



# Perspective & Context of Historic Demand and Alternative Fuels

## Staff Workshop on the Role of Alternative Fuels in California's Transportation Energy Future

Staff Workshop

November 14, 2011

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**DOCKET**

**11-IEP-1L**

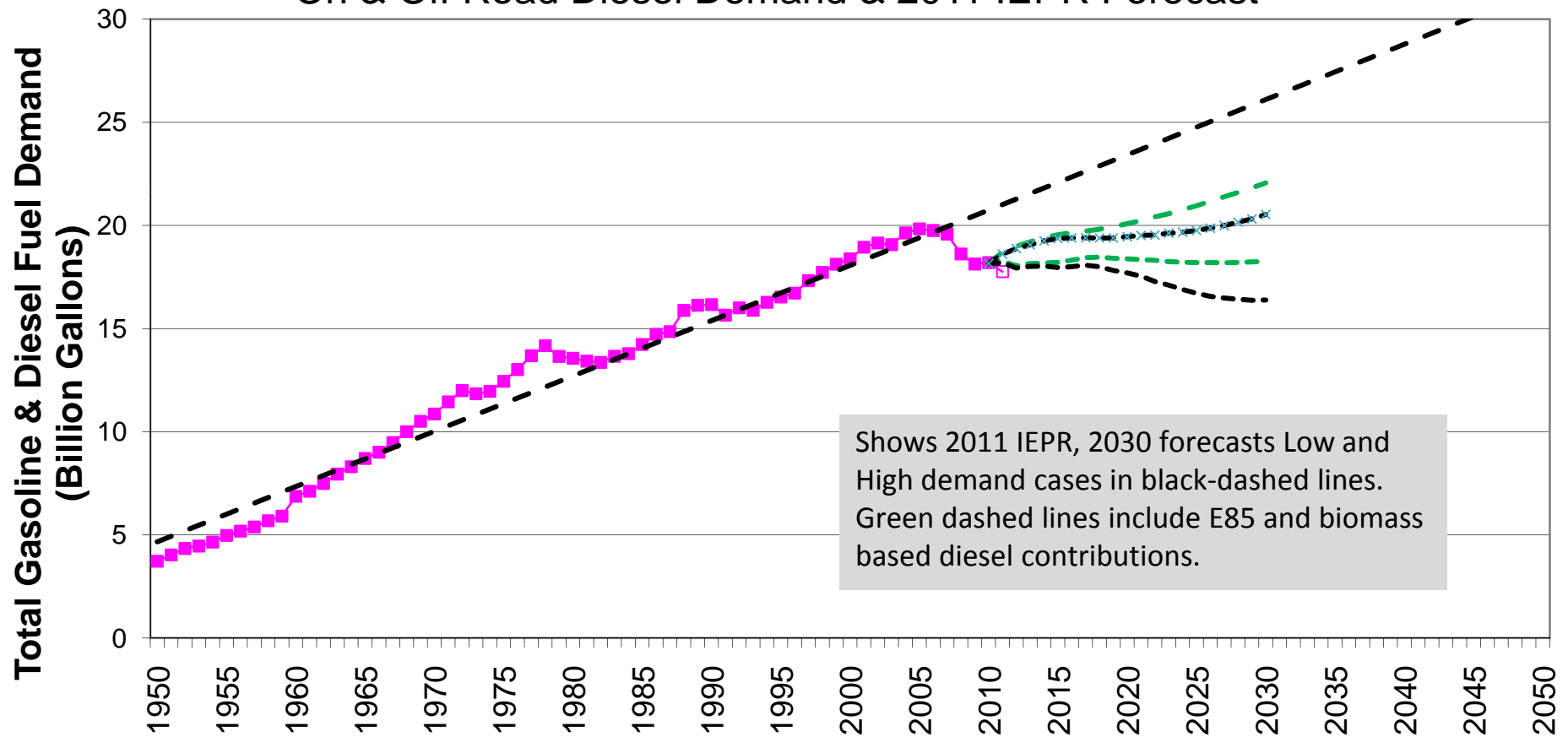
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# Transportation Fuel Trend & Forecast

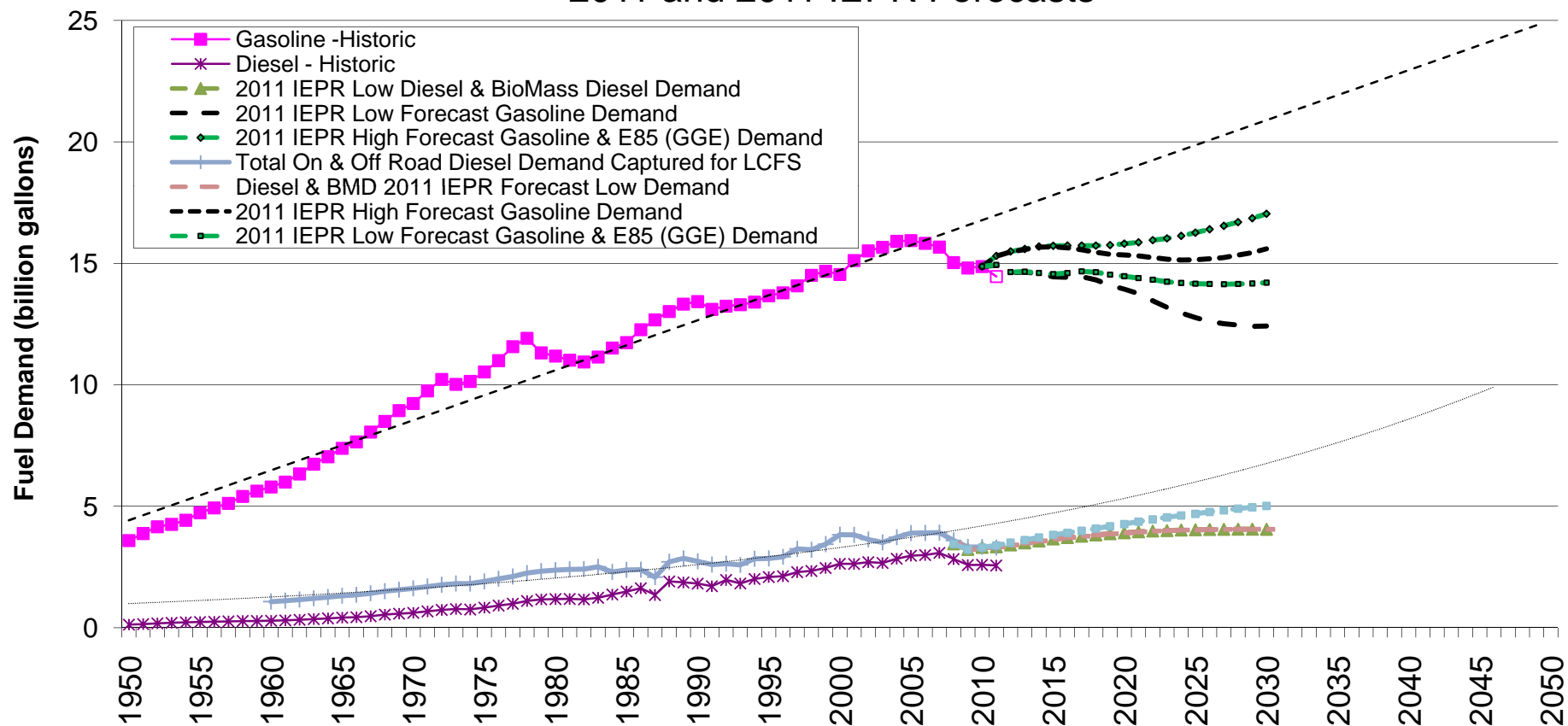
100-year Trend -California's Combined Historic Gasoline & On & Off Road Diesel Demand & 2011 IEPR Forecast





# 100-Year Transportation Fuel Demand View

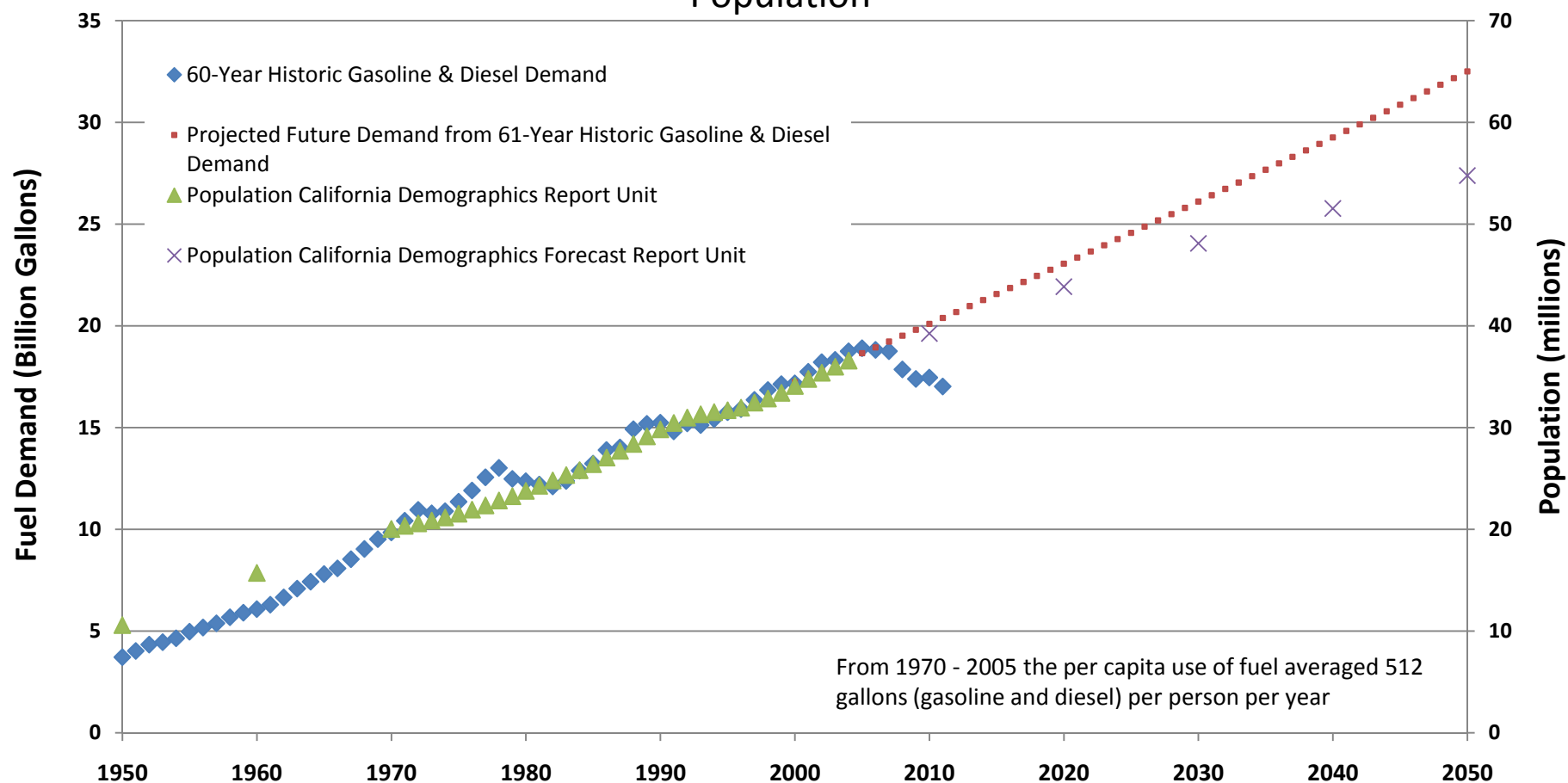
100 Year View - California's 61-year Gasoline and Diesel Trends 1950 - 2011 and 2011 IEPR Forecasts





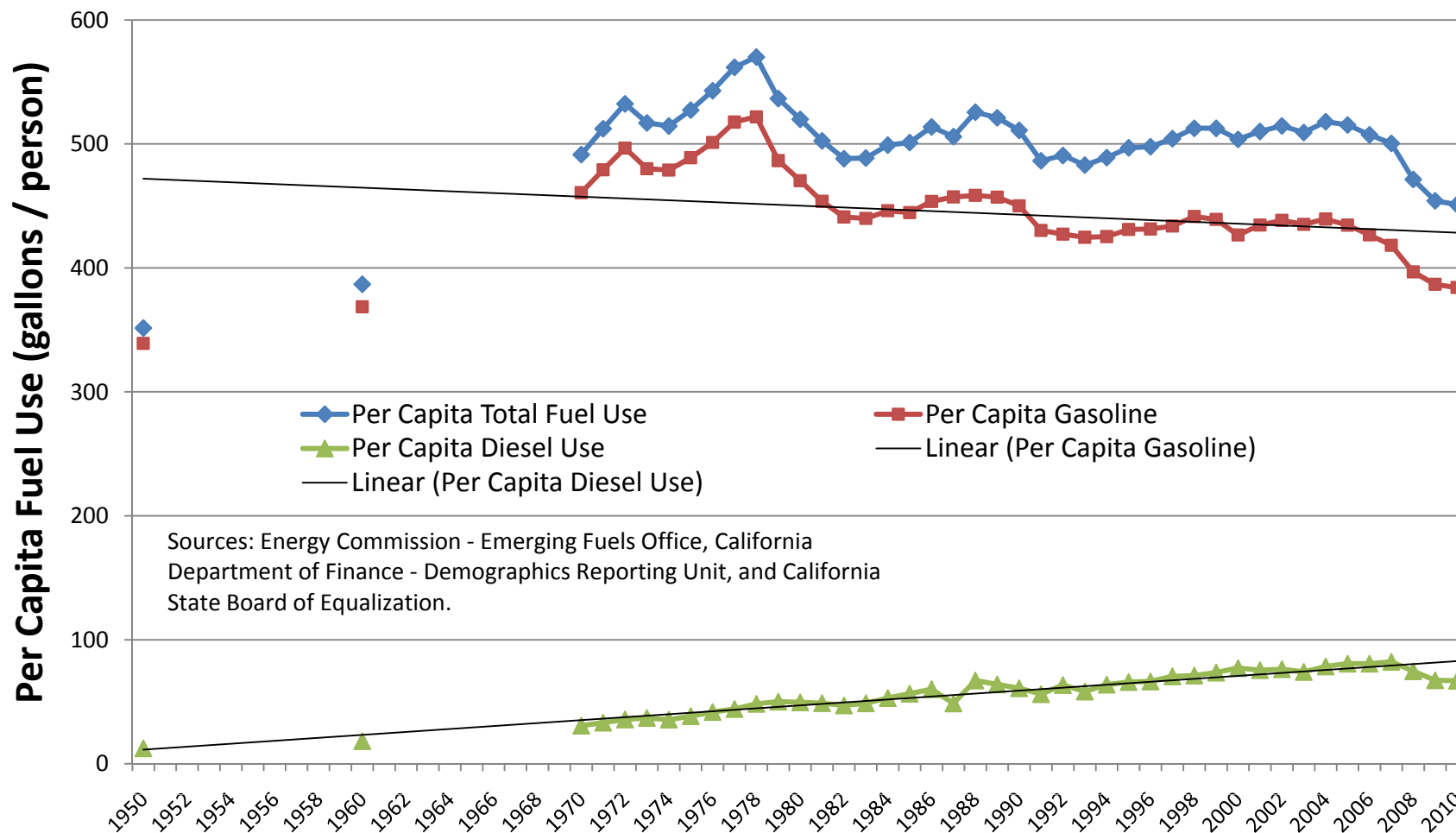
# Population $\approx$ Demand

California's 100 Year Aggregate Gasoline and Diesel Demand versus Population





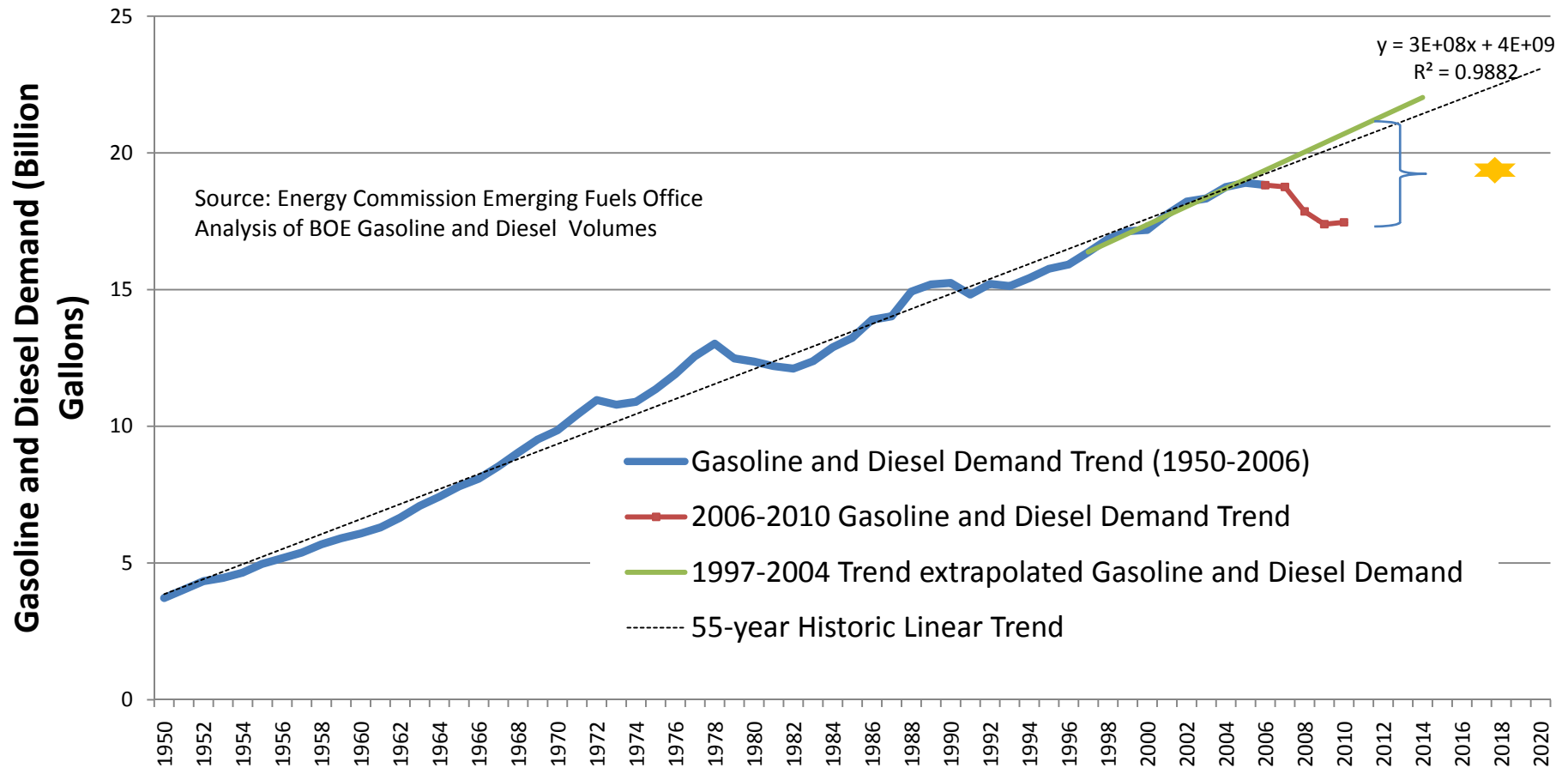
# Per Capita Demand: Diesel Up and Gasoline Down





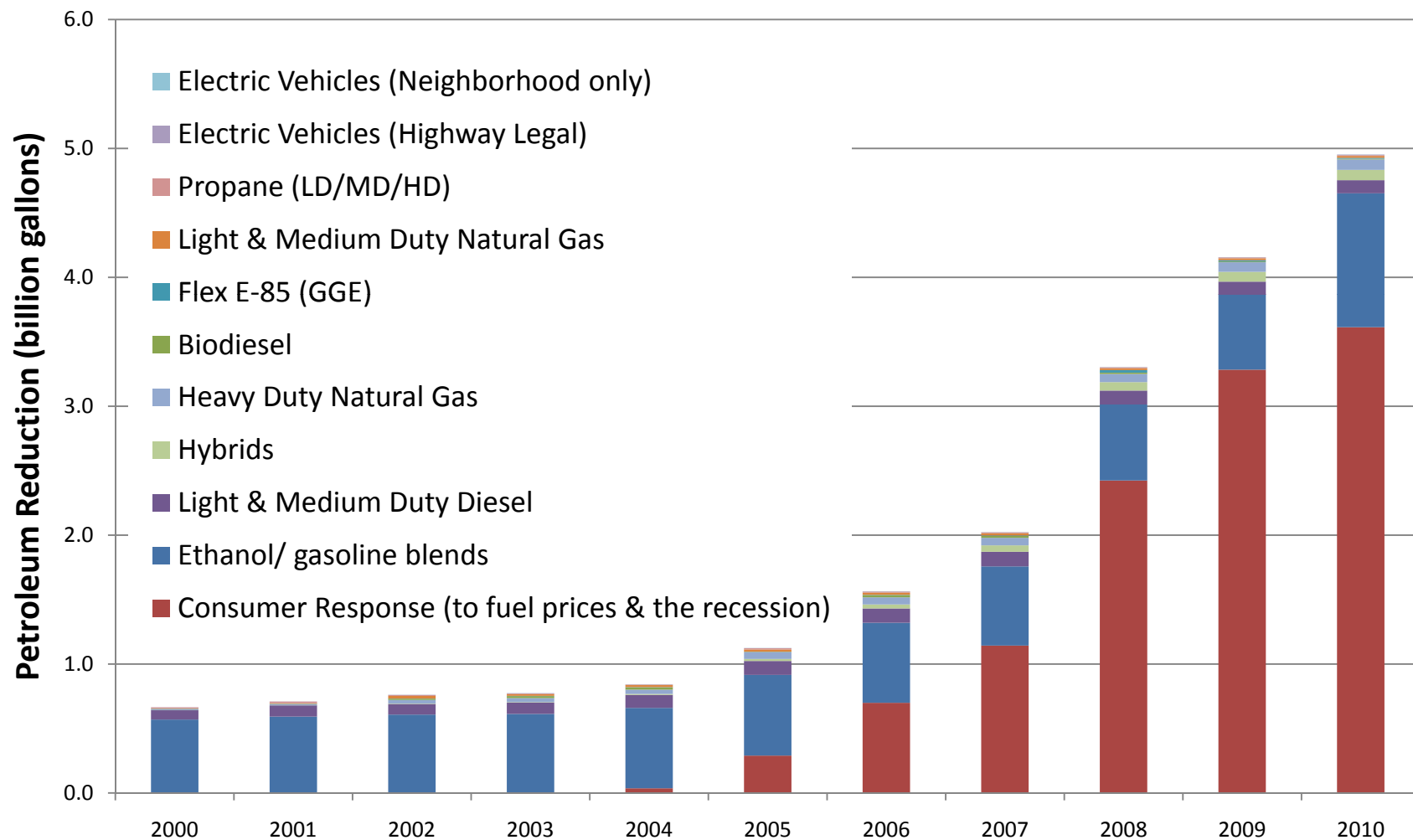
# What has changed over the last decade?

## California Gasoline & Diesel Demand Trend (1950-2010)



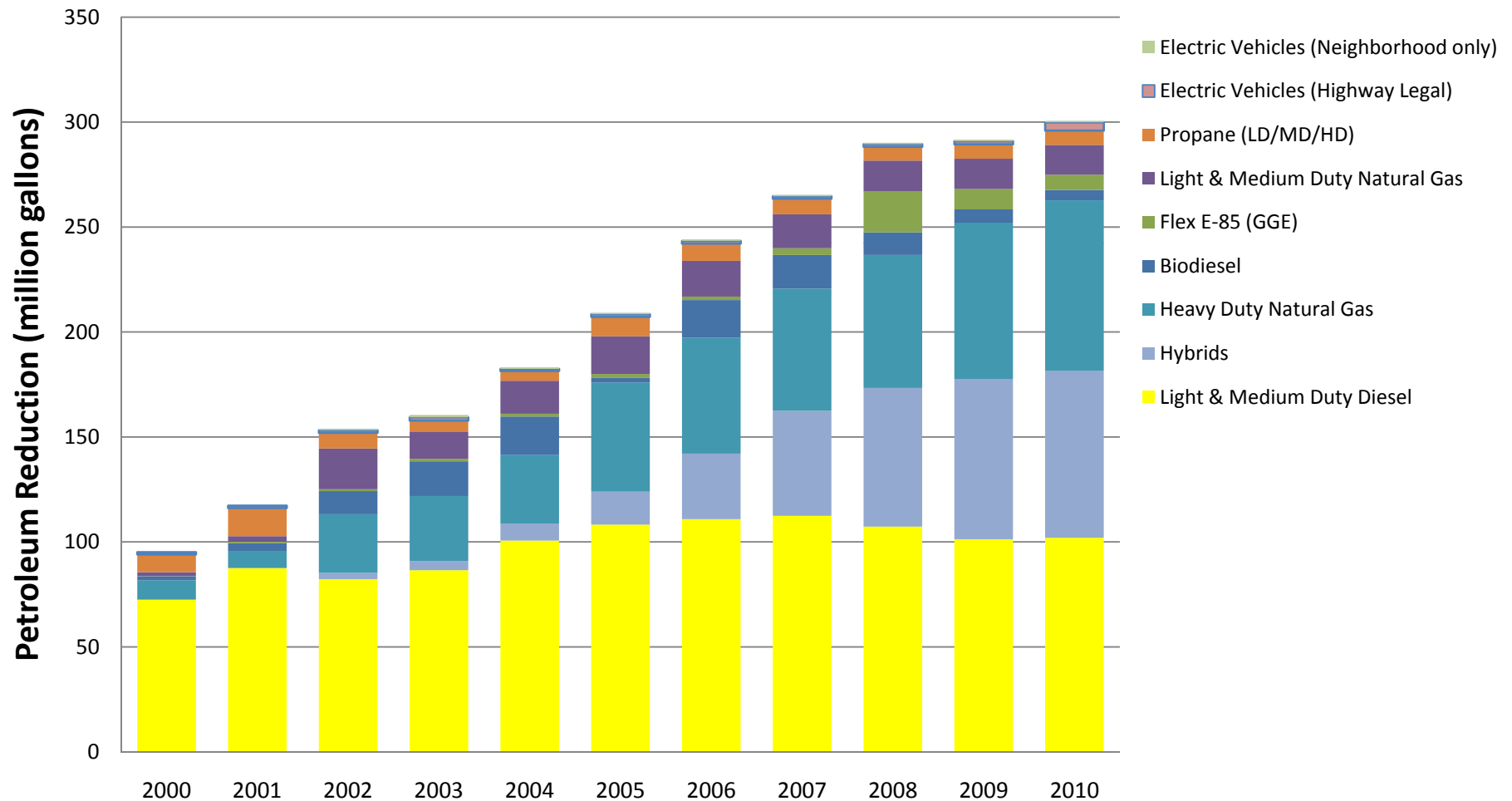


# Demand Response & Alternative Fuels





# Petroleum Displacement Other Than E10 and Consumer Response

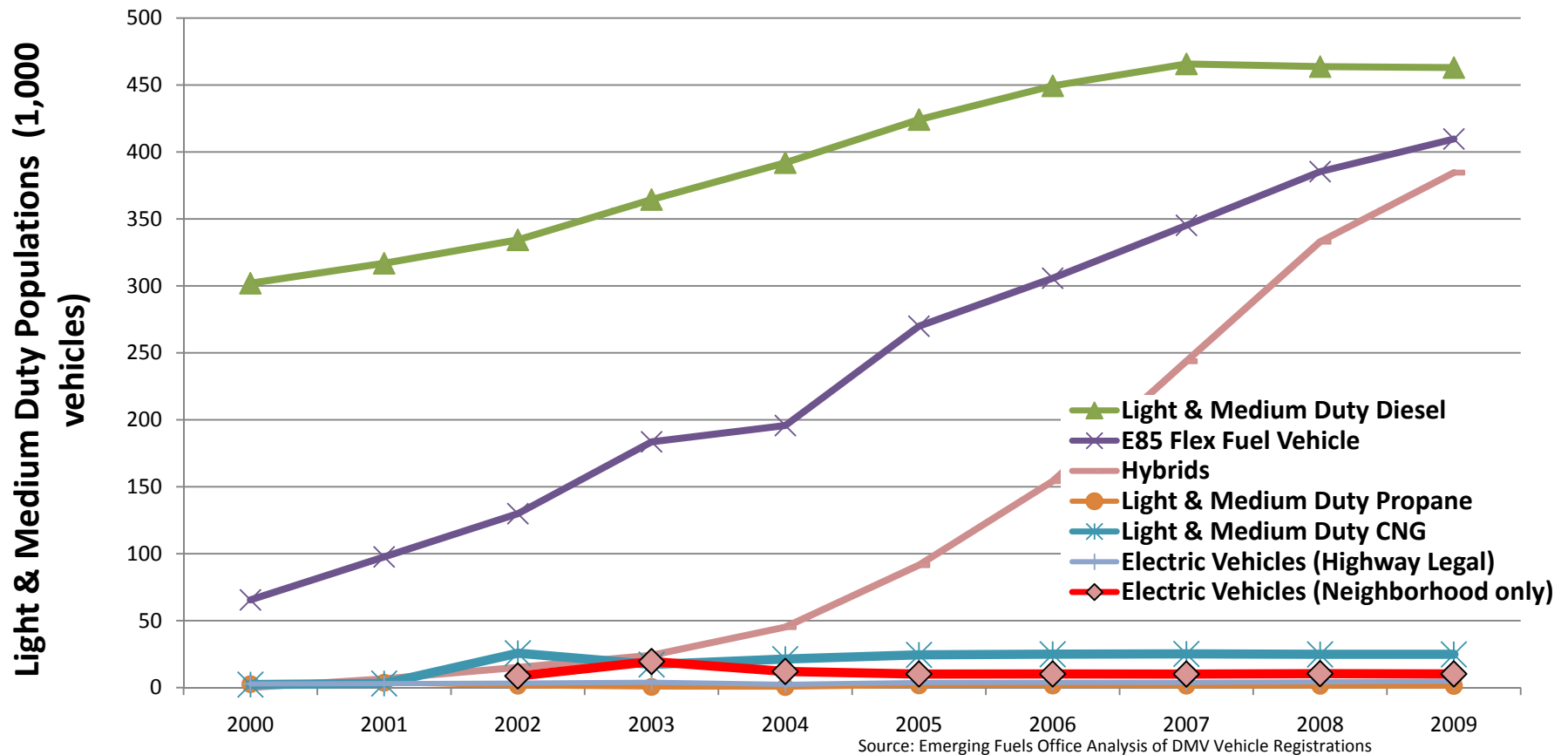






# 3 Vehicle Types Grew 2000-2009

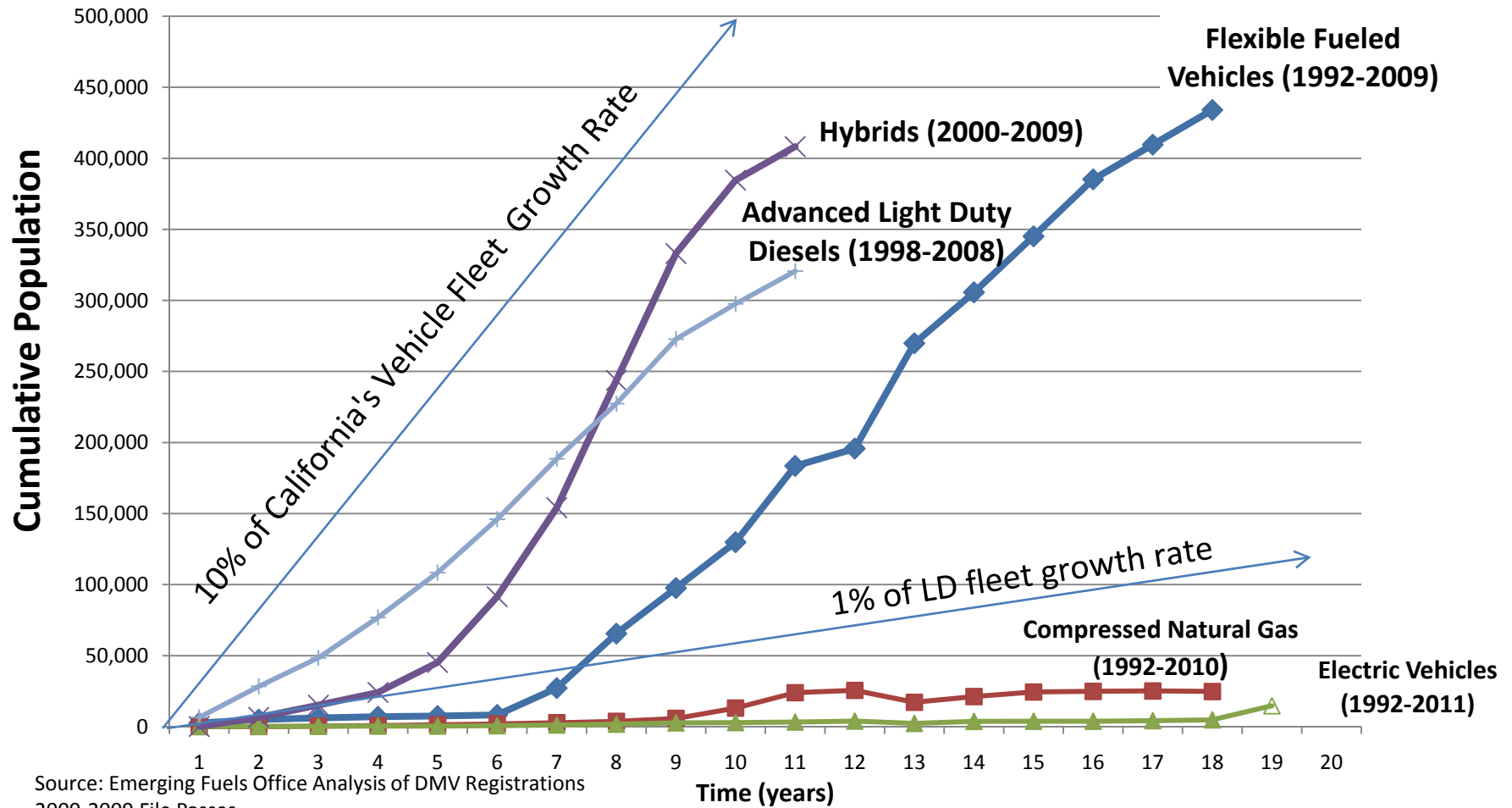
## California Light & Medium Duty Vehicle Population Trends





# Non-Conventional Vehicle Trends

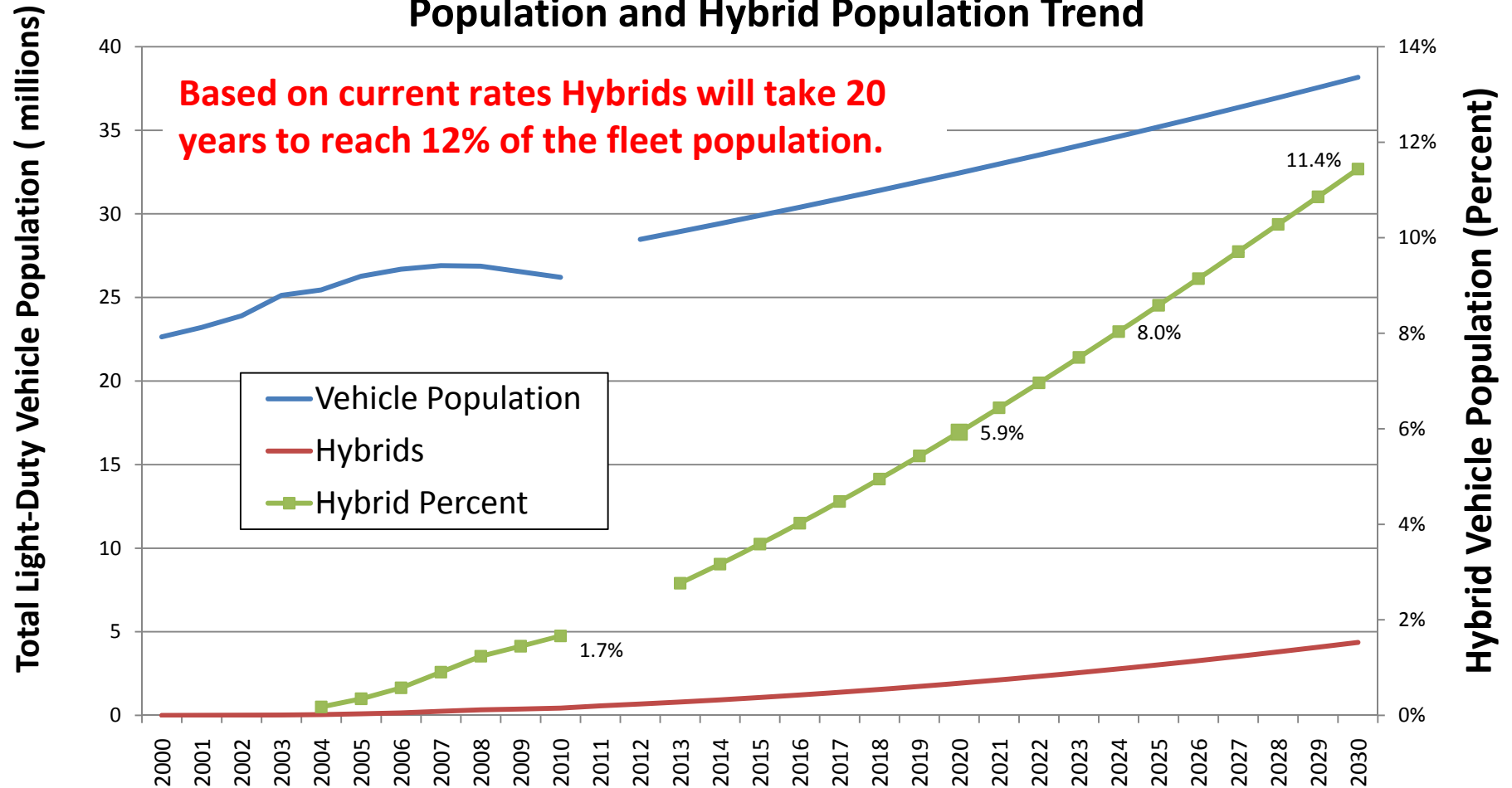
## California's Historical Light Duty (LD) Technology Penetration





# Vehicle Migration Takes Time

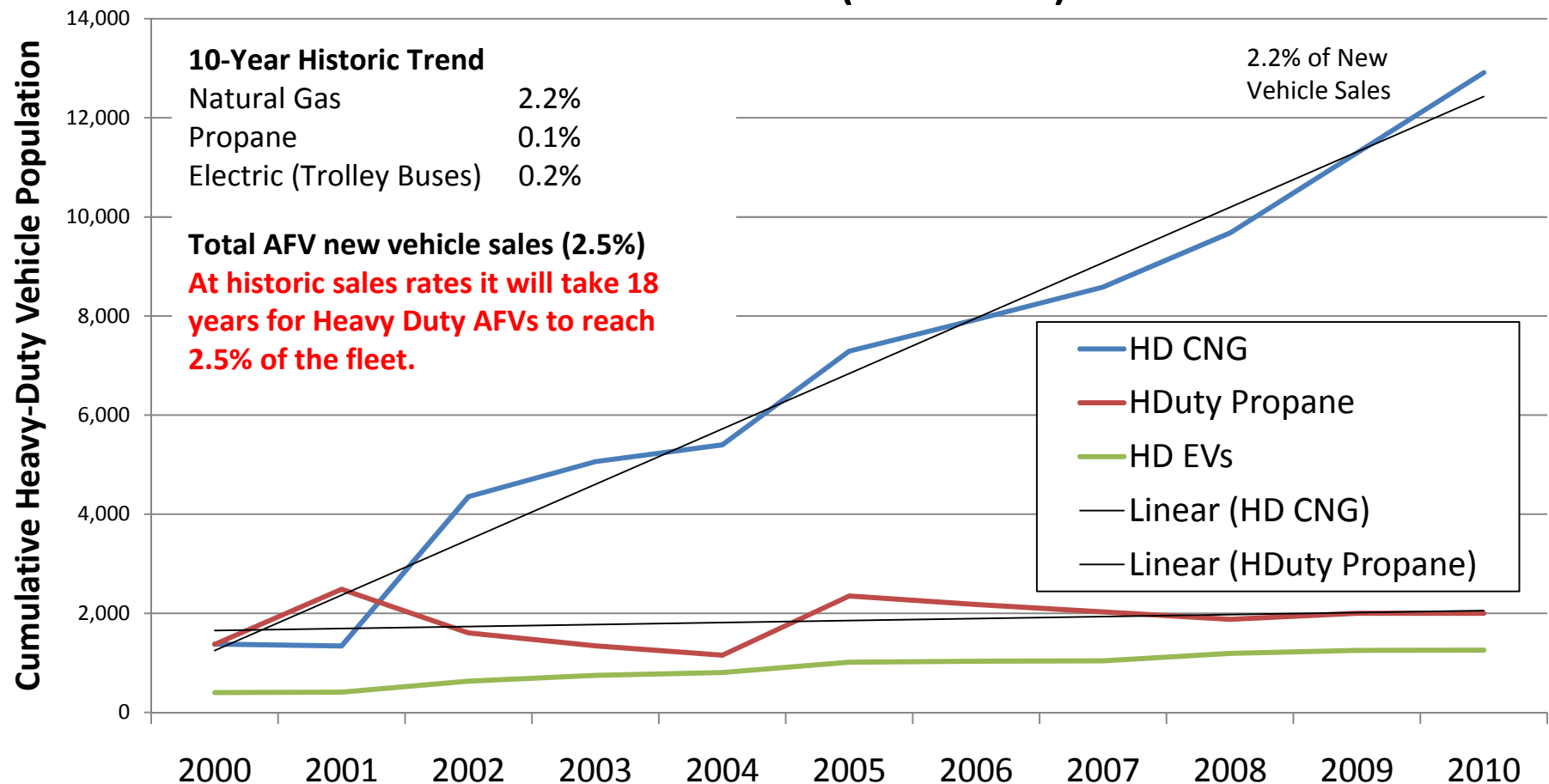
## California's Historic and Projected Total Light Duty Vehicle Population and Hybrid Population Trend





# Heavy Duty AFV Trend

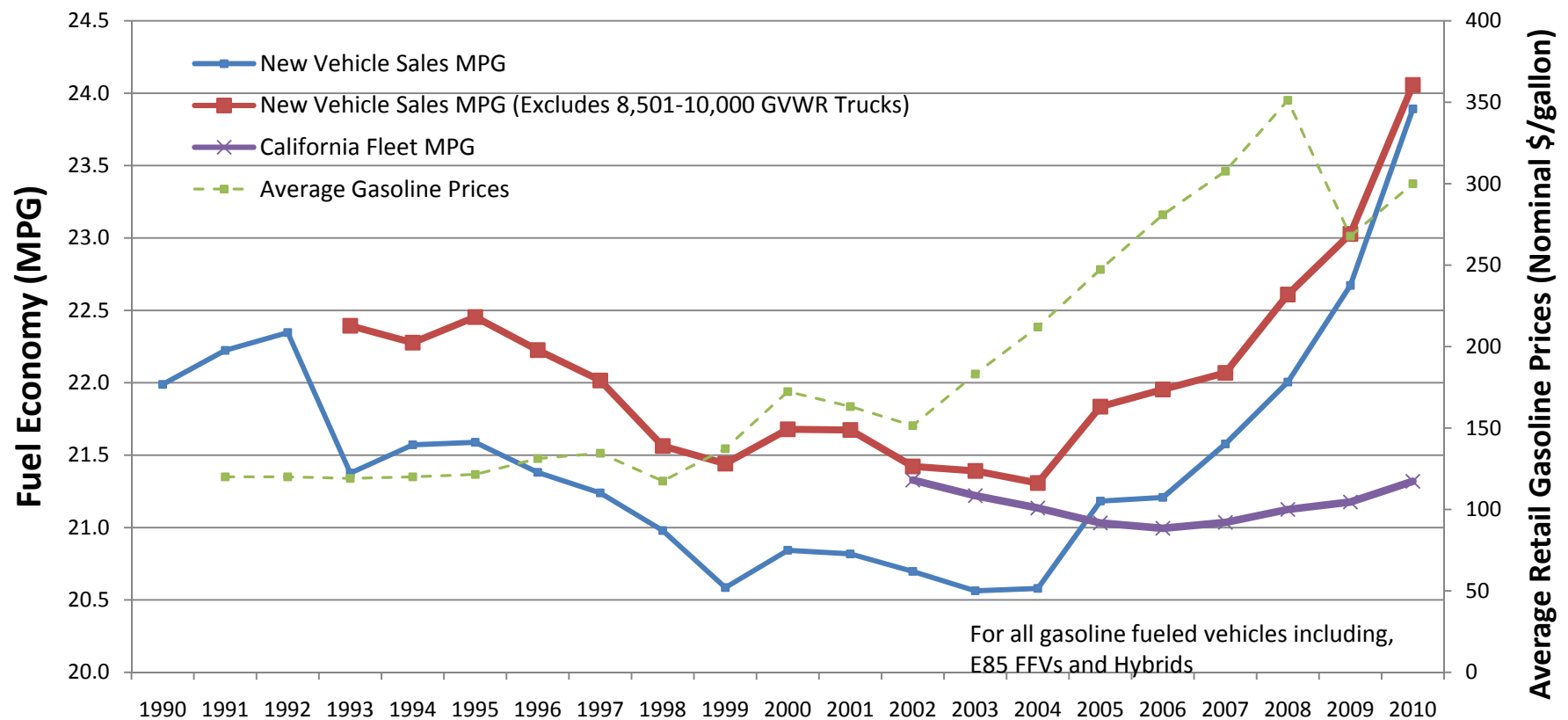
## Historic California Heavy Duty Alternative Fuel Vehicles (AFVs) Penetration Rates (2000-2009)





# Sustained Fuel Economy Improvement since 2005

## New Light Duty Gasoline Vehicle Sales Weighted Average MPG

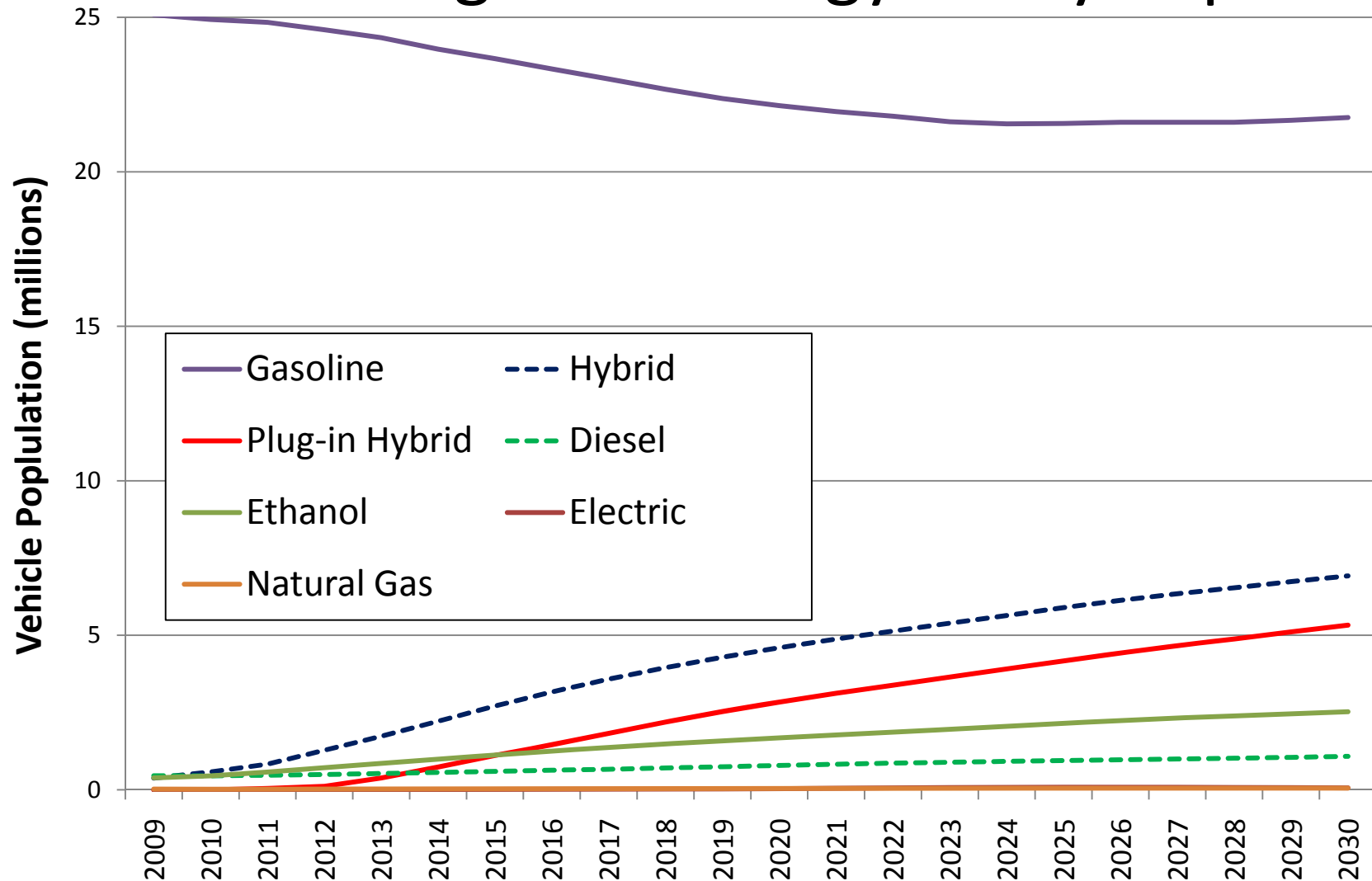


Source: G Yowell, Energy Commission Emerging Fuels Office Analysis, DMV Registered Vehicle, Total Fuel Use Analysis and EIA retail gasoline prices.



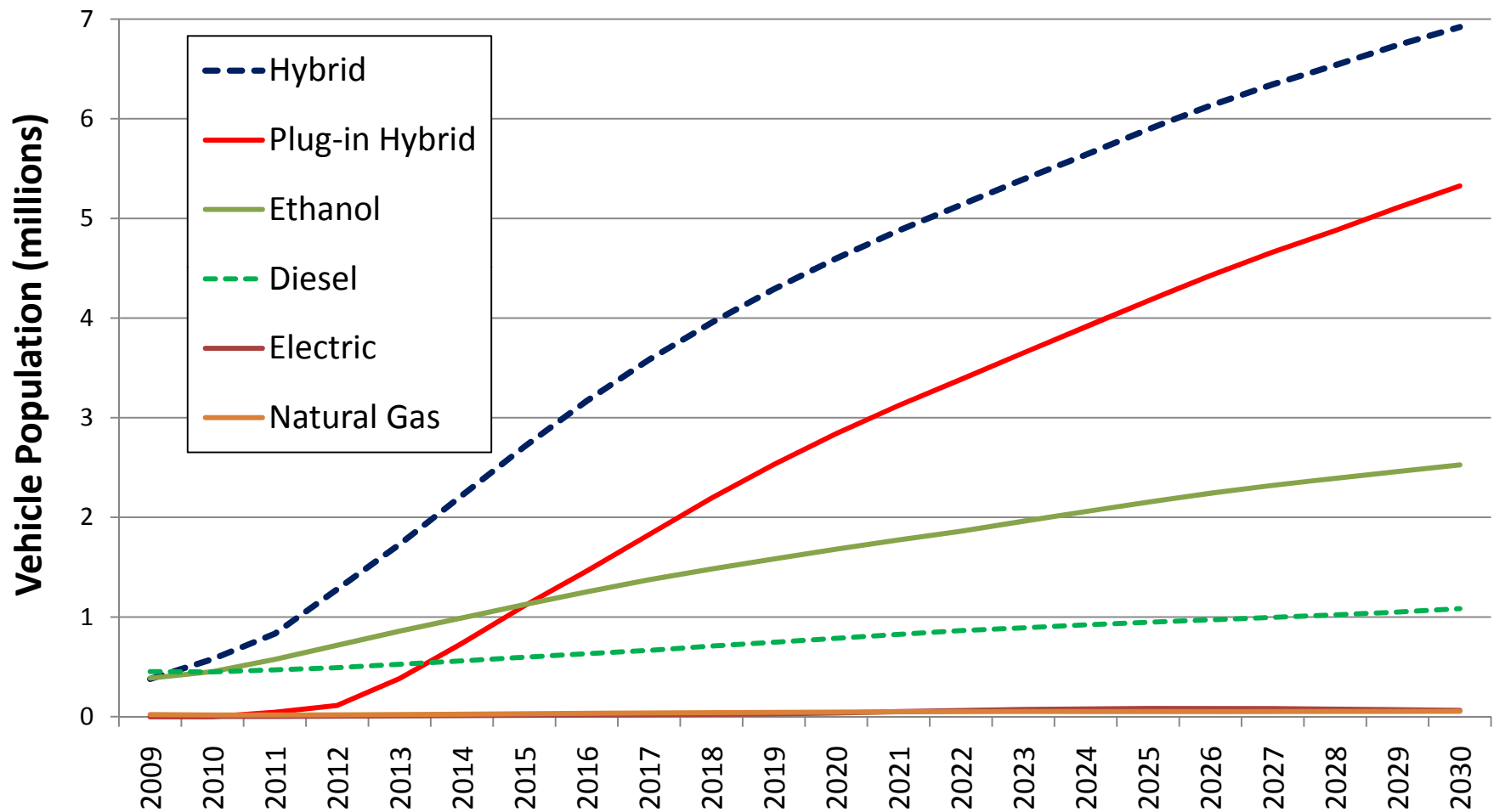
# California Vehicle Forecast

## 2011 Integrated Energy Policy Report



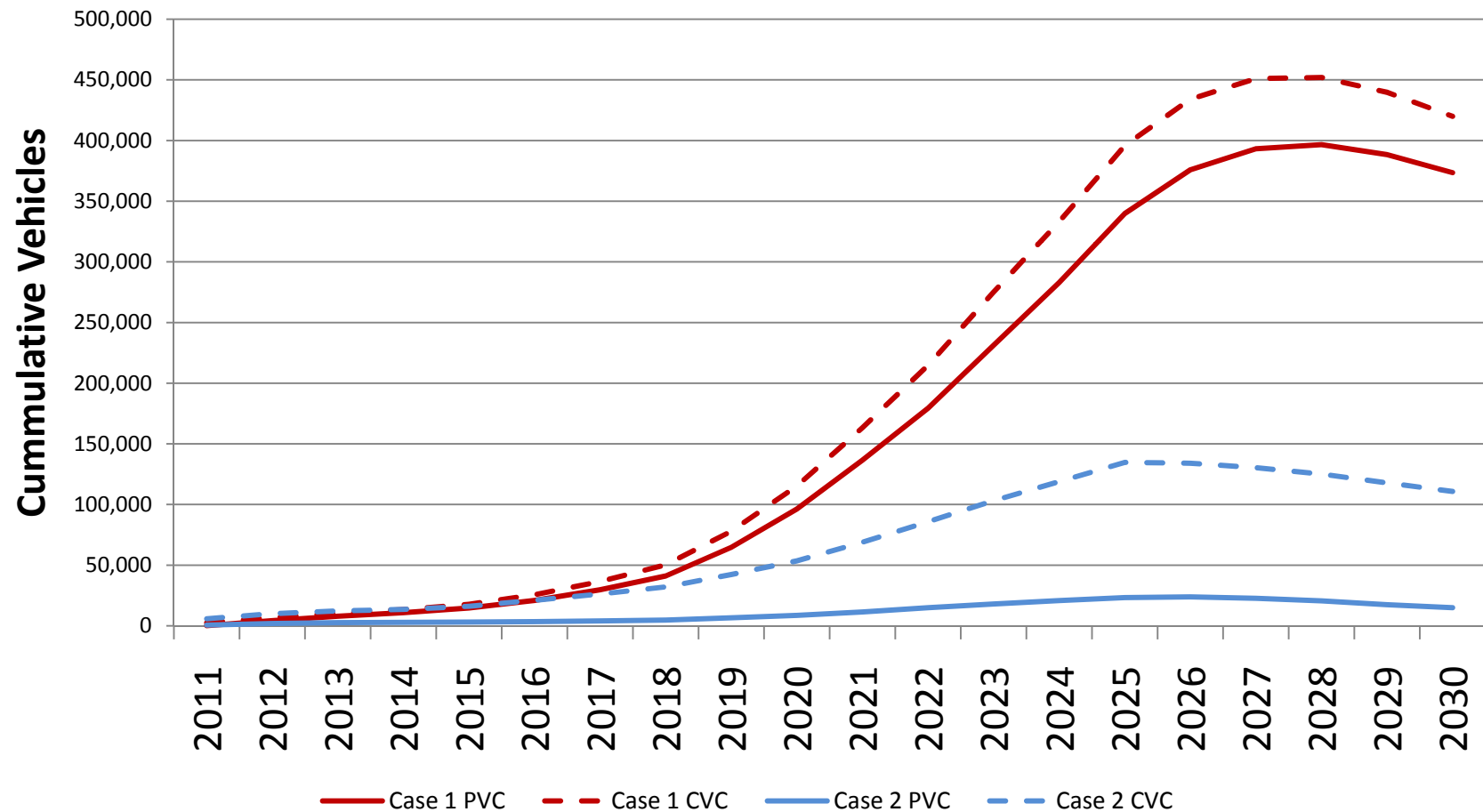


# Light Duty Vehicle Forecast – 2011 IEPR





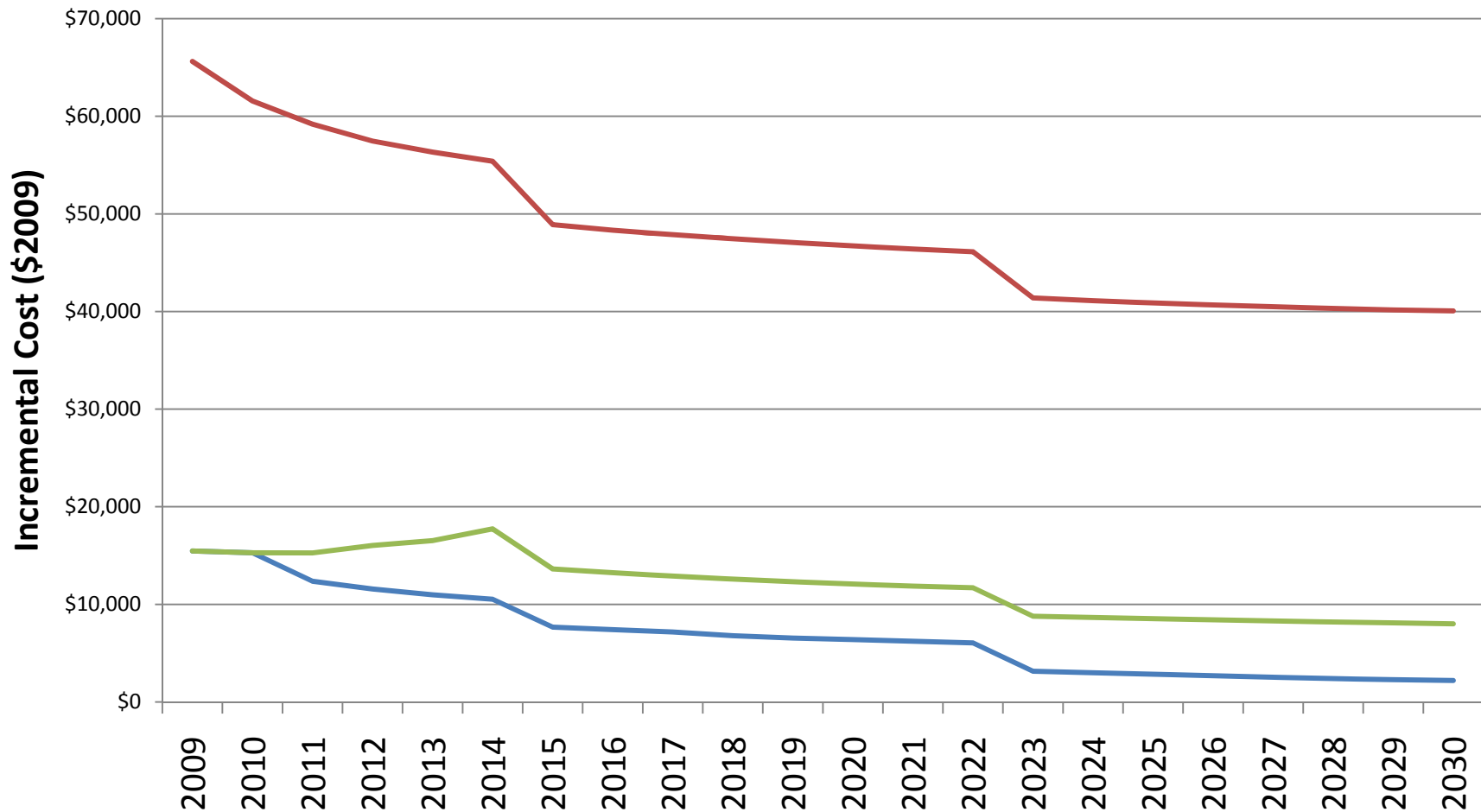
# California Electric Vehicles





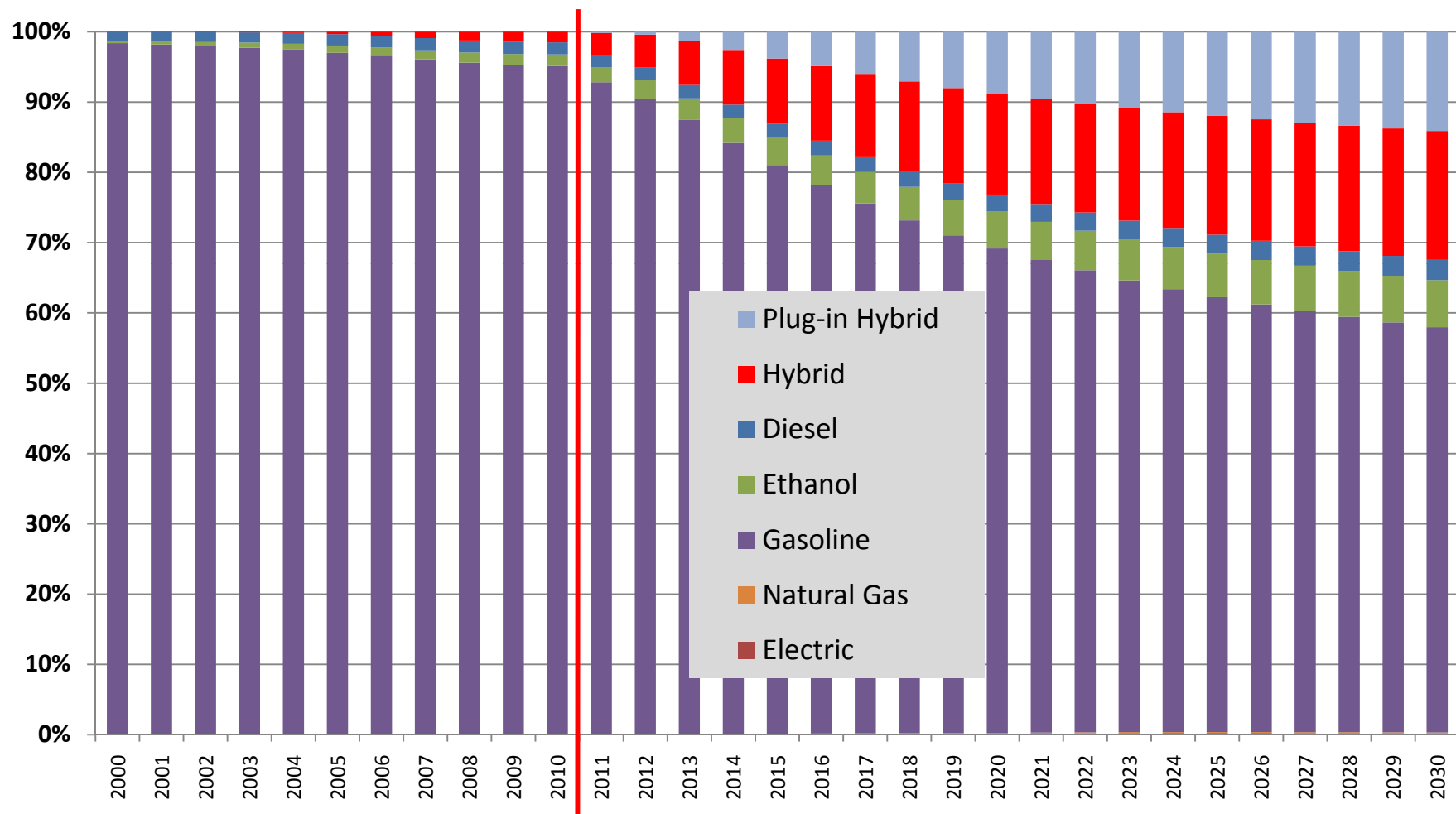


# Electric Vehicle Incremental New Purchase Price





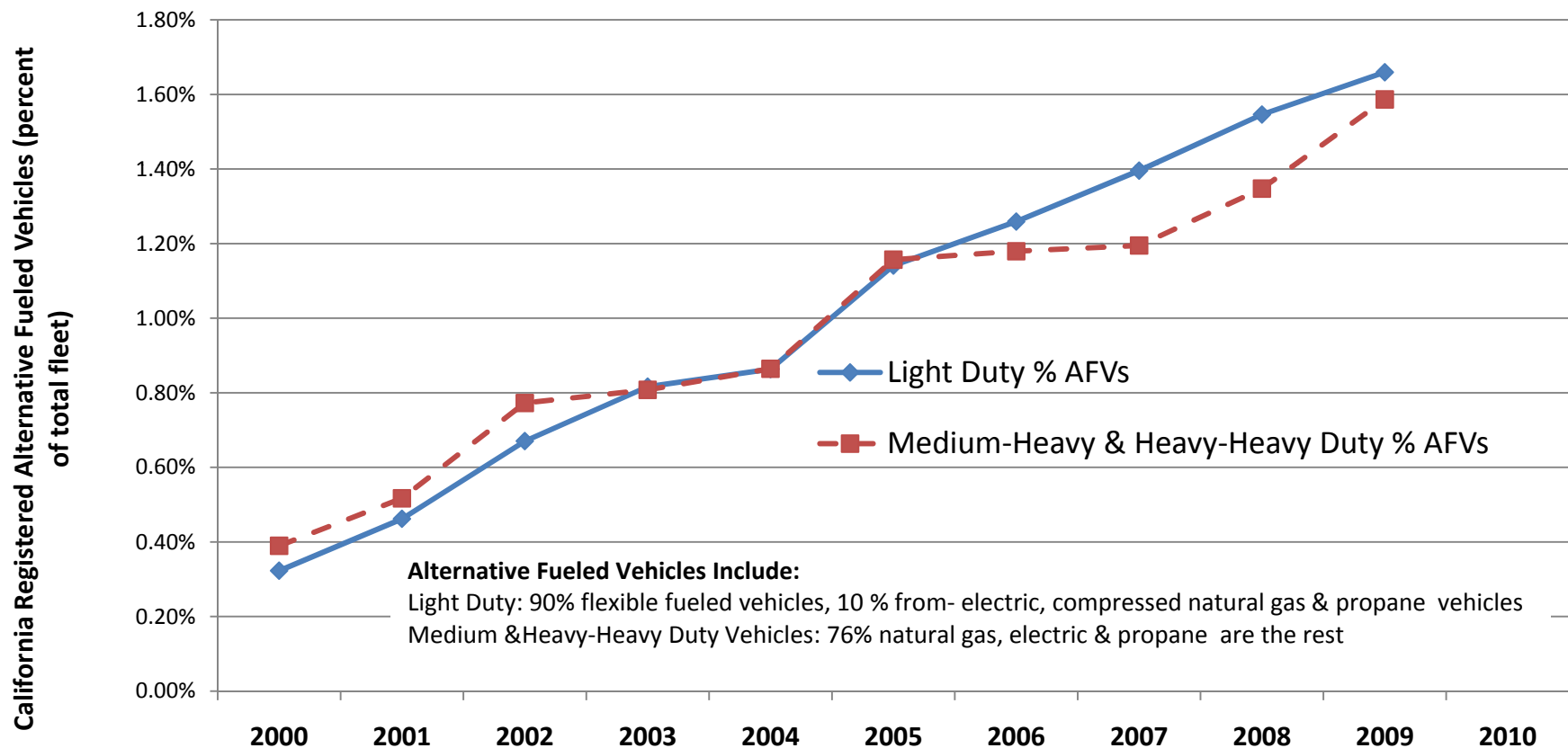
# Light Duty Vehicle Trends Historic and 2011 IEPR Forecast





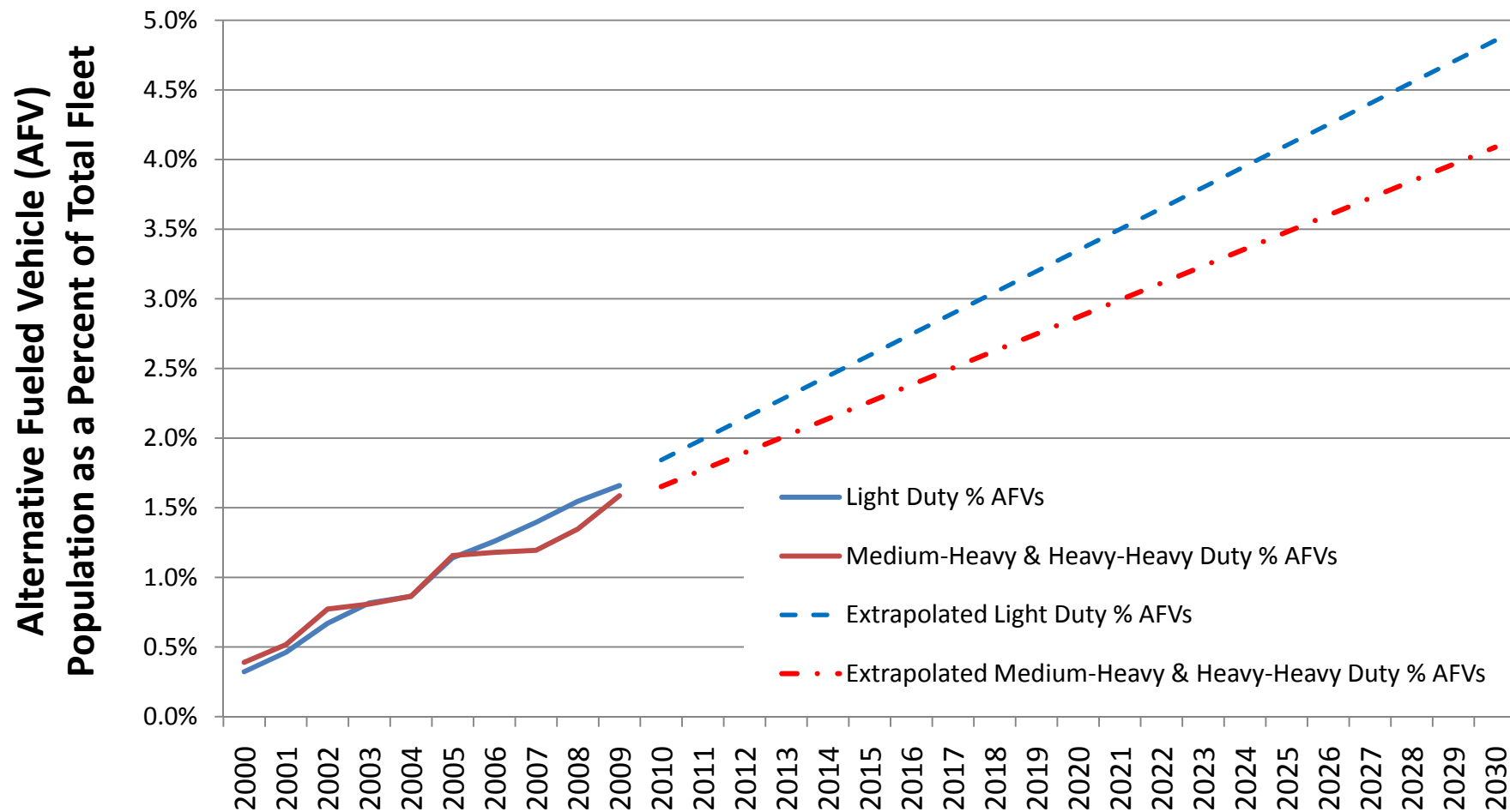
# Alternative Fueled Vehicles (AFVs) Migration Rate Has Been Slow

Percent of Total Fleet Trend





# Historic Trends Project AFV Penetration Below 5% of the Fleet by 2030



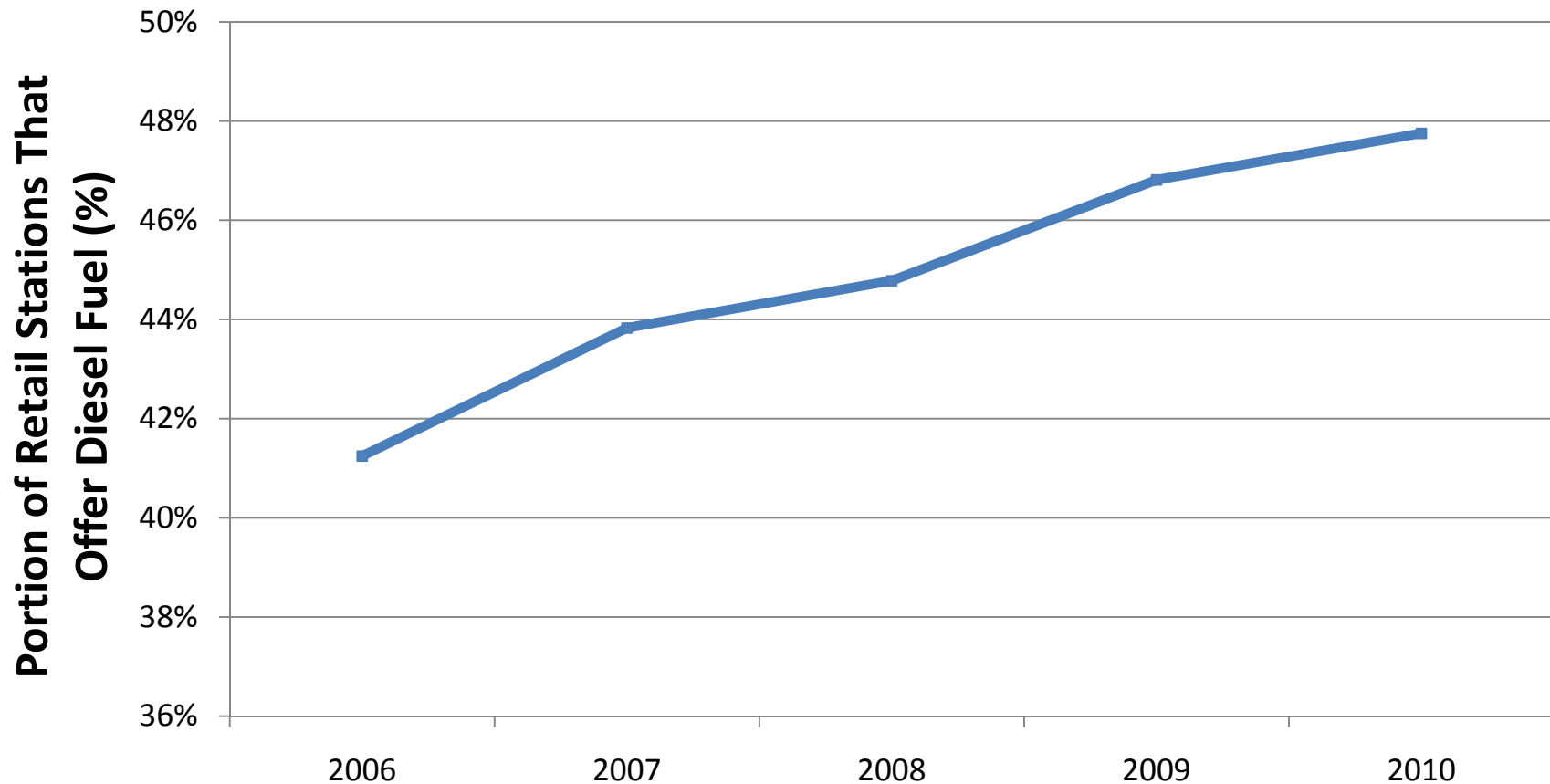


# Transportation Fuels Infrastructure Comparison

Fuel Type	Estimated Average Dispensing Station Cost Excluding Land	Estimated Maximum Fuel Dispensing Capacity Per Station Per Year	Source or Number of Stations Used to Estimate Costs	Average Quantity Fuel Dispensed Per Location 2010	Fuel Availability Locations 2010
Gasoline	\$470,000	18,235,545	Industry	1,225,316	7,700
Diesel	\$300,000	18,235,545	Industry	118,325	3,700
Propane (0.9 EER -gge)	\$125,000	4,275,389	Industry	16,784	190
E85 (gge)	\$331,914	4,204,800	23	73,272	50
CNG (dge)	\$1,747,000	1,241,455	3	46,307	54
LNG/CNG (dge)	\$2,474,150	8,500,000	1	4,400,000	1
LNG (dge)	\$1,568,667	8,795,738	3	62,500	0
EV Home Charger (2.9 EER - gge)	\$3,400	2,993	3	360	N/A
PHEV Home Charger (Volt - gge)	\$3,400	1,497	3	155	N/A
PHEV Home & Public Charger (Volt-gge)	\$3,400	748	4	160	N/A
EV Retail Light Duty (gge)	\$8,800	7,483	3	70	N/A
EV Heavy Duty (2.7 EER - dge)	\$125,000	22,449	3	6,000	N/A
Hydrogen (2.2 EER- gge)	\$2,757,208	192,720	11	19,272	11
Hydrogen (@24kg/day) (H2/kg)	\$2,757,208	87,600	11	8,760	11



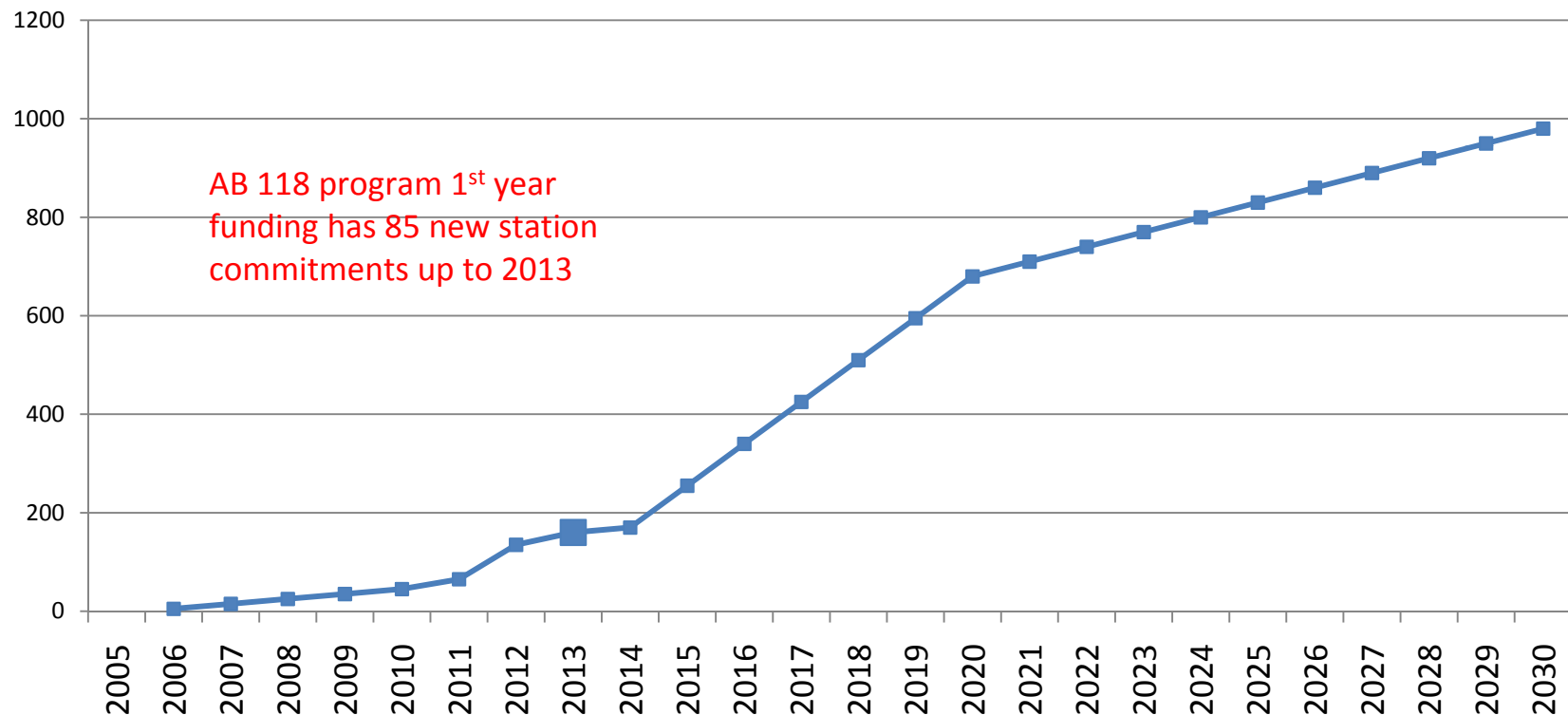
# Fueling Station Availability of Diesel Continues to Grow in California





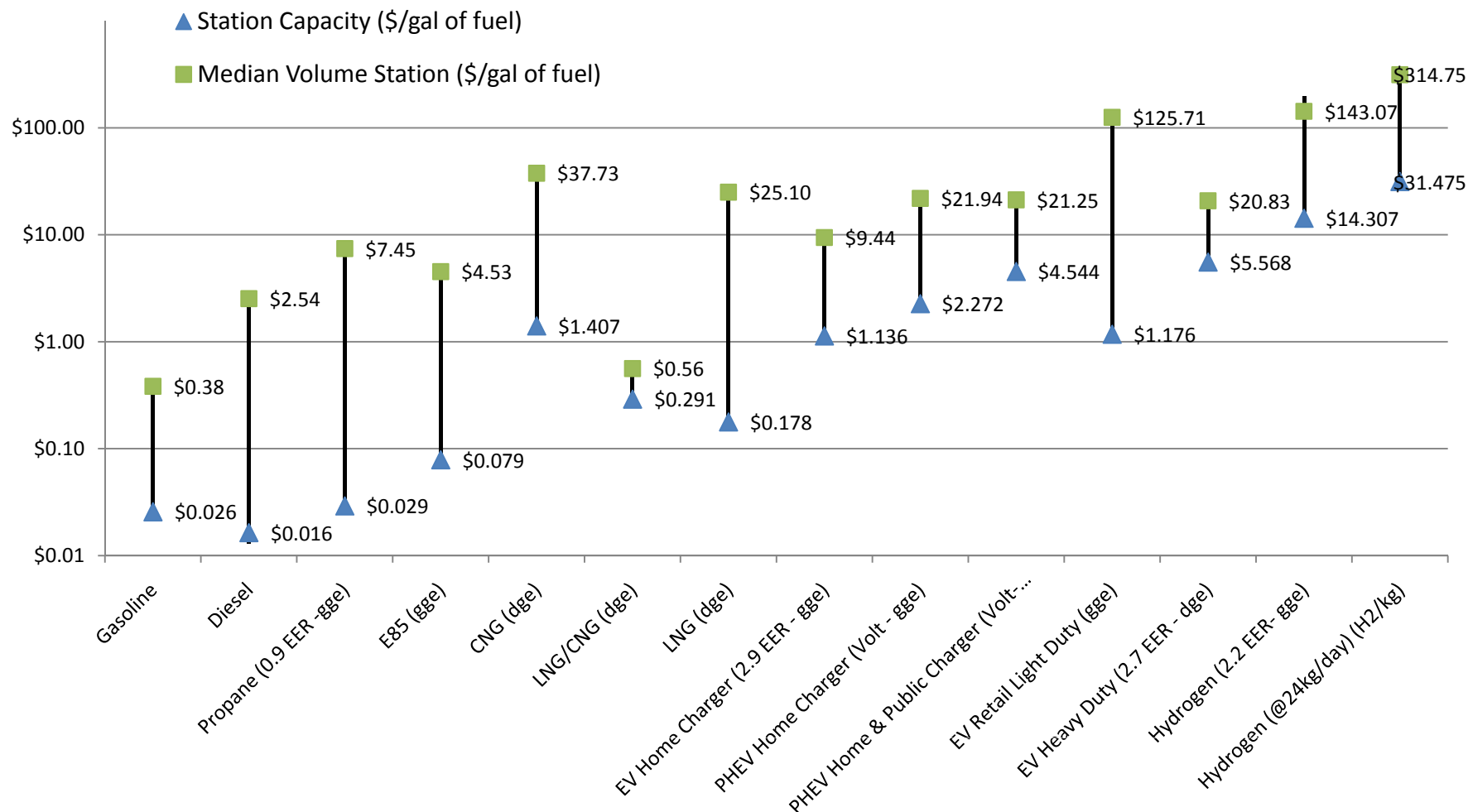
# E85 Stations Past and Projected

Cumulative E85 Stations





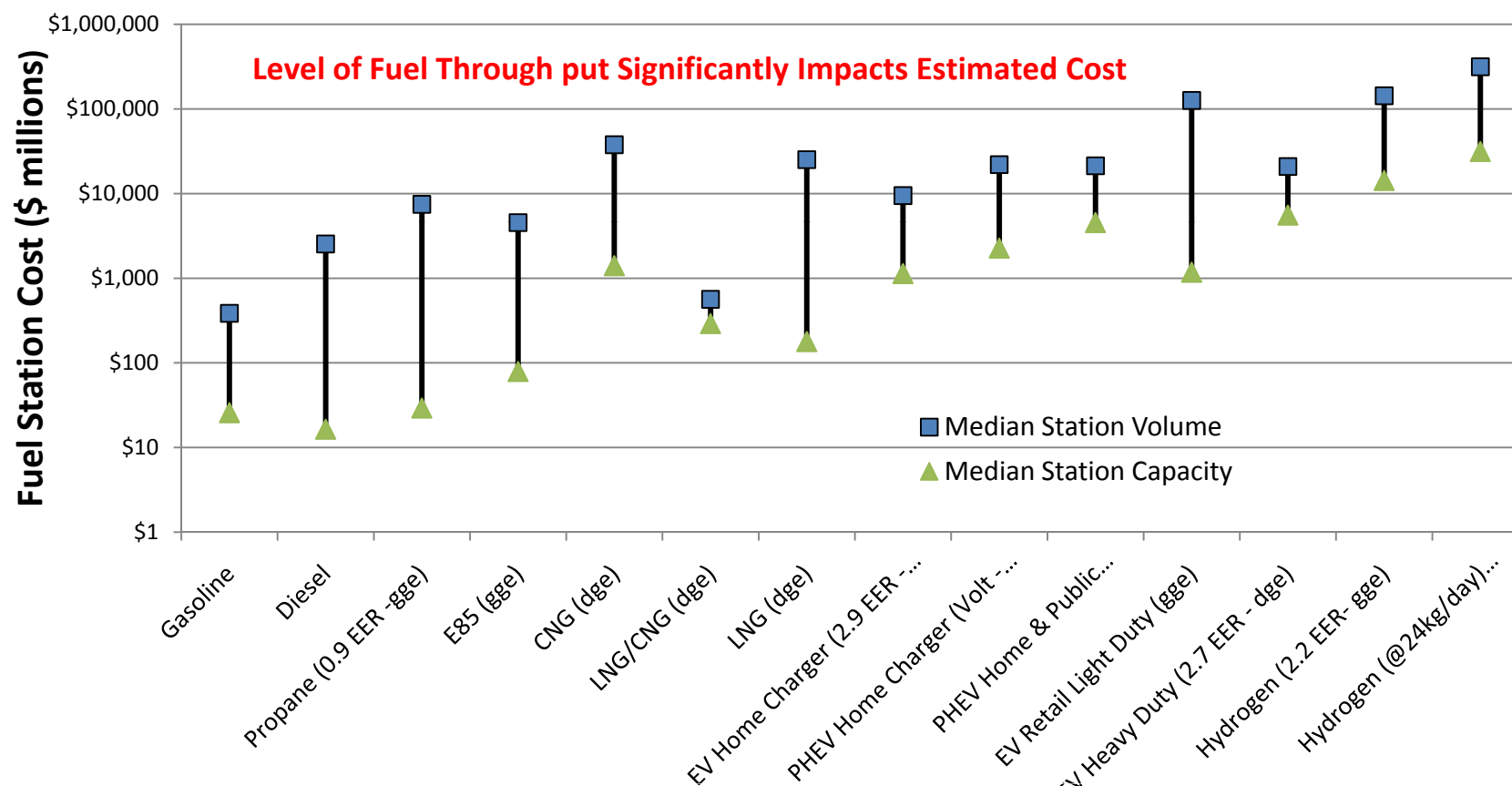
# Infrastructure Cost Per Annual Capacity Dollars per Gallon of Dispensed Fuel (Gasoline or Diesel Gallon Equivalent)







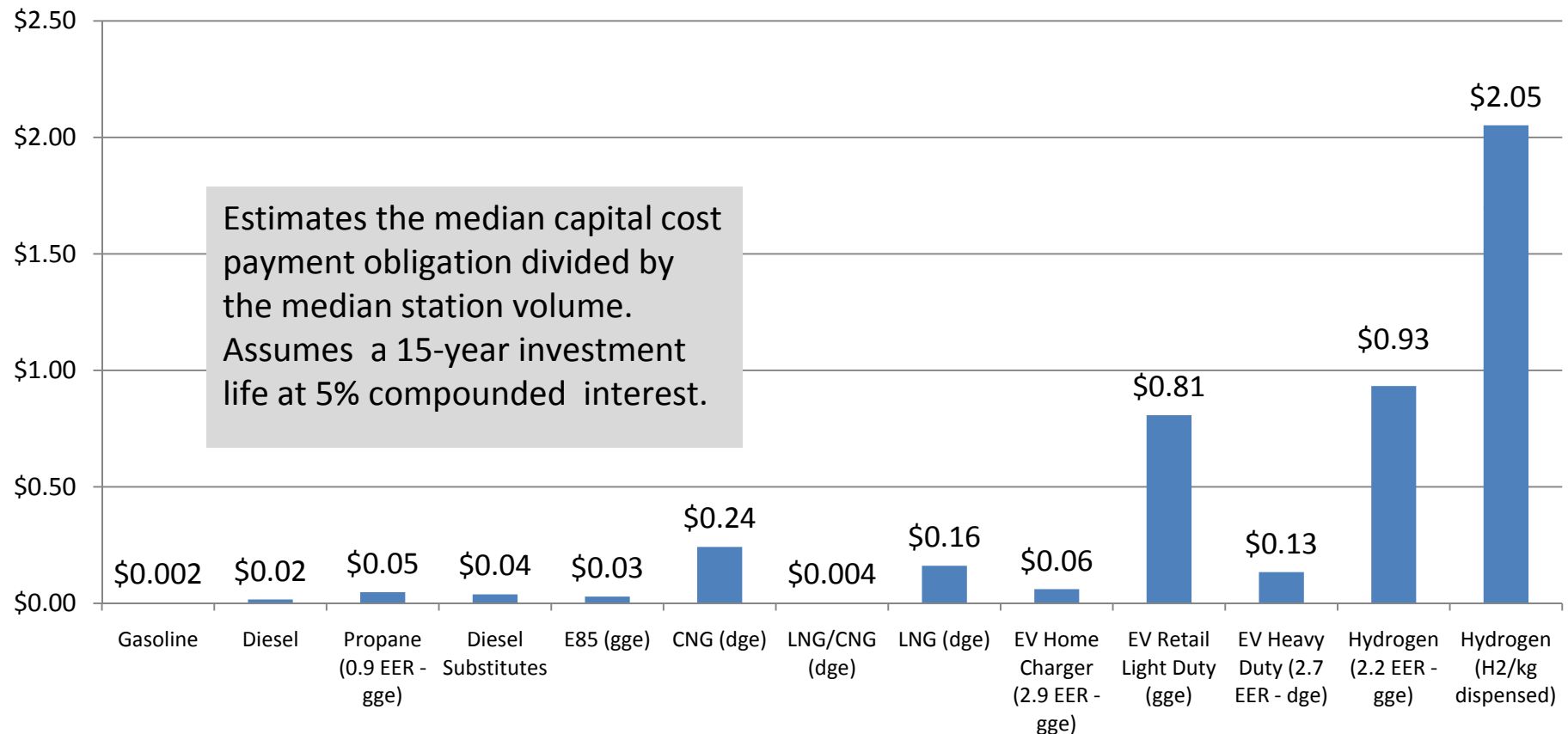
# Estimated Fueling Station Capital Costs per Billion Gallons Dispensed



Sources: Estimated costs based on state-funded projects. Volumes based on Energy Commission data.



# Median Station Financial Cost per Dispensed Gallon of Fuel





# Hydrogen Station Cost Analysis Assumptions

- Fuel cell vehicle (FCV) travels 12,000 miles per year
- FCV fuel economy of 55 miles per kg of H<sub>2</sub>
- 2010-2011 hydrogen station cost (AB 118)
  - Average of \$2,798,408 per location
  - Capacity of 240 kg H<sub>2</sub> dispensed per 12-hour day
  - 5% interest
  - 15-year station useful life



# Hydrogen Retail Equipment Cost (\$/kg)

# vehicles	Number of Hydrogen Stations									
	5	10	15	20	25	30	35	40	45	50
100	\$61.8	\$123.6	\$185.4	\$247.1	\$308.9	\$370.7	\$432.5	\$494.3	\$556.1	\$617.8
200	\$30.9	\$61.8	\$92.7	\$123.6	\$154.5	\$185.4	\$216.2	\$247.1	\$278.0	\$308.9
300	\$20.6	\$41.2	\$61.8	\$82.4	\$103.0	\$123.6	\$144.2	\$164.8	\$185.4	\$205.9
400	\$15.4	\$30.9	\$46.3	\$61.8	\$77.2	\$92.7	\$108.1	\$123.6	\$139.0	\$154.5
500	\$12.4	\$24.7	\$37.1	\$49.4	\$61.8	\$74.1	\$86.5	\$98.9	\$111.2	\$123.6
600	\$10.3	\$20.6	\$30.9	\$41.2	\$51.5	\$61.8	\$72.1	\$82.4	\$92.7	\$103.0
700	\$8.8	\$17.7	\$26.5	\$35.3	\$44.1	\$53.0	\$61.8	\$70.6	\$79.4	\$88.3
800	\$7.7	\$15.4	\$23.2	\$30.9	\$38.6	\$46.3	\$54.1	\$61.8	\$69.5	\$77.2
900	\$6.9	\$13.7	\$20.6	\$27.5	\$34.3	\$41.2	\$48.1	\$54.9	\$61.8	\$68.6
1,000	\$6.2	\$12.4	\$18.5	\$24.7	\$30.9	\$37.1	\$43.2	\$49.4	\$55.6	\$61.8
2,000	\$3.1	\$6.2	\$9.3	\$12.4	\$15.4	\$18.5	\$21.6	\$24.7	\$27.8	\$30.9
4,000	\$1.5	\$3.1	\$4.6	\$6.2	\$7.7	\$9.3	\$10.8	\$12.4	\$13.9	\$15.4
5,000	\$1.2	\$2.5	\$3.7	\$4.9	\$6.2	\$7.4	\$8.6	\$9.9	\$11.1	\$12.4

**The greater the number of fuel cell vehicles serviced per retail location, the lower the average cost for dispensing hydrogen.**



# Hydrogen Retail Equipment \$/ gasoline gallon (2.2 EER applied)

	(2.2 EER applied- gges)										
	Number of Hydrogen Stations										
# vehicles	1	5	10	15	20	25	30	35	40	45	50
100	\$5.53	\$27.67	\$55.34	\$83.01	\$110.68	\$138.35	\$166.02	\$193.69	\$221.36	\$249.03	\$276.70
200	\$2.77	\$13.84	\$27.67	\$41.51	\$55.34	\$69.18	\$83.01	\$96.85	\$110.68	\$124.52	\$138.35
300	\$1.84	\$9.22	\$18.45	\$27.67	\$36.89	\$46.12	\$55.34	\$64.56	\$73.79	\$83.01	\$92.23
400	\$1.38	\$6.92	\$13.84	\$20.75	\$27.67	\$34.59	\$41.51	\$48.42	\$55.34	\$62.26	\$69.18
500	\$1.11	\$5.53	\$11.07	\$16.60	\$22.14	\$27.67	\$33.20	\$38.74	\$44.27	\$49.81	\$55.34
600	\$0.92	\$4.61	\$9.22	\$13.84	\$18.45	\$23.06	\$27.67	\$32.28	\$36.89	\$41.51	\$46.12
700	\$0.79	\$3.95	\$7.91	\$11.86	\$15.81	\$19.76	\$23.72	\$27.67	\$31.62	\$35.58	\$39.53
800	\$0.69	\$3.46	\$6.92	\$10.38	\$13.84	\$17.29	\$20.75	\$24.21	\$27.67	\$31.13	\$34.59
900	\$0.61	\$3.07	\$6.15	\$9.22	\$12.30	\$15.37	\$18.45	\$21.52	\$24.60	\$27.67	\$30.74
1,000	\$0.55	\$2.77	\$5.53	\$8.30	\$11.07	\$13.84	\$16.60	\$19.37	\$22.14	\$24.90	\$27.67
2,000	\$0.28	\$1.38	\$2.77	\$4.15	\$5.53	\$6.92	\$8.30	\$9.68	\$11.07	\$12.45	\$13.84
4,000	\$0.14	\$0.69	\$1.38	\$2.08	\$2.77	\$3.46	\$4.15	\$4.84	\$5.53	\$6.23	\$6.92
5,000	\$0.11	\$0.55	\$1.11	\$1.66	\$2.21	\$2.77	\$3.32	\$3.87	\$4.43	\$4.98	\$5.53



# Alternative Fuel Vehicles Incremental Cost Range

**Incremental Vehicle Prices**

Vehicle	Gasoline	Diesel	Propane	FFVs	Compressed Natural Gas	Liquid Natural Gas	Home Charger	Plug In Hybrids	Electric Vehicles	Hybrids	Fuel Cell	
Cars & Light Trucks (SUVS & Vans) <sup>1</sup>	\$0	\$4,696	\$15,000	-\$1,005	\$9,578	N/A	\$3,500	\$10,729	\$18,097	\$3,330	\$50,000	
Class 3-5 <sup>2</sup>	\$0	\$6,500	\$25,000	\$5,000	\$20,000	N/A	\$50,000	\$50,000	\$100,000	\$100,000	\$100,000	
Class 6-8s (40 foot Transits) <sup>2,3</sup>	-\$44,103	\$44,103	N/A	\$5,000	\$84,935	\$41,433	\$100,000	\$100,000	\$906,166	\$224,344	\$2,992,505	

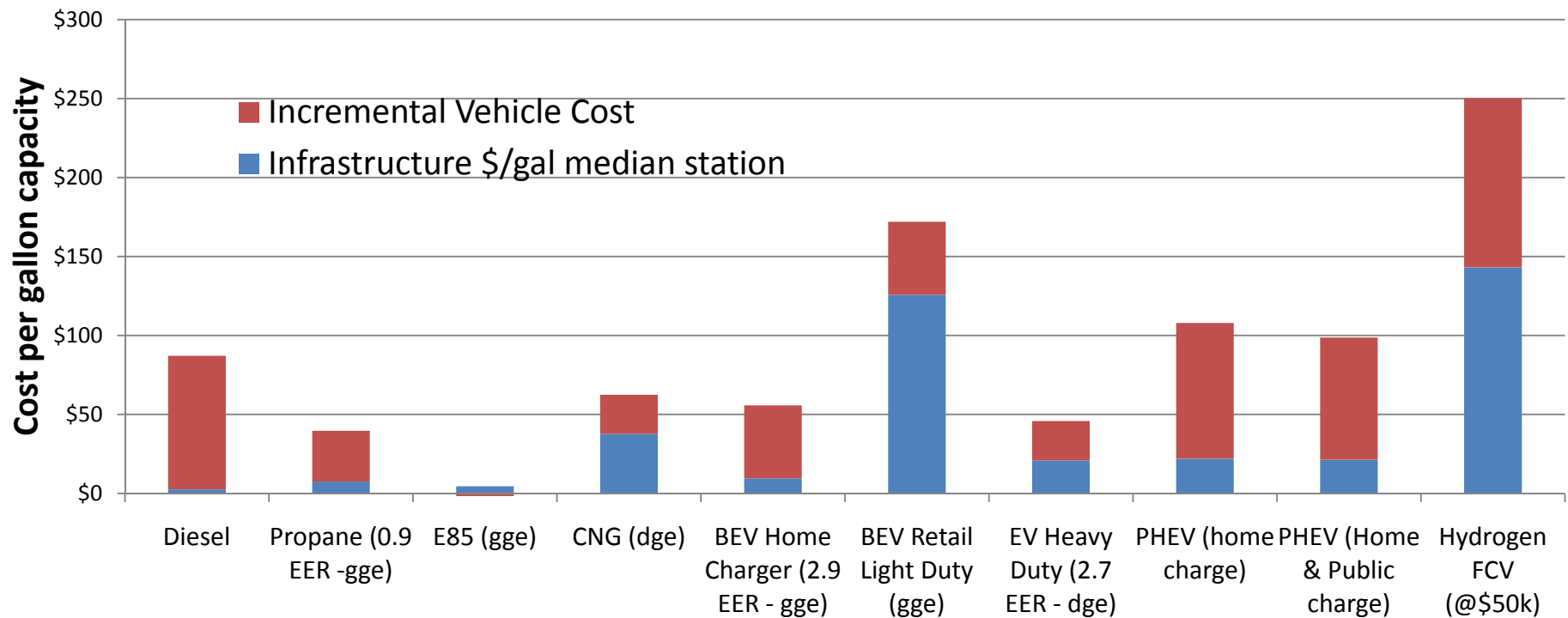
<sup>1</sup> Source: CEC 2011 IEPR High Fuel Demand Case, excluding Fuel Cell (staff assumed \$50k incremental retail price)

<sup>2</sup> Source: 2010-2011 retail prices, & CEC Medium & Heavy Duty Vehicle buy down program.

<sup>3</sup> CEC AB 118, 2010-2011 Applications, ARB Heavy Duty Hybrid Vehicle buy down program



# Vehicle and Fuel Station Cost/Gallon Capacity





# ARB Scenarios

## Incremental Cost Matrix

	Vehicle Population	Incremental Near Term Vehicle Retail Price Scenarios								
FCVs	146,784	\$20,000	\$30,000	\$40,000	\$50,000	\$60,000	\$70,000	\$80,000	\$90,000	\$100,000
PHEVs	1,618,899	\$5,000	\$10,000	\$15,000	\$20,000	\$25,000	\$30,000	\$35,000	\$40,000	\$45,000
BEVs	367,791	\$5,000	\$5,000	\$10,000	\$15,000	\$20,000	\$25,000	\$30,000	\$35,000	\$40,000
		Cost Below are in Billion \$s								
FCVs		\$2.9	\$4.4	\$5.9	\$7.3	\$8.8	\$10.3	\$11.7	\$13.2	\$14.7
PHEVs		\$8.1	\$16.2	\$24.3	\$32.4	\$40.5	\$48.6	\$56.7	\$64.8	\$72.9
BEVs		\$1.8	\$1.8	\$3.7	\$5.5	\$7.4	\$9.2	\$11.0	\$12.9	\$14.7
	Total	\$12.9	\$22.4	\$33.8	\$45.2	\$56.6	\$68.0	\$79.4	\$90.8	\$102.2





# Questions?

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