Transportation Energy Demand Forecast

Demand Analysis Working Group Presentation

November 15, 2022

Statewide Light-Duty Vehicle Forecast: Statewide & Regional Vehicles

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Overview

- Baseline Forecast Context & Scenario
- Statewide ZEV Forecast Results
- Regional PEV Forecast Results

Key Light Duty Vehicle Demand Forecast Drivers

Fleet Size & New Vehicle Sales

Economic & Demographic Factors

Fleet Composition

- Vehicle Attributes
- Technology Schedule
- Federal and Statewide Incentives
- Consumer Preferences

Baseline PEV/ZEV Scenario

INPUTS/Assumptions	Baseline Mid Case Forecast
Economic and Demographic Data	Baseline Mid
PREFERENCES	
Consumers' PEV Preference	Increase with PEV market growth
INCENTIVES/Regs	
IRA Federal Tax Credit	To 2032
Clean Fuel Rewards	To 2030
State Rebate	To 2025
HOV Lane Access	To 2025
2035 ZEV Regulation Requirement	Reserved for AATE scenarios
ATTRIBUTES	
Availability of PEVs (2035)	PEV models available in **15** of the 15 CEC LDV classes, in Standard and/or luxury
Vehicle / Battery Price (by 2035)	PEV prices based on battery price declining to **~$71/kWh**
Max. Range (2035)	~400 miles for Standard, 500 mile for Luxury
Refuel Time (2035)	15 -21 min
Time to Station (2035)	Same as gasoline
ZEV Population (2035)	~ 10 million

Key Updates

- Consumer Preferences for PEVs
- Price: Actual prices to 2022, ZEV announcements 2023 onward
- MPG: Actual MPGs to 2022, ZEV announcements for 2023 onward
- Range: Based on actual range values to 2022 and projected range for 2023 onward
- Technology Introduction Schedule: Based on DMV data to 2023, and OEM announcements afterward

ZEV Technology Introduction Schedule

Class	Standard				Luxury			
	BEV	PHEV	FCV	PFCV	BEV	PHEV	FCV	PFCV
Car-Compact	2011	2011			2023	2014		
Car-Large	2028	2016			2012	2014		
Car-Midsize	2017	2012			2020	2016	2027	
Car-Sport	2021				2021	2014		
Car-Subcompact	2011		2016		2014	2014		
Pickup-Compact	2025							
Pickup-Heavy	2028			2024	2023			
Pickup-Std	2022	2024			2022	2035	2025	
SUV-Compact	2012	2018	2019		2016	2016		
SUV-Heavy								
SUV-Large	2023	2025			2022			2024
SUV-Midsize	2023	2021			2020	2015		
SUV-Subcompact	2015	2018			2014	2020		
Van-Heavy	2023							
Van-Minivan	2023	2023						
Van-Std	2023					2017		

Never Introduced

Source: Energy Commission Staff Analysis

ICE Technology Termination Schedule

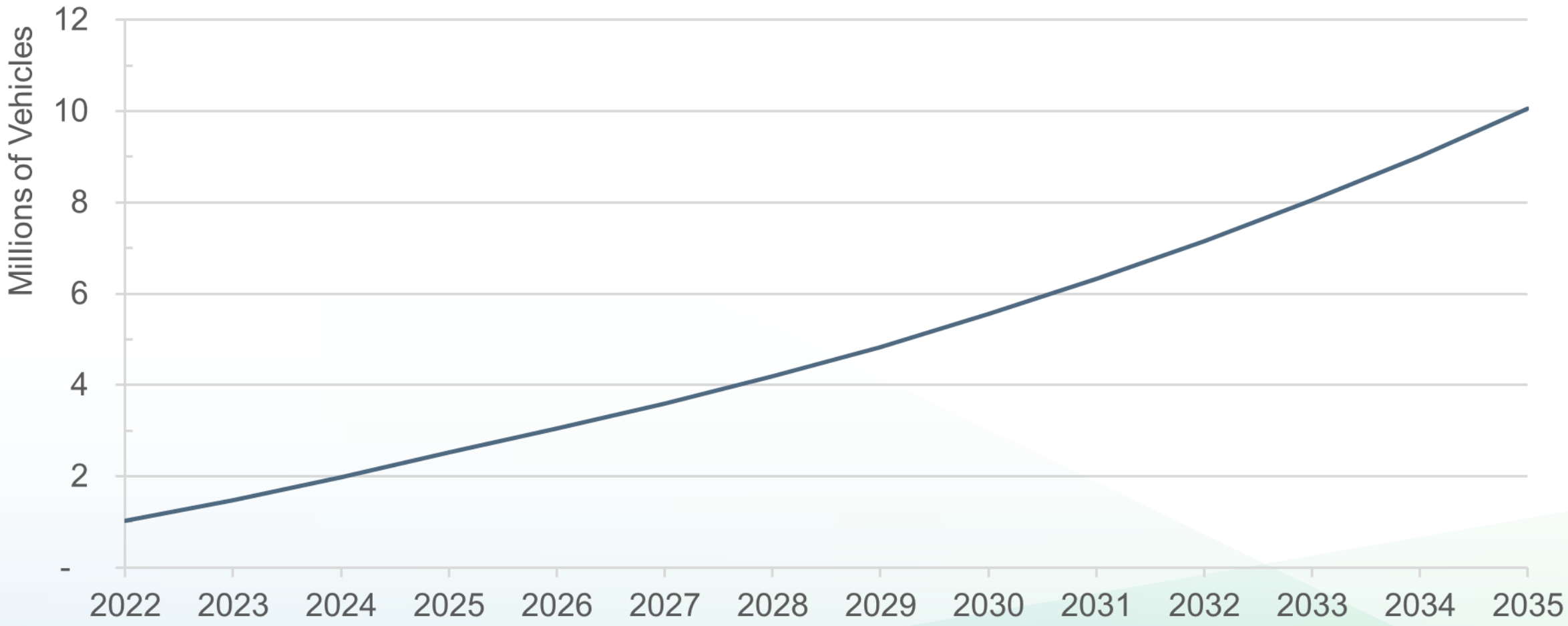
Class	Standard				Luxury			
	Gasoline	Diesel	Hybrid	FFV	Gasoline	Diesel	Hybrid	FFV
Car-Compact		2016		2019		2019	2018	2011
Car-Large		1983	2018	2021		2019	2016	2016
Car-Midsize		2020		2016		2020		2015
Car-Sport			2017	2017				2015
Car-Subcompact	2029	2016	2020			2015		
Pickup-Compact	2028	2031	2022	2012				
Pickup-Heavy				2022				
Pickup-Std		2030			2009			
SUV-Compact		2020		2020		2020		2014
SUV-Heavy	2014	2006		2014				
SUV-Large	2029	2023	2016	2021		2022	2014	2015
SUV-Midsize		2022		2013		2022		2016
SUV-Subcompact		2016	2018	2012		1988	2023	2007
Van-Heavy	2029	2022		2022	2023			2017
Van-Minivan	2035	1984		2021				
Van-Std				2017	2022			

Continues to 2035+ | Never Existed

Source: Energy Commission Staff Analysis

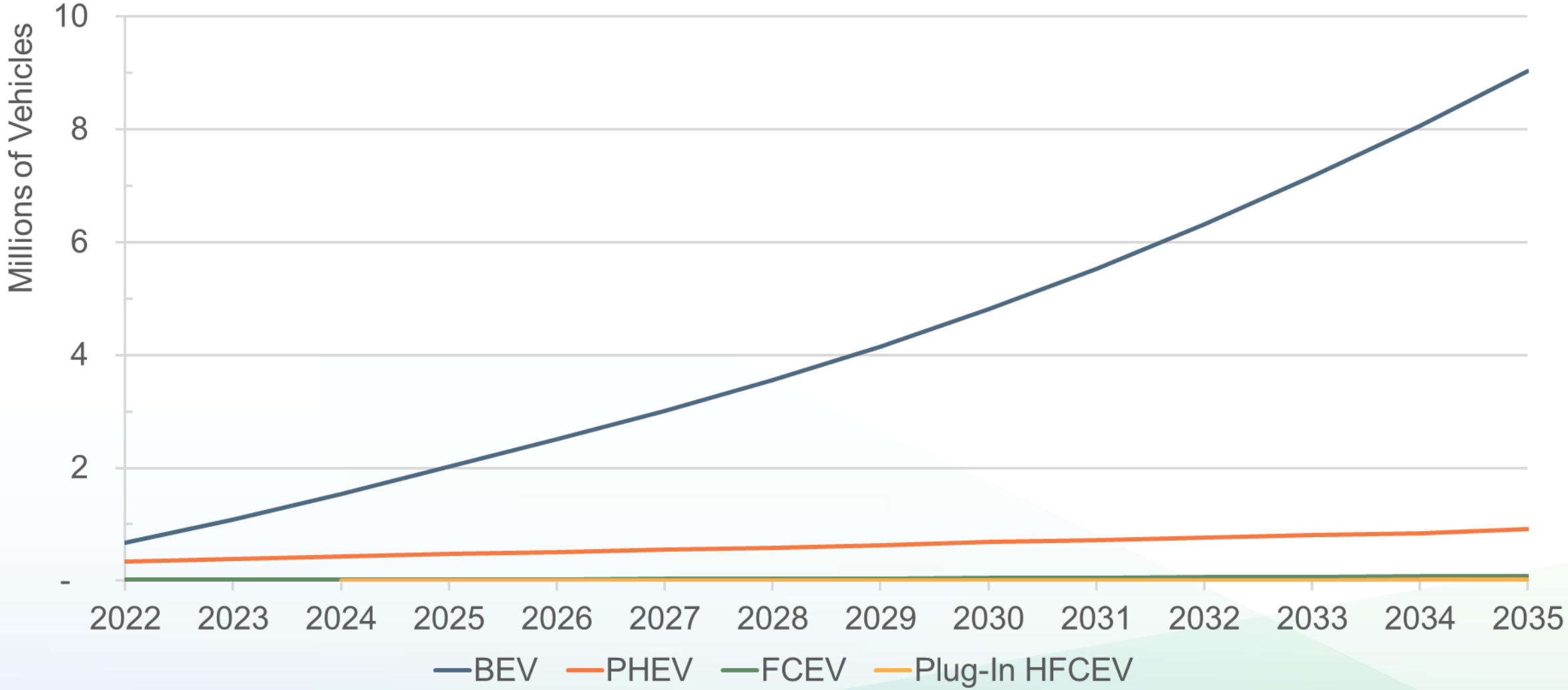
Total Forecasted ZEV Stock

Baseline Scenario



Forecasted ZEV Stock by Fuel

Baseline Scenario



BEV, PHEV and PHFCV Stock by Utility

Baseline Scenario, Thousands of Vehicles

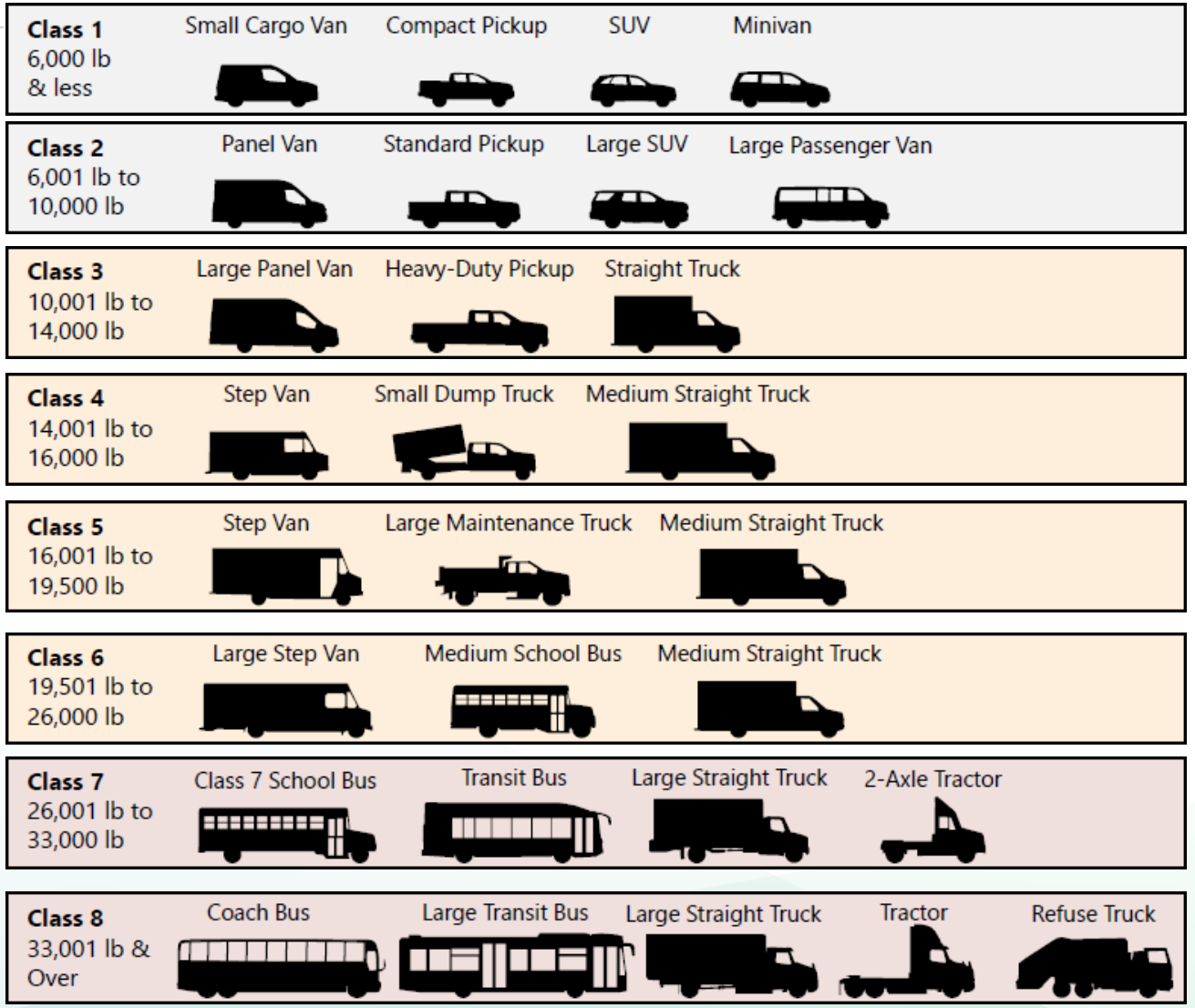
Utility Region	2021	2025	2030	2035
LADWP	81	250	570	1,100
PG&E	330	1,000	2,200	4,000
SCE	290	840	1,800	3,100
SDG&E	83	250	540	950
SMUD	24	69	160	310
Others	18	52	100	170
Total	**830**	**2,500**	**5,400**	**9,700**

Medium- and Heavy-Duty Truck Forecast Methods

Bob McBride

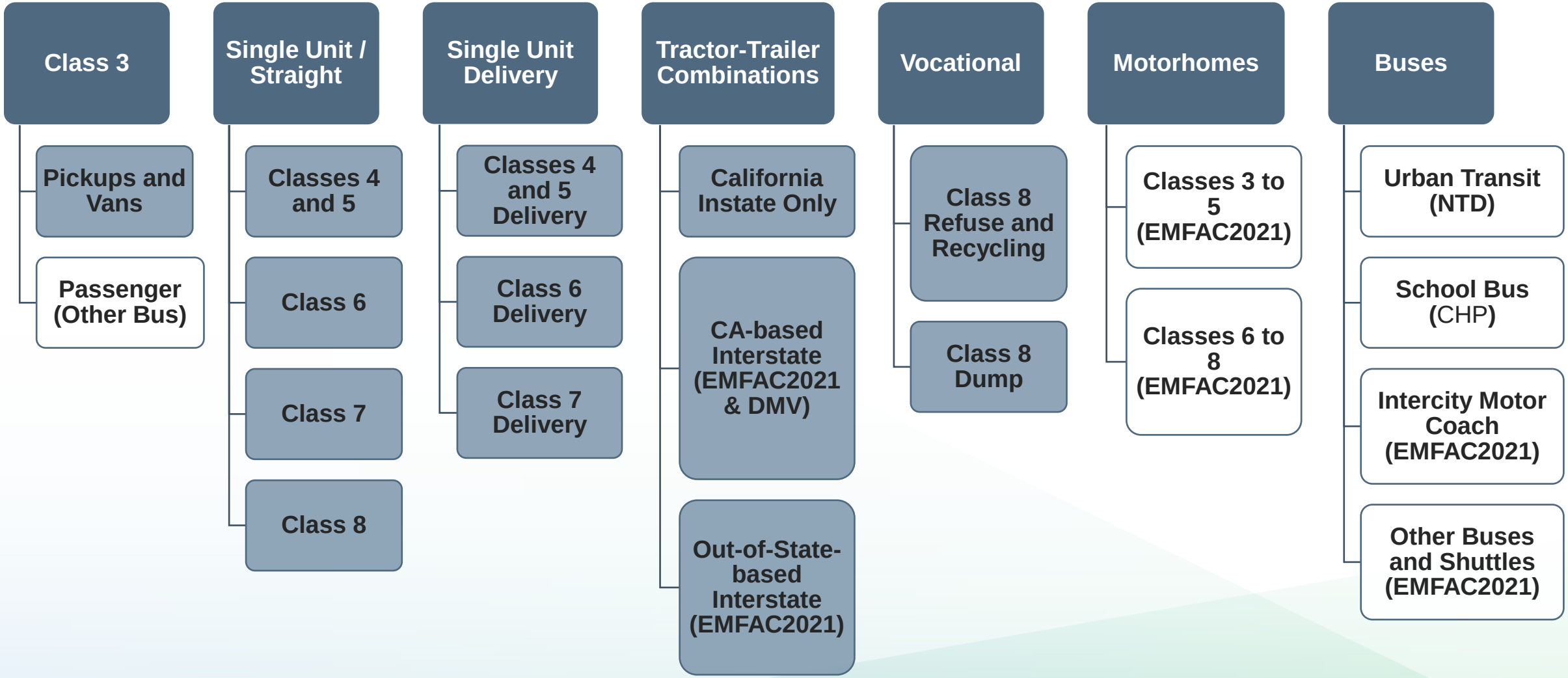
MD-HD Overview

- MD-HD Vehicle Classes
- Inputs and Assumptions
- Data Sources
- Incentives
- Policy Constraints



Source: California Energy Commission staff

MDHD Vehicle Classes



Zero-Emission Truck Inputs and Assumptions

	Baseline
CARB Regulations	Advanced Clean Trucks (ACT), other existing rules
Regional Regulations	SCAQMD Truck and Bus rules
HVIP (all years)	Voucher amounts scaled to incremental truck price
Inflation Reduction Act	$7,500 for Class 3 and $40,000 for Classes 6 and 7
Hydrogen Price	NREL mid price
Electricity Rates	Commercial Rates, Mid
BEV Truck Prices given battery pack price in 2035	BEV prices based on battery price $488/kWh in 2021, declines to $73/kWh in 2035
Miles Per Gallon (conventional / alternative)	Same as Mid for IEPR 2021, based on ICF(2021) and KGD(2019)

Key Data Sources

- In-state truck stock based on analysis of DMV data
- Interstate truck stock based on EMFAC2021
- Commodity movement based on Freight Analysis Framework 5.3
- Allocation of commodities to trucks based on CSF2TDM and CA-VIUS
- Truck prices, fuel efficiency and infrastructure cost from ICF 2021 contract
- Battery pack prices from 2022 to 2026 reflect higher lithium price due to production shortage due to high demand
- Choice model calibrated so that ICE and electric truck purchase share aligns to CY2021 actual DMV and HVIP values
- Share calibration performed as adjustment of initial preference factor

State and Federal Incentives

- CARB Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP) MDHD Truck Vouchers
  - Flat rates by weight class for vehicle purchase vouchers
  - Zero-emission truck (ZET) drayage truck voucher at $150,000, others lower
  - Buses and trucks in same weight class receive same amount
- Inflation Reduction Act (IRA) Federal Incentive
  - For Class 3, incentives for ZET and plug-in hybrid electric vehicle (PHEV) capped at $7,500
  - For Classes 6 and 7, capped at $40,000
- Assumptions
  - IRA incentives run from 2023 to 2031
  - HVIP and IRA incentives can be stacked
  - HVIP voucher is scaled to incremental truck price, and adjusted to achieve Advanced Clean Truck regulation compliance

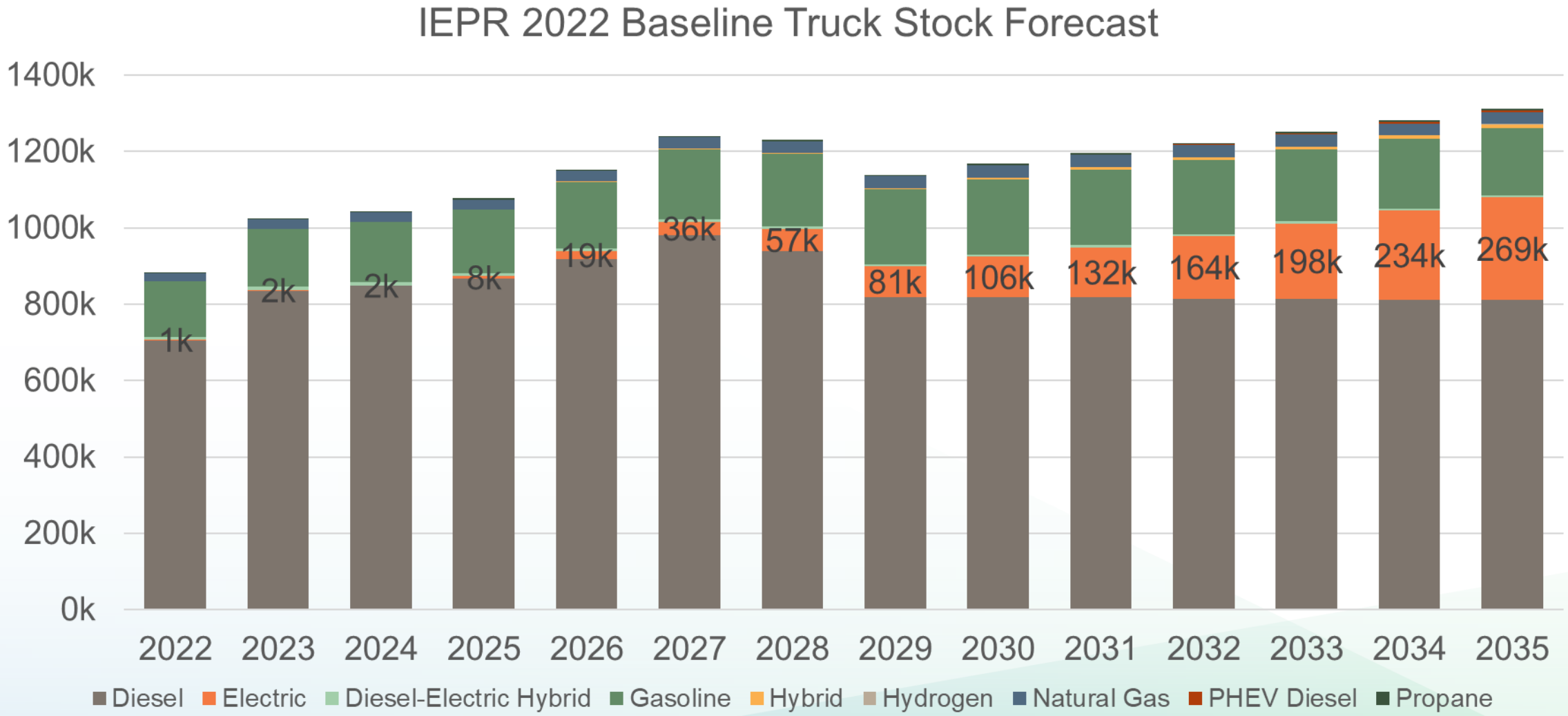
Policy Constraints

- Statewide Truck Rules
- SCAQMD Regional Rules
  - ‘Alternative fuel’ required for transit buses, refuse and public fleets
- Advanced Clean Truck regulation
  - Sets percent ZEV required for compliance and weights by truck class
  - Included in Truck Choice & Freight model as a compliance calculator
- Advanced Clean Fleets regulation (AATE 3 only)
  - Data from CARB for ACF plus ACT scenario
  - Assume the maximum of ZEV share each forecast year, from CARB ACF data or CEC truck choice shares

Medium- and Heavy-Duty Truck Forecast Results

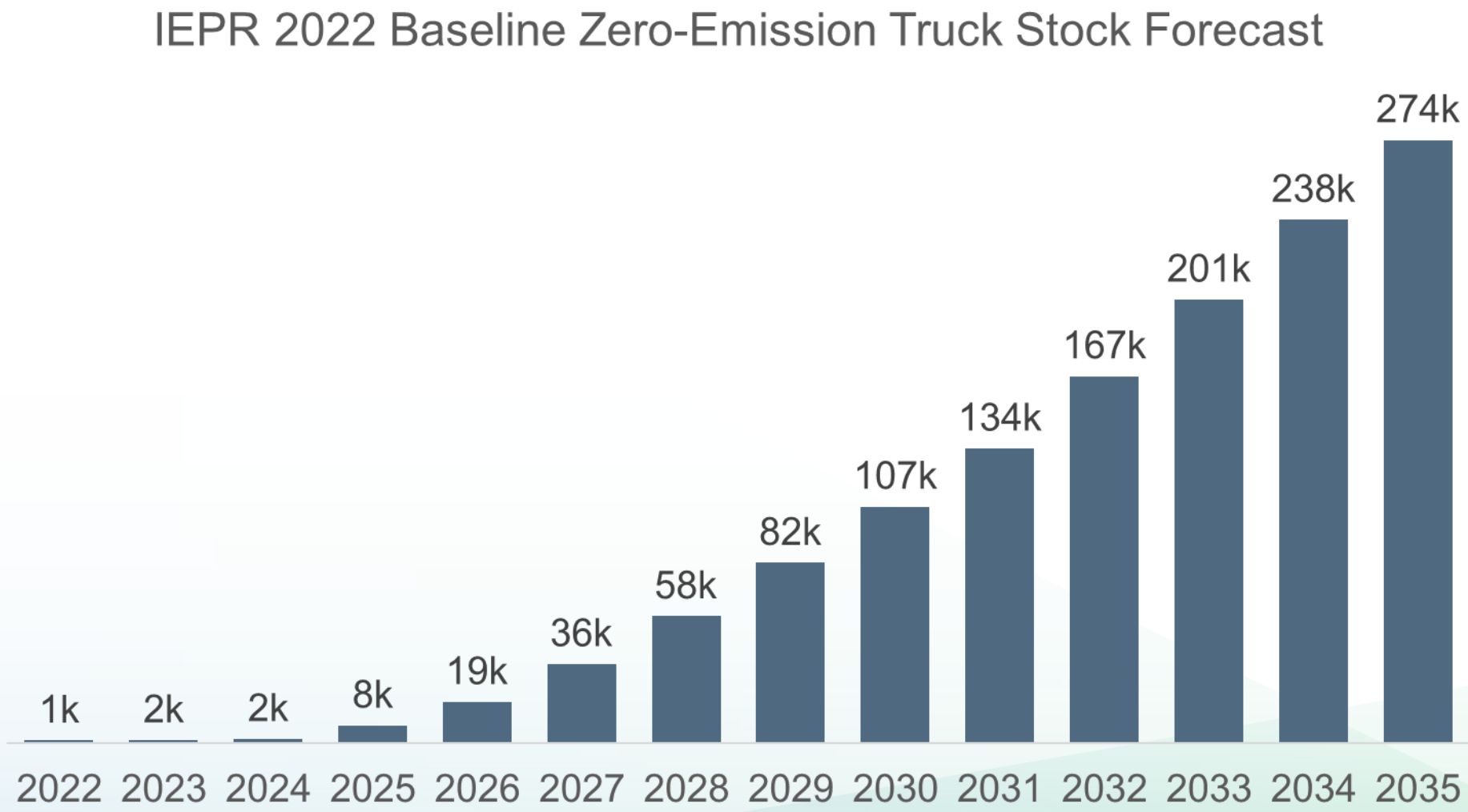
Maggie Deng

Baseline Truck Stock



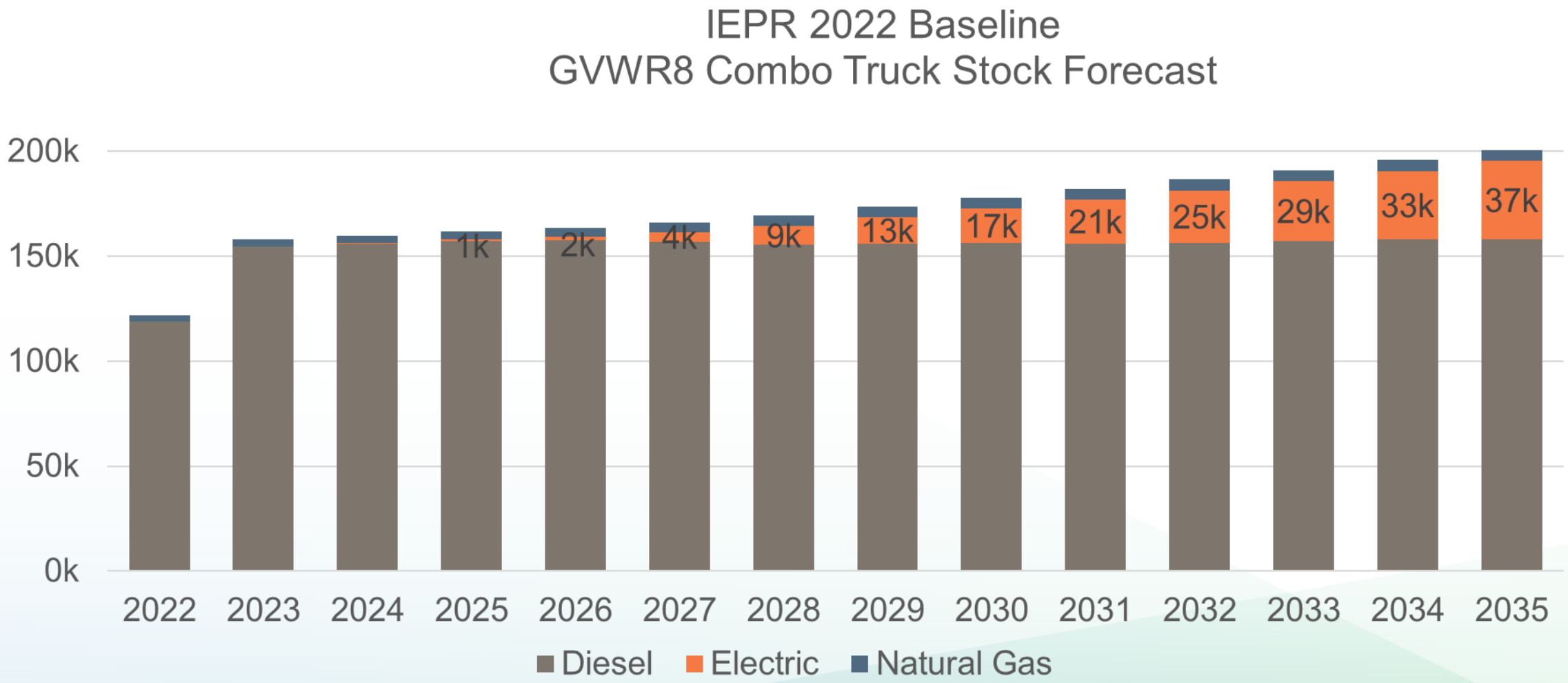
Source: California Energy Commission staff analysis

Baseline Zero-Emission Truck Stock



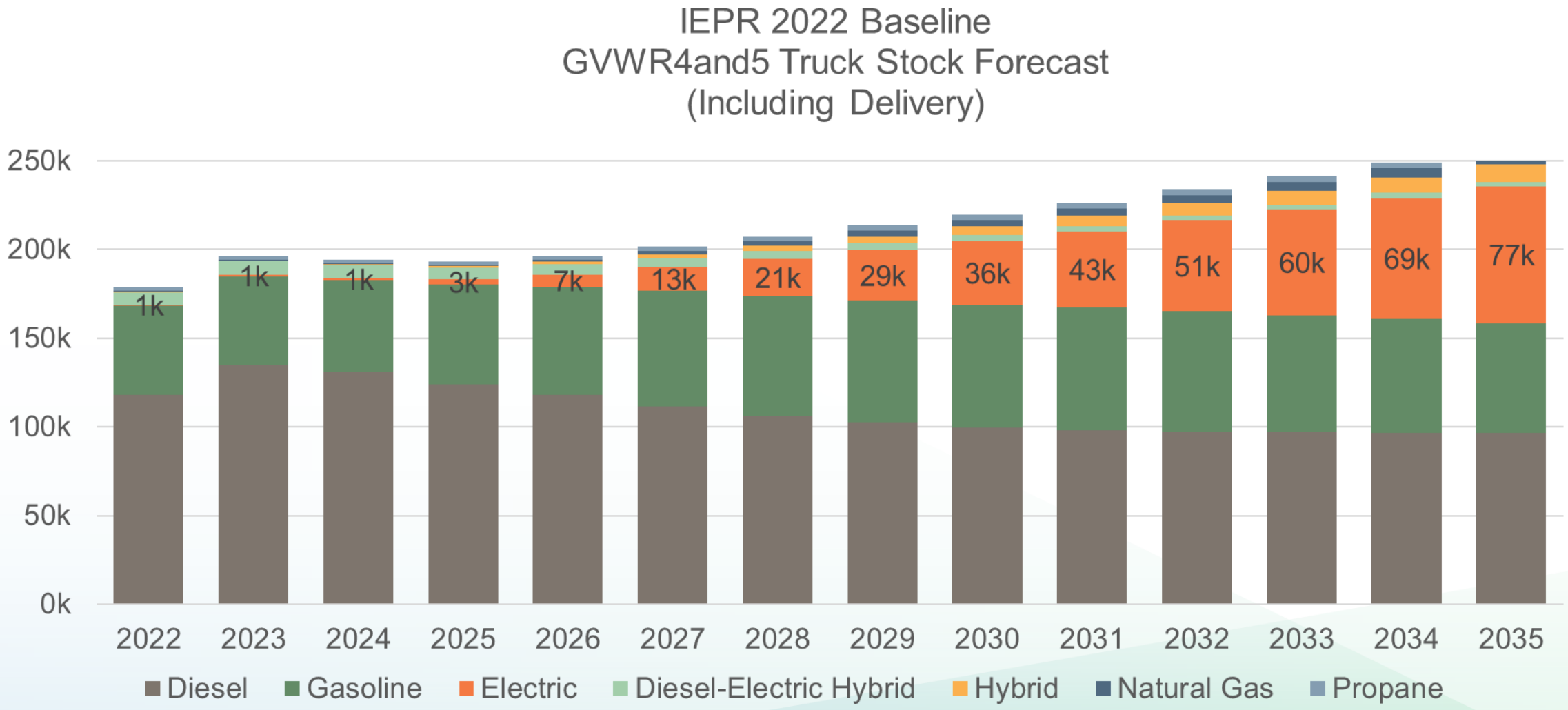
Source: California Energy Commission staff analysis

Baseline GVWR8 Combo Stock



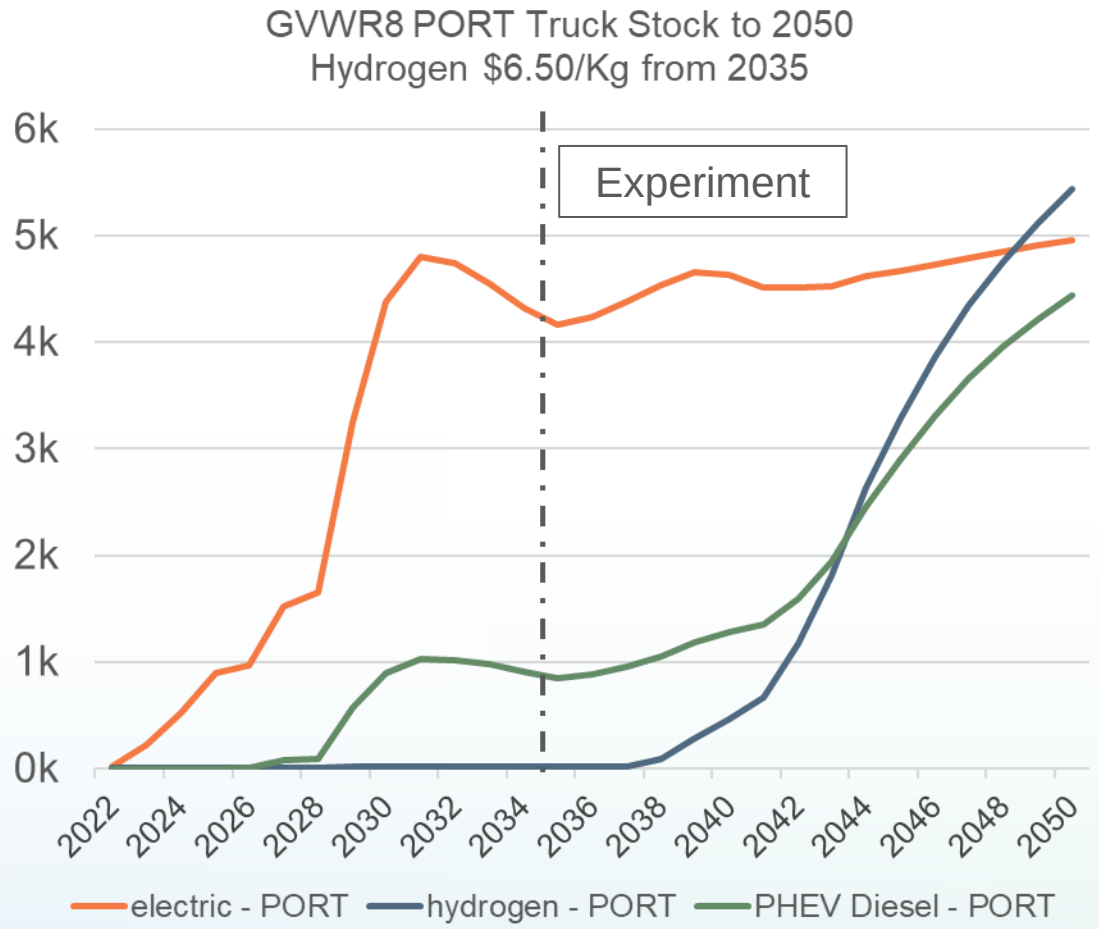
Source: California Energy Commission staff

Baseline GVWR4and5 Truck Stock

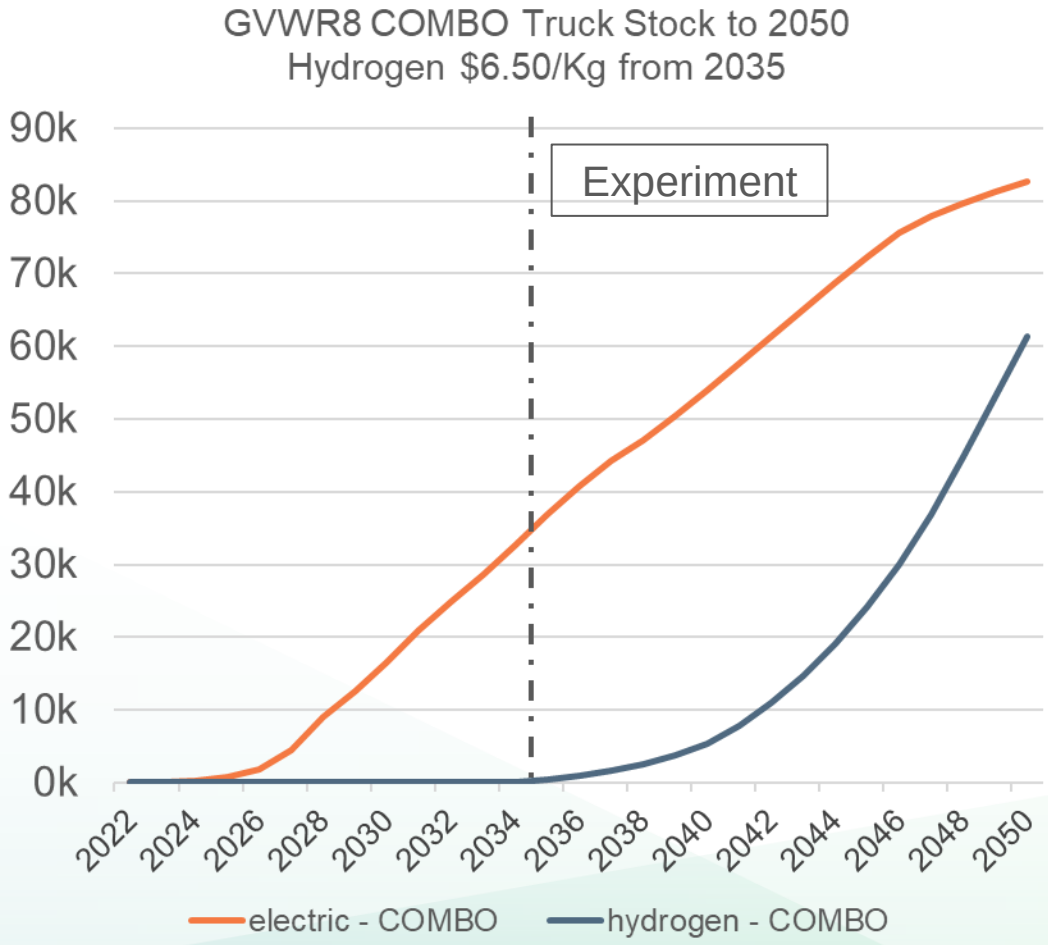


Source: California Energy Commission staff analysis

Hydrogen Fuel Price Experiment Using $6.50/Kg H2 Price from 2035

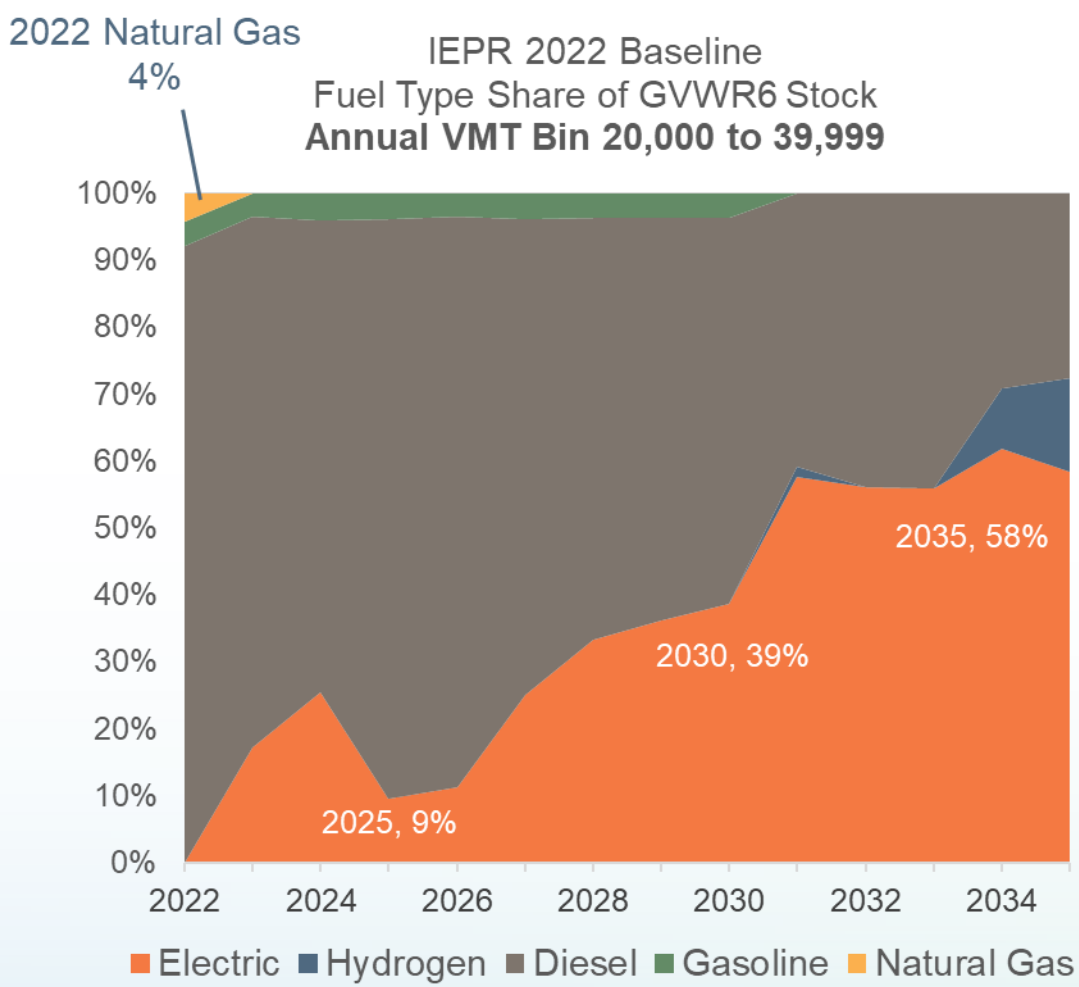


Source: California Energy Commission staff analysis

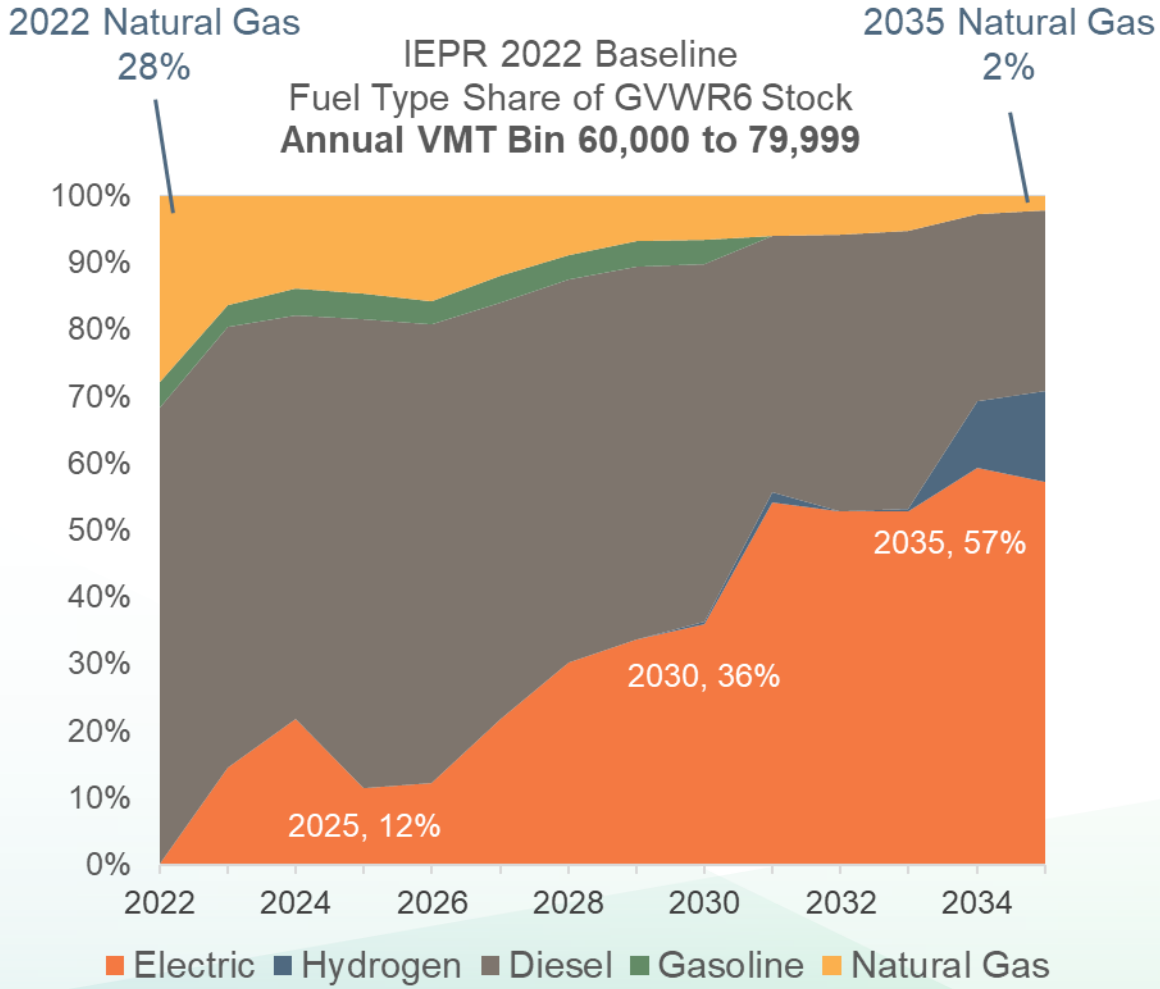


Source: California Energy Commission staff analysis

Relationship of Annual VMT to Fuel Type Share



Source: California Energy Commission staff analysis



Source: California Energy Commission staff analysis

Additional Achievable Transportation Electrification (AATE)

Rationale, Method, and Results

Quentin Gee

Additional Achievable Transportation Electrification (AATE): Synopsis

- AATE enables the expansion of the original IEPR forecasting approach used for transportation.
- **Managed forecasts** above the baseline are used for integration of supply-side policies that existing demand-side models cannot readily account for.
- AATE 2 and AATE 3 are managed forecasts that post-process some vehicle fuel types to align with sales proportions or population proportions stipulated by Advanced Clean Cars II and Advanced Clean Trucks.
- Because AATE 3 is the recommended scenario for planning and the baseline ZEV forecast is already high, staff do not anticipate significant impacts from removing AATE 1.

Light-Duty AATE Scenarios 2 and 3

- Preferences for body style (e.g., increasing consumer interest in SUVs or Pickups) are maintained, which allows for modeling energy consequences of such preferences under high ZEV policy scenarios.
- Total vehicle population across Baseline, AATE 2, and AATE 3 are the same – only fuel types of new vehicle sales change.

Electricity Consequences for PEVs

- Lower per vehicle electricity consumption from 2021 IEPR.
- Increased population-weighted PEV fuel economy.
- Improvements to VMT forecast.
- PHEV energy consumption improvements.

Post-Processing: Simplified Example

Baseline Scenario	Quantity
Total LD Vehicle Population	34,000,000
New LD Vehicle Sales	2,400,000
ZEV Sales Requirement	59%
Standard Mid Size Sales	400,000
Gasoline*	265,328
Electric*	134,672

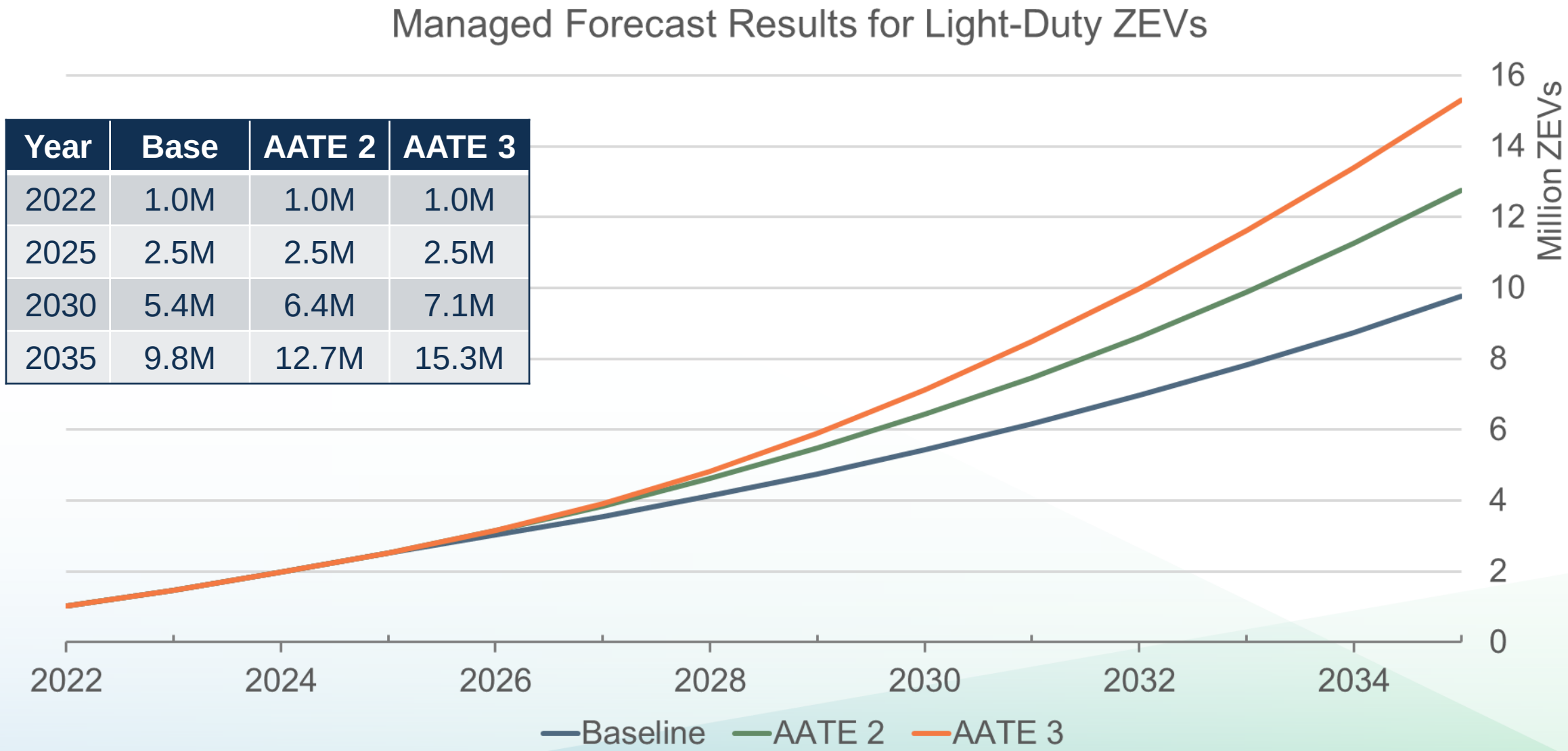
AATE Scenario 3	Quantity
Total LD Vehicle Population	34,000,000
New LD Vehicle Sales	2,400,000
ZEV Sales Requirement	59%
Standard Mid Size Sales	400,000
Gasoline*	164,000
Electric*	236,000

In the post-processing approach, the distribution of ZEVs will change, but the vehicle population, new vehicle sales, and classes of new vehicles will remain constant. ZEV populations within a class may not align precisely to the sales, but the total ZEV sales will align.

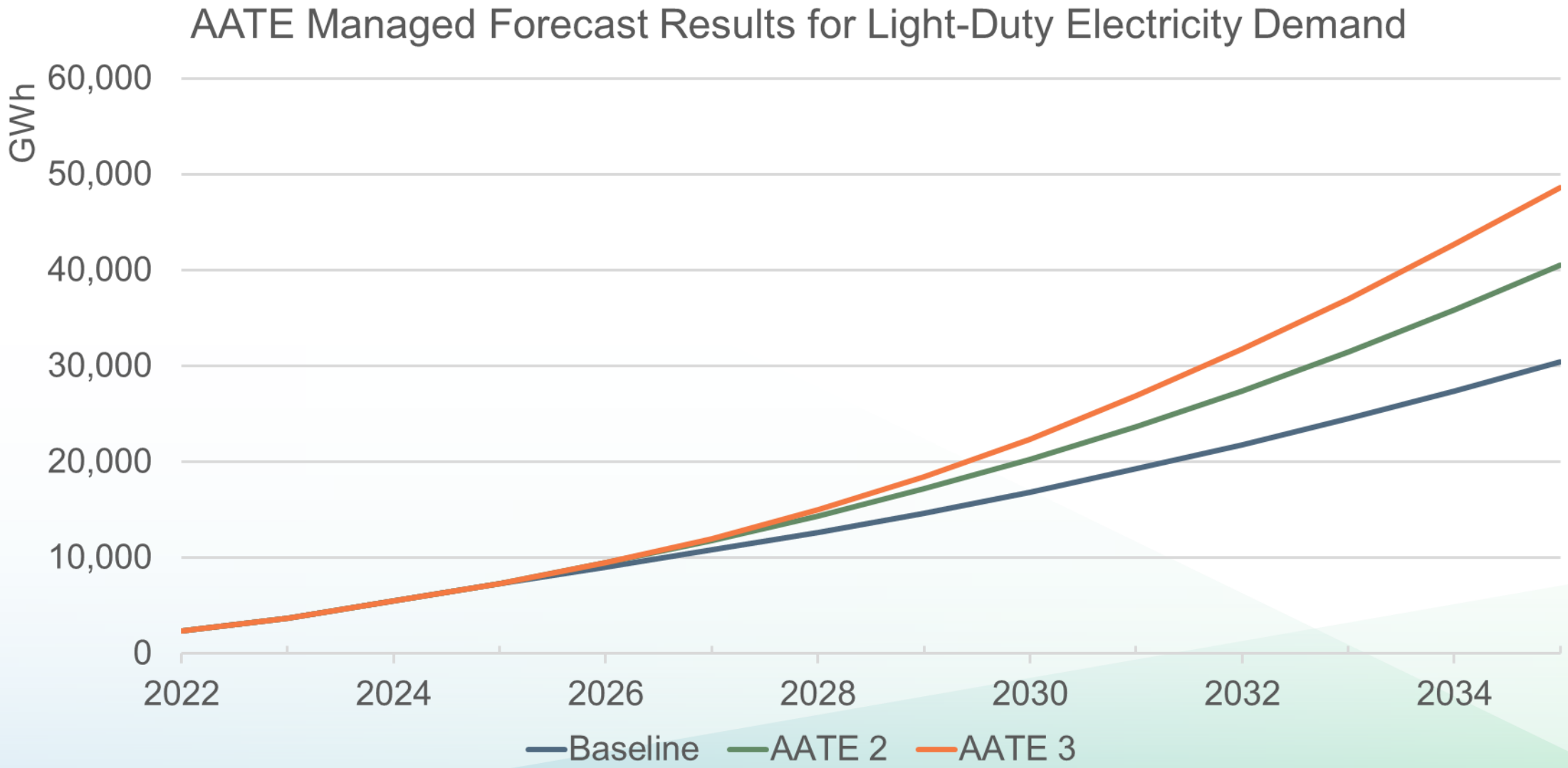
*there are four major ZEV fuel types, and many combustion fuel types. This example is simplified for illustration.

Light-Duty ZEV Stock: Scenario Comparisons

Year	Base	AATE 2	AATE 3
2022	1.0M	1.0M	1.0M
2025	2.5M	2.5M	2.5M
2030	5.4M	6.4M	7.1M
2035	9.8M	12.7M	15.3M



Light-Duty Electricity Demand: Scenario Comparisons



Regional Light-Duty PEV Population Forecast (AATE3)

Liz Pham

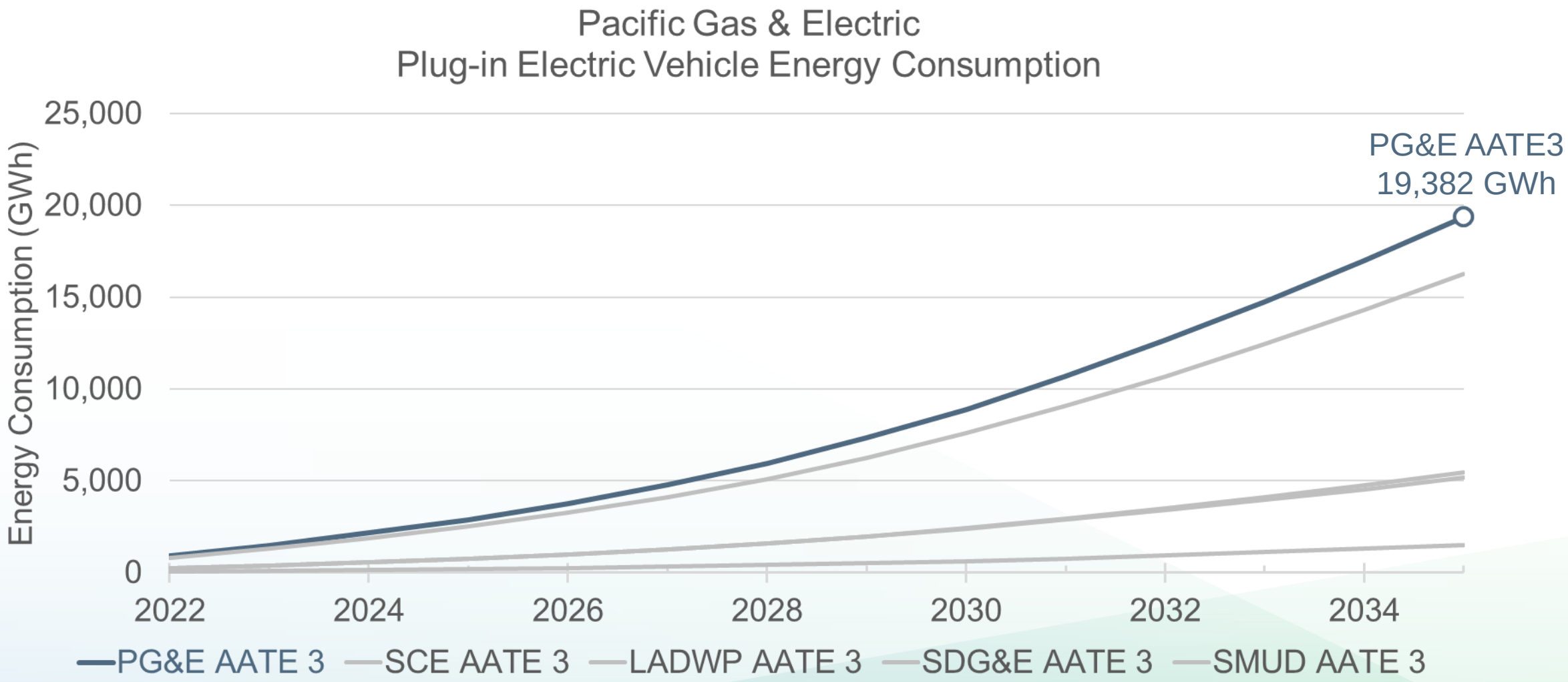
BEV, PHEV and PHFCV Stock by Utility

AATE 3 Scenario, Thousands of Vehicles

Utility Region	2021	2025	2030	2035
LADWP	81	250	750	1,700
PG&E	330	1,000	2,900	6,300
SCE	290	840	2,300	4,900
SDG&E	83	250	710	1,500
SMUD	24	69	210	500
Others	18	52	130	270
Total	**830**	**2,500**	**7,000**	**15,000**

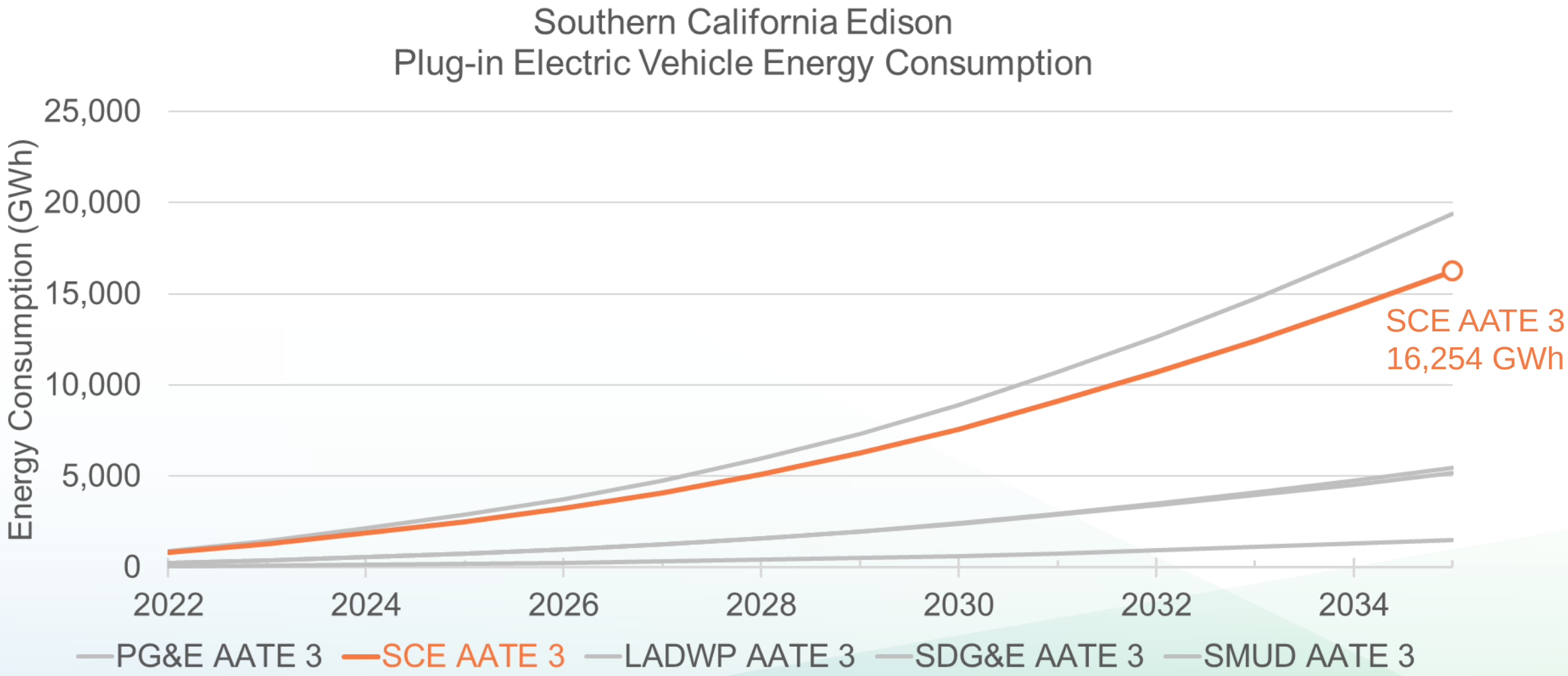
Regional Light-Duty PEV Energy Forecast (AATE3)

Light-Duty PEV Energy Forecast: Pacific Gas & Electric



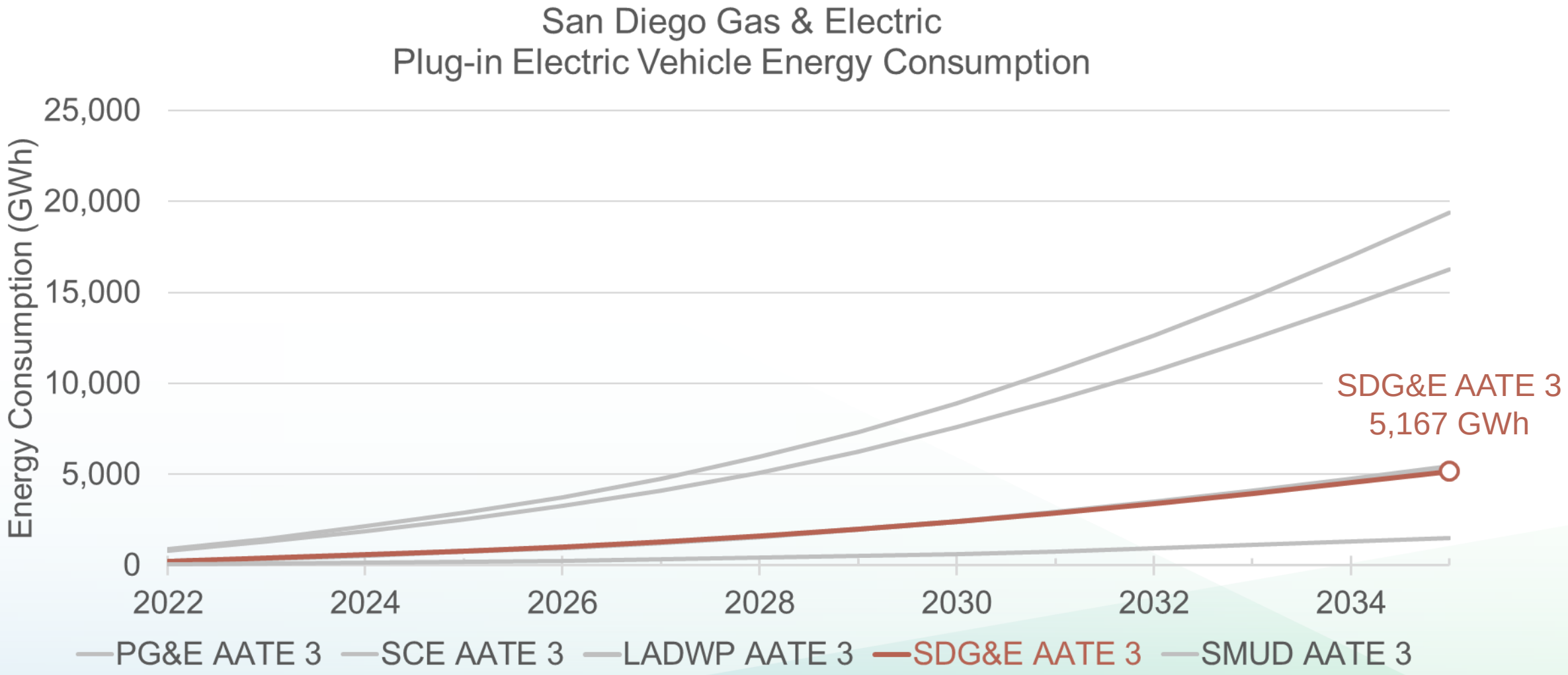
Source: Energy Commission Staff Analysis

Light-Duty PEV Energy Forecast: Southern California Edison



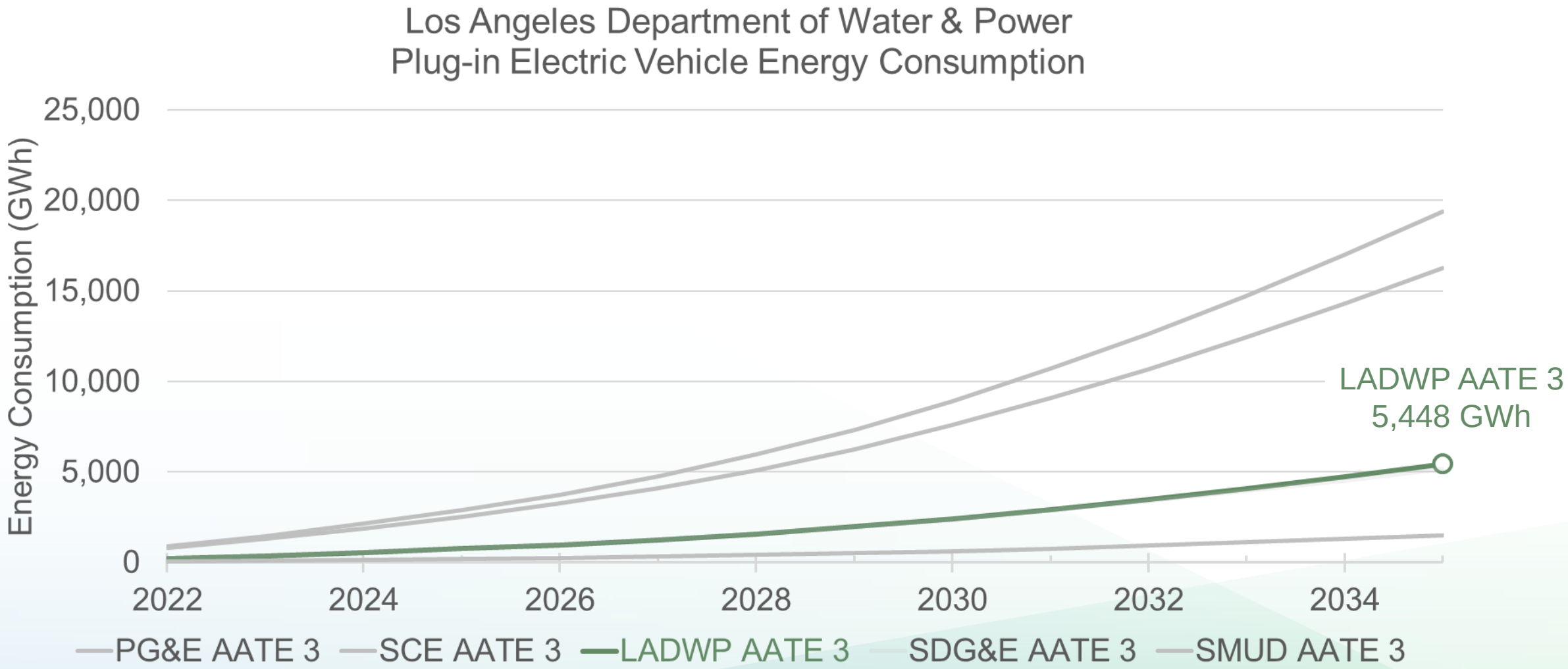
Source: Energy Commission Staff Analysis

Light-Duty PEV Energy Forecast: San Diego Gas & Electric



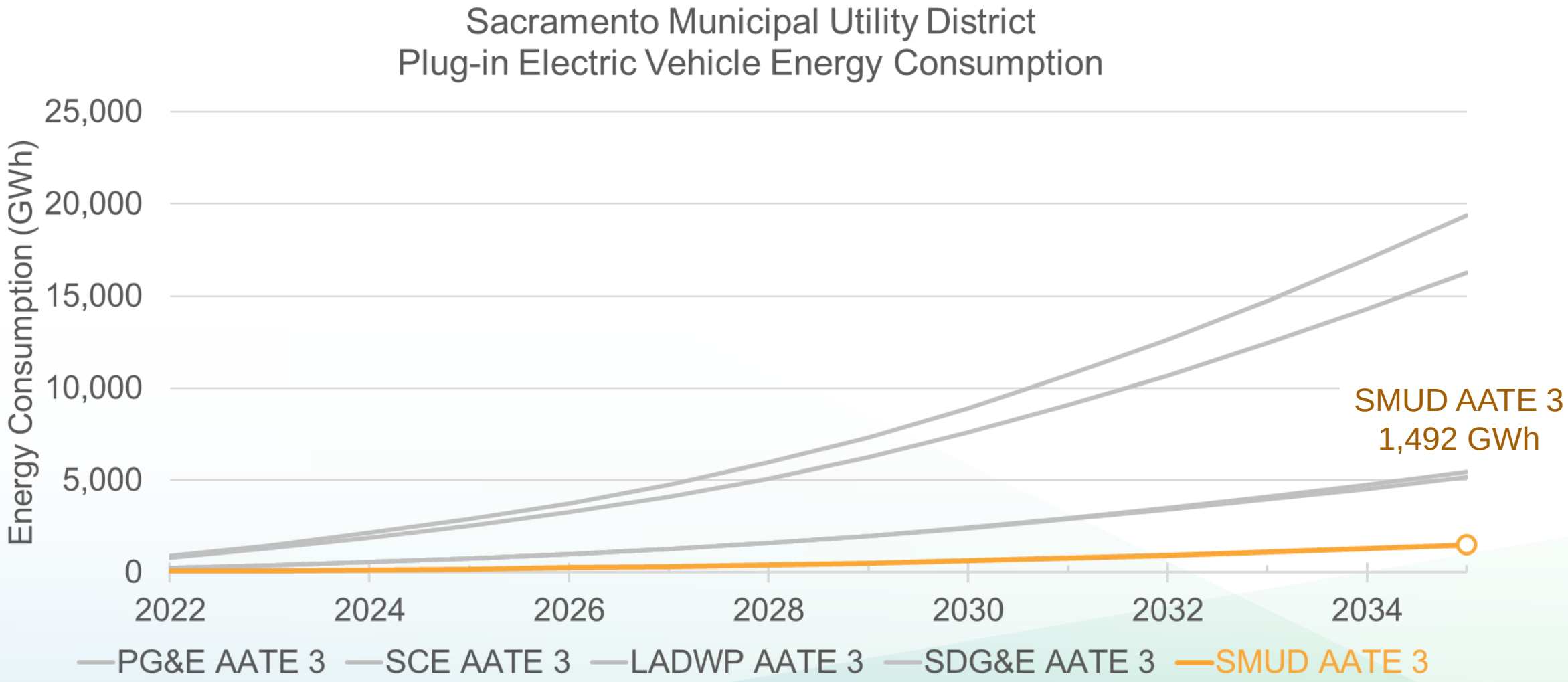
Source: Energy Commission Staff Analysis

Light-Duty PEV Energy Forecast: Los Angeles Department of Water & Power



Source: Energy Commission Staff Analysis

Light-Duty PEV Energy Forecast: Sacramento Municipal Utility District



Source: Energy Commission Staff Analysis

Medium- and Heavy-Duty AATE

Bob McBride

Maggie Deng

AATE and Baseline Zero-Emission Truck Inputs and Assumptions

Input/Assumption	Baseline	AATE 2	AATE 3
CARB Regulations	Advanced Clean Trucks (ACT), other existing rules	Advanced Clean Trucks, other existing rules	Advanced Clean Fleets, ACT, and other existing rules
Regional Regulations	SCAQMD Truck and Bus rules	Implicit for refuse trucks and urban transit buses	Same as MID Case
HVIP (all years)	Voucher amounts scaled to incremental truck price	Same as Baseline	Same as Baseline
Inflation Reduction Act	$7,500 for Class 3 and $40,000 for Classes 6 and 7	Same as Baseline	Same as Baseline
Hydrogen Price	NREL mid price	NREL mid price	NREL mid price
Electricity Rates	Commercial Rates, Mid	Commercial Rates, Mid	Commercial Rates, Mid
BEV Truck Prices given battery pack price in 2035	BEV prices based on battery price $488/kWh in 2021, declines to $73/kWh in 2035	Baseline truck prices plus 5%	Same as Baseline
Miles Per Gallon (conventional / alternative)	Same as Mid for IEPR 2021, based on ICF(2021) and KGD(2019)	Same as Baseline	Same as Baseline

Additional Achievable Transportation Electrification: Medium- and Heavy-Duty Trucks

AATE 2

Based on baseline scenario with:

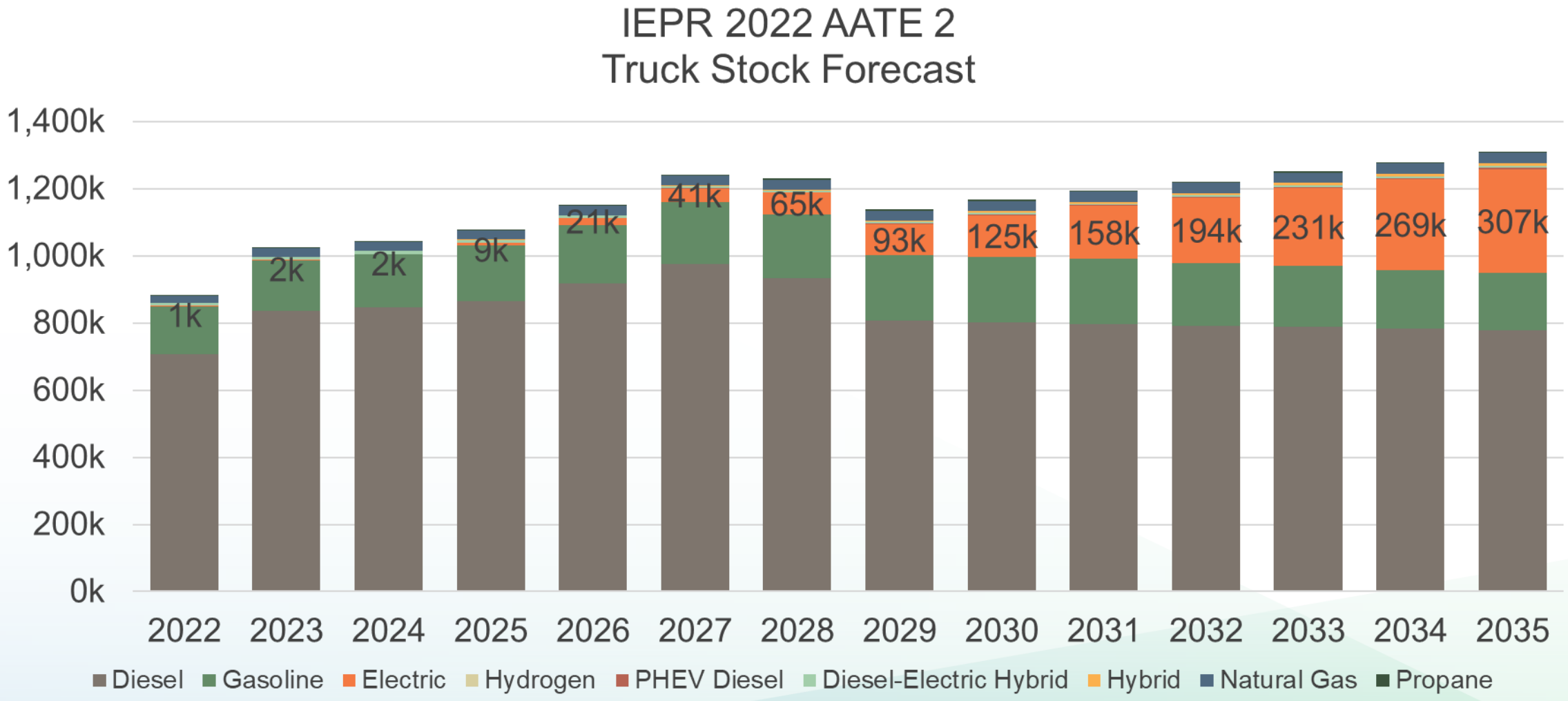
- High case truck prices
- Truck survival rate calculated from CARB ACF data

AATE 3

Based on CARB ACF scenario (ACT and ACF) with:

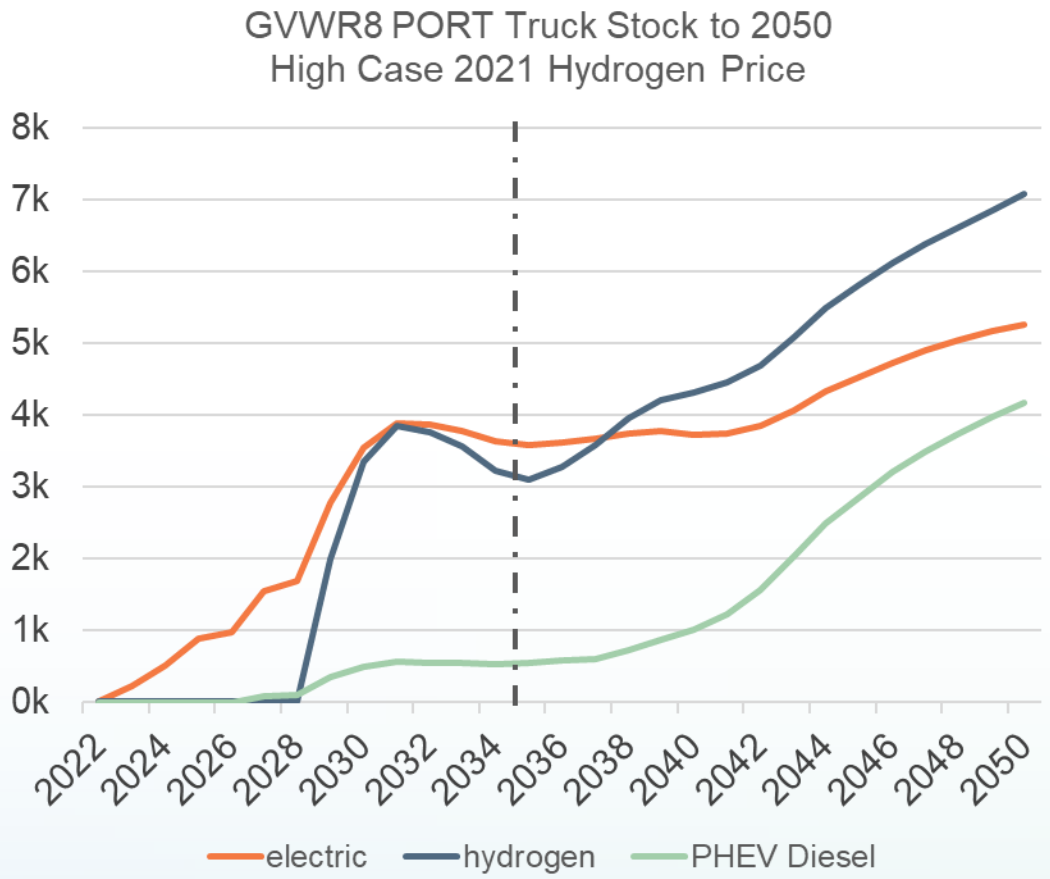
- CARB ACF ZEV percentage outcome
  - AATE 3 applies maximum ZEV share between CARB ACF scenario and CEC's Truck Choice and Freight Model
- CARB data disaggregated to CEC fuel type shares using baseline forecast
- Truck survival rate calculated from CARB ACF data

AATE 2 Truck Stock

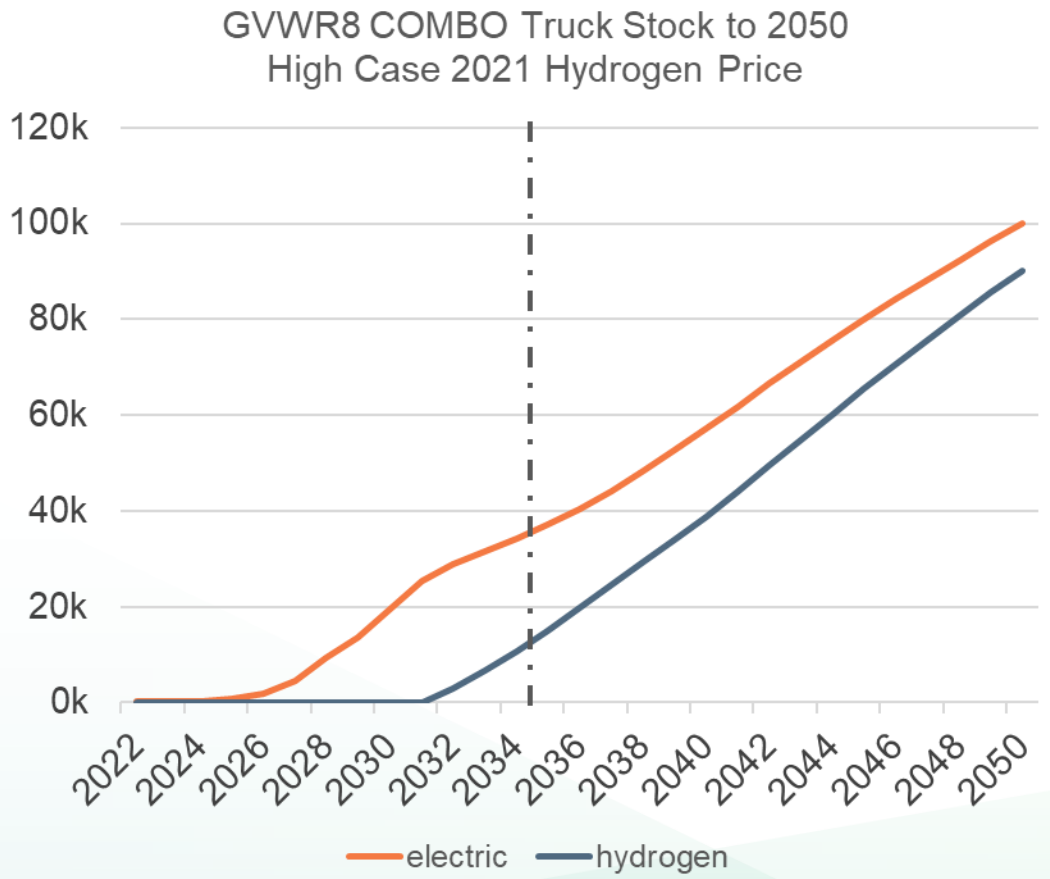


Source: California Energy Commission staff

AATE 2 Fuel Price Experiment Using IEPR 2021 High Case Hydrogen Price

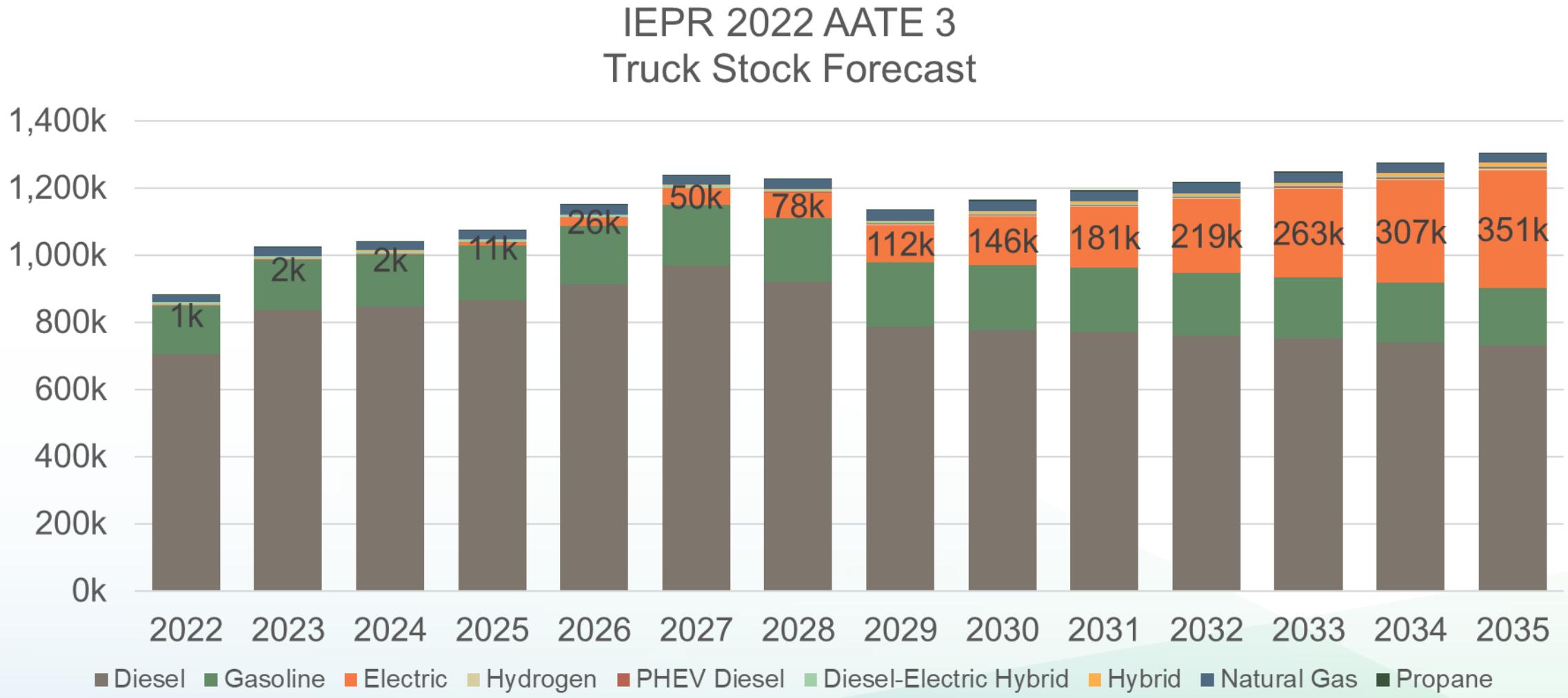


Source: California Energy Commission staff analysis



Source: California Energy Commission staff analysis

AATE 3 Truck Stock



Source: California Energy Commission staff

Truck Stock Comparison: CEC Forecast and CARB ACF Scenario

Comparison of MDHD GVWR3 to GVWR8 Truck Stock Forecasts

Calendar Year	CARB ACT + ACF Total ZETS	CEC Baseline Total ZETs	AATE 2 Total ZETs	AATE 3 Total ZETs
2024	13,892	2,032	2,104	2,030
2025	25,376	8,146	9,025	10,688
2026	40,466	18,783	21,533	26,776
2027	62,188	36,031	41,433	51,565
2028	84,526	57,684	65,890	79,464
2029	113,341	81,965	94,651	115,888
2030	146,820	107,421	126,872	151,570
2031	185,461	133,810	160,640	186,954
2032	225,802	166,597	196,917	226,175
2033	265,821	201,380	234,369	270,758
2034	311,533	237,572	273,525	314,892
2035	360,109	273,702	313,039	360,342

Source: California Air Resources Board staff and California Energy Commission staff

Transportation Energy Forecasting Team

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Liz Pham
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Thank You!

Questions Via Email

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Appendix

IEPR 2022 Baseline Truck Stock Forecast

Fuel Type	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Diesel	706,120	835,921	847,678	866,419	919,484	980,561	939,992	819,033	818,291	817,625	814,509	813,552	811,359	810,814
Diesel-Electric Hybrid	7,754	8,942	8,555	7,781	6,994	6,300	5,749	5,392	5,203	5,067	5,063	5,139	5,297	5,518
Electric	1,315	1,509	2,032	8,120	18,679	35,748	57,264	80,947	105,888	131,887	164,234	198,418	233,878	269,015
Gasoline	144,774	151,445	156,295	165,236	175,007	184,115	190,658	195,063	197,571	198,388	193,882	188,075	182,262	176,370
Hybrid	344	368	552	926	1,520	2,210	2,974	3,853	4,825	5,867	6,916	7,925	8,850	9,754
Hydrogen	0	0	0	0	0	0	0	0	58	157	185	190	254	412
Natural Gas	20,565	24,532	25,540	26,247	27,471	29,000	30,015	30,896	31,520	31,956	32,157	32,256	32,116	31,787
PHEV Diesel	0	0	0	26	104	283	420	1,018	1,475	1,766	2,178	2,772	3,440	4,275
Propane	2,422	2,444	2,445	2,454	2,604	2,884	3,109	3,272	3,396	3,495	3,559	3,602	3,595	3,569
Total Stock	883,294	1,025,162	1,043,096	1,077,209	1,151,864	1,241,100	1,230,180	1,139,474	1,168,227	1,196,209	1,222,683	1,251,931	1,281,051	1,311,513