

HYDROGEN FUEL CELL



PARTNERSHIP

2/8/2024

Laying the Foundation for Fuel Cell Electric Vehicles

NASEO Transportation Committee

David Park, Industry Affairs, H2FCP

NASEO 2024 Energy Policy Outlook Conference

Uses of Hydrogen

Power generation and grid balancing

Centralized power (including storage) and distributed power (off-grid, backup power)

Hydrogen as an energy carrier and storage medium

Feedstock for industrial applications (ammonia, methanol, refineries, steel) and long-distance transport (aviation, marine)



Transportation fuel (including material handlings, light- and heavy- duty vehicles, captive fleets, rail)

Heating fuel for **residential and commercial buildings** (including blending hydrogen into the gas grid)

Did you know...

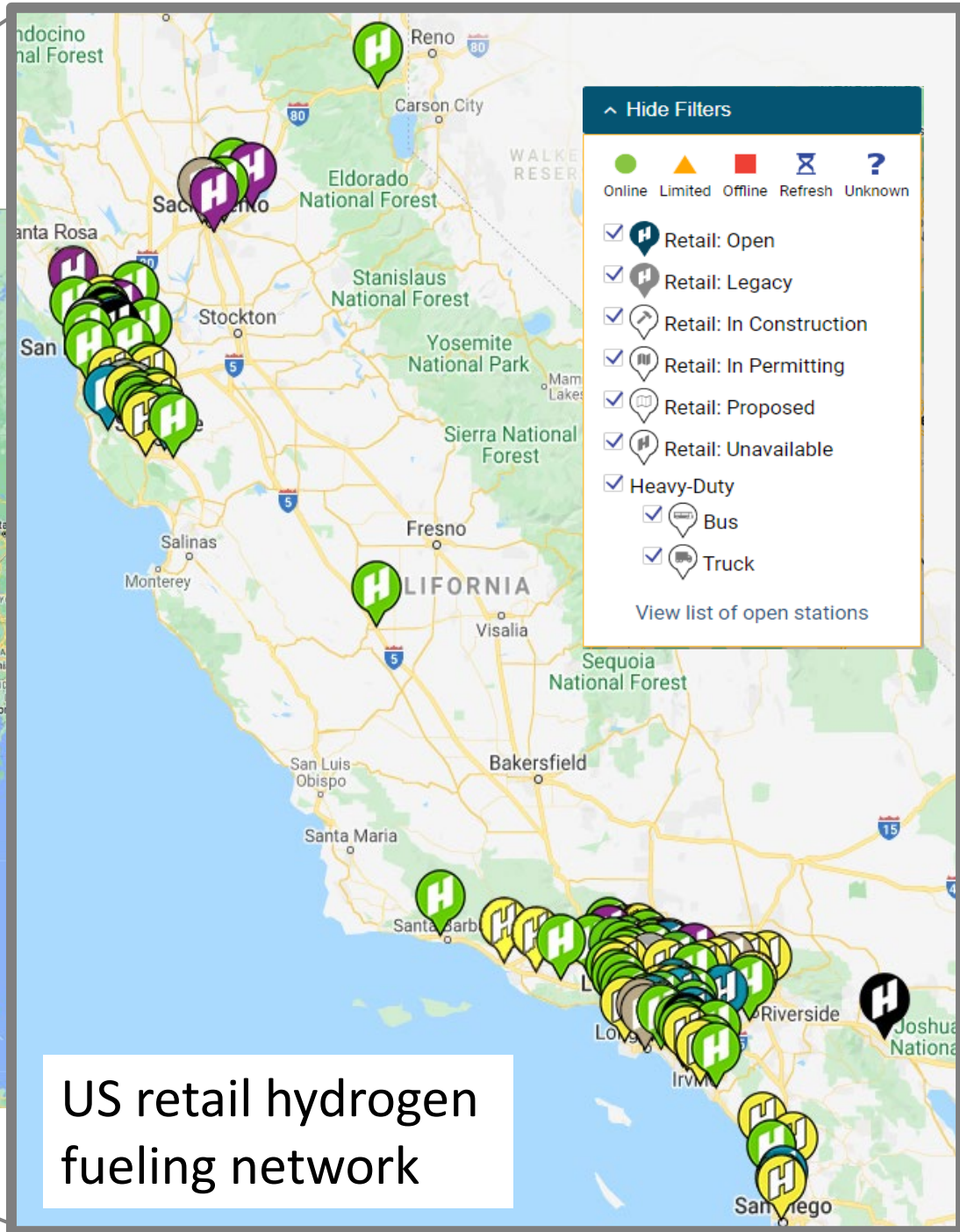
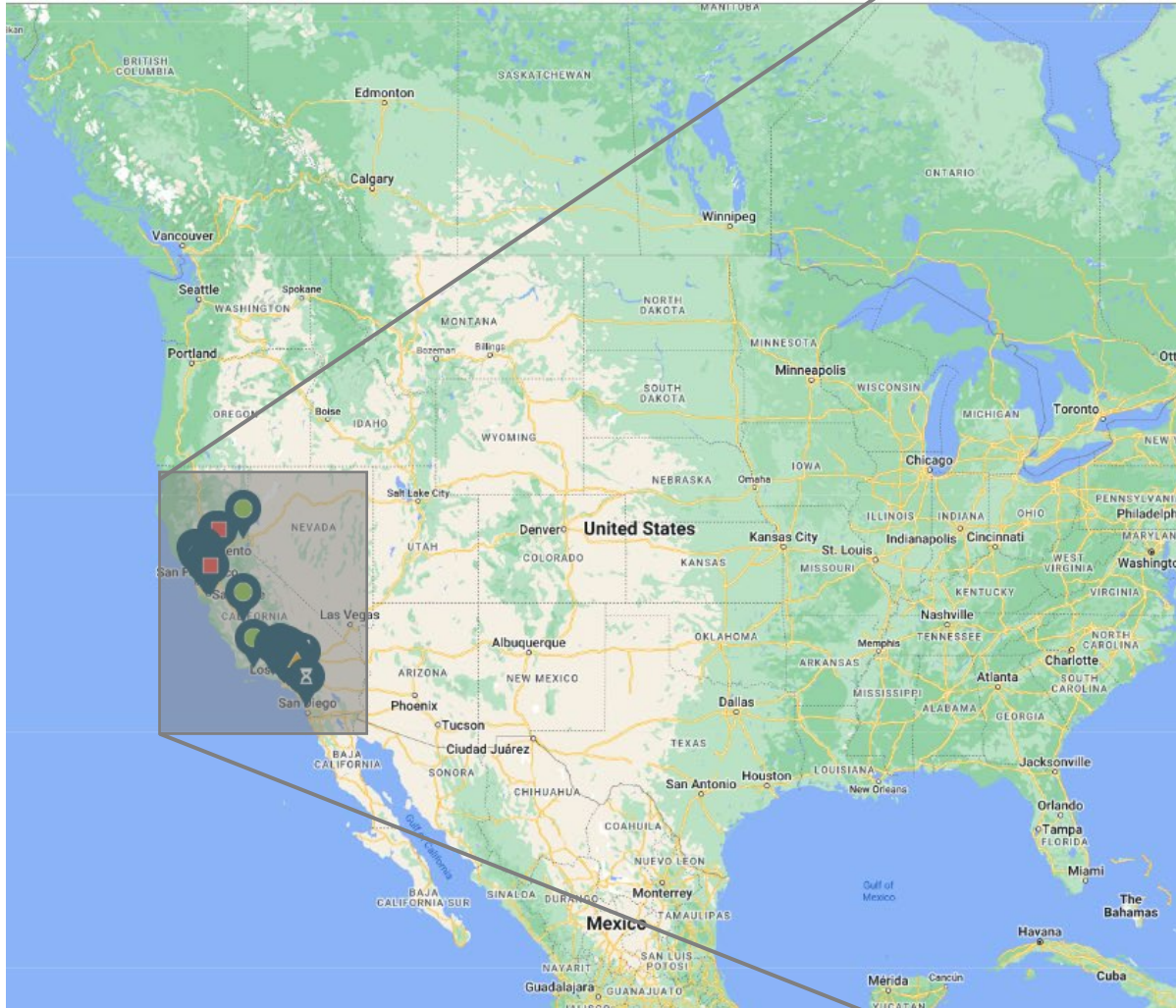


...that in California, you can walk into a dealership and purchase a hydrogen fuel cell electric car?



...and you can drive that car to a fueling station to fill with hydrogen?

It is true.



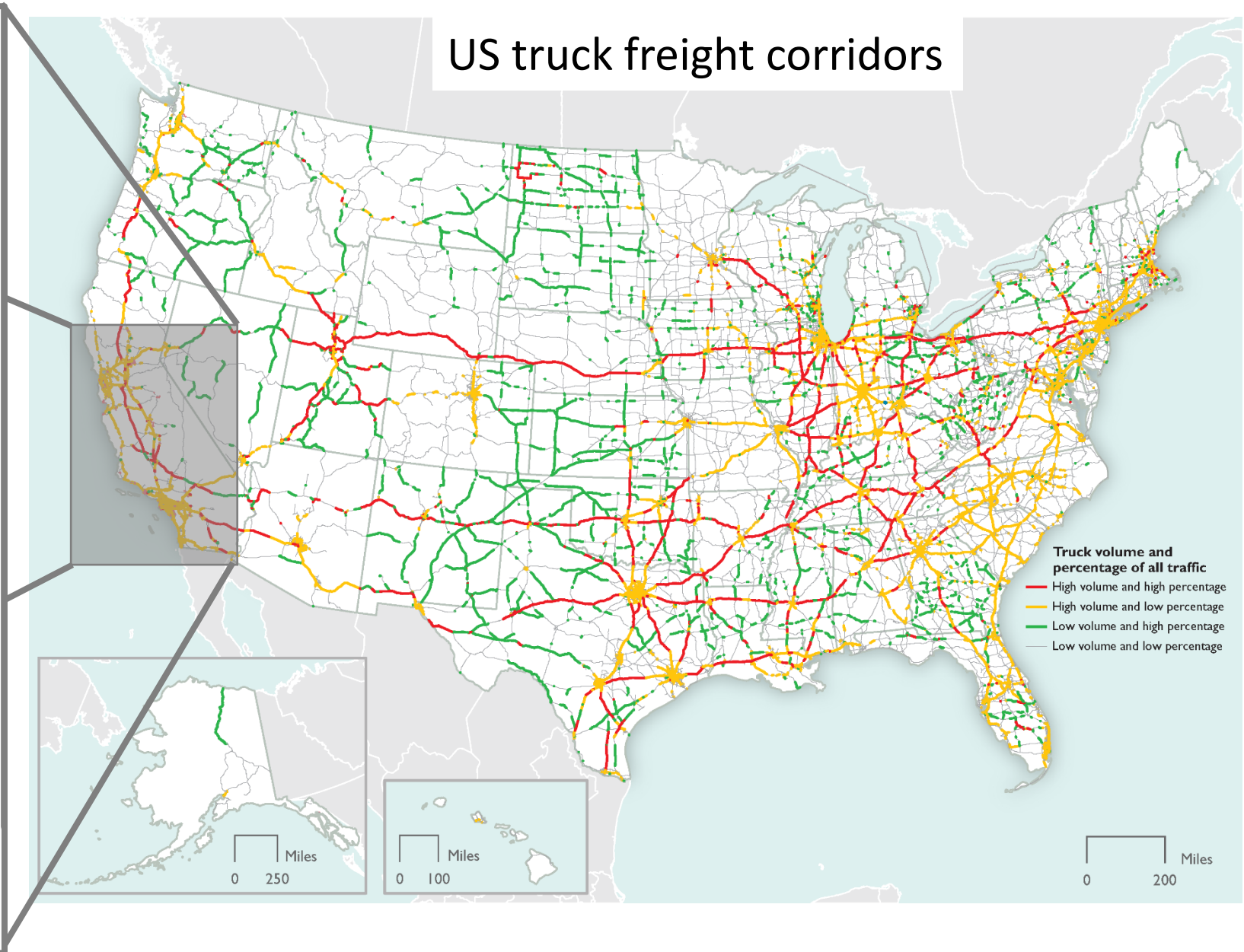
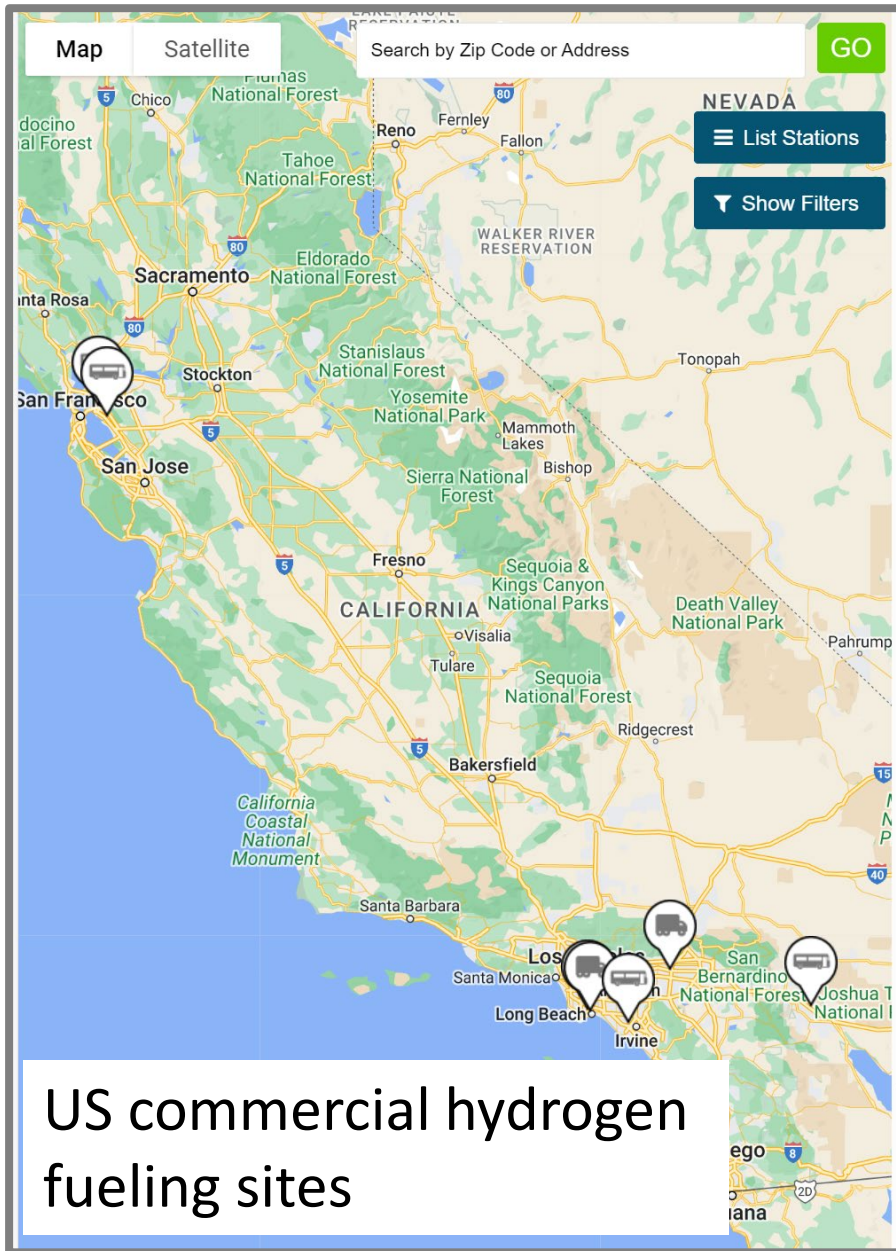
US retail hydrogen fueling network

Did you also know...



...that California has a nascent and growing fuel cell truck and bus market?

This is also true.



...so, what do you think are the keys to ZEV success?

Vision

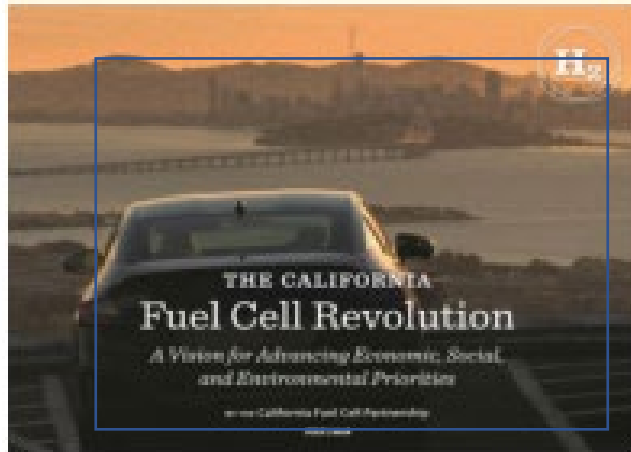
Leadership- Political Will

\$- Investment

Customers- Market Certainty

Partnership and Trust

Common Visions & Strategies as a North Star



California Fuel Cell Revolution

Enable market conditions to support:

1,000 hydrogen stations
+ 1,000,000 vehicles =

693.5 million gallons per year of gasoline displaced
2.7 million metric tons per year GHG avoided
3,900 metric tons per year NOx avoided
97% of disadvantaged communities within the station network coverage



Fuel Cell Electric Truck Vision

Enable market conditions to support:

200 hydrogen stations
+ 70,000 trucks =

541.8 million gallons per year of diesel displaced
6.7 million metric tons per year GHG avoided
18,100 metric tons per year NOx avoided

Leadership



Climate	<ul style="list-style-type: none"> • 2045 – 100% zero carbon electricity (SB 100) • 2045 – Carbon neutral economy (EO B-55-18)
Air Quality	<ul style="list-style-type: none"> • 2031 – 80% reduction in smog-forming Nox
Zero Emission Vehicles (ZEVs)	<ul style="list-style-type: none"> • <i>ZEV regulation</i> – increasing ZEV sales requirement for LD automakers • <i>Innovative Clean Transit</i> – 100% ZEV purchases by 2029, 100% operations by 2040 • <i>Advanced Clean Trucks</i> – increasing sales requirement for MHD manufacturers starting 2024, and 100% ZEV sales by 2045 • 2030 – 5 million ZEVs (EO B-48-18) • 2035 – 100% in-state passenger vehicle sales are ZEV (EO-N-79-20) • 2045 – 100% in-state M-HD vehicle sales are ZEV (EO-N-79-20)
Vehicle Incentives	<ul style="list-style-type: none"> • Clean Vehicle Rebate Program (CVRP) - up to \$4,500 for FCEV, \$2,000 for BEV • Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP) - \$240,000 for a FC electric truck; \$120,000 for a battery-electric truck
ZEV infrastructure and fuels	<ul style="list-style-type: none"> • 2025 – 200 hydrogen stations and 250,000 chargers (EO B-48-18)

Investment & Incentives

Low Carbon Fuel Standard



Vehicle Incentives

- Clean Vehicle Rebate Program (CVRP) - up to \$4,500 for FCEV, \$2,000 for BEV
- Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP) - \$240,000 for a FC electric truck; \$120,000 for a battery-electric truck

Infrastructure Market Mechanisms

- Low Carbon Fuel Standard Hydrogen Refueling Infrastructure Credit- sets carbon intensity standard for fuels, with fuel producers producing and selling credits around the standards

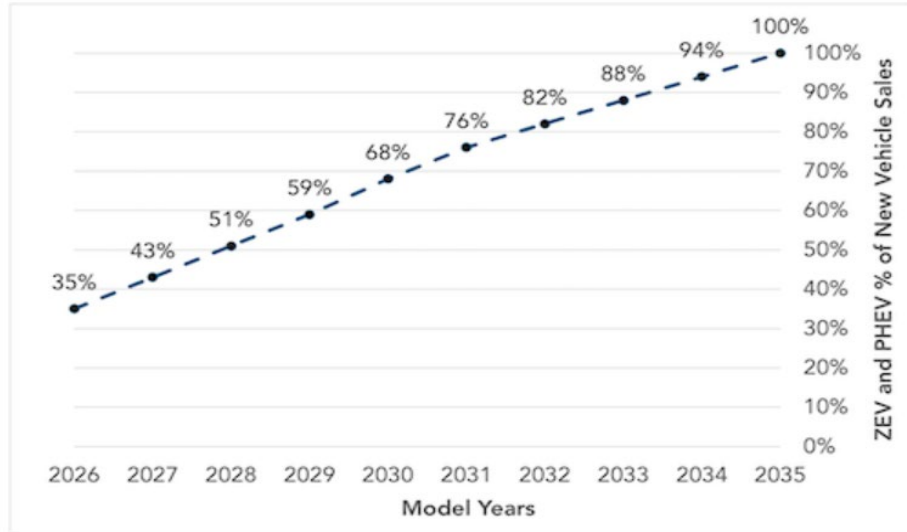
ZEV Infrastructure Investment

CEC Solicitation/ Contract	Year	Funding Amount	Grant Capital Share
GFO 19-602	2020	\$115.7MM	50%
GFO 15-605	2015	\$33MM	70% - 85%
PON 13-607	2014	\$46.6MM	70% - 85%
PON 12-606	2013	\$28.6MM	65%
PON 9-608	2010	\$19MM	40% - 70%

Zero Emission Vehicles – Regulatory Trends

Current ZEV Regulations (California is Driving the Market)

Light Duty Advanced Clean Cars II ZEV Sales Requirements



Transit Innovative Clean Fleet ZEV Purchase Requirements

Year	Large Transit	Small Transit
2023	25%	-
2024	25%	-
2025	25%	-
2026	50%	25%
2027	50%	25%
2028	50%	25%
2029	100%	100%

Heavy Duty Advanced Clean Fleets ZEV Purchase Requirements

Percentage of vehicles that must be zero-emission	10%	25%	50%	75%	100%
Milestone Group 1: Box trucks, vans, buses with two axles, yard tractors, light-duty package delivery vehicles	2025	2028	2031	2033	2035 and beyond
Milestone Group 2: Work trucks, day cab tractors, buses with three axles	2027	2030	2033	2036	2039 and beyond
Milestone Group 3: Sleeper cab tractors and specialty vehicles	2030	2033	2036	2039	2042 and beyond

TNC Clean Miles Standards eVMT Requirements

Calendar Year	Percent eVMT Target	GHG (g CO ₂ /PMT) Target
2023	2%	252
2024	4%	237
2025	13%	207
2026	30%	161
2027	50%	110
2028	65%	69
2029	80%	30
2030+	90%	0

First step: roadmap

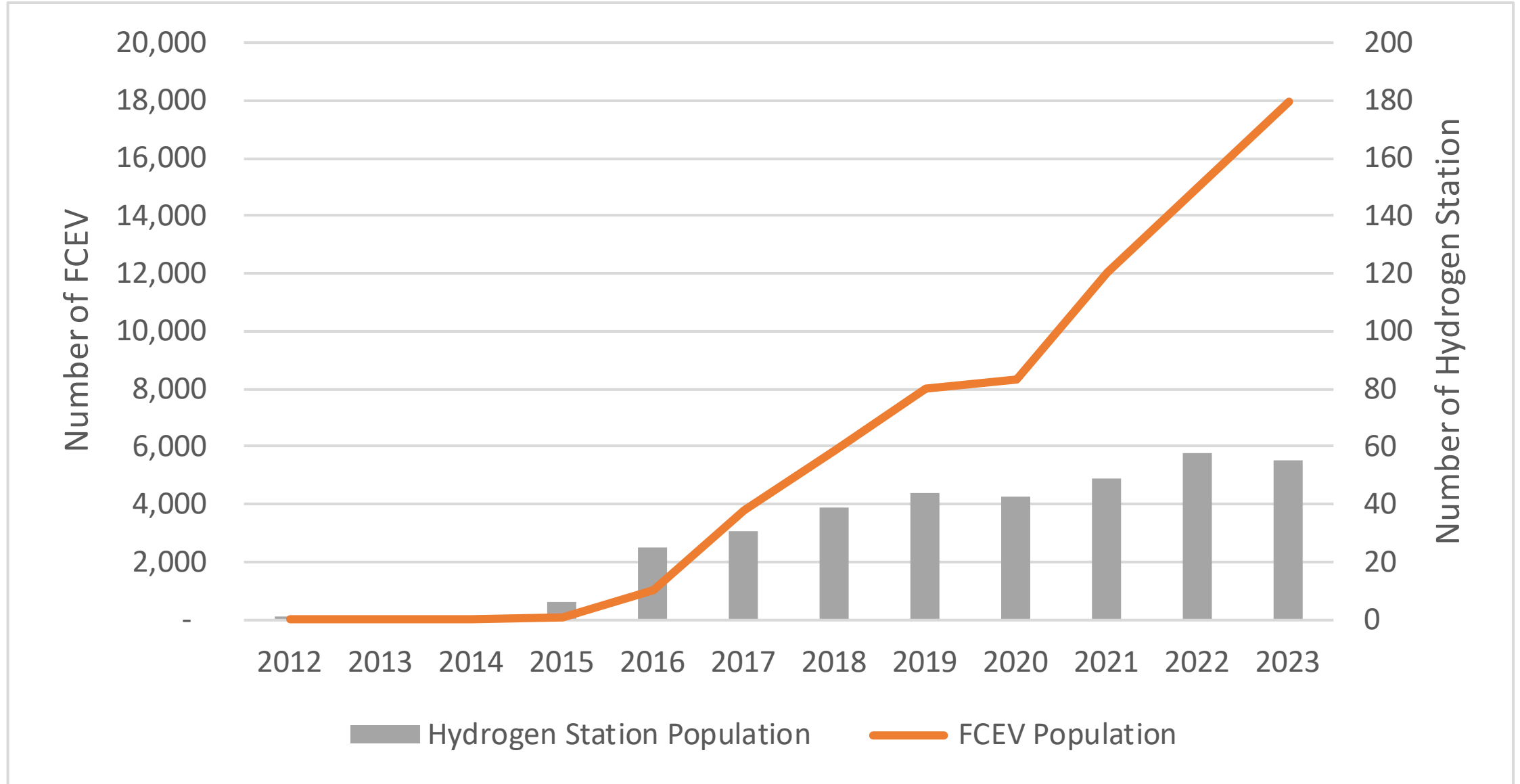
But unlikely linear path!



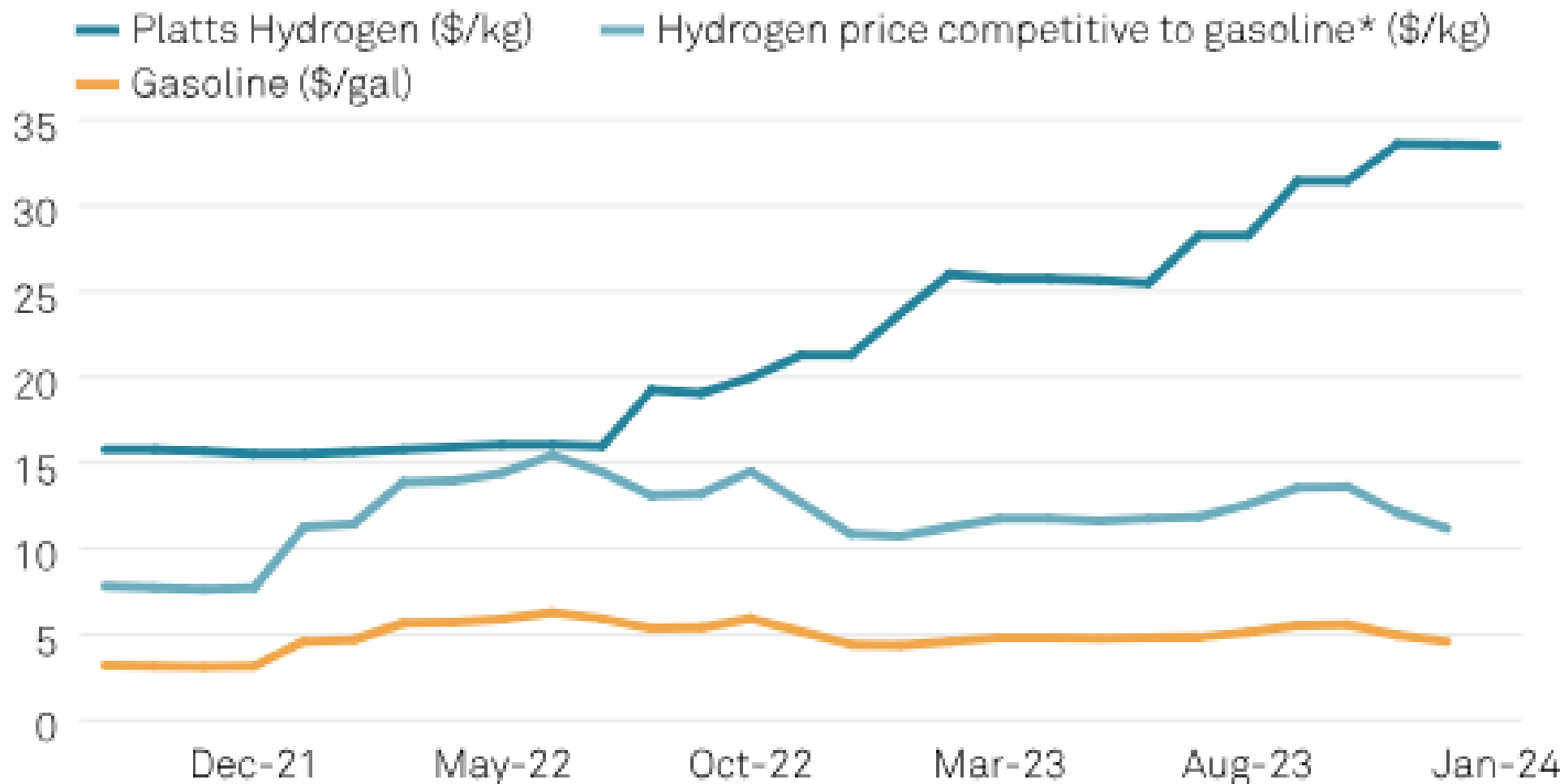
What about the customers?

What is the current state of the California fuel cell vehicle and hydrogen market?

California LD FCEV and Retail Hydrogen Station Trends



Retail California hydrogen pump price vs benchmark



*EER adjusted

Source: S&P Global Commodity Insights, Energy Information Administration

The roadmap to success...

- What will yours be ?
 - Expect the unexpected...
 - Longer; harder; maybe ultimately **even bigger**



Where is the Partnership and Trust?

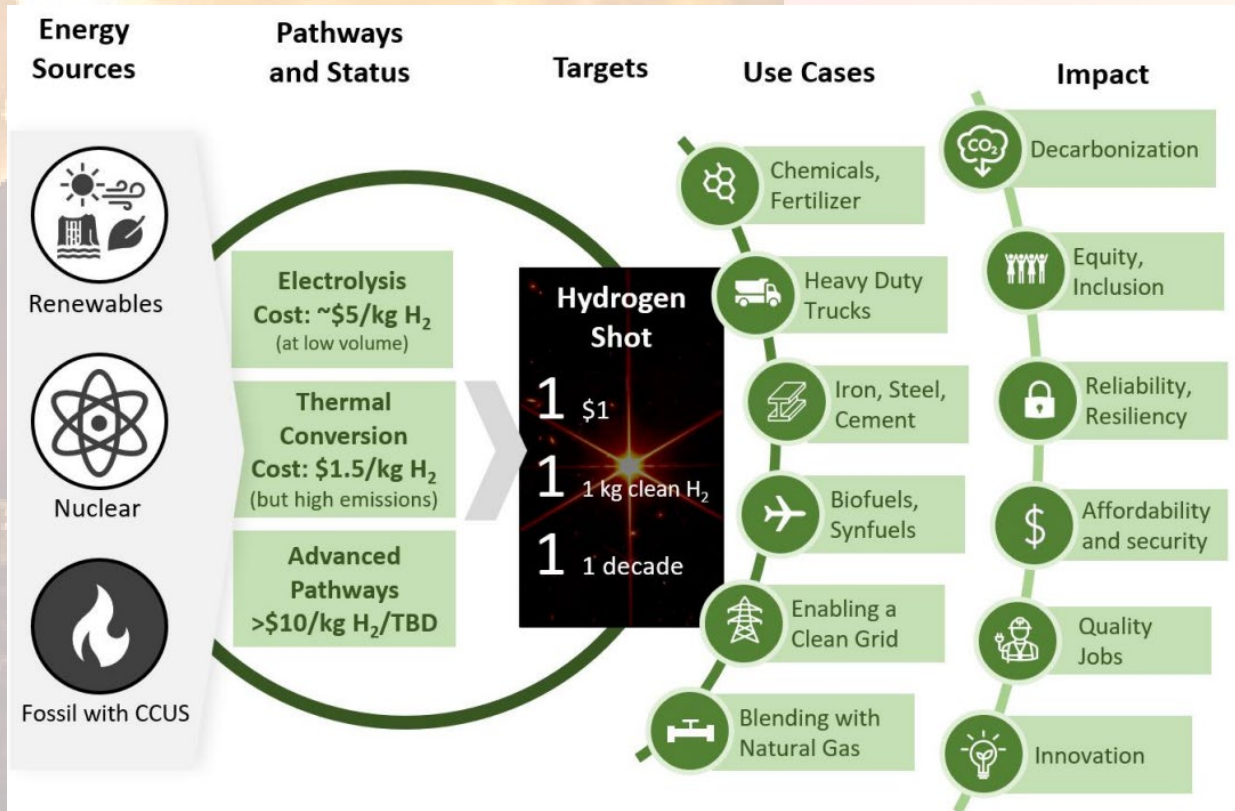
Market Transformation Focus

- **Decreasing Station Development Cost**
 - 40% decrease in station development costs
- **3x to 8x Increase in Station Capacity**
 - 2016: ~180-400 kg/day
 - 2020: ~1,200-1,600 kg/day
 - Largest stations fill 4 cars simultaneously, reliably
 - Truck stations estimated at 6,000 kg capacity
- **90% Reduction in FC Platinum**
 - Automotive fuel cell uses the same amount of platinum as a catalytic converter
- **LCFS Carbon Market Adjustment in 2024**
 - Increased carbon offsets required for fossil fuel sales
- **20%-300% Increase in Renewable Content**
 - Overall network dispensing over 90% renewable hydrogen
- **Emerging MD and HD FC Truck Market**
 - Many OEMs are actively developing product; Agencies are planning funding in the space

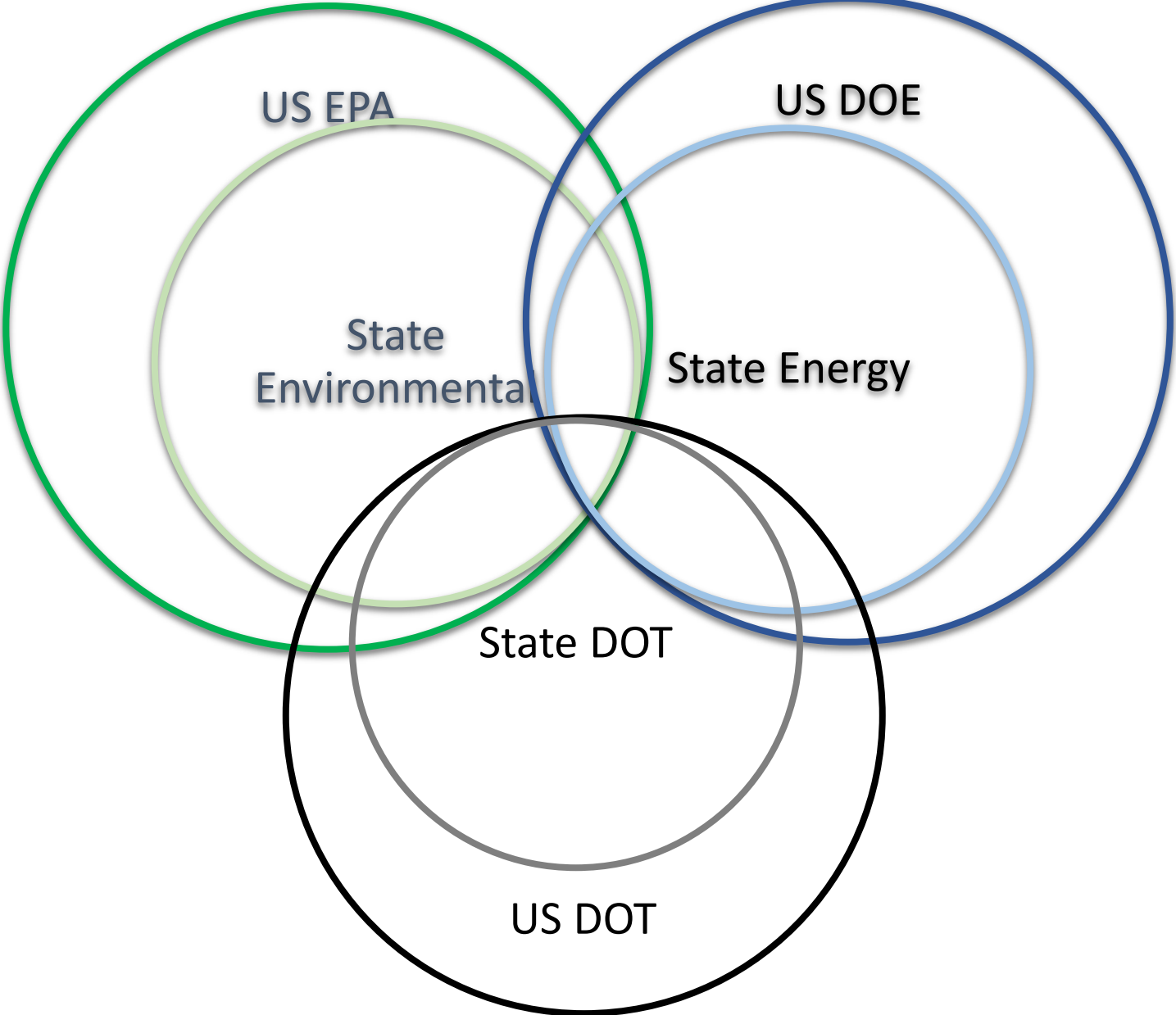


Scaling Hydrogen

National Targets, Investments, and Leadership



Federal leadership is happening



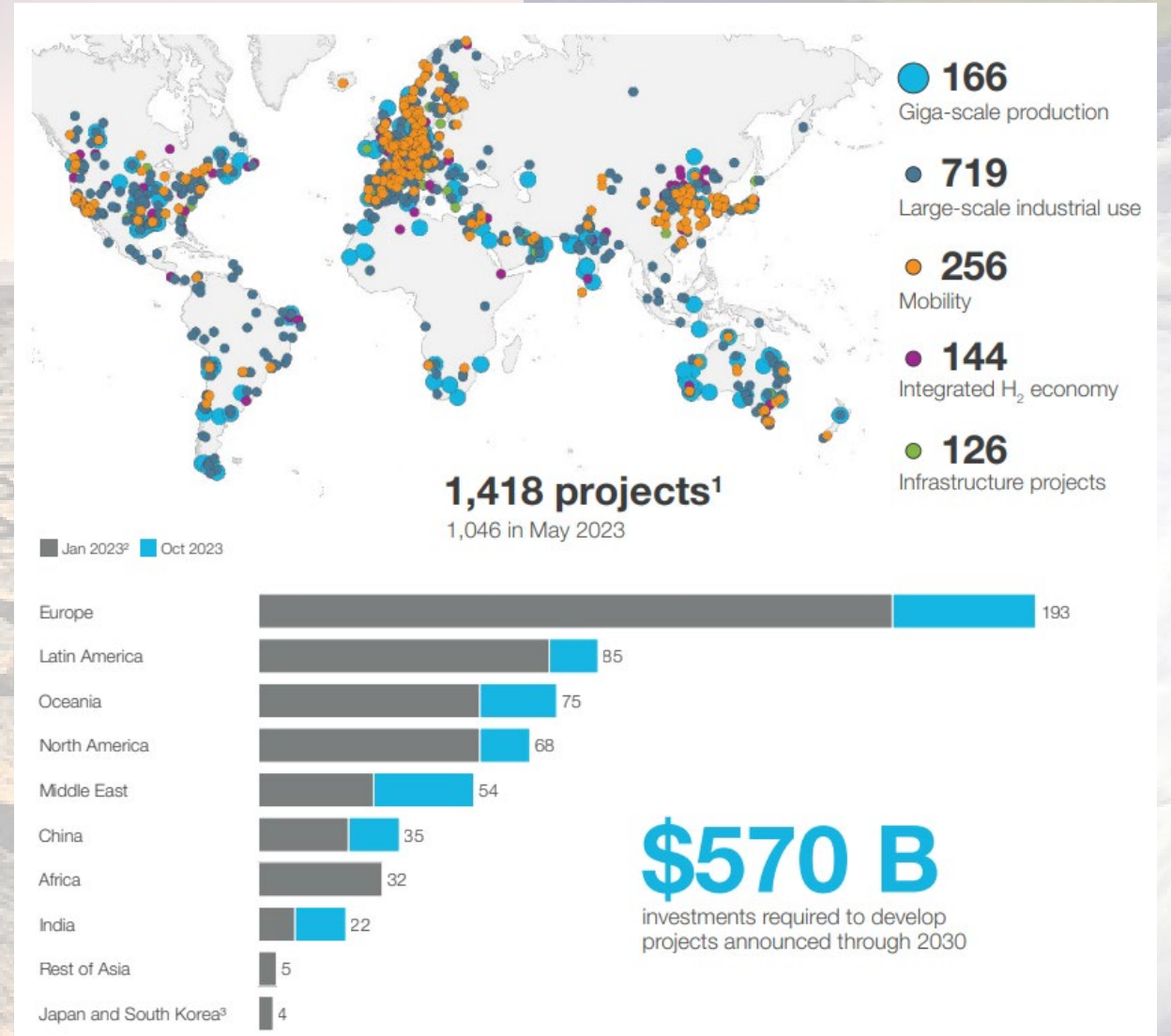
Scaling Hydrogen

Global Activity is Rising Rapidly

>1,400 hydrogen project proposals announced globally, more than 1,000 of which plan full or partial deployment by 2030

\$570 billion direct investments into hydrogen projects announced through 2030, with \$310 billion committed or in advanced planning

45 Mt p.a. clean hydrogen supply announced globally 2030, about 1 Mt p.a. deployed today



Scaling Hydrogen

Personal Thoughts on North America

- Significant focus on Production, more needed on Demand and Distribution
- Simultaneously developing a new market in a competitive environment will be challenging

- Consider Long-term Objectives around decarbonization needs and potential
- Hydrogen today is like Solar, Wind and Batteries ~2 decades ago – *Innovation and Cost Reduction!*

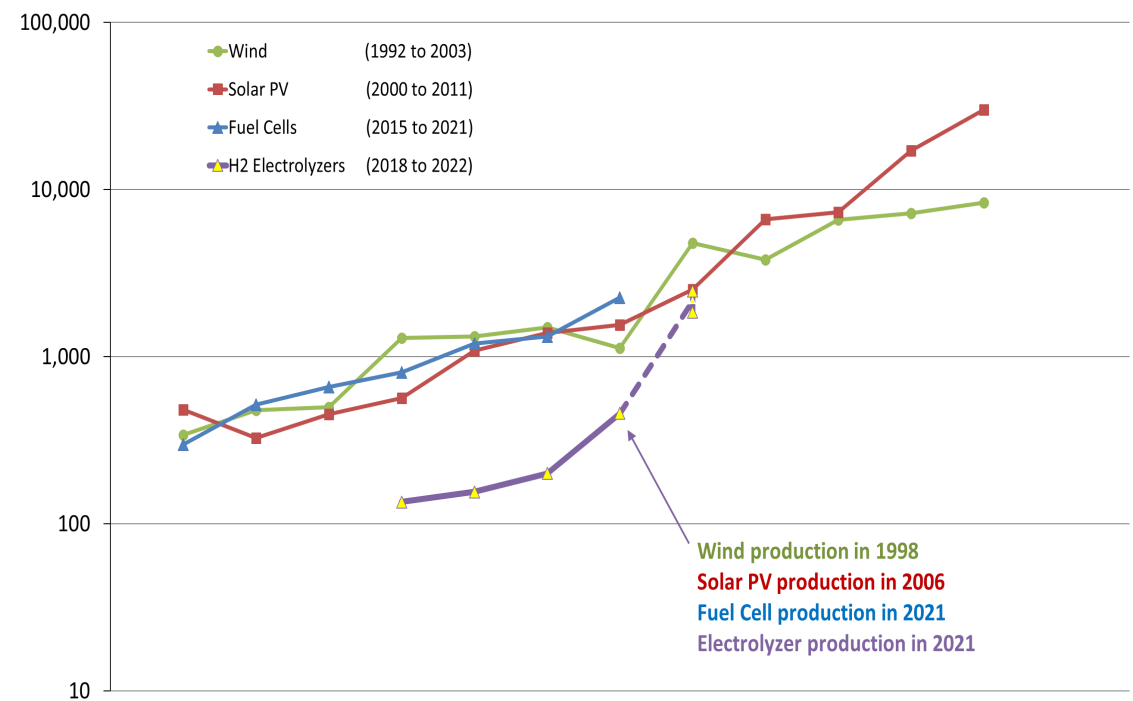
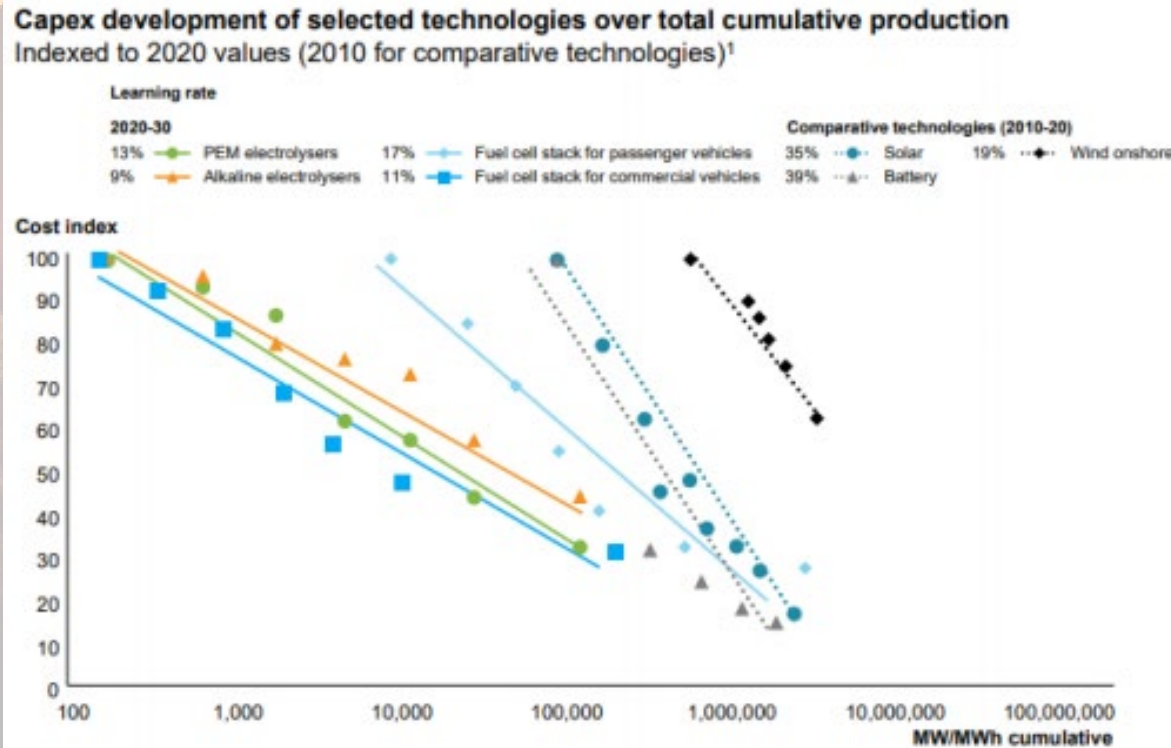


chart: M Klippenstein (@ElectronComm). Data: World on the Edge, Global Outlook on Photovoltaics Report 2014-2018, E4Tech, Bernstein Research, BNEF.

ZEV Technology Lessons Learned:

David Park
dpark@h2fcp.org
h2fcp.org

- **Global** markets are underway – *and will drive competition*
- **Leadership** is crucial – *through the thick and thin*
- Shared **vision and plans** are fundamental – *everyone moving together*
- Policy and investment **commitments** move markets – *watch the money*
- **Partnership** between government and industry – *neither succeeds alone*
- Focus on **long-term** sustainability and scale – *think and aim for success*
- **Every ZEV** will be needed! – *no silver bullet exists*

It is no longer a matter of “**IF HYDROGEN**”,
rather “**WHO LEADS**”, “**WHERE FIRST**” and “**HOW FAST**”

Hydrogen Fuel Cell Partnership:

A public-private collaboration to advance ZEV deployments



- Public-private collaboration with common goal:
Advance hydrogen and fuel cell vehicle technology to **build a sustainable ZEV market** that achieves our common environmental and economic objectives
 - Drive Market Success* by establishing successful market conditions
 - Win Hearts and Minds* by demonstrating the value of the technology
 - Be the Trusted Resource* by bringing together leaders and experts, and produce high-quality data and tools to inform decisions

Partnership Members and Advisors



— 20+ years of collaboration —

Additional Slides

What and Why Hydrogen?

Most common element in the universe – as an energy carrier and fuel option

- Excellent energy carrier
- Non-toxic
- Multiple feedstock options
- Reduces GHGs & Pollutants by 50-100%
- Economically competitive
- As safe as gasoline, diesel, or electricity



Long range – 300+ / 500+ miles



Fast fill with ~5 / ~15 min fills, supports large fleet fueling



Makes electricity on board vehicle



Extreme temperature performance



Multi-unit dwellers and on-street parkers, super commuters



Diverse vehicle sizes, complements BEV technology



Most automakers have fuel cell tech

Achieving the Transition – CA Self-sufficiency Study

Self-Sufficiency
Achieved by:

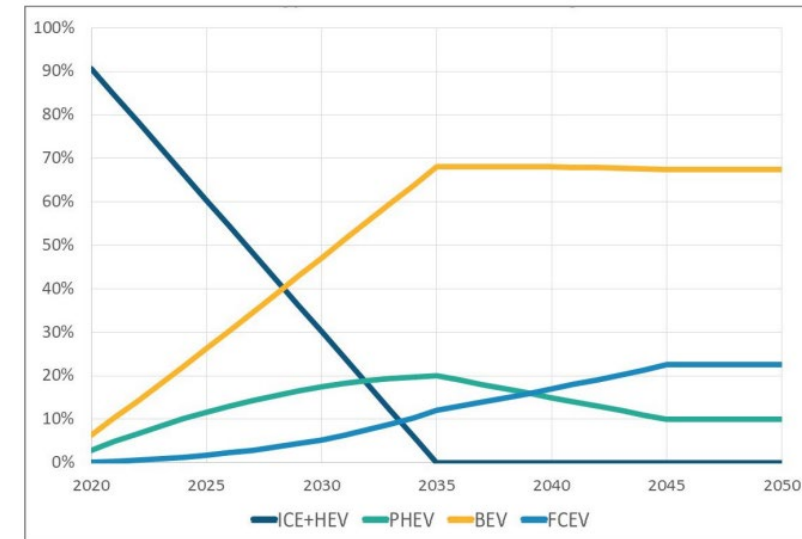
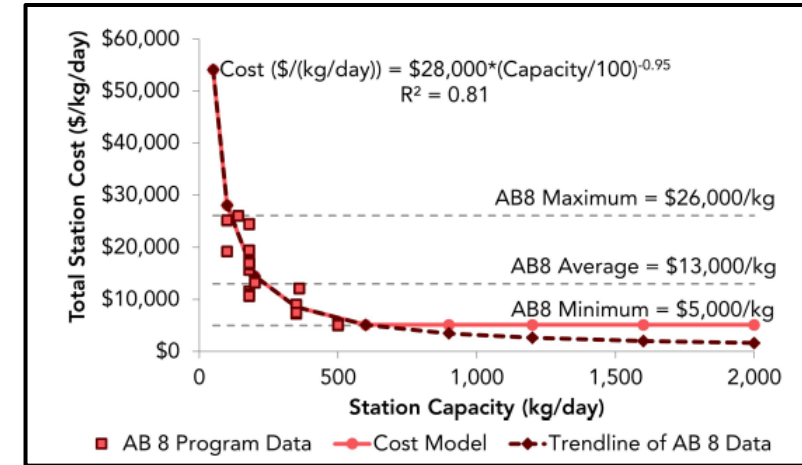
2030

With State
Support
up to:

300M

- Self-sufficiency is possible with State support
- Industry supports the majority of network growth
- California’s network growth rate drives its own economies of scale
- Stations and FCEV deployments need to grow together to gain full benefit
- State support offers benefits to the consumer and may be sufficient to accelerate reductions in price at the pump and other hydrogen/FC applications
- ZEV technologies complimentary & necessary to reach state environmental objectives

<http://ww2arb.ca.gov/resources/documents/self-sufficiency-report>



What and Why Hydrogen?

A versatile energy carrier critical to decarbonization

H2@Scale Enabler for Deep Decarbonization

