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Light Duty Vehicle Attributes

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Energy Commission Workshop

Overview

- Background and Key Objectives
- Data Sources, Methods and Key Assumptions
- Attribute Forecasts

Background

- Vehicle attributes are used as input data for Energy Commission consumer choice modeling to forecast the characteristics of the California vehicle fleet.
- Light-duty attributes include vehicle price, fuel economy, number of different models offered, as well as performance and utility metrics.
- Light-duty attributes are forecast for:
  - Vehicle classes comprising 15 light-duty size and vehicle type categories used by CEC; and
  - Technology/fuel groups encompassing 10 conventional and emerging alternative fuels (gas, diesel, CNG, ethanol, electricity) and vehicle technologies (conventional, hybrids, plug-in hybrids, electric and fuel cell).

Key Objectives

- Extend historical database of attributes developed under 2013 IEPR – added model years 2012 and 2013 to 1992-2011 database.
- Develop attribute forecasts for model years 2014-2026.
- Evaluate three fuel/economic/demographic scenarios:
  - Reference – Reference projections of fuel prices and economic/demographic outlook.
  - Low PEV Demand – High fuel prices, low econ./demographic
  - High PEV Demand – Low fuel prices, high econ./demographic
- All scenario forecasts reflect compliance with adopted federal standards (CAFE, GHG, RFS) and state regulations (ZEV and LCFS) that run through MY2025.

Scope and Key Sources

- Focus on five "priority" attributes:
  1. Number of make/model configurations
  2. Vehicle price (MSRP, in $2013)
  3. Fuel economy (adjusted to on-road)
  4. Driving range (in miles)
  5. Maintenance cost (per mile) – 5-year annual average

- Light-duty fleet attribute forecast sources:
  - *Price and Fuel Economy* – 2013 NAS "Transitions to Alternative Vehicles and Fuels" study, LAVE-Trans model
  - *ZEV Sales Targets* – CARB 2013/14 ZEV Amendments
  - *Driving Range* – EIA Annual Energy Outlook 2014
  - *Make/Models and Maintenance Costs* – scaled from existing data

Light-Duty Attribute Forecasts - NAS-Based Assumptions & Methods

- 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
- Key NAS assumptions:
  - No further efficiency improvements to diesel engines – assumed improvements for conventional vehicles focused on gasoline engines
  - Lithium-ion is long-term technology for plug-in hybrid and battery electric vehicles
  - Weight reduction of 15%-20% (relative to 2010) by 2030
  - Manufacturers will trade past performance/utility increases for downsizing to comply with stringent GHG/FE standards

Light-Duty 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

Light-Duty 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 and CNG technologies.
- Diesels - NAS-based load reduction gains (and costs) for gas ICEs used to forecast FE improvements and MSRP.
- Diesel hybrids – FE scaled using relative benefits from gasoline hybrids.
- 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)

Light-Duty Attribute Forecasts - Additional Adjustments

- 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
  - PHEVs, EVs, FCVs:
    - Grown from 2013 baseline to reflect updated ZEV light-duty vehicle sales targets through MY2025
    - CARB-based splits by vehicle type (car vs. truck)
- Fuel price-triggered vehicle price shifts within car and truck fleets (2013 Busse, et al. study of vehicle vs. fuel price elasticity)

Light-Duty Attribute Forecasts - Additional Adjustments (cont.)

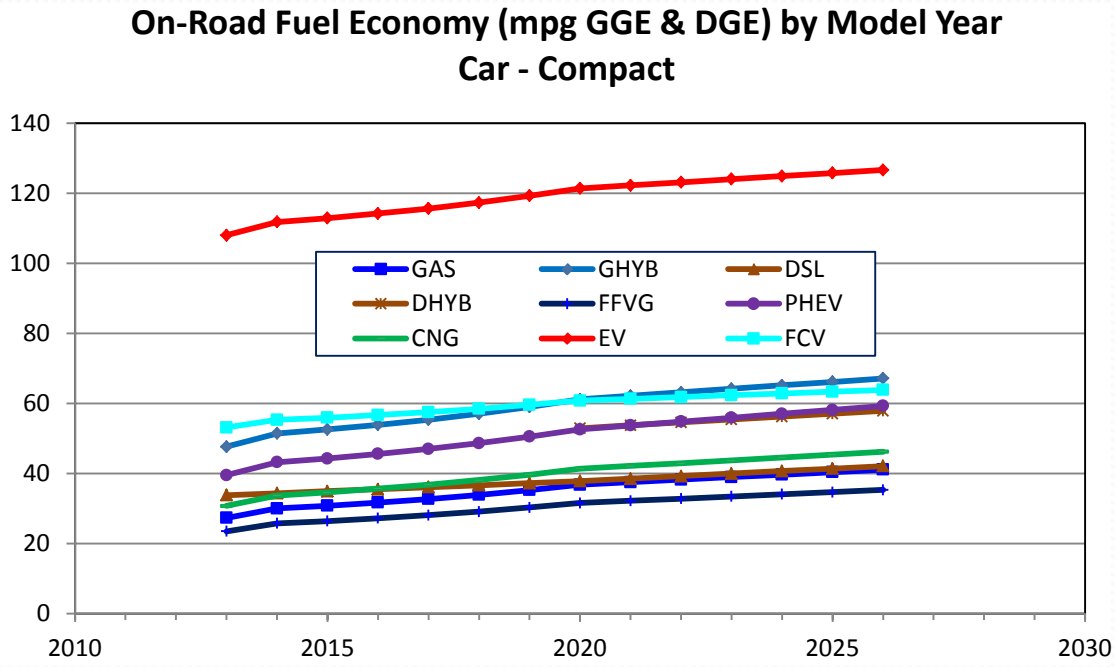
- Preliminary IEPR attribute forecasts run through Commission's demand model projected sales for ZEV technologies (PHEV, BEV, FCV) below ZEV regulation compliance levels (using CARB Calif. sales targets)
- Current attribute forecasts reflect vehicle price adjustments for PHEV & BEV modeled with LAVE-Trans.
- LAVE-Trans vehicle choice component used to determine level of price adjustments needed by model year to generate sales levels meeting CARB targets.
- Targets based on relative LDV sales shares

Forecasted Attribute Results

- Forecasted vehicle prices and make/model availability modeled differ under each of the three demand scenarios evaluated.
- Projected fuel economy, driving range and maintenance costs (by fuel/tech group and vehicle class) were not assumed to differ over the demand scenarios.

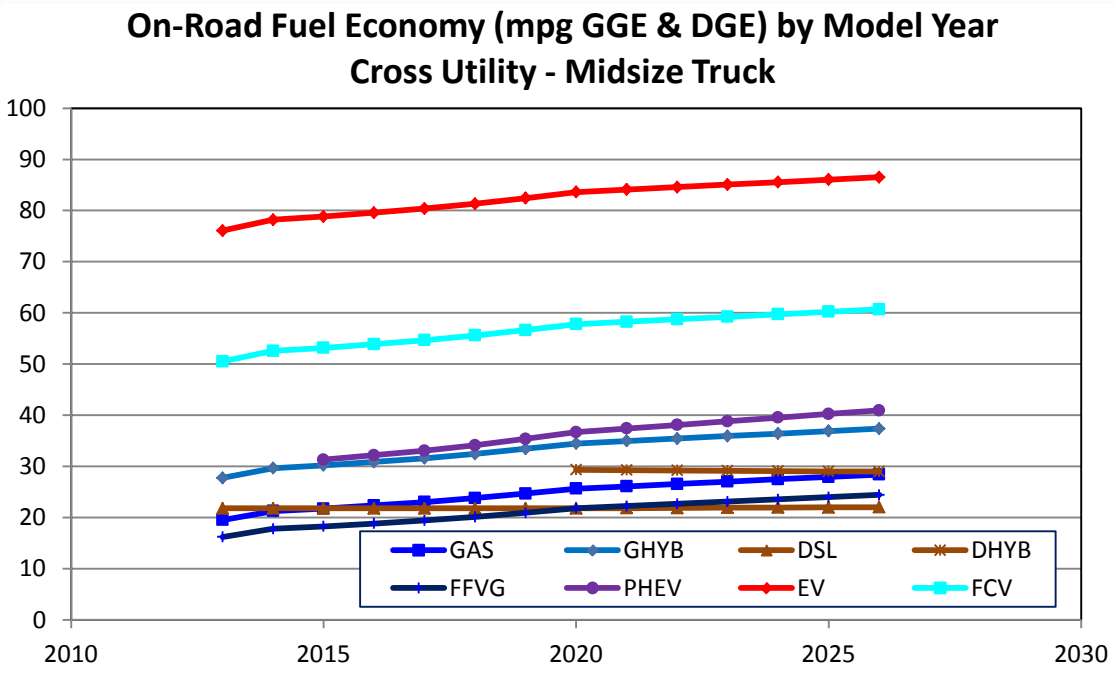
Forecasted Fuel Economy Compact Car

- Fuel economy improvements are based on trends in the 2013 NAS study and are largely triggered by CAFE compliance through MY2025.



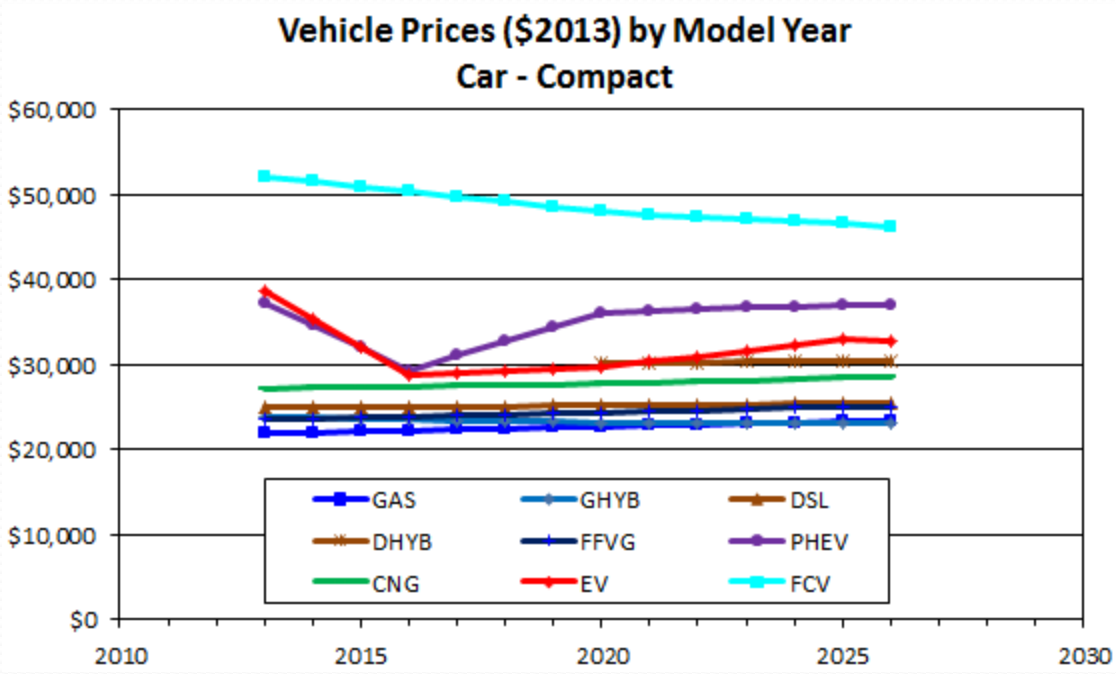
Forecasted Fuel Economy Midsize Cross Utility Vehicle

- Similar but less step improvements for light truck classes reflect differences in stringency between CAFE standards for cars vs. trucks.



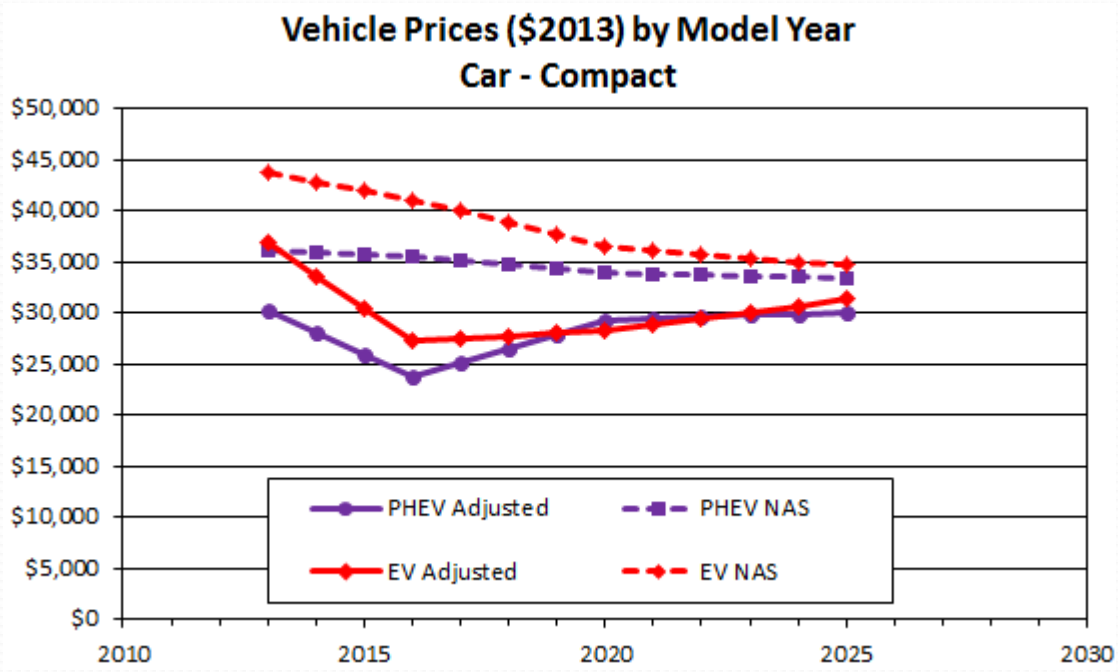
Forecasted Vehicle Prices Compact Car, Reference Demand

- Prices (2013 dollars) rise nominally for conventional technologies
- Assumed prices have to be adjusted for PHEV and EV technologies early in forecast period to induce ZEV-compliant sales



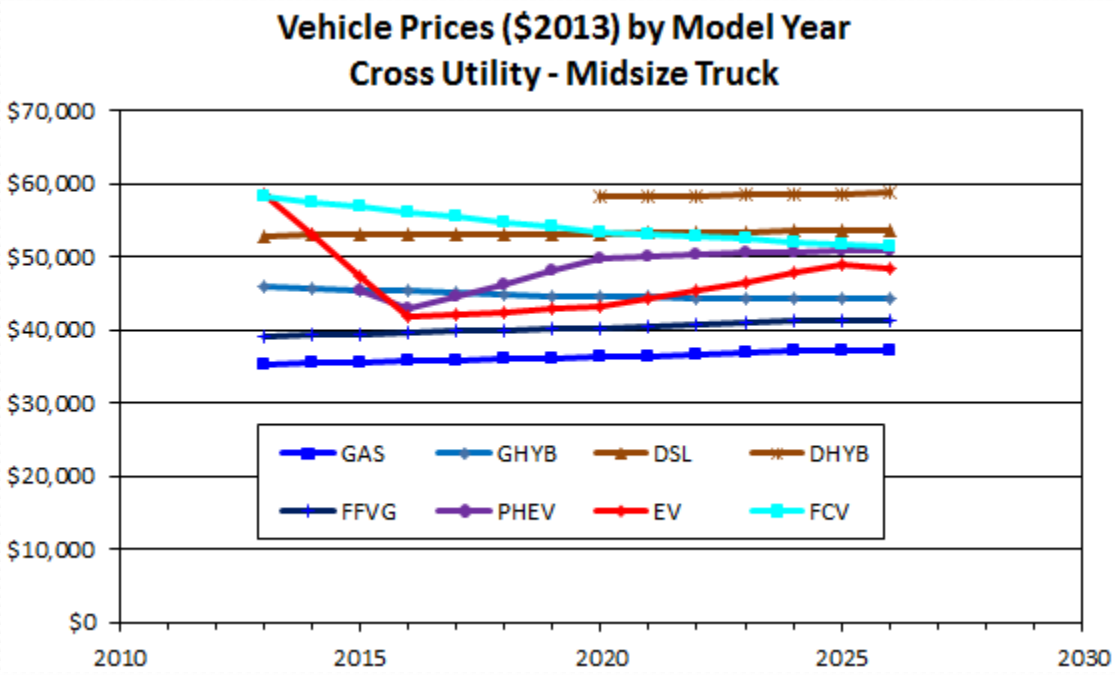
Forecasted Vehicle Prices Compact Car, Reference Demand

- Comparison of NAS and adjusted prices for PHEV and EV technologies
- Price adjustments of as much as 30% are required to meet ZEV sales requirements



Forecasted Vehicle Prices Midsize Cross Utility Vehicle, Reference Demand

- Similar price trends forecasted for CUV conventional and ZEV technologies



LAVE-Trans Projected Sales Shares

- Within LAVE-Trans, effects of price adjustments applied separately for cars and trucks were used to evaluate ZEV compliance from the vehicle choice component and the model's predicted sales (as % of LDVs)

	ZEV Category	LAVE-Trans ZEV Compliance Verification										
		2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
CARB ZEV Compliance Targets (% LDVs)	PHEV	0.8%	1.1%	2.3%	4.8%	6.5%	6.6%	6.6%	6.7%	6.7%	6.7%	6.7%
	BEV	0.2%	0.3%	0.7%	1.5%	1.9%	2.7%	3.3%	4.3%	4.8%	5.1%	5.2%
	FCV	0.1%	0.1%	0.1%	0.3%	0.4%	0.7%	1.1%	1.8%	2.2%	2.8%	3.5%
	BEV+FCV	0.3%	0.4%	0.9%	1.8%	2.4%	3.4%	4.4%	6.1%	7.1%	7.9%	8.7%
LAVE-Trans Shares (% LDVs)	PHEV	0.2%	0.6%	5.6%	4.8%	7.4%	7.0%	7.9%	8.5%	9.7%	10.5%	11.7%
	BEV	0.1%	0.3%	1.7%	2.4%	3.4%	4.9%	7.1%	9.7%	12.1%	13.2%	13.3%
	FCV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	BEV+FCV	0.1%	0.3%	1.7%	2.4%	3.4%	4.9%	7.1%	9.7%	12.1%	13.2%	13.3%
Comp. Margin	**PHEV**	**-0.6%**	**-0.6%**	**+3.3%**	**+0.0%**	**+0.9%**	**+0.4%**	**+1.3%**	**+1.9%**	**+3.0%**	**+3.7%**	**+5.0%**
	BEV+FCV	**-0.2%**	**-0.1%**	**+0.8%**	**+0.6%**	**+1.0%**	**+1.5%**	**+2.7%**	**+3.7%**	**+5.1%**	**+5.3%**	**+4.6%**

Forecasted Vehicle Prices
Low and High Demand Differences

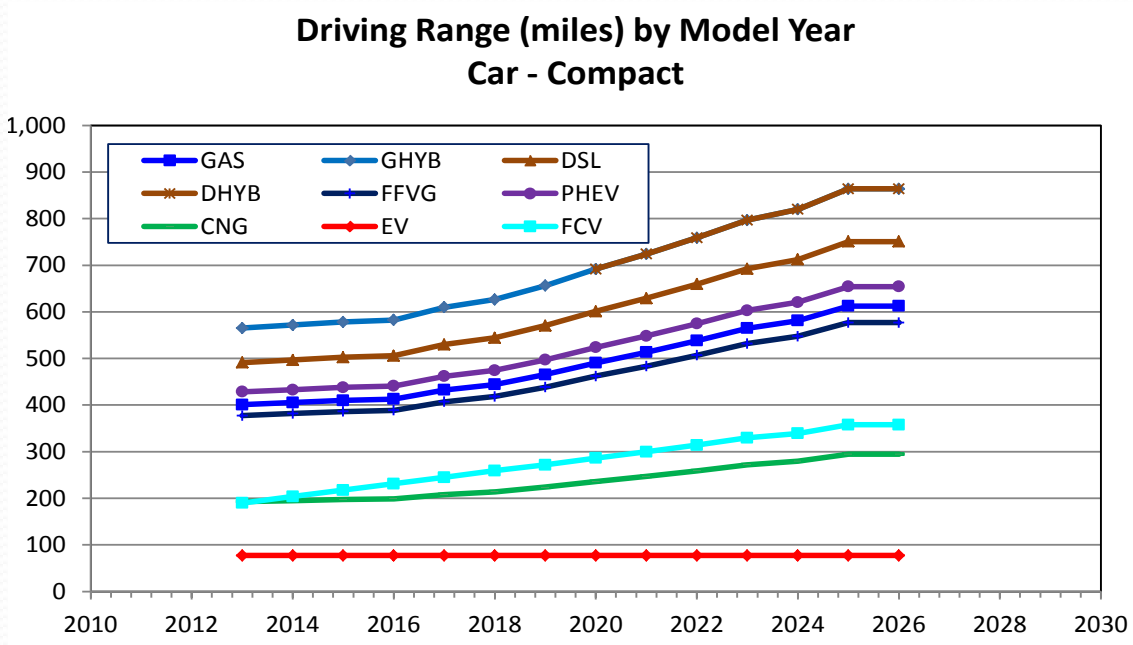
- Based on responses to fuel prices, modest changes in vehicle prices are expected in Low and High Demand scenarios based on Busse (2013)
- Incremental price differences are shown for highest and lowest fuel economy fuel/class groups in fleet and reflect the range of price differences modeled

Vehicle Price Differences (Low Demand vs. Reference)															
TechAbb	ClassDesc	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
EV	Compact (1-6000 lbs)	+$0	+$15	+$18	+$25	+$27	+$33	+$39	+$45	+$45	+$46	+$46	+$46	+$48	+$50
GAS	Pickup - Standard (6001-8500 lbs)	+$0	-$14	-$93	-$124	-$161	-$165	-$193	-$199	-$218	-$235	-$253	-$274	-$295	-$317

Vehicle Price Differences (High Demand vs. Reference)															
TechAbb	ClassDesc	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
EV	Compact (1-6000 lbs)	+$0	-$15	-$18	-$25	-$27	-$33	-$39	-$45	-$45	-$46	-$46	-$46	-$48	-$50
GAS	Pickup - Standard (6001-8500 lbs)	+$0	+$9	+$10	+$33	+$112	+$135	+$132	+$152	+$157	+$163	+$171	+$180	+$189	+$198

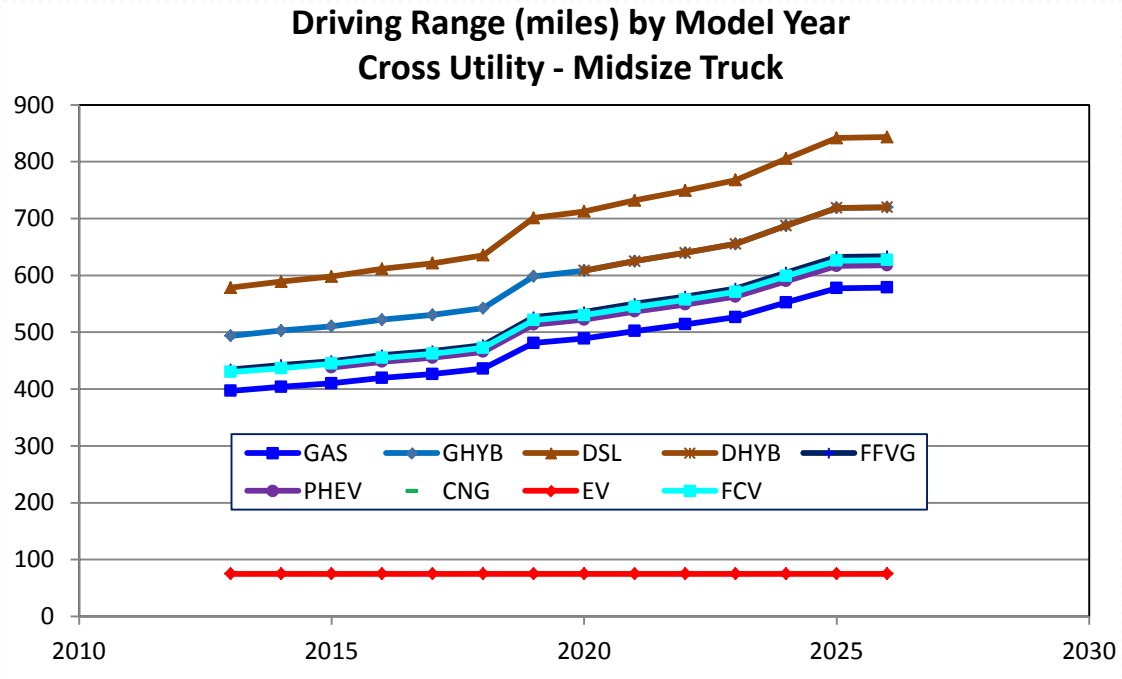
Forecasted Driving Range Compact Car

- Forecasted increases in driving range are based on EIA AEO2014 Reference projections
- We are weighing reducing these increases (for ICE technologies) after 2020 as CAFE stringency increases significantly – manufacturers may reduce fuel tanks to save size and weight.



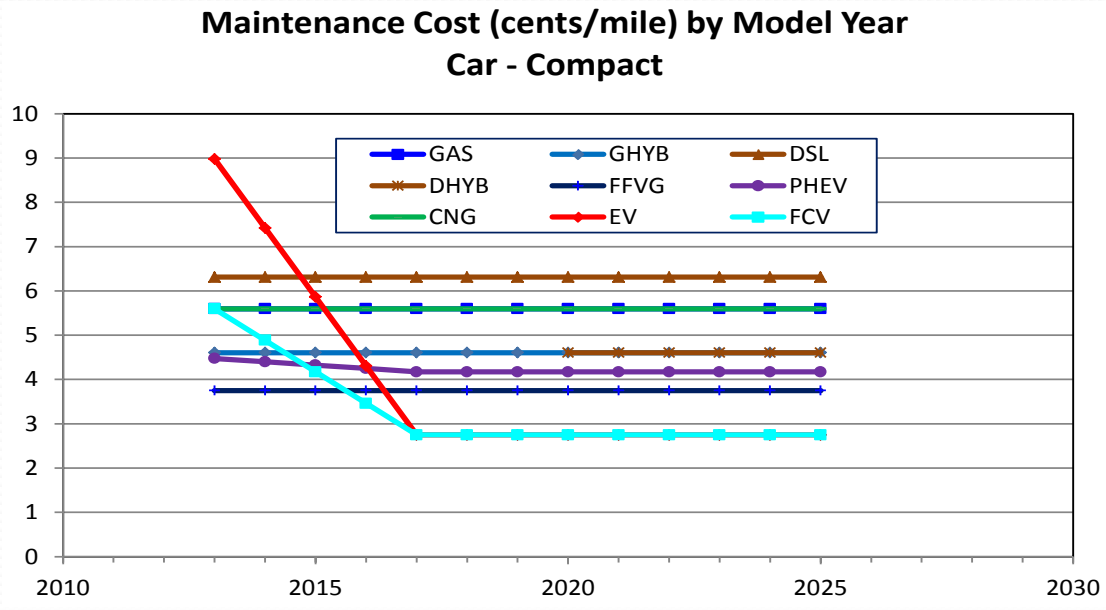
Forecasted Driving Range Midsize Cross Utility Vehicle

- Similar trends in range (using AEO2014) also forecasted for truck classes



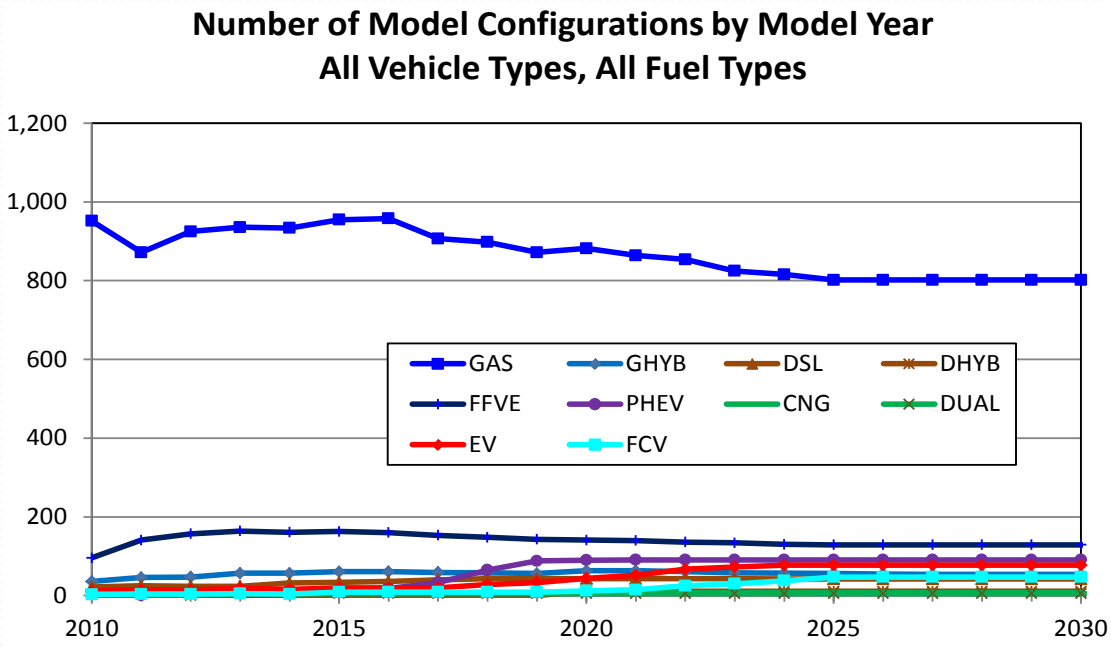
Forecasted Maintenance Costs Compact Car

- Maintenance cost held constant at 2013 levels for conventional technologies
- Discounted by 25% for PHEVs and 50% for EVs & FCVs relative to gasoline vehicles – less estimated maintenance for battery/regen vehicles
- Slopes from 2013 to 2017 reflect interpolation from actual, but limited historical data in 2013 to "long-term" discounted levels above (assumed by 2017)



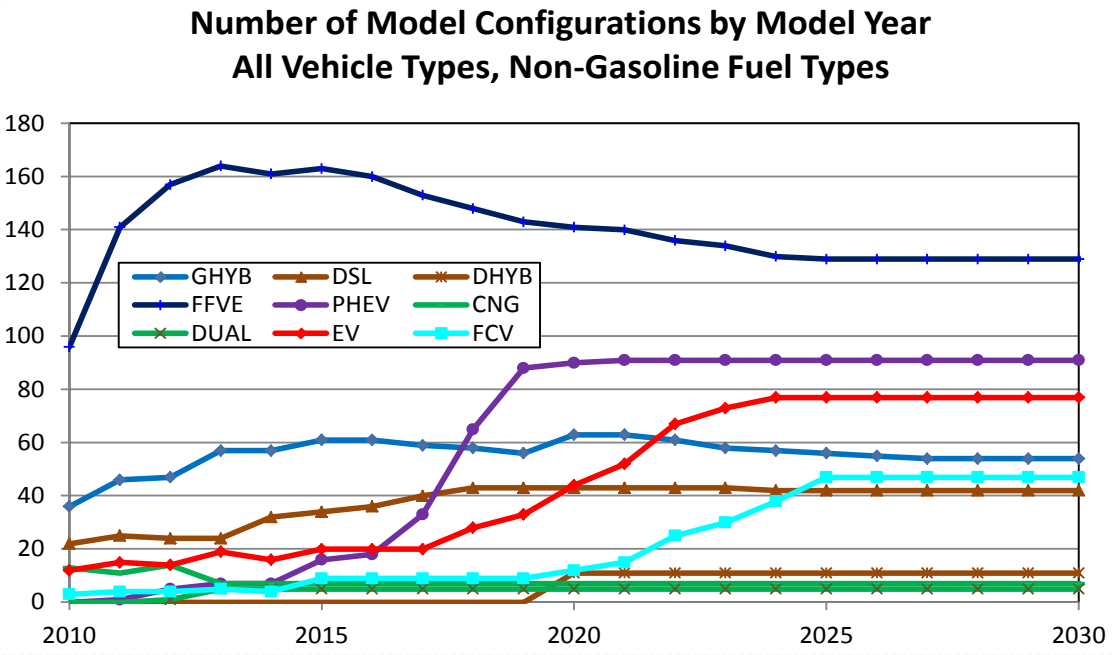
Forecasted Makes/Models
All Classes and Technologies

- Trends in make/model configurations by technology generally track sales projections in LAVE-Trans
- Decrease in gasoline models offset by rises in alternative technology offerings (largely ZEV regulation triggered)



Forecasted Makes/Models
All Classes, Non-Gasoline Technologies

- Removing gasoline models from the last plot more clearly shows ZEV models increasing, FFVs taper off due to phase-out of CAFE credits
- Though not shown, we are projecting modest (~10%) increases in model availability in the High PEV Demand case and vice versa under Low PEV Demand case



Closing Summary

- Current forecasts for all scenarios project “ZEV compliant” attributed based on price adjustments modeled through LAVE-Trans
- Sierra and Energy Commission staff will be continue on-going sensitivity analyses, reviewing/incorporating feedback and examining consistency with other IEPR forecast elements
- Final attribute forecasts and detailed report to be delivered next month

Questions and Comments

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Thank you!