California Energy Commission

CONSULTANT REPORT

Light-Duty Vehicle Attribute Projections (Years 2015-2030)

Prepared for: **California Energy Commission**
Prepared by: **National Renewable Energy Laboratory**

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ABSTRACT

This report describes the National Renewable Energy Laboratory's projections of vehicle attributes for light-duty vehicles expected to be available within California for model years 2015 to 2030. The projected attributes, which are provided by light-duty vehicle class and powertrain, include fuel economy, acceleration, driving range, manufacturer suggested retail price, and vehicle footprint. Attributes are weighted by California vehicle sales, which are projected using a historically validated consumer choice model – the Automotive Deployment Option Projection Tool (ADOPT) – integrated with a modeling framework that simulates vehicle fuel economy, cost, and acceleration performance while optimizing vehicle components – the Future Automotive Systems Technology Simulator model (FASTSim). Both models were developed at the National Renewable Energy Laboratory and have been adapted to represent the California light-duty vehicle market. The analysis includes several scenarios, as established by the California Energy Commission, pertaining to electricity demand in California. Results suggest that implementation of policies, such as the Corporate Average Fuel Economy standards, affect vehicle attribute projections. The results also suggest that standards and policy targets are not exclusively met by changes in vehicle attributes, but also through shifts in market demand and sales for certain vehicle powertrains. The projected vehicle attributes serve an important role in projecting future vehicle ownership decisions in California.

Keywords: Vehicle attributes, powertrains, fuel economy, driving range, MSRP, vehicle performance, California, vehicle adoption models, alternative fuel vehicles, Corporate Average Fuel Economy, CAFE

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LIST OF ACRONYMS

ADOPT	NREL's Automotive Deployment Options Projection Tool
AEO	U.S. DOE Energy Information Administration Annual Energy Outlook
BEV	battery electric vehicle
CAFE	Corporate Average Fuel Economy
FASTSim	NREL's Future Automotive Systems Technology Simulator
FCEV	fuel cell electric vehicle
HEV	hybrid electric vehicle
LDV	light-duty vehicle
MSRP	manufacturer suggested retail price
NREL	National Renewable Energy Laboratory
PEV	plug-in electric vehicle
PHEV	plug-in hybrid electric vehicle
U.S. DOE	U.S. Department of Energy
U.S. EPA	U.S. Environmental Protection Agency
ZEV	zero-emission vehicle

EXECUTIVE SUMMARY

This report describes the National Renewable Energy Laboratory's approach to projecting vehicle attributes for light-duty vehicles by vehicle class and powertrain. Vehicle attribute projections are then used as inputs when modeling future light-duty vehicle ownership decisions and consumer adoption levels, which drive light-duty vehicle transportation energy demand and consumption. The focus of this report is the California light-duty vehicle market, with projected attributes including fuel economy, acceleration, range, manufacturer suggested retail price, and vehicle footprint from 2015 to 2030. These attributes are developed using a historically validated consumer choice model – the Automotive Deployment Option Projection Tool (ADOPT) – integrated with a modeling framework that simulates vehicle fuel economy, cost, and performance through the optimization of vehicle components – the Future Automotive Systems Technology Simulator model (FASTSim). FASTSim is a simulation tool used to estimate vehicle efficiency, fuel economy, acceleration, battery size and its cost. The National Renewable Energy Laboratory developed both models, which have been adapted to reflect the California light-duty vehicle market for this report.

The projected vehicle attributes are an output of the ADOPT framework (FASTSim and ADOPT integration) simulations. The attribute results are grouped by vehicle classes and powertrains specified by California Energy Commission staff. Because the ADOPT modeling framework considers consumer demand when estimating vehicle attributes, each attribute is weighted by the ADOPT projection of California vehicle sales to reflect California-specific policy and market conditions. The study described in this report includes the following major components:

- Description of component-level inputs for technology improvements over time across several powertrain types
- Projections of both national and California (provided by the Energy Commission) fuel prices used as ADOPT inputs, with several scenarios reflecting alternative future price projections
- Enhancements and adjustments to the existing ADOPT modeling framework to better reflect the California light-duty vehicle market
- Projections of vehicle attributes over time, along with discussion on the ADOPT modeling framework results.

The National Renewable Energy Laboratory's analysis assesses the future of conventional and alternative powertrain light-duty vehicles through several scenarios predefined by Energy Commission staff, including a mid electricity demand case (a base scenario both with and without an extension of Corporate Average Fuel Economy [CAFE] policy through 2030), low electricity demand case, and high electricity demand case. The inputs and approach of the modeling have been customized to reflect market expectations for California, following guidance from the Energy Commission staff. These California-specific modifications include setting introductory years for certain powertrain/vehicle classes to adhere to manufacturer announcements, adjusting average fuel economy for each vehicle class and powertrain to match

historical 2015 California fuel economy data, and striving to match the number of powertrain makes and models to California agencies' projections.

These projected vehicle attributes are adjusted and used by the Energy Commission to project light-duty vehicle demand and fuel consumption in the State of California, while using the Commission's transportation energy demand models. Key considerations and outcomes of the effort to inform vehicle attributes projections for the Energy Commission include the following:

- For the mid electricity demand scenario (which is essentially a business-as-usual case), ADOPT results suggest that fuel economy projections for conventional gasoline technologies are affected significantly by federal policies such as CAFE. Under the assumption that CAFE target levels continue to increase linearly, fuel economy projections also continue to increase. Under the assumption that CAFE levels off with constant target levels after 2025, the results show that manufacturers are not offered incentives to keep improving fuel economy. This trend is particularly evident with the gasoline and hybrid vehicle attribute projections. Comparing those two scenarios, attributes differ even for the period between 2015 and 2025 due to differences in the CAFE coefficients for ADOPT that ensure long-term planning for meeting requirements in the CAFE extension scenario compared to the base case when the targets level off.
- Comparing the mid electricity demand case to cases with a more aggressive battery cost reduction projection – such as the high electricity demand case – underscores that fuel economy targets are not exclusively met with vehicle attribute adjustments, but also with sales shifts between powertrains.
- ADOPT accounts for tradeoffs among several attributes, such as the effects of increasing fuel economy on the manufacturer suggested retail price and the tradeoffs between fuel economy and acceleration performance. These relative trends are evident in the sales-weighted attribute results.
- For the majority of vehicle classes and powertrains examined in this work, fuel economy increases over the planning horizon, particularly within classes where new models are introduced. For plug-in electric vehicles, the manufacturer suggested retail price increases during the initial years when electric range increases and economies of scale are not yet achieved. Then, the manufacturer suggested retail price is projected to decrease even though electric ranges are projected to increase. The number of gasoline vehicle models decreases over the years as the number of alternative fuel options increases. (The greatest increase is for hybrid electric models, followed by plug-in hybrid electric models, and then battery-electric models.)
- The results reflect California light-duty vehicle market expectations as several findings are supported and used in the modeling efforts of the Energy Commission. The ADOPT 2015 vehicle sales projections have been validated through comparison with actual California light-duty vehicle sales. The projected numbers of new makes and models are well aligned with California Air Resources Board expectations and manufacturer announcements. Base year (2015) fuel economy data by powertrain and vehicle class are adjusted to match the California data.

CHAPTER 1: Introduction

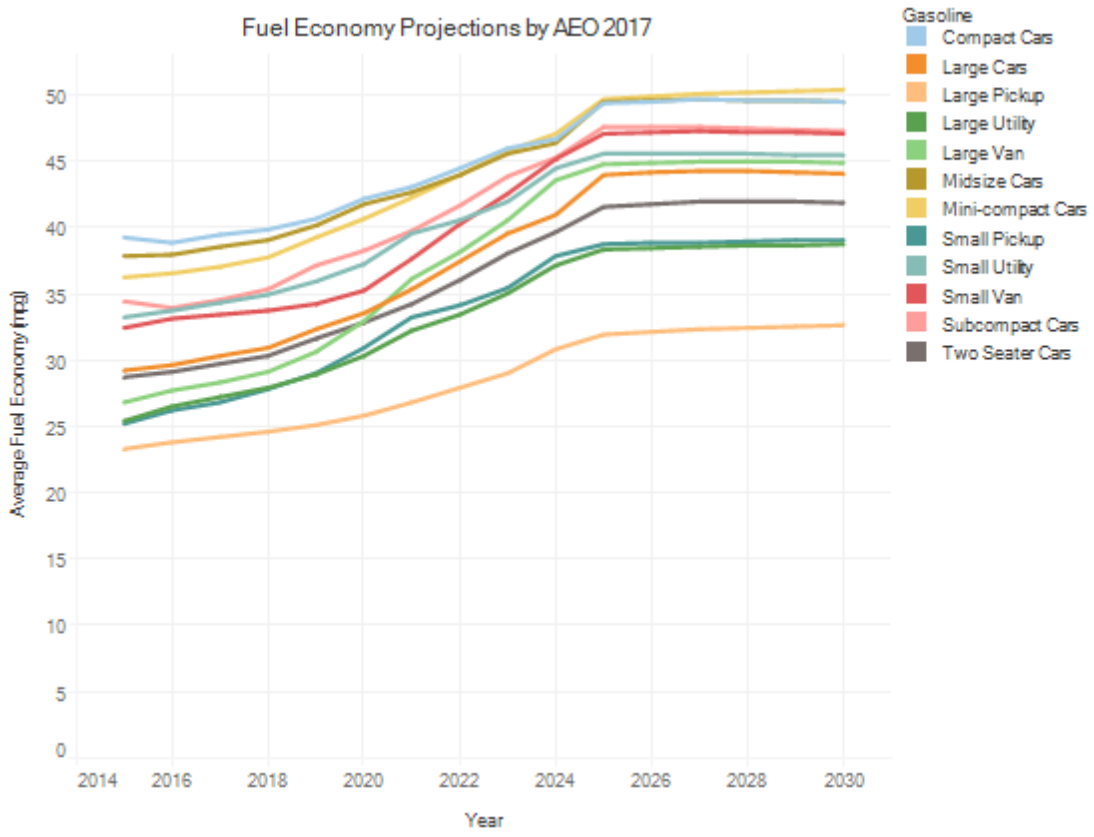
Background

Vehicle purchase decisions are driven by vehicle attributes such as manufacturer suggested retail price (MSRP), acceleration, fuel economy, range, and interior volume, as well as other considerations such as income, current and expected fuel prices, current vehicle ownership within the household, consumer demographics, and personal preferences (Bhat, Sen, and Uluru 2009; Brownstone, Bunch, and Train 2000; Greene 2001). Vehicle class (that is, compact car, large car, sport utility, pick-up truck) and powertrain type (for example, conventional gasoline, diesel, hybrid electric, plug-in hybrid electric, battery electric, fuel cell) are also important vehicle differentiators. Some advanced vehicle powertrain types – such as battery-electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs) – may present significant and rapidly evolving tradeoffs in terms of MSRP, acceleration, range, and interior volume when compared to conventional gasoline internal combustion engine vehicles. Therefore, as light-duty vehicle (LDV) markets and technologies change over time, estimating how vehicle attributes will evolve is crucial to project consumer adoption levels.

Many analytical studies estimate future vehicle attributes at the national level. These studies include the Annual Energy Outlook (AEO) from the U.S. Energy Information Administration (EIA 2017a), the vehicle attribute projections prepared for the Government Performance and Results Act analysis of the U.S. Department of Energy (U.S. DOE) (Ward 2013), the Technical Assessment Report from the U.S. Environmental Protection Agency, National Highway Traffic Safety Administration, and California Air Resources Board (U.S EPA, NHSTA, CARB 2016), and long-term assessments prepared by the National Research Council (NRC 2013). The results of these studies have been used as inputs or indicators of future vehicle attribute trends for several vehicle adoption decision modeling frameworks (Stephens et al. 2017), such as the LAVE-Trans (Greene, Park, and Liu 2014), ParaChoice (Stephens et al. 2016), Automotive Deployment Option Projection Tool (ADOPT) (Brooker et al. 2015a), and Market Acceptance of Advanced Automotive Technologies (MA3T) (Lin and Greene 2010) models. Vehicle attributes projections have also been used to assess the economic value of the market growth of vehicles with new powertrains (Melaina et al. 2016).

Figure 1 shows one example of a projection of vehicle attribute at the national level, showing results for gasoline LDV fuel economy from the 2017 AEO. Fuel economy for 12 vehicle classes is projected to 2030 under reference case technology and economic conditions (EIA 2017b). In the national AEO projection, fuel economies improve to 2025 and then hold relatively constant after meeting Corporate Average Fuel Economy (CAFE) requirements.

Figure 1: Fuel Economy Projections for Gasoline LDV Classes



Source: EIA 2017b

To capture characteristics of the LDV market in California, the national-level vehicle attributes projections are weighted by the projected LDV sales. Such case studies, focusing on sales-weighted average vehicle attributes, are limited in the existing literature. This report helps fill that gap by projecting vehicle attributes for different LDV classes and powertrains for California.

Objective

This report describes the process used to project vehicle attributes for a combination of different LDV classes and powertrains. It focuses on California and presents projections for MSRP, fuel economy, acceleration, and range (total and all-electric) for 2015 to 2030. The approach relies on a historically validated consumer choice model – ADOPT – which is integrated with a similarly validated vehicle model that estimates vehicle fuel economy, cost, and performance – the Future Automotive Systems Technology Simulator model, or FASTSim. Both models were developed by staff at the National Renewable Energy Laboratory (Brooker et al. 2015a and 2015b). The projected attributes inform the Commission's transportation energy demand model (Bahreinian et al. 2017) that is used to project vehicle ownership decisions in California using information from 2015-2017 California Vehicle Survey (Fowler et al. 2018), which is hosted in the Transportation Secure Data Center (TSDC) (NREL 2017).

The projected vehicle attributes are based on FASTSim and ADOPT simulations, with results grouped by vehicle classes and powertrain types specified by the California Energy Commission staff. These specifications ensure that the model results are consistent with the analytic framework used by the Energy Commission to assess future LDV markets (Energy Commission 2017a). Because the ADOPT modeling framework estimates vehicle attributes in response to consumer demand, the attributes are reported by class and powertrain based on weighted California LDV sales (as projected by ADOPT) that reflect California-specific policy and market conditions.[1] The study includes:

- Preparation and use of detailed component-level inputs for technology improvements across several powertrain types.
- Presentation of forecasts and projections, informed by the Energy Commission staff, of national and California fuel prices used as ADOPT inputs, with several scenarios reflecting alternative future price trends.
- Enhancements and adjustments to the standard modeling frameworks to better capture the California LDV market.
- Estimation of vehicle attribute trajectories over time, along with discussion on the ADOPT modeling framework findings.

Report Organization

The remainder of this report is organized as follows. Chapter 2 describes the approach used to project vehicle attributes for California. The enhancements and adjustments made to the ADOPT model to better reflect the California LDV market are presented, and study scenarios are defined. Chapter 3 shows results in terms of fuel economy, performance, MSRP, and range for several vehicle classes and powertrains while discussing underlying tradeoffs between these attributes over time. This chapter also discusses relationships between vehicle attributes to underline the need to capture tradeoffs among different vehicle performance and efficiency characteristics. Chapter 4 summarizes key findings and considerations and suggests areas for future research.

1 These include California's Zero Emission Vehicle Program and state-level rebates.

CHAPTER 2: Approach

This chapter presents the analytical methods and tools used to develop the vehicle attributes, as well as the California-specific customization of input assumptions used in each scenario.

ADOPT Modeling Updates

The subsections below provide background information on ADOPT, present the enhancements made to ADOPT modeling framework to better capture the California vehicle market, and describe the process used to aggregate, or group, ADOPT results into specific vehicle and powertrain classes.

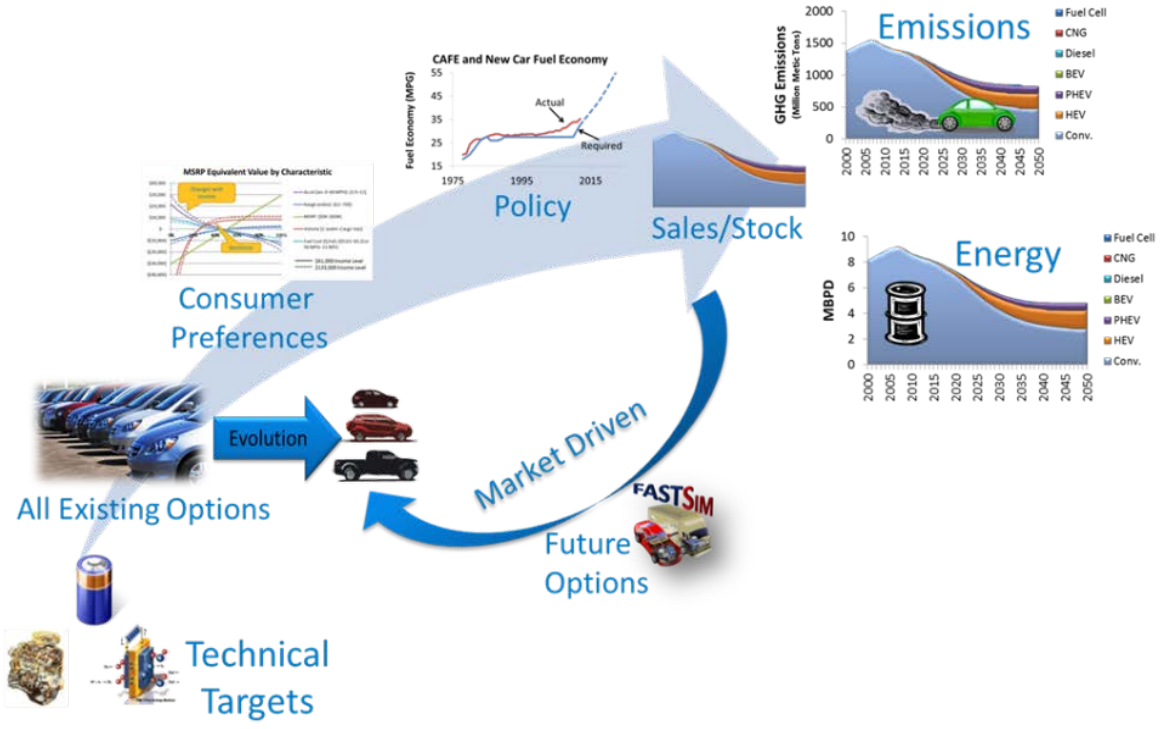
Background

ADOPT estimates technology improvement effects on future vehicle sales, energy use, and greenhouse gas emissions, as summarized in Figure 2 (Brooker et al. 2015a). It is well regarded (receiving the top score in the most recent merit review of vehicle choice models by DOE's Vehicle Technologies Office) (U.S. DOE 2015) because it uniquely captures the following key analytical aspects:

- All base year (2015) and subsequent vehicle makes, models, and trims with related key attributes of price, fuel cost per mile, acceleration, size, and range represent the current market accurately.
- The model is extensively validated, considering consumer preference tradeoffs to ensure confidence in the results (Brooker et al. 2015a).
- Regulations that influence sales and average fuel economy including CAFE[2] and greenhouse gas standards. The zero-emission vehicle (ZEV) mandate is not explicitly modeled within ADOPT, but the vehicle sales results for California were verified to meet the credit requirements for all scenarios.

2 The Corporate Average Fuel Economy (CAFE) standards are intended to reduce energy consumption by increasing the fuel economy of cars and trucks sold in the United States (U.S. EPA and NHTSA 2012). CAFE targets depend on vehicle footprint, which measures the size of a vehicle as the multiplication of the wheelbase of a vehicle by the associated track width.

Figure 2: ADOPT Overview



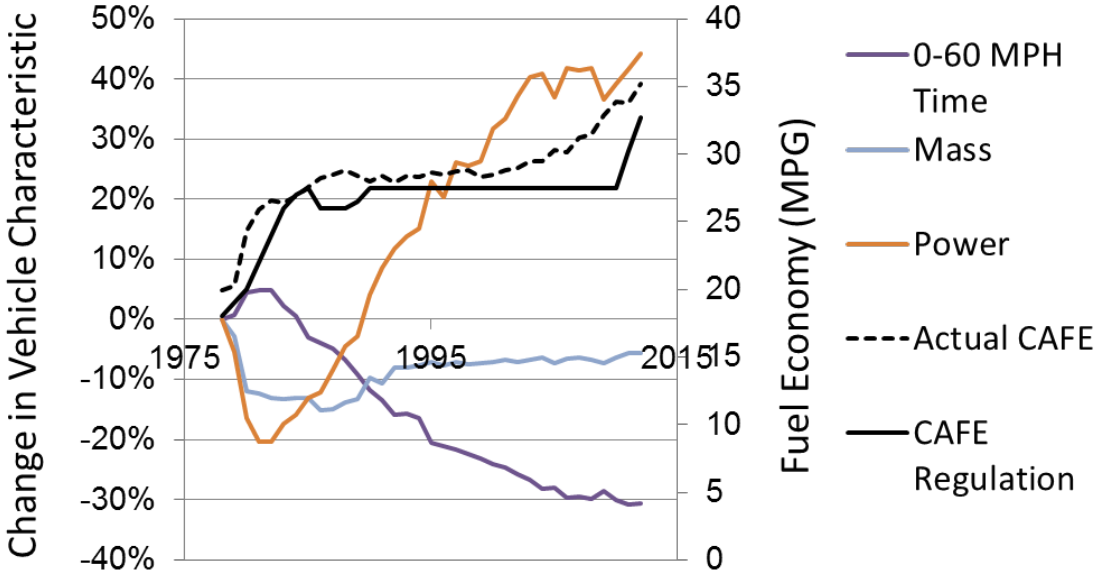
Source: National Renewable Energy Laboratory

Regulations

ADOPT estimates vehicle sales that conform to the CAFE and greenhouse gas standards by applying three techniques based on historical trends. These trends are shown in Figure 3. First, ADOPT uses specified technological improvements, such as engine efficiency and lightweighting (which describes the use of lighter materials to improve vehicle's efficiency), over time to help conform to the regulations. Based on historical data, when CAFE regulations stay relatively flat, market forces tend to focus much of the benefits of technology improvement toward improving acceleration and increasing vehicle size, as shown in Figure 3 (based on historical data). Second, ADOPT reduces engine power to meet fuel economy regulations. This strategy is an attempt to mimic past trends that pertain to the behavior of vehicle manufacturers; for example, fuel economy started improving rapidly in 1978 when federal CAFE standards were introduced. To achieve fuel economy improvements, manufacturers decreased vehicle power, and vehicles showed slower acceleration levels. Reducing engine power improves vehicle efficiency because smaller engines tend to operate more efficiently. However, engine downsizing in ADOPT is limited so as not to reduce acceleration excessively, which is historically correlated with a reduction in sales. Effectively, this limits engine downsizing by the amount of lightweighting specified in ADOPT (Brooker et al. 2015b) and forces the benefits to go toward efficiency rather than acceleration. The third technique ADOPT uses to conform to regulations is to adjust MSRP through monetary incentives and penalties. Vehicle price incentives are applied to vehicles exceeding the regulations proportional to the amount they exceed it. Similarly, price penalties

are applied to vehicles falling short of the regulations proportional to the shortfall. The model iterates to find incentive and penalty rates that when applied offset each other.

Figure 3: Changes in Vehicle Attributes as CAFE Regulations Increased



Source: NREL

ADOPT Enhancements

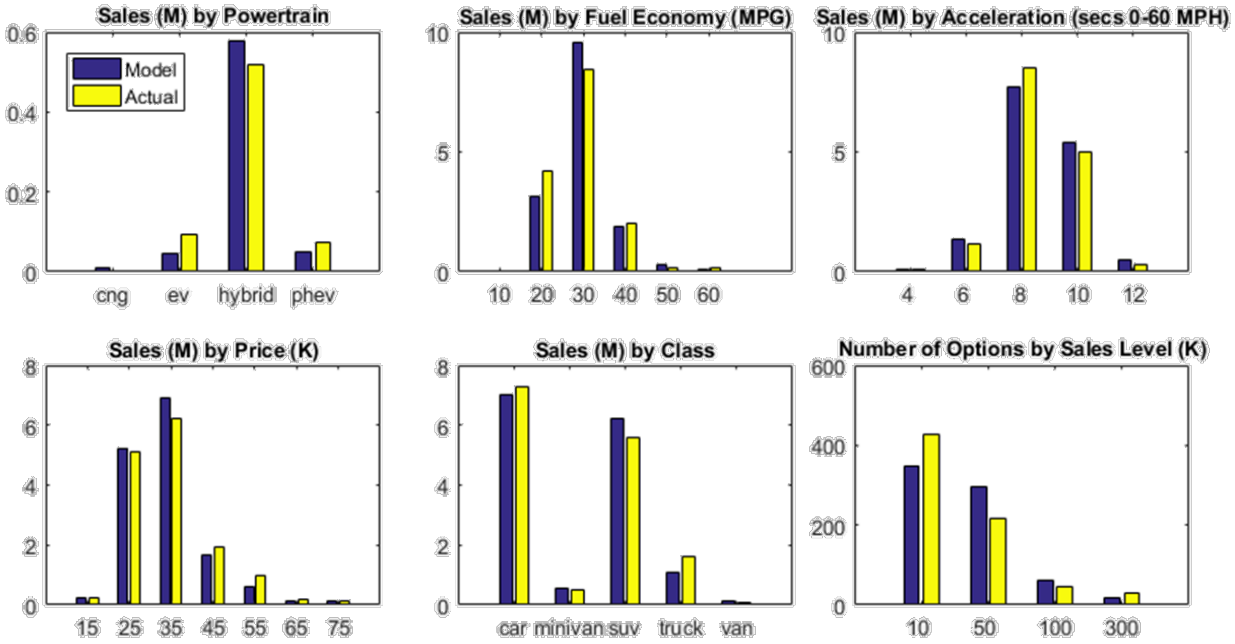
NREL made several improvements to ADOPT for this analysis. The initial 2012 model year vehicle database for ADOPT was updated to model year 2015 to provide better market representation, which included adding hybrid (HEV), PHEV, BEV, and FCEV models introduced since 2012. All existing 2015 makes, models, and trims were added to ADOPT, along with the price, fuel economy, acceleration, range, size, and footprint for each vehicle, according to 2015 fueleconomy.gov data (fueleconomy.gov 2017). ADOPT uses these attributes as a starting point for modeling the evolution of fleet powertrain and class options into the future.

NREL validated ADOPT sales projections against real-world data from vehicles in 2015. ADOPT uses a logistic function[3] to estimate sales based on key attributes including vehicle price, fuel cost, acceleration, range, and interior volume (for passengers or cargo). The preference for these attributes is nonlinear across the range for all attributes except price. Also, the preference for all the attributes changes with household income level, with higher-income households placing less importance on fuel cost and price. To test the accuracy of ADOPT, the preference for attributes were calibrated so the estimated vehicles sales of ADOPT matched 2008 national sales data. Then projected sales were compared to actual sales results, which matched well for different regions in 2008 and nationally in 2012 (Brooker et al. 2015a) and 2015. The first five charts in

3 *Logistic function* is the cumulative distribution function of the logistic distribution and is a sigmoid ("S") curve. The logistic distribution is used for various growth and logistic regressions models (Washington et al. 2003).

Figure 4 compare the 2015 LDV sales distribution of ADOPT to national-level 2015 LDV sales data (IHS Markit 2017). The sixth chart shows the number of models selling at different sales levels. There, it is shown that about 200 vehicle models sold between 50,000 and 100,000 vehicles. ADOPT also accounts for the fact that providing very few powertrain/technology vehicle options may have a negative effect on vehicle sales (Shocker et al. 1991).

Figure 4: ADOPT National-Level Validation of Sales by Attribute for 2015 Vehicles



Source: NREL

Two additional updates improved the available vehicle options, increased the number of vehicle models available per powertrain and class, and improved the vehicle attribute diversity for more realistic aggregations by vehicle class denoted by the Energy Commission. First, powertrain component sizing, such as engine, motor, and battery, was optimized to maximize LDV sales at five income levels instead of optimizing to total market demand. This update accounts for the fact that some vehicles (for example, the Tesla Model S, with its fast acceleration and high cost) are aimed at higher-income households, whereas others (for example, the Nissan Leaf) are aimed at more mainstream consumers. The income levels that vehicle attributes/components are optimized for are reevaluated for each powertrain as new vehicle options are created. Second, vehicle diversification was improved by restricting the reuse of high-selling vehicle classes. Before a model option can be reused for a given powertrain and income level, all the other existing options whose sales remained high enough to not be retired must be used first. This ADOPT adjustment helps maintain diverse vehicle options within a class and across classes and accommodates a heterogeneous set of consumers.

Data Processing

ADOPT generates future vehicle attributes for more than 700 vehicle makes and models, given assumptions about technology trends, policy drivers, consumer preferences, and fuel prices. In this work results are aggregated into sales-weighted averages for the vehicle class and powertrain categories presented in Table 1, as those are established by the Energy Commission staff.

Table 1: Vehicle Class and Powertrain Categories Used in the Analysis

Vehicle Classes	Powertrains
Car-Compact	Diesel
Car-Large	Electric (BEV)
Car-Midsize	Flex-Fuel (E85)
Car-Sport (in ADOPT as Two-Seaters)	Gasoline
Car-Subcompact	Hybrid Electric
Cross/Utility-Midsize	Hydrogen Fuel Cell
Cross/Utility-Small-Car	Plug-In Hybrid
Cross/Utility-Small-Truck	Natural Gas (Compressed)
Pickup-Compact	
Pickup-Standard	
Sport/Utility-Compact	
Sport/Utility-Large	
Sport/Utility-Midsize	
Van-Compact	
Van-Standard	

Source: NREL

The sales-weighted vehicle attributes projected by ADOPT are an outcome of vehicle evolution and optimization based on calibration to 2015 vehicle sales, as discussed in the "Background" section and Brooker et al. (2015a). The introduction and discontinuation of different powertrain makes and models over time adheres to Energy Commission staff initial estimations, based on LDV manufacturer feedback; see Table 4 and text referring to it for further discussion.

The vehicle-specific ADOPT results are aggregated into the vehicle classes shown in Table 2 (the naming of the vehicle classes adheres to Energy Commission classification) according to vehicle passenger and cargo volume (for cars) and gross vehicle weight (for light-duty trucks/vans).

Table 2: Vehicle Class Categorization

Cars	**Passenger and Cargo Volume**	**Unit**
Two-Seaters	Any	
Car-Subcompact	85 to 99	cubic ft
Car-Compact	100 to 109	cubic ft
Car-Midsize	110 to 119	cubic ft
Car-Large	120 or more	cubic ft
Cross/Utility-Small-Car	<130	cubic ft
Cross/Utility-Midsize	130 to 159	cubic ft
Cross/Utility-Large	160 or more	cubic ft
Sport/Utility-Compact	<124	cubic ft
Sport/Utility-Midsize	124 to 170	cubic ft
Sport/Utility-Large	>170	cubic ft
Trucks/Vans	**Gross Vehicle Weight Rating**	**Unit**
Pickup-Compact	<6,000	lb
Pickup-Standard	6,000 to 10,000	lb
Van-Compact	<8,500	lb
Van-Standard	8,500 to 10,000	lb

Source: fueleconomy.gov 2017; ASG 2017

An example of the aggregation process and categorizations generated from this postprocessing of ADOPT results is provided in Table 3 for BEVs. For each powertrain and vehicle class, the sales-weighted average attribute is computed for each year of the forecast period of the study (2015—2030). A similar process is followed for each powertrain and class to report the vehicle attribute trends.

Table 3: Example Categorization of ADOPT Results: BEVs, All Classes, 2017

Powertrain	Vehicle Class	Make	Model	2017 Makes
Electric	Car-Compact	Chevrolet	Bolt	
Electric	Car-Compact	Ford	Focus Electric	3
Electric	Car-Compact	VW	e-Golf	
Electric	Car-Large	Tesla	Model S (60 kWh)	1
Electric	Car-Midsize	Mercedes-Benz	B-Class Electric Drive	2
Electric	Car-Midsize	Nissan	Leaf	
Electric	Car-Subcompact	BMW	i3 BEV	
Electric	Car-Subcompact	Chevrolet	Spark EV	3
Electric	Car-Subcompact	Fiat	500e	
Electric	Cross/Utility-Small-Car	Kia	Soul Electric	1
Electric	Car-Sport	Smart	For-two electric drive coupe	1

Source: NREL

Analysis Scenarios

The following are the scenarios NREL used to perform this analysis; the naming and the notation of each scenario stem from the Energy Commission notation (Energy Commission 2017a). Several assumptions have been made about technological improvements, fuel prices, and transportation policies. The scenario naming generally aims to represent different levels of transportation electricity demand, which essentially reflects electrified vehicle sales anticipated. The scenarios are the following:

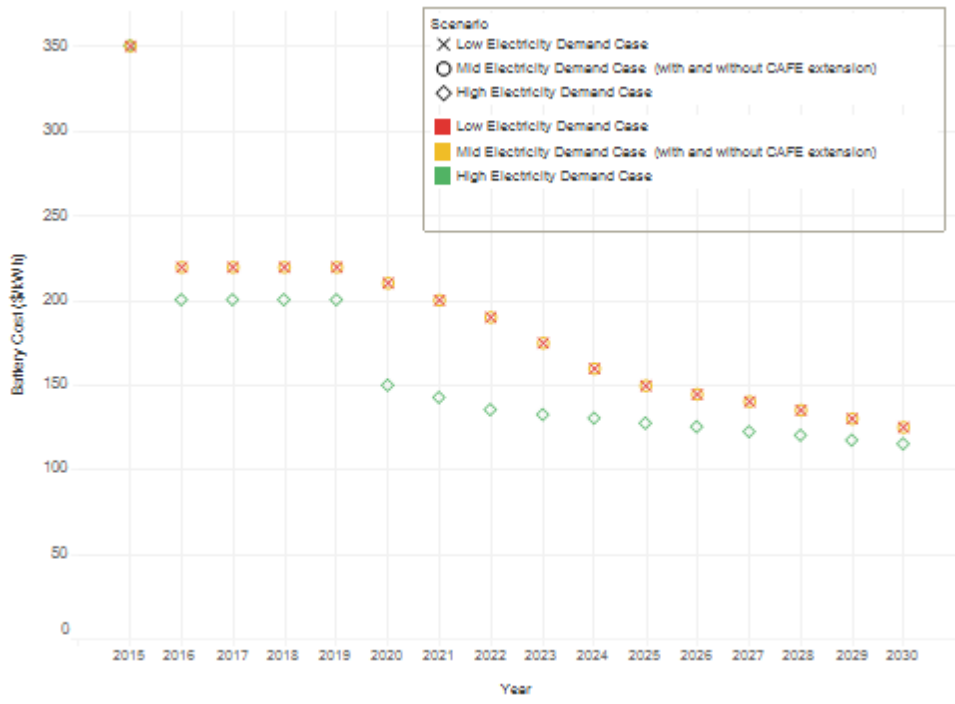
- Mid electricity demand case: Business-as-usual technological improvements, reference case national-level fuel prices (EIA 2017c), specific fuel prices for California (based on Energy Commission staff projections), standard CAFE policy assumptions (U.S. EPA and NHTSA 2012) with targets leveling off after 2025.
- CAFE policy extension: Same as mid electricity demand case, with CAFE targets linearly extended to 2030.
- High electricity demand case: High technological improvements, high national-level oil/gasoline prices (EIA 2017c) and California-specific fuel prices, standard CAFE policy assumptions.
- Low electricity demand case: Low technological improvements, low national-level oil/gasoline prices (EIA 2017c) and California-specific fuel prices, standard CAFE policy assumptions.

A combination of high technological improvements for the new alternative fuel vehicles and high oil prices is generally expected to result in greater plug-in electric vehicle demand because BEVs and PHEVs are expected to be more cost-effective than conventional vehicles under those conditions (IEA 2017). On the other hand, a combination of low technological improvements for new alternative fuel technologies and low oil prices is more likely to result in the continuation of incumbent gasoline powertrains. Therefore, different sets of LDV attributes would be expected for each scenario.

Technology Improvement Assumptions

Battery costs for the plug-in electric vehicles in the mid, low, and high electricity demand cases stem from an Energy Commission analysis of third-party estimates. Figure 5 shows the battery-cost assumptions for each scenario. There are no differences between the low and mid electricity demand case battery cost projections; however, fuel prices are different for these three scenarios (low, mid, and high).

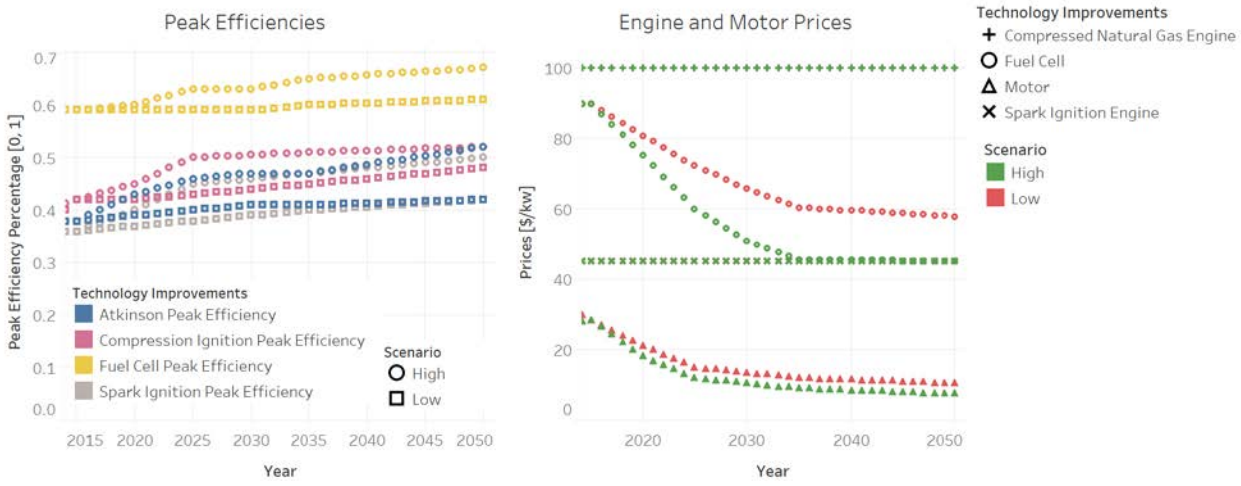
Figure 5: Battery Cost Assumptions



Source: California Energy Commission

Projections for other component technology trends for each powertrain type align with DOE technical targets – low technology, and high technology improvements – as presented in Moawad et al. (2016) and shown in Figure 6. Trajectories of the peak efficiency of Atkinson, compression ignition, fuel cell, and spark ignition technologies are reported in the "Peak Efficiencies" percentage subplot. Engine and motor price assumptions for compressed natural gas (CNG), fuel cell, and spark ignition are reported in the second subplot.

Figure 6: Other Vehicle Components Assumptions



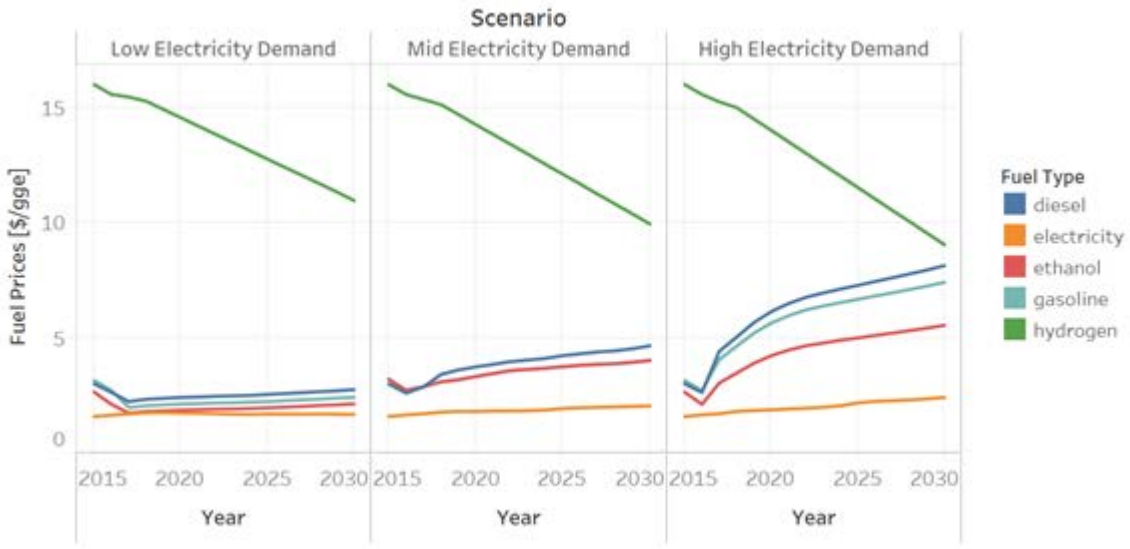
Source: Moawad et al. 2016

In general, these technologies are standard component cost and performance input assumptions in ADOPT and other DOE models (Moawad et al. 2016). They are used in ADOPT when projecting evolution of LDV components and attributes.

Fuel Price and Policy Assumptions

At the national level, fuel price trajectories are based on AEO 2017 reference, high, and low oil price cases (EIA 2017a). The California-specific fuel prices used in ADOPT stem from the Energy Commission's preliminary *2017 Integrated Energy Policy Report* (*IEPR*) forecast. Figure 7 presents the fuel price projections used in the low, mid, and high electricity demand scenario. In the mid electricity demand scenario, the California-specific gasoline price is projected to be the same as the ethanol (E85) price.

Figure 7: California Fuel Price Projections



Source: California Energy Commission

National-level plug-in electric vehicle incentives are set in accordance with federal legislation (AFDC 2017). ADOPT captures the 4-kilowatt-hour (kWh) battery size requirement for the base $2,500 incentive, the additional $417/kWh for batteries sized beyond the minimum, and the 200,000-vehicle cap per manufacturer. The number of plug-in electric vehicles sold before 2015 that count toward the 200,000-vehicle cap per manufacturer has been accounted for. The California-specific incentives are accounted for as well, based on information from the California Clean Vehicle Rebate Project (CVRP 2017). The following state-level rebates are included in ADOPT: $1,500 for PHEVs, $2,500 for BEVs, and $5,000 for FCEVs.

CHAPTER 3:
Results

This chapter presents the major vehicle attribute results from NREL's ADOPT market-adoption simulations for the scenarios defined in Chapter 2. Results for the mid electricity demand case with CAFE extension are discussed primarily in this chapter because the outcomes of this scenario are used by the Energy Commission for its 2017 Transportation Energy Demand Forecast (Bahreinian et al. 2017) and LDV demand analysis (Energy Commission 2017b) for California.

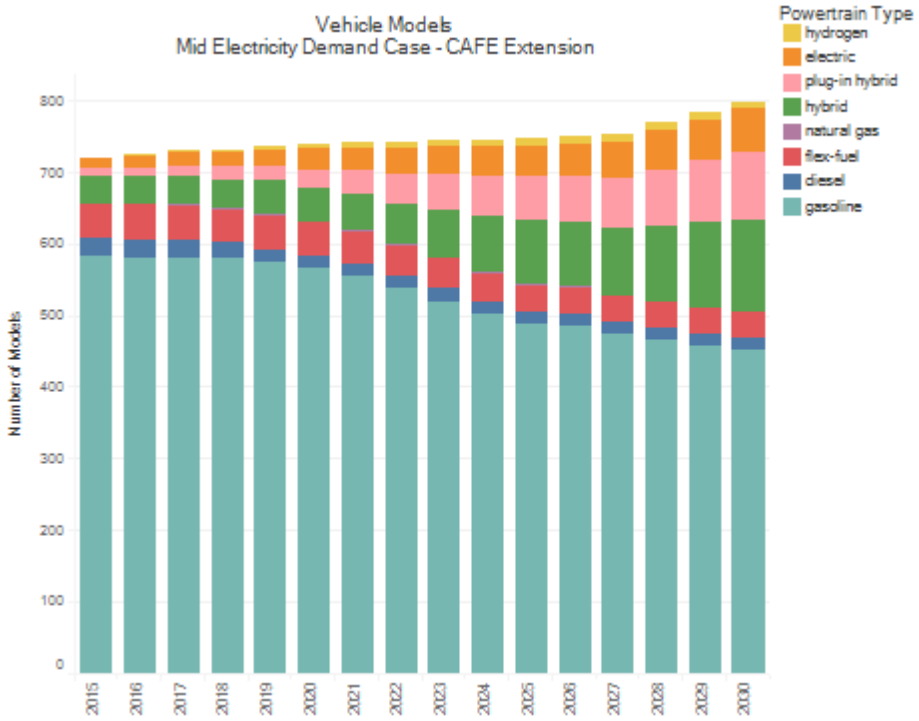
Certain comparisons among scenarios are presented to denote the effect of varying inputs and policies on vehicle attribute projections. Complete scenario results are documented in Appendix A.

Mid Electricity Demand Case With CAFE Extension: Vehicle Attribute Projections

Vehicle attribute projections for the mid electricity demand case with CAFE extension are reported in this section. The projected attributes include the number of available models, fuel economy, acceleration, vehicle range, and MSRP for gasoline, HEV, PHEV, BEV, and FCEV powertrains.

The availability of different makes and models for a given powertrain affects a consumer's range of acceptable vehicle choices, which has a major effect on the overall purchasing decision (Shocker et al. 1991). ADOPT projects that the available number of models will decrease for gasoline, diesel (which agrees with Cohan 2017), and flex-fuel vehicles, whereas the available number of models for HEVs, PHEVs, BEVs, and FCEVs is projected to increase over time. These trends are shown in Figure 8. In the ADOPT modeling framework, every time a new vehicle model is introduced (in accordance with the method described in the "ADOPT Enhancements" subsection of Chapter 2), a poorly selling one is scrapped. As HEVs, PHEVs, and other alternative powertrains become more competitive, more of these models are introduced, and conventional gasoline vehicle models (that do not sell well) are retired. This consideration is well aligned with existing data on the total number of vehicle models in the United States (Statista 2017).

Figure 8: Numbers of LDV Models in the Mid Electricity Demand Case With CAFE Extension



Source: NREL

Based on reviews of manufacturer announcements and media reports, the Energy Commission has constructed a list of potential years of introduction and elimination of new and outdated vehicle classes/powertrains, respectively. Diesel vehicles for many classes are projected to be discontinued, as are flex-fuel vehicles in the sport car class. Conversely, HEV, PHEV, and BEV models are being introduced into several new vehicle classes. Table 4 shows the ADOPT results for the anticipated introduction and elimination years of various powertrains, with rules that were initially informed by an analysis conducted by Energy Commission staff.

Table 4: Expected Introduction and Elimination Years of Vehicle Classes/Powertrains (ADOPT Outputs)

Class	HEV	PHEV	BEV	Diesel	Flex-Fuel
Car-Subcompact				2017	
Car-Compact					
Car-Midsize					
Car-Large				2017	
Car-Sport			2015		2015
Crossover-Small-Car		2019	2016		
Crossover-Small-Truck					
Crossover-Midsize		2019			
Sport/Utility-Compact		2017	2018	2017	
Sport/Utility-Midsize		2020			
Sport/Utility-Large		2026			
Van-Compact	2019				
Van-Large		2017			
Pickup-Compact					
Pickup-Standard	2017				

Exists 2015—2030	
Introduced	YEAR
Eliminated	YEAR
Never Introduced	

Source: NREL

Fuel Economy Standards

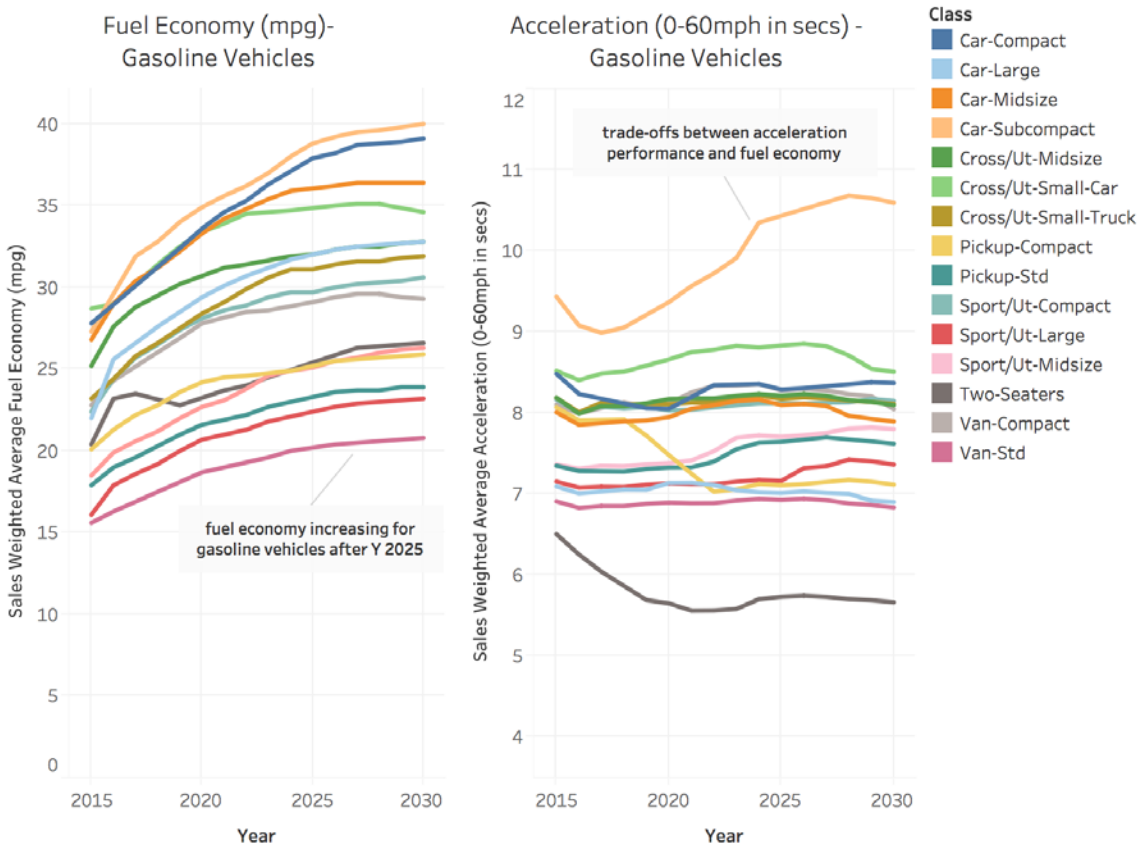
Federal CAFE standards are an important driver of vehicle offerings, as evidenced by the fact that new vehicle average fuel economy has historically followed the CAFE regulation requirements (U.S. EPA 2016; Shiau, Michalek, and Hendrickson 2009). The ADOPT modeling framework captures the influence of the federal CAFE standards, including the crucial role that vehicle footprint[4] plays in CAFE estimation. The CAFE standards are also found to have different implications for each advanced vehicle powertrain (Brooker et al. 2015a). Because the CAFE target continues to increase after 2025 under the CAFE extension scenario, the gasoline

4 *Vehicle footprint* is the area defined by the four points where the vehicle tires touch the pavement. *Footprint* is the product of the wheelbase and the average track width of the vehicle (U.S. DOE 2011).

powertrain fuel economy projected for all vehicle classes also continues to increase. When CAFE regulation flattens out after 2025, under the standard CAFE assumption, the fuel economy was adjusted to remain constant and avoid any performance tradeoffs (which are captured with vehicle acceleration changes). ADOPT outputs suggest that as CAFE flattens out after 2025, technology improvements go into improving acceleration instead of fuel economy.

Figure 9 shows the fuel economy and acceleration projections of gasoline vehicles. The overall trends are similar to those from AEO 2017 in Figure 1 through model year 2025 because EIA (2017b) and ADOPT capture the general effect of CAFE on average vehicle fuel economy. An example of the effect of CAFE seen in Figure 8 is that the acceleration of subcompact cars worsens over the forecast period to enable the significant increase in fuel economy.

Figure 9: Gasoline Vehicle Fuel Economy by Class for the Mid Electricity Demand Case With CAFE Extension



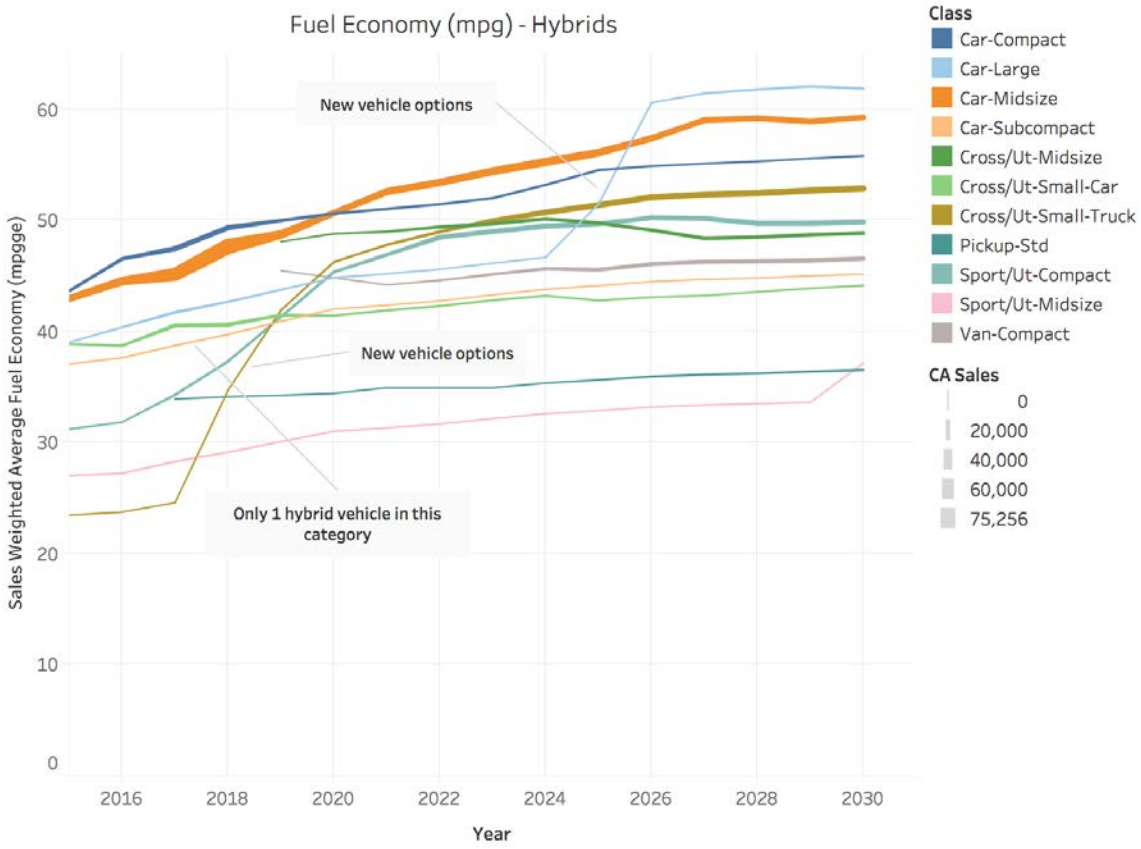
Source: NREL

Vehicle Fuel Economy

Figure 10 shows that HEV fuel economy is projected to increase steadily across all vehicle classes. Rapid increases in fuel economy across some classes are due to the introduction of new vehicle models (for example, large car and cross-utility small truck categories). Sales are also projected to increase for these classes where more efficient vehicle options are introduced (for example, cross-utility small truck HEV class).

The fuel economy for large cars (including, for example, the Ford C-Max Hybrid, with a combined fuel economy of 39 mpg in the initial years) is higher than for subcompacts (including, for example, the Honda CR-Z, with a combined fuel economy of 36 mpg in the initial years), following actual vehicle data (fueleconomy.gov 2017). Similarly, the fuel economy in the initial years is higher for crossover-small cars (a sales-weighted combination of the 2015 Subaru XV Crosstrek Hybrid at 31 mpg and the Toyota Prius V at 41 mpg) than it is for subcompacts (represented only by the Honda CR-Z) (fueleconomy.gov 2017).

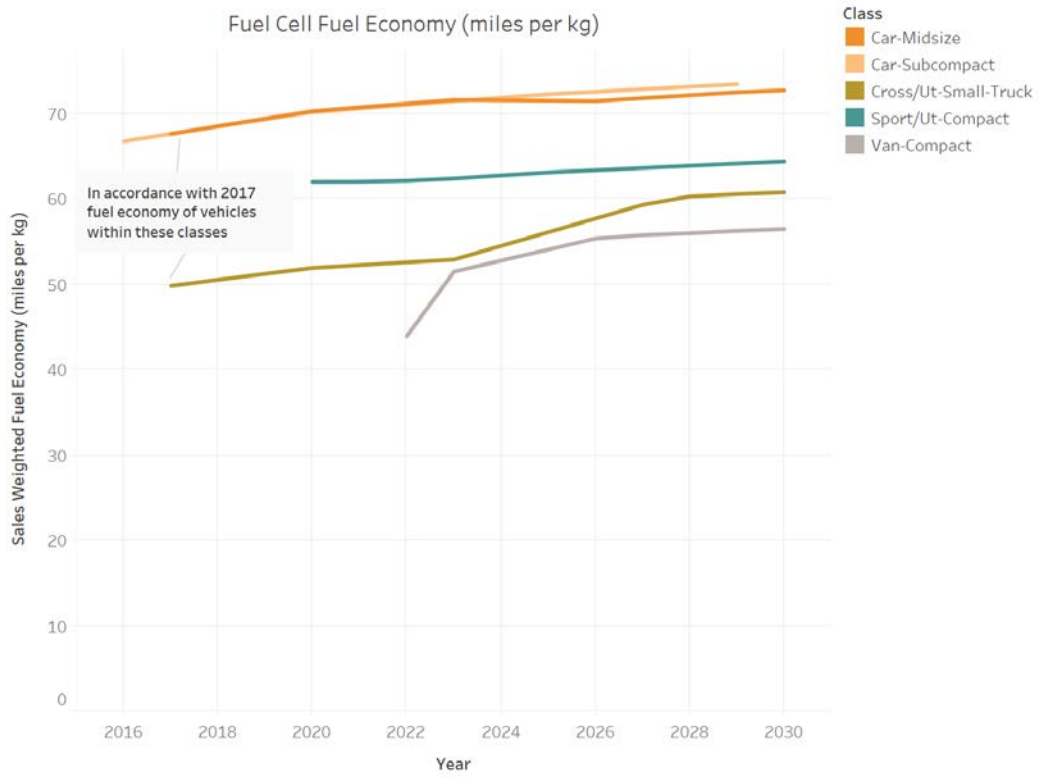
Figure 10: Hybrid Vehicle Fuel Economy by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL Note: The thickness of the lines is proportional to the California LDV sales for this powertrain.

Figure 11 shows the fuel economy projections for FCEVs. A moderate increase of the fuel economy is projected over the forecast years. Of the five vehicle classes that are projected for FCEVs, three already have available market models. Specifically, in the early years the subcompact car class consists of the Toyota Mirai, the midsize class Honda Clarity, and the cross-utility small truck class Hyundai Tucson. The early year (2016—2017) projected fuel economy is also well-aligned with the actual fuel economy (as reported in fueleconomy.gov 2017) of these vehicles. Cars in the sport utility compact car class are introduced in 2020, and compact vans are introduced in 2022.

Figure 11: FCEV Fuel Economy by Class for the Mid Electricity Demand Case With CAFE Extension

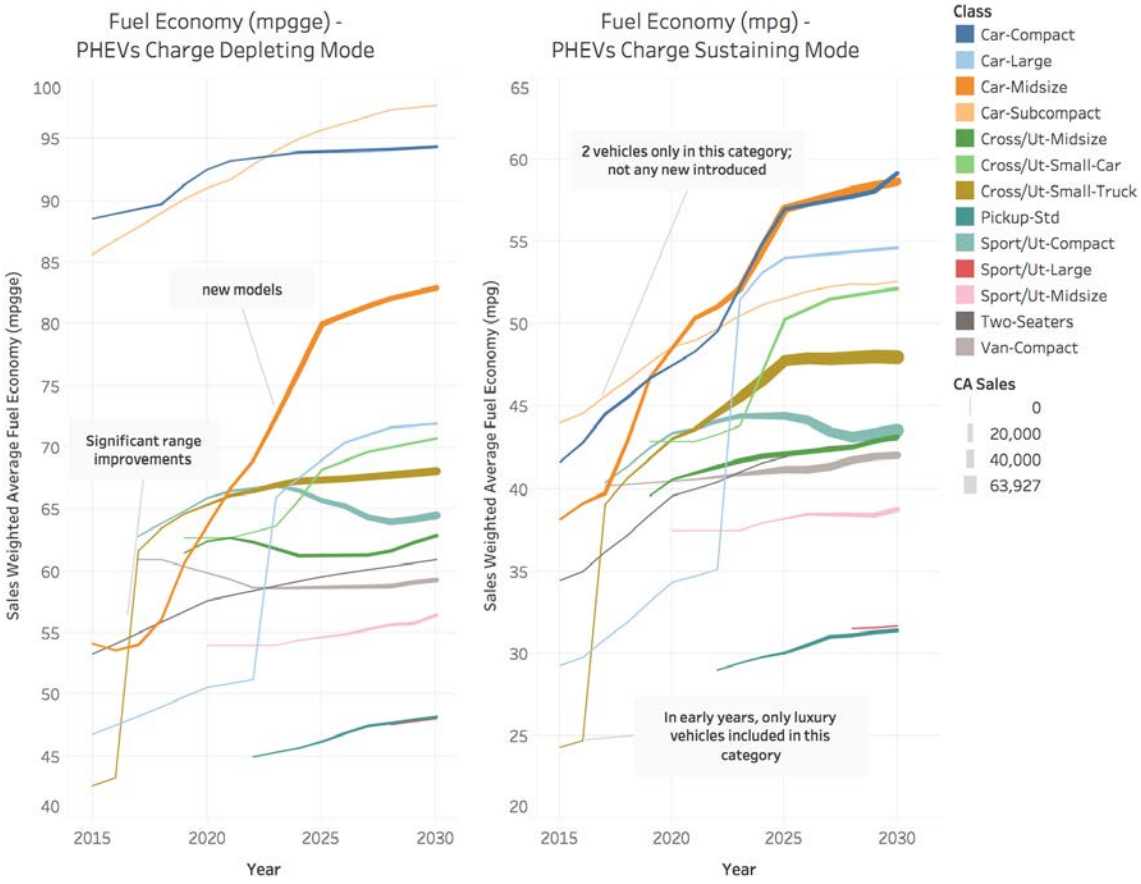


Source: NREL

As shown in Figure 12, PHEVs have charge-depleting and charge-sustaining modes,[5] for which fuel economy values differ significantly. The charge-depleting mode average fuel economy is driven by battery size, vehicle weight, aerodynamics, and acceleration. The thickness of each line in Figure 11 corresponds to estimated California sales generated by ADOPT. Because ADOPT generates new vehicle models by class and powertrain each year based on the success of existing models, fuel economy increases for better-selling classes (such as the midsize car class and the crossover/utility small truck class), due to technological advancements and the need to meet the CAFE standards. For example, the midsize car class consists of the Toyota Prius and other models, but new vehicle makes and models lead to an increase of the average fuel economy of both the charge-depleting and charge-sustaining modes. Charge-depleting mode fuel economy increases for most vehicle classes, particularly for the compact, midsize, and large car classes. The same thing holds for the charge-sustaining mode, for which increasing fuel economy is observed for most of the PHEV vehicle classes.

5 *Charge-depleting mode* is where the vehicle is powered primarily by the onboard battery. *Charge-sustaining* mode is where the vehicle is powered by the internal combustion engine.

Figure 12: PHEV Fuel Economy by Class for the Mid Electricity Demand Case With CAFE Extension

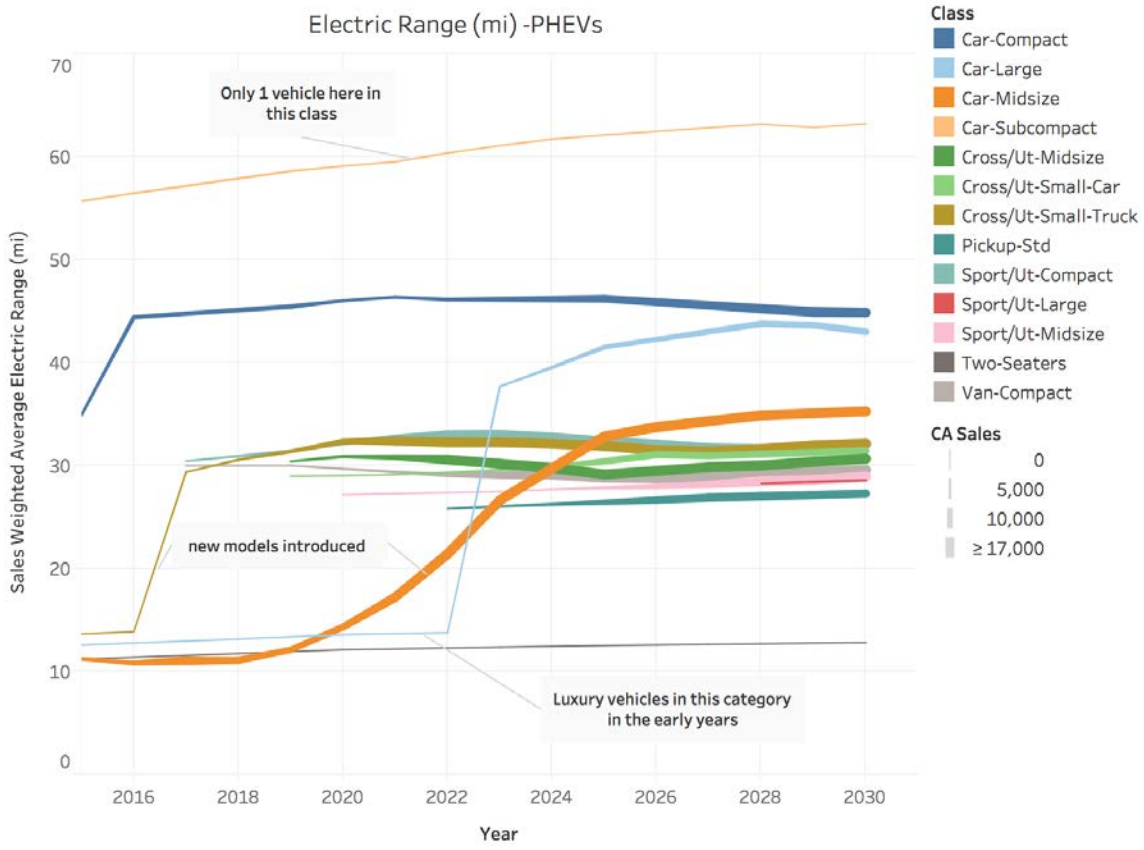


Source: NREL. Note the difference between scales for the two graphs.

Vehicle Range

Figure 13 shows trends in PHEV electric-range. By 2030, the average electric range for most PHEV vehicle classes is around 30 miles. The authors observe that the introduction of new, more efficient vehicles in some vehicle classes (such as the midsize and the large car categories) results in greater improvements in electric range. The PHEV charge-depleting mode fuel economy and PHEV electric range are related (for example, compare the trends for the midsize cars in the two figures) over the years, associated with the footprint and the volume of the vehicle class. The detailed results should be interpreted with the understanding that some of the vehicle classes are represented by only one vehicle (for example, the subcompact car class is represented by only the BMW i3 Rex), whereas other classes include several existing 2015 vehicle models (for instance, the Toyota Prius, and Fusion Energi for the midsize class).

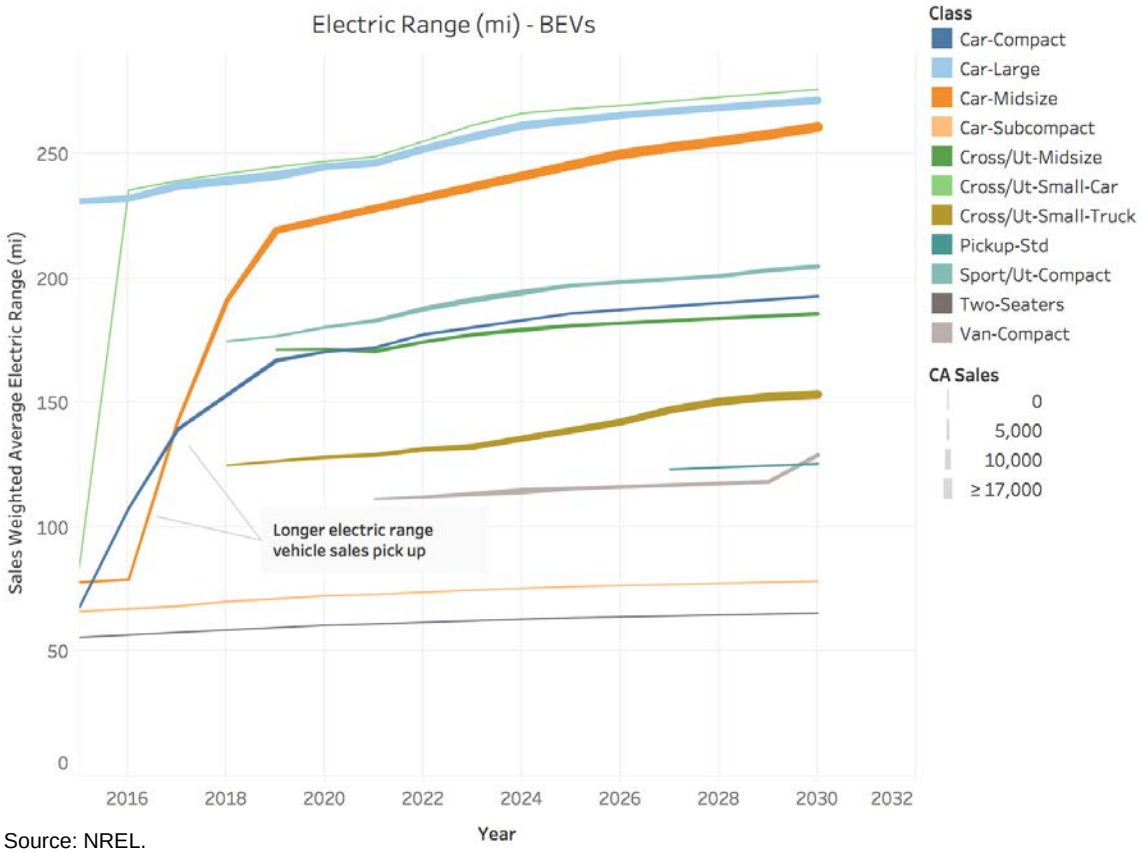
Figure 13: PHEV Electric Range by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL

Figure 14 shows driving ranges increasing for BEVs, particularly for classes such as midsize, large, and small crossover/utility cars, which exceed 250 miles of range by 2030. Projections for those classes also show significant diversity of vehicle models. Jumps in projected range are often due to introduction of new models within a vehicle class. The realism of the modeling outputs is explored by comparing ADOPT electric range outputs to the base year's actual ranges. As expected, midsize cars from 2017 onward maintain greater electric ranges compared with compact cars due to the addition of the Tesla Model 3 in the former class. In the compact car class, a vehicle similar to the Chevrolet Bolt leads to an increase in the driving range during the initial years of the forecast period.

Figure 14: BEV Electric Range by Class for the Mid Electricity Demand Case With CAFE Extension

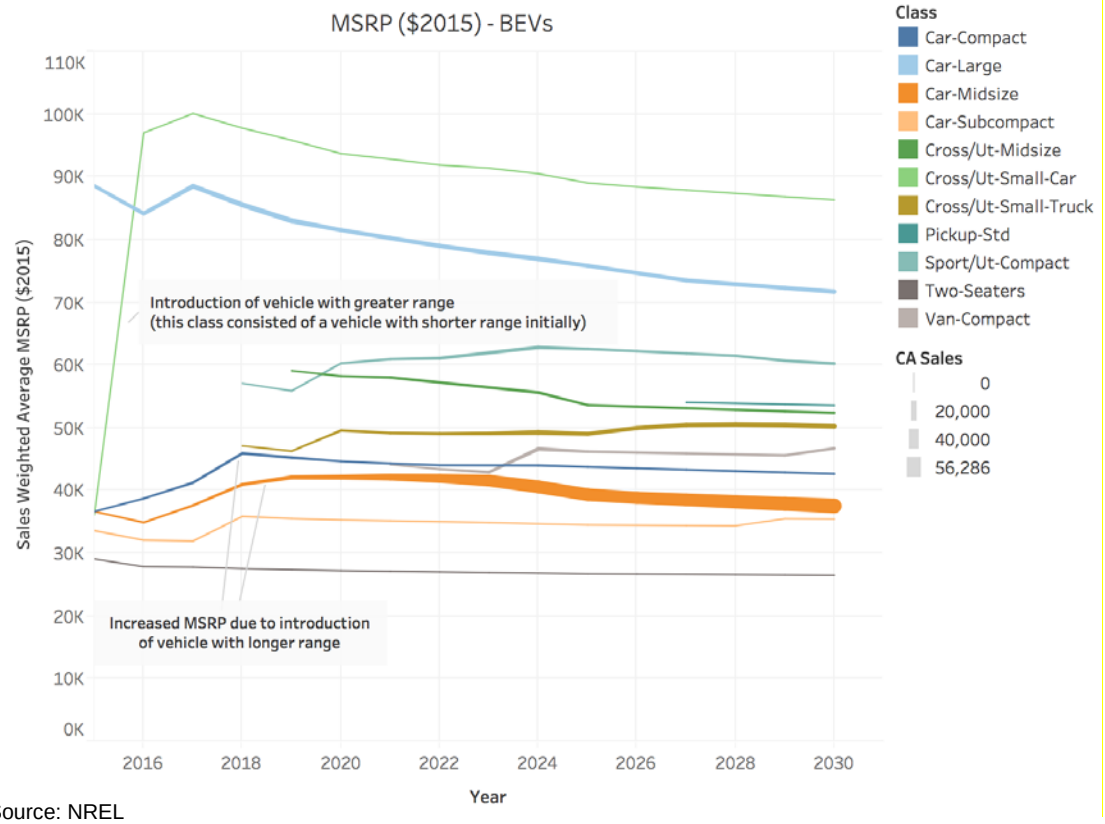


Source: NREL.

The significant increase in electric range of BEVs during the early years of the forecast leads to an increasing MSRP trend on average until 2018. However, MSRPs decline in subsequent years due to battery cost reductions, particularly for the vehicle classes characterized by a significant increase in the number of models, such as the midsize car class. Those trends are portrayed in Figure 15. The only BEV in the two-seater class is the Smart Fortwo, and it has the only BEV MSRP below $30,000. In 2016, the introduction of the Tesla Model X, which has a range of 257 miles, significantly increased the sales-weighted average electric range for the cross-utility small car class since only the Kia Soul Electric (with a range of 90 miles) was present in this class in 2015. Introductions of vehicles with longer ranges in the compact and midsize car classes lead to increasing sales-weighted average MSRP during the early years.

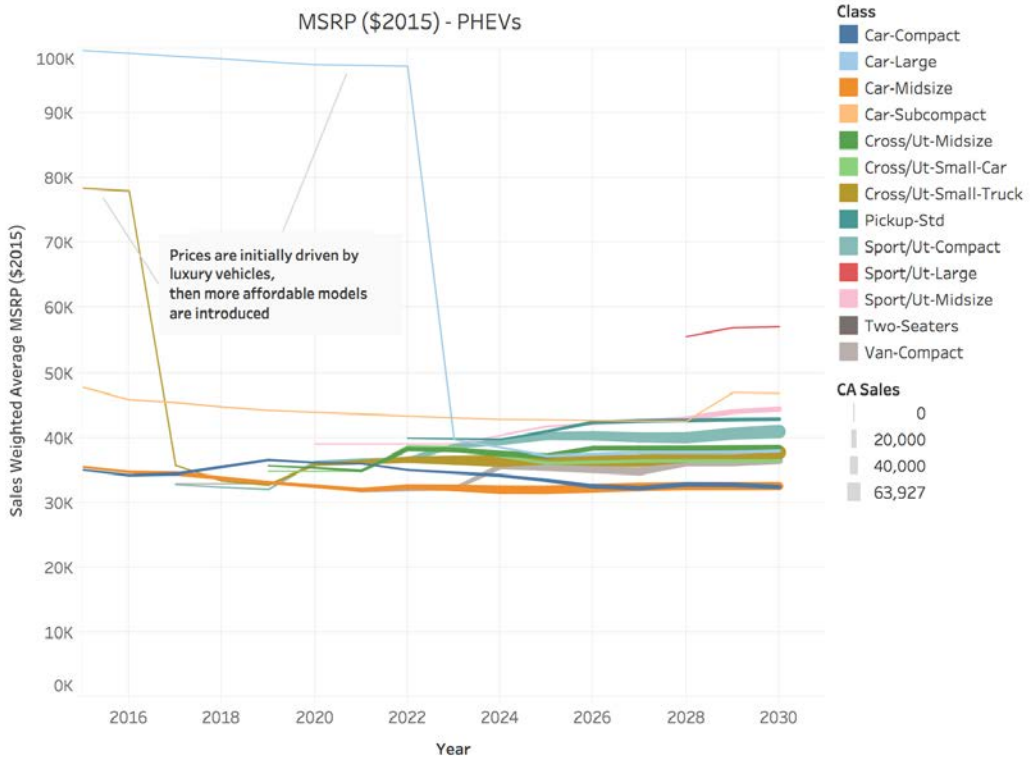
Figure 16 shows MSRPs for PHEVs. The high average prices in the early years in some classes – driven by the availability of luxury vehicles – decline over time as nonluxury models are introduced (via ADOPT's fleet evolution mechanism). By 2030, MSRPs for PHEVs in all vehicle classes are between $35,000 and $50,000. Moreover, the nonlinear (or stepwise) trends of MSRP for certain vehicle classes are attributed to fluctuations of the sales-weighted averages, because as new models are introduced in a vehicle class, the share of sales within that class shifts as consumers evaluate the newly available options.

Figure 15: BEV MSRPs by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL

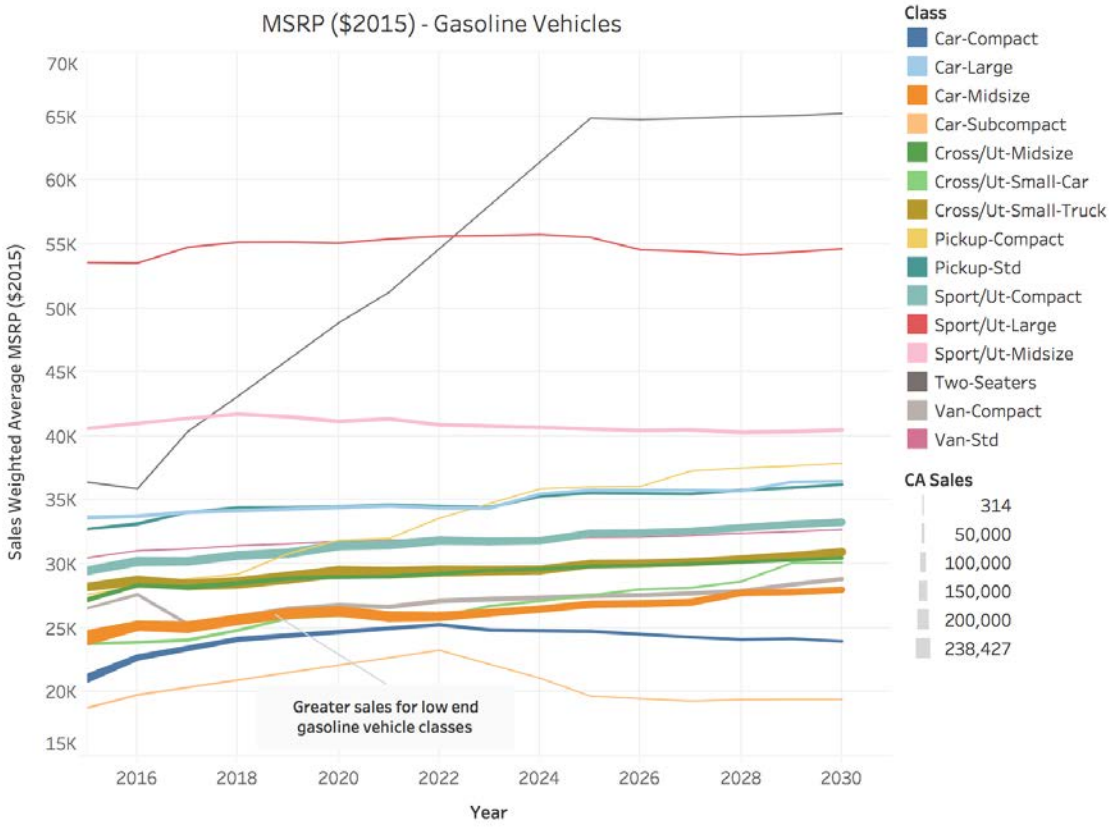
Figure 16: PHEV MSRPs by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL

As shown in Figure 17, average MSRP slightly increases for gasoline vehicle classes. This is a result of ADOPT generating vehicles with greater acceleration. As in previous figures, steep changes in MSRP are attributed to shifting sales of models within a certain class. Generally, classes that are characterized by these steep changes are classes with lower-volume sales. For example, a significant MSRP increase is projected for the sports car (two-seaters) class; that is attributed to market shift within the segment toward more expensive luxury vehicles.

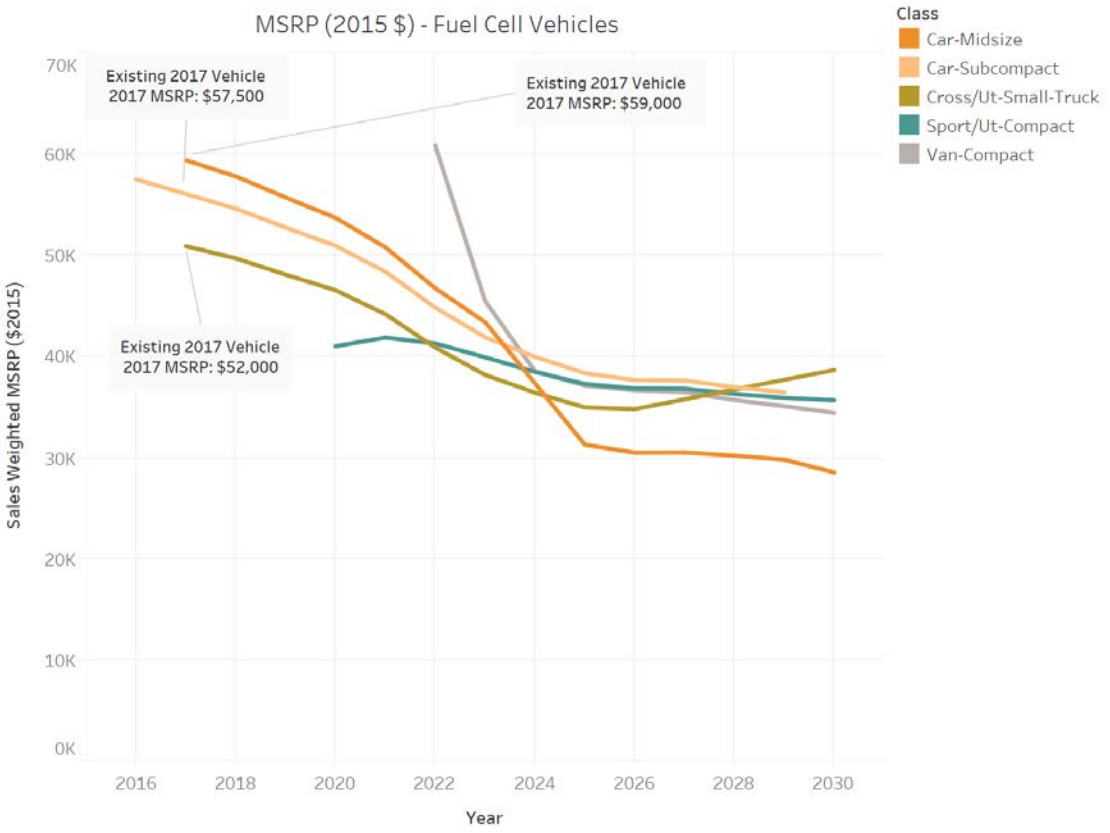
Figure 17: Gasoline Vehicle MSRPs by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL

FCEV MSRP is projected to decrease, as expected, due to learning by doing and reaching economies of scale within the forecast period. In Figure 18, the projected (2016—2017) sales-weighted average MSRPs of FCEV vehicle classes are well-aligned with manufacturer stated MSRPs.

Figure 18: FCEV MSRPs by Class for the Mid Electricity Demand Case With CAFE Extension



Source: NREL

Capturing Relationships Among Attributes

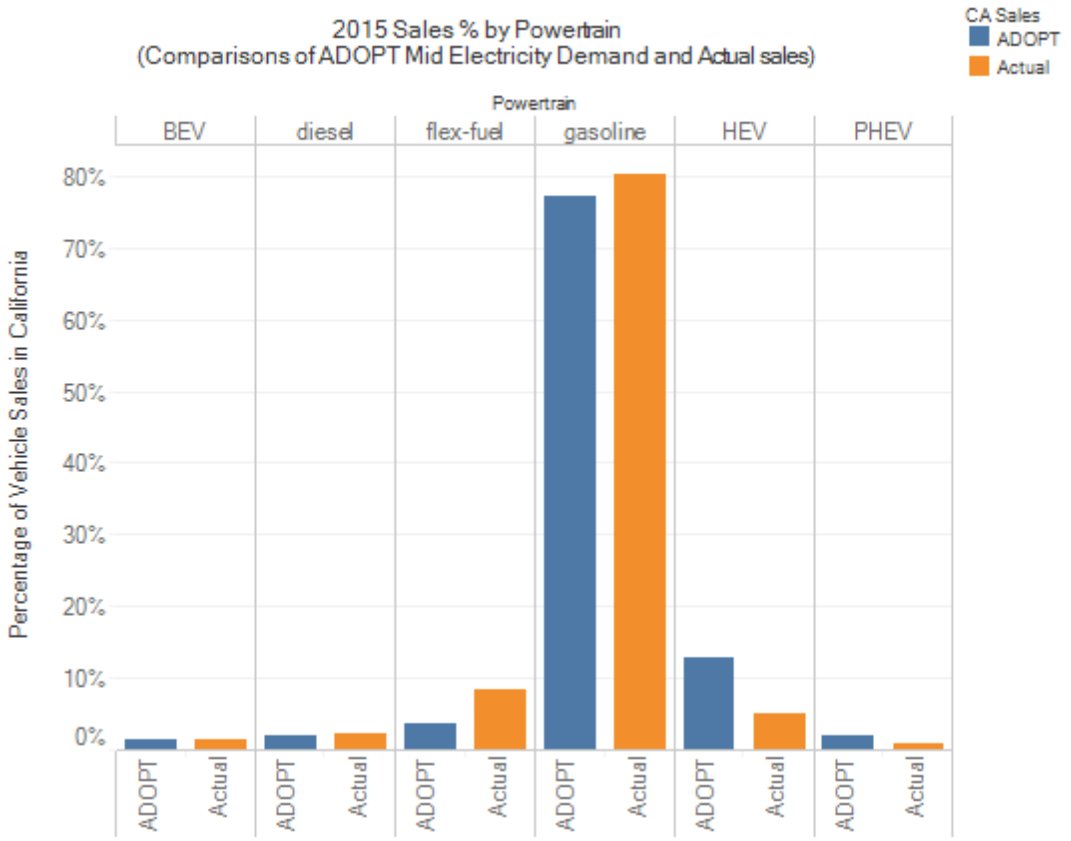
The relationships among attributes over time are captured via the ADOPT modeling framework. In projecting future vehicle attributes and market adoption, the ADOPT modeling framework uses NREL's FASTSim model to size possible combinations of vehicle components and weights the evolution of various characteristics such as acceleration, range, fuel economy, and vehicle size that influence market adoption.

For example, the relationship among acceleration, range, and MSRP is a major determinant of vehicle adoption in ADOPT. New BEVs tend to have longer range and good acceleration. For example, the 2015 Tesla Model S (70D), with a 240-mile all-electric range, achieves 0–60 mph in 5.2 seconds (Kane 2015), whereas the 2017 Tesla Model S (75D), with an electric range up to 259 miles, can achieve that in 4.2 seconds (Tesla 2017). Capturing the underlying trends among these attributes is crucial to understanding the tradeoffs among electric range, MSRP, and vehicle performance.

The reported vehicle attributes throughout this report are weighted by the number of vehicles sold in California as they are projected by ADOPT. As a precursor step, ADOPT California sales were validated based on California vehicle sales in 2015 under the mid electricity demand (which corresponds to business-as-usual) case. Compared with actual California sales data from the Department of Motor Vehicles (which were provided by Energy Commission staff), the ADOPT

projections accurately captured 2015 BEV, PHEV, and diesel sales; slightly overestimated HEV sales; and slightly underestimated gasoline and flex-fuel vehicle sales (Figure 19).

Figure 19: Comparison of ADOPT 2015 Sales by Powertrain With Actual California Sales Data

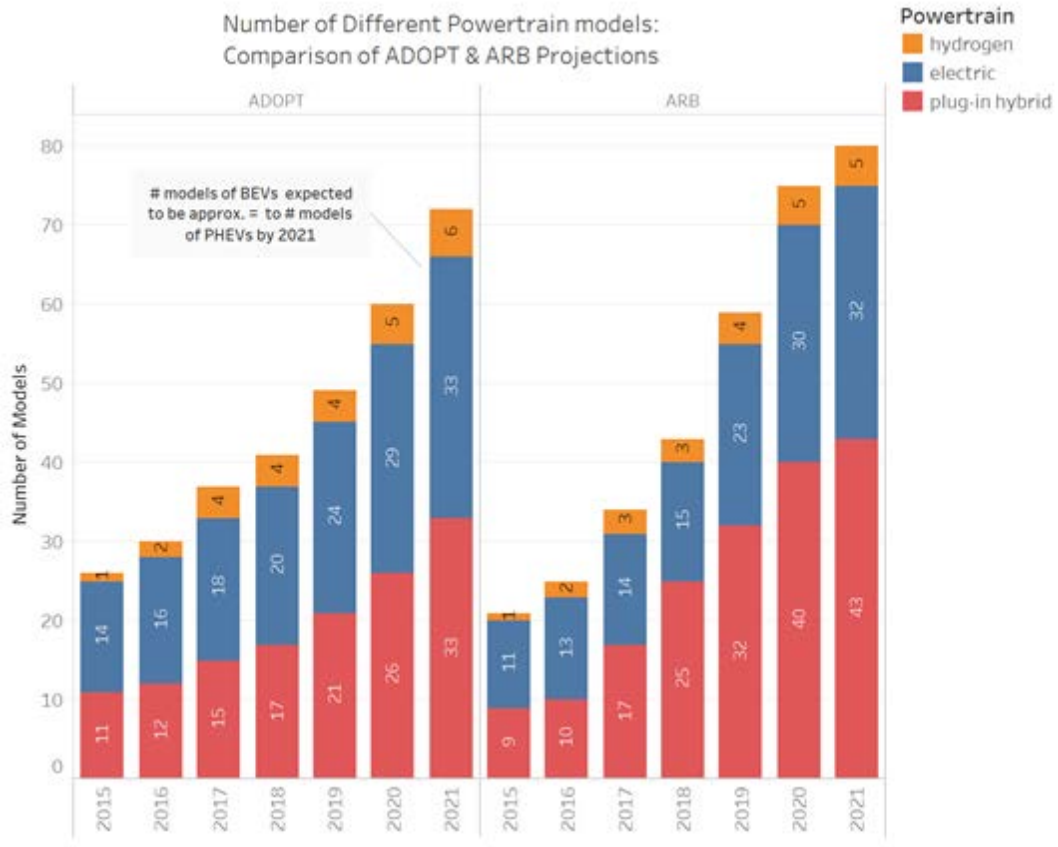


Source: Actual sales data from California Department of Motor Vehicles provided by Energy Commission

Projected Availability of Vehicle Models

The number of models of ZEVs (including BEVs, PHEVs, and FCEVs) is compared to the California Air Resources Board (CARB) projections for *California's Advanced Clean Cars Midterm Review* in Figure 20 (CARB 2017a). ADOPT results suggest that by 2021, there will be the same number of models of PHEV and BEV powertrains.

Figure 20: Comparison of 2015—2021 Sales by Powertrain by ADOPT and CARB Projections



Source: CARB 2017a

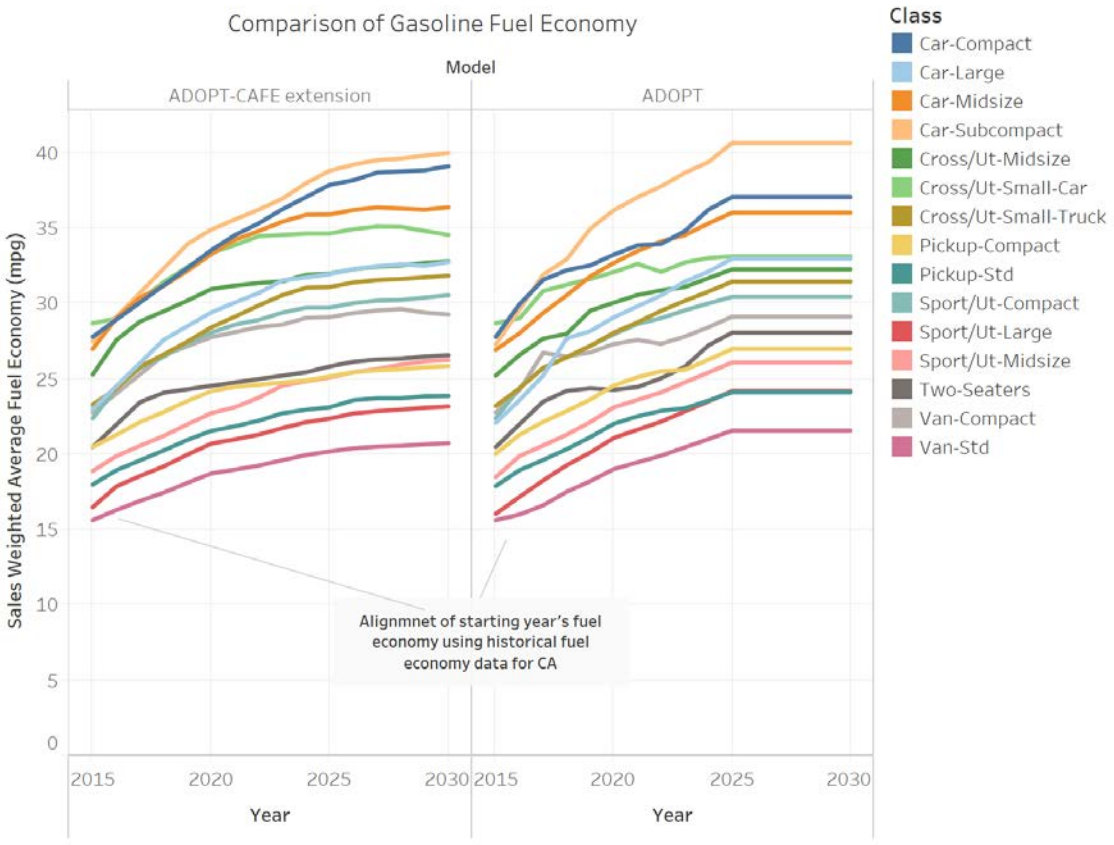
Vehicle Attribute Comparisons: Mid Electricity Demand Case With and Without CAFE Extension

In the CAFE policy extension scenario, ADOPT inputs regarding the CAFE program are modified to assume a linear increase of the program targets after 2025; in the mid electricity demand case without CAFE extension, targets level off after 2025. Figure 21 presents the resulting ADOPT attributes for the gasoline vehicle classes, showing linear fuel economy trajectories for the mid electricity demand case with and without CAFE extension (left and right subgraph, respectively). The fuel economy values for any powertrain are not significantly greater in the CAFE extension case, and for some classes, the final year's fuel economy is lower. This occurs primarily because ADOPT achieves CAFE targets mainly by shifting demand across powertrains on top of vehicle attribute improvements. For example, when CAFE targets level off, manufacturers are projected to prioritize improvements in performance, and sales differ. ADOPT attributes between the two scenarios differ from 2015 to 2025 due to the differences in the CAFE coefficients used in ADOPT (which define the fuel economy requirement based on vehicle footprint). These differences enable CAFE targets to be met after 2025.

Under the scenario without CAFE extension, the fuel economy projections for the gasoline vehicles are similar to the AEO 2017 projections in Figure 1. The ADOPT outcome in this case is

well aligned with AEO 2017 forecasts since both ADOPT and the modeling framework used for the AEO projections account for the effect of the CAFE policy.

Figure 21: Comparison of Gasoline Fuel Economy between Mid Electricity Demand With and Without CAFE Extension



Source: NREL

Both mid electricity demand scenarios follow the same CAFE-achieved trajectories until 2025 (when 40 miles per gasoline gallon equivalent is achieved for the fleet of all powertrains). After 2025, when the CAFE extension is in effect, average fuel economy increases until reaching roughly 44 miles per gasoline gallon equivalent increased between 2025 and 2030. When CAFE targets are not extended after 2025, fleet fuel economy basically stays constant from 2025 to 2030.

Other Scenario Results

Table 5 compares gasoline fuel economy results across all four of the scenarios introduced in Chapter 2. For certain vehicle classes, the final-year fuel economy is greater in the low and mid demand electricity cases than in the high demand electricity case; this is because for the low and mid case CAFE requirements are met primarily with improving gasoline vehicle fuel economy, whereas for the high case, it is met with increased sales of BEVs. Recall that the several attributes are projected by the integrated modeling framework of ADOPT, which weights the relative effects for different powertrains and classes. Therefore, the various attribute trajectories

should be examined simultaneously, rather than in isolation, to infer the effects of the inputs of each scenario on the projected results (for example, tradeoffs between fuel economy and performance, as shown in Figure 9, and tradeoffs between electric range and MSRP when comparing Figure 14 and Figure 15).

Table 5: Gasoline Vehicle Fuel Economy Trends for Different Scenarios

Gasoline Fuel Economy (mpg)
17.90 — 39.10

Scenario	Class	Year 2015	2020	2025	2030
Mid-CAFE extension	Car-Compact	27.80	33.60	37.90	39.10
	Car-Large	22.00	29.40	32.00	32.80
	Car-Midsize	26.80	33.30	35.90	36.40
	Cross/Ut-Small-Car	28.70	33.40	34.70	34.60
	Pickup-Compact	20.10	24.20	25.20	25.90
	Pickup-Std	17.90	21.60	23.10	23.90
	Sport/Ut-Compact	22.40	28.10	29.70	30.60
Mid	Car-Compact	27.80	33.30	37.10	37.10
	Car-Large	22.10	29.10	33.00	33.00
	Car-Midsize	26.90	32.70	36.00	36.00
	Cross/Ut-Small-Car	28.70	32.10	33.20	33.20
	Pickup-Compact	20.10	24.60	27.00	27.00
	Pickup-Std	17.90	22.00	24.10	24.10
	Sport/Ut-Compact	22.40	28.00	30.50	30.50
Low	Car-Compact	27.80	34.00	38.00	37.00
	Car-Large	22.00	30.00	33.00	32.00
	Car-Midsize	26.90	33.00	36.00	35.00
	Cross/Ut-Small-Car	28.70	33.00	35.00	34.00
	Pickup-Compact	20.10	24.00	25.00	25.00
	Pickup-Std	17.90	22.00	24.00	23.00
	Sport/Ut-Compact	22.40	28.00	30.00	30.00
High	Car-Compact	27.80	33.67	36.82	36.82
	Car-Large	22.00	29.15	32.33	32.33
	Car-Midsize	26.80	33.18	36.27	36.27
	Cross/Ut-Small-Car	28.70	33.51	34.66	34.66
	Pickup-Compact	20.10	23.90	24.84	24.84
	Pickup-Std	17.90	21.22	22.60	22.60
	Sport/Ut-Compact	22.40	27.86	30.29	30.29

Source: NREL

CHAPTER 4:
Conclusions and Future Research

This report documents projections of LDV attributes including fuel economy, vehicle range, and MSRP, for several powertrains (for example, gasoline, HEVs, PHEVs, BEVs) and vehicle class combinations for the 2015–2030 modeling horizon for California. ADOPT and FASTSim (Brooker et al. 2015a; Brooker et al. 2015b) are used to estimate those attributes, based on customized inputs that reflect California market characteristics. Attributes are weighted by California sales to capture the LDV demand in the state. Key considerations and results include the following:

- For the mid electricity demand case, ADOPT results suggest that fuel economy projections for conventional gasoline technologies are affected significantly by federal policies such as the CAFE standards. Under the assumption that CAFE standards continue to increase linearly, fuel economy projections also continue to increase. Under the assumption that CAFE levels off after 2025, manufacturers are not encouraged to keep improving fuel economy. This trend is particularly evident with the gasoline and hybrid vehicle results. Comparing those two scenarios, attributes differ even for the period between 2015 and 2025 due to differences in the CAFE coefficients of ADOPT that ensure long-term planning for meeting requirements in the CAFE extension scenario compared to the base case, when the targets level off.
- Comparing the mid electricity demand case to cases with more aggressive battery cost reduction projections – such as the high electricity demand case – underscores that fuel economy targets are not exclusively met with vehicle attribute adjustments, but also with consumer demand shifting between powertrains.
- ADOPT accounts for tradeoffs among several vehicle attributes, including the effects of increasing fuel economy on MSRP and the technologically limiting tradeoffs between fuel economy and acceleration. These relative trends are evident in the sales-weighted attribute results.
- For most of the vehicle classes and powertrains examined in this work, fuel economy increases over the forecast period, particularly within classes where new models are introduced. Under this scenario, lightweighting is used, and the growth in acceleration levels off. For plug-in electric vehicles, MSRP increases during the initial years when electric range increases and economies of scale are not yet achieved. Then, MSRP is projected to decrease due to decreasing battery prices while electric ranges are projected to increase. The number of gasoline vehicle options decreases over the years as the number of alternative fuel options increases (the greatest increase is for HEVs, then PHEVs, and then BEVs).
- The results reflect California LDV market expectations as several findings are supported and used in the modeling efforts of the Energy Commission. The ADOPT 2015 vehicle sales projections have been validated through comparison with actual California LDV

sales. The numbers of new makes and models, as well as the years of introduction of new powertrain/vehicle classes, are well-aligned with CARB expectations and manufacturer announcements. Initial (2015) fuel economy by powertrain and vehicle class is adjusted to match the California 2015 data. The Energy Commission has reviewed the projected LDV attributes.

The vehicle attributes for the different class and powertrain combinations presented in this work are expected to inform the California transportation energy demand model (Energy Commission 2017b) developed by the Energy Commission for 2018–2030. This report focused primarily on the attributes of the mid electricity demand case with CAFE extension, since those are used by the Energy Commission to capture LDV demand in California. The scenario results are included in the Appendix A. Future research based on this study includes the following:

- Test different vehicle introduction considerations and examine alternate inputs that might primarily affect vehicle technologies, such as BEVs and FCEVs. ADOPT modeling framework inputs and additional policies that affect alternative fuel vehicles may alter resulting attribute trends accordingly (for example, if focusing primarily on hydrogen prices and market). A more rigorous analysis would include scenarios in which inputs may favor other technologies (for example, a high hydrogen demand case) that are expected to affect manufacturers' choices and may shape consumer demand.
- Explicitly model the effects of the ZEV mandate. The ZEV mandate (CARB 2017b) is expected to significantly influence the California LDV market, promoting manufacturer research and development on electric and hydrogen fuel cell technologies. Although the ADOPT runs presented here have not explicitly modeled the effects of the ZEV mandate, the reported attribute projections are consistent with meeting ZEV program requirements. In ADOPT, for the mid and high electricity demand cases, optimistic preliminary projections of ZEV and transitional ZEV sales in California are observed, and these are in compliance with the California ZEV program requirements. The same thing holds even for the low electricity demand scenario. However, a more explicit representation of the ZEV mandate, especially with increasing stringency beyond 2025, may provide greater insights into policy influences on technology innovation.
- Investigate the influence and availability of workplace and public charging equipment on vehicle attributes and ZEV competitiveness. For example, the density of public charging may influence BEV (Lin 2014) and PHEV (Kontou, Yin, and Lin 2015) battery sizes and vice versa. Estimates of charging infrastructure needs (for example, Wood et al. 2017) can be integrated with ADOPT to capture potential correlation of vehicle component advancements and charging infrastructure availability for plug-in electric vehicles.

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GLOSSARY

ADOPT	Automotive Deployment Options Projection Tool, created by NREL, is a model that projects vehicle sales at a national, state, or county level.
AEO	Annual Energy Outlook, produced by U.S. EIA, provides projections of U.S. energy markets based on assumptions for oil prices, technological process, and energy policies.
BEV	Battery-electric vehicle
CARB	California Air Resources Board, a California state agency charged with protecting the public from the harmful effects of air pollution and developing programs and actions to fight climate change.
CAFE	Corporate Average Fuel Economy, are light-duty vehicle fuel economy standards established by NHSTA.
Energy Commission	California Energy Commission
FASTSim	Future Automotive Systems Technology Simulator, created by NREL, provides a simple way to compare powertrains and estimate the impact of technology improvements on light-, medium-, and heavy-duty vehicle efficiency, performance, cost, and battery life.
FCEV	Fuel cell electric vehicle
HEV	Hybrid-electric vehicle
LAVE-Trans	Light-duty Alternative Vehicle Energy Transitions model, a model that predicts changes in the efficiency of vehicles over time and possible penetration of alternatively fuel vehicles.
LDV	Light-duty vehicle, consisting of passenger cars and light-duty trucks
MSRP	Manufacturer suggested retail price
NREL	National Renewable Energy Laboratory, is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

NHTSA	National Highway Traffic Safety Administration is a United States federal agency responsible for keeping people safe on America's roadways.
NRC	National Research Council is the operating arm of the three National Academies: Sciences, Engineering, and Medicine. It issues studies and reports.
PEV	Plug-in electric vehicle, a vehicle category that includes BEVs and PHEVs
PHEV	Plug-in hybrid electric vehicle
U.S. DOE	United States Department of Energy
U.S. EIA	United States Energy Information Administration
U.S. EPA	United States Environmental Protection Agency
TSDC	Transportation Secure Data Center makes vital transportation data available online. It also hosts the California Household Travel Survey data.
ZEV	Zero-emission vehicle, a vehicle category that includes BEVs and FCEVs

APPENDIX A:
Data for Mid Electricity Demand Case with CAFE Extension

The vehicle attributes by class are weighted by California sales projected by ADOPT modeling framework.

Table A-1: Number of Gasoline Vehicle Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	gasoline	83	82	78	73	64	61	54	51	50	47	44	43	39	37	33	32
Car-Large	gasoline	55	55	55	55	57	58	58	58	56	52	51	51	50	49	47	45
Car-Midsize	gasoline	97	97	102	105	109	107	103	97	90	89	88	88	87	84	80	80
Car-Subcompact	gasoline	20	20	16	16	14	14	13	13	13	9	8	8	8	7	7	7
Cross/Ut-Midsize	gasoline	12	12	15	15	15	15	16	16	16	16	16	16	16	16	15	15
Cross/Ut-Small-Car	gasoline	15	15	13	14	16	17	17	16	16	15	14	14	14	12	11	11
Cross/Ut-Small-Truck	gasoline	72	72	78	80	80	80	81	74	70	69	63	63	59	59	59	57
Pickup-Compact	gasoline	15	15	13	13	10	7	7	5	3	3	2	2	2	2	2	2
Pickup-Std	gasoline	21	21	21	21	21	21	22	22	23	21	19	20	19	19	19	19
Sport/Ut-Compact	gasoline	64	64	66	65	64	62	61	61	58	58	57	54	55	56	57	56
Sport/Ut-Large	gasoline	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13	13
Sport/Ut-Midsize	gasoline	56	56	56	56	56	56	56	58	59	59	59	59	60	60	62	63
Two-Seaters	gasoline	59	59	57	56	54	52	50	50	50	49	49	49	49	49	49	49
Van-Compact	gasoline	10	10	11	11	14	15	16	16	16	16	17	17	16	16	15	15
Van-Std	gasoline	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-2: Number of Diesel Vehicle Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	diesel	5	5	5	5	3	3	3	3	3	3	3	3	3	3	3	3
Car-Large	diesel	2	2										1	1	1	1	1
Car-Midsize	diesel	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Car-Subcompact	diesel	1	1														
Pickup-Std	diesel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sport/Ut-Compact	diesel	1	1	1													
Sport/Ut-Midsize	diesel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Van-Compact	diesel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-3: Number of Flex-Fuel Vehicle Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	flex-fuel	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Car-Large	flex-fuel	4	4	4	4	4	4	4	4	4	4	4	4	3	3	3	3
Car-Midsize	flex-fuel	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3
Car-Subcompact	flex-fuel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cross/Ut-Small-Car	flex-fuel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cross/Ut-Small-Truck	flex-fuel	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Pickup-Std	flex-fuel	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Sport/Ut-Compact	flex-fuel	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3
Sport/Ut-Large	flex-fuel	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sport/Ut-Midsize	flex-fuel	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Two-Seaters	flex-fuel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Van-Compact	flex-fuel	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4

Table A-4: Number of Hybrid Vehicle Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	hybrid	8	8	8	8	8	8	8	8	9	9	9	5	5	5	6	6
Car-Large	hybrid	3	3	3	3	3	3	3	3	3	5	5	4	4	4	5	5
Car-Midsize	hybrid	17	17	17	17	19	19	20	23	23	26	26	21	20	19	19	21
Car-Subcompact	hybrid	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cross/Ut-Midsize	hybrid					2	3	3	4	5	5	5	6	6	7	7	7
Cross/Ut-Small-Car	hybrid	3	3	3	3	3	3	3	3	4	5	5	5	5	5	5	6
Cross/Ut-Small-Truck	hybrid	3	3	3	4	4	5	6	9	11	12	16	16	17	19	22	26
Pickup-Std	hybrid			2	2	2	2	2	2	2	2	4	6	6	6	6	7
Sport/Ut-Compact	hybrid	5	5	6	6	6	7	7	7	9	12	14	17	19	24	27	28
Sport/Ut-Large	hybrid	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2
Sport/Ut-Midsize	hybrid	4	4	4	4	4	4	4	4	4	5	7	8	10	15	16	17
Van-Compact	hybrid					3	2	3	3	5	7	8	8	9	9	10	10

Table A-5: Number of PHEV Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	PHEV	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4
Car-Large	PHEV	3	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4
Car-Midsize	PHEV	4	4	4	6	6	7	10	10	11	12	11	12	12	12	12	12
Car-Subcompact	PHEV	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Cross/Ut-Midsize	PHEV					3	4	4	5	5	5	5	5	6	6	6	6
Cross/Ut-Small-Car	PHEV					2	2	2	2	2	3	3	3	3	3	3	3
Cross/Ut-Small-Truck	PHEV	2	2	3	3	4	5	7	10	10	11	14	14	14	16	17	19
Pickup-Std	PHEV	1	1	1	1	1	1	1	2	2	2	3	5	5	5	5	5
Sport/Ut-Compact	PHEV	1	1	2	2	2	3	4	5	7	8	10	12	13	16	19	21
Sport/Ut-Large	PHEV														1	2	2
Sport/Ut-Midsize	PHEV						2	2	2	2	2	3	4	5	7	10	12
Two-Seaters	PHEV	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Van-Compact	PHEV			2	2	2	2	3	4	6	7	8	8	8	8	8	8

Table A-6: Number of BEV Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	BEV	3	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3
Car-Large	BEV	5	5	5	5	5	5	5	5	5	5	5	6	6	6	6	6
Car-Midsize	BEV	3	3	5	5	7	8	9	11	11	11	10	11	11	12	12	12
Car-Subcompact	BEV	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Cross/Ut-Midsize	BEV					3	4	4	4	4	4	4	4	4	4	4	4
Cross/Ut-Small-Car	BEV	2	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2
Cross/Ut-Small-Truck	BEV			1	2	2	3	5	7	8	9	9	9	9	10	11	12
Pickup-Std	BEV													2	2	2	2
Sport/Ut-Compact	BEV	1	1	1	2	2	3	3	3	3	4	4	5	7	10	10	11
Sport/Ut-Midsize	BEV				1	1	1	1	1	1	1	1	1	2	2	4	4
Two-Seaters	BEV	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Van-Compact	BEV							3	3	3	4	6	6	6	7	7	7

Table A-7: Number of Fuel Cell Vehicle Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize	hydrogen			2	2	2	2	2	2	2	3	3	3	3	3	3	3
Car-Subcompact	hydrogen	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Cross/Ut-Small-Truck	hydrogen			2	2	2	2	2	2	2	2	2	3	3	3	3	3
Sport/Ut-Compact	hydrogen						2	2	2	2	2	2	2	2	2	2	2
Van-Compact	hydrogen								2	2	2	2	2	2	2	2	2

Table A-8: Number of Natural Gas Models by Class

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	natural gas	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Table A-9: Gasoline Vehicle Fuel Economy by Class (in mpg)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	27.8	28.8	29.5	31.5	32.4	33.6	34.6	35.3	36.3	37.1	37.9	38.2	38.7	38.8	38.9	39.1
Car-Large	22	25.6	26.6	27.6	28.5	29.4	30.1	30.7	31.2	31.7	32	32.3	32.5	32.6	32.7	32.8
Car-Midsize	26.8	29	30.4	31.2	32.2	33.3	34.2	34.8	35.4	35.9	36.05	36.2	36.4	36.4	36.4	36.4
Car-Subcompact	27.3	29.6	31.9	32.8	34	34.9	35.6	36.2	37	38	38.8	39.2	39.5	39.6	39.8	40
Cross/Ut-Midsize	25.2	27.6	28.8	29.5	30.2	30.7	31.2	31.4	31.65	31.9	32	32.3	32.5	32.5	32.7	32.8
Cross/Ut-Small-Car	28.7	29	30.2	31.4	32.5	33.4	33.9	34.5	34.6	34.7	34.85	35	35.1	35.1	34.85	34.6
Cross/Ut-Small-Truck	23.2	24.4	25.8	26.6	27.5	28.4	29.1	29.9	30.6	31.1	31.1	31.4	31.6	31.6	31.8	31.9
Pickup-Compact	20.1	21.3	22.2	22.8	23.6	24.2	24.5	24.6	24.75	24.9	25.2	25.5	25.6	25.7	25.8	25.9
Pickup-Std	17.9	19	19.6	20.3	21	21.6	21.9	22.2	22.7	23	23.3	23.6	23.7	23.7	23.9	23.9
Sport/Ut-Compact	22.4	24.4	25.7	26.5	27.4	28.1	28.6	28.9	29.4	29.7	29.7	30	30.2	30.3	30.4	30.6
Sport/Ut-Large	16.1	17.9	18.6	19.2	20	20.7	21	21.3	21.8	22.1	22.4	22.7	22.9	23	23.1	23.2
Sport/Ut-Midsize	18.5	19.9	20.6	21.2	22	22.7	23.1	23.8	24.6	24.9	25.1	25.5	25.7	26	26.2	26.3
Two-Seaters	20.4	23.2	23.5	23.15	22.8	23.25	23.7	24	24.5	24.95	25.4	25.85	26.3	26.4	26.5	26.6
Van-Compact	22.8	24.3	25	26	26.9	27.8	28.15	28.5	28.6	28.85	29.1	29.4	29.6	29.6	29.4	29.3
Van-Std	15.6	16.3	16.9	17.5	18.1	18.7	19	19.3	19.6	20	20.2	20.4	20.5	20.6	20.7	20.8

Table A-10: Diesel Vehicle Fuel Economy by Class (in mpgge)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	30.7	31.3	32.5	33.8	40.2	41.7	42.6	43.2	44.2	45.1	46.0	46.0	46.0	46.0	46.0	46.0
Car-Large	23.9	24.3														
Car-Midsize	29.6	29.8	30.8	31.7	32.66	33.7	34.3	34.8	35.6	34.5	33.8	33.8	33.8	33.8	33.8	33.8
Car-Subcompact	27.1	27.5														
Pickup-Std	16.7	17.1	17.6	18.2	18.3	18.3	18.7	19.2	19.8	20.5	21.1	21.1	21.1	21.1	21.1	21.1
Sport/Ut-Compact	27.9	28.4														
Sport/Ut-Midsize	23.8	24.3	25.0	25.8	26.7	27.8	28.4	28.9	29.6	30.2	30.9	30.9	30.9	30.9	30.9	30.9

Table A-11: Flex-Fuel Vehicle Fuel Economy by Class (in mpg)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	22.1	22.5	22.8	23.3	24.2	25.1	25.3	23.4	23.7	24.1	24.5	24.7	24.9	24.9	25.1	25.2
Car-Large	19.4	19.9	20.4	21.1	22.1	23.0	23.3	23.5	24.0	24.4	23.8	24.1	24.2	24.3	24.4	24.4
Car-Midsize	22.7	23.1	23.9	24.6	25.5	26.4	26.6	27.0	27.4	25.8	25.9	26.2	26.3	26.4	26.5	26.6
Car-Subcompact	34.2	34.3	35.2	35.7	36.6	37.5	38.0	38.4	38.9	30.5	30.8	31.1	31.2	31.3	31.5	31.6
Cross/Ut-Small-Car	20.1	20.4	21.0	21.8	22.6	23.4	23.7	24.0	24.5	24.9	25.2	25.4	25.6	25.7	25.8	25.8
Cross/Ut-Small-Truck	19.1	19.4	20.1	20.8	21.5	22.2	22.5	22.8	23.3	23.6	23.9	24.2	24.3	24.4	24.5	24.6
Pickup-Std	17.9	18.2	18.8	19.5	20.3	21.0	21.3	21.6	22.0	22.4	22.7	23.0	23.1	23.2	23.3	23.4
Sport/Ut-Compact	19.2	19.3	20.1	20.4	21.2	21.8	22.1	22.2	22.6	23.0	23.2	23.4	23.6	23.6	23.7	23.8
Sport/Ut-Large	16.6	16.9	17.6	18.2	19.0	19.7	20.0	20.3	20.8	21.2	21.4	21.7	21.8	21.9	22.0	22.1
Sport/Ut-Midsize	16.5	16.8	17.5	18.1	18.9	19.6	19.9	20.2	20.6	21.0	21.2	21.5	21.6	21.7	21.8	21.9
Two-Seaters	25.0	25.4	26.1	26.9	27.9	28.9	29.1	29.5	29.9	30.4	30.8	31.1	31.3	31.4	31.5	31.6
Van-Compact	22.5	22.7	24.0	25.2	25.7	26.0	26.6	26.9	27.0	27.1	27.2	27.5	27.6	27.7	27.9	28.0

Table A-12: Hybrid Vehicle Fuel Economy by Class (in mpgge)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	44	47	47	49	50	51	51	51	52	53	55	55	55	55	56	56
Car-Large	39	40	42	43	44	45	45	46	46	47	51	61	61	62	62	62
Car-Midsize	43	45	45	48	49	51	53	53	54	55	56	57	59	59	59	59
Car-Subcompact	37	38	39	40	41	42	42	43	43	44	44	45	45	45	45	45
Cross/Ut-Midsize					48	49	49	49	50	50	50	49	48	49	49	49
Cross/Ut-Small-Car	39	39	41	41	41	41	42	42	43	43	43	43	43	43	44	44
Cross/Ut-Small-Truck	23	24	25	35	42	46	48	49	50	51	51	52	52	52	53	53
Pickup-Std			34	34	34	34	35	35	35	35	36	36	36	36	36	37
Sport/Ut-Compact	31	32	34	37	41	45	47	49	49	50	50	50	50	50	50	50
Sport/Ut-Midsize	27	27	28	29	30	31	31	32	32	33	33	33	33	33	34	37
Van-Compact					45	45	44	45	45	46	46	46	46	46	46	47

Table A-13: PHEV Fuel Economy by Class (in mpgge) – Charge Depleting Mode

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	89	89	89	90	91	93	93	93	94	94	94	94	94	94	94	94
Car-Large	47	48	48	49	50	51	51	51	66	68	69	70	71	72	72	72
Car-Midsize	54	54	54	56	61	65	67	69	72	76	80	81	81	82	83	83
Car-Subcompact	86	87	88	89	90	91	92	93	94	95	96	96	97	97	97	98
Cross/Ut-Midsize					61	62	63	62	62	61	61	61	61	62	62	63
Cross/Ut-Small-Car					63	63	63	63	64	66	68	69	70	70	70	71
Cross/Ut-Small-Truck	43	43	62	63	65	65	66	66	67	67	67	67	67	68	68	68
Pickup-Std								45	45	46	46	47	47	48	48	48
Sport/Ut-Compact			63	64	65	66	66		67	67	66	65	64	64	64	65
Sport/Ut-Large														48	48	48
Sport/Ut-Midsize						54	54	54	54	54	54	55	55	56	56	56
Two-Seaters	53	54	55	56	57	58	58	58	59	59	60	60	60	60	61	61
Van-Compact			61	61	61	60	59	59	59	59	59	59	59	59	59	59

Table A-14: PHEV Fuel Economy by Class (in mpg) – Charge Sustaining Mode

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	42	43	45	46	47	47	48	50	53	55	57	57	58	58	58	59
Car-Large	29	30	31	32	33	34	35	35	52	53	54	54	54	55	55	55
Car-Midsize	38	39	40	43	47	48	50	51	52	55	57	57	58	58	58	59
Car-Subcompact	44	45	46	47	48	49	49	50	51	51	52	52	52	52	52	53
Cross/Ut-Midsize					40	41	41	41	42	42	42	42	42	43	43	43
Cross/Ut-Small-Car					43	43	43	43	44	47	50	51	52	52	52	52
Cross/Ut-Small-Truck	24	25	39	41	42	43	44	45	46	47	48	48	48	48	48	48
Pickup-Std								29	29	30	30	31	31	31	31	31
Sport/Ut-Compact			40	41	43	43	44	44	44	44	44	44	43	43	43	44
Sport/Ut-Large														32	32	32
Sport/Ut-Midsize						37	37	37	37	38	38	38	38	38	38	39
Two-Seaters	34	35	36	37	38	40	40	40	41	42	42	42	43	43	43	43
Van-Compact			40	40	40	40	41	41	41	41	41	41	41	42	42	42

Table A-15: BEV Fuel Economy by Class (in mpgge)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	111	114	117	120	122	123	124	124	125	126	126	127	128	129	130	131
Car-Large	98	98	99	100	101	102	103	106	108	110	112	113	114	114	115	116
Car-Midsize	106	107	116	123	127	129	131	134	137	139	141	143	144	145	146	147
Car-Subcompact	120	122	123	126	128	130	131	132	134	135	136	137	138	139	139	140
Cross/Ut-Midsize					85	85	85	87	89	92	94	95	95	96	96	97
Cross/Ut-Small-Car		90	91	92	93	94	95	97	99	101	103	103	104	105	105	106
Cross/Ut-Small-Truck				94	95	96	97	99	101	104	106	108	109	108	109	109
Pickup-Std													76	76	77	77
Sport/Ut-Compact				87	88	89	89	91	93	94	95	96	96	97	98	98
Two-Seaters	107	109	111	112	114	116	117	118	120	121	122	123	123	124	125	126
Van-Compact							93	92	92	92	92	93	93	94	95	93

Table A-16: Fuel Cell Vehicle Fuel Economy by Class (in miles per kg)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize			67.63	68.53	69.42	70.28	70.74	71.18	71.61	71.55	71.49	71.47	71.81	72.15	72.5	72.73
Car-Subcompact		66.75	67.64	68.5	69.35	70.18	70.62	71.04	71.46	71.86	72.26	72.56	72.86	73.15	73.44	73.44
Cross/Ut-Small-Truck			49.83	50.54	51.24	51.93	52.26	52.59	52.91	53.97	55.74	57.98	59.32	60.3	60.57	60.79
Sport/Ut-Compact						62.01	62.02	62.13	62.4	62.76	63.11	63.37	63.63	63.89	64.15	64.39
Van-Compact								43.94	51.5	52.9	53.8	55.37	55.77	55.98	56.26	56.48

Table A-17: Natural Gas Vehicle Fuel Economy by Class (in mpgge)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19

Table A-18: Gasoline Vehicle Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	8.49	8.24	8.10	8.10	8.06	8.06	8.20	8.35	8.35	8.36	8.29	8.31	8.34	8.36	8.38	8.37
Car-Large	7.10	7.01	7.03	7.06	7.06	7.14	7.14	7.11	7.05	7.02	7.02	7.03	7.02	7.01	6.92	6.91
Car-Midsize	8.01	7.86	7.88	7.90	7.91	7.95	8.06	8.10	8.15	8.17	8.10	8.12	8.09	7.97	7.93	7.90
Car-Subcompact	9.44	9.08	8.99	9.06	9.21	9.37	9.57	9.73	9.91	10.35	10.44	10.51	10.60	10.69	10.65	10.60
Cross/Ut-Midsize	8.19	7.99	8.09	8.09	8.12	8.18	8.19	8.19	8.22	8.24	8.22	8.24	8.21	8.16	8.14	8.10
Cross/Ut-Small-Car	8.52	8.41	8.49	8.51	8.59	8.66	8.75	8.78	8.83	8.81	8.84	8.86	8.83	8.71	8.55	8.51
Cross/Ut-Small-Truck	8.19	8.01	8.13	8.10	8.12	8.11	8.13	8.14	8.18	8.22	8.18	8.20	8.18	8.16	8.14	8.12
Pickup-Compact	8.07	7.91	7.92	7.92	7.72	7.48	7.26	7.03	7.06	7.13	7.11	7.13	7.15	7.18	7.16	7.12
Pickup-Std	7.35	7.29	7.28	7.28	7.31	7.33	7.33	7.40	7.56	7.64	7.65	7.68	7.70	7.68	7.65	7.62
Sport/Ut-Compact	8.17	8.01	8.08	8.06	8.08	8.04	8.04	8.07	8.10	8.12	8.12	8.12	8.13	8.13	8.18	8.15
Sport/Ut-Large	7.16	7.08	7.09	7.09	7.12	7.14	7.13	7.13	7.16	7.18	7.17	7.32	7.35	7.43	7.41	7.37
Sport/Ut-Midsize	7.37	7.32	7.35	7.35	7.37	7.39	7.42	7.53	7.70	7.73	7.71	7.73	7.76	7.81	7.82	7.81
Two-Seaters	6.51	6.26	6.05	5.87	5.70	5.66	5.57	5.57	5.59	5.71	5.74	5.75	5.73	5.71	5.69	5.67
Van-Compact	8.11	8.00	8.06	8.13	8.09	8.12	8.26	8.34	8.34	8.36	8.28	8.30	8.28	8.24	8.21	8.05
Van-Std	6.91	6.83	6.86	6.86	6.88	6.90	6.89	6.89	6.92	6.94	6.93	6.95	6.93	6.89	6.87	6.84

Table A-19: Diesel Vehicle Acceleration by Class (in secs from 0-60mph)

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	diesel	7.9	7.8	8.0	8.2	8.4	8.5	8.6	8.7	8.8	8.9	9.1	9.0	9.0	9.0	9.0	9.0
Car-Large	diesel	6.5	6.4														
Car-Midsize	diesel	8.8	8.5	8.5	8.6	8.6	8.7	8.8	8.9	8.8	8.7	8.7	8.7	8.7	8.7	8.7	8.7
Car-Subcompact	diesel	8.3	8.2														
Pickup-Std	diesel	6.4	6.3	6.3	6.3	6.3	6.2	6.2	6.3	6.3	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Sport/Ut-Compact	diesel	9.1	9.0														
Sport/Ut-Midsize	diesel	9.8	9.7	9.7	9.8	9.8	9.9	28.4	10.1	10.2	10.3	10.5	10.7	10.5	10.5	10.5	10.5

Table A-20: Flex-Fuel Vehicle Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	6.5	6.4	6.3	6.3	6.3	6.3	6.3	5.8	5.8	5.9	5.8	5.9	5.9	5.9	5.8	5.8
Car-Large	5.9	5.9	5.8	5.8	5.8	5.9	5.8	5.8	5.8	5.8	5.7	5.7	5.7	5.7	5.6	5.6
Car-Midsize	6.8	6.7	6.7	6.7	6.7	6.7	6.3	6.3	6.3	6.6	6.6	6.7	6.6	6.6	6.6	6.6
Car-Subcompact	9.2	9.0	9.1	9.0	9.0	9.1	9.0	9.1	9.1	8.2	8.2	8.2	8.2	8.1	8.1	8.0
Cross/Ut-Small-Car	6.3	6.2	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.2
Cross/Ut-Small-Truck	6.8	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.8	6.8	7.0	7.0	7.0	7.0	6.9	6.9
Pickup-Std	6.8	6.8	6.7	6.7	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.8	6.7
Sport/Ut-Compact	7.0	6.9	6.9	6.8	6.8	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	6.8	6.8	6.8
Sport/Ut-Large	6.6	6.5	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5
Sport/Ut-Midsize	6.6	6.5	6.5	6.5	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.6	6.5
Two-Seaters	6.9	6.9	6.8	6.8	6.8	6.9	6.9	6.9	6.9	6.9	6.9	7.0	6.9	6.9	6.9	6.9
Van-Compact	8.3	8.2	8.3	8.5	8.4	8.3	8.3	8.3	8.0	7.9	7.8	7.9	7.8	7.8	7.8	7.7

Table A-21: Hybrid Vehicle Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	8.2	8.5	8.5	8.4	8.4	8.3	8.2	8.2	8.3	8.5	9.2	9.2	9.2	9.2	9.2	9..2
Car-Large	8.9	8.9	8.8	8.8	8.8	8.7	8.7	8.7	8.7	8.7	9.0	9.5	9.5	9.5	9.4	9.7
Car-Midsize	7.8	7.5	7.4	7.4	7.5	7.8	8.3	8.6	9.0	9.3	9.6	9.9	10.2	10.2	10.2	10.2
Car-Subcompact	9.8	9.6	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.8	9.7	9.7	9.7	9.6	9.6	9.5
Cross/Ut-Midsize					11.1	11.2	11.2	11.2	11.3	11.4	11.5	11.6	11.6	11.5	11.5	11.4
Cross/Ut-Small-Car	8.8	8.7	8.6	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.8	8.7	10.2	10.9	10.8
Cross/Ut-Small-Truck	7.6	7.5	7.5	9.0	9.9	10.4	10.5	10.8	11.1	11.4	11.5	11.5	11.5	11.4	11.3	11.2
Pickup-Std			12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.2	12.2	12.1	12.0	11.9
Sport/Ut-Compact	7.6	7.4	7.4	8.0	8.8	9.6	9.9	10.1	10.3	10.4	10.6	10.8	10.8	10.9	10.9	10.8
Sport/Ut-Midsize	8.6	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.4	8.4	9.9
Van-Compact					11.9	11.9	11.8	11.8	11.8	11.8	11.8	11.9	11.9	11.9	11.9	11.8

Table A-22: PHEV Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	7.0	7.0	7.0	6.9	6.9	6.9	6.8	6.9	7.0	7.1	7.1	7.0	7.0	6.9	6.9	6.9
Car-Large	5.9	5.8	5.7	5.7	5.7	5.7	5.7	5.7	6.8	6.9	6.7	6.5	6.5	6.5	6.5	6.6
Car-Midsize	7.6	7.6	7.5	7.5	7.3	7.2	7.3	7.3	7.3	7.3	7.2	7.2	7.2	7.1	7.1	7.1
Car-Subcompact	6.3	6.2	6.2	6.1	6.1	6.0	6.0	6.0	5.9	5.9	5.8	5.7	5.7	5.7	5.7	5.7
Cross/Ut-Midsize					7.6	7.5	7.5	7.4	7.4	7.4	7.5	7.4	7.4	7.4	7.3	7.3
Cross/Ut-Small-Car					8.2	8.2	8.2	8.1	8.1	7.7	7.4	7.4	7.3	7.3	7.2	7.2
Cross/Ut-Small-Truck	6.8	6.7	7.1	7.1	7.1	7.1	7.2	7.2	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.2
Pickup-Std								8.4	8.4	8.3	8.3	8.2	8.2	8.1	8.1	8.0
Sport/Ut-Compact			8.1	8.0	7.9	7.8	7.7	7.6	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Sport/Ut-Large													8.5	8.4	8.3	32
Sport/Ut-Midsize						7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Two-Seaters	5.5	5.4	5.4	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.2	5.1
Van-Compact			8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	7.9	7.9	7.8	8.0

Table A-23: BEV Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	8.5	7.8	7.4	7.0	6.7	6.6	6.6	6.5	6.3	6.1	6.0	5.9	5.9	5.9	5.8	5.8
Car-Large	4.4	4.2	4.1	4.0	4.0	3.9	3.9	3.9	3.9	3.8	3.8	3.9	3.9	3.9	3.9	3.9
Car-Midsize	10.5	10.4	8.0	7.2	6.5	5.7	5.7	5.6	5.4	5.4	5.3	5.3	5.3	5.2	5.2	5.1
Car-Subcompact	8.0	7.9	7.8	7.6	7.5	7.3	7.3	7.2	7.1	7.1	7.0	6.9	6.9	6.9	6.8	6.8
Cross/Ut-Midsize					6.7	6.5	6.4	6.3	6.2	6.2	6.1	6.1	6.1	6.0	6.0	6.0
Cross/Ut-Small-Car		11.3	5.6	5.5	5.4	5.4	5.4	5.3	5.2	5.1	5.1	5.0	5.0	5.0	4.9	4.9
Cross/Ut-Small-Truck				6.7	6.6	6.6	6.5	6.5	6.5	6.5	6.4	6.3	6.2	6.2	6.1	6.1
Pickup-Std													7.4	7.3	7.3	7.2
Sport/Ut-Compact							6.7	6.7	6.6	6.5	6.3	6.2	6.1	6.0	6.0	6.0
Two-Seaters	11.8	11.5	11.3	11.0	10.8	10.5	10.4	10.2	10.1	9.9	9.8	9.7	9.6	9.5	9.4	9.3
Van-Compact							7.0	7.0	6.9	6.9	6.8	6.8	6.7	6.7	6.7	6.6

Table A-24: Fuel Cell Vehicle Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize			8.0	7.9	7.7	7.7	7.6	7.6	8.7	9.0	9.0	9.0	8.9	8.8	9.0	8.0
Car-Subcompact		7.9	7.8	7.7	7.6	7.5	7.4	7.3	7.3	7.2	7.2	7.2	7.2	7.1	7.0	7.0
Cross/Ut-Small-Truck			10.1	9.9	9.7	9.6	9.5	9.4	9.3	9.3	9.2	9.3	8.1	7.4	7.4	7.3
Sport/Ut-Compact						10.5	10.0	9.7	9.5	9.4	9.4	9.3	9.3	9.2	9.1	9.1
Van-Compact								6.4	7.9	8.7	8.5	8.4	8.4	8.3	8.2	8.2

Table A-25: Natural Gas Vehicle Acceleration by Class (in secs from 0-60mph)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	10.7	10.5	10.6	10.6	10.7	10.7	10.7	10.7	10.7	10.8	10.8	10.8	10.8	10.8	10.8	10.8

Table A-26: Gasoline Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	404	402	409	413	420	431	443	456	459	468	468	467	470	472	467	468
Car-Large	463	460	477	473	458	450	449	448	444	436	434	435	435	434	433	434
Car-Midsize	471	461	463	462	461	462	466	466	469	470	468	468	467	465	465	465
Car-Subcompact	366	376	346	345	345	345	342	341	339	334	328	327	327	327	327	327
Cross/Ut-Midsize	434	436	435	433	430	425	423	420	414	414	411	411	411	411	410	410
Cross/Ut-Small-Car	426	415	423	425	431	434	436	438	447	446	455	454	454	458	450	448
Cross/Ut-Small-Truck	387	386	387	391	393	393	396	401	404	405	404	404	404	403	402	401
Pickup-Compact	441	439	441	441	439	436	436	430	431	420	420	420	420	420	420	420
Pickup-Std	499	500	497	497	494	490	487	469	441	430	415	409	409	399	399	396
Sport/Ut-Compact	404	403	405	405	404	403	402	400	399	397	393	393	393	392	392	393
Sport/Ut-Large	502	499	502	502	500	498	498	499	499	499	496	472	465	446	445	446
Sport/Ut-Midsize	405	402	404	404	402	400	400	398	394	392	391	390	387	384	382	381
Two-Seaters	362	355	354	352	333	330	328	329	330	346	347	348	348	348	348	348
Van-Compact	428	424	418	416	415	414	409	399	390	391	390	390	390	390	385	383
Van-Std	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416	416

Table A-27: Diesel Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	437	434	439	441	543	542	543	543	543	543	543	542	542	542	542	542
Car-Large	536	536	535													
Car-Midsize	473	472	475	475	474	473	473	473	472	485	482	478	478	479	479	479
Car-Subcompact	392	392														
Pickup-Std	432	436	431	431	433	390	390	390	390	390	390	390	390	390	390	390
Sport/Ut-Compact	437	437														
Sport/Ut-Midsize	602	603	602	602	602	602	602	602	601	601	601	601	601	601	602	602

Table A-28: Flex-Fuel Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	357	356	351	349	348	350	348	327	326	326	326	326	326	326	326	326
Car-Large	361	364	358	358	359	362	361	360	359	358	343	343	343	343	343	343
Car-Midsize	382	381	382	382	381	380	372	373	373	407	403	403	403	403	403	403
Car-Subcompact	463	461	460	457	456	455	456	456	456	403	403	403	403	403	403	403
Cross/Ut-Small-Car	376	376	376	376	376	376	376	376	376	376	376	376	376	376	376	376
Cross/Ut-Small-Truck	391	390	391	391	390	390	390	390	390	390	390	390	390	390	390	390
Pickup-Std	490	485	489	488	486	484	485	485	485	485	483	482	482	482	482	482
Sport/Ut-Compact	378	378	377	373	374	376	376	378	377	377	379	379	379	379	379	379
Sport/Ut-Large	513	513	513	513	512	512	512	512	512	512	512	512	512	512	512	512
Sport/Ut-Midsize	420	418	420	420	419	418	418	418	419	419	417	417	417	417	417	417
Two-Seaters	415	415	416	416	416	415	415	415	416	416	415	415	415	415	415	415
Van-Compact	386	387	383	383	385	386	386	386	390	391	392	392	392	392	392	392

Table A-29: Hybrid Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	510	517	520	518	518	517	517	517	517	541	590	705	704	705	705	706
Car-Large	537	539	539	539	539	538	538	538	538	538	614	768	773	775	775	771
Car-Midsize	620	629	633	630	634	651	674	680	688	693	703	712	719	720	713	716
Car-Subcompact	392	392	392	392	392	392	392	392	392	392	392	392	392	392	392	392
Cross/Ut-Midsize					651	646	644	644	641	640	633	620	608	608	608	608
Cross/Ut-Small-Car	477	472	476	470	468	461	462	462	462	462	457	457	456	483	520	522
Cross/Ut-Small-Truck	536	536	537	590	624	641	647	650	652	653	657	661	661	661	661	661
Pickup-Std			452	452	452	452	452	452	452	452	452	452	452	452	452	452
Sport/Ut-Compact	497	496	507	533	568	603	617	630	630	629	629	631	628	621	619	618
Sport/Ut-Midsize	495	498	496	497	497	497	497	497	497	497	497	497	497	497	497	517
Van-Compact					539	539	580	580	581	581	575	577	577	576	575	575

Table A-30: PHEV Electric Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	35	44	44	45	45	46	46	46	46	6	46	46	45	45	45	45
Car-Large	13	13	13	13	13	14	14	14	38	40	42	42	43	44	44	43
Car-Midsize	11	11	11	11	12	14	17	21	27	30	33	34	34	35	35	35
Car-Subcompact	56	56	57	58	59	59	60	60	61	62	62	62	63	63	63	63
Cross/Ut-Midsize					30	31	31	31	30	30	29	30	30	30	30	31
Cross/Ut-Small-Car					29	29	29	29	30	30	30	31	31	31	31	31
Cross/Ut-Small-Truck	14	14	29	31	31	32	32	32	32	32	32	32	31	32	32	32
Pickup-Std								26	26	26	26	27	27	27	27	27
Sport/Ut-Compact			30	31	31	32	33	33	33	33	32	32	32	32	32	32
Sport/Ut-Large														28	28	29
Sport/Ut-Midsize						27	27	27	27	28	28	28	28	28	29	29
Two-Seaters	11	11	12	12	12	12	12	12	12	12	13	13	13	13	13	13
Van-Compact			30	30	30	30	29	29	29	29	29	29	29	29	29	30

Table A-31: PHEV Gasoline Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	472	507	543	542	538	542	542	564	722	736	788	820	819	773	774	801
Car-Large	692	693	692	692	692	692	692	692	770	775	781	788	789	784	780	771
Car-Midsize	578	572	570	592	654	716	723	730	746	770	796	802	802	801	801	801
Car-Subcompact	173	173	174	175	177	179	180	180	181	182	184	184	185	185	189	190
Cross/Ut-Midsize					615	616	618	615	611	607	595	598	602	602	604	606
Cross/Ut-Small-Car					29	635	635	635	636	636	669	703	717	710	710	711
Cross/Ut-Small-Truck	637	638	635	635	635	638	640	647	652	659	670	667	664	662	662	660
Pickup-Std								459	459	459	462	468	472	473	473	473
Sport/Ut-Compact			634	635	635	636	636	638	638	637	632	626	616	612	612	613
Sport/Ut-Large														476	476	476
Sport/Ut-Midsize						553	553	553	553	553	560	554	559	554	552	555
Two-Seaters	440	440	441	441	441	441	441	442	442	442	442	442	442	442	442	442
Van-Compact			616	616	616	617	597	589	588	587	581	577	576	580	580	580

Table A-32: BEV Electric Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	68	108	139	153	167	171	172	178	181	183	186	187	189	190	192	193
Car-Large	231	232	237	239	241	245	246	252	257	262	264	266	267	269	270	272
Car-Midsize	78	79	143	191	219	224	229	234	239	244	249	250	253	255	258	261
Car-Subcompact	66	67	68	70	71	72	73	74	75	75	76	77	77	78	78	78
Cross/Ut-Midsize					171	172	171	175	178	179	181	182	183	184	185	186
Cross/Ut-Small-Car	84	236	239	242	245	247	249	255	262	266	268	270	271	273	275	276
Cross/Ut-Small-Truck				125	127	128	129	131	132	135	138	142	147	151	153	153
Pickup-Std													123	124	125	126
Sport/Ut-Compact				175	177	181	183	188	192	194	197	199	200	201	203	205
Two-Seaters	56	57	58	59	60	61	61	62	62	63	64	64	64	65	65	66
Van-Compact							112	112	113	115	116	116	117	118	118	129

Table A-33: Fuel Cell Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize			366	366	366	366	366	366	366	365	365	364	364	364	365	365
Car-Subcompact		312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
Cross/Ut-Small-Truck			265	265	265	265	265	265	265	265	265	268	271	274	274	274
Sport/Ut-Compact						323	292	270	262	263	263	263	264	265	266	267
Van-Compact								230	267	275	284	282	283	283	283	284

Table A-34: Natural Gas Vehicle Range by Class (in miles)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248	248

Table A-35: Gasoline Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	21,096	22,712	23424	24,136	24,420	24,704	24,988	25,273	24,858	24,806	24,754	24,530	24,306	24,125	24,183	23,990
Car-Large	33,652	33,763	34,073	34,197	34,321	34,445	34,570	34,411	34,391	35,502	35,806	35,800	35,793	35,742	36,427	36,499
Car-Midsize	24,265	25,194	25,085	25,670	26,153	26,321	25,918	25,920	26,210	26,500	26,867	26,920	27,033	27,762	27,830	28,010
Car-Subcompact	18,777	19,798	20,378	20,958	21,538	22,118	22,698	23,275	22,187	21,098	19,704	19,497	19,317	19,427	19,445	19,450
Cross/Ut-Midsize	27,222	28,350	28,189	28,517	28,899	28,995	29,044	29,258	29,528	29,621	29,842	29,897	30,024	30,178	30,331	30,493
Cross/Ut-Small-Car	23,790	23,903	24,077	24,840	25,798	26,030	26,029	25,872	26,740	27,122	27,581	28,039	28,163	28,649	30,099	30,134
Cross/Ut-Small-Truck	28,225	28,716	28,389	28,555	28,954	29,395	29,337	29,465	29,498	29,551	30,014	30,057	30,170	30,369	30,636	30,955
Pickup-Compact	27,639	28,236	28,860	29,228	30,838	31,880	32,014	33,607	34,753	35,898	36,040	36,086	37,299	37,523	37,682	37,880
Pickup-Std	32,761	33,156	34,073	34,445	34,440	34,498	34,650	34,534	34,457	35,313	35,581	35539.5	35,498	35,797	35,985	36,238
Sport/Ut-Compact	29,490	30,223	30,234	30,697	30,868	31,462	31,524	31,847	31,789	31,831	32,417	32,461	32,582	32,855	33,118	33,290
Sport/Ut-Large	53,584	53,542	54,778	55,172	55,188	55,108	55,424	55,638	55,689	55,770	55,558	54,576	54,446	54,197	54,389	54,646
Sport/Ut-Midsize	40,618	41015.5	41,413	41,737	41,533	41,172	41,367	40,904	40,805	40,705	40,574	40,462	40,510	40,306	40,368	40,503
Two-Seaters	36,417	35,906	40,384	43,149	46,011	48,872	51,267	54,667	58,067	61,467	64,850	64,766	64,853	64,988	65,068	65,237
Van-Compact	26,566	27,628	25,327	25,938	26,547	26,816	26,669	27,129	27,269	27,376	27,518	27,584	27,722	27,902	28,419	28,842
Van-Std	30,507	31,067	31,212	31,452	31,590	31,788	31,892	31,967	31,951	31,967	32,087	32,115	32,240	32,425	32,553	32,715

Table A-36: Diesel Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	23,953	23,480	24,283	24,649	41,945	42,144	42,127	42,124	42,098	42,029	41,990	42,291	42,628	43,009	43,372	43,684
Car-Large	97,969	98,707	99,125													
Car-Midsize	24,318	25,495	25,950	26,477	27,106	27,315	27,481	27,506	27,474	45,449	44,913	44,648	45,089	45,604	46,074	46,511
Car-Subcompact	30,762	31,261														
Pickup-Std	29,988	29,049	31,109	31,156	30,543	45,828	45,639	45,475	45,179	44,908	44,643	45,134	45,723	46,410	47,060	47,596
Sport/Ut-Compact	40,787	41,461														
Sport/Ut-Midsize	55,787	56,184	57,252	57,833	58,289	58,647	58,711	58,824	58,906	58,984	59,073	59,378	59,769	60,210	60,639	61,039

Table A-37: Flex-Fuel Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	40,452	40,501	42,625	43,282	43,183	42,451	43,076	52,285	52,398	52,443	51,981	51,922	52,018	52,177	52,269	52,429
Car-Large	38,653	37,926	40,102	40,480	39,692	38,590	39,203	39,704	40,047	40,098	43,227	43,270	43,304	43,499	43,625	43,842
Car-Midsize	31,887	31,923	33,067	33,419	33,122	32,777	33,852	34,113	34,279	48,642	47,613	47,631	47,765	47,955	48,090	48,279
Car-Subcompact	34,783	35,586	35,982	36,631	37,095	37,507	37,590	37,690	37,785	43,801	43,957	44,030	44,180	44,379	44,531	44,711
Cross/Ut-Small-Car	32,737	33,266	33,342	33,522	33,590	33,723	33,809	33,864	33,819	33,809	33,913	33,920	34,034	34,213	34,329	34,483
Cross/Ut-Small-Truck	37,415	36,137	38,353	38,479	37,657	36,867	37,288	37,674	37,939	38,021	48,649	48,691	48,837	49,049	49,198	49,385
Pickup-Std	41,241	40,634	42,287	42,595	42,311	42,058	42,365	42,583	42,627	42,616	42,369	42,410	42,595	42,860	43,047	43,294
Sport/Ut-Compact	27,791	28,480	28,636	29,187	29,318	29,502	29,621	29,791	29,788	29,807	29,873	29,905	30,038	30,235	30,371	30,543
Sport/Ut-Large	67,692	68,537	68,733	69,081	69,287	69,580	69,730	69,835	69,802	69,819	70,012	70,049	70,234	70,512	70,700	70,942
Sport/Ut-Midsize	58,691	56,862	59,808	60,082	59,282	57,834	58,551	59,019	59,412	59,515	57,672	57,696	57,884	58,132	58,323	58,607
Van-Compact	25,300	25,994	25,596	25,756	26,108	26,461	26,591	26,704	27,017	27,143	27,283	27,335	27,468	27,648	27,782	27,946

Table A-38: Hybrid Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	30,816	28,424	28,248	28,071	28,471	28,871	29,271	29,669	29,733	28,383	27,033	26,367	25,701	25,750	25,821	25,878
Car-Large	29,489	26,667	26,315	26,928	27,541	28,154	28,767	28,928	29,096	29,227	29,025	29,088	29,150	28,890	28,982	28,351
Car-Midsize	31,022	29,115	29,921	28,360	28,684	28,310	27,341	26,826	26,150	25,645	25,220	24,940	24,599	24,692	24,841	24,977
Car-Subcompact	20,942	21,244	21,388	21,532	21,676	21,820	21,964	22,105	22,139	22,172	22,258	22,307	22,398	22,515	22,607	22,715
Cross/Ut-Midsize					26,465	27,005	27,218	27,317	27,331	27,030	26,669	27,227	27,797	27,950	28,080	28,224
Cross/Ut-Small-Car	30,597	30,675	30,728	30,781	30,821	30,928	30,972	31,007	31,003	31,016	62,183	31,167	31,262	30,723	30,189	30,287
Cross/Ut-Small-Truck	60,673	61,332	61,400	44,957	34,517	29,303	27,437	26,424	26,124	26,502	26,829	26,665	26,783	26,912	27,026	27,151
Pickup-Std			27,950	27,950	27,950	27,950	27,950	27,950	27,950	28,091	28,284	28,458	28,631	28,859	29,058	29,274
Sport/Ut-Compact	47,214	46,522	43,218	39,776	35,221	31,150	29,868	28,339	29,010	29,684	30,358	29,925	29,759	29,647	30,142	30,302
Sport/Ut-Midsize	47,724	47,962	48,199	48,438	48,602	48,823	48,934	49,019	49,043	49,066	49,189	49,256	49,404	49,603	49,753	44,372
Van-Compact					21,693	21,693	23,209	23,317	23,391	23,477	23,821	24,964	25,255	25,261	25,113	25,269

Table A-39: PHEV MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	35,014	34,189	34,403	35,491	36,578	36,166	36,004	34,997	34,585	34,173	33,431	32,471	32,204	32,790	32,746	32,383
Car-Large	99,675	99,237	98,768	98,356	97,862	97,425	97,327	97,186	39,724	38,461	37,198	37,455	37,711	37,732	37,726	37,922
Car-Midsize	35,476	34,695	34,480	33,789	33,097	32,510	31,923	32,405	32,246	31,946	31,932	32,194	32,397	32,525	32,524	32,531
Car-Subcompact	47,758	45,836	45,399	44,704	44,166	43,867	43,612	43,339	43,075	42,827	42,779	42,664	42,568	42,473	46,928	46,831
Cross/Ut-Midsize					35,654	35,336	34,864	38,232	38,087	37,553	37,172	38,360	38,370	38,390	38,436	38,479
Cross/Ut-Small-Car					34,794	34,794	34,794	38,734	38,603	37,136	36,068	36,242	36,415	36,427	36,428	36,435
Cross/Ut-Small-Truck	78,396	77,993	35,714	33,342	32,716	35,842	36,228	36,613	36,537	36,389	36,679	36,509	36,468	37,120	37,398	37,741
Pickup-Std								39,939	39,839	39,749	40,935	42,374	42,592	42,663	42,798	42,863
Sport/Ut-Compact			32,753	32,344	31,992	36,270	36,581	36,706	38,651	39,333	40,254	40,284	40,017	39,968	40,628	40,946
Sport/Ut-Large														55,584	56,908	57,071
Sport/Ut-Midsize						39,025	39,025	39,025	39,025	40,368	41,711	42,129	42,546	42,962	43,971	44,363
Two-Seaters	139,320	138,691	138,189	137,689	137,143	136,646	136,510	136,350	136,114	135,905	135,782	135,709	135,716	135,773	137,868	137,906
Van-Compact			32,895	32,895	32,895	32,579	31,665	31,909	32,152	35,552	35,416	35,118	34,804	36,147	36,165	36,514

Table A-40: BEV MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	36,692	38,755	41,276	45,946	45,278	44,676	44,337	44,066	44,051	44,036	43,795	43,574	43,353	43,130	42,908	42,686
Car-Large	88,573	84,156	88,530	85,564	83,013	81,530	80,262	79,016	77,901	76,954	75,848	74684	73,520	72,913	72,317	71,724
Car-Midsize	36,687	34,932	37,661	40,996	42,129	42,156	42,161	41,949	41,611	40,611	39,375	38,870	38,551	38,241	37,916	37,573
Car-Subcompact	33,636	32,113	31,971	35,906	35,554	35,339	35,200	35,058	34,919	34,729	34,560	34,512	34,464	34,416	35,532	35,485
Cross/Ut-Midsize					59,110	58,264	58,048	57,086	56,155	55,652	53,633	53,396	53,155	52,905	52,659	52,415
Cross/Ut-Small-Car	36,175	97,038	100,101	97,792	95,853	93,716	92,843	91,905	91,409	90,522	89,054	88,424	87,905	87,386	86,848	86,350
Cross/Ut-Small-Truck				47,140	46,304	49,593	49,199	49,097	49,131	49,280	49,066	49,991	50,475	50,554	50,466	50,261
Pickup-Std													54,077	53,918	53,760	53,601
Sport/Ut-Compact				57,111	55,897	60,301	60,971	61,125	61,984	62,843	62,596	62,239	61,881	61,514	60,721	60,260
Two-Seaters	29,125	27,898	27,833	27,582	27,424	27,266	27,164	27,062	26,961	26,859	26,757	26,712	26,667	26,621	26,576	26,531
Van-Compact							44,158	43,440	42,952	46,656	46,230	46,080	45,930	45,780	45,629	46,742

Table A-41: Fuel Cell Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize			59,429	57,835	55,750	53,743	50,819	46,770	43,424	37,365	31,305	30,515	30,536	30,212	29,824	28,562
Car-Subcompact		57,544	56,093	54,647	52,775	50,969	48,406	44,864	41,931	39,993	38,378	37,691	37,653	36,982	36,480	36,480
Cross/Ut-Small-Truck			50,938	49,729	48,117	46,577	44,206	40,914	38,205	36,442	34,988	34,822	35,788	36,754	37,720	38,687
Sport/Ut-Compact						41,040	41,896	41,321	39,942	38,506	37,305	36,859	36,841	36,324	35,933	35,704
Van-Compact								60,873	45,510	38,565	37,143	36,680	36,502	35,727	35,107	34,453

Table A-42: Natural Gas Vehicle MSRP by Class (in 2015 U.S. $)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	27,528	27,811	27,682	27,658	27,541	27,492	27,416	27,314	26,974	26,926	27,528	27,528	27,528	27,528	27,528	27,528

Table A-43: Gasoline Vehicle Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	43.49	43.71	43.83	44.13	44.63	44.56	44.51	44.43	44.04	43.86	43.88	43.9	43.69	43.68	43.83	43.75
Car-Large	49.51	49.33	49.42	49.64	49.63	49.54	49.68	49.9	50.25	50.34	50.07	50.07	50.07	50.03	50.13	50.03
Car-Midsize	46.81	46.79	46.71	46.78	46.86	46.87	46.75	46.68	46.72	46.81	46.89	46.9	46.9	47	46.98	46.99
Car-Subcompact	38.11	38.54	39.9	39.81	39.76	39.76	39.45	39.18	38.96	38.29	37.63	37.57	37.49	37.49	37.47	37.44
Cross/Ut-Midsize	44.74	45.04	44.76	44.79	44.86	44.81	44.87	45.06	45.39	45.36	45.47	45.53	45.58	45.57	45.63	45.65
Cross/Ut-Small-Car	44.5	44.08	43.95	44.18	44.43	44.43	44.54	44.43	44.93	45.13	45.58	45.59	45.59	45.98	46.83	46.89
Cross/Ut-Small-Truck	46.37	46.54	46.43	46.58	46.76	46.81	46.9	47.06	47.18	47.18	47.25	47.25	47.25	47.26	47.3	47.36
Pickup-Compact	56.49	56.65	56.59	56.61	57.23	57.82	57.83	57.87	57.89	55.5	55.5	55.5	55.6	55.6	55.6	55.6
Pickup-Std	61.7	61.82	62.12	62.15	61.97	61.83	61.75	61.54	61.61	61.93	61.44	61.14	61.14	60.95	60.95	61.15
Sport/Ut-Compact	46.47	46.72	46.45	46.54	46.69	46.83	46.82	46.95	47.02	47.08	47.23	47.25	47.26	47.38	47.45	47.44
Sport/Ut-Large	58.18	58.21	58.19	58.19	58.16	58.11	58.12	58.13	58.14	58.18	58.09	57.78	57.68	57.44	57.43	57.43
Sport/Ut-Midsize	52.32	52.35	52.19	52.19	52.18	52.16	52.13	51.97	51.84	52.16	52.09	51.96	51.95	52.03	52.05	52.09
Two-Seaters	44.58	45.06	45.41	45.35	46.01	45.58	45.92	45.91	45.9	45.61	45.55	45.55	45.55	45.55	45.55	45.55
Van-Compact	52.02	52.51	50.2	51.02	51.72	51.92	51.71	52.23	52.71	52.89	53.03	53.03	53.01	52.99	53.3	53.53
Van-Std	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97	61.97

Table A-44: Diesel Vehicle Footprint by Class (in square feet)

Class	Powertrain	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	diesel	44.0	43.9	44.0	44.1	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3	46.3
Car-Large	diesel	54.2	54.2	54.2													
Car-Midsize	diesel	45.2	45.3	45.3	45.4	45.4	45.5	45.5	45.5	45.5	48.8	48.8	48.7	48.7	48.7	48.7	48.7
Car-Subcompact	diesel	44.1	44.1														
Pickup-Std	diesel	58.8	58.0	59.0	58.9	58.6	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5	66.5
Sport/Ut-Compact	diesel	45.3	45.3														
Sport/Ut-Midsize	diesel	52.8	52.7	52.8	52.8	52.8	52.8	52.8	52.8	52.8	52.9	52.9	52.9	52.9	52.8	52.8	52.8

Table A-45: Flex-Fuel Vehicle Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	46.1	46.0	46.3	46.4	46.4	46.2	46.3	47.9	47.9	47.9	47.9	47.8	47.8	47.8	47.8	47.8
Car-Large	51.0	50.9	51.1	51.1	51.1	50.9	51.0	51.0	51.1	51.1	52.9	52.9	52.9	52.9	52.9	52.9
Car-Midsize	47.0	46.9	47.1	47.1	47.0	47.0	47.1	47.1	47.1	49.0	48.8	48.8	48.8	48.8	48.8	48.8
Car-Subcompact	44.6	44.7	44.7	44.8	44.9	44.9	44.9	44.9	44.9	47.1	47.1	47.1	47.1	47.1	47.1	47.1
Cross/Ut-Small-Car	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1	49.1
Cross/Ut-Small-Truck	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9	48.9
Pickup-Std	68.8	68.1	69.1	69.2	69.0	68.7	68.8	68.9	69.0	69.0	68.6	68.6	68.6	68.6	68.6	68.7
Sport/Ut-Compact	49.1	49.2	49.2	49.5	49.5	49.5	49.5	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6	49.6
Sport/Ut-Large	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0	62.0
Sport/Ut-Midsize	54.3	54.1	54.3	54.3	54.2	54.1	54.1	54.2	54.2	54.2	54.1	54.1	54.1	54.1	54.1	54.1
Two-Seaters	42.6	42.6	42.8	42.8	42.8	42.7	42.7	42.7	42.8	42.8	42.6	42.6	42.6	42.6	42.6	42.6
Van-Compact	50.3	51.1	50.3	50.5	50.9	51.3	51.3	51.3	51.9	52.9	53.1	53.1	53.1	53.1	53.1	53.1

Table A-46: Hybrid Vehicles Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	42.93	42.47	42.64	42.39	42.58	42.75	42.74	42.75	42.78	42.82	42.98	44	44.01	44	43.99	43.98
Car-Large	44.71	44.11	44.02	44.13	44.3	44.39	44.42	44.44	44.47	44.5	47.19	53.02	52.97	52.95	52.95	52.49
Car-Midsize	46.86	46.8	47.16	46.66	46.74	46.75	46.62	46.71	46.77	46.76	46.69	46.53	46.35	46.35	46.5	46.5
Car-Subcompact	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69	39.69
Cross/Ut-Midsize					44.46	44.44	44.44	44.44	44.38	44.3	44.51	45.26	45.96	45.97	45.97	45.98
Cross/Ut-Small-Car	43.87	43.78	43.86	43.75	43.72	43.59	43.6	43.6	43.6	43.59	43.51	43.5	43.5	44.52	45.57	45.61
Cross/Ut-Small-Truck	50.21	50.26	50.27	48.45	47.29	46.69	46.47	46.51	46.71	47.06	47.34	47.23	47.23	47.22	47.22	47.22
Pickup-Std			56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77	56.77
Sport/Ut-Compact	46.84	46.73	46.38	46.37	46.32	46.24	46.22	46.18	46.21	46.23	46.23	46.15	46.22	46.4	46.47	46.49
Sport/Ut-Midsize	50.68	51.02	50.84	50.88	50.92	50.95	50.95	50.95	50.94	50.94	50.94	50.93	50.93	50.93	50.93	50.35
Van-Compact					55.13	55.13	53.06	53.06	53.06	53.06	53.5	53.82	53.91	53.97	54.05	54.06

Table A-47: PHEVs Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	44.92	44.73	44.54	44.55	44.57	44.56	44.56	44.44	43.78	44.4	43.99	43.36	43.19	43.54	43.54	43.42
Car-Large	53.31	53.3	53.32	53.33	53.32	53.34	53.34	53.34	51.05	50.9	51.22	51.7	51.78	51.55	51.42	51.01
Car-Midsize	45.99	45.45	45.22	45.34	45.56	45.79	46.18	46.29	46.46	46.39	46.32	46.32	46.28	46.38	46.38	46.38
Car-Subcompact	43.56	43.55	43.55	43.55	43.56	43.58	43.58	43.58	43.58	43.58	43.59	43.59	43.59	43.59	43.63	43.63
Cross/Ut-Midsize					44.43	44.43	44.36	44.58	44.92	45.28	46.15	45.99	45.86	45.86	45.98	46.06
Cross/Ut-Small-Car					49.14	49.14	49.14	49.14	49.14	47.17	45.37	44.98	45.08	45.08	45.08	45.08
Cross/Ut-Small-Truck	51.22	51.22	46.4	46.18	46.16	46.5	46.64	46.82	46.95	47.15	47.02	46.67	46.55	46.73	46.77	46.84
Pickup-Std								56.77	56.77	56.77	58.72	60.58	60.31	60.31	59.88	59.88
Sport/Ut-Compact			46.06	46.06	46.06	46.1	46.13	46.1	46.13	46.17	46.41	46.79	47.15	47.36	47.56	47.71
Sport/Ut-Large														55.34	55.34	55.34
Sport/Ut-Midsize						49.11	49.11	49.11	49.11	49.11	49.39	50.76	50.67	51.08	51.12	51.2
Two-Seaters	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51	49.51
Van-Compact			51	51	51	51	52.02	52.41	52.69	52.88	53.25	53.55	53.57	53.39	53.38	53.51

Table A-48: BEVs Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	43.89	43.12	42.5	41.99	41.98	41.95	41.94	41.92	41.59	41.86	42.06	42.06	42.06	42.05	42.05	42.05
Car-Large	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91	52.91
Car-Midsize	44.78	44.78	46.72	48.15	48.64	49.59	49.55	49.48	49.67	49.34	49.38	49.14	49.16	49.18	49.21	49.24
Car-Subcompact	37.16	37.14	37.2	37.9	37.92	38.04	38.06	38.07	38.09	38.07	38.07	38.07	38.07	38.07	38.07	38.07
Cross/Ut-Midsize					44.46	44.44	44.42	44.42	44.29	44.12	44.03	44.03	44.03	44.03	44.03	44.03
Cross/Ut-Small-Car	43.57	52.64	52.72	52.73	52.73	52.7	52.7	52.7	52.76	52.76	52.69	52.67	52.67	52.66	52.66	52.66
Cross/Ut-Small-Truck				46.06	46.06	46.06	46.06	46.53	47.12	47.71	47.44	47.65	47.78	47.62	47.55	47.54
Pickup-Std													56.77	56.77	56.77	56.77
Sport/Ut-Compact				46.06	46.06	46.15	46.22	46.27	46.28	46.28	46.29	46.29	46.29	46.29	46.11	46.08
Two-Seaters	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78	25.78
Van-Compact							51	52.02	52.41	52.62	52.84	52.84	52.84	52.84	52.85	53.15

Table A-49: Fuel Cell Vehicle Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Midsize			46.85	46.85	46.85	46.85	46.85	46.85	46.85	47.21	47.29	47.31	47.31	47.31	47.31	47.36
Car-Subcompact		46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93	46.93
Cross/Ut-Small-Truck			45.02	45.02	45.02	45.02	45.02	45.02	45.02	45.02	45.02	47.88	47.85	48.42	48.42	48.41
Sport/Ut-Compact						46.06	46.18	46.26	46.29	46.29	46.29	46.29	46.28	46.28	46.28	46.28
Van-Compact								55.13	53.24	52.27	52.37	52.47	52.42	52.43	52.41	52.41

Table A-50: Natural Gas Vehicle Footprint by Class (in square feet)

Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car-Compact	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1	43.1

Table A-51: Preliminary ADOPT Runs Fuel Cell Vehicle Attributes (used by the Energy Commission)

Attribute	Class	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Fuel Economy	Car-Midsize		66.8	67.1	67.4	67.7	67.9	68.2	68.4	68.6	68.8	68.9	69.1	69.2	69.3	69.4	69.5
	Cross/Ut-Small-Truck			49.9	50.1	50.3	50.5	50.7	50.8	53.9	56.4	56.9	57.2	57.3	57.4	57.5	57.5
	Sport/Ut-Compact			57.6	57.9	58.2	58.6	58.8	59	59.2	59.4	59.6	59.7	59.7	59.8	59.9	60
MSRP	Car-Midsize		66,140	65,294	61,634	57,868	55,138	52,589	49,574	48,192	46,453	45,435	45,176	44,917	44,658	44,399	44,141
	Cross/Ut-Small-Truck			59,536	56,083	52,534	49,984	47,587	44,751	44,010	43,099	42,439	42,299	42,105	41,911	41,717	41,526
	Sport/Ut-Compact			54,003	51,305	48,408	46,225	44,214	46,291	45,233	43,931	43,147	42,886	42,774	42,605	42,414	42,222
Range	Car-Midsize		312	312	312	312	312	312	312	312	312	312	312	312	312	312	312
	Cross/Ut-Small-Truck			265	265	265	265	265	265	231	205	200	197	197	197	198	198
	Sport/Ut-Compact			228	228	224	216	210	200	195	190	184	178	173	172	172	172
Acceleration	Car-Midsize		7.8	7.8	7.8	7.7	7.7	7.7	7.6	7.6	7.6	7.6	7.5	7.5	7.5	7.5	7.5
	Cross/Ut-Small-Truck			10.1	10.0	9.9	9.9	9.7	9.8	9.4	9.1	9	8.9	8.9	8.9	8.9	8.9
	Sport/Ut-Compact			9.2	9.1	9.1	9.0	8.9	8.9	8.8	8.8	8.7	8.7	8.6	8.5	8.5	8.5