

# Status Update: Zero Emission Vehicle Infrastructure

September 2012

# Driving ZEVs to California



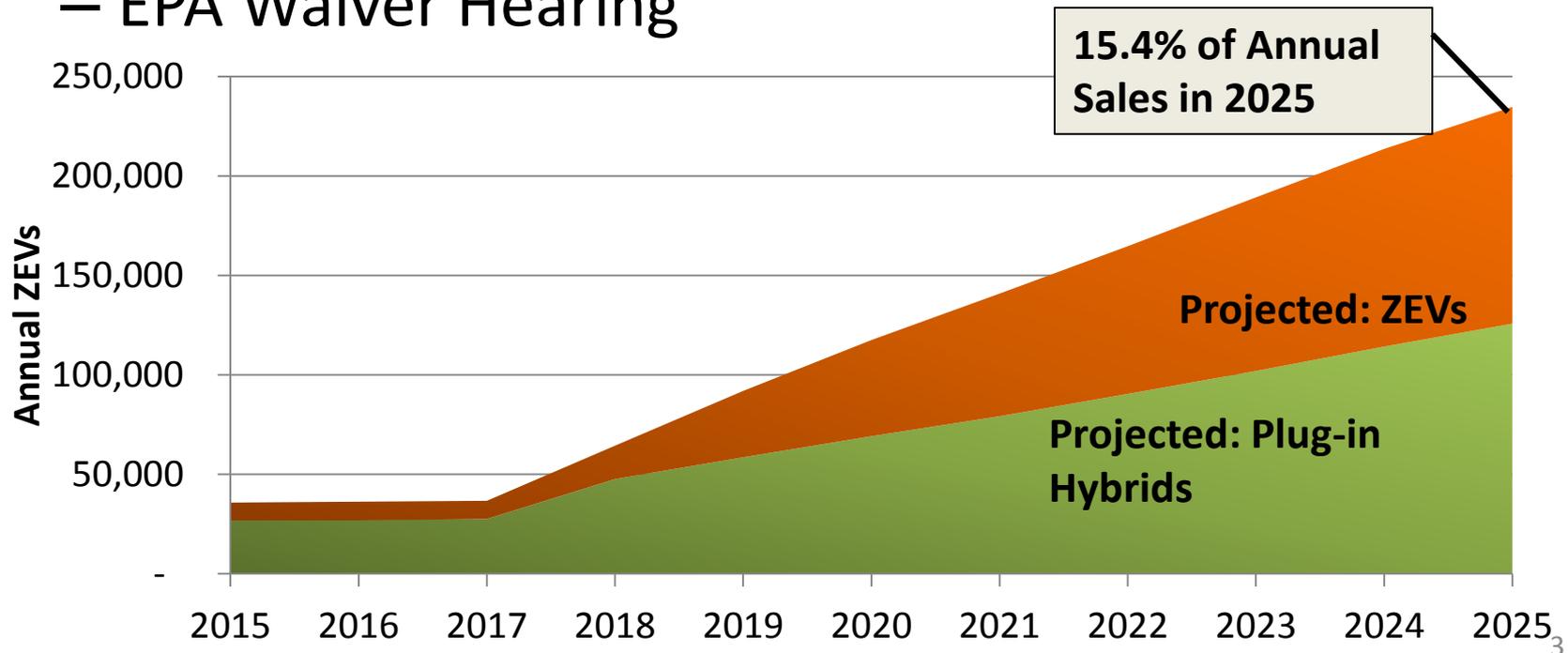
Advanced Clean Cars

- ZEV Regulation
- Clean Vehicle Rebate Program
- Infrastructure
- ZEV Executive Order and Action Plan
- Partner presentations

# Driving ZEVs to California

Advanced Clean Cars

- ZEV Amendments adopted January 2012
  - Finalized
  - EPA Waiver Hearing



# ZEVs Coming to Market

## Advanced Clean Cars

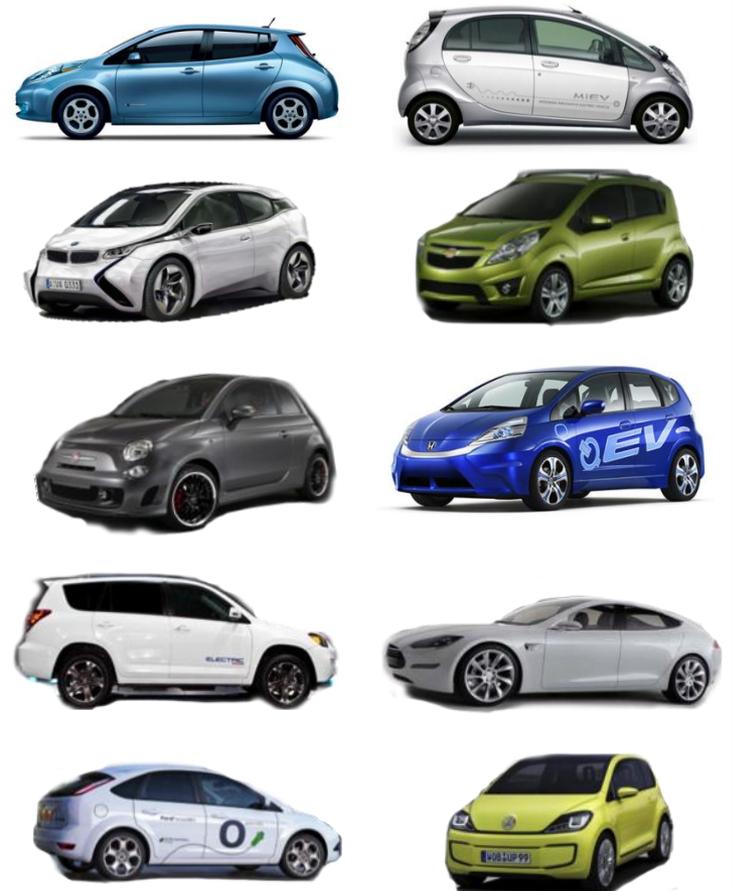
### Plug-In Hybrids



### Fuel Cell Vehicles



### Battery Electric Vehicles



# Clean Vehicle Rebates

Advanced Clean Cars

- ZEVs - \$2,500 per car, PHEVs - \$1,500 per car
- Over 9,000 vehicles have received rebates
  - 5,800 BEVs and FCVs
  - 3,200 PHEVs
- Nearly \$25 million allocated
- \$2,500 per ZEV
- \$2,000 per NEV
- \$1,500 per plug in hybrid

# ZEV Infrastructure Considerations



Advanced Clean Cars

- Accessible
- Affordable
- Easy to establish
- Reliable
- Environmentally beneficial

# ZEV Executive Order

- Signed March 23, 2012
- Support rapid commercialization of ZEVs
  - Infrastructure and community readiness
    - The state's infrastructure will support 1 million ZEVs by 2020
  - Consumer awareness
  - State fleet transformation
    - 10 percent of fleet purchases by 2015 and 25 by 2020
  - Economic development and investment
- 1.5 Million ZEVs by 2025

# Today's Presentations

Advanced Clean Cars

- Plug-in Electric Vehicle Infrastructure: Current and Future Plans in California
  - *Diane Wittenberg, Plug-In Electric Vehicle Collaborative*
- FCEVs and Hydrogen in California: Preparing for Market Launch
  - *Catherine Dunwoody, California Fuel Cell Partnership*
- California Investments in ZEV Infrastructure
  - *Pat Perez, California Energy Commission*



CALIFORNIA

PLUG-IN ELECTRIC VEHICLE  
COLLABORATIVE

# *Plug-in Electric Vehicle Infrastructure: Current and Future Plans in California*

Diane Wittenberg, Executive Director, PEVC  
ARB Board Presentation  
September 20, 2012



# 2012 Membership

## State Government

- ARB
- CEC
- CPUC
- Legislature members
- Governor's office

## Automakers

- BMW
- CODA
- Ford
- GM
- Honda
- Nissan
- Tesla
- Toyota

## Regional Government

- CAPCOA, Sonoma
- BAAQMD
- SCAQMD

## Utilities

- LADWP
- PG&E
- SCE
- SDG&E
- SMUD

## Consulting / Research

- CALSTART
- EPRI
- ICCT
- UC Davis

## Advocacy Organizations

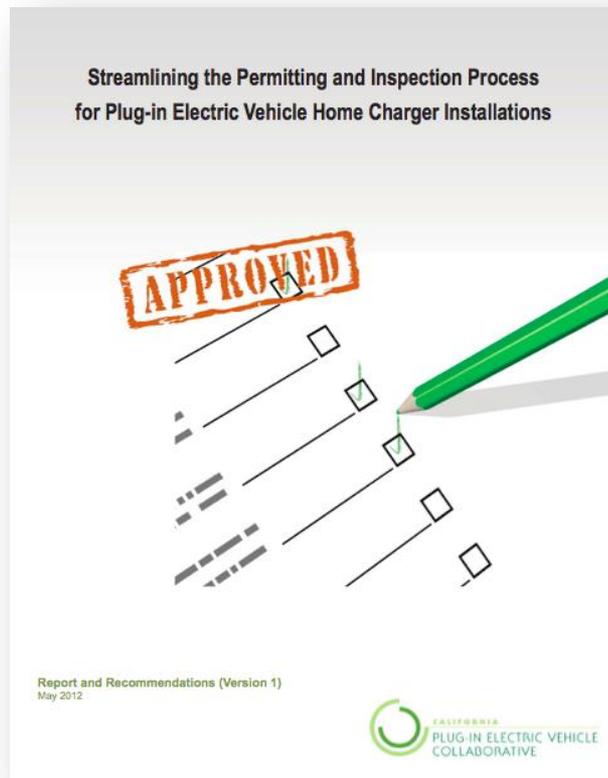
- American Lung A.
- CalETC
- CEERT
- NRDC
- Plug In America
- UCS

## Network Providers

- AeroVironment
- Better Place
- Clean Fuel Connection
- Coulomb
- ECOtality
- Greenlots
- NRG

# The PEV Collaborative

A California public-private partnership focused on addressing challenges in the PEV market in a multi-stakeholder forum



The infographic is titled "HOW DO COMMUNITIES BECOME PEV READY?" and is from the California Plug-in Electric Vehicle Collaborative. It provides a list of key messages and a breakdown of stakeholder roles. The key messages are divided into "PEV Ready Communities Take Action" and "Leadership 'Walks the Talk'". The stakeholder roles are categorized into PEV Drivers, State Government, Fleets, Electric Utilities, Electric Vehicle Supply Equipment (EVSE) Manufacturers, Environmental Advocates, Automakers, Residential Property Managers, and Local & Regional Governments. The background of the infographic shows a city skyline.

### HOW DO COMMUNITIES BECOME PEV READY?

California is leading the nation in Plug-in Electric Vehicle (PEV) sales today, with dozens of new plug-in models coming to market. PEVs benefit local communities by bringing jobs, healthy air, a reduced carbon footprint, quieter streets, incentive funding and opportunities for leadership.

#### KEY MESSAGES

- PEV Ready Communities Take Action**
  - Streamline construction permitting and inspection processes for PEV charging installation; train permitting staff and building officials.
  - Offer first responder training to police and fire personnel.
  - Update building codes, zoning and parking rules to be PEV ready.
  - Address PEV charging needs in apartments and condos.
  - Create a plan to deploy public charging and participate in regional infrastructure planning.
  - Encourage local employers to offer customer and workplace charging.
  - Utilize the resources of the local electric utility to promote PEV education and training.
  - Communicate what's being done to be PEV ready, why it's good for the community, and quality of life benefits.
- Leadership "Walks the Talk"**
  - Identify a PEV champion in your organization or community to guide the process of becoming PEV Ready.
  - Purchase and drive a PEV and install workplace and public charging.
  - Establish incentives for home and commercial charging, as well as preferential PEV parking. Encourage green businesses.

#### "It Takes a Village" to Become PEV Ready: Stakeholders and Roles

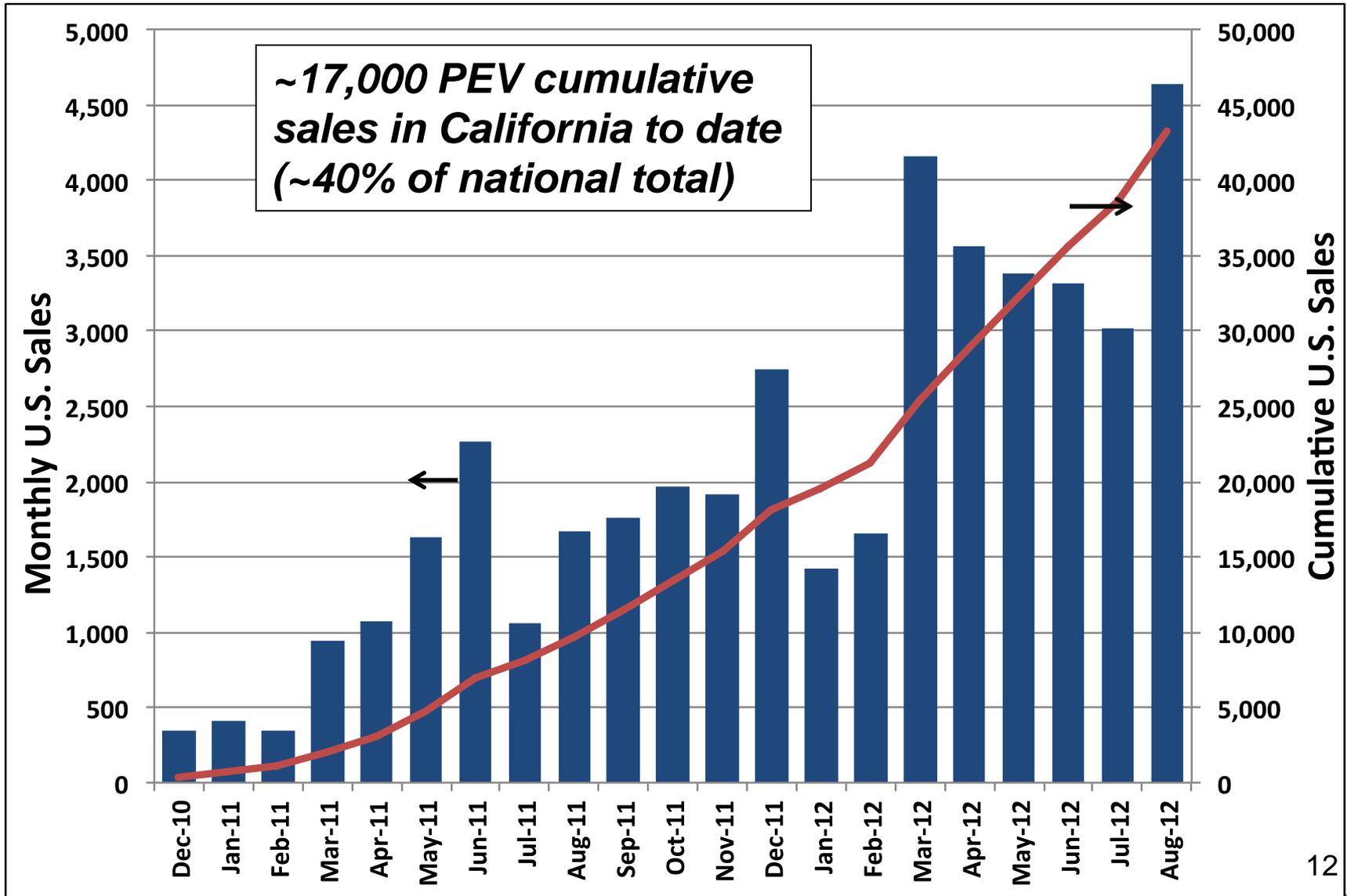
<b>PEV Drivers</b> Encourage PEV Ready communities	<b>Electric Utilities</b> Offer special rates for PEVs. Advise on best rate options. Grid reliability	<b>Automakers</b> Roll out and market PEVs	<b>Employers</b> Encourage employees to drive PEVs. Offer workplace charging
<b>State Government</b> Regulations, policies, guidance, incentives to spur PEV market. Resources to local governments	<b>Electric Vehicle Supply Equipment (EVSE) Manufacturers</b> Offer charging solutions	<b>Residential Property Managers</b> Respond promptly and positively to PEV charging requests. Develop strategy to include PEV charging in Multi-unit Dwellings	<b>Local &amp; Regional Governments</b> Lead by example. Adopt a PEV Readiness Plan
<b>Fleets</b> Purchase PEVs. Support PEV car sharing, rentals, loans	<b>Environmental Advocates</b> Advocate for PEVs. Scientific studies on health impacts of air pollution		

Source: California PEV Collaborative (2008-11)

Communication Guide 5  
March 2012

www.PEVCollaborative.org

# PEV Sales in the U.S. (2011-2012)



# Levels of Charging Infrastructure

- Level 1: 120V circuit
- Level 2: 240V circuit
- DC Fast Charge: 400+ volts
- Battery switch: Replace empty with charged battery



Leviton

Charge Point



ChargePoint dual-port configuration

ECOtality



# Charging Infrastructure Location Goals

**3: Public**

**2: Work**

**1: Home**



# Unresolved Market Issues

- What influences public charging business models?
- How does workplace charging fit in?
- What is the best balance between charge levels?
- How do we reach a single DC charge standard?
- How do we maximize off-peak charging?
- How do we insure interoperability among chargers?

# Home charging trends

- 60 – 80% of charging occurs at home
- Level 1 may be sufficient for many drivers (esp. PHEVs)
- Level 2 costs coming down
- Apartments present unique challenge



Leviton

# Workplace charging trends

- Second most important location after home
- Extends electric range of PEVs
- “Second showroom” for potential PEV buyers
- Could be combination of Level 1 and 2 (lower cost)

## WHO OFFERS WORKPLACE CHARGING?



Source: California PEV Collaborative (CG7-1)

# Public charging – Existing plans in California

	Installed	Planned *	NRG Settlement w/ PUC
Residential	~ 3,675	~ 175	
Commercial **	~ 1,525	~ 1,970	10,000
DC Fast Charging	5	65	200

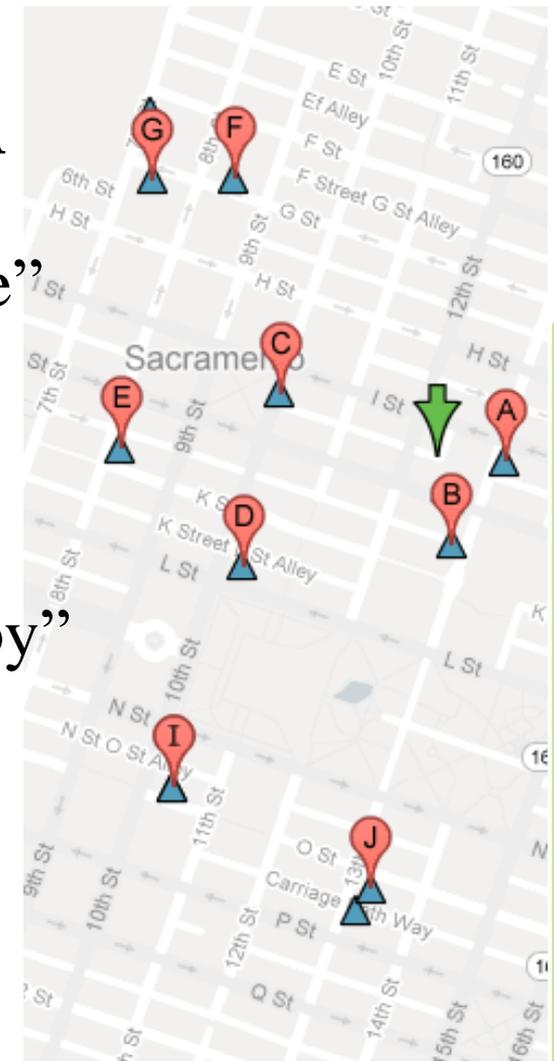
\* *Planned stations to be finished in next 1-2 years (NRG settlement over 4 yrs)*

\*\* *Commercial includes: workplace, public, industrial*

# Public charging - Future

## Scenario: 1 million PEVs by 2020 in CA

- EPRI analysis: “Supporting Infrastructure”
  - 33,500 public (~3% ratio to cars)
  - 48,000 workplace (~5% ratio)
- UCD analysis: “Increases electric VMT by”
  - Workplace charging: 7%
  - Public Level 2: 4%
  - DC Fast Charging: 15%



# Profile of charging infrastructure industry

- Partnerships emerging with retail outlets
- Network services to play larger role in business plans
- IT driver services emerging – “Maps and Apps”
- Established companies competing with start-ups



better place



chargepoint



Public Charging Locator  
Recargo app

# Government's role in charging infrastructure

- Establishing rules for use of electricity as a fuel
- Charging infrastructure financial incentives
- Local government planning
- Governor's ZEV Executive Order



California Environmental Protection Agency  
**Air Resources Board**



# Summary of PEV Charging Infrastructure

*Electric fuel is plentiful, affordable,  
and available everywhere, but...*

*Large uncertainties exist about  
ideal charging infrastructure design*

# Contact Information

Diane Wittenberg

Executive Director

PEV Collaborative

[dwittenberg@pevcollaborative.org](mailto:dwittenberg@pevcollaborative.org)

[www.PEVCollaborative.org](http://www.PEVCollaborative.org)

# FCEVs and Hydrogen in California

Preparing for market launch



Catherine Dunwoody  
September 2012

# A fuel cell vehicle is electric!

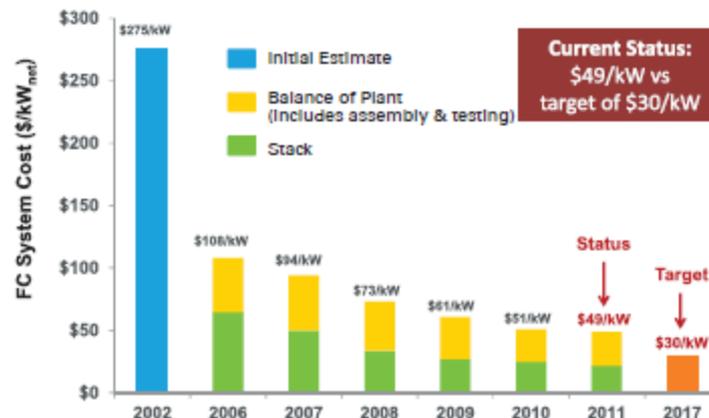
- 250-400 mile range
- Zero-tailpipe emissions
- Minutes to fill the tank
- Passenger & cargo capacity



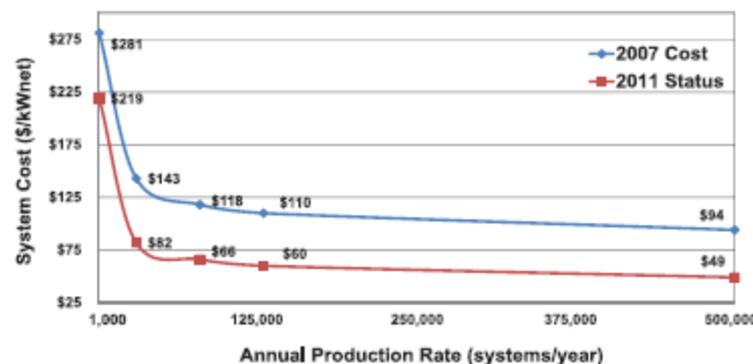
# Ready for commercial launch

- ✓ Fuel cell system costs <\$50/kW (2011); reduced 30% from 2008
- ✓ 2,500-hour real-world durability (75,000 miles); 5,000-hours on single cell (lab)
- ✓ Validated driving range of 250 to 400+ miles

**Projected Transportation Fuel Cell System Cost**  
-projected to high-volume (500,000 units per year)-



**Projected Costs at Different Manufacturing Rates**

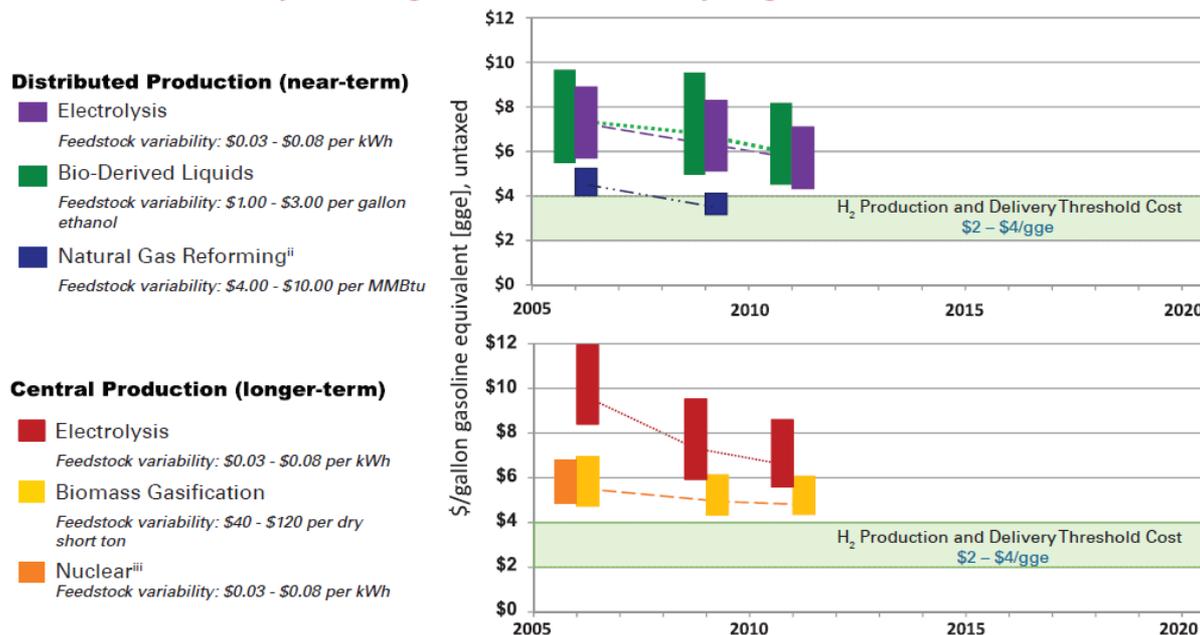


Source: US DOE H2 and Fuel Cell Program Plan, April 2012; [www.eere.doe.gov/hydrogenandfuelcells](http://www.eere.doe.gov/hydrogenandfuelcells)

# Ready for commercial launch

- ✓ Projected H<sub>2</sub> costs reduced to \$3.00/kg—competitive with gasoline
- ✓ 59% efficiency
- ✓ >2x fuel economy of gasoline internal combustion engines

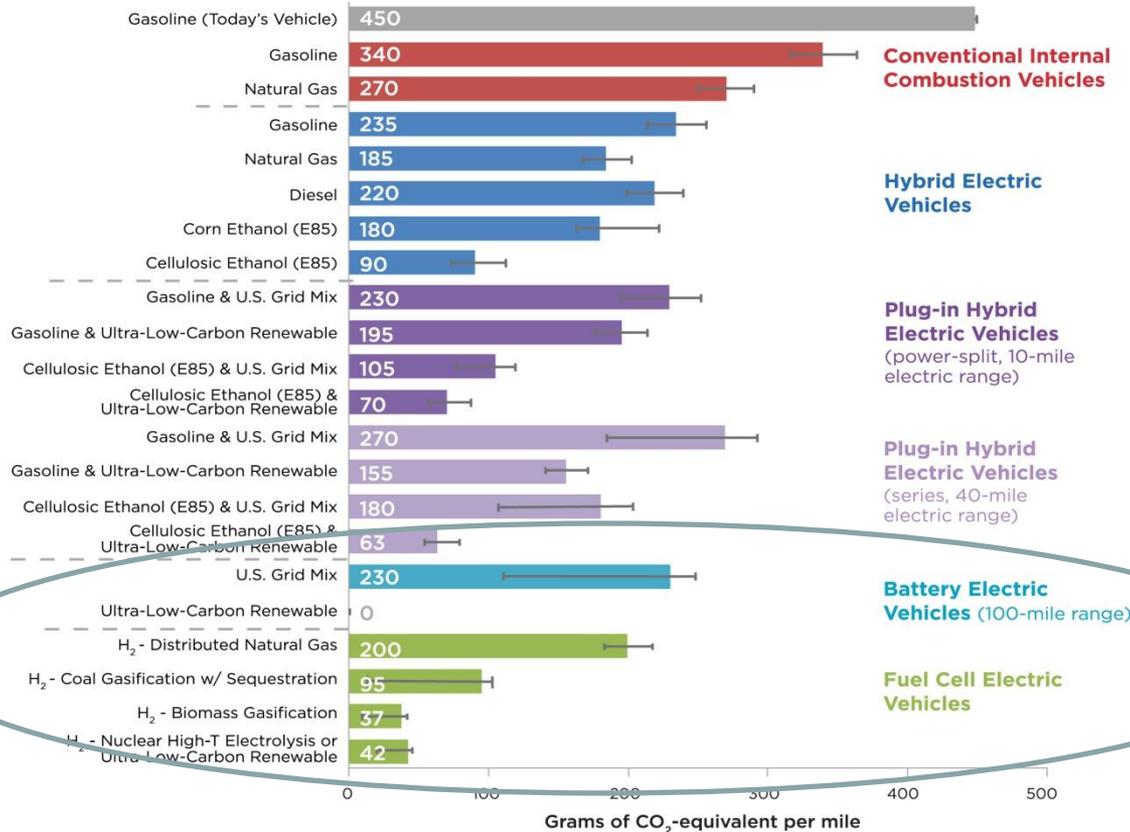
## Projected High-Volume Cost of Hydrogen<sup>i</sup> – Status



Source: US DOE H<sub>2</sub> and Fuel Cell Program Plan, April 2012; [www.eere.doe.gov/hydrogenandfuelcells](http://www.eere.doe.gov/hydrogenandfuelcells)

# Reducing GHGs

Well-to-Wheels Greenhouse Gas Emissions



✓ FCEVs are one of the lowest GHG options

**Figure 1.8a. Well-to-Wheels Analysis of Greenhouse Gas Emissions.**

Substantial reductions in greenhouse gas emissions are possible through the use of a variety of advanced transportation technologies and fuels, including fuel cell electric vehicles using hydrogen from a variety of sources. Notes: (1) analysis based on a mid-sized car; (2) assumes the state of the technologies expected in 2035–2045; (3) ultra-low-carbon renewable electricity includes wind, solar, etc.; (4) the life-cycle effects of vehicle manufacturing and infrastructure construction/decommissioning are not accounted for.<sup>30</sup>

# FCEV and H<sub>2</sub> progress

- ▶ Passenger vehicles leased to customers
- ▶ Buses in revenue service
- ▶ Hydrogen stations open and more coming
- ▶ California is first US market



# Projected FCEVs in CA

<i>CaFCP survey of automakers</i>	Hundreds	Thousands	Tens of thousands
	Through 2013	2014	2015-2017
Total Passenger Vehicles	430	1,400	53,000

\*For competitive reasons, detailed volume assessments have not been provided during 2015-2017.



# Public H<sub>2</sub> stations in CA today



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



# H<sub>2</sub> stations coming by 2013

- ▶ Beverly Hills
- ▶ Diamond Bar (upgrade)
- ▶ Harbor City
- ▶ Hawthorne
- ▶ Hermosa Beach
- ▶ Irvine (upgrade)
- ▶ Irvine North
- ▶ Laguna Nigel
- ▶ Los Angeles
- ▶ San Francisco
- ▶ Santa Monica
- ▶ West LA
- ▶ West 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



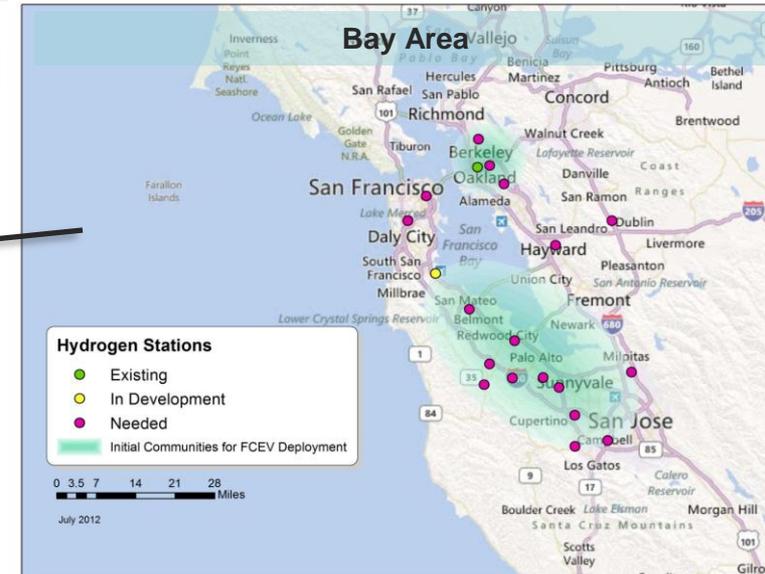
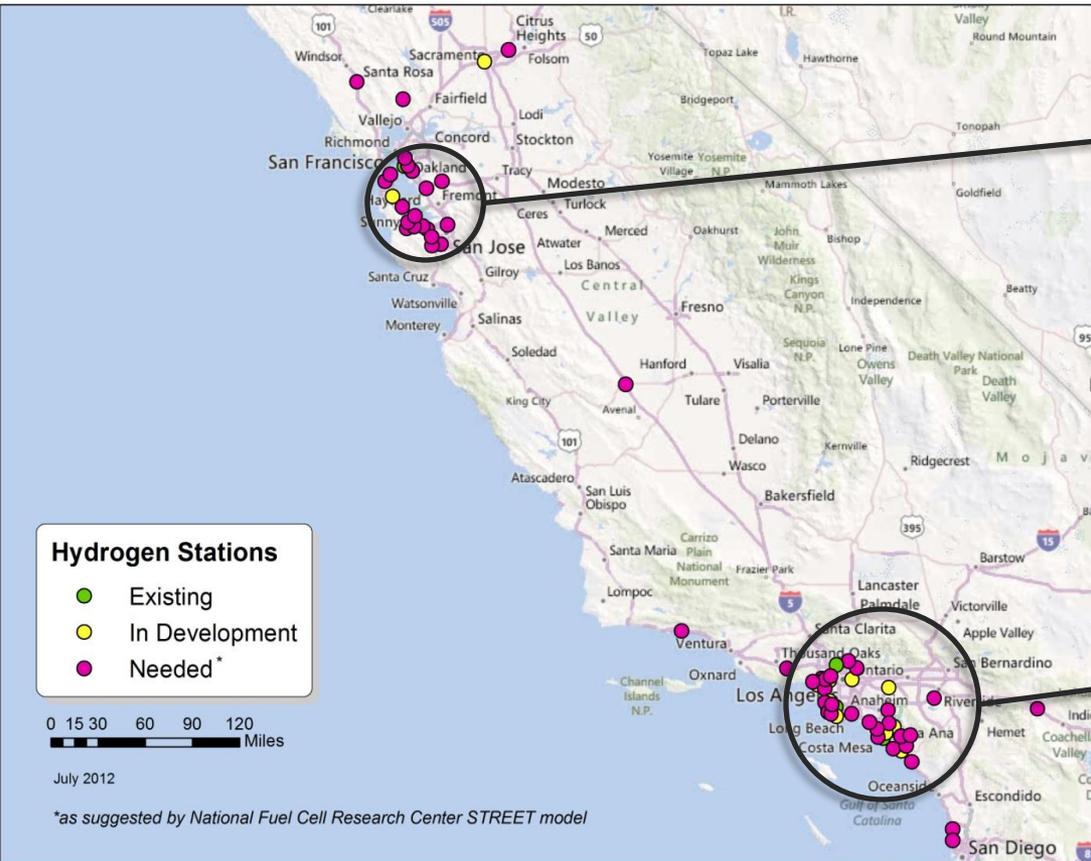
# How many stations?

- ▶ OEMs identified need for 68 stations by 2016
  - Balances coverage and capacity utilization
  - Supports 20,000 FCEVs
- ▶ 45 stations in cluster communities
  - UC Irvine STREET model
- ▶ 23 connector and destination stations that seed new clusters
  - Based on travel patterns, OEM marketing information



# Building a statewide network

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



# 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 all stations operating as vehicle volume grows
- ▶ Analysis shows \$65M additional incentives needed



# 68 Hydrogen stations provide...

## ▶ Coverage

- Fueling opportunities

## ▶ Confidence

- Automakers build volume
- Customers purchase FCVs

## ▶ Commercial

- To launch market and build capacity



# Implementing the road map

- ▶ Develop funds and framework to achieve 68 station network
- ▶ Promote hydrogen readiness
  - Communities, businesses, consumers
- ▶ Accelerate station implementation
  - Timeliness, performance, path to profitability

*These actions will enable CA to meet the Governor's ZEV EO milestones for 2015*

**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

Stakeholders estimate 37 stations will be funded and operating in 2015, leaving a gap of 31 needed stations.

**\$65 MILLION**  
IN ADDITIONAL FUNDING NEEDED!

\$10M

Stakeholders estimate 37 stations will be funded and operating in 2015, leaving a gap of 31 needed stations. Bridging this gap is essential for creating, building and maintaining confidence that California will be ready for the early commercial FCEV market.

Download A California Road Map at  
[www.cafcp.org/roadmap](http://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](http://www.cafcp.org)



### **AUTOMOTIVE**

Chrysler  
Daimler  
General Motors  
Honda  
Hyundai  
Nissan  
Toyota  
Volkswagen

### **TECHNOLOGY**

AFCC

### **GOVERNMENT**

CA Energy Commission  
CA Air Resources Board  
South Coast AQMD  
US EPA  
US DOE  
US DOT

### **ASSOCIATE**

AC Transit  
Air Liquide  
Air Products  
Ballard Power Systems  
CDFA  
CEERT  
EIN  
Hydrogenics  
ITS – UC Davis  
Linde  
NFCRC – UC Irvine  
NREL  
Powertech Labs  
Praxair  
Sandia National Labs  
Santa Clara VTA  
SoCal Gas  
SunLine Transit  
UTC Power

California Fuel Cell Partnership  
[www.cafcp.org](http://www.cafcp.org)  
[info@cafcp.org](mailto:info@cafcp.org)



# AB 118 Projects Update

## Zero Emission Vehicle Infrastructure

September 20, 2012

**Pat Perez, Deputy Director**  
Fuels and Transportation Division

*[www.energy.ca.gov](http://www.energy.ca.gov)*



# Alternative and Renewable Fuel and Vehicle Technology Program

## Purpose

To transform California's transportation market into a diverse collection of alternative fuels and technologies and reduce California's dependence on petroleum.

*“...develop and deploy innovative technologies that transform California’s fuel and vehicle types to help attain the state’s climate change policies.”* (Health and Safety Code Section 44272(a))

For the *Alternative & Renewable Fuel and Vehicle Technology Program*, the Energy Commission will receive \$100 million/year for over 7 years.



## Investment Plan ZEV Allocations Infrastructure and Vehicle Deployment

ARFVT Program Category	Funding Allocations (Millions)			
	FY 08-10	FY 10-11	FY 11-12	FY 12-13*
American Recovery and Reinvestment Act (vehicles and infrastructure)	\$17.4	-	-	-
Electric Vehicle Charging Infrastructure	\$3.2	\$3.0	\$7.0	\$7.5
Hydrogen Fueling Infrastructure	\$15.7	\$13.0	\$8.5	\$11.0
Light Duty Electric Vehicle Deployment	\$2.0	-	\$0.6	\$5.0
Medium- and Heavy-Duty Vehicle Deployment	\$4.0	-	-	-
Medium- and Heavy-Duty Advanced Vehicle Demonstrations (Electric Drive)	\$10.0	\$14.0	^	^
Manufacturing Facilities and Equipment	\$19.0	\$7.5	^	^
Plug-in Electric Vehicle Regional Readiness Plans	-	\$1.0	\$1.0	^
<b>Totals</b>	<b>\$71.3</b>	<b>\$38.5</b>	<b>\$16.1</b>	<b>\$23.5</b>

\*Does not include potential fund reductions.

^Category was expanded beyond strictly electric drive technologies.



## Hydrogen Infrastructure

\$18.7 million awarded for 12 hydrogen stations

- 2 stations with Linde LLC
- 8 stations with Air Products and Chemicals, Inc.
- 1 station with Airport Commission, City and County of San Francisco
- 1 station with AC Transit

11 stations with Linde, Air Products, and AC Transit moving forward.



## Hydrogen Infrastructure

**Draft Hydrogen solicitation for 2012 is posted at  
[www.energy.ca.gov/altfuels/](http://www.energy.ca.gov/altfuels/)**

- Comments on this draft solicitation were due September 17, 2012 at 3:00 p.m.
- Energy Commission is working to finalize and release a solicitation for up to \$29.69 million for approximately 15 to 20 stations.



## PEV Infrastructure

### Executed Agreements Total \$16 million

	Installed*	Planned*	Total*
Residential	1,740	176	1,916
Commercial, Fleet, and Workplace	1,266	1,972	3,238
Fast Charging	0	38	38
Totals	3,006	2,186	5,192

\* Numbers are for charge points. More than one charge point may be installed at one site.



## PEV Infrastructure Awarded on August 16, 2012

Category	Charge Points	Funding
Fast Charge	28	\$1,400,554
Residential	806	\$2,499,512
Workplace	118	\$420,481
Fleet	59	\$335,921
<b>TOTAL</b>	<b>1,011</b>	<b>\$4,656,468</b>



## Other Recent ZEV-Related Investments

- PEV Regional Readiness Plans (\$2 million)
- Pre-commercial medium- and heavy-duty bus and truck demonstrations (\$10.2 million)
  - Battery electric medium-duty truck
  - Electric shuttle bus
  - Battery electric truck
  - Fuel cell bus
  - Battery electric transit buses
  - Electric drayage truck
- Manufacturing (\$19.8 million)
  - Electric drive system for trucks
  - Zero-emission motorcycle
  - Light-duty vehicle
  - Lithium-ion battery modules



## ZEV-Related Activities Planned for 2012-2013

- Hydrogen infrastructure solicitation.
- Plug-in electric vehicle infrastructure solicitation.
- Regional planning grants.
- Centers for alternative fuels and advanced vehicle technologies.
- Medium- and heavy-duty vehicle technology demonstrations.

# Summary and Conclusion

- Roadmaps to making infrastructure:
  - Accessible
  - Affordable
  - Easy to establish
  - Reliable
  - Environmentally beneficial
- ZEVs in the marketplace
- Government role to ensure infrastructure is established until private investment takes over