DOCKETED	
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Project Title:	Electricity and Natural Gas Demand Forecast
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Document Title:	Revised Transportation Energy Demand Forecast
Description:	Transportation Forecast Presentations by: Mark Palmere, Bob McBride and Aniss Bahreinian of CEC
Filer:	Raquel Kravitz
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Docketed Date:	12/2/2019

Revised Transportation Energy Demand Forecast

IEPR Workshop on Revised California Energy Demand Forecast

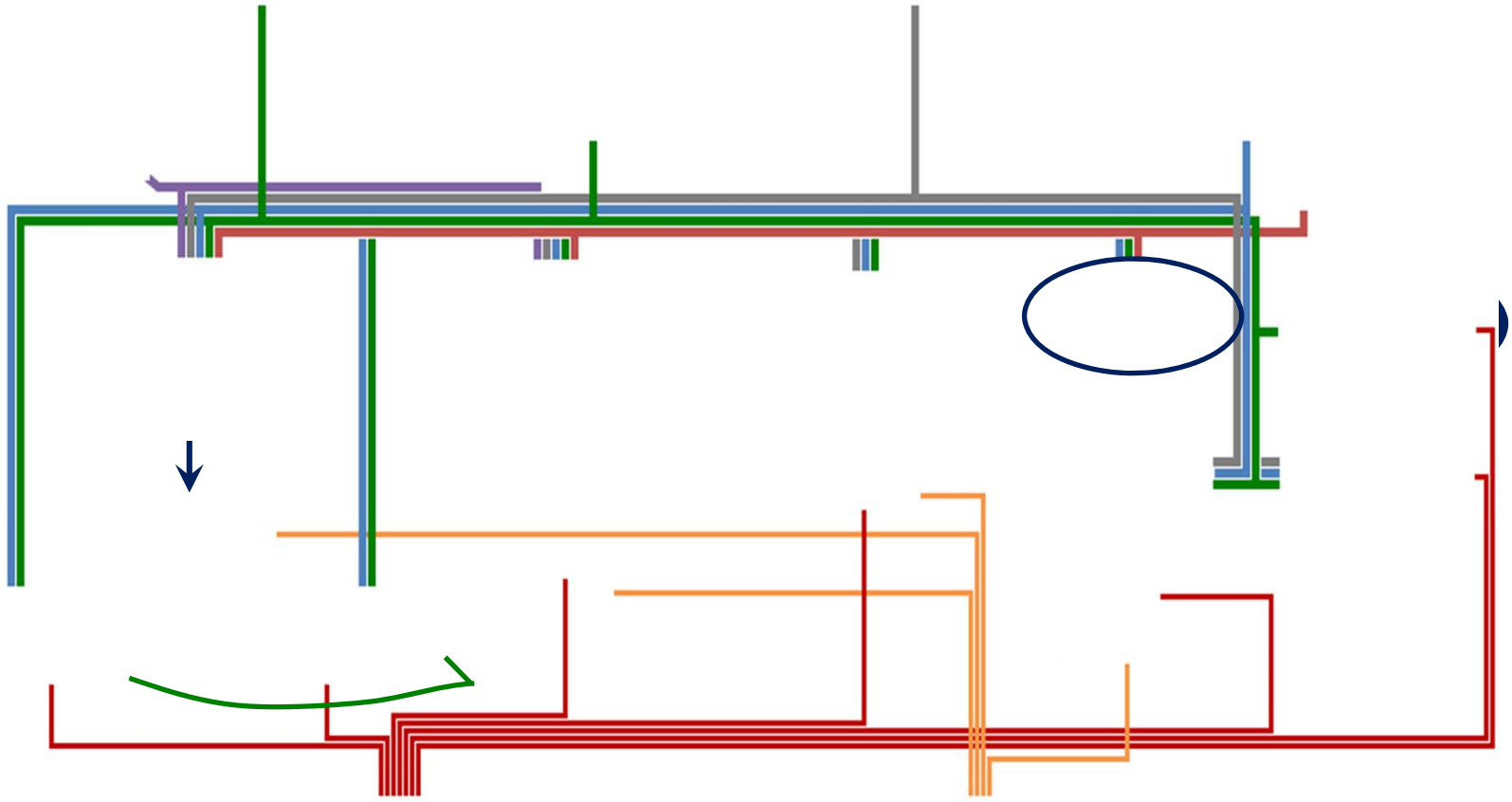
December 2, 2019

Transportation Energy Forecasting Unit
Demand Analysis Office
Energy Assessments Division

Presentation Outline

- Light duty vehicles
- Medium and heavy duty vehicles
- Overall fuel consumption

Transportation Energy Demand Forecasting Models



Transportation Energy Demand *(forecast)*

(forecast)

Transportation Energy Demand Modeling Uses both Base Year and Projected Inputs

Base year (2017) values

- Vehicle stock by sector, size class and fuel type (DMV, CARB's 2017 EMFAC, NTD, Staff)
- Household type distribution (2017 ACS, Staff)
- Fuel consumption (BOE, Staff)
- VMT (Caltrans, 2017 NHTS, 2017 CalVIUS, Staff)

Projected Inputs (2018-2030)

- Economic & Demographic data (Moody's, DOF, Staff)
- Energy prices (EIA, Staff)
- Vehicle attributes (Contractor, Staff)
- Transit & School Bus Population (Clean transit regulations, Staff)

Transportation Demand Forecasting Scenarios are Electricity-Based

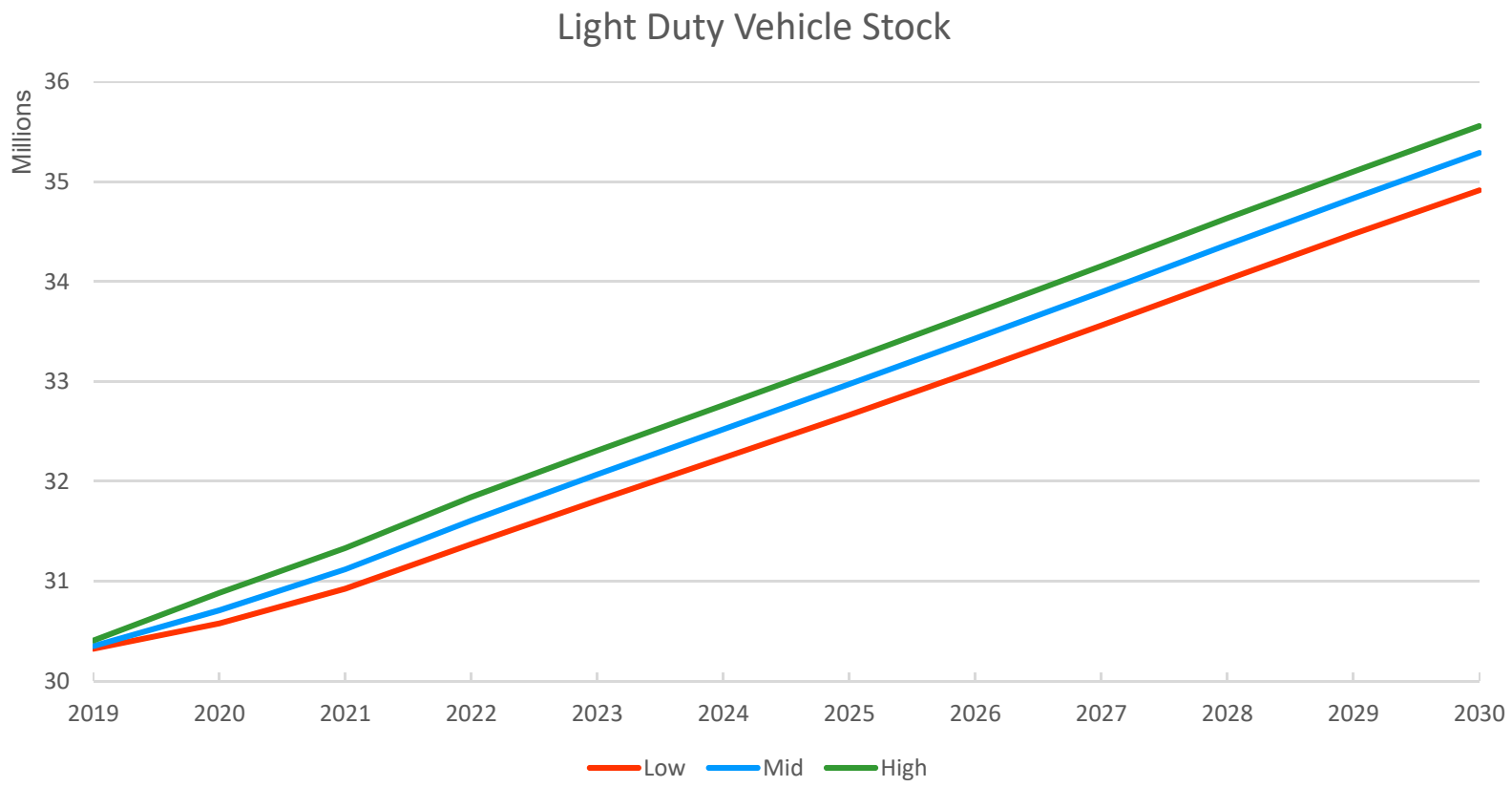
Demand Case	Population Growth	Income Growth	Fuel Prices	
			Petroleum Fuels	Electricity Natural Gas Hydrogen
High Demand	High	High	High	Low
Mid Demand	Mid	Mid	Mid	Mid
Low Demand	Low	Low	Low	High

LIGHT DUTY VEHICLES

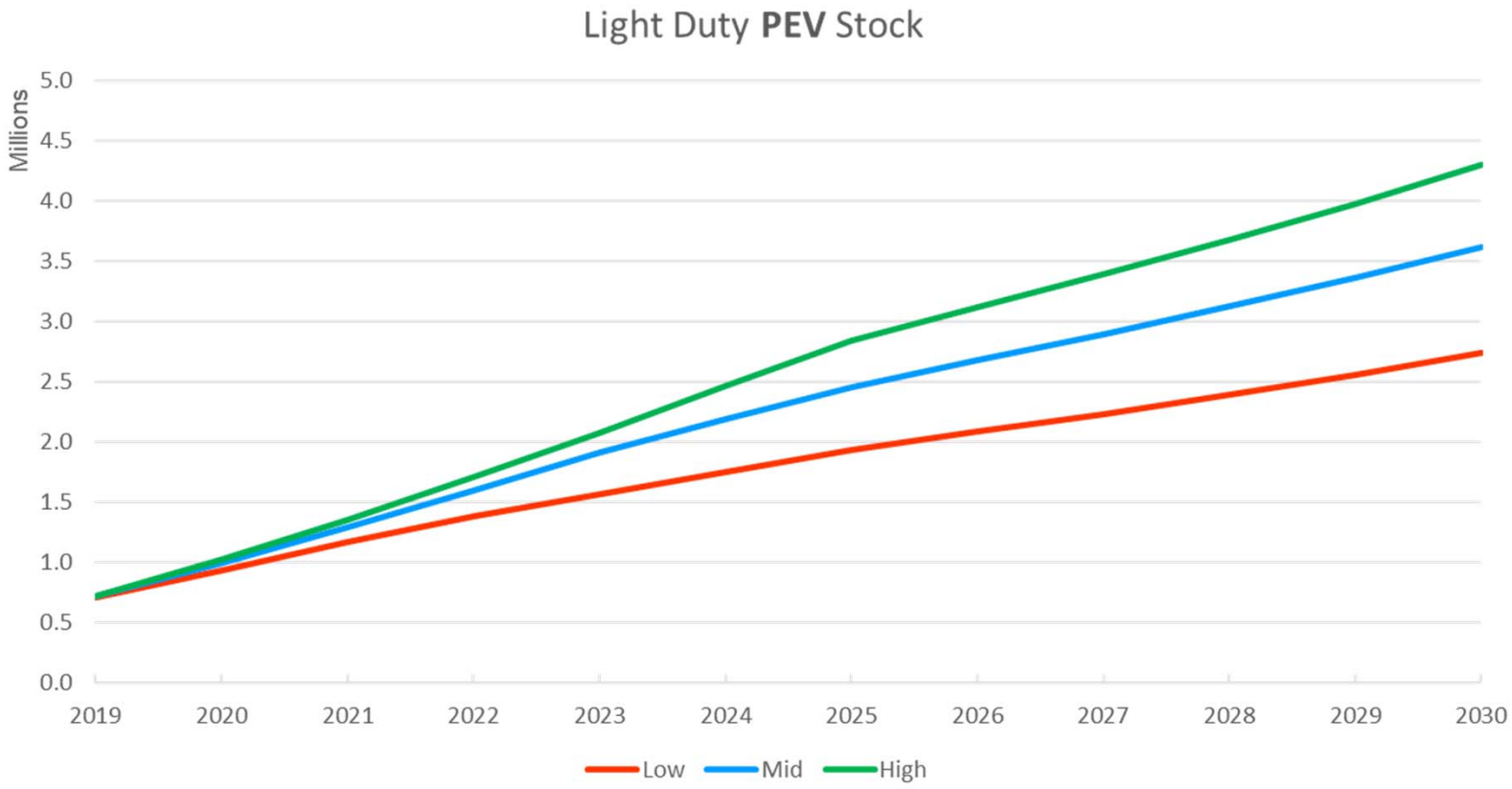
2019 IEPR Light Duty PEV Scenarios Reflect a Range of Possible Futures

	ZEV SCENARIOS, 2019				
INPUTS	**Low**	**Reference**	**High**	**Aggressive**	**Bookend**
PREFERENCES					
Consumers' ZEV Preference	Constant at 2017 Level	Increase with ZEV market growth	Increase with ZEV market growth	Increase with ZEV market growth	Increase with ZEV market growth
INCENTIVES					
Federal Tax Credit	Decreasing starting 2019, Eliminated after 2022	Decreasing starting 2019	Decreasing starting 2019	Decreasing starting 2019	Decreasing starting 2019
State Rebate	To 2025	To 2025	To 2025	To 2030 for BEV/FCV	To 2030 for BEV/FCV
HOV Lane Access	To 2021	To 2023	To 2025	To 2025 for PHEV, to 2030 for BEV/FCV	To 2025 for PHEV, to 2030 for BEV/FCV
ATTRIBUTES					
Availability (in 2030)	Models available in 11 of 15 BEV and 13 of 15 PHEV classes	Models available in 12 of 15 BEV and 14 of 15 PHEV classes	Models available in 14 of 15 BEV and 14 of 15 PHEV classes	Models available in 15 of 15 BEV and 14 of 15 PHEV classes	Models available: BEV in 15, PHEV in 14, FCV in 11, PHFCV in 6 CEC LDV classes
Vehicle / Battery Price (by 2030)	ZEV prices based on battery price declining to **~$120/kWh**	ZEV prices based on battery price declining to **~$100/kWh**	ZEV prices based on battery price declining to **~$80/kWh**	ZEV prices based on battery price declining to **~$70/kWh**	ZEV prices based on battery price declining to **~$62/kWh**
Max Range (Midsize, 2030)	~312 miles	~312 miles	~313 miles	~313 miles	~313 miles
Refuel Time (2030)	15 -21 min	15 -21 min	10-16 min	10-16 min	10-16 min
Time to Station (2030)	7-8 min	Same as gasoline	Same as gasoline	Same as gasoline by 2025	Same as gasoline by 2025
FORECAST RESULTS					
2030 ZEV Population	2.7 million	3.7 million	4.4 million	5.2 million	5.6 million

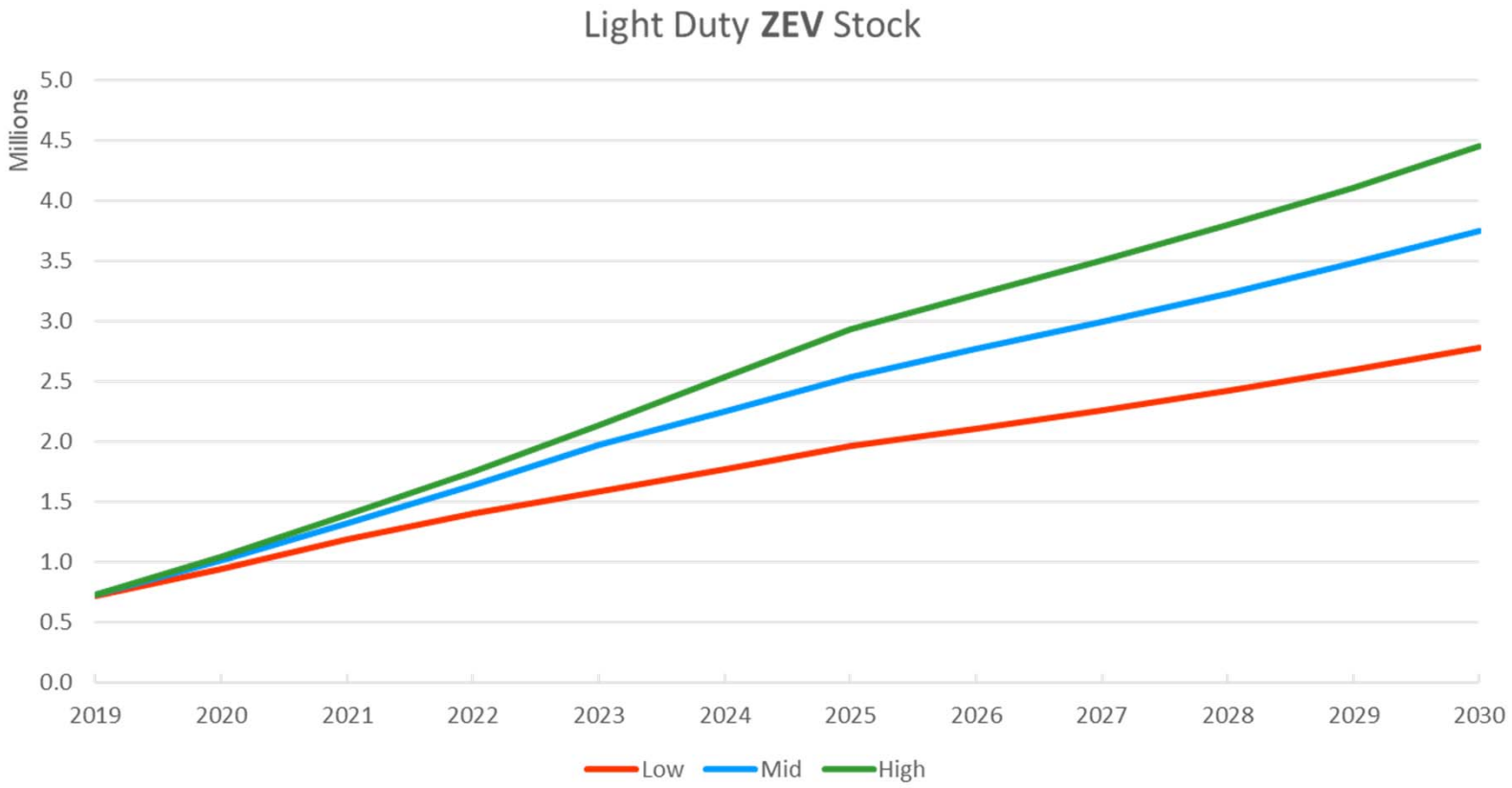
Total LDV Stock Increases With Income and Population



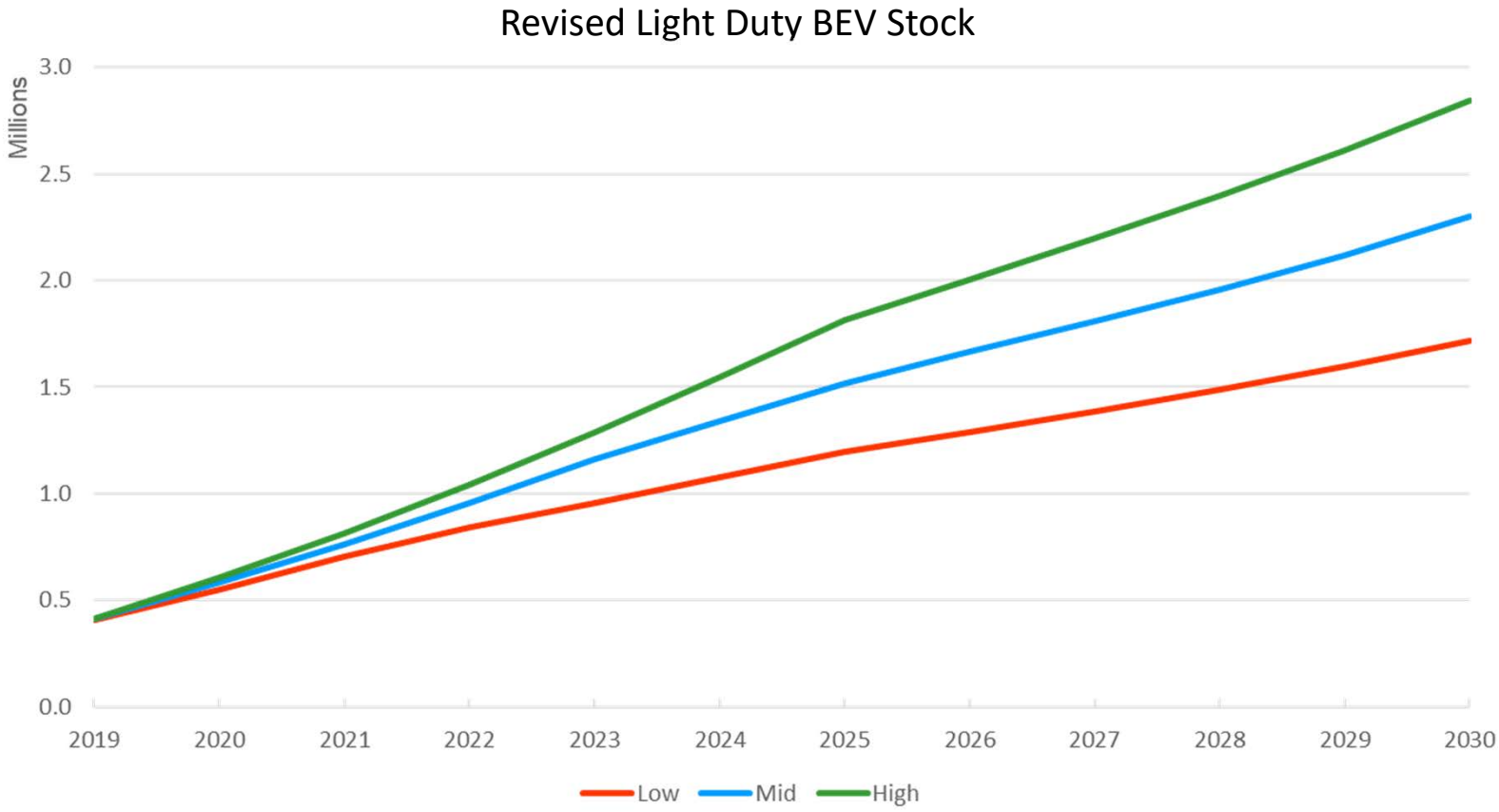
ZEV and PEV Penetration is Forecast to Rise Significantly



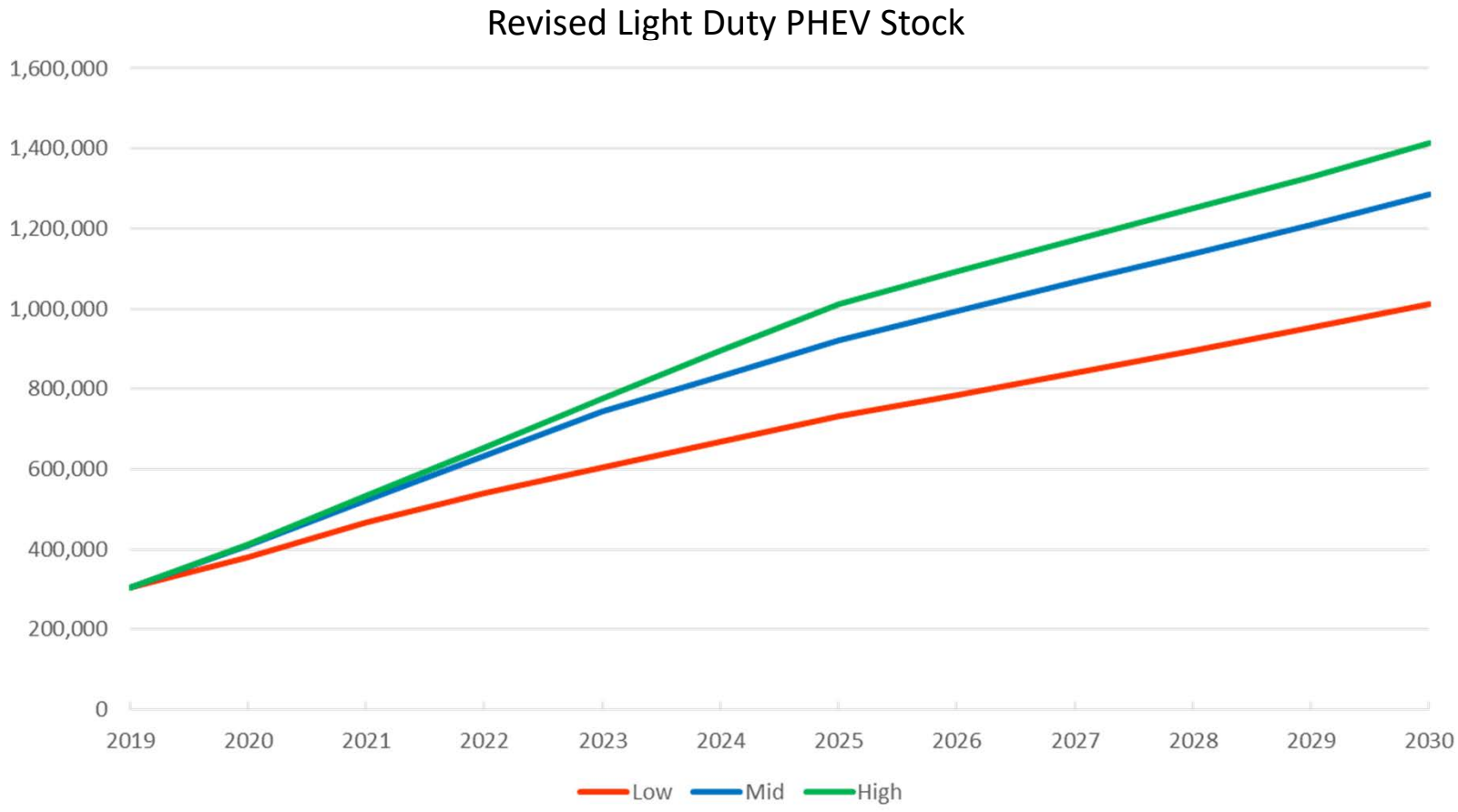
ZEV and PEV Penetration is Forecast to Rise Significantly



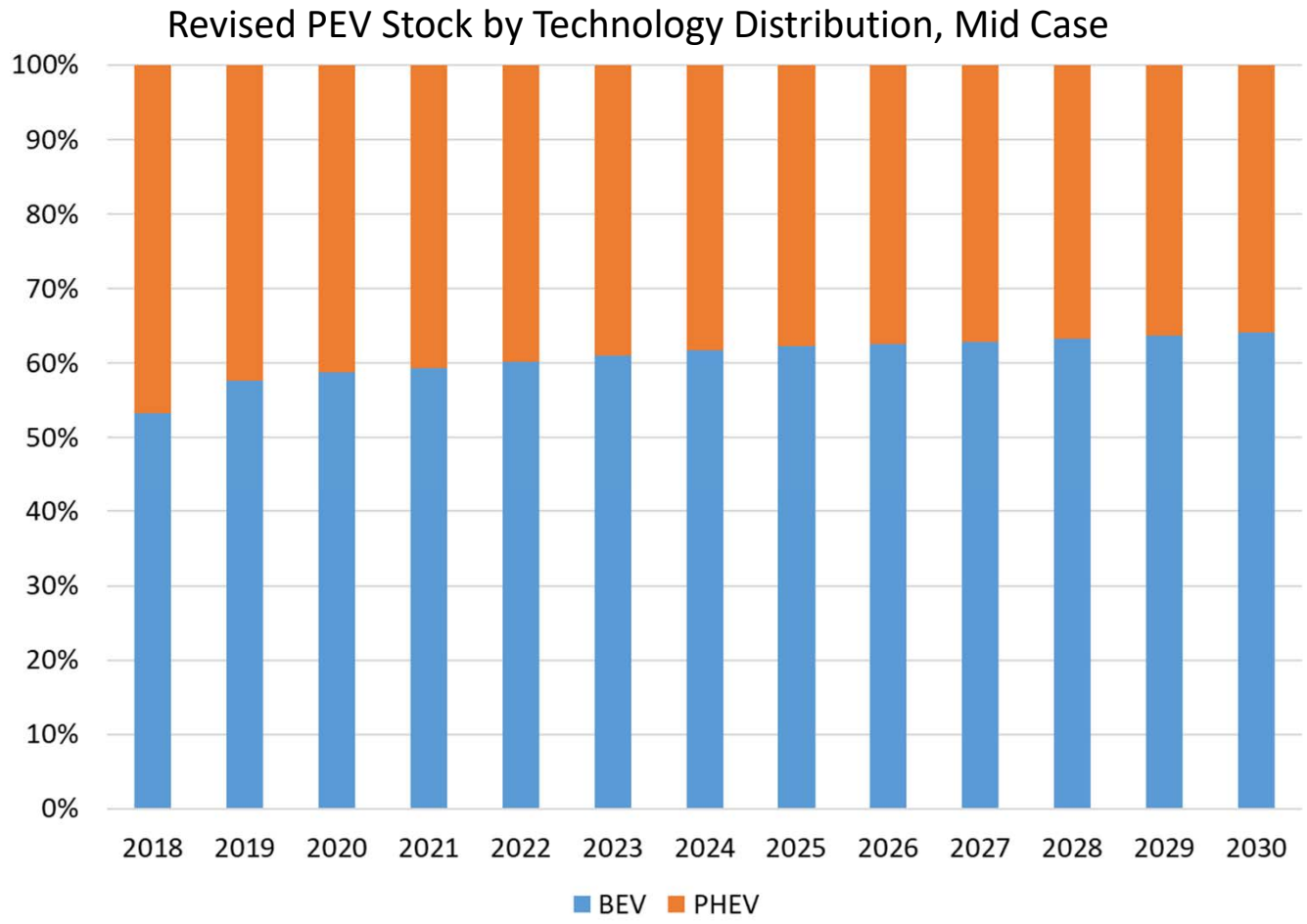
BEV Stock Increases to as High as Ten Percent of Total Vehicle Stock



PHEV Stock Grows Significantly, but at a Slower Rate than BEVs

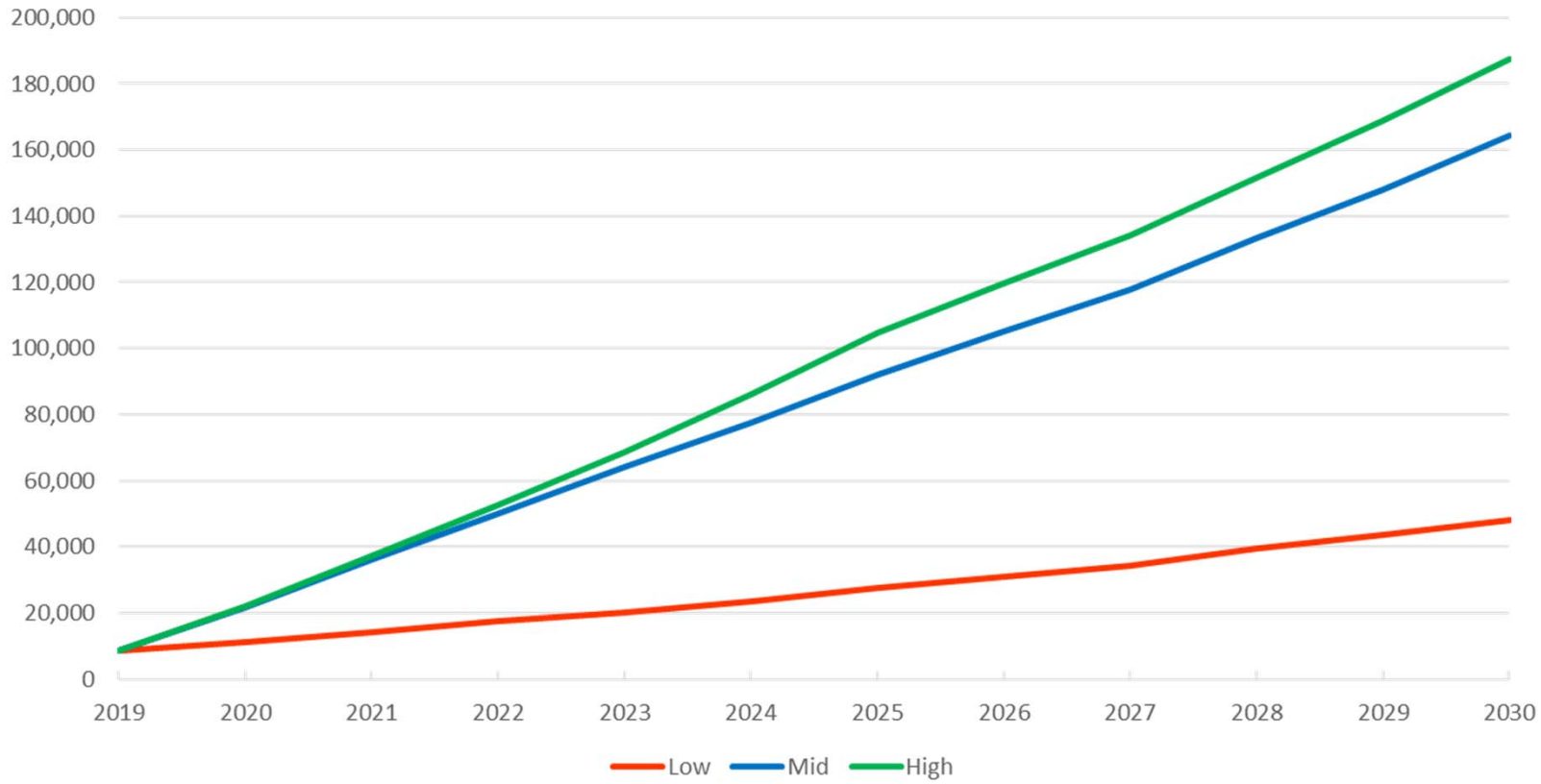


BEVs Continue to Overtake PHEVs in Popularity During Forecast



Fuel Cell Vehicle Stock Shows Significant Growth in Mid and High Cases

Revised Light Duty FCEV Stock

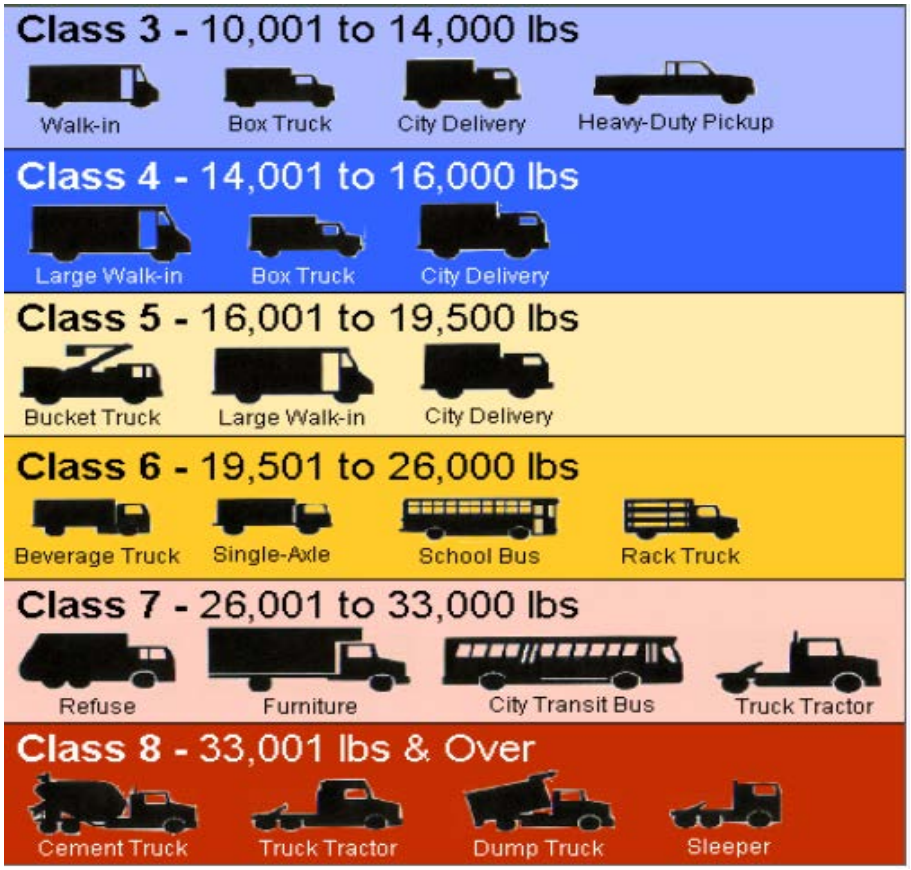


MEDIUM AND HEAVY DUTY VEHICLES

Outline

- Overview of ZEV MHD Truck Scenarios
- Transit, airport shuttle, and school buses
- Trucks
  - Data changed from preliminary truck forecast
  - Incentive assumptions for trucks vary by scenario
  - MHD truck market share analysis
  - Purchases
  - ZEV MHD truck purchases and counts

MHD Vehicle Classes



2019 MHD Truck Scenarios

INPUTS	Low	Mid	High
CALIFORNIA REGULATIONS			
CARB Regulations	Applied to urban transit bus and shuttle bus, implicit for current truck rules		
INCENTIVES			
HVIP (through 2021)	99% of current HVIP voucher percentage of vehicle incremental cost*		
HVIP (from 2022 on)	No Incentives	80% of the above	Same as above
ATTRIBUTES			
Battery Pack Price (MHD vehicle, in 2030)**	MHD BET prices based on battery price declining to **~$158/kWh**	BEV prices based on battery price declining to **~$131/kWh**	BEV prices based on battery price declining to **~$106/kWh**
MPG	Low	Mid/High	Mid/High
Truck Range of Operation	For classes 3 to 6, purchased trucks with typical trips under 100 miles can choose battery-electric; for in-state tractor-trailers, trips within the Urban regions are given this choice		
FORECAST			
Battery electric stock in 2030	**11,977**	**77,345**	**100,221**
Catenary Electric Stock in 2030	**262**	**624**	**5,294**
Hydrogen fuel cell stock in 2030	**365**	**389**	**13,356**
Total ZEV stock 2030	**12,604**	**78,358**	**118,871**

*** -- incremental cost is the difference between the purchased truck and the least expensive truck in the class**

**** -- MHD battery price assumed about 30% higher than LDV battery, due to cost of built-in resilience to more intensive drive cycles**

Transit, Airport Shuttles, and School Buses, High Case

- ZEV transit and airport shuttle buses are based on regulations
- ZEV school buses are based on funding availability

ZEV Bus Population in 2030	
Transit Buses	3,964
Airport Shuttles	730
School Buses	2,305

MEDIUM- AND HEAVY-DUTY TRUCKS

Changes in Revised MHD Forecast

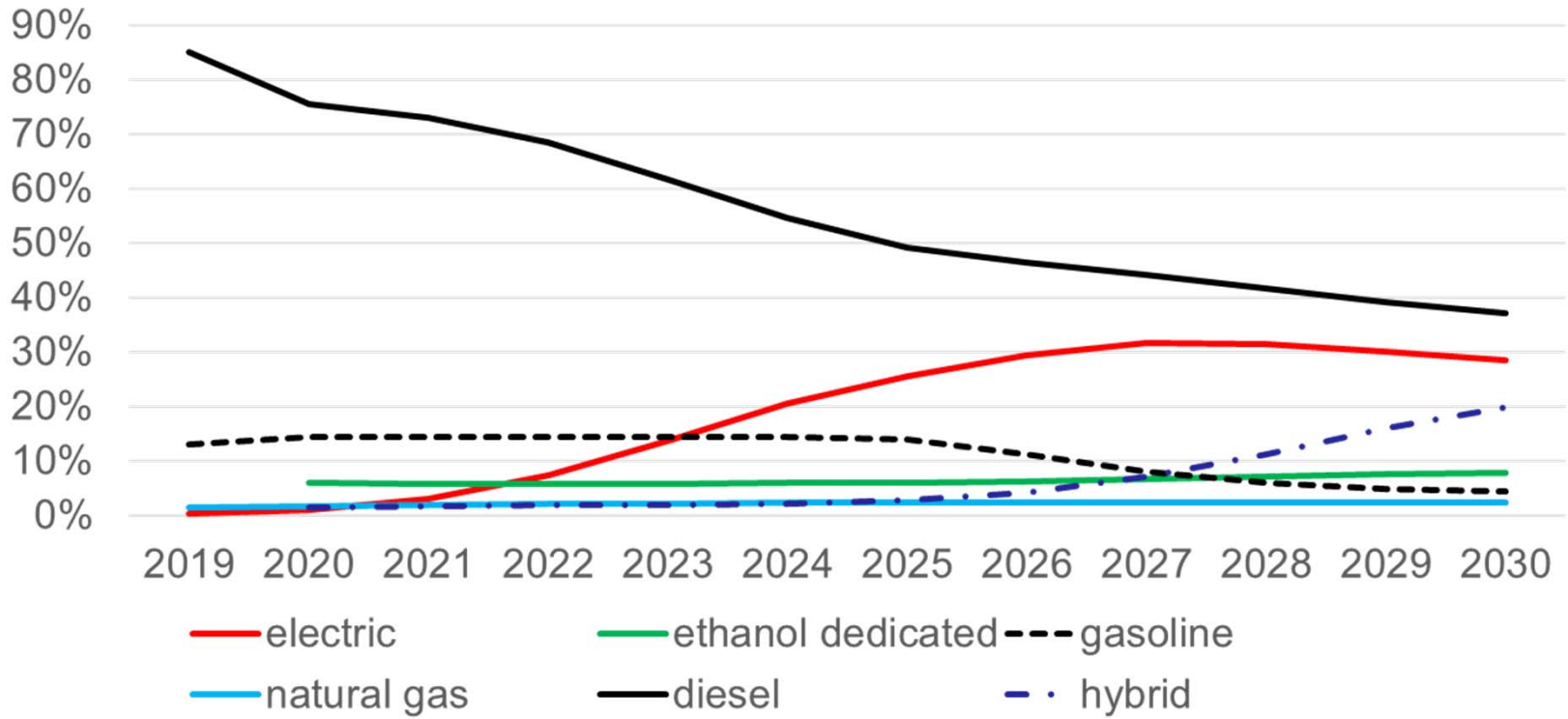
- Reduced the battery cell prices for battery-electric trucks by assuming the price is 30% higher than LDV battery cell price
- Fleets choosing a fuel technology for new trucks now consider a higher annual VMT, making alternative fuels more likely
- Truck retirement by age is now three distinct cases
- Hydrogen fuel is changed from the commercial retail price to a dedicated fleet price for the high demand case
  - Higher station utilization by dedicated fleets
  - Lower tank pressure for large trucks

MHD Incentives Assumed for Revised Forecast

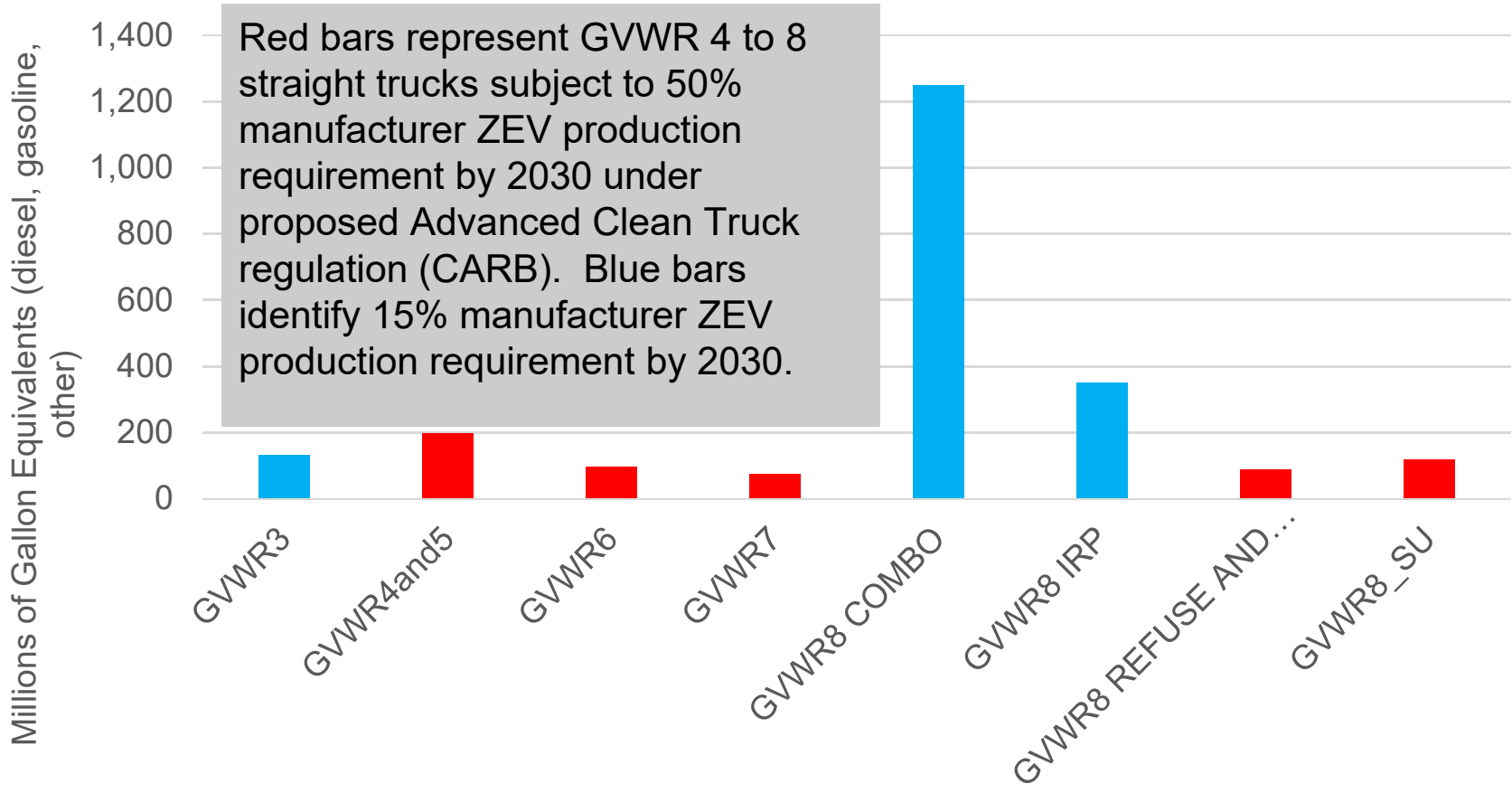
- Using CARB's recent* HVIP voucher through 2021, which is a percent of the truck's incremental cost
  - Covers ZEV, natural gas, and diesel-electric hybrid*
  - Varies by fuel and truck class: ZEV near 100%, low NOx lower
  - Assumes funding is available for all purchases through 2021
- From 2022 - 2030, ZEV voucher is assumed to be:
  - High case: 99% of the incremental cost
  - Mid case: 80% of the recent voucher amount
  - Low case: no incentive

* ARB to discontinue hybrid and Low NOx voucher, except 12 liter Low NOx engine

GVWR 3 Medium-duty Truck & Van Market Share (10,001 to 14,000 pounds gross weight)



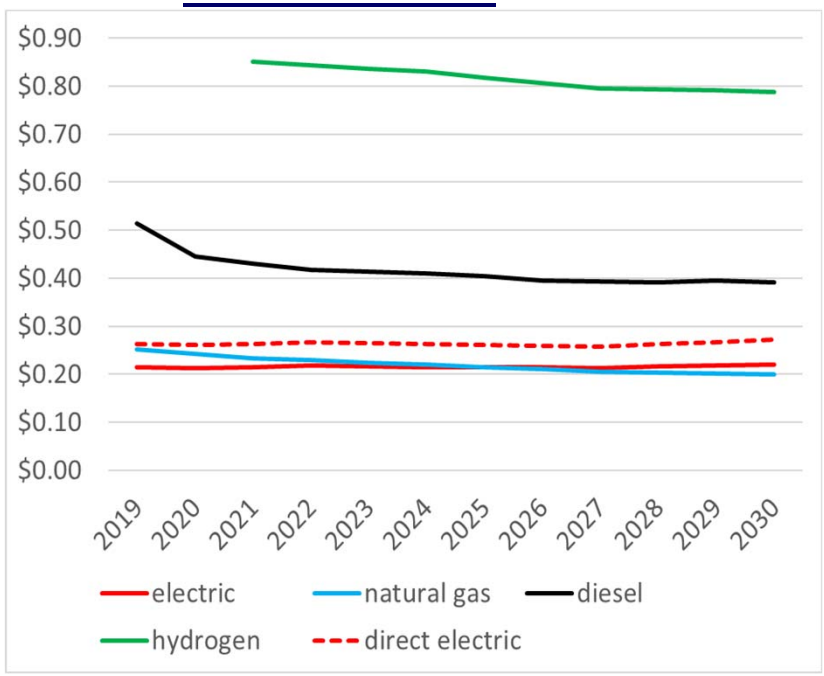
In-state Tractor-trailers Consume the Most California Fuel



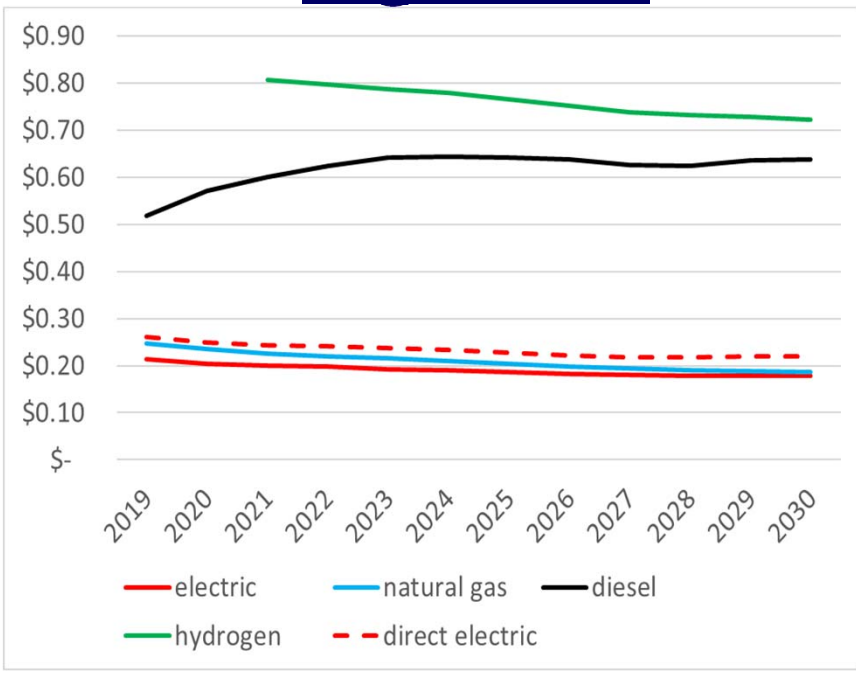
Emerging ZEV Tractor-trailers

Fuel Cost per Mile
Mid and High Cases, In-state Tractor-trailer

Mid Case



High Case



Dedicated Fleets on the Rise? Short or Longer Term Change?

EXHIBIT 1

One-Way vs. Dedicated Truckload Fleet Growth: 2017 to 2018

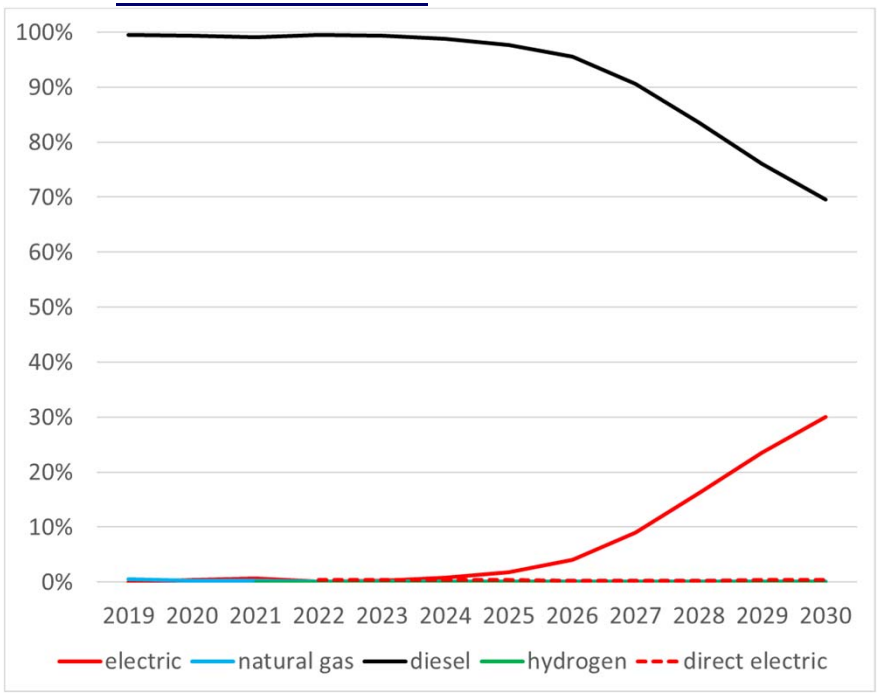
Carrier	One-Way Truckload Average Truck Count 2017	2018	% Change	Dedicated Truckload Average Truck Count 2017	2018	% Change
Marten	1,837	1,613	-12.2%	847	1,088	28.5%
Schneider	7,930	7,651	-3.5%	3,930	3,917	-0.3%
Swift	9,419	7,484	-20.5%	3,089	3,058	-1.0%
U.S. Xpress	3,788	3,562	-6.0%	2,440	2,701	10.7%
Universal Truckload Services	1,950	1,787	-8.4%	960	1,038	8.1%
Werner	3,483	3,345	-4.0%	3,822	4,277	11.9%
Total	28,407	25,442	-10.4% Weighted Average -9.1% Simple Average	15,088	16,079	6.6% Weighted Average 9.6% Simple Average

SOURCE: COMPANY REPORTS
CHART PREPARED BY SJ CONSULTING GROUP INC.

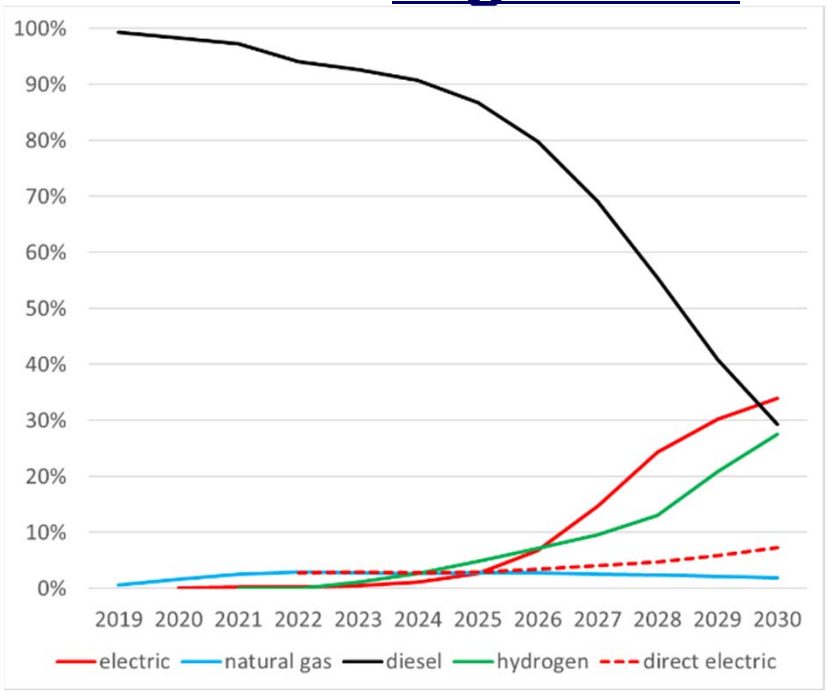
https://www.dcvelocity.com/articles/20190503-the-rise-of-private-fleets--and-dedicated-operations-/

Truck Market Share, In-state Tractor-trailer

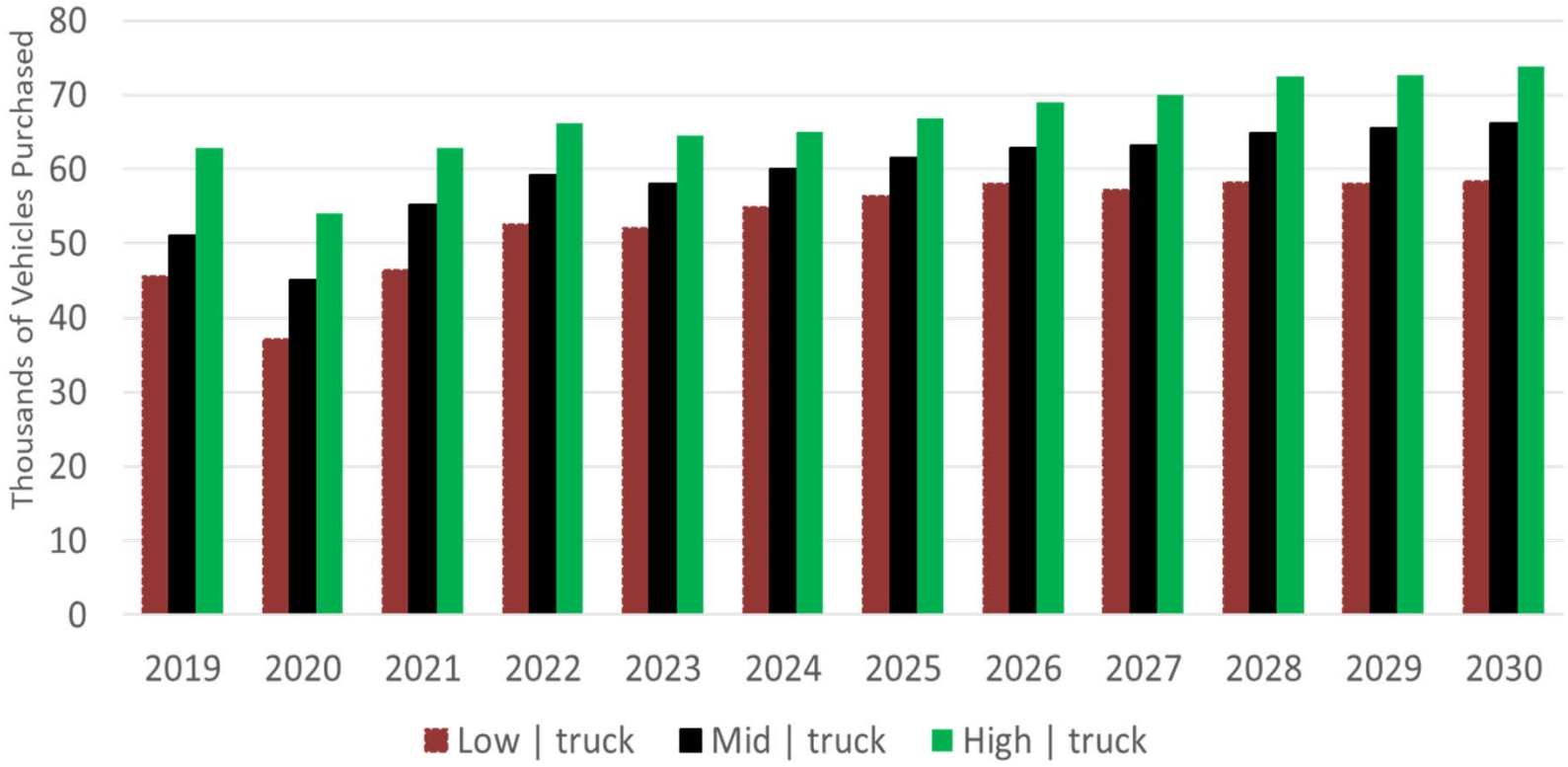
Mid Case



High Case



New MHD Truck Purchases (All Classes)



Freightliner eCascadia and eM2; Volvo VNR Electric

Considering ZEV Tractor-trailer Announced Prices

- We tested prices announced by Nikola and Tesla
  - Battery electric and hydrogen fuel cell trucks would achieve a significant market share at the prices announced for the Tesla Semi and Nikola Two
  - However, there is uncertainty around these announced prices
- We used bottom-up component-based price estimates
- High case incentives cover 99% of incremental cost for ZEV, regardless

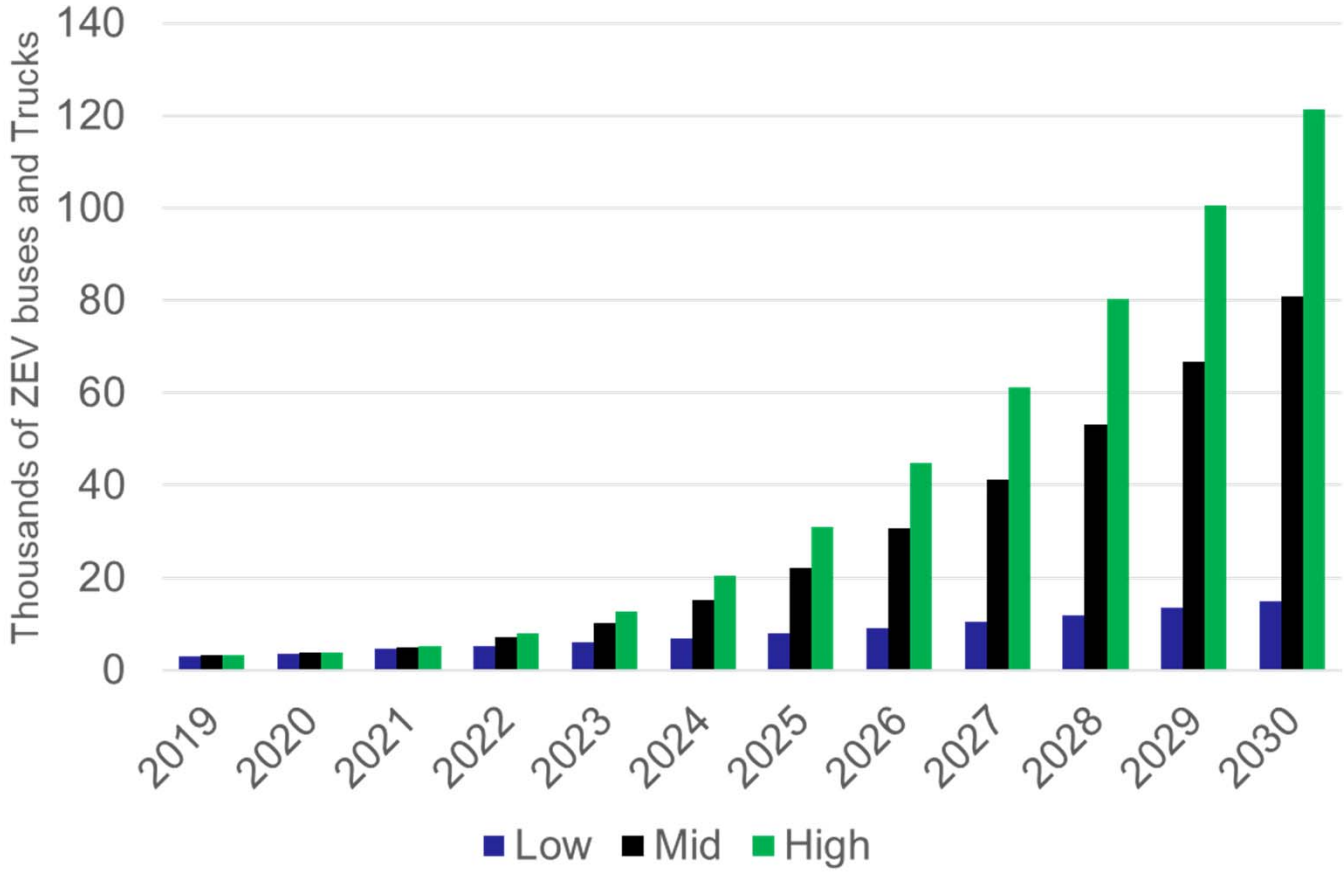
Hydrogen Fuel Cell Tractor-trailer

- Retail hydrogen prices are too high for hydrogen fuel cell to compete with other fuels
- Introduced a high case hydrogen price based on two factors that support a $5 to $7 per Kg price for dedicated fleets:
  - Tank pressure of 5,000 psi instead of 10,000 psi bring savings on tank and compression
  - Dedicated-route fleets can ‘right-size’ each station, increase their utilization
- Nikola Motors plans fleet and fuel station in Los Angeles area in 2021
  - Iveco Truck (European OEM) partnered with Nikola Motors (Sept. 2019)

    “IVECO is a huge global player and this shows, more and more, that Nikola is a serious company,” Antti Lindström, IHS Markit, told Trucks.com.”
- Toyota – Kenworth HFC and Hyundai HD trucks also anticipated

Sources: Nikola Motors; Toyota Motor NA; CA FC Partnership; trucks.com

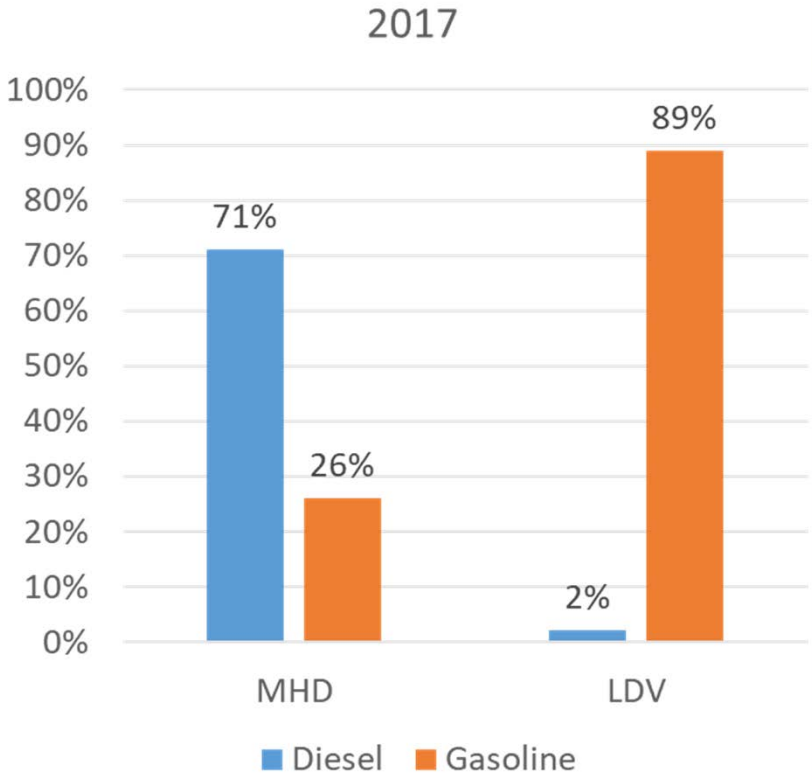
MHD ZEV Stock Forecast



REVISED TRANSPORTATION ENERGY DEMAND

Fuel Types and Vehicle Types

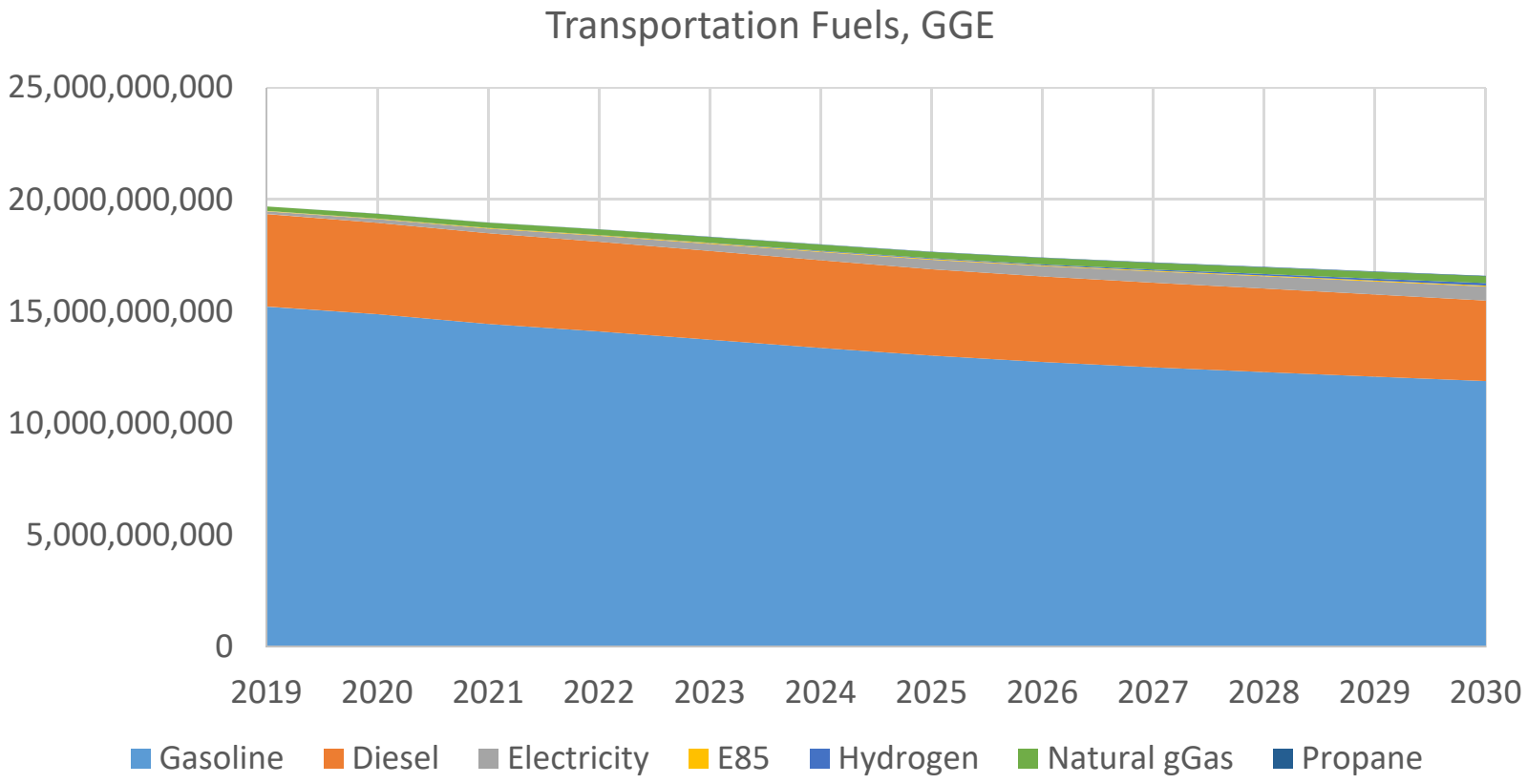
2017 Diesel & Gasoline Share by Vehicle Type



Fuel Types & Vehicle Types

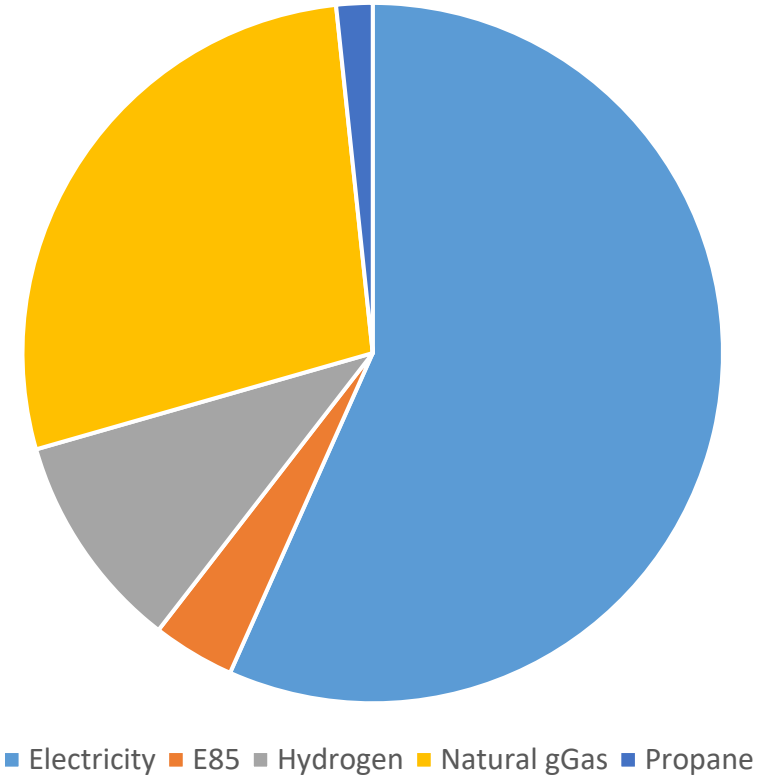
LDV Up to 10,000 lb	MHDV >10,000 lb	Rail
Gasoline	Gasoline	
Gasoline Hybrid	Gasoline Hybrid	
Flex Fuel Vehicle (E85)	Dedicated E85	
Diesel	Diesel	Diesel
	Diesel Hybrid	
BEV	BEV	
PHEV		
	Direct Electric	Direct Electric
FCEV	FCEV	
PHFCV		
	CNG	
	LNG	
	Propane	

Revised High Transportation Fuel Demand Forecast by Fuel Type (Gasoline Gallon Equivalent, or GGE)

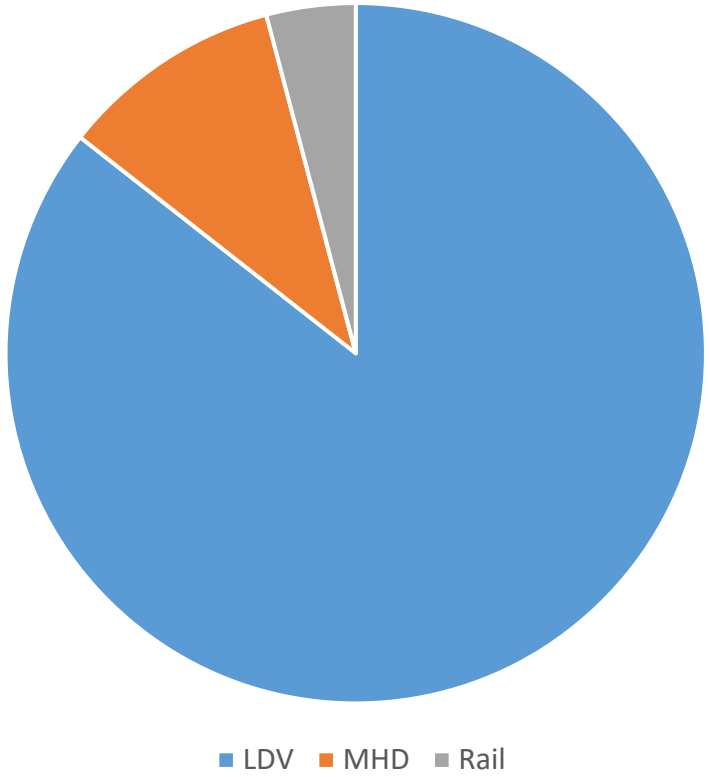


2030 High Demand Forecast

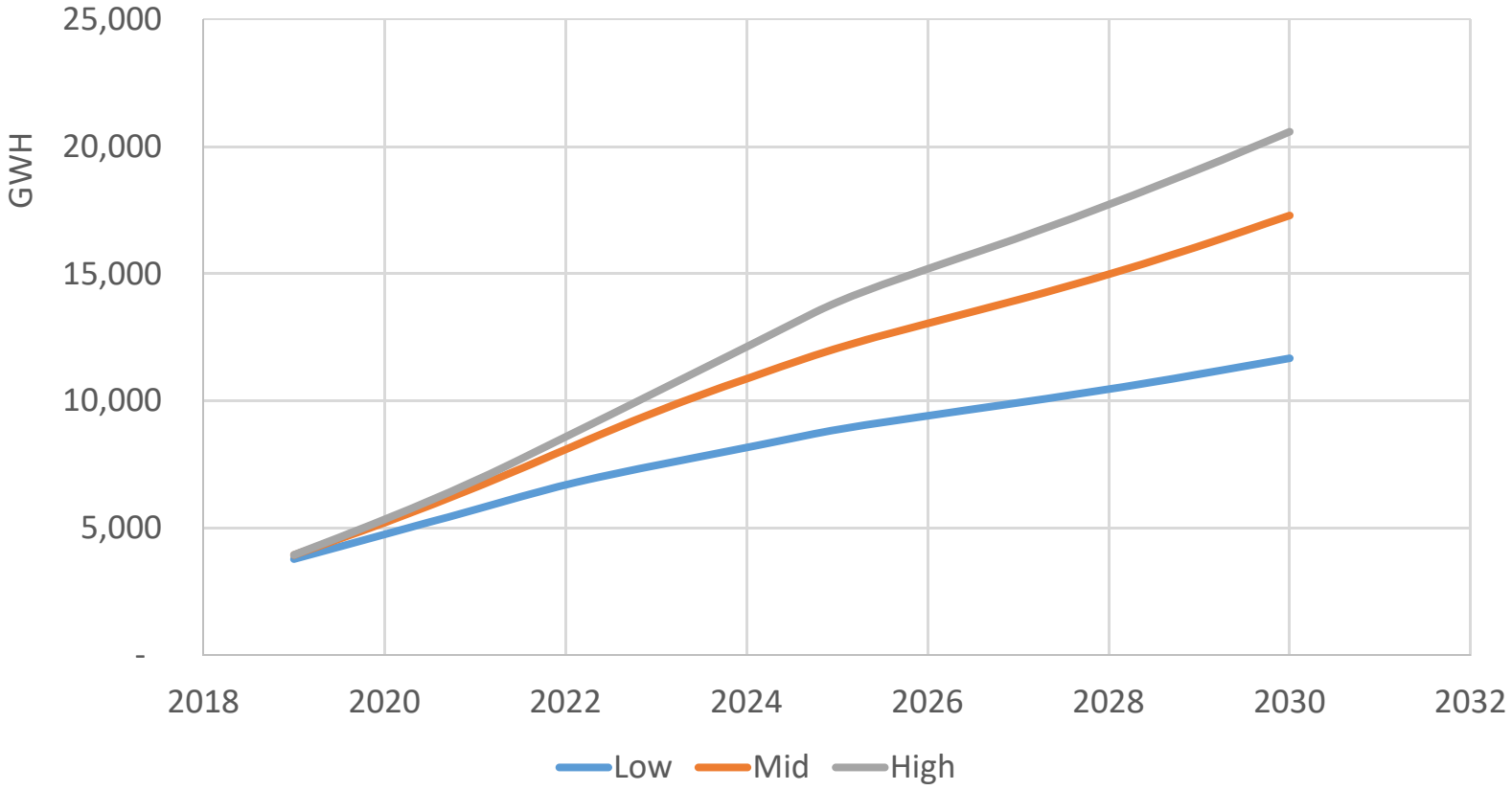
Alternative Fuels by Fuel Type



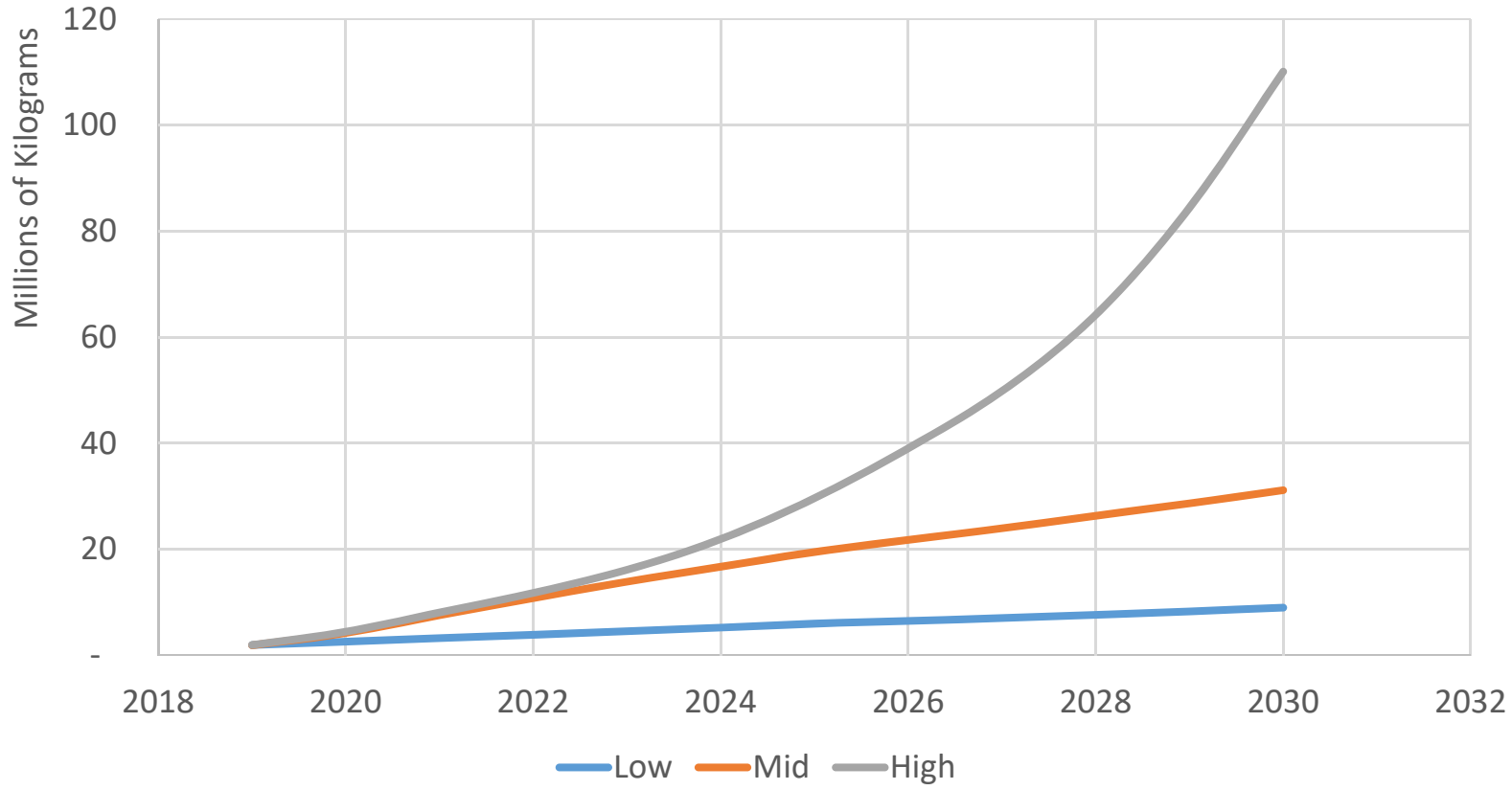
Electricity Demand Distribution by Vehicle Type



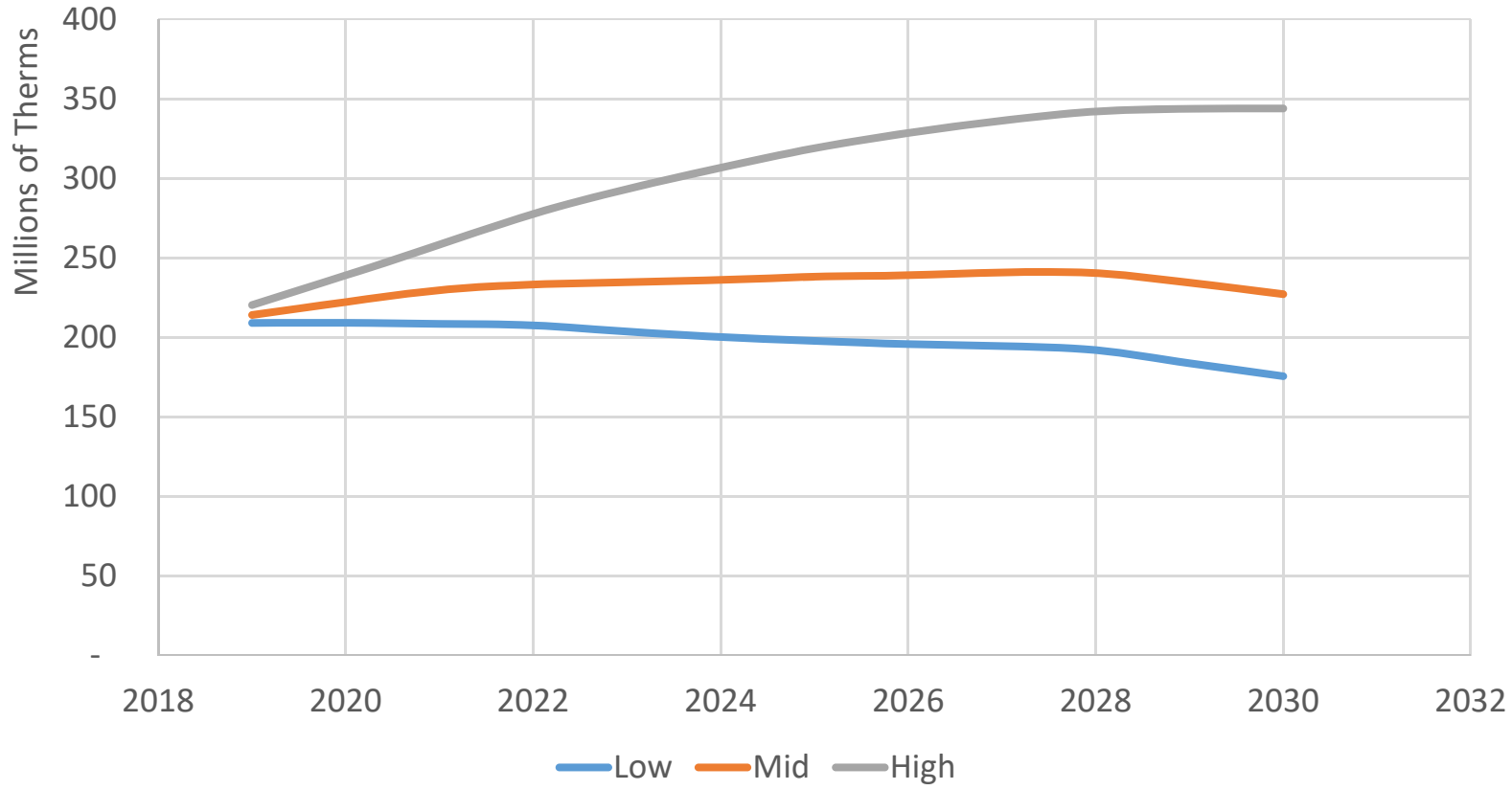
Revised Transportation Electricity Demand Forecast by Scenario



Revised Transportation Hydrogen Demand Forecast



Revised Transportation Natural Gas Demand Forecast



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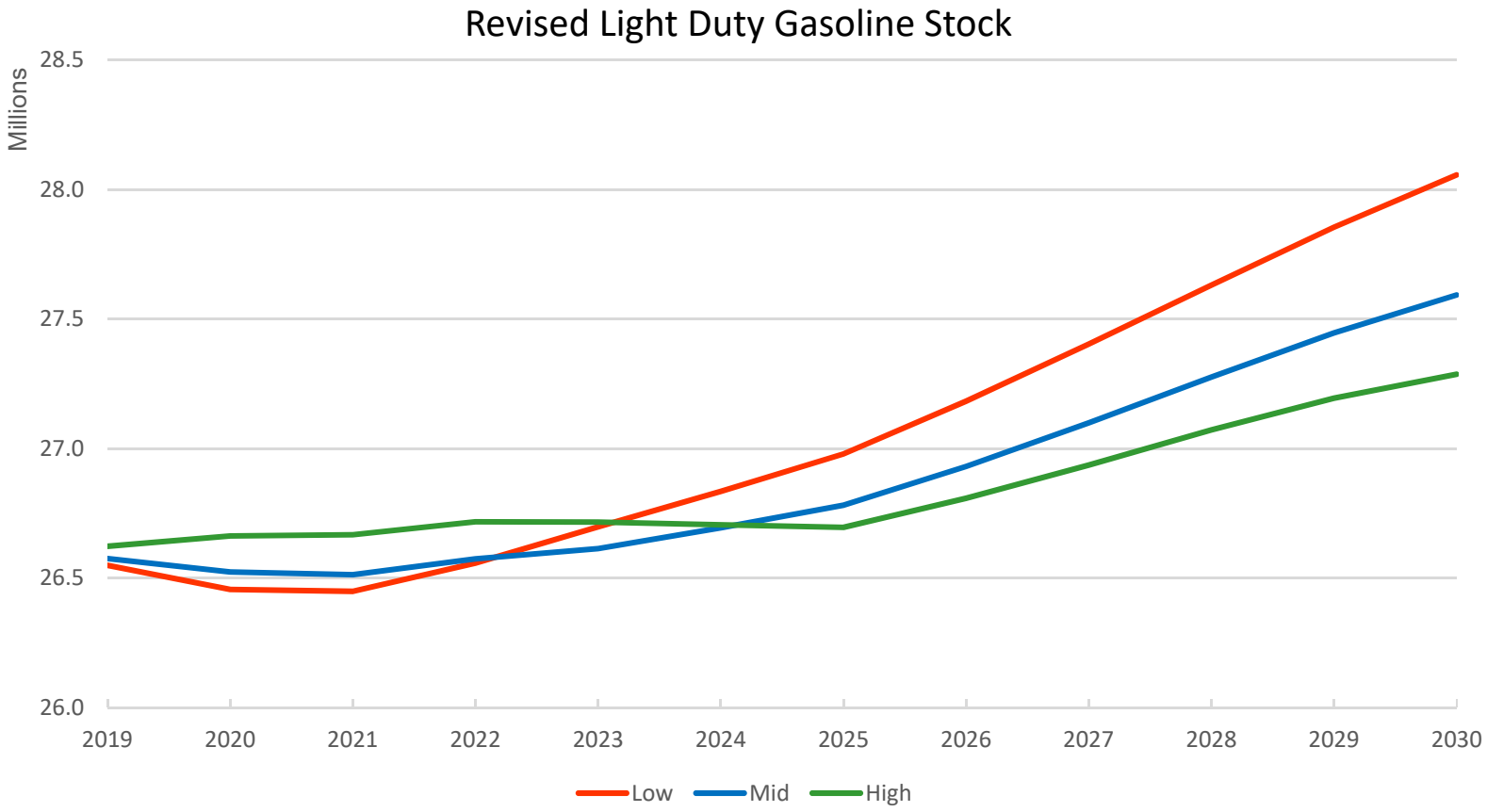
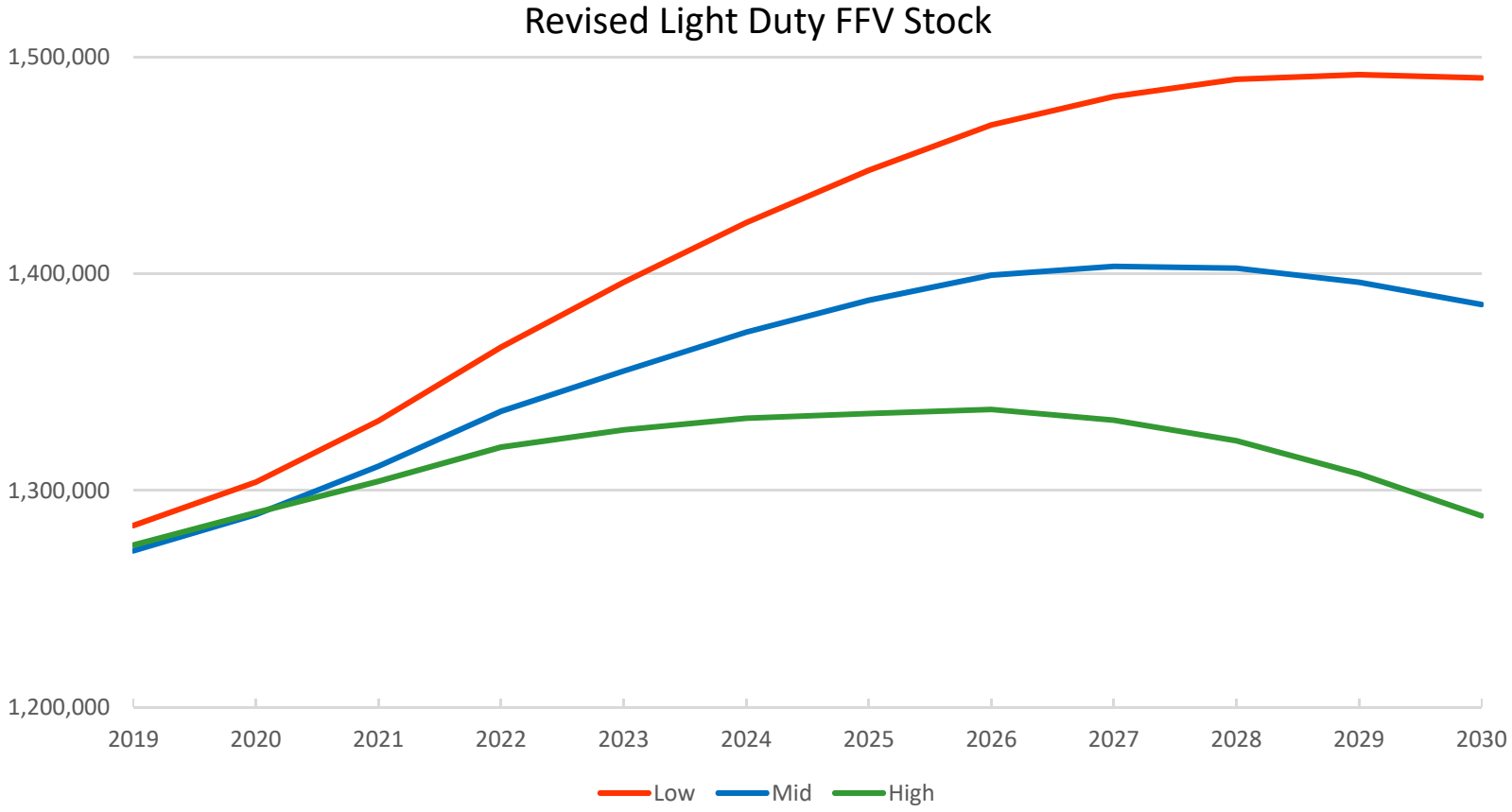
Appendix

LIGHT DUTY VEHICLE STOCK

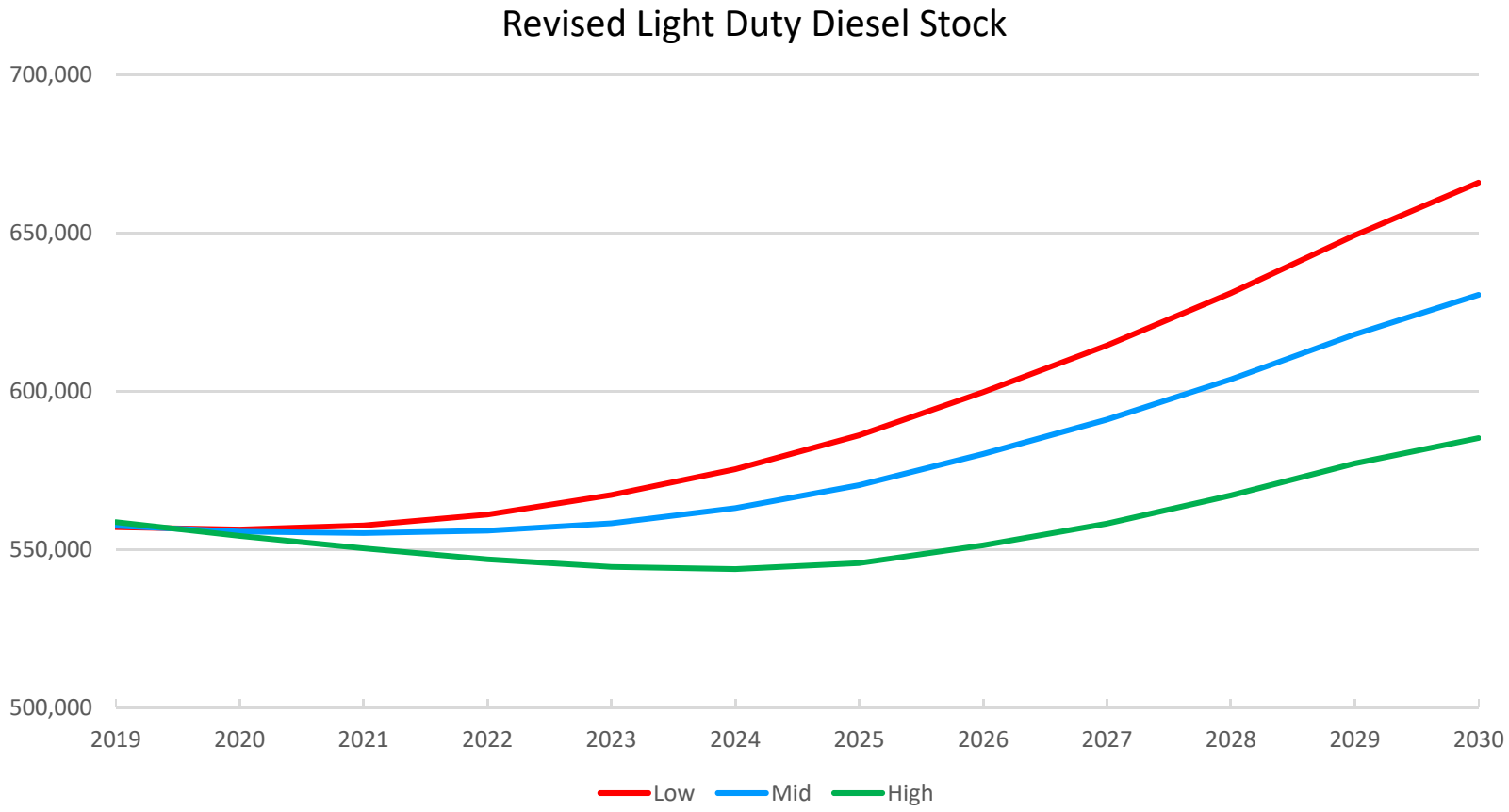
Gasoline Vehicle Stock Begins Steadily but Shows Increases by End of Forecast



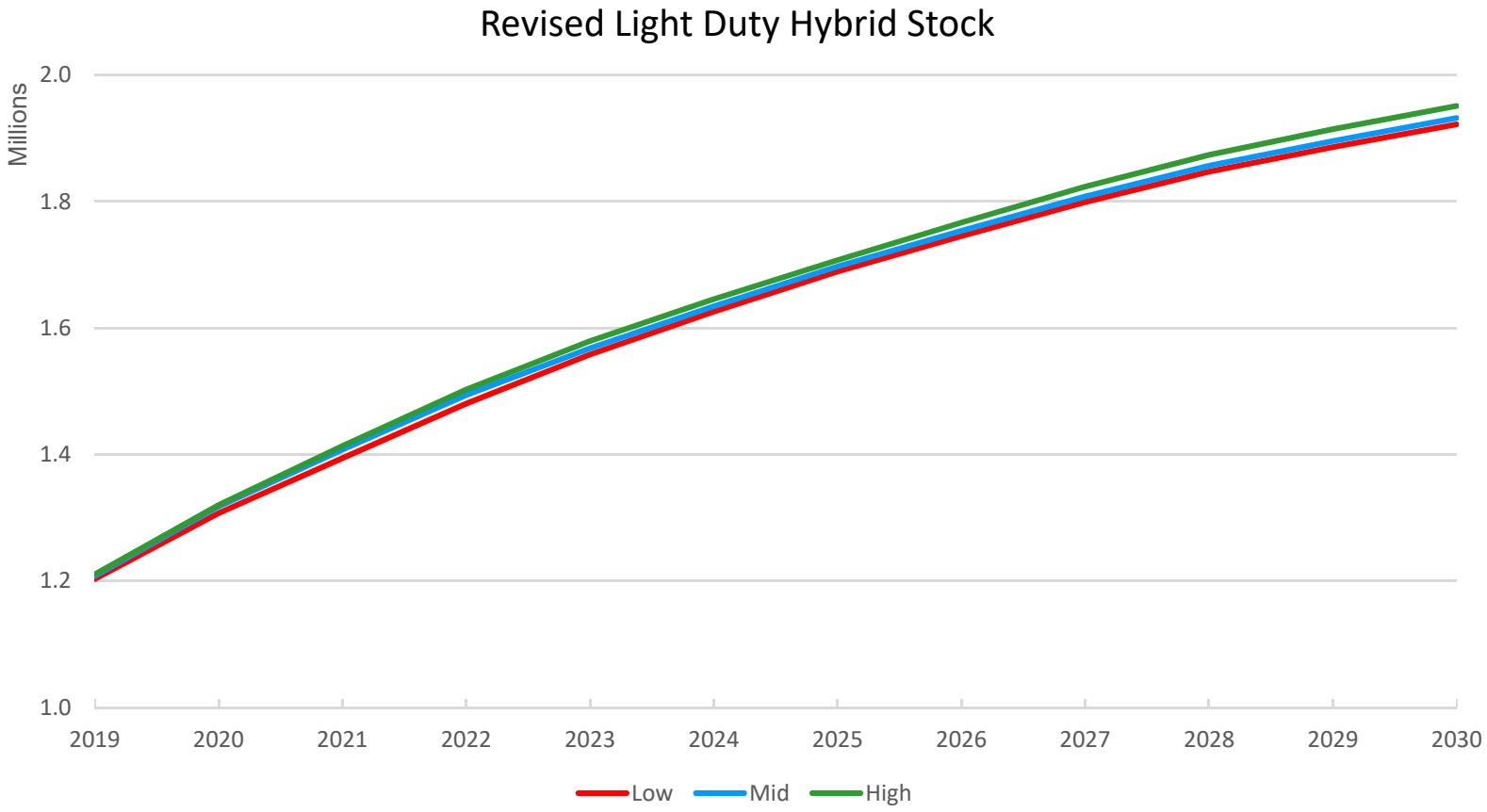
Flex-Fuel Vehicle Stock Shows Short Term Increases but Levels Off by End of Forecast



Diesel Stock is Steady in Short Term but Increases in the Longer Forecast

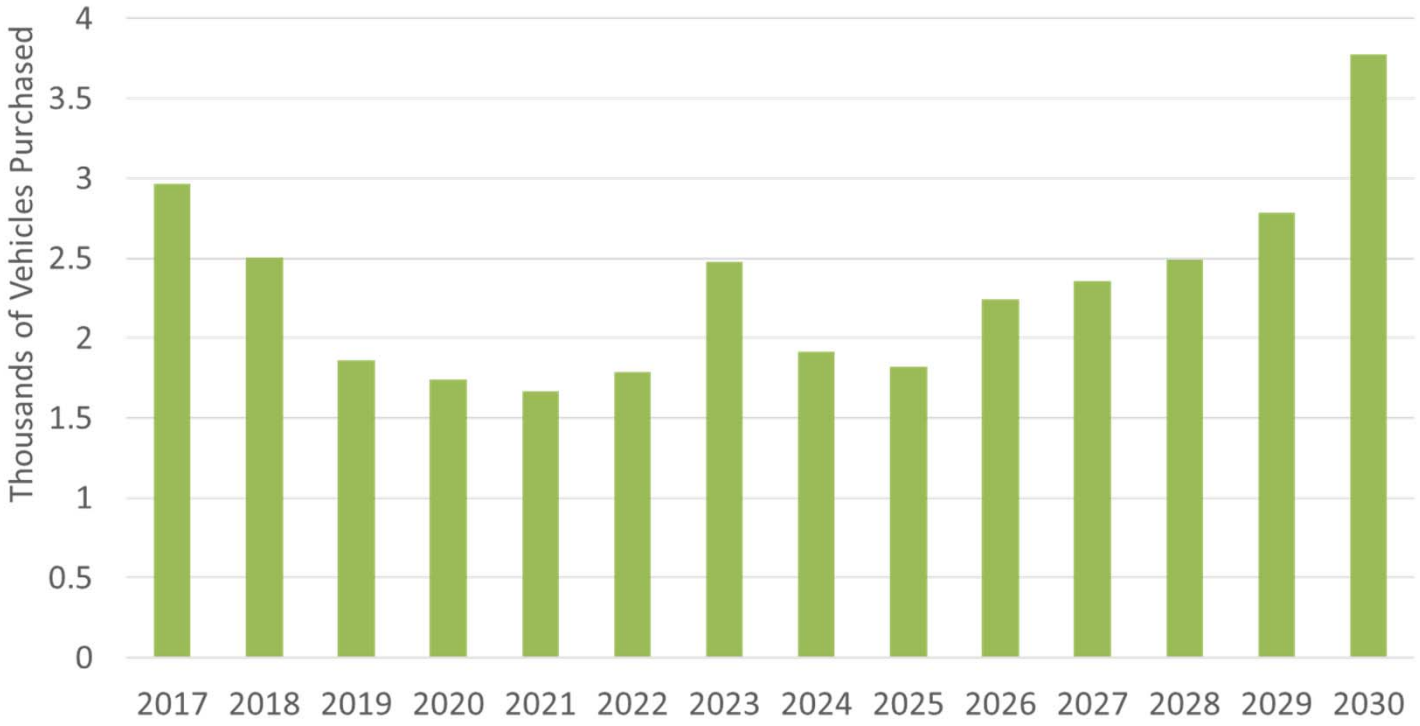


Hybrid Vehicle Stock Scenarios are Very Similar



TRANSIT, AIRPORT SHUTTLES, AND SCHOOL BUSES

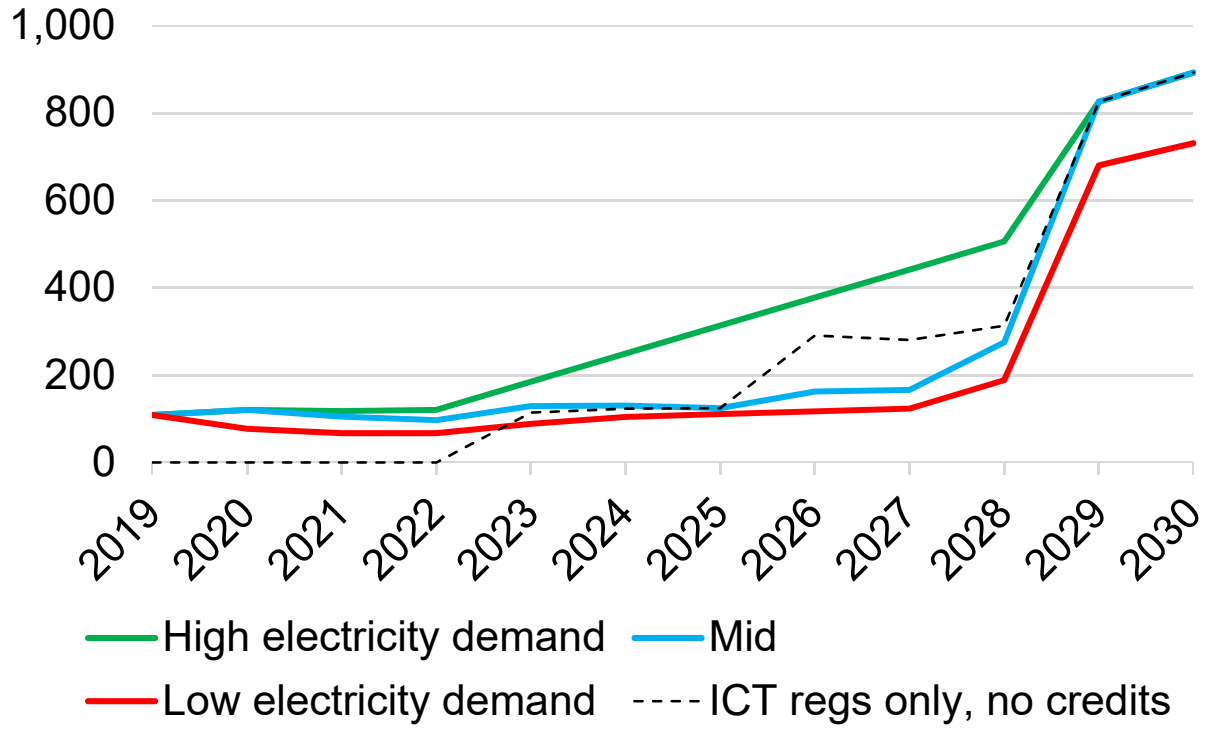
New MHD Bus Purchases: Transit, School, and Shuttle buses



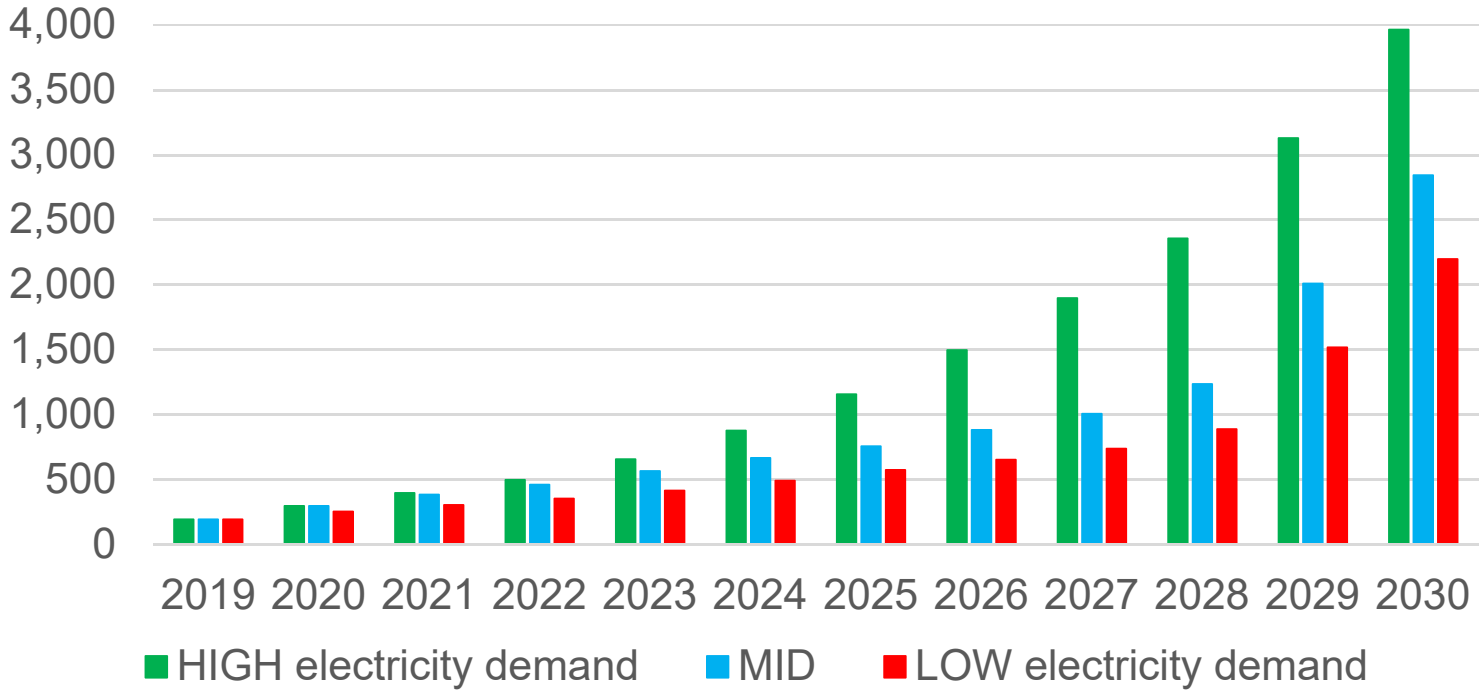
Innovative Clean Transit Regulations

- January 1, 2020: new conventional internal combustion engine bus or hybrid bus purchases must have low-NOx engines
- Large transit agencies must purchase a minimum number of zero-emission buses in each calendar year
  - 2023: 25% of the total number of new bus purchases
  - 2026: 50% of the total number of new bus purchases
  - 2029: 100% of the total number of new bus purchases
- Small transit agencies have a delayed schedule

Zero Emission Transit Bus Purchases Based on ICT Regulations



Battery Electric Urban Transit Bus Stock



Zero Emission Airport Shuttle

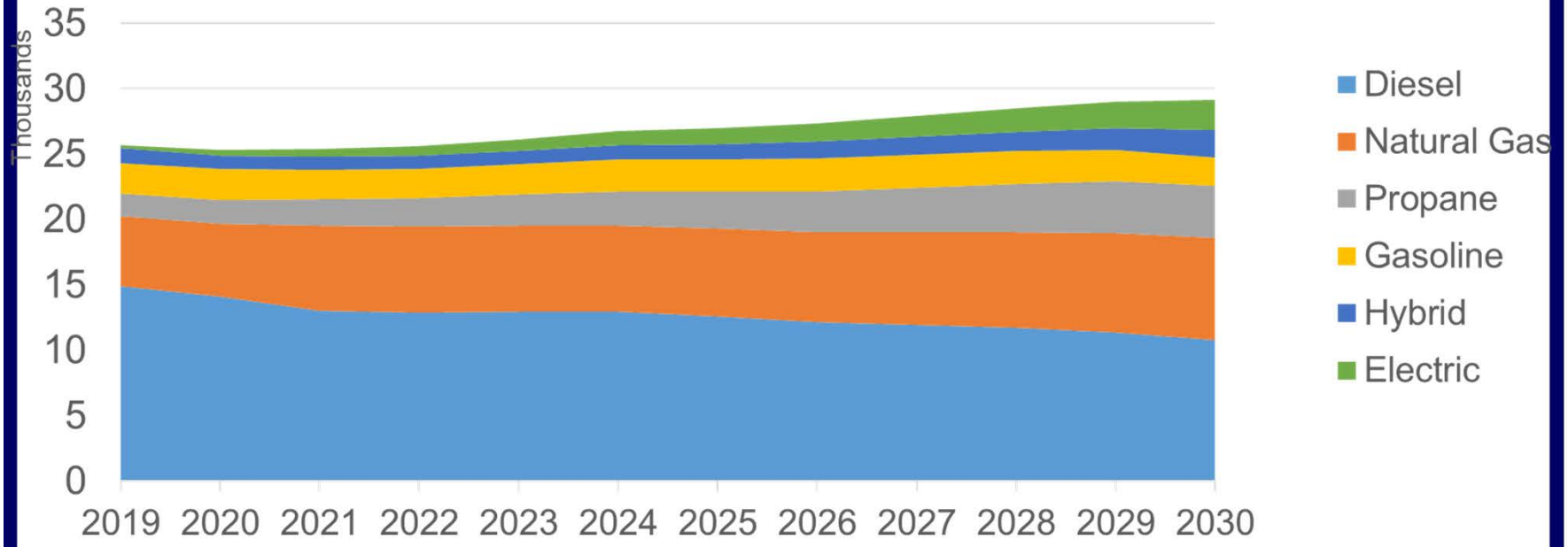
Purchase Requirements Based on Regulation

- Shuttle operators in 13 regulated airports must purchase a minimum number of zero emission shuttles in each calendar year listed below
  - 2027: 33% of fleet must be zero emission
  - 2031: 66% of fleet must be zero emission
  - 2035: 100% of fleet must be zero emission
- Starting in 2023, a zero emission shuttle can be only replaced with another zero emission shuttle
- Exemptions and Extensions:
  - Shuttles that operate less than 3,000 miles per year are defined as “reserve” and are not included in calculating the ZEV fleet percentage
  - Extensions will be granted to applicants with unforeseen circumstances such as natural disasters or inadequate charging/ fueling infrastructure

Electric School Buses

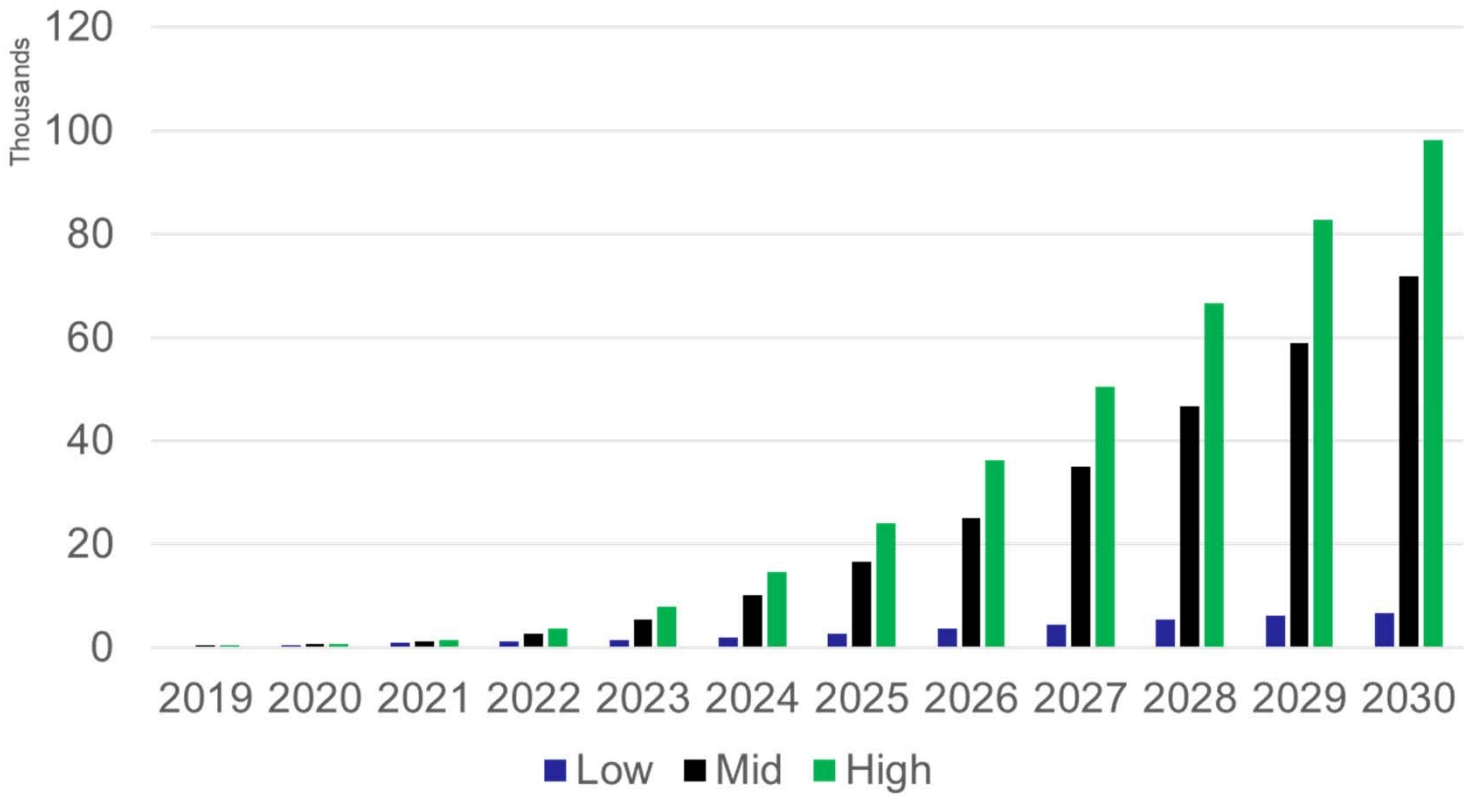
Purchases are based on funding availability

School Bus Stock by Fuel

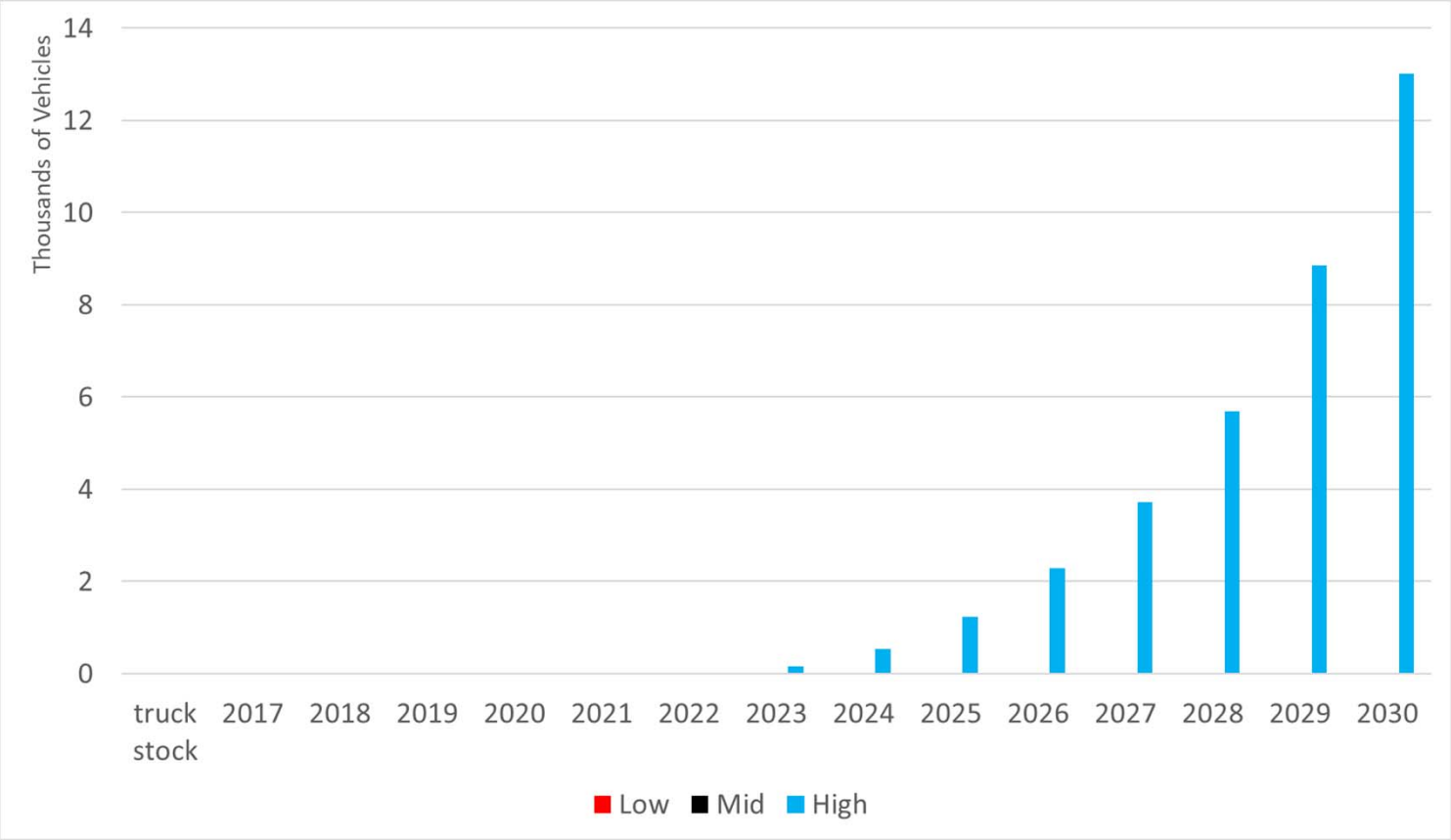


BATTERY ELECTRIC AND FUEL CELL TRUCK STOCK

Electric Truck Stock Forecast (includes battery and catenary electric)

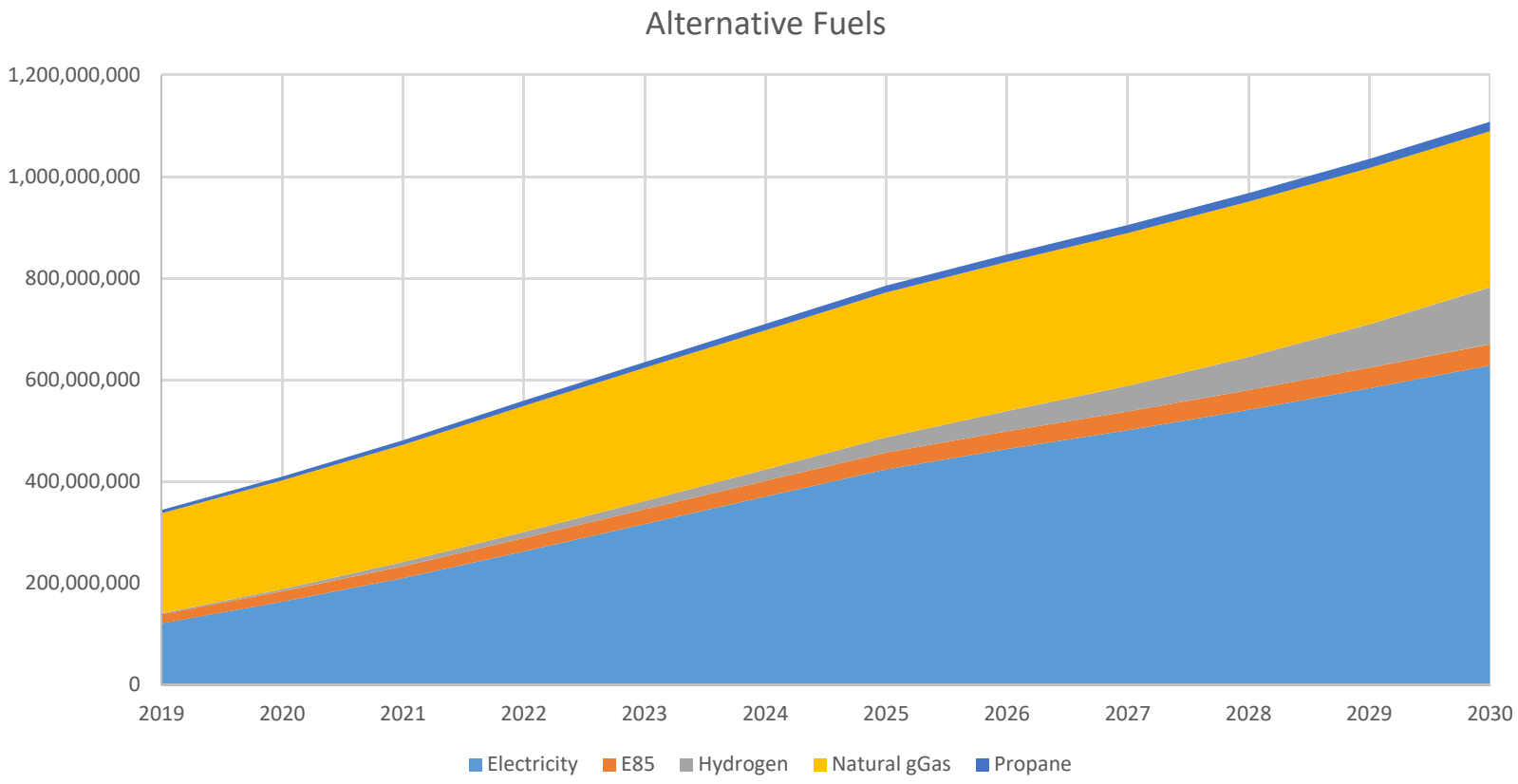


Hydrogen Fuel Cell Truck Stock Forecast

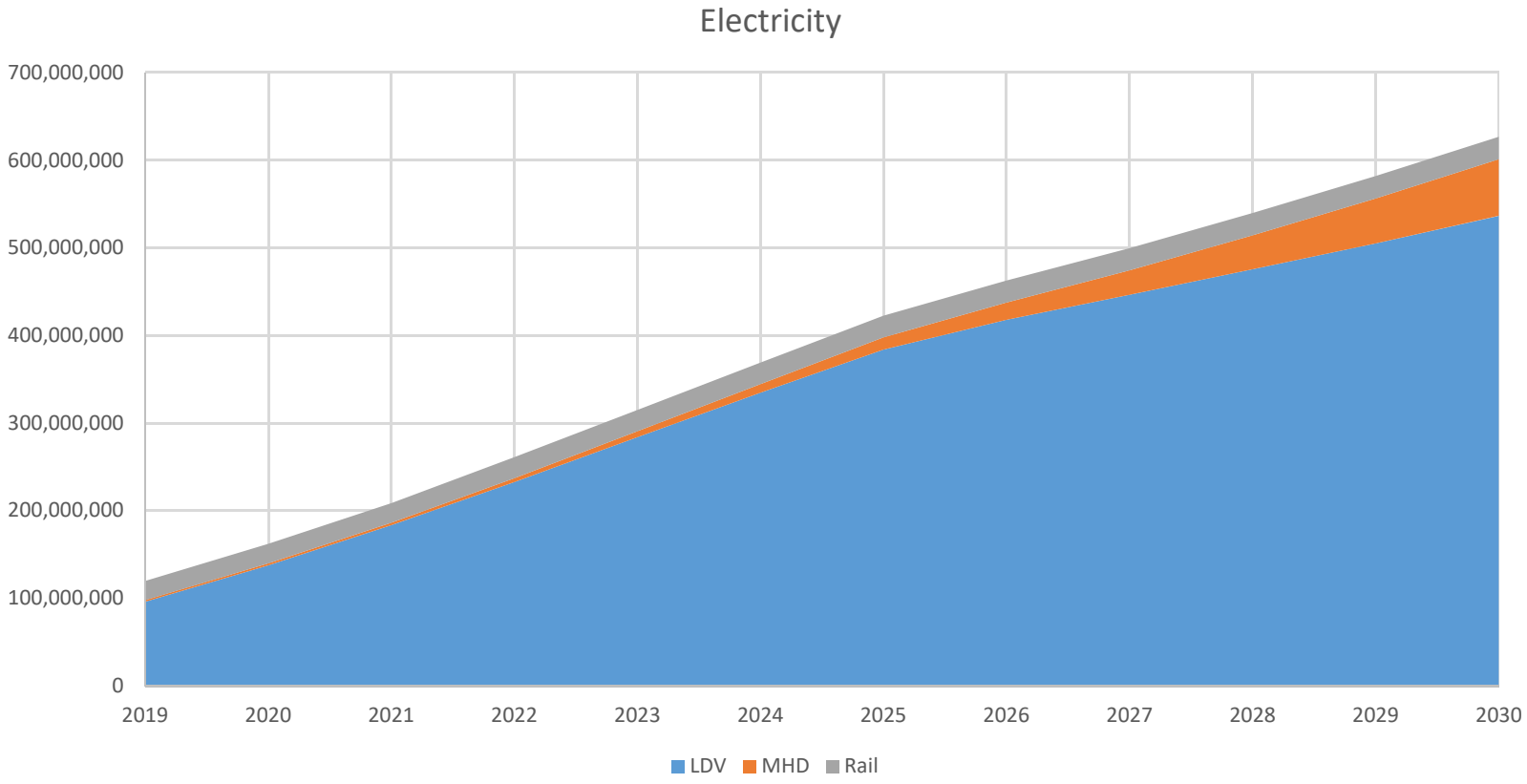


FUEL CONSUMPTION

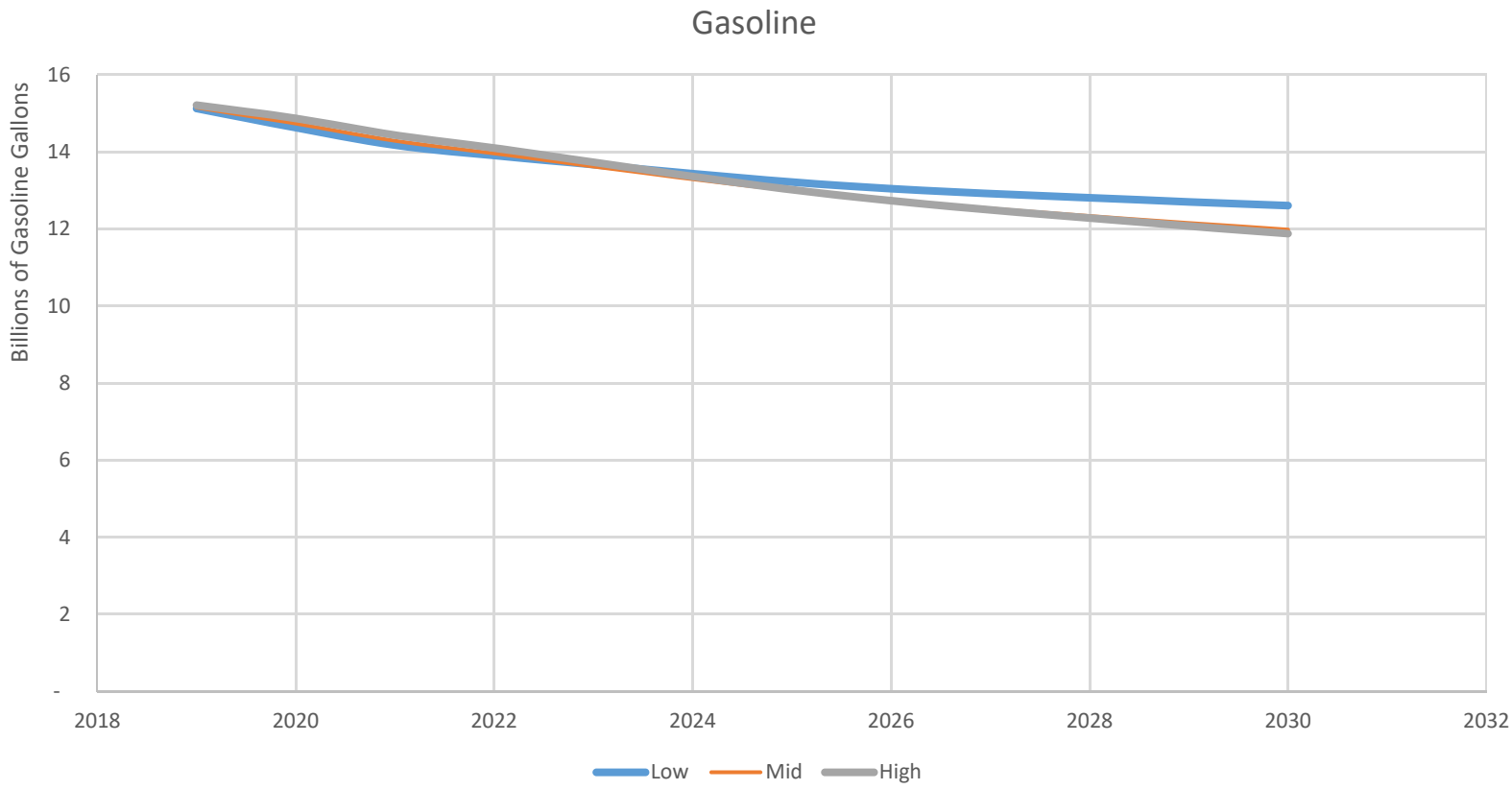
Revised High Alternative Fuel Demand Forecast, by Fuel Type (GGE)



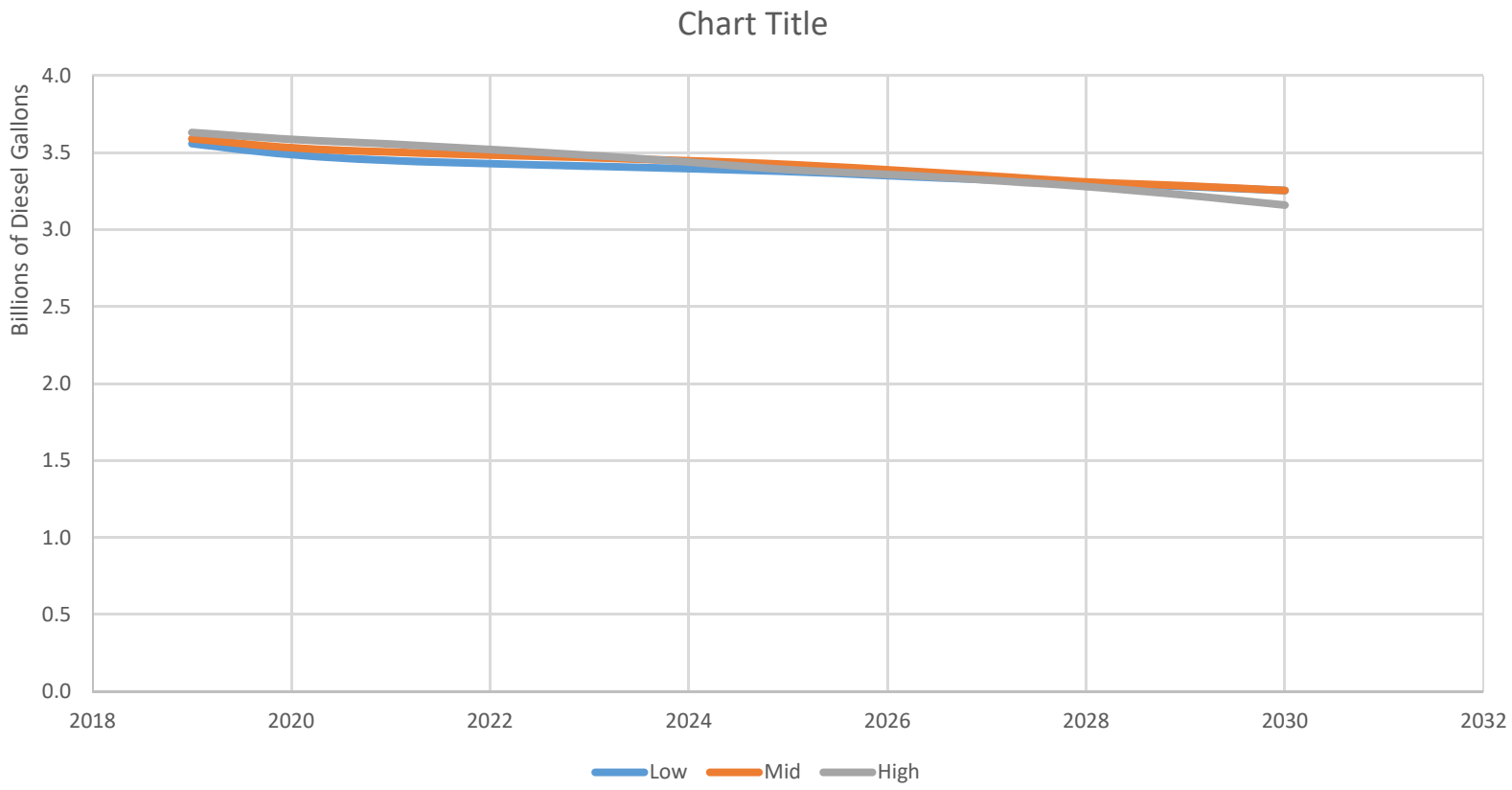
Revised High Electricity Demand by Sector (GGE)



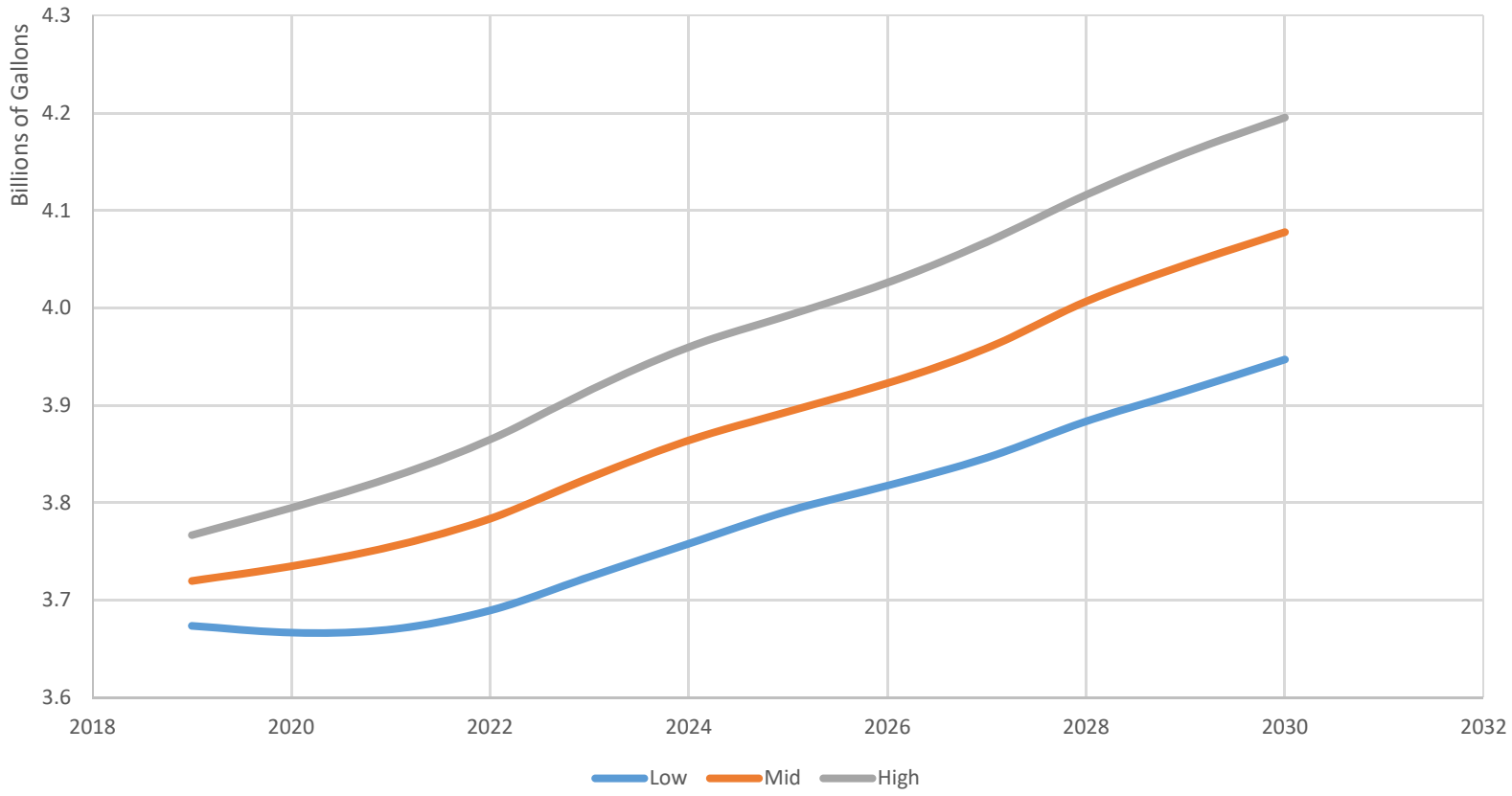
Revised Gasoline Demand Forecast



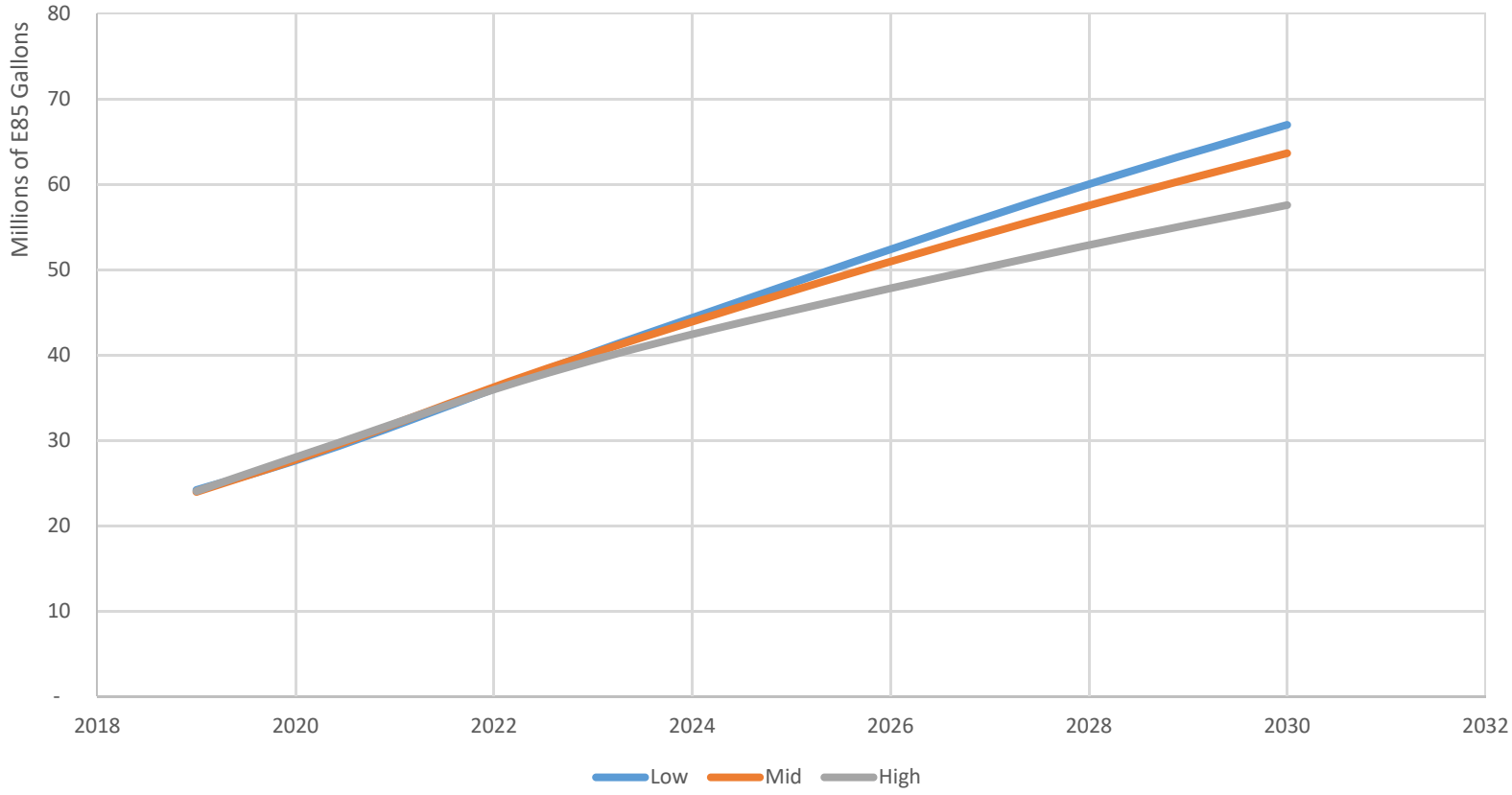
Revised Diesel Demand Forecast



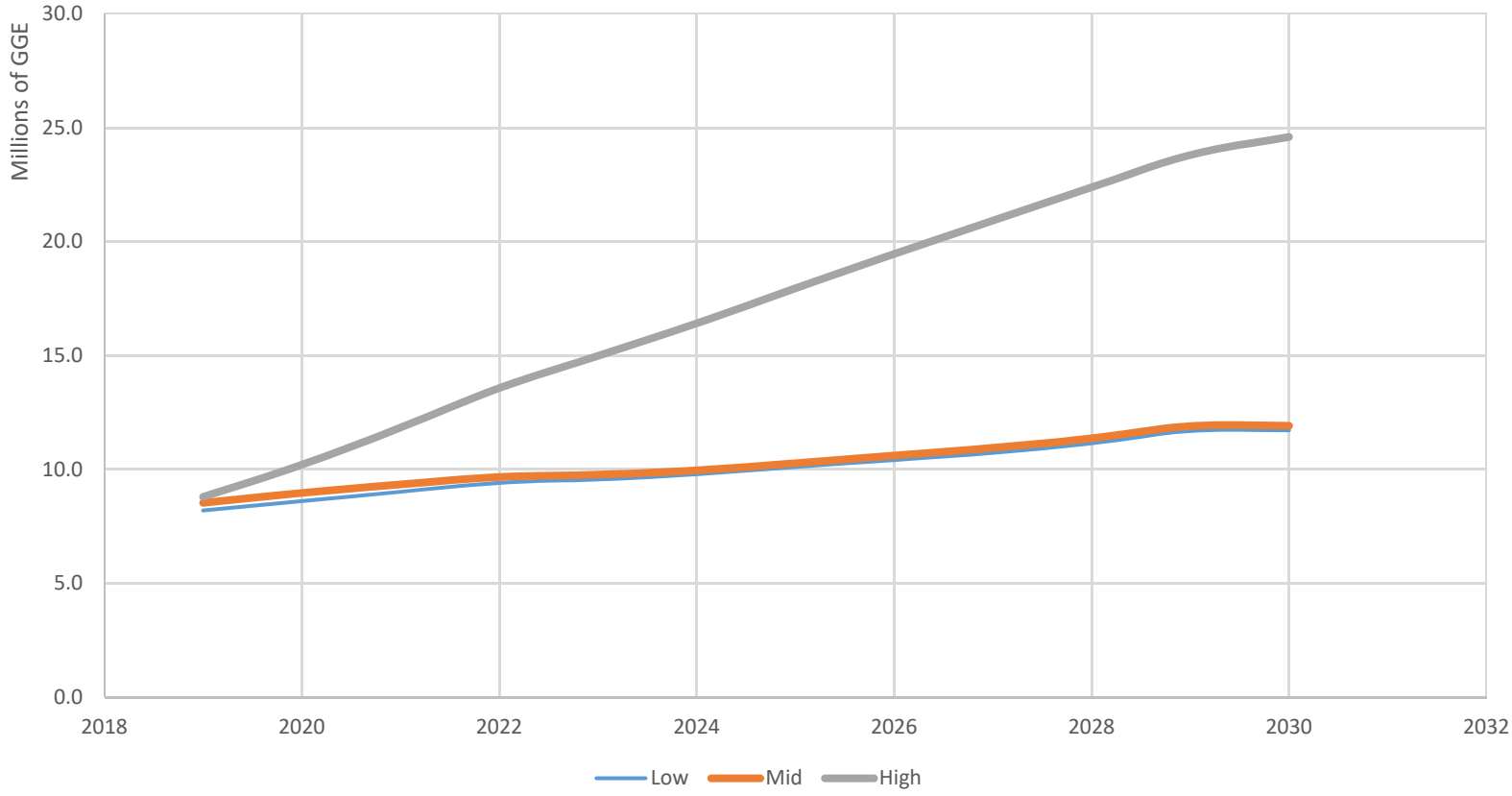
Revised Jet Fuel Demand Forecast



Revised E85 Demand Forecast



Revised Propane Demand Forecast



MHD Truck Consumption of Diesel Plus Gasoline