



2019 IEPR Revised Medium- and Heavy-duty Vehicle Forecast

2019 Integrated Energy Policy Report Second Floor Fishbowl

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In this presentation

- Medium- and heavy-duty vehicle purchases
- Focus on urban transit buses
- Data changed from preliminary truck forecast
- Incentive assumptions across scenarios
- MHD truck forecast results
 - MHD truck fuel market shares for some truck classes
 - ZEV MHD truck purchases and counts

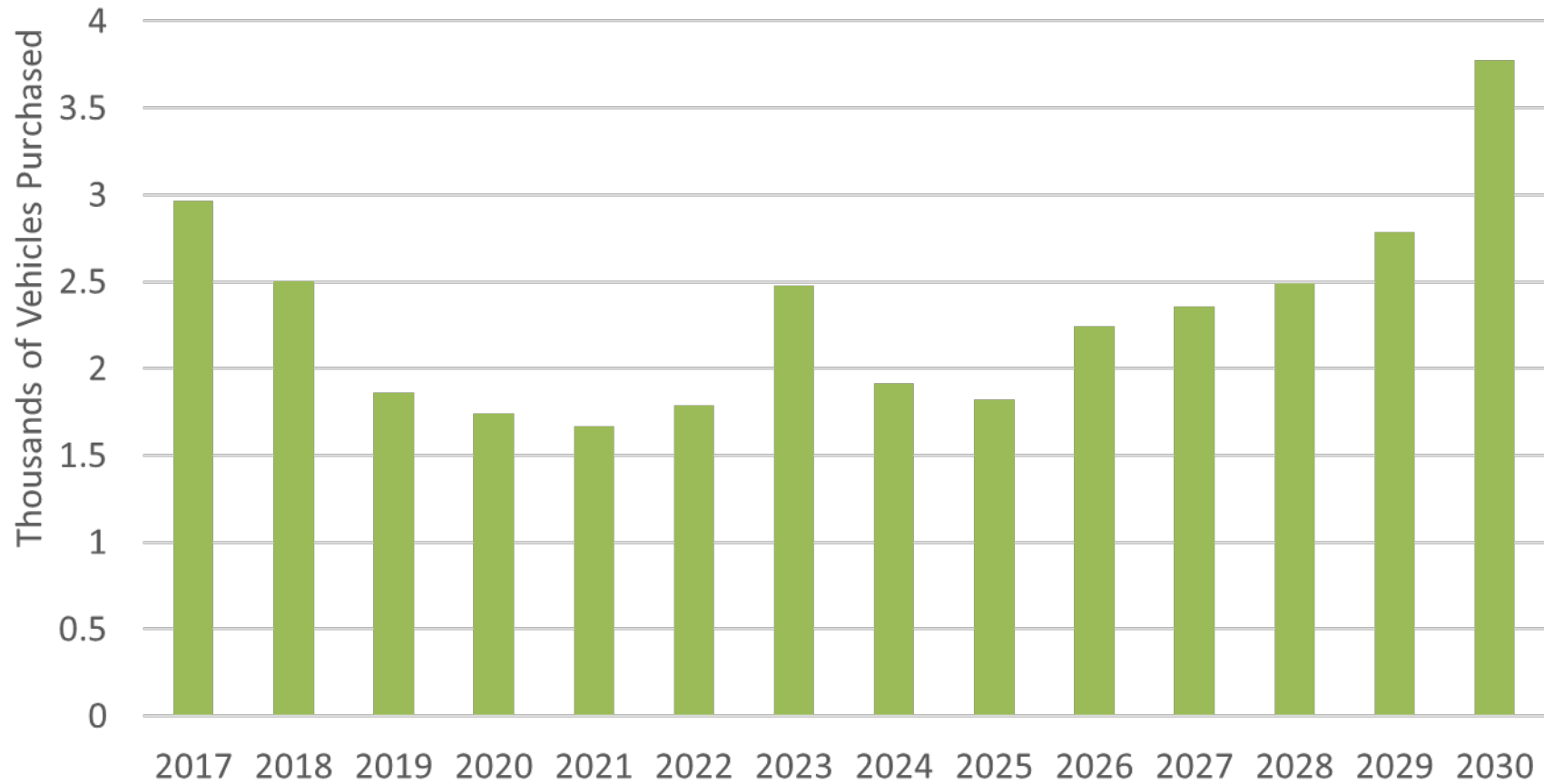


MD/HD Vehicle Classes

Class 3 - 10,001 to 14,000 lbs  Walk-in  Box Truck  City Delivery  Heavy-Duty Pickup
Class 4 - 14,001 to 16,000 lbs  Large Walk-in  Box Truck  City Delivery
Class 5 - 16,001 to 19,500 lbs  Bucket Truck  Large Walk-in  City Delivery
Class 6 - 19,501 to 26,000 lbs  Beverage Truck  Single-Axle  School Bus  Rack Truck
Class 7 - 26,001 to 33,000 lbs  Refuse  Furniture  City Transit Bus  Truck Tractor
Class 8 - 33,001 lbs & Over  Cement Truck  Truck Tractor  Dump Truck  Sleeper

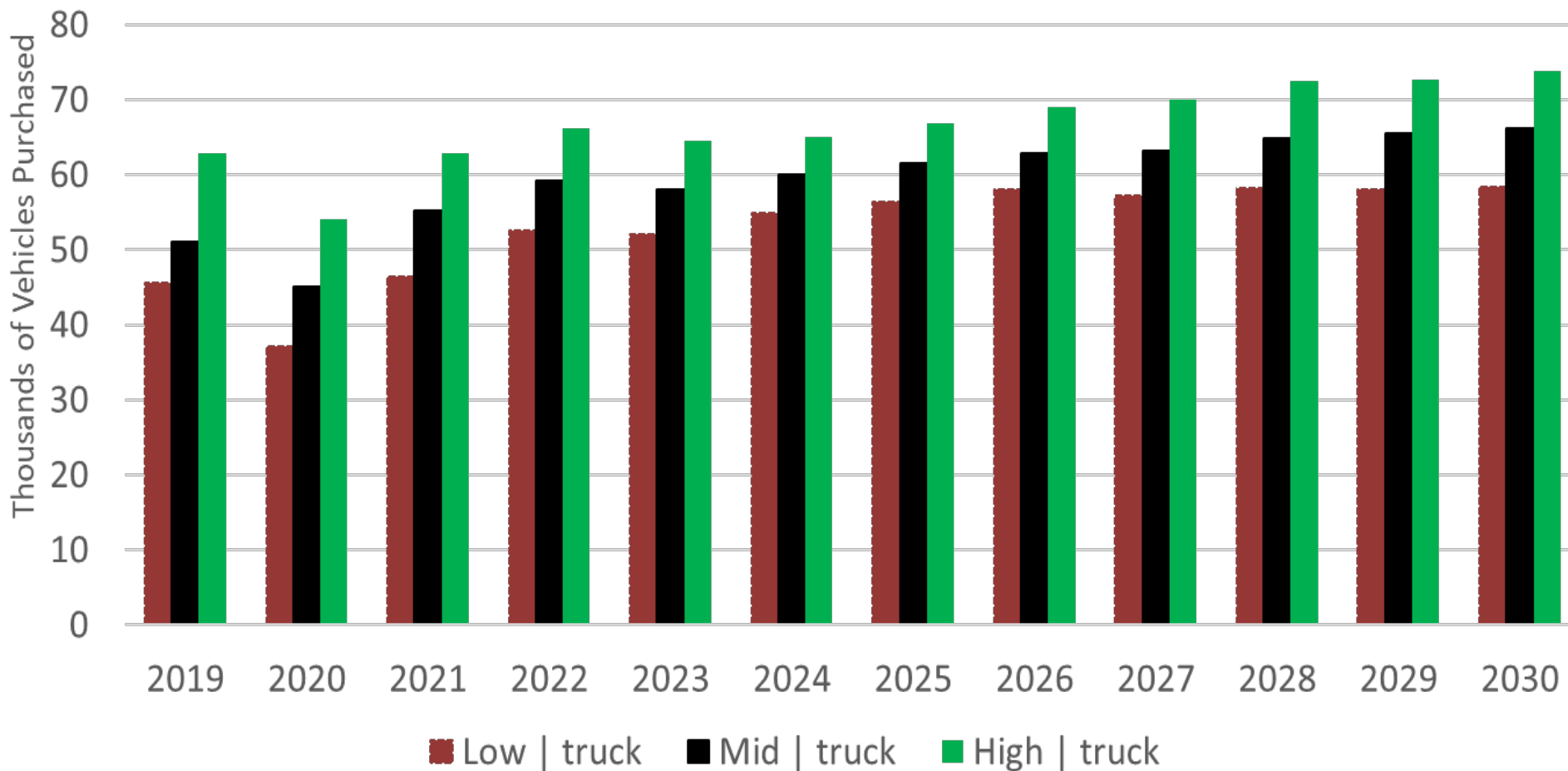


New MHD Bus Purchases



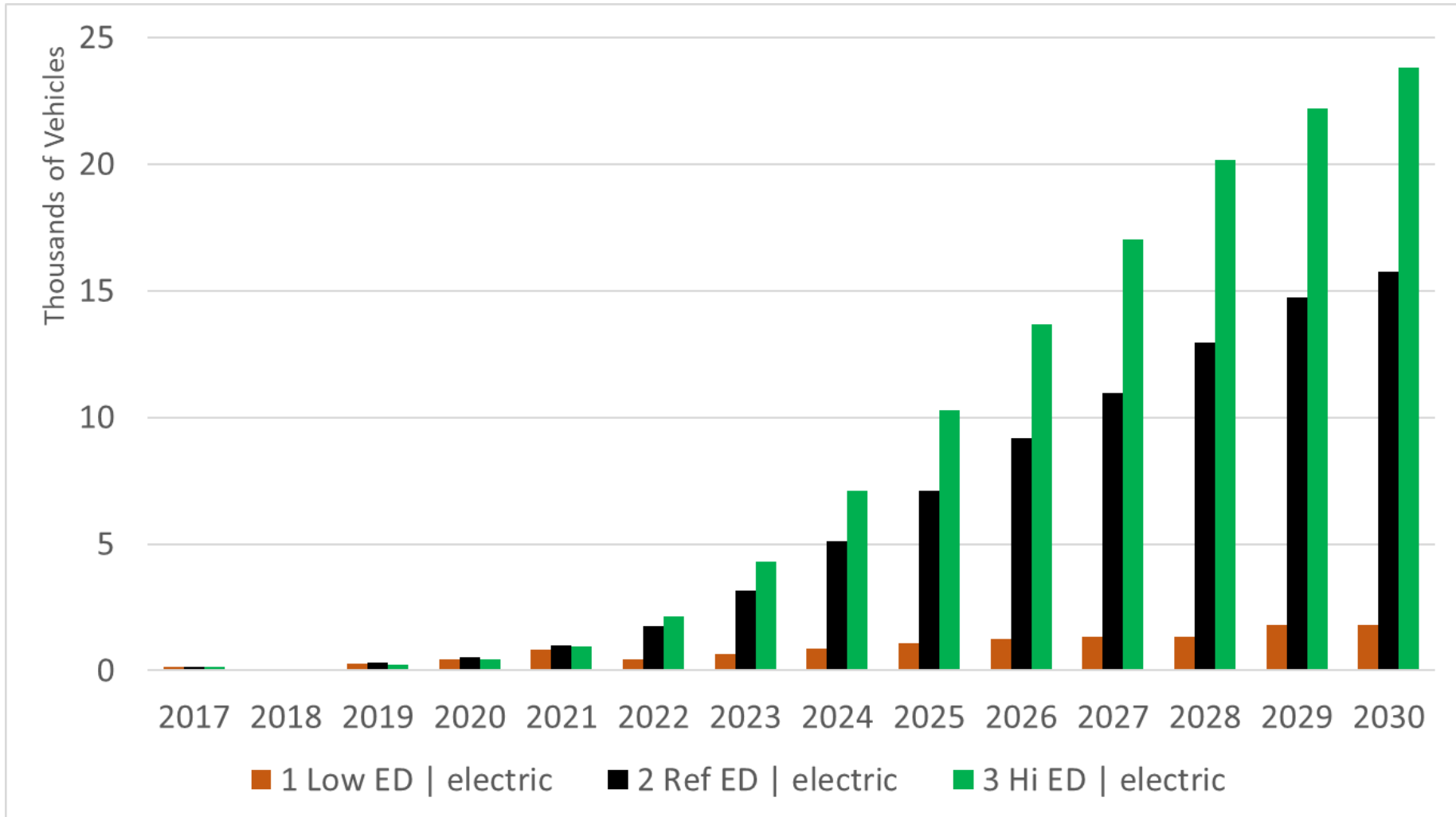


New MHD Truck Purchases



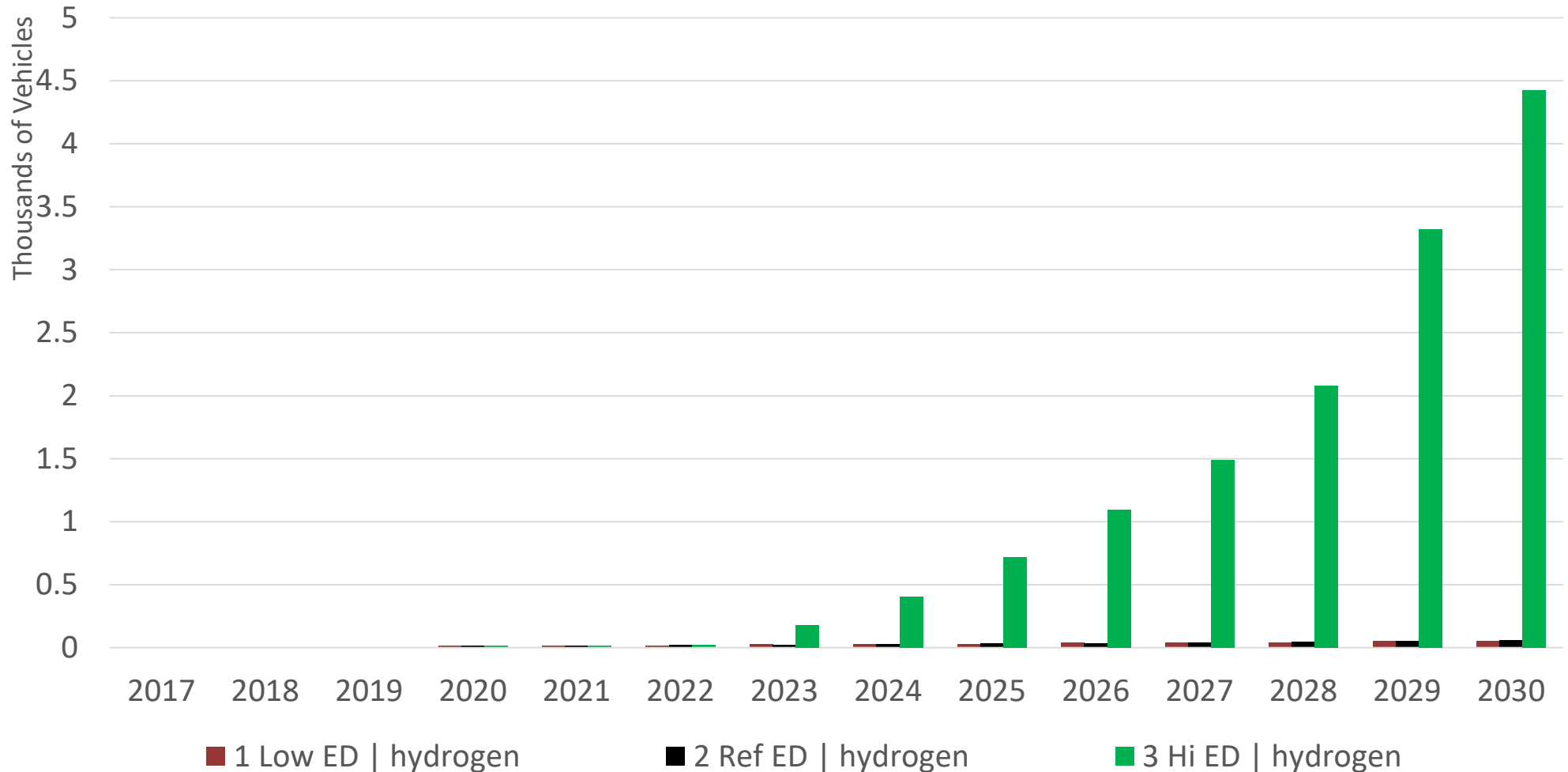


New battery & catenary electric MHD Purchases





New hydrogen fuel cell MHD purchases (nearly all are in-state GVWR8 tractor-trailers)





URBAN TRANSIT BUSES

Forecast ...

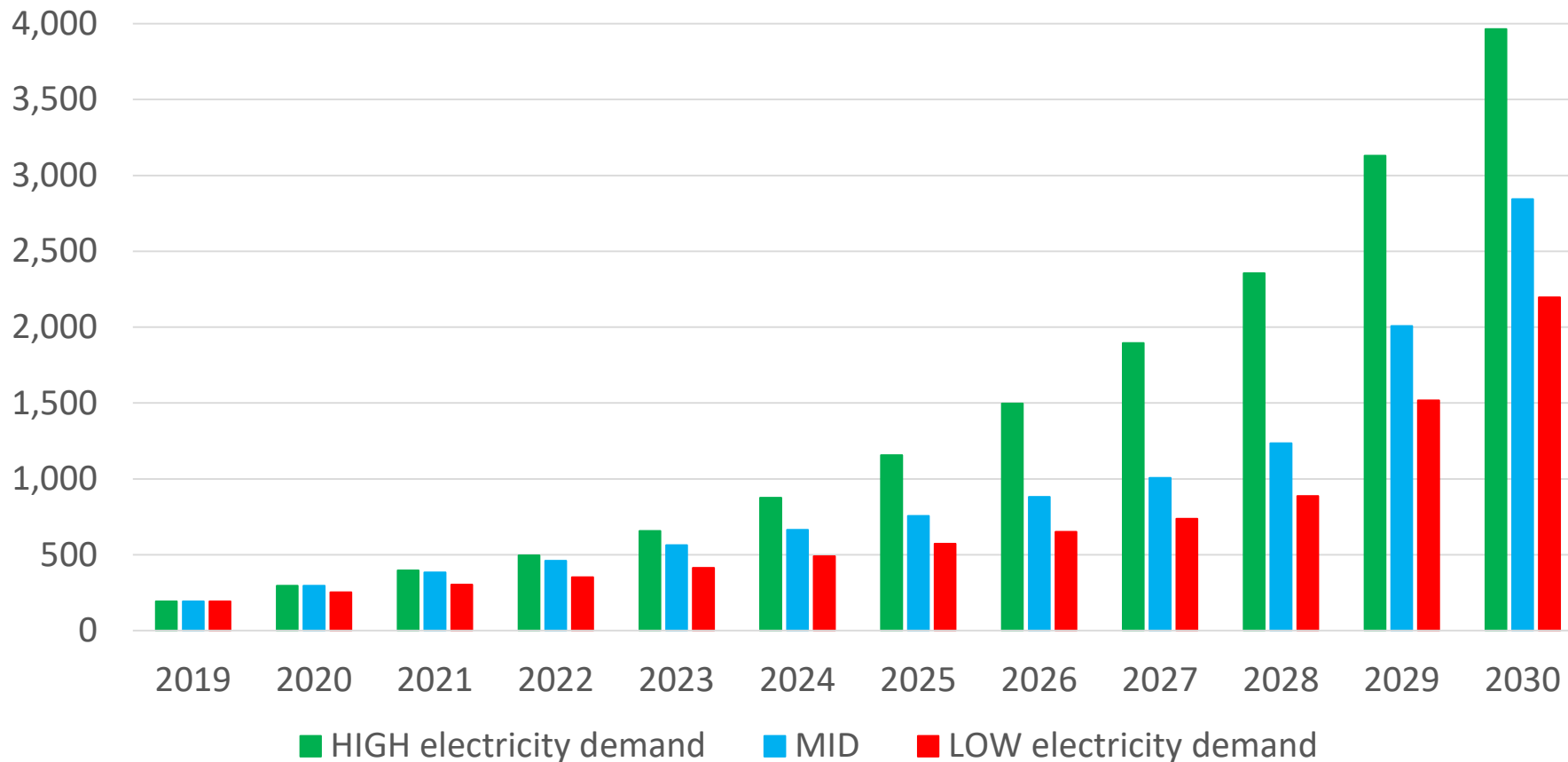


Innovative Clean Transit Regulations

- January 1, 2020: new conventional internal combustion engine bus or hybrid bus purchases must purchase buses with Low-NOx engines
- Large transit agencies must purchase a minimum number of zero-emission buses in each calendar year
 - 2023: 25 percent of the total number of new bus purchases
 - 2026: 50 percent of the total number of new bus purchases
 - 2029: 100 percent of the total number of new bus purchases
- Small transit agencies have a delayed schedule
- All agencies can earn credit for *past* electric bus purchases

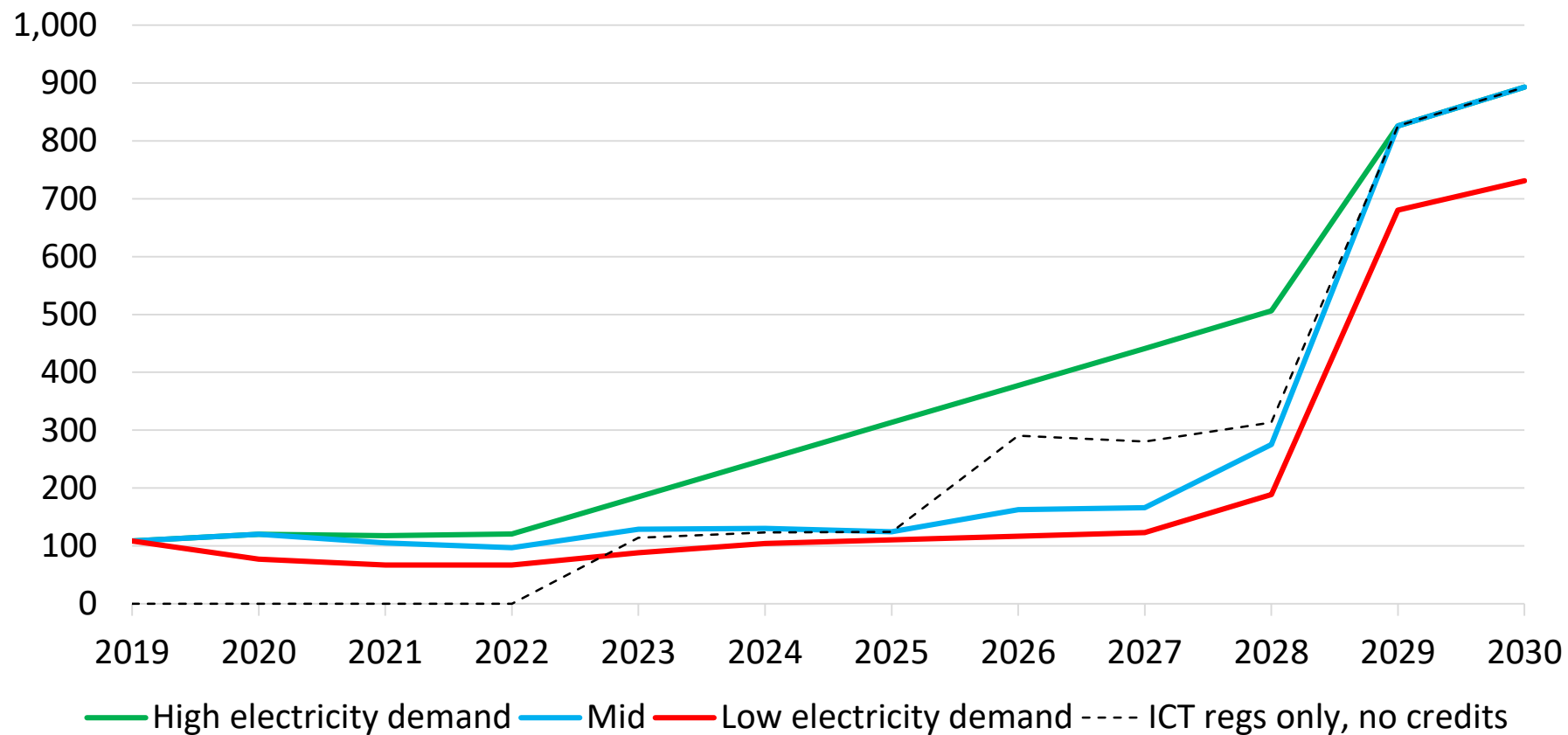


Battery Electric Urban Transit Bus Stock 2019-2030





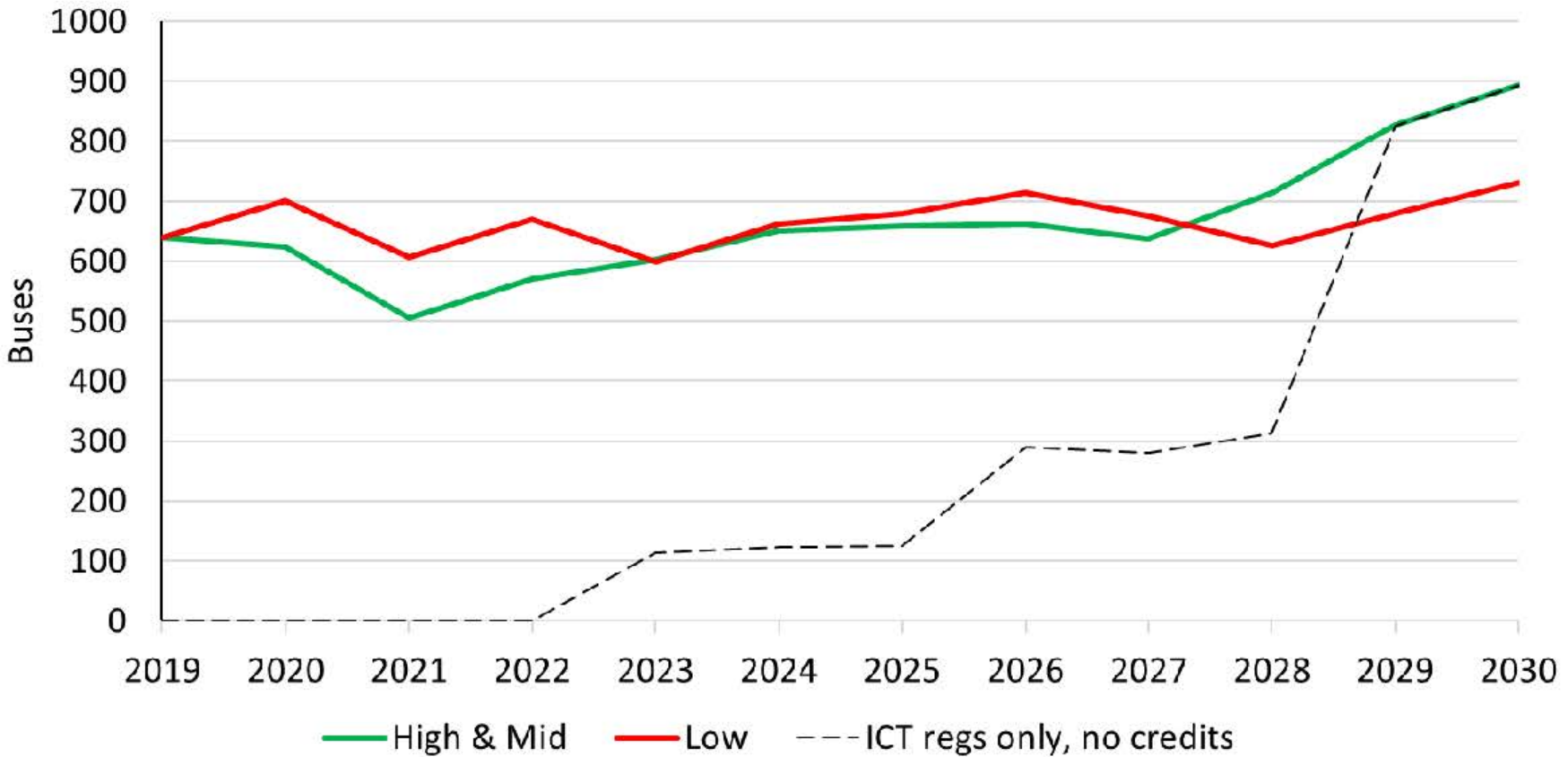
Zero Emission Transit Bus Purchases, 3 scenarios and ICT regs





Total Transit Bus Purchases

Estimated retirements + growth adjustment



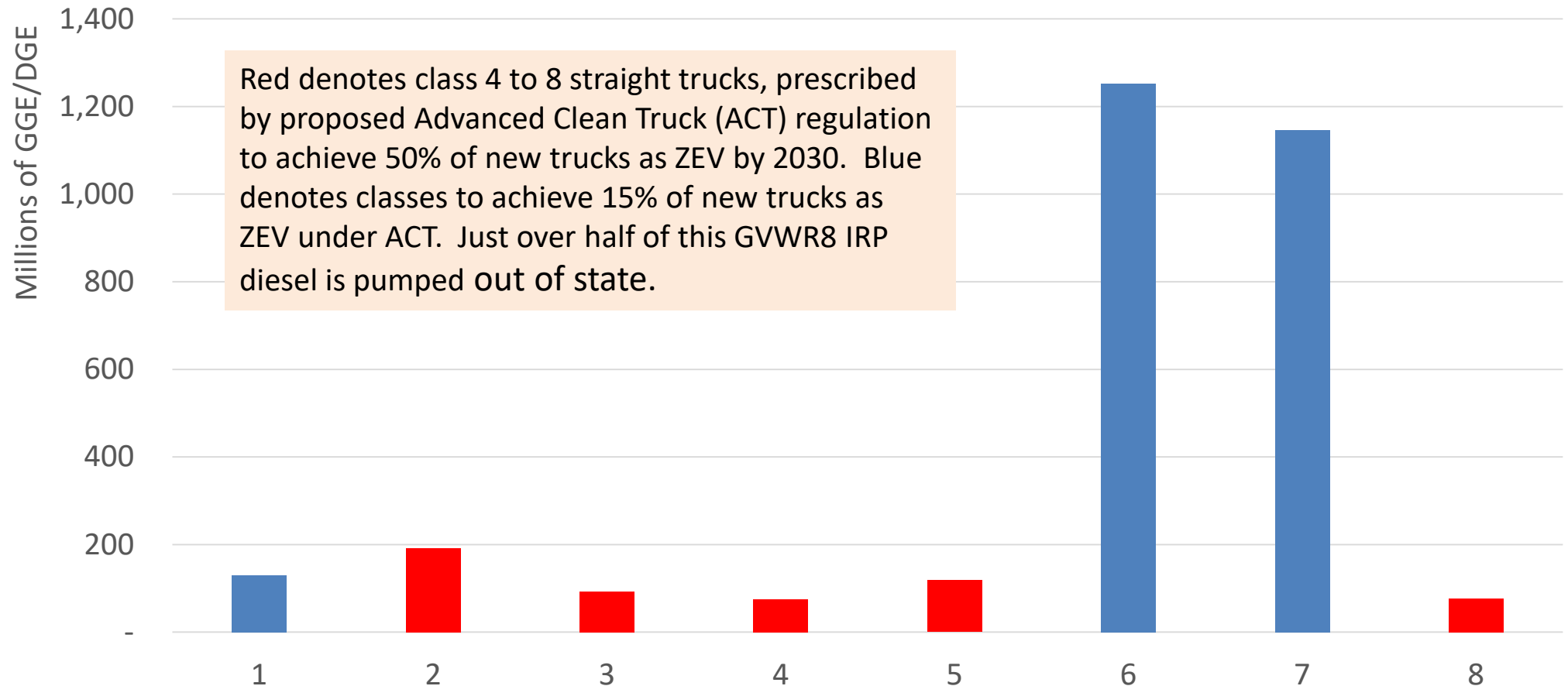


MEDIUM- AND HEAVY-DUTY TRUCKS

Forecast ...



MHD truck fuel use dominated by tractor-trailers (2017)





Emerging ZEV Tractor-trailers





ZEV Tractor-trailer Manufacturer Prices

- Both battery electric and hydrogen fuel cell would achieve commercial success at the Tesla Semi and Nikola Two announced prices
- We chose to not create a separate scenario with two hypotheticals in competition, since no commercialized truck in this class currently
- However, if you build it (at this price, and given infrastructure), fleets will come (and buy trucks).



Data Changes in Revised MHD Truck Forecast

- Changes in battery cell prices for battery-electric trucks
- Fewer model years of expected VMT now used as the basis for modeling the market shares (older trucks have less VMT)
- High case truck retirement by age earlier, so more replacements
- Low case truck retirement by age later, so less replacements
- Hydrogen fuel price changed to reflect higher station utilization by dedicated fleets
 - Tough at retail price >\$15/Kg, LDV forecast lowest at \$8.74/Kg in 2030
 - Two factors support \$5 to \$7/Kg for HFC fleets:
 - Tank pressure 350 bar instead of 700 bar: savings on tank build & compression cost
 - Dedicated-route or home-based MHD fleets can 'right-size' fueling to improve station utilization



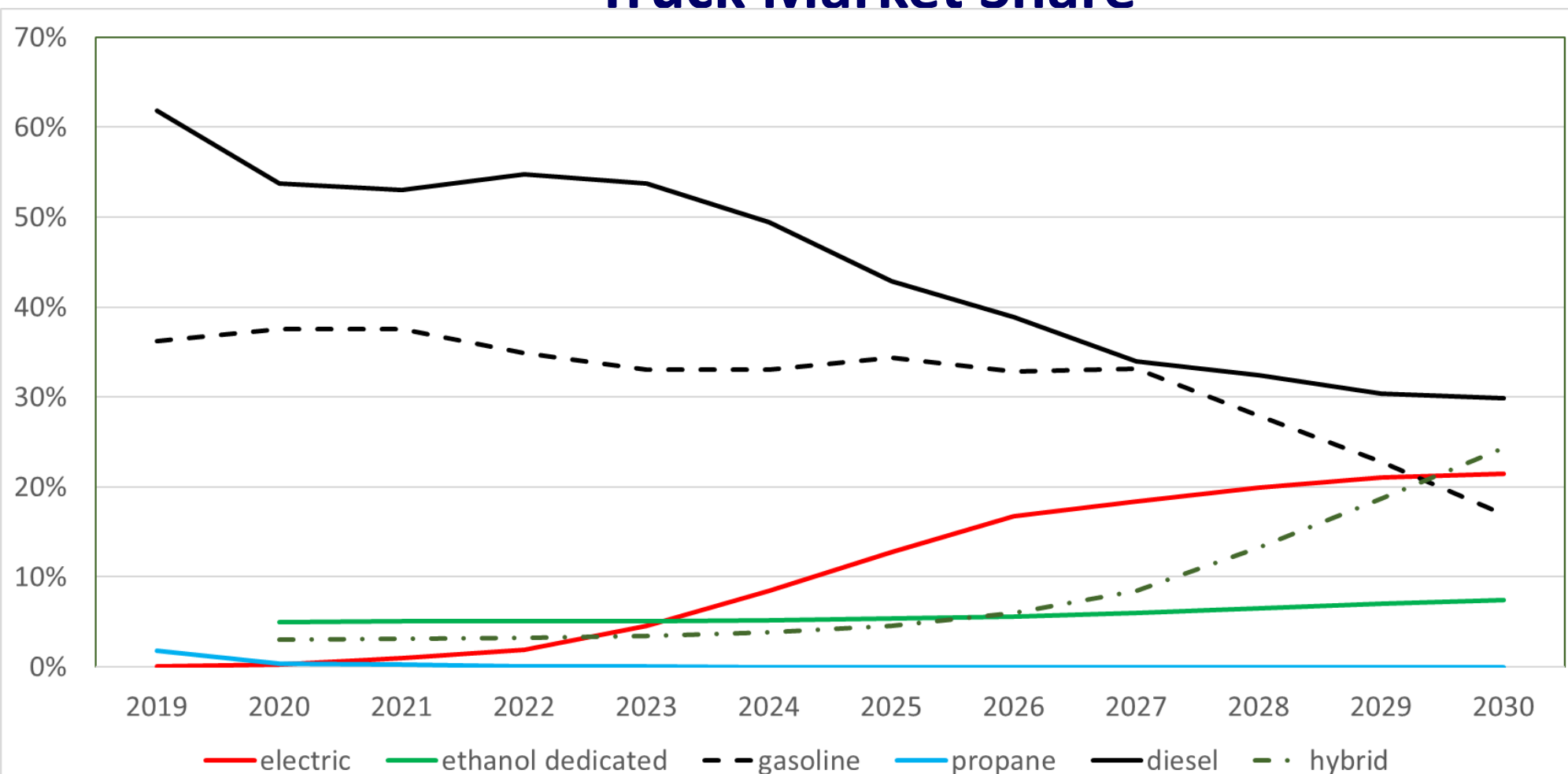
MHD Truck Incentives Assumed for Revised Forecast

- Using HVIP voucher percent of truck incremental cost
- Varies by fuel and truck class: ZEV near 100%, Low NOx lower
- Assumes funding is available for all purchases through 2021
- Covers ZEV, natural gas, and diesel-electric hybrid*
- From 2021, ZEV voucher for incremental cost:
 - High case: full HVIP voucher amount through to 2030, “all in”
 - Mid case: 80% of full voucher amount from 2022 to 2030
 - Low case: no incentive from 2022 on

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

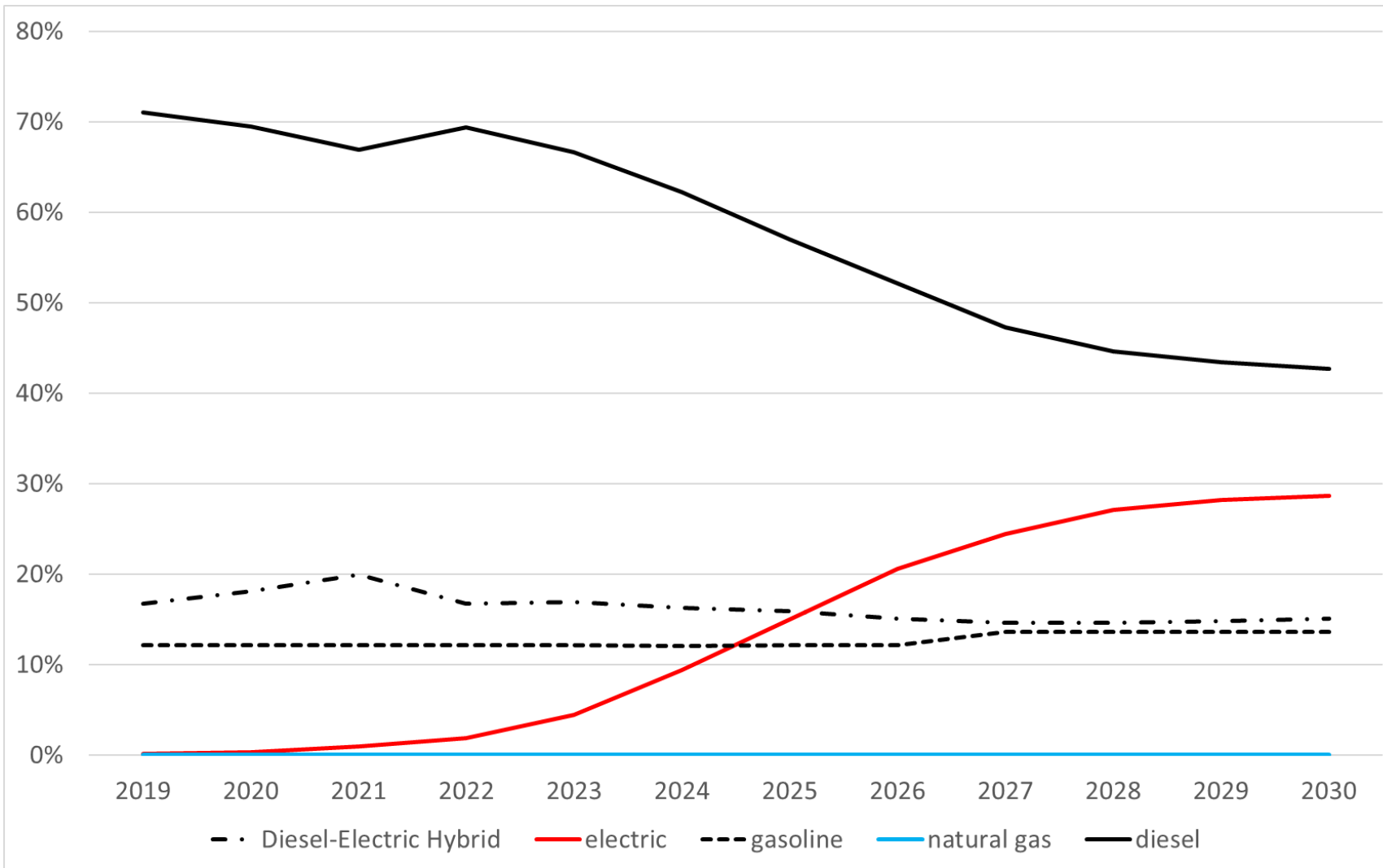


Mid case GVWR 4 and 5 Fuel Type Truck Market Share





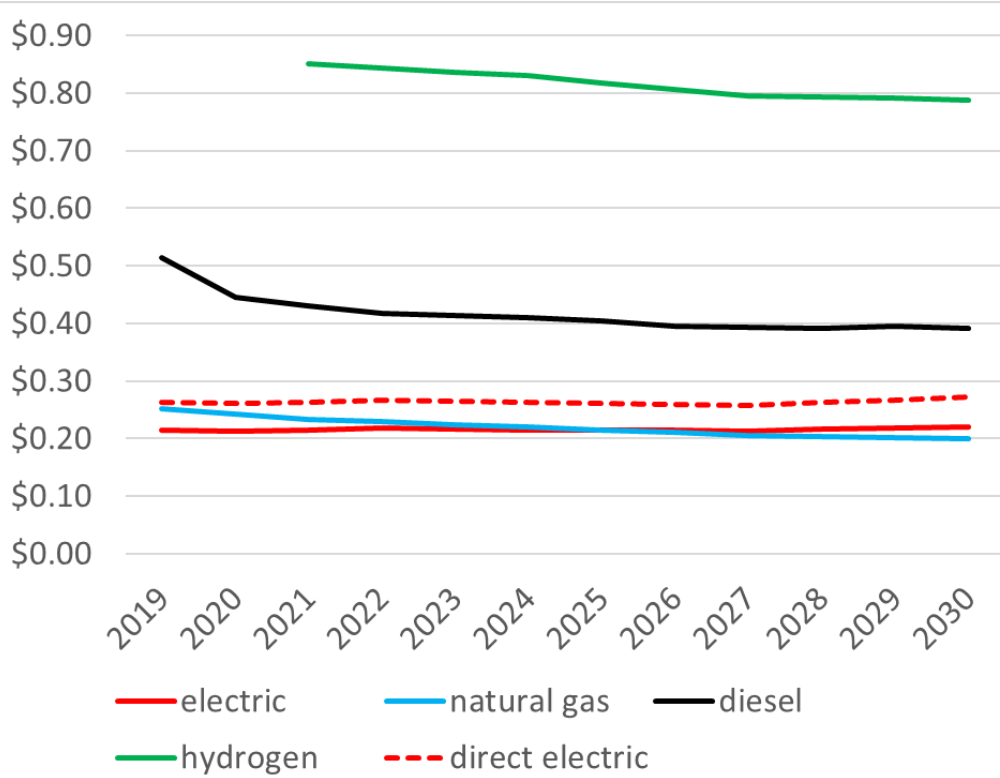
GVWR6 Fuel Type Truck Market Share – Mid case



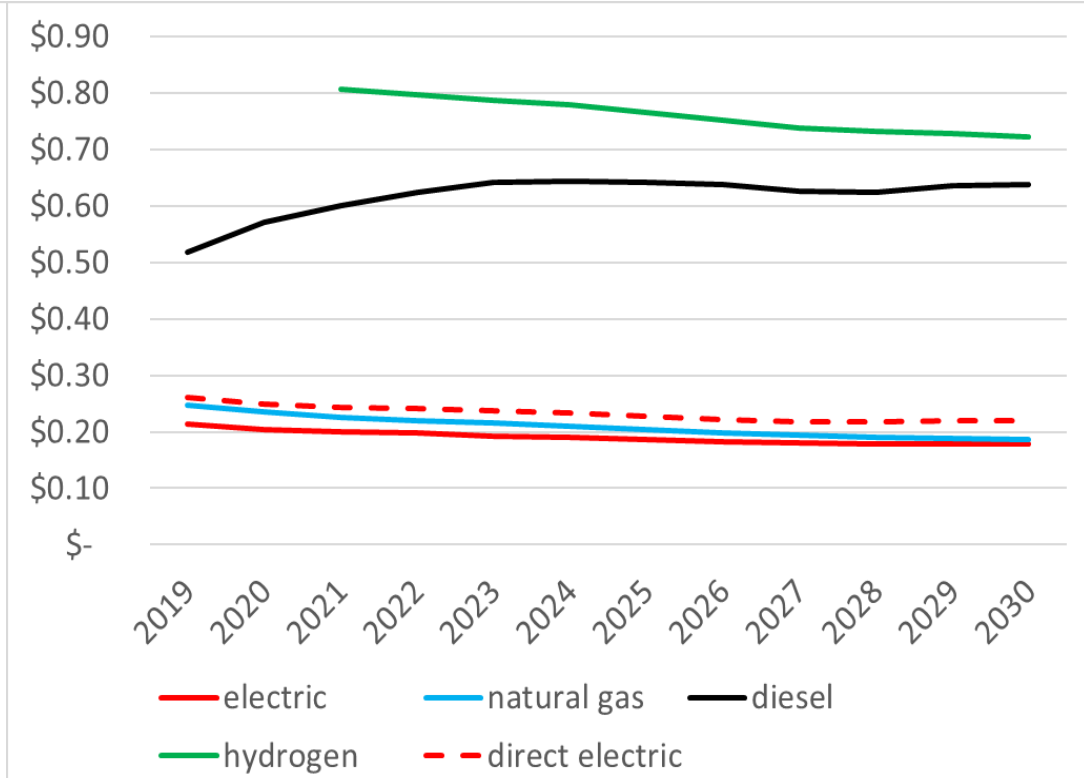


Fuel Cost per Mile, Mid/High Cases, In-state Tractor-trailer

Mid case



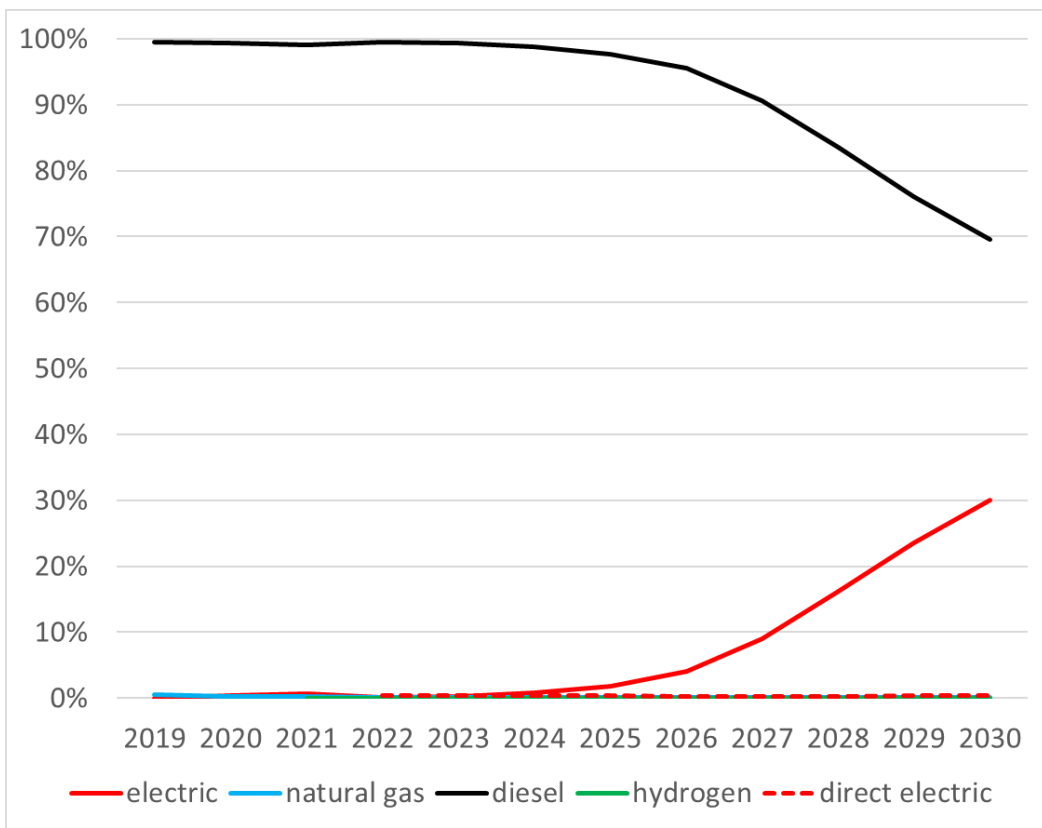
High case



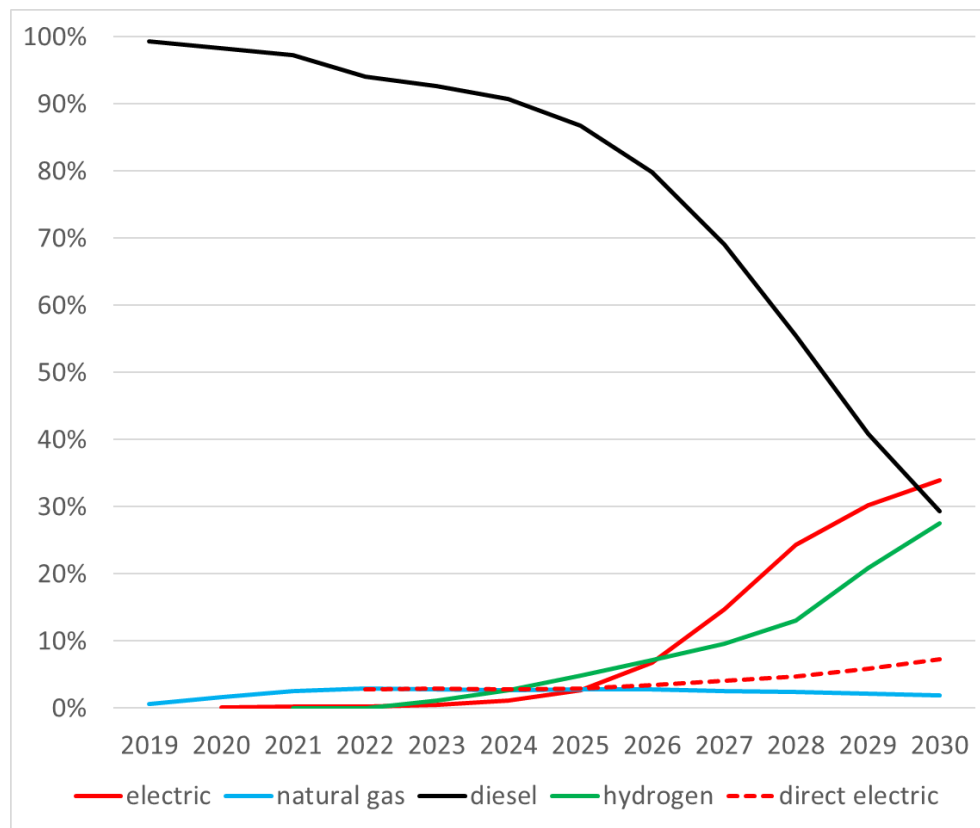


Mid/High cases, Truck Market Share, In-state Tractor-trailer

Mid case

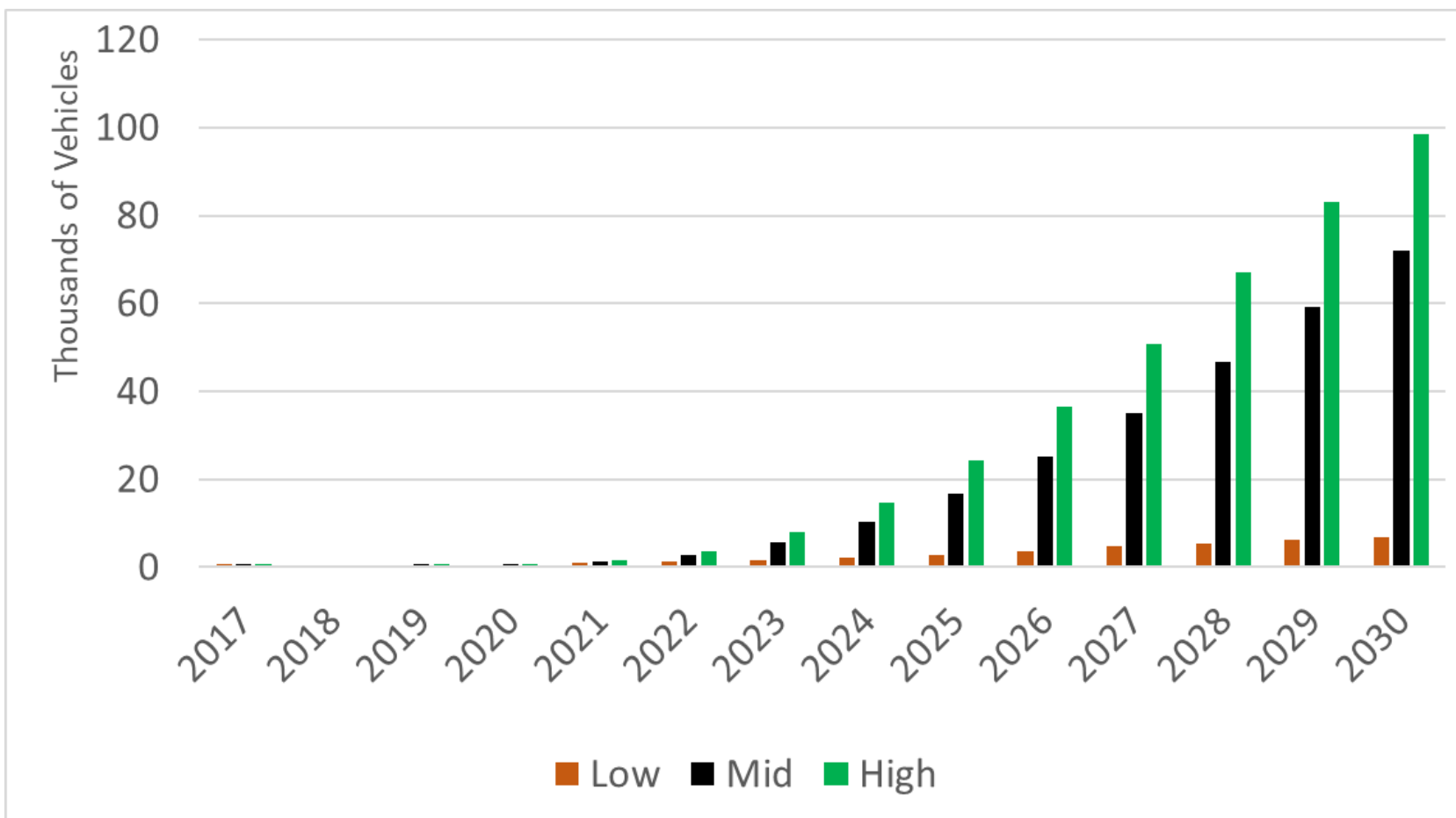


High case





Electric Truck Stock Forecast (includes battery and catenary electric)





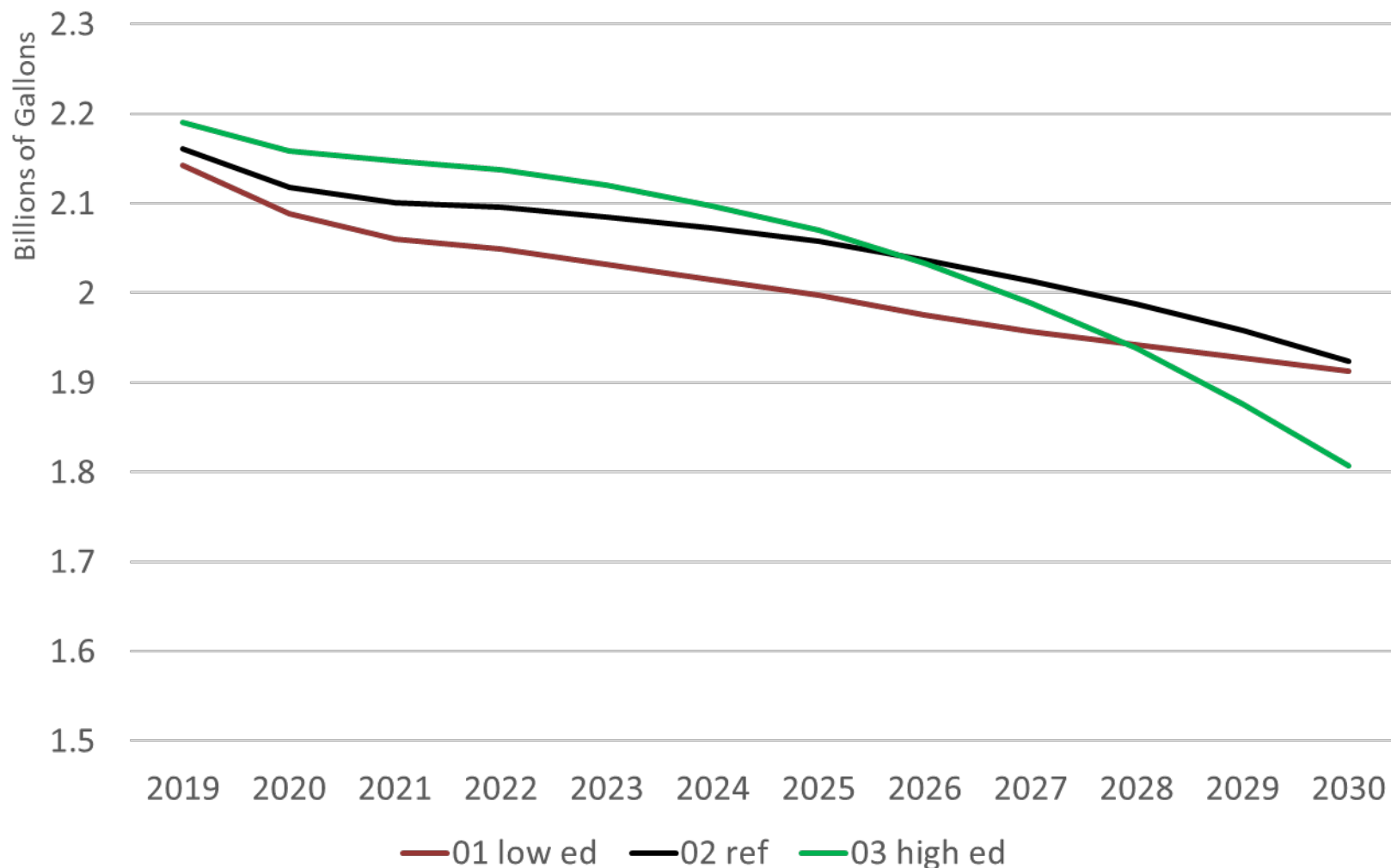
2019 MHD ZEV Vehicle Forecast

INPUTS	2019 IEPR Medium & Heavy Duty ZEV Scenarios		
	Low	Mid	High
CALIFORNIA REGULATIONS			
CARB Regulations	Applied to urban transit bus and shuttle bus, implicit for current truck rules	Applied to urban transit bus and shuttle bus, implicit for current truck rules	Applied to urban transit bus and shuttle bus, implicit for current truck rules
SCAQMD Truck & Bus Rules	Implicit for refuse trucks and urban transit buses	Implicit for refuse trucks and urban transit buses	Implicit for refuse trucks and urban transit buses
INCENTIVES			
HVIP (through 2021)	Current HVIP voucher percentage of vehicle incremental cost*	Current HVIP voucher percentage of vehicle incremental cost*	Current HVIP voucher percentage of vehicle incremental cost*
HVIP (from 2022 on)	No Incentives	80% of the current HVIP voucher percentage of incremental cost*	The full current HVIP voucher percentage of incremental cost*
Fuel Prices			
Hydrogen Price	Commercial High case	Commercial Mid case through 2021; constant at \$6.75/Kg from 2022 on	Commercial High case through 2021; constant at \$6.50/Kg from 2022 on
Electricity Rates	Commercial Rates, High	Commercial Rates, Mid	Commercial Rates, Low
ATTRIBUTES			
Vehicle / Battery Price (by 2030)	BEV prices based on battery price declining to ~\$120/kWh	BEV prices based on battery price declining to ~\$100/kWh	BEV prices based on battery price declining to ~\$80/kWh
MPG	Low	Mid/High	Mid/High
Range (2030)	Constrains percentage of truck class based on length of typical trips	Constrains percentage of truck class based on length of typical trips	Constrains percentage of truck class based on length of typical trips
Station Cost/Time	Not Considered	Not Considered	Not Considered
Forecast			
Battery electric MHD Stock (2030)	9,783	74,507	96,258
Electric MHD Stock (2030)	11,977	77,707	105,253
ZEV MHD Stock (2030)	12,342	78,096	118,609

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



MHD Truck consumption of diesel plus gasoline





Possible future work



Toyota – Kenworth hydrogen fuel cell day cab

- Refine incentive schedules
- Include infrastructure cost
- New truck choice model(s)
- Seeking distinct FE for drive cycles
- Newer freight & activity forecasts
- County and utility forecast zone geography
- Regulatory rule-based choice sets
- Test ZEV in other truck classes

Please make suggestions, now or in writing...



Questions? Contact Info:



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