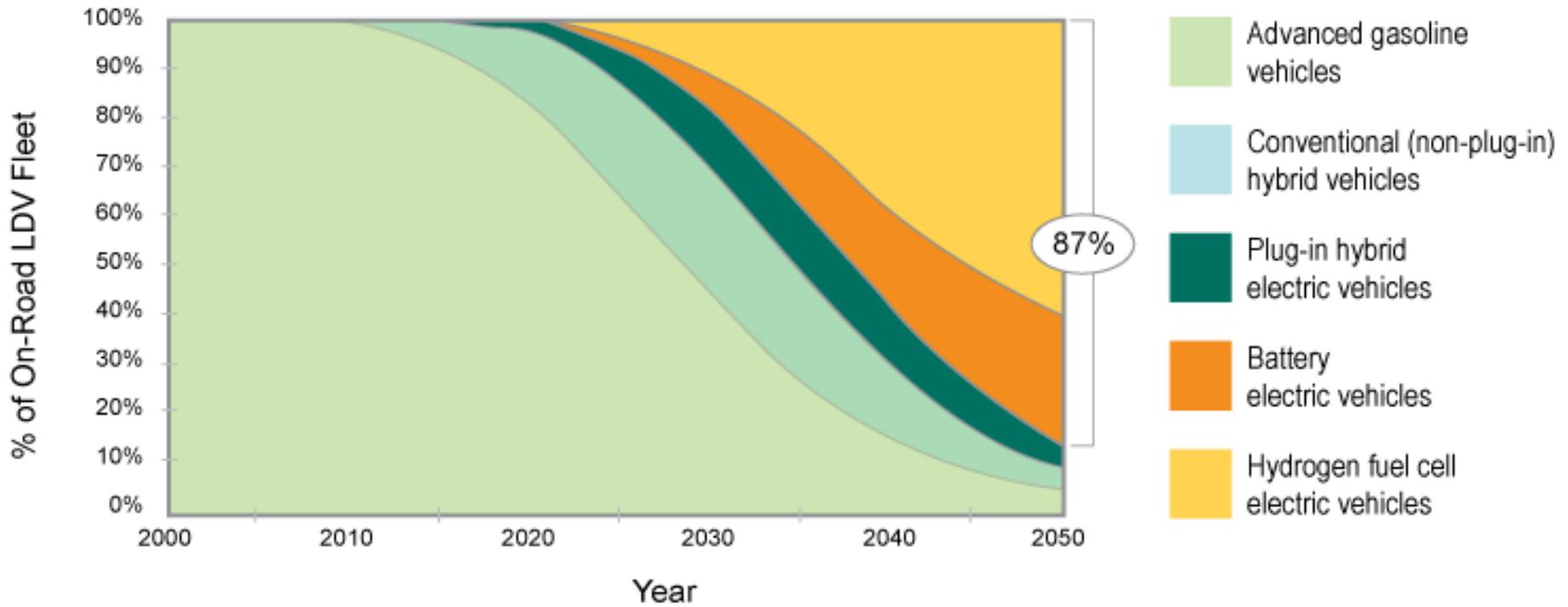
- ▶ By 2015: California major metropolitan areas “ZEV-ready” with infrastructure and streamlined permitting
- ▶ By 2020: California ZEV infrastructure can support up to 1 million vehicles
- ▶ By 2025: Over 1.5 million ZEVs in California



California's electric drive future



On Road Light-duty Vehicle Scenario to Reach 2050 Goal



Source: CA Air Resources Board

Working with station owners



“Am I going to make a million-dollar mistake by offering—or not offering—a new fuel?”

“How is this different from the way I operate now?”

“What’s the ROI for hydrogen?”

“How can it exist without subsidies? Can it stand on it’s own?”

Market opportunity

- ▶ Hydrogen can be a fast growing market, with high margins

	Projected FCEVs ¹	Market Value (@\$10/kg)	Retail Profit Margins (\$2-\$4/kg)
2017	52,000	\$114m	\$23m - \$46m
2025	130,200 - 306,000	\$285m – \$670m	\$57m - \$268m

¹ 2017 figure from CaFCP survey, 2025 figure from ARB CFO regulation, lower and upper bounds

- ▶ Market leadership/first-mover opportunities
 - Currently no dominant company in U.S.
 - Statewide and national growth beyond this
- ▶ High profile brand & customer opportunities
- ▶ Current discussions focus on incentive package to reward first movers, with financial support and other strategic incentives

Source: Ken Gunn, Caliber Consulting and 

68 stations in Roadmap provide...

▶ Coverage

- Fueling opportunities

▶ Confidence

- Automakers build volume
- Customers purchase FCEVs

▶ Commercial

- To launch market and build capacity



... to enable FCEV market launch

FCEBs in CA Strategy



- ▶ Meet or exceed DOE/DOT FCEB targets
 - Industry can go from TRL 7 to 8 (new NREL FCEB rating)
- ▶ Two “Centers of Excellence”
 - H35, 1200 kg/day/location, \$4-8/kg
 - Start in 2014-15
 - 12-year program
- ▶ Feb/Mar release

Table 1. Performance, cost, and durability targets for fuel cell transit buses.

	Units	2012 Status	2016 Target	Ultimate Target
Bus Lifetime	years/miles	5/100,000 ¹	12/500,000	12/500,000
Power Plant Lifetime ^{2,3}	hours	12,000	18,000	25,000
Bus Availability	%	60	85	90
Fuel Fills ⁴	per day	1	1 (< 10 min)	1 (< 10 min)
Bus Cost ⁵	\$	2,000,000	1,000,000	600,000
Power Plant Cost ^{2,5}	\$	700,000	450,000	200,000
Hydrogen Storage Cost	\$	100,000	75,000	50,000
Road Call Frequency (Bus/Fuel Cell System)	miles between road calls	2,500/10,000	3,500/15,000	4,000/20,000
Operation Time	hours per day/days per week	19/7	20/7	20/7
Scheduled and Unscheduled Maintenance Cost ⁶	\$/mile	1.20	0.75	0.40
Range	miles	270	300	300
Fuel Economy	miles per gallon diesel equivalent	7	8	8

Lessons learned, what's next

▶ Enhance collaboration between H₂ centers

- Link regional programs (CA, CT, HI, OH, SC, etc)
- Enable and encourage individualism and focus
- Harmonize materials & approach through regular interaction

▶ Data collection and sharing

▶ Funding is not enough

- Strong project management by funders
- Demonstrate commitment over time
- Champions needed to drive stakeholders forward

▶ More research needed

- Driver habits & vehicle use
- Co-location and applications
- Policy options and implications
- Emission reductions
- Infrastructure development
- ... *using TRB's strength*

Questions or Comments?

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