Status Update:
Zero Emission Vehicle Infrastructure

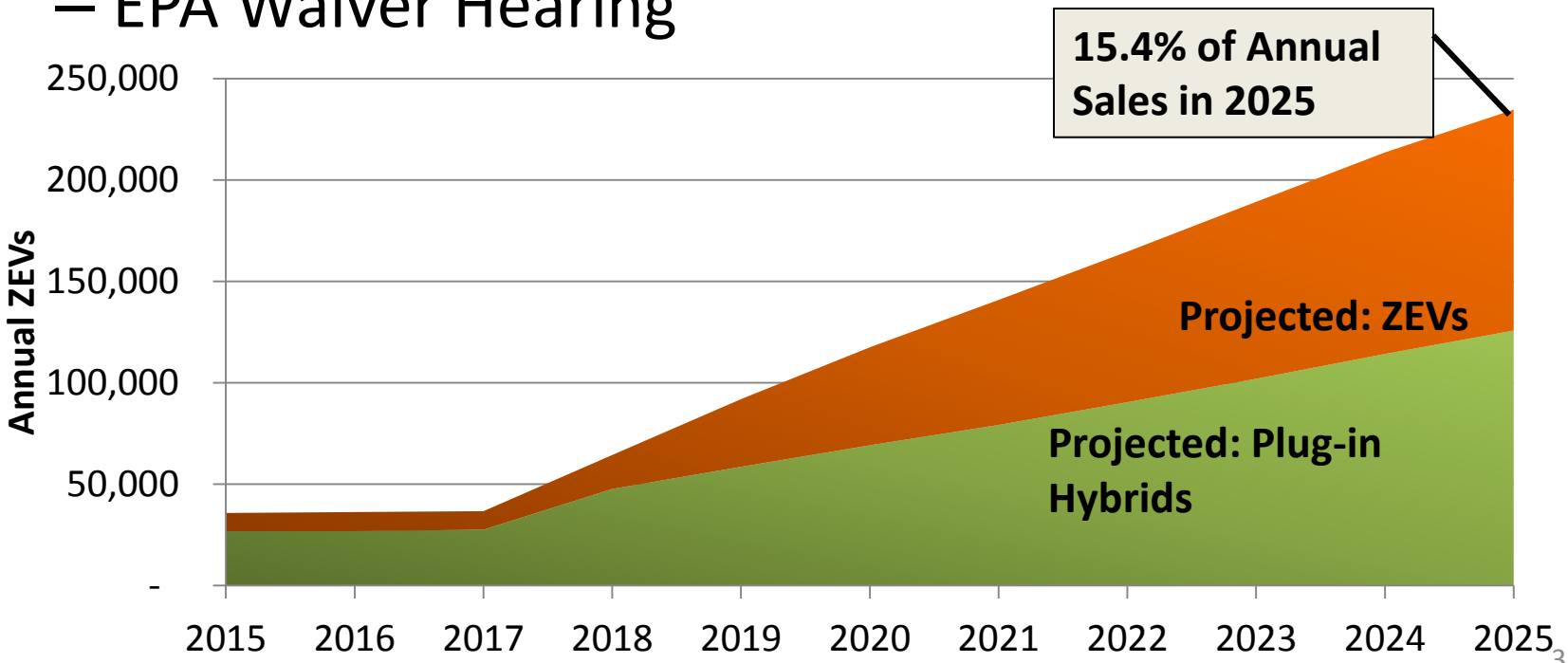
September 2012

Driving ZEVs to California

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

Driving ZEVs to California

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



ZEVs Coming to Market

Plug-In Hybrids

Fuel Cell Vehicles

Battery Electric Vehicles

Clean Vehicle Rebates

- 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

- 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

- 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

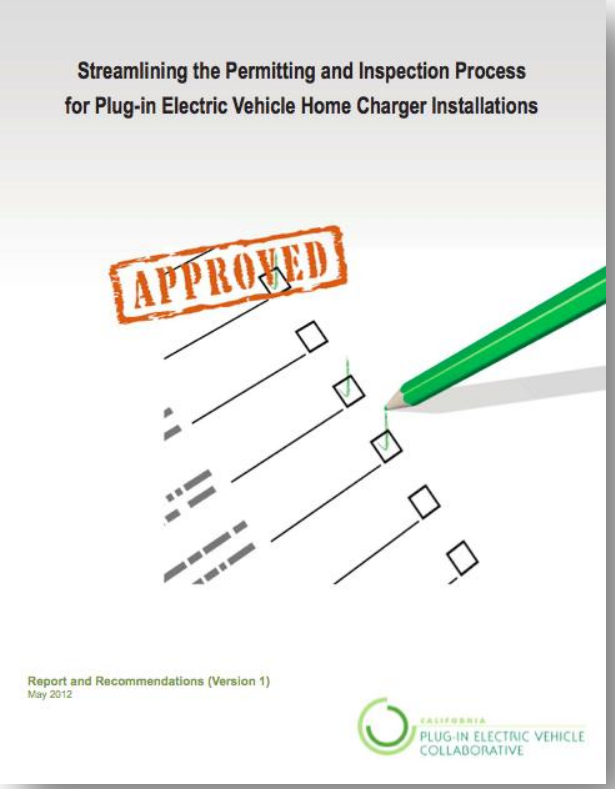
- American Lung A.
- CalETC
- CEERT
- NRDC
- Plug In America
- UCS

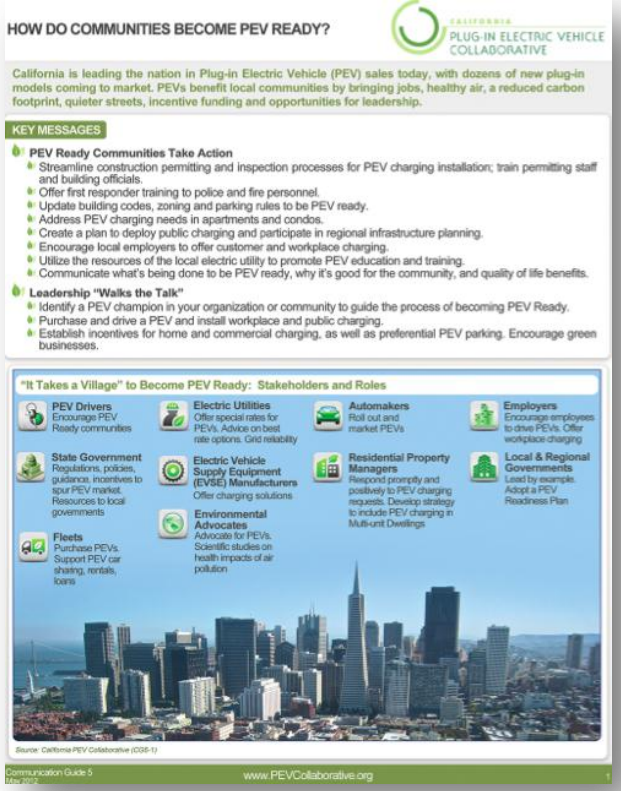
Network Providers

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

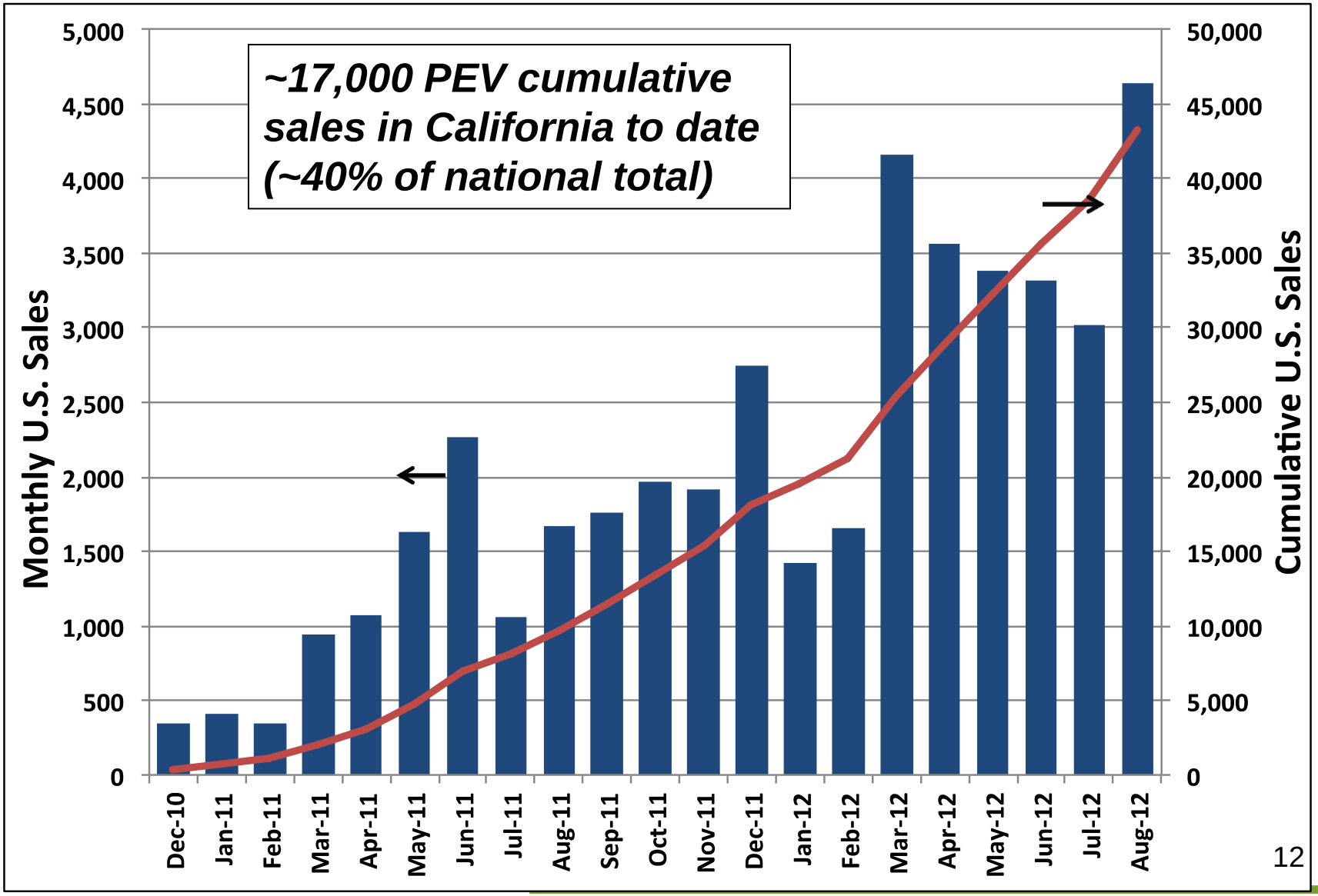
The PEV Collaborative

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





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



Source: HybridCars.com

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

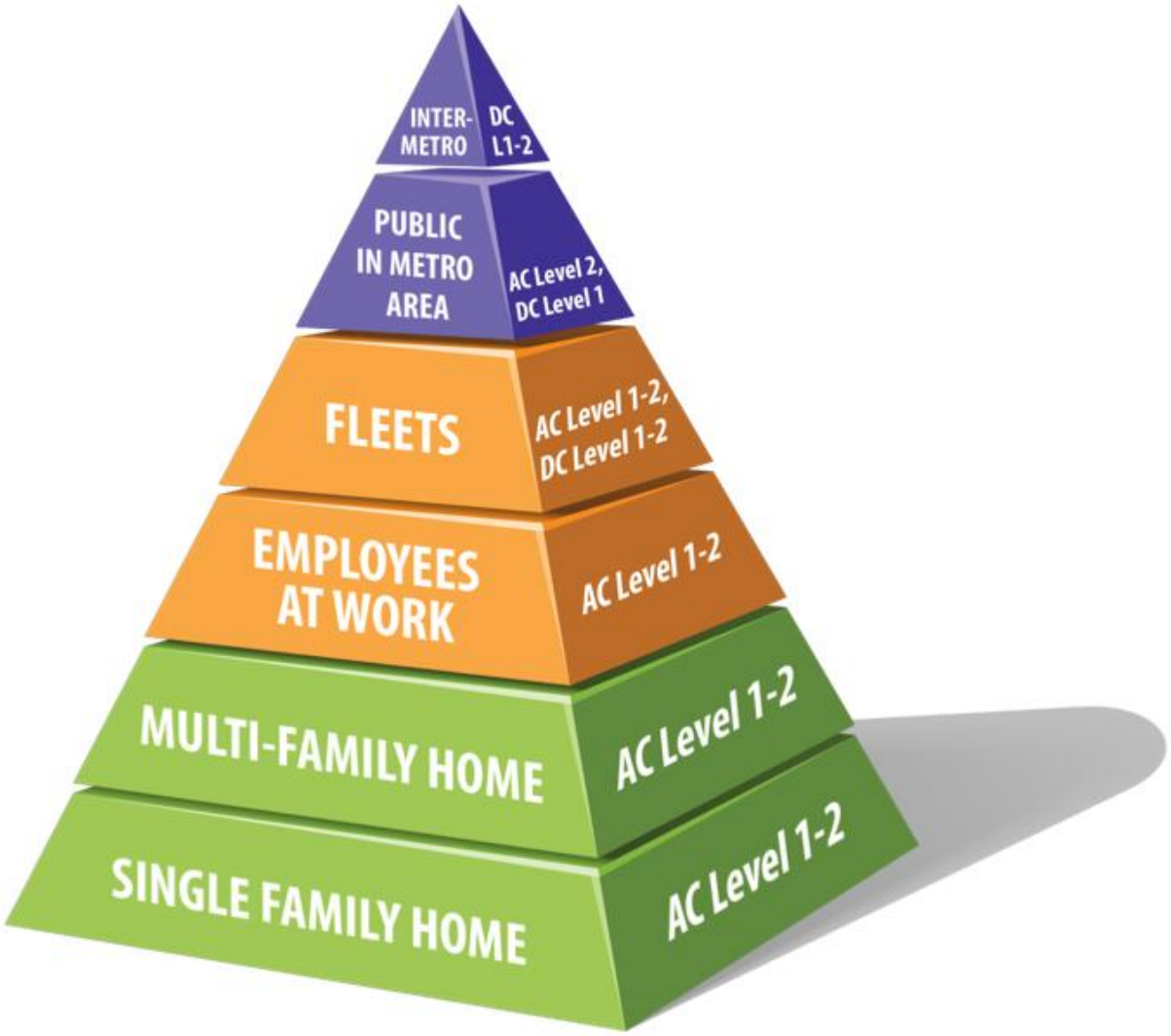
ECOtality

Charging Infrastructure Location Goals

3: Public

2: Work

1: Home



Courtesy of Argonne National Laboratory

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)

Public charging – Existing plans in California

	Installed	Planned *	NRG Settlement w/ PUC
Residential	~ 3,675	~ 175	10,000
Commercial **	~ 1,525	~ 1,970	
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

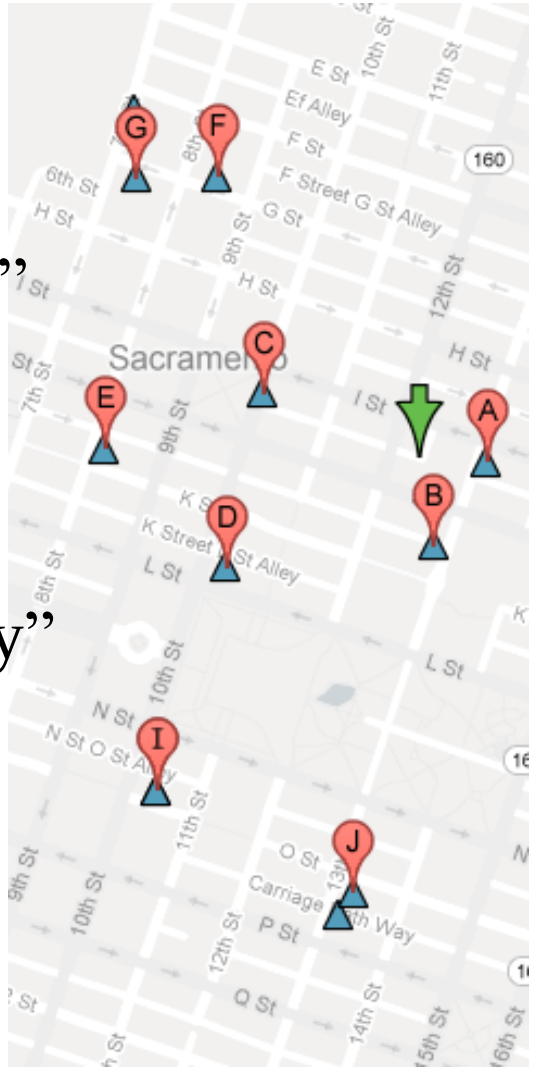
Scenario: 1 million PEVs by 2020 in CA

•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

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

AQMD

Bay Area Air Quality Management District

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

www.PEVCollaborative.org

FCEVs and Hydrogen in California

Preparing for market launch

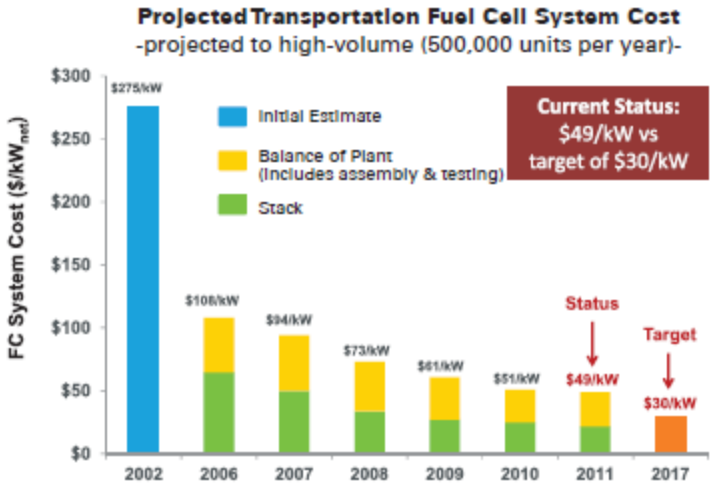
Catherine Dunwoody
September 2012

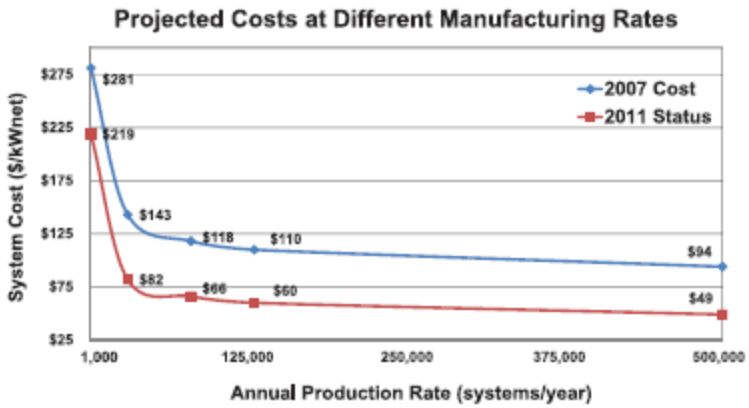
A fuel cell vehicle is electric!

- 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





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

Ready for commercial launch

- ✓Projected H_2 costs reduced to $3.00/kg—competitive with gasoline
- ✓59% efficiency
- ✓>2x fuel economy of gasoline internal combustion engines

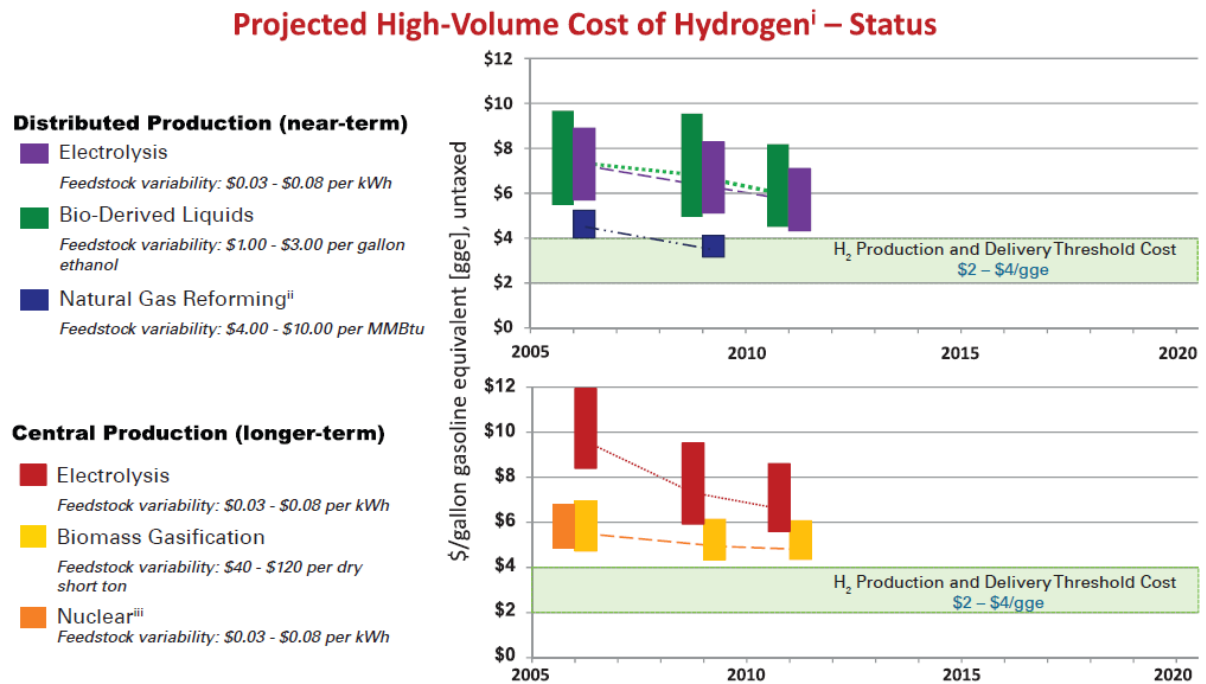


Figure 2.4. Hydrogen Production and Delivery Cost Status. Significant progress has already been made in several hydrogen production pathways. The Hydrogen Threshold Cost represents the cost at which hydrogen fuel cell electric vehicles are projected to become competitive on a cost-per-mile basis with competing vehicles (gasoline hybrid-electric vehicles) in 2020. Notes: (i) Costs shown include all delivery and dispensing costs, but do not include taxes. A

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

Reducing GHGs

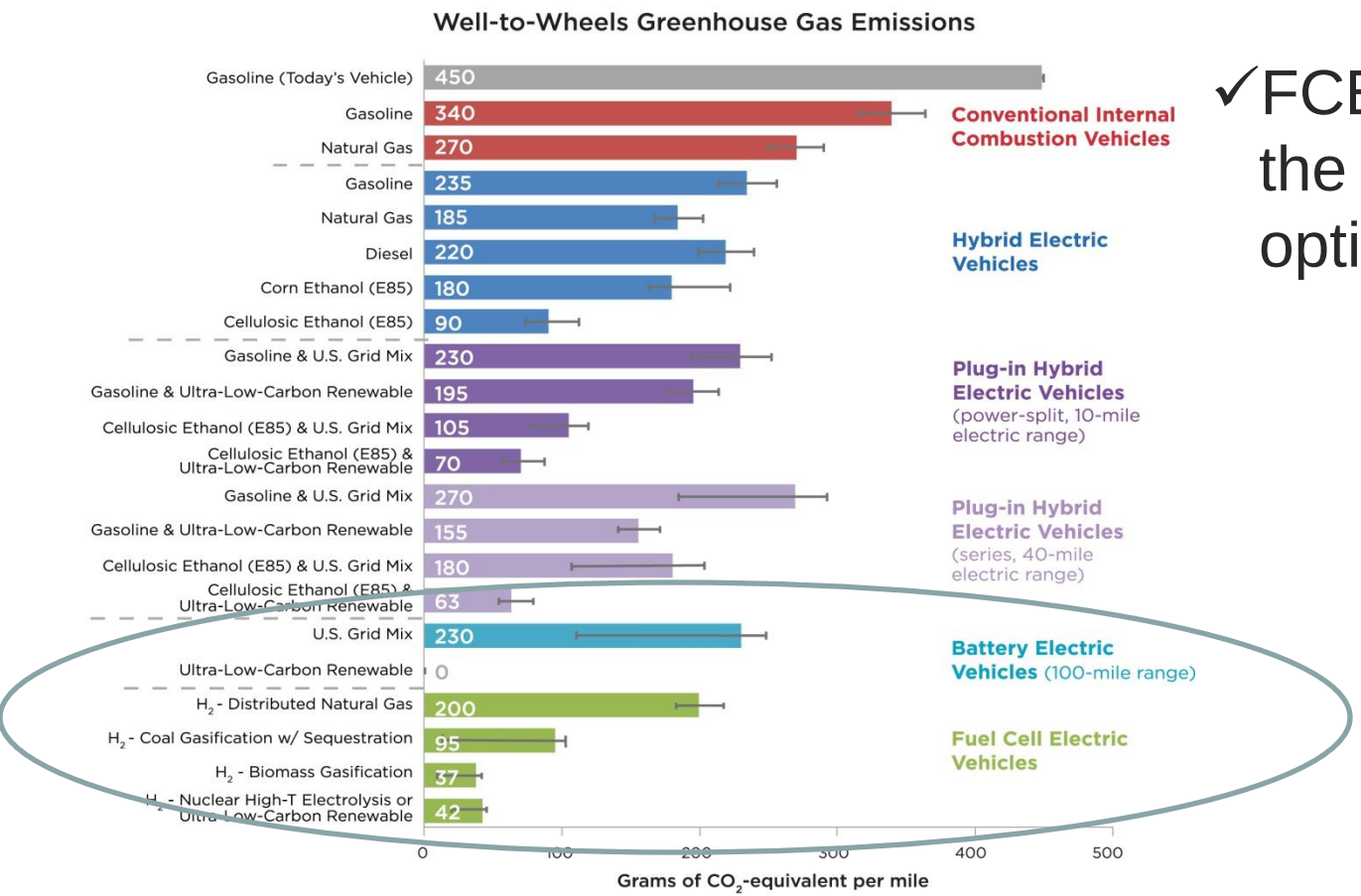


Figure 1.8a. Well-to-Wheels Analysis of Greenhouse Gas Emissions.
Substantial reductions in greenhouse gas emissions are possible through the use of a variety of advanced transportation technologies and fuels, including fuel cell electric vehicles using hydrogen from a variety of sources. Notes: (1) 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.[30]

- ✓FCEVs are one of the lowest GHG options

FCEV and H_2 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

CaFCP survey of automakers	**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_2 stations in CA today

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

H_2 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

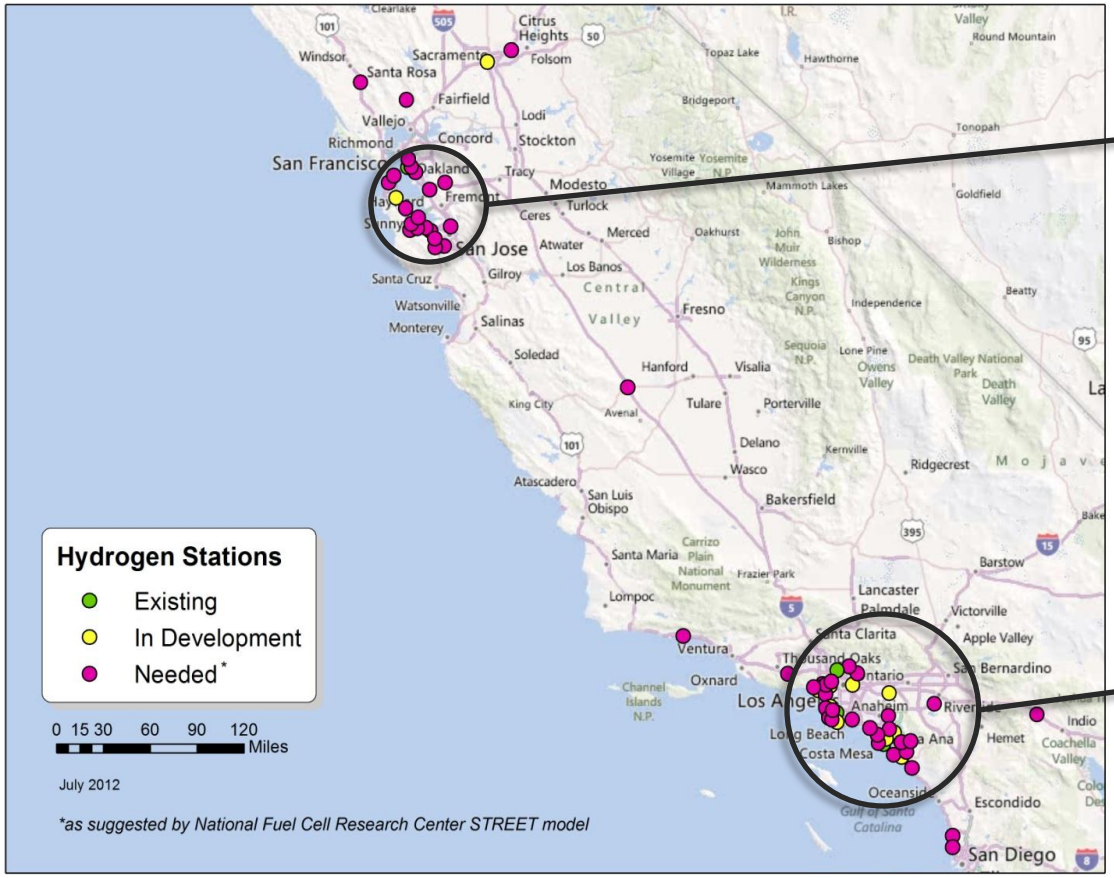
- Stations must come before vehicles
- People want fuel near home, work and in weekend destinations
- Stations must be customer friendly
- Six minutes is the target maximum travel time
  - For early market clusters

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

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
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

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	^
Totals	$71.3	$38.5	$16.1	$23.5

*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/

- 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
TOTAL	1,011	$4,656,468

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