

**Draft 2013 IEPR
Vehicle Attribute Forecasts**

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Background

- Vehicle attributes are used as input data for CEC consumer choice modeling to estimate the characteristics of the California vehicle fleet.
- Attributes include vehicle price, fuel economy, number of models, as well as performance and utility metrics.
- Attributes are forecast for:
 - ❖ Vehicle classes comprising 18 light-duty size and vehicle type categories defined by CEC; and
 - ❖ Technology/fuel groups encompassing conventional and emerging alternative fuels (gas, diesel, NG, ethanol, electricity) and a spectrum of vehicle technologies (conventional, hybrids, plug-in hybrids, electric and fuel cell).

Draft 2013 IEPR Scope

- 2013 attribute forecasts:
 - ❖ Light-duty vehicle fleet only
 - ❖ Based upon:
 - 2013 National Academy of Sciences “Transitions to Alternative Vehicles & Fuels” study
 - Bosch estimates of diesel vehicle penetration (June 2013 CEC workshop)
 - CARB 2012 ZEV Amendments
 - Updated historical data (MY2010-2011 data)

Analysis Framework – Vehicle Classes

Subfleet	CEC Class	Class Description	Example Models
Car Classes	01A	Subcompact (1-6000 lbs)	Toyota Echo, Hyundai Accent, VW Golf
	02A	Compact (1-6000 lbs)	Honda Civic, Chevy Cavalier, Ford Focus
	03A	Midsize (1-6000 lbs)	Honda Accord, Ford Taurus, Toyota Camry
	04A	Large (1-6000 lbs)	Buick LeSabre, Ford Crown Victoria
	05A	Sport (1-6000 lbs)	Ford Mustang, Chevy Camaro, Toyota Celica
	06A	Cross Utility - Small (1-6000 lbs)*	Chrysler PT Cruiser, Toyota Matrix
Light-Duty Truck Classes	07A	Cross Utility - Small (1-6000 lbs)*	Toyota RAV4, Honda CRV, Ford Escape
	08A	Cross Utility - Midsize (1-6000 lbs)	Toyota Highlander, Honda Pilot, Lexus RX300
	09A	Sports Utility - Compact (1-6000 lbs)	Chevy Blazer, Nissan Xterra, Isuzu Amigo
	10A	Sports Utility - Midsize (1-6000 lbs)	GMC Envoy, Dodge Durango, Isuzu Trooper
	11A	Sports Utility - Large (6001 - 8500 lbs)	Chevy Tahoe, Toyota Sequoia, Ford Expedition
	11B	Sports Utility - Heavy (8501 - 10000 lbs)	Chevy R2500 Suburban, Ford Excursion
	12A	Van - Compact (1-6000 lbs)	Ford Windstar, Dodge Caravan, Honda Odyssey
	13A	Van - Large (6001-8500 lbs)	Ford Econoline, Chevy Express, Dodge RamVan
	13B	Van - Heavy (8501-10000 lbs)	Chevy Express Van G30, Ford Comm Strip E350
	14A	Pickup - Compact (1-6000 lbs)	Chevy S10, Ford Ranger, Nissan Frontier
	15A	Pickup - Standard (6001-8500 lbs)	Ford F150, GMC Sierra, Toyota Tundra
	15B	Pickup - Heavy (8501-10000 lbs)	GMC Sierra C3500, Dodge D300/350, Ford F350

* Cross Utility - Small is bifurcated into "Car" and "Truck" due to CAFE differences.

Analysis Framework – Tech/Fuel Groups

Tech/Fuel Group		Fuel/Tech Group Description
No.	Abbrev	
1	GAS	Gasoline
2	GHYB	Gasoline Electric Hybrids
3	DSL	Diesel
4	BDSL	Diesel (Biodiesel)
5	DHYB	Diesel Electric Hybrid
6	LPG	Propane
7	FFVG	Flexible Fuel Vehicles (FFV), Gas-Fueled
8	FFVE	Flexible Fuel Vehicles (FFV), E85-Fueled
9	PHEV	Plug-in Electric Gasoline Hybrids (PHEV)
10	CNG	Compressed Natural Gas (CNG)
11	LNG	Liquefied Natural Gas (LNG)
12	DUAL	Dual Fuel – Gasoline and CNG
13	EV	Full Electric (EV)
14	FCV	Hydrogen Vehicles (FCV)

Analysis Framework – Attributes Modeled

AttrShrt	Attribute Description
#Configs	Number of individual makes and models (by model year, class and fuel/tech group)
MSRP	Manufacturer suggested retail price (MSRP) of a new car expressed in 2011 U.S. dollars
OnRdFE	Fuel economy (on-road miles per gallon equivalent, mpge)
Acc0-60	Acceleration (seconds to 60 miles per hour)
TowCap	Towing capacity (lb), new for 2013 IEPR
MaintCst	Annual new car maintenance cost in 2011 dollars, incl. fees for oil changes/regular maint.
Gradblty	Gradability
DriveRng	Driving Range (miles)
VehLife	Average expected vehicle lifetime (yrs), new for 2013 IEPR
SeatCap	Passenger Seat Capacity (number of passengers)
StorVol	Trunk or Storage Space (in cubic feet), new for 2013 IEPR
FuelTime	Time needed to complete full fueling or charging
BattCost	Battery cost (for HEV/PHEV/EV), new for 2013 IEPR
ChrgCost	Charging Equipment Cost, external equipment (for EV/CNG), new for 2013 IEPR
CurbWt	Curb weight of vehicle (lb)
HP	Engine rated power (hp)
Lit	Engine displacement (liters)

- Attributes estimated by model year, vehicle class and fuel/tech group – sales weighted composites

Historical Baseline (Step 1)

- 2011 IEPR based on model year (MY) 1992 through 2009 historical data.
- For 2013 IEPR, Sierra developed **independent** MY1992-2011 historical database with additional attributes described earlier:
 - ❖ Data compiled at vehicle model & powertrain level
 - ❖ Historical averages by model year, vehicle class and fuel/tech group based on U.S. fleet new vehicle sales
 - ❖ Plan to update with California-specific new vehicle registrations purchased from R.L. Polk
- Price (MSRP) and fuel economy data collected for MYs 2012-2013 to test early-year forecasts.

Attribute Forecasts - Overview

- Attribute forecasts through MY2035 were prepared for a set of fuel price/economic/regulatory policy scenarios specified by CEC.
- Scenarios assumed compliance with adopted federal (CAFE, GHG, & RFS), and California (GHG, ZEV, & LCFS) regulations .
- Primary source for attribute forecasts was 2013 NAS “Transitions to Alt. Vehicles & Fuels” study

Attribute Forecasts -

NAS-Based Assumptions & Methods

- Key 2013 NAS analysis scenarios:
 - ❖ Reference – Adopted federal regs. through 2025 (CAFE, RFS2) – **used for Draft 2013 IEPR**
 - ❖ Midrange – Policy support beyond 2025 seeking 50% LDV GHG reductions by 2030 from 2005 levels
 - ❖ Optimistic – Aggressive policy support and “stretch goals” requiring greater R&D and vehicle design success
- NAS technology penetrations:
 - ❖ Powertrain improvements - Vehicle simulation modeling performed for EPA 2025 GHG regulations
 - ❖ Load reductions – Improvements from light-weighting, aero. drag & rolling resistance reductions and accessory efficiency gains

Attribute Forecasts -

NAS-Based Assumptions & Methods (cont.)

- NAS-based technology costs:
 - ❖ Fully-learned, high-volume costs and phase-in schedules
 - ❖ Separate estimates developed for:
 - Internal combustion engines (ICEs)
 - Hybrids (HEVs) – added as increment to ICE costs (subtracting credits for smaller engines)
 - Plug-In Hybrids (PHEVs) – 3-10 times higher battery/motor sizes
 - Battery-Electric Vehicles (EVs) – 30 times higher battery/motor sizes than HEVs
 - Fuel Cell Vehicles (FCVs) and Compressed Natural Gas Vehicles (CNGVs) – cheaper than EVs, infrastructure constrained

Attribute Forecasts -

NAS-Based Assumptions & Methods (cont.)

- Key NAS assumptions:
 - ❖ NAS did not consider further efficiency improvements to diesel engines – assumed manufacturers would focus ICE improvements on gasoline engines
 - ❖ Lithium-ion is long-term technology for plug-in hybrid and battery electric vehicles
 - ❖ Weight reductions ranging from 15% to 20% (relative to 2010) by 2030
 - ❖ Markup factor of 1.25 (to translate production costs to retail-equivalent increments)
 - ❖ Manufacturers will trade historical increases in performance and utility for downsizing to comply with stringent GHG/FE standards

Attribute Forecasts -

NAS-Based Assumptions & Methods (cont.)

- LAVE-Trans spreadsheet model developed under NAS study used to generate FE and vehicle price forecasts
- Used NAS-based relative FE improvements and vehicle prices (MSRP) for gas ICE, HEV, PHEV, FCVs and CNG technologies.
- Diesels - NAS-based load reduction gains (and costs) for gas ICEs used to forecast FE improvements and MSRP.
- Future battery costs scaled from NAS “midrange” estimates: (over 80% reductions in 2035 for HEVs, 70-75% for PHEVs, 65% for EVs relative to 2010)

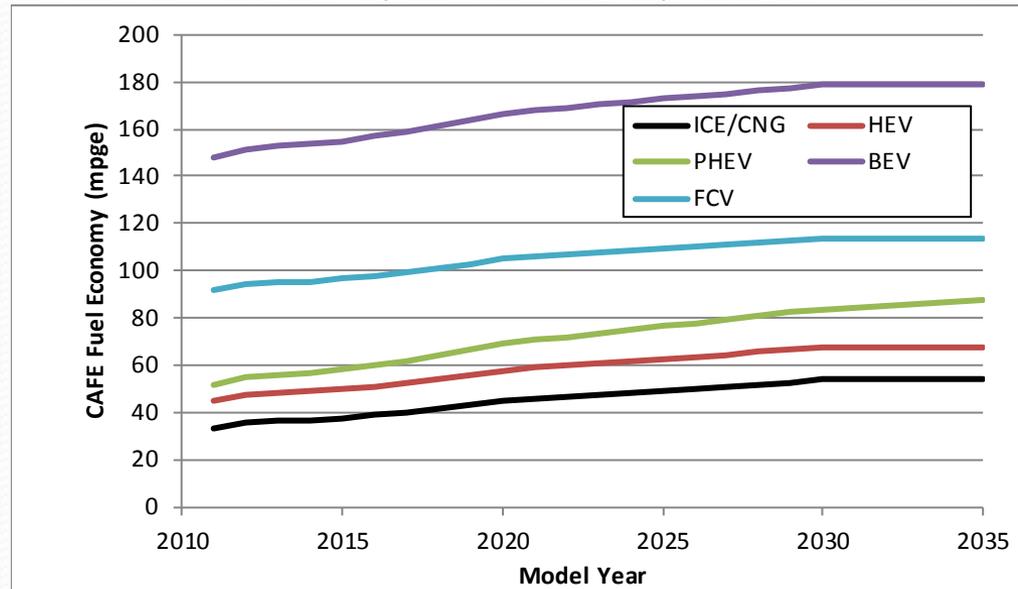
Attribute Forecasts -

NAS-Based Assumptions & Methods (cont.)

- Model availability forecasts (number of models):
 - ❖ Gas ICEs & HEVs – Scaled from LAVE-Trans sales projections
 - ❖ Diesel ICEs – grown through MY2018 based on Bosch projections from June 2013 workshop
 - ❖ CNG & Dual-Fuel – Held constant after 2013
 - ❖ PHEVs, EVs, FCVs:
 - Grown from 2011 baseline to reflect updated ZEV light-duty vehicle production targets by 2025 (5.9% PHEVs, 4.6% EVs, 3.3% FCVs)
 - CARB-based splits by vehicle type (car vs. passenger car)
 - Restricted number of vehicle classes for EVs

Attribute Forecasts - FE Results

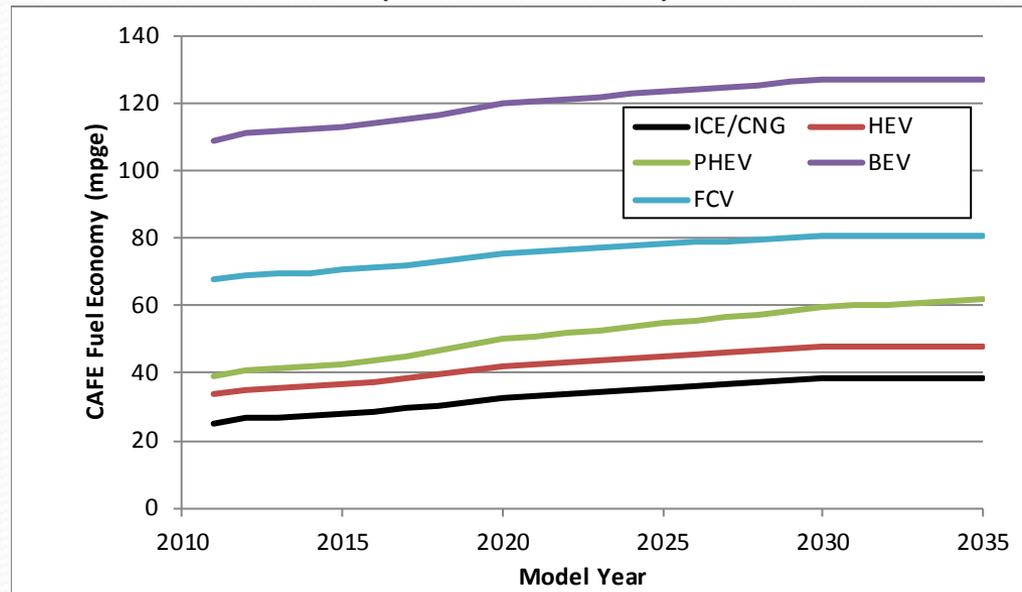
Forecasted Passenger Car CAFE Fuel Economy (mpge) by Fuel/Tech Group
(NAS Reference Case)



- ICE/CNG passenger car FE increases 61% (from 2011 to 2030)
- HEV passenger car FE increases 49%
- PHEV passenger car FE increases 61%
- BEV passenger car FE increases 21%
- FCV passenger car FE increases 24%

Attribute Forecasts - FE Results (cont.)

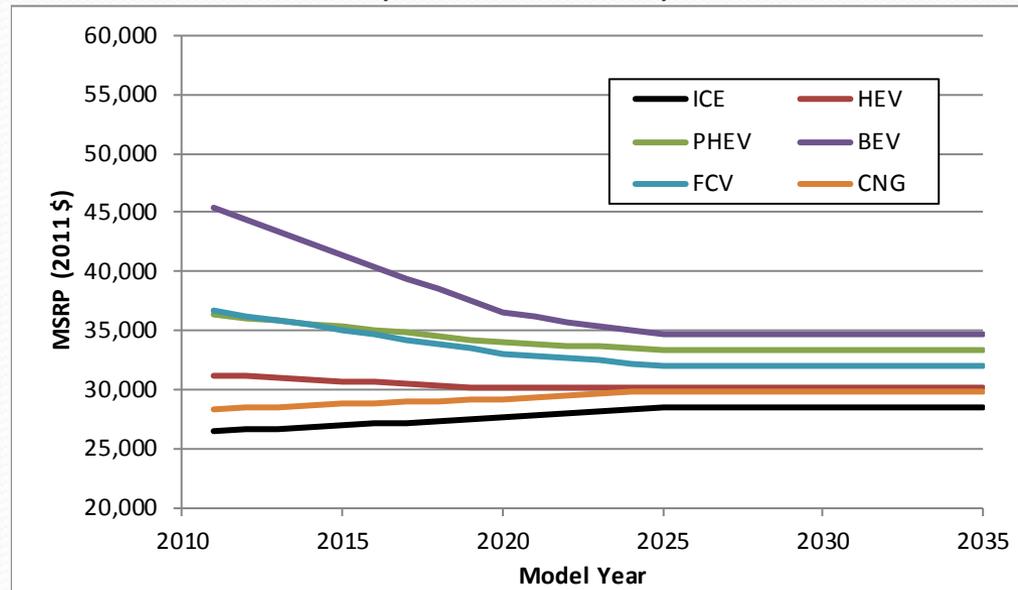
Forecasted Light Truck CAFE Fuel Economy (mpge) by Fuel/Tech Group
(NAS Reference Case)



- ICE/CNG light truck FE increases 55% (from 2011 to 2030)
- HEV light truck FE increases 41%
- PHEV light truck FE increases 60%
- BEV light truck FE increases 16%
- FCV light truck FE increases 20%

Attribute Forecasts – Retail Price Results

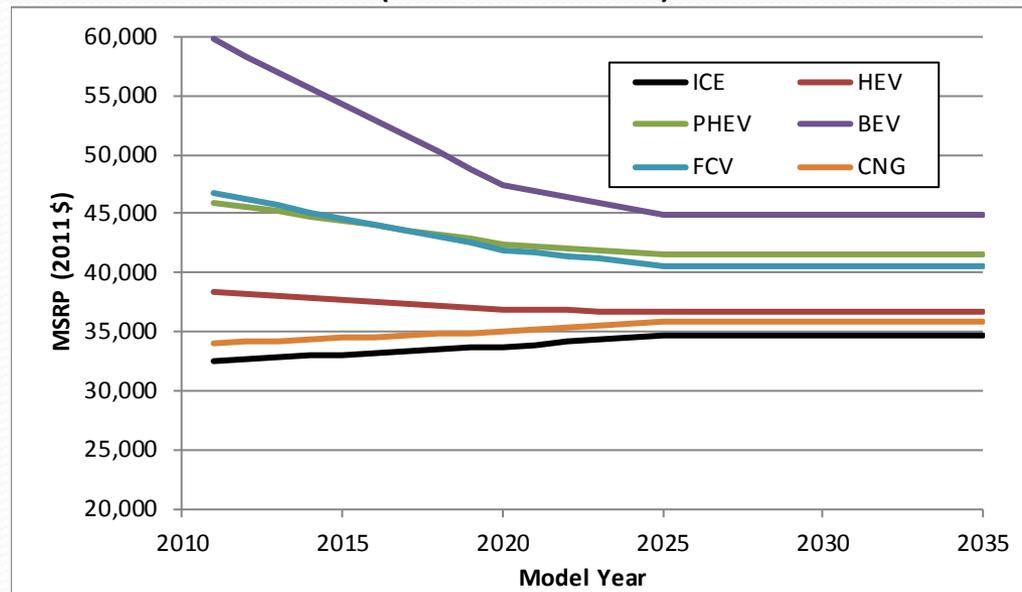
Forecasted Passenger Car MSRP by Fuel/Tech Group
(NAS Reference Case)



- ICE passenger car MSRP increases 7% (from 2011 to 2030)
- HEV passenger car MSRP **decreases** 4%
- PHEV passenger car MSRP **decreases** 8%
- BEV passenger car MSRP **decreases** 24%
- FCV passenger car MSRP **decreases** 13%

Attribute Forecasts – Retail Price Results

Forecasted Light-Duty Truck MSRP by Fuel/Tech Group
(NAS Reference Case)



- ICE light truck MSRP increases 6% (from 2011 to 2030)
- HEV light truck MSRP **decreases** 4%
- PHEV light truck MSRP **decreases** 10%
- BEV light truck MSRP **decreases** 25%
- FCV light truck MSRP **decreases** 13%

Questions and Comments

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THANK YOU!