ZEV Mandate Assessment Update

January 17, 2023

Prepared for:

American Petroleum Institute

Martec

Agenda

Background

Scope of Work

Fuel Demand Modeling

2022 Midterm Election Results

ACC II Impact on Federal Compliance & EV Targets

Summary of Findings & Path Forward

Why is this research necessary?

BACKGROUND

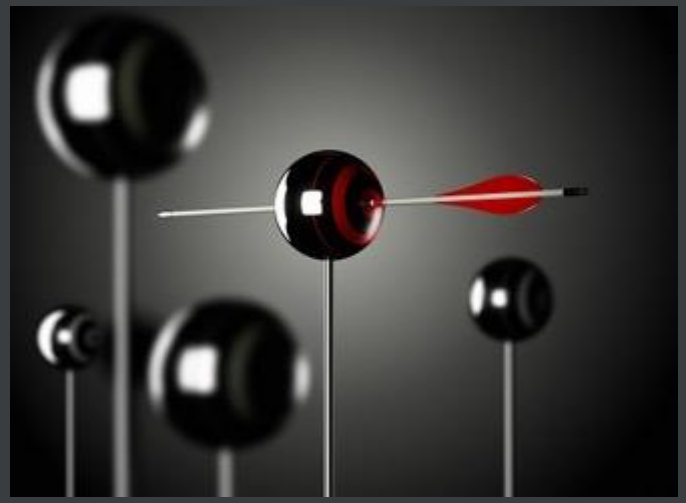
BACKGROUND

Enacted or proposed poli scenarios (i.e., policies) exist that could significantly impact the transportation fleet and number of vehicles that rely on liquid fuels and electricity for powering propulsion. Implementation and structure of these policies span across currently existing federal regulatory authority (U.S. EPA / NHTSA for tailpipe and fuel efficien), expansion of California's state program (CARB- Advanced Clean Car II) to other states (section 177 under the federal Clean Air Act), and aspirational goals of the current Biden administration, boosted by provisions of the Inflation Reduction Act (IRA). For example, Advanced Clean Cars II (ACC II)

The number of zero emission vehicles (ZEVs) or battery electric vehicles (BEVs) in the fleet has increased in recent years, primarily due to a wider availability and increased production by automobile manufacturers, a federal tax credit for qualified purchasers, and various incentives implemented by the states or local jurisdictions. Policies outlined below could result in a faster expansion in the number of ZEVs or possibly shuffle ZEVs across state boundaries and increase their concentration within certain geographic regions.

The Need

"Telling the Story"



American Petroleum Institute (API) is a leading organization that represents all aspects of America's O&G industry representing ~600 members involved in production, refinement, distribution and other services within the petroleum industry. API supports its members with research to help understand facts and trends occurring in the overall market.

API has requested assistance quantifying, through appropriate modeling, the potential implications ZEV policies could have on the oil and gas industry, transportation fuel demand, and impacts on electricity demand and the power grid.

Three of the most relevant policies that could shape the future of the vehicle fleet include:

1. CARB passed a rule that requires OEMs to manufacture 100% of their vehicles as ZEVs by 2035.
2. The U.S. EPA has finalized a rule that is projected to cause automobile manufacturers (OEMs) to increase ZEV production to 17% of total production by 2026.
3. The Biden Administration has set a goal of 50% ZEV sales by 2030.

Martec's analysis will include a baseline to be utilized for measuring impacts of each poli for relevant milestones or specified years over the timeframe extending to at least 2035 and possibly 2050.

What will be covered in the research?

SCOPE OF WORK

Detailed Objectives – ACC II

Martec will leverage primary and secondary research to evaluate the regional impact of ZEV regulations and growth on fuel usage and power requirements.

Objective 1: Identify the current and future number of ZEVs in states affected by ACC II including the following:

- Provide national and regional (by state) penetration forecast for BEV, PHEV and HEV models (2020 – 2045) for modeling purposes and gauging impact of regulations and organic capacity on ZEV growth (3 vehicle cles from now)
- Breakdown for the number of BEVs vs. plug in hybrids vs. internal combustion engine powered LDVs (ICE vehicles) for CA and other identified states, and the national total
  - milestone years charted such as 2026, 2030, 2035, etc.
- Key vehicle and fuel usage metrics in focus (preliminary list):
  - *VIO (Vehicles In Operation – calculated to include the rate for cars coming off the road)*
  - *Total VMT Split (Vehicle Miles Traveled)*
  - *CO2 Reductions (via automotive interventions, capture, and power generation shift – measured in tons)*
  - *Others as identified*
- Assess current demand and supply from 2020 – 2045(F) for leading fuel and power considering national shifts in vehicle types on the road (ICE vs. ZEV vs. Hybrid)
  - *Volume in gallons*
  - *Will be modeled and forecasted across leading fuel types and battery configurations (gallons and barrels)*
    - ✓ *Gasoline*
    - ✓ *Diesel*
    - ✓ *Ethanol*
    - ✓*Battery*
    - ✓*Hydrogen*
    - ✓*Bio-diesel*

Detailed Objectives – ACC II by state

Martec will leverage primary and secondary research to evaluate the regional impact of ZEV regulations and growth on fuel usage and power requirements.

Objective 2: Detail the sensitivities to number of states adopting ACC II.

- Create a national heat map on a state/regional basis
  - *Show where regulations are likely to shuffle ZEV location vs. increase overall national ZEV penetration*
  - *Understand and relate the induvial regulatory and growth environment for ZEVs by state*
  - *Identify where trends or scenarios exist for potential barriers*
- Identify and summarize the ability for each state/region to fulfill the expected fuel and power demands forecast

Objective 3: Geographical impacts related to state adoption of ACC II relative to other states.

- Identify and present current and future mix of vehicle types
  - *Summarize the state and speed of adoption for each*
  - *Uncover and detail the leading barriers and drivers behind each forecast*
  - *Clarify the narrative behind specific bottlenecks and contradictions uncovered in the models*

Detailed Objectives – OEM Implications & ZEV Growth Model

Martec will leverage primary and secondary research to evaluate the regional impact of ZEV regulations and growth on fuel usage and power requirements.

Objective 4: Implications of OEMs increasing ZEV production to comply with federal requirements.

Objective 5: Implications and potential for the IRA or other Biden administration proposal to reach 50% ZEV sales by 2030. (includes an updated feasibility forecast with a visible model)

- Drivers (preliminary examples):
  - *Government mandates/regulations (i.e., California ZEV, European ZEV, etc.)*
  - *Government contracts (purchasing targets/technology mandates)*
  - *OEM Corporate/Fleet statements and mandates*
  - *Potential deregulation (i.e., mining, env. Regulations or processes)*
  - *Technology phases*
  - *Others as identified*
- Barriers (preliminary examples):
  - *Location of key materials (mining & processing)*
  - *Speed of capture (exploration/development, mining, refining/purification, etc.)*
  - *Cap-Ex/Investment from mining & processing community*
  - *Environmental sustainability & resources (water, labor, etc.)*
  - *Material pricing volatility*
  - *Transportation/Logistics & transportation costs*
  - *Petroleum market response*
  - *Others as identified (e.g., OEM resistance, supply chain delays, etc.)*

Detailed Objectives – Supply & Demand Scenarios

Martec will leverage primary and secondary research to evaluate the regional impact of VEZ regulations and growth on fuel usage and power requirements.

Objective 6: Change in liquid fuel consumption resulting from changes in the number of ZEV in the transportation fleet.

- Identify the total expected impact of ZEV growth on liquid fuel consumption by state
- Detail leading the expected consequences of the decreased fuel consumption demand
  - *Will power production and storage keep pace with ZEV charging demand?*
  - *What bottlenecks exist and potentially when?*
  - *Which industries will experience significant restructuring, labor loss, and financial complications with the expected drop in fuel demand?*
- Martec will conduct feasibility scenarios for supply and demand for fuel consumption and dedicated power

Objective 7: Analysis of power sector in meeting new transportation fuel demand.

- Analyze and assess the status of the current and future power sector readiness for the projected ZEV penetration by state

Objective 8: Conclusions

- Martec will analyze & summarize the delta between ZEV growth scenarios and associated fuel consumption by state vs. mandated/projected targets considering current & future challenges on a US and state by state basis

Identify the current and future number of ZEVs in states affected by ACC II

FUEL DEMAND MODELING

Fuel Demand Model Inputs and Assumptions

- Total fuel demand is based on the number of vehicles, the distance those vehicles travel, and the average fuel economy of those vehicles
    - Our approach is to look a 2 separate cohorts, cars and trucks, for analysis as their driving patterns, fuel consumption, full useful life because each are significantly different and should be accounted for given the shift from cars to trucks in the US fleet.

- 2022 vehicles in operation (VIO) is generated from Polk vehicle registration data
    - Vehicles by type (car vs truck)
    - Model year of the vehicle
    - State where vehicle is registered
    - EV volume for each type, model year, and state

- Forecast of vehicle sales in the US is based on the Energy Information Administration in its annual energy outlook
    - This is broken out by cars and trucks through 2050

Fuel Demand Model Inputs and Assumptions

- Since we are forecasting a VIO we need to account for the retirement of vehicles from the fleet over time
    - EPA publishes this data that they use for MOVES3 in document EPA-420-R-20-023, published in November 2020
    - This data is said to be developed from the same Polk dataset we are using for this project
    - Martec has used the Polk data to develop the retirement rates for up-to-date vehicle retirement factors for older trucks to more accurately account for the number of these vehicles

- This same EPA document also publishes average miles traveled based on vehicle age
    - 25-year average miles per year for cars
    - 32-year average miles per year for trucks
    - Potential issues accounting for lockdown effect in the short term

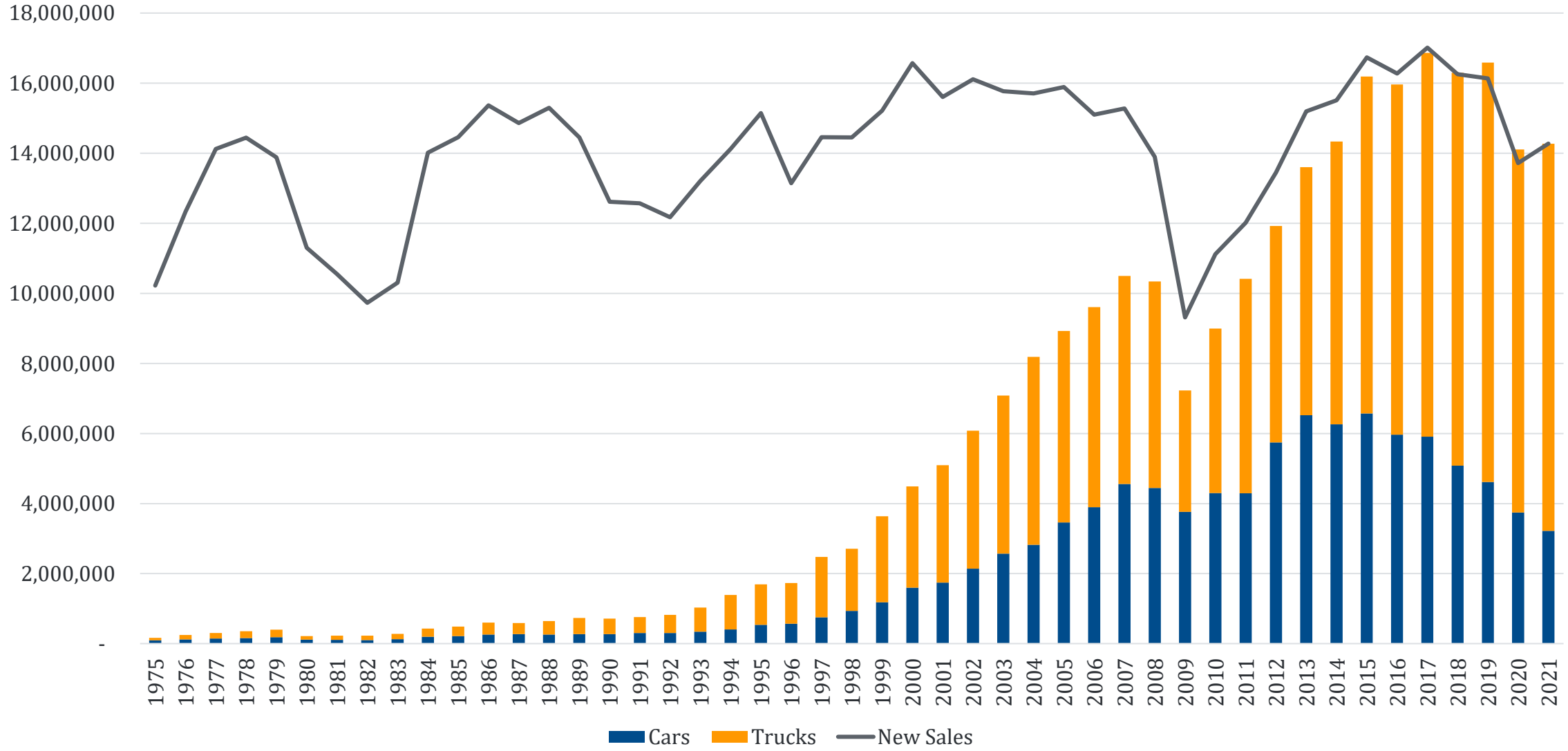
- We also must account for the number of vehicles not consuming fuel (EVs)
    - Scenario 1: EIA's EV forecast - ~10% EVs/year by 2050
    - Scenario 2: Biden EV forecast - ~50% EVs/year by 2030, ~80% EVs/year by 2050
    - Scenario 3: "Baby Bear" forecast - ~25% EVs/year by 2050

Fuel Demand Model Inputs and Assumptions

- Finally, we need to find the average fuel economy for cars and trucks over the entire timeline we are modeling, 1975-2050
    - Historic miles per gallon (MPG) data is published by EPA yearly in their Fuel Economy Trends Report
        - This is broken out by cars and trucks
        - Real world MPG values are used rather than compliance cle values
        - MPG effects from BEVs are backed out to get true ICE fuel economy values
    - Forecasted MPG are calculated based on the historic growth of fuel economy over the past 10 years
        - Cars MPG growth rate: ~1.3%
        - Trucks MPG growth rate: ~1.6%
        - Values used for the model assume a 1% growth rate in MPG
            - This is to account for the reduced requirements in ICE improvement rate due to the EV impact on compliance

~280M Light-duty Vehicles in the U.S. Fleet

2022 Vehicles in Operation by Model Year

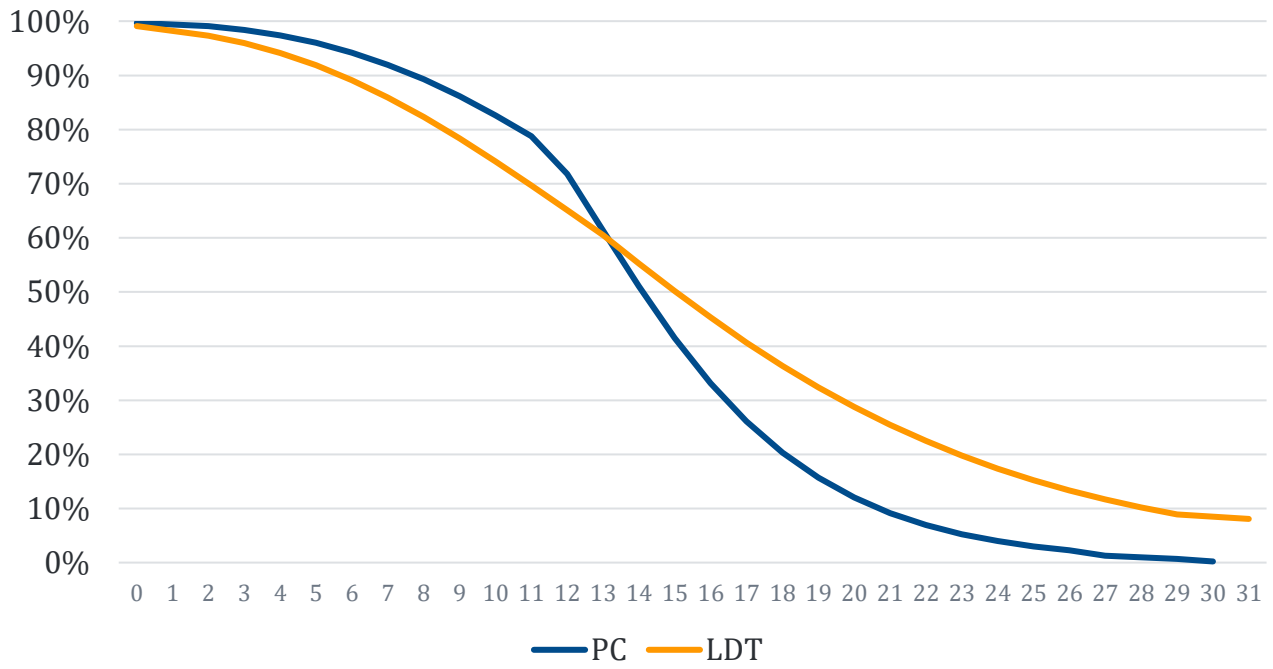


Source: Polk US Vehicles in Operation (October 2022), EPA Fuel Economy Trends Report 2022

Replacement Schedule for Vehicles in the U.S.

Table C-1 Vehicle survival rate by age

Age	Motorcycles	Passenger Cars	Light-duty Trucks (Passenger and Light Commercial)	Heavy-duty Vehicles (Buses, Single-Unit Trucks and Combination Trucks)
0	1.000	0.997	0.991	1.000
1	0.979	0.997	0.991	1.000
2	0.940	0.997	0.991	1.000
3	0.940	0.993	0.986	1.000
4	0.940	0.990	0.981	0.990
5	0.940	0.986	0.976	0.980
6	0.940	0.981	0.970	0.980
7	0.940	0.976	0.964	0.970
8	0.940	0.971	0.958	0.970
9	0.940	0.965	0.952	0.970
10	0.940	0.959	0.946	0.960
11	0.940	0.953	0.940	0.960
12	0.940	0.912	0.935	0.950
13	0.940	0.854	0.929	0.950
14	0.940	0.832	0.913	0.950
15	0.940	0.813	0.908	0.940
16	0.940	0.799	0.903	0.940
17	0.940	0.787	0.898	0.930
18	0.940	0.779	0.894	0.930
19	0.940	0.772	0.891	0.920
20	0.940	0.767	0.888	0.920
21	0.940	0.763	0.885	0.920
22	0.940	0.760	0.883	0.910
23	0.940	0.757	0.880	0.910
24	0.940	0.757	0.879	0.910
25	0.940	0.754	0.877	0.900
26	0.940	0.754	0.875	0.900
27	0.940	0.567	0.875	0.900
28	0.940	0.752	0.873	0.890
29	0.940	0.752	0.872	0.890
30	0.300	0.300	0.300	0.300



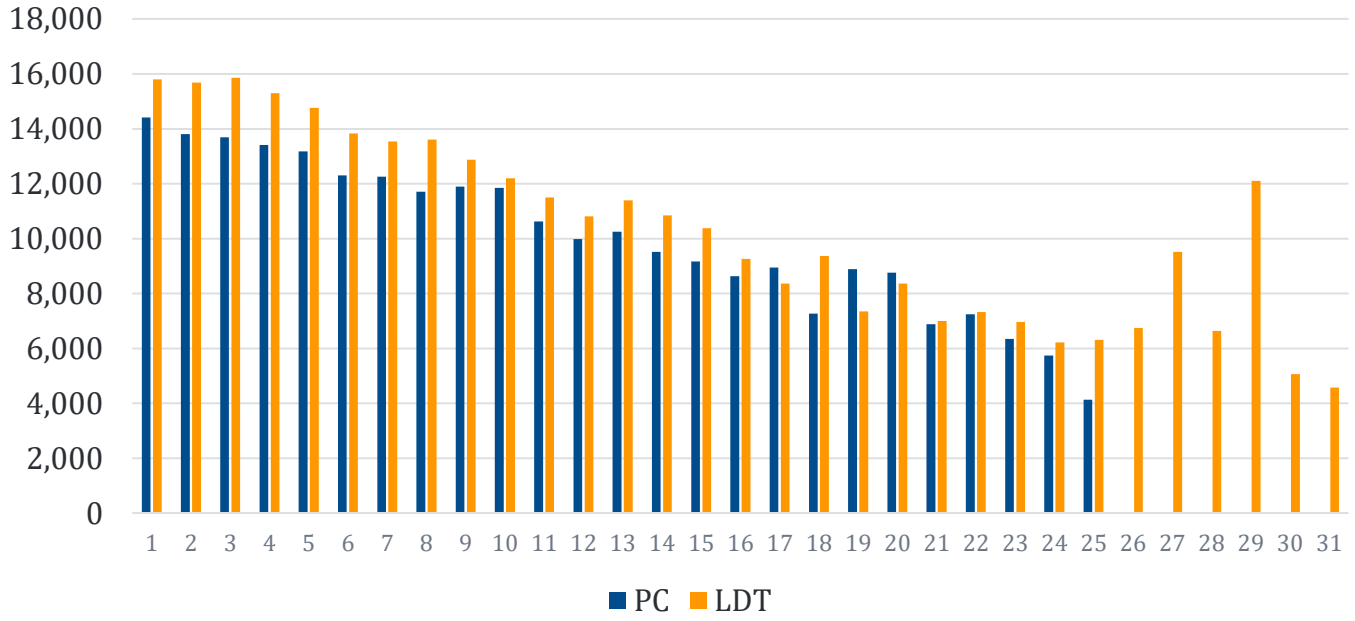
- These values establish the remaining passenger car and light truck units for future years.
  - For example, of all the passenger cars sold in 2022, only 82.6% will still be in operation in 10 years.
  - This accounts for vehicles that have gone out of service due to accidents or wear.

Source: Population and Activity of Onroad Vehicles in MOVES3, Docket: EPA-420-R-20-023 November 2020, Martec Analysis

Vehicle Miles Traveled (VMT) Schedule

Table 6-1 NHTSA Vehicle Miles Traveled from 2001 National Household Travel Survey

	Annual Vehicle Miles Traveled	
Vehicle Age	Passenger Cars	Light Trucks
1	14,417	15,806
2	13,803	15,683
3	13,692	15,859
4	13,415	15,302
5	13,183	14,762
6	12,301	13,836
7	12,253	13,542
8	11,709	13,615
9	11,893	12,875
10	11,855	12,203
11	10,620	11,501
12	9,986	10,815
13	10,248	11,391
14	9,515	10,843
15	9,168	10,378
16	8,636	9,259
17	8,941	8,358
18	7,267	9,371
19	8,890	7,352
20	8,759	8,363
21	6,878	6,999
22	7,242	7,327
23	6,350	6,969
24	5,745	6,220
25	4,130	6,312
26		6,745
27		9,515
28		6,635
29		12,108
30		5,067
31		4,577
32		6,923



- These values establish how many miles are driven based on the age of the passenger car and light truck.
  - Cars older than 25 years and trucks older than 31 years are assumed to not be driven enough to impact the model

Source: Population and Activity of Onroad Vehicles in MOVES3, Docket: EPA-420-R-20-023 November 2020, Martec Analysis

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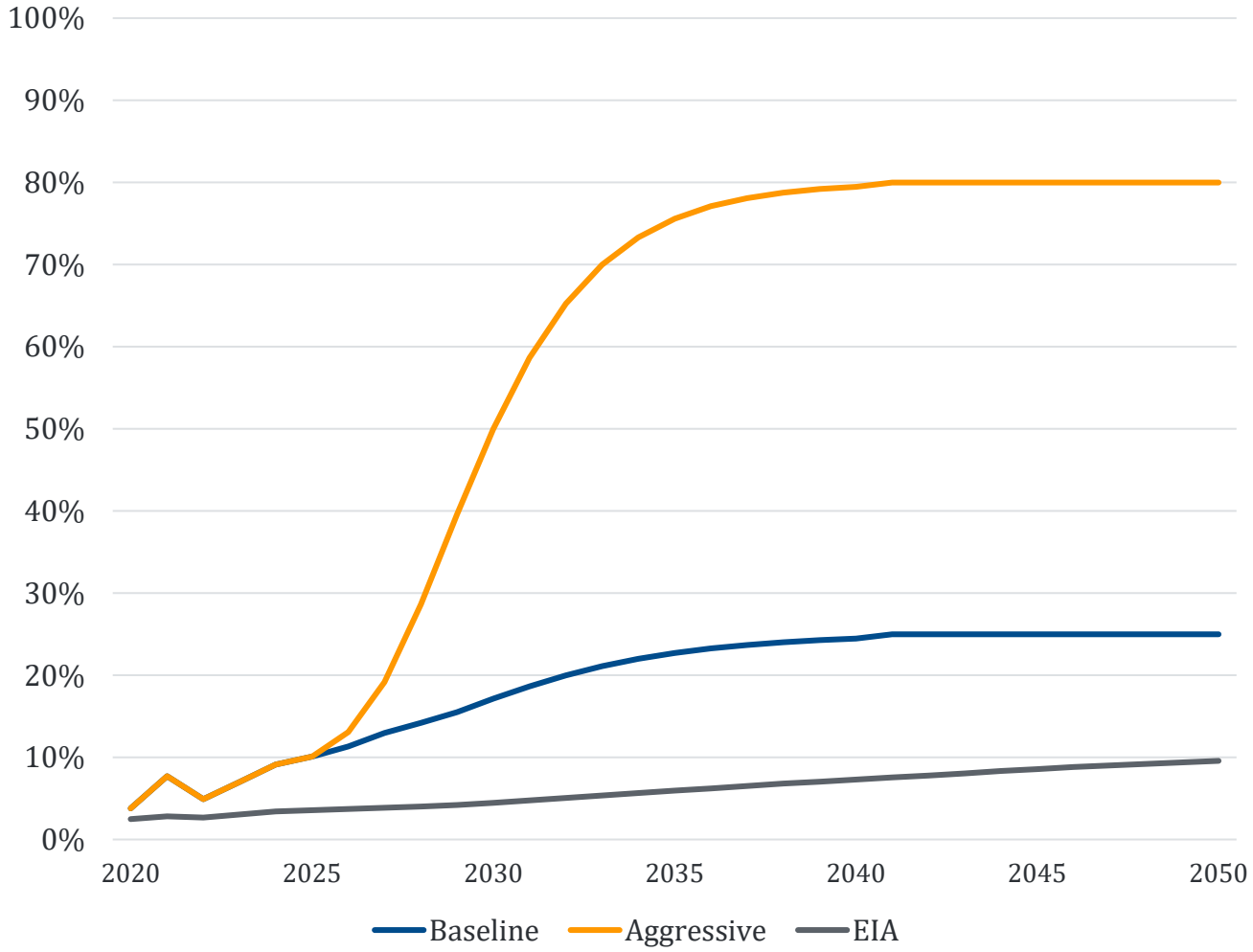
U.S. Electric Vehicle Forecast

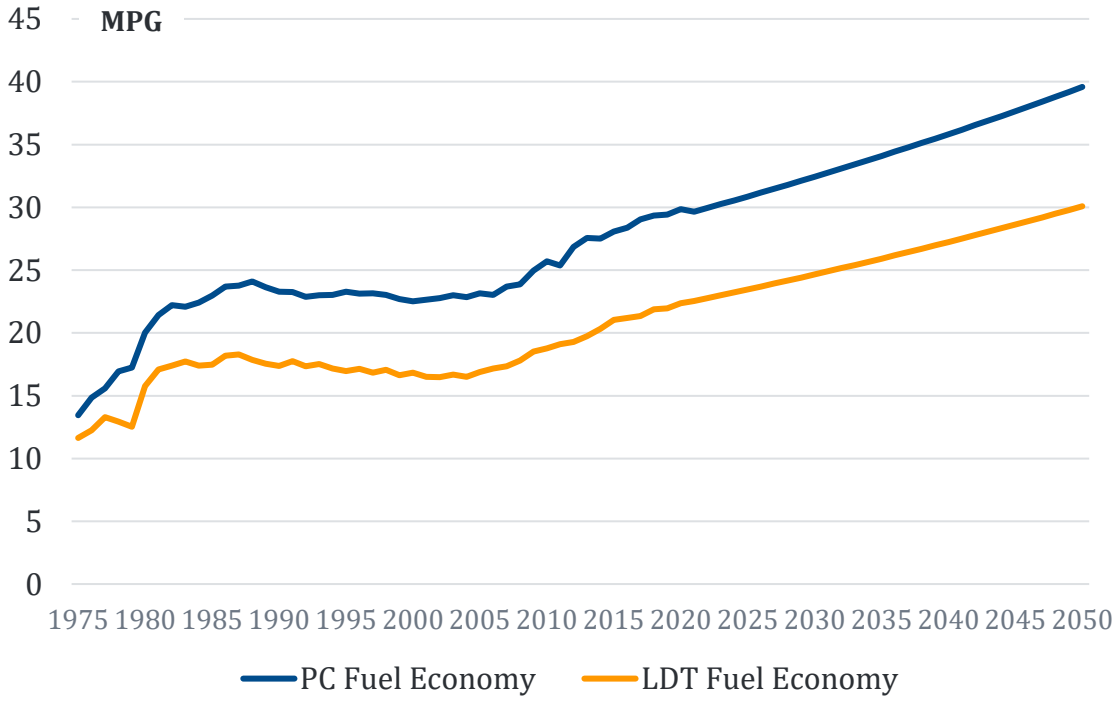


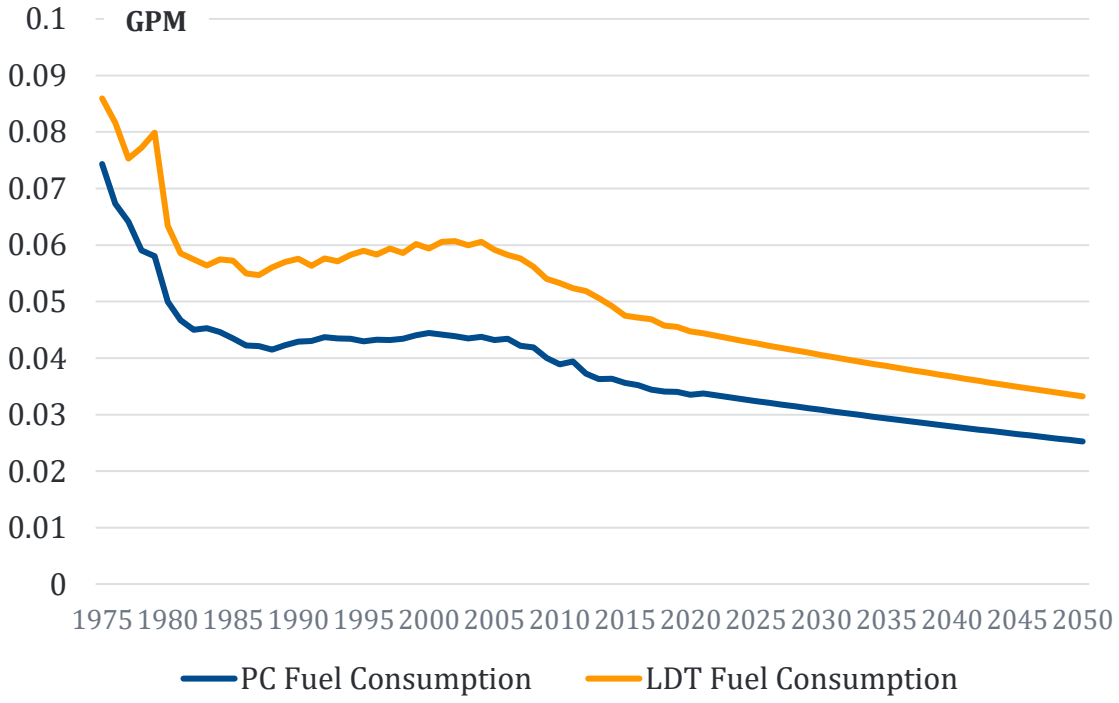
3 scenarios for electric vehicle adoption rates were considered.

- The aggressive scenario follows the U.S. goals of 50% EV market share by 2030
  - This shift creates a tipping point where the majority of automaker investments are in EVs
  - Ultimately rests on 80% market saturation by 2040
- The baseline scenario assumes that EV adoption is limited to 25% due to:
  - Infrastructure and critical material limitations
  - Technology cost increases and charging time reduction stagnates
  - Consumer reluctance to abandon ICE: HEVs and PHEVs implemented to improve fuel economy and CO_2
- EIA's forecast for EVs is limited to 10% of the new vehicle share by 2050.

Source: Martec Analysis

Fuel Economy Trends and Forecast





- Fuel economy has been improving by 1.5-1.8% per year for the last 40 years
- Future fuel economy improvements are reduced to 1% per year improvement to account for the additional spending on electric vehicles and the impact those vehicles will have on overall fuel economy compliance for the fleet.

Source: EPA Fuel Economy Trends Report 2021, Martec Analysis

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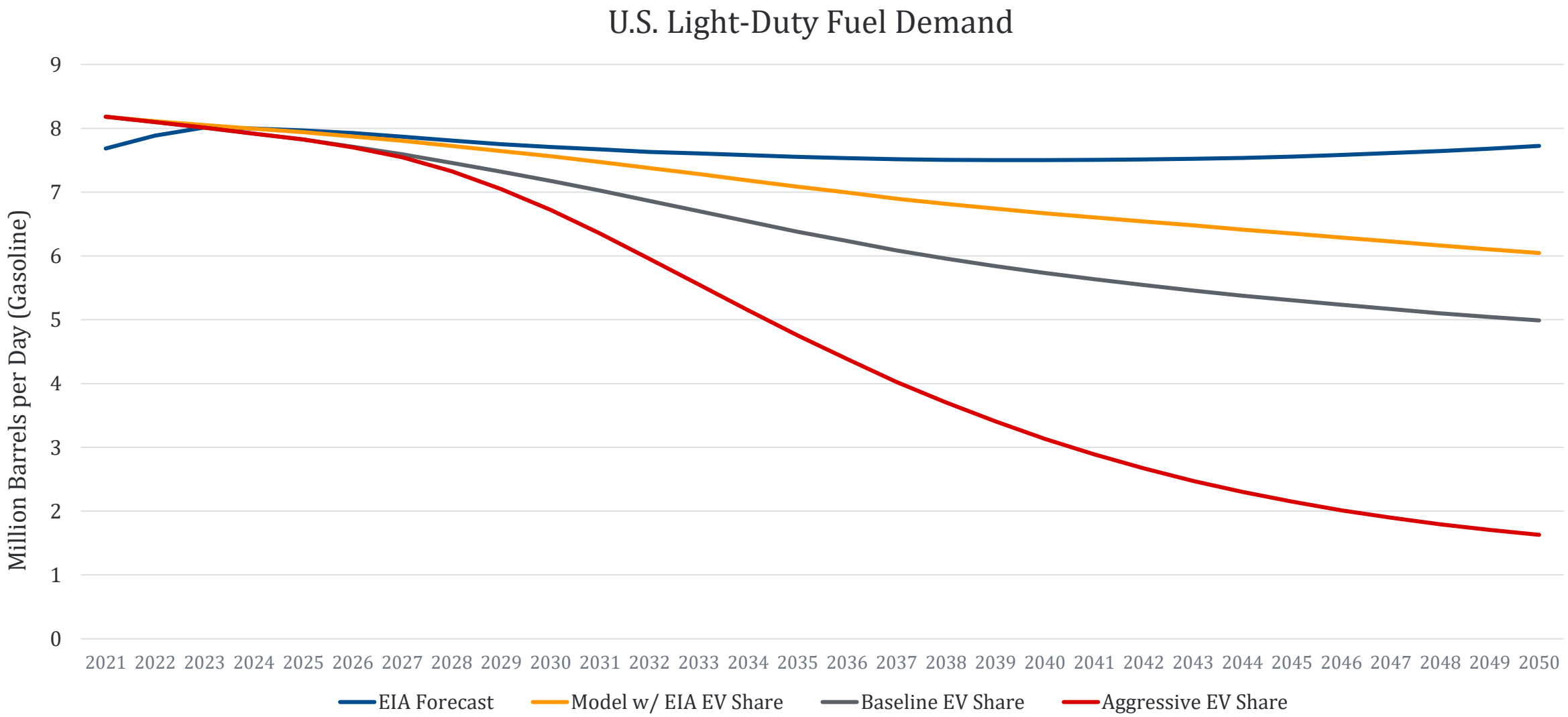
National Fuel Demand Based on Model Output



Source: Martec Analysis, EIA Table 37. Light-Duty Vehicle Energy Consumption by Technology Type and Fuel Type (November 2022)

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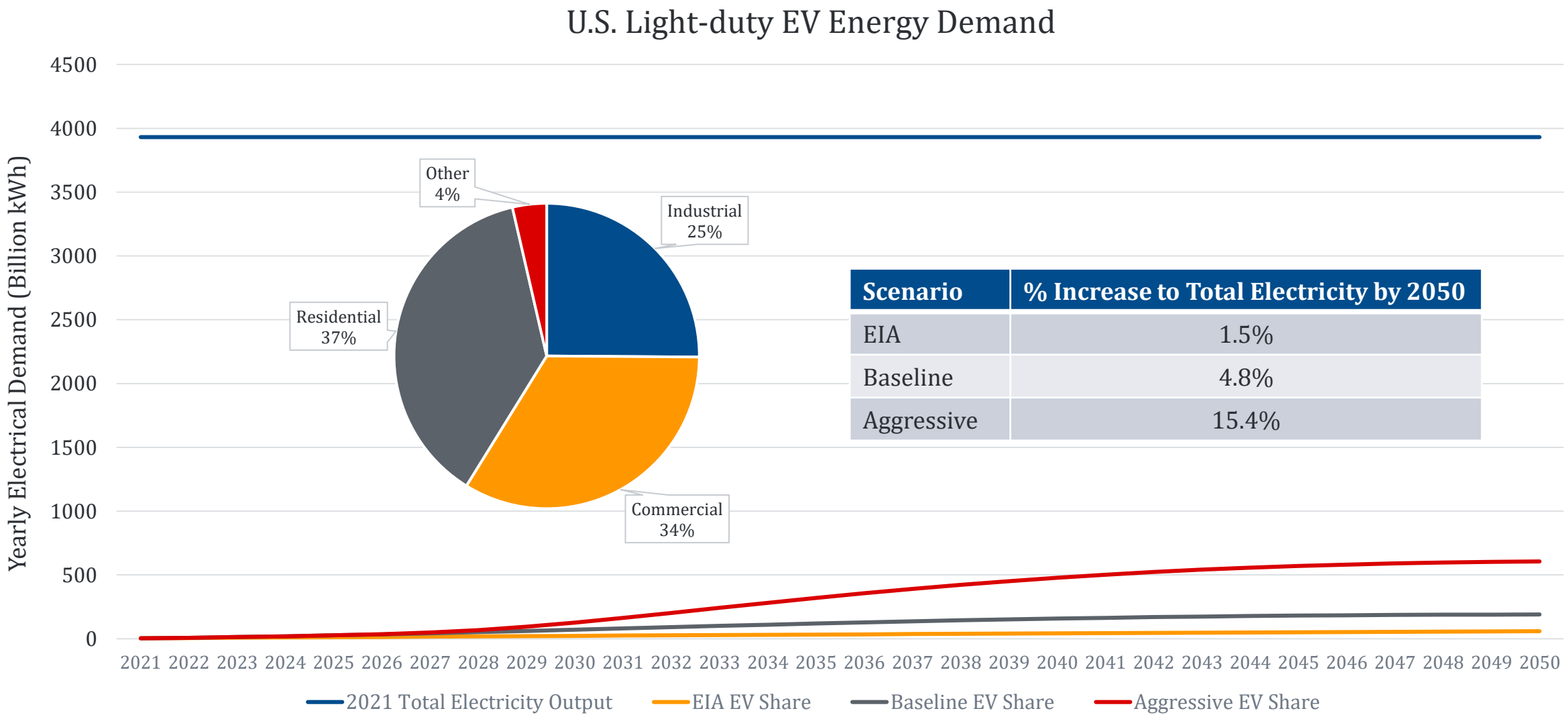
National Electrical Demand Based on Model Output



Scenario	% Increase to Total Electricity by 2050
EIA	1.5%
Baseline	4.8%
Aggressive	15.4%

Source: Martec Analysis, EIA Table 7.2a (November 2022)

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Results from the 2022 elections and how they are likely to affect the adaption of Section 177 of the Federal Clean Air Act

2022 MIDTERM ELECTION RESULTS

The Senate

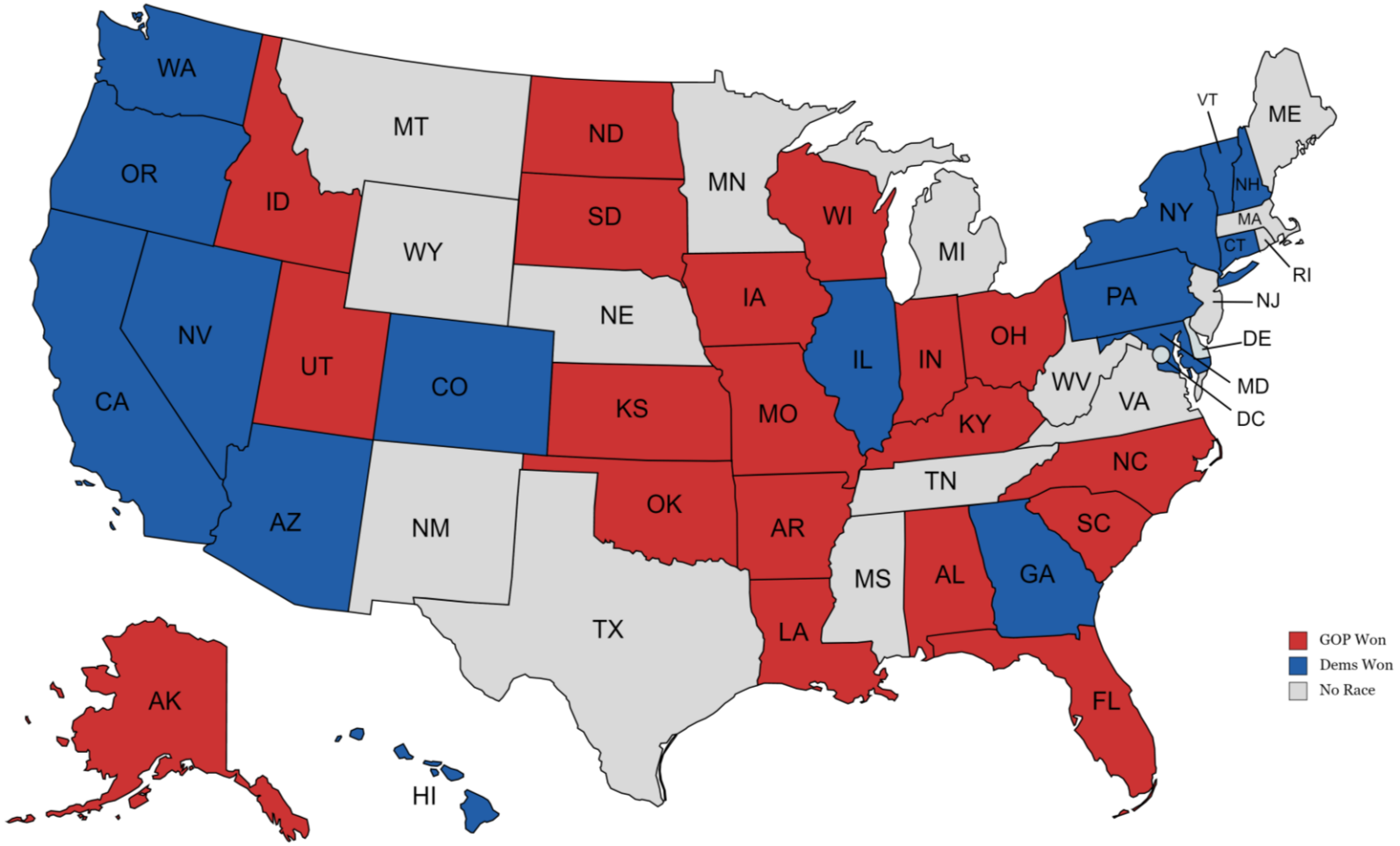
The Senate remains under Democratic control after the 2022 Midterm Election.

Flips to Democrat:

- Pennsylvania

Flips to GOP:

- None



Source: Senate 2022 Election Results, Politico

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The House

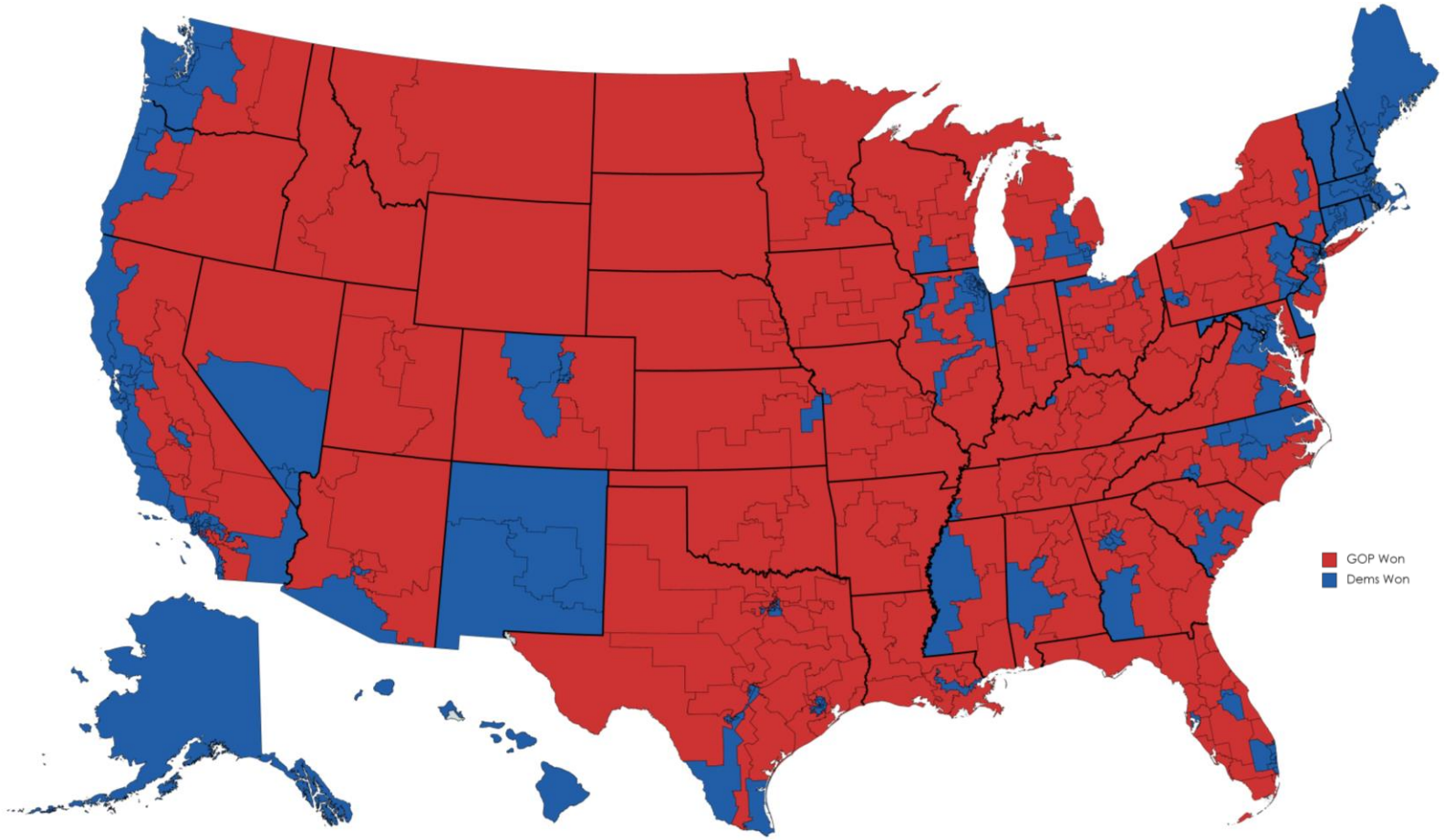
The GOP won the House after the 2022 Midterm Election.

Flips to Democrat:

- AK-AL, CA-21, IL-13, MI-03, NC-13, NM-02, OH-01, OH-13, WA-03

Flips to GOP:

- AZ-02, AZ-06, CA-05, CA-13, FL-04, FL-07, FL-13, GA-06, IA-03, MI-10, NJ-07, NY-03, NY-04, NY-17, NY-19, OR-05, TX-15, VA-02, WI-03



Source: House 2022 Election Results, Politico

Gubernatorial

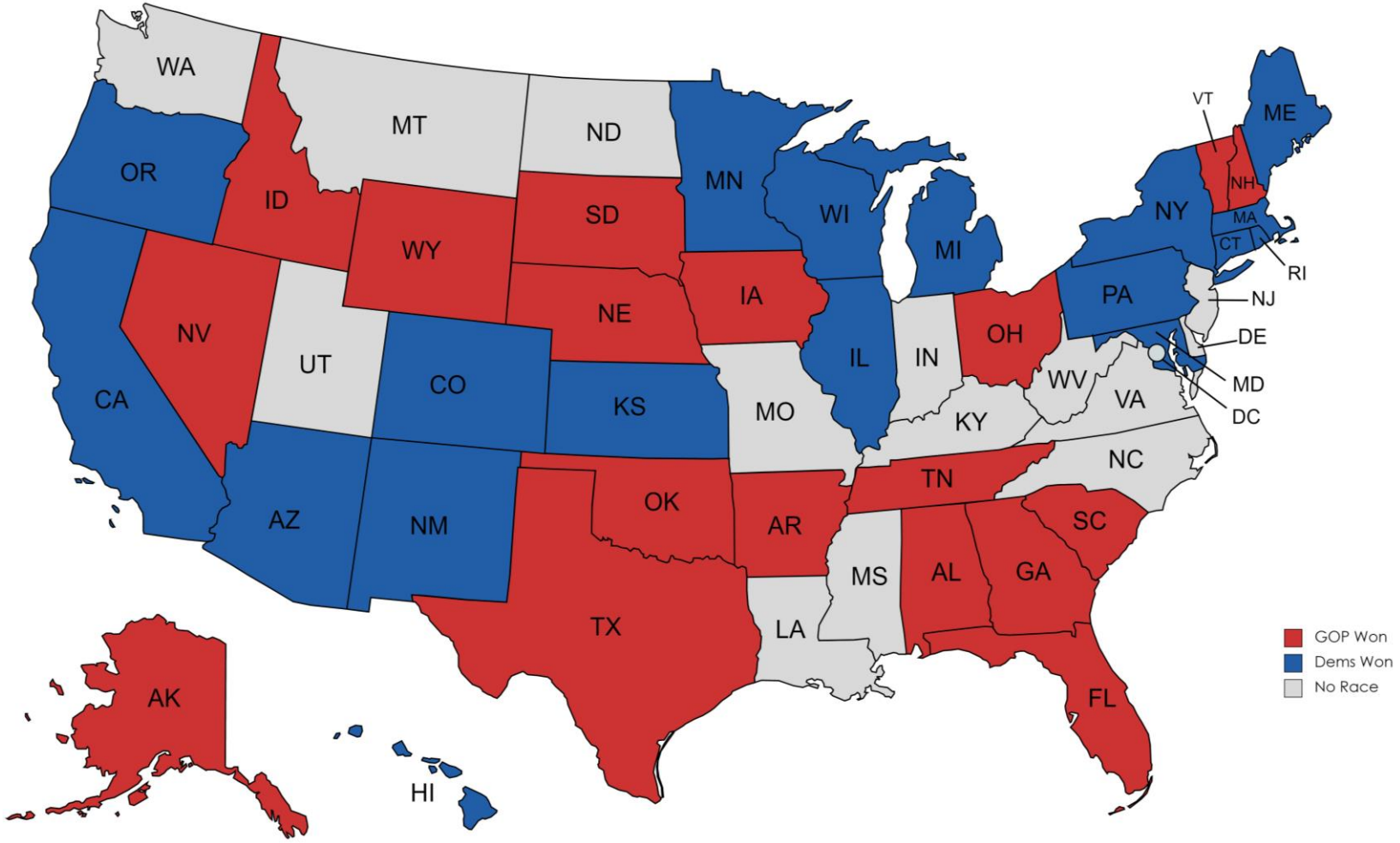
Four states were flipped in gubernatorial elections.

Flips to Democrat:

- Maryland
- Massachusetts
- Arizona

Flips to GOP:

- Nevada

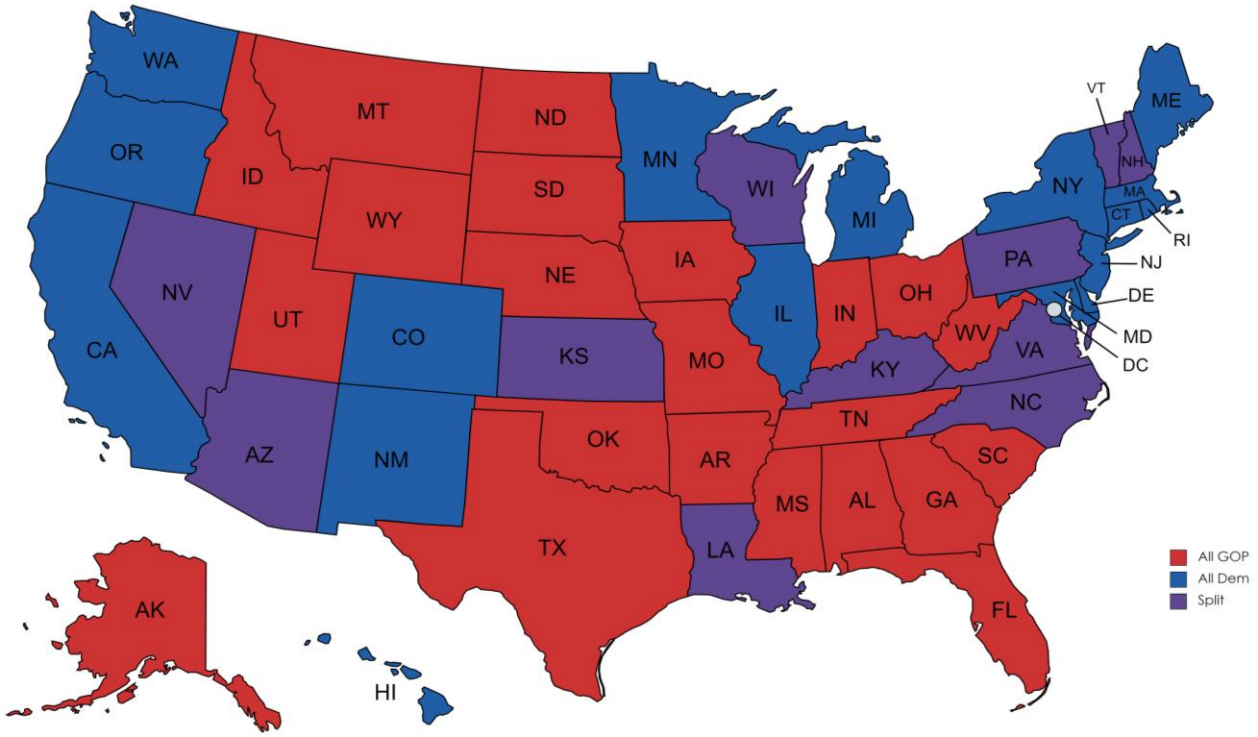


Source: Governor 2022 Election Results, Politico

State Governments

Eleven states now have split state governments.

Split States	Governor	Senate Majority	House Majority
Arizona			
Kansas			
Kentucky			
Louisiana			
Nevada			
New Hampshire			
North Carolina			
Pennsylvania			
Vermont			
Virginia			
Wisconsin			



Source: Governor 2022 Election Results, Politico

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State Governments & CAA Section 177 Pre-ACC II

Committed to Adopting CAA Section 177 (Before Advanced Clean Cars II Rule Adjustment)	Governor (as of 2022 Midterm Election)	Senate Majority (as of 2022 Midterm Election)	House Majority (as of 2022 Midterm Election)
California	Newsom (D) [Incumbent]	Democrat	Democrat
Colorado	Polis (D) [Incumbent]	Democrat	Democrat
Connecticut	Lamont (D) [Incumbent]	Democrat	Democrat
Delaware	Carney (D) *[Elected 2020]*	Democrat	Democrat
Maine	Mills (D) [Incumbent]	Democrat	Democrat
Maryland	Moore (D)	Democrat	Democrat
Massachusetts	Healey (D)	Democrat	Democrat
Minnesota (begin in model year 2025)	Walz (D) [Incumbent]	Democrat	Democrat
Nevada (begin in model year 2025)	Lombardo (R)	Democrat	Democrat
New Jersey	Murphy (D) *[Elected 2020]*	Democrat	Democrat
New Mexico (begin in model year 2025)	Lujan Grisham (D) [Incumbent]	Democrat	Democrat
New York	Hochul (D) [Incumbent]	Democrat	Democrat
Oregon	Kotek (D)	Democrat	Democrat
Pennsylvania	Shapiro (D)	GOP	Democrat
Rhode Island	McKee (D) [Incumbent]	Democrat	Democrat
Vermont	Scott (R) [Incumbent]	Democrat	Democrat
Virginia (begin in model year 2025)	Youngkin (R) *[Elected 2021]*	Democrat	GOP
Washington	Inslee (D) *[Elected 2020]*	Democrat	Democrat

https://ww2.arb.ca.gov/sites/default/files/2022-05/%C2%A7177_states_05132022_NADA_sales_r2_ac.pdf
Source: Senate 2022 Election Results, Politico

State Governments & CAA Section 177 Post-ACC II

The announcement of Advanced Clean Cars II has caused some discourse amongst the original adopting states.

As of January 2023, the only state that is set to fully adopt Advanced Clean Cars II is California.

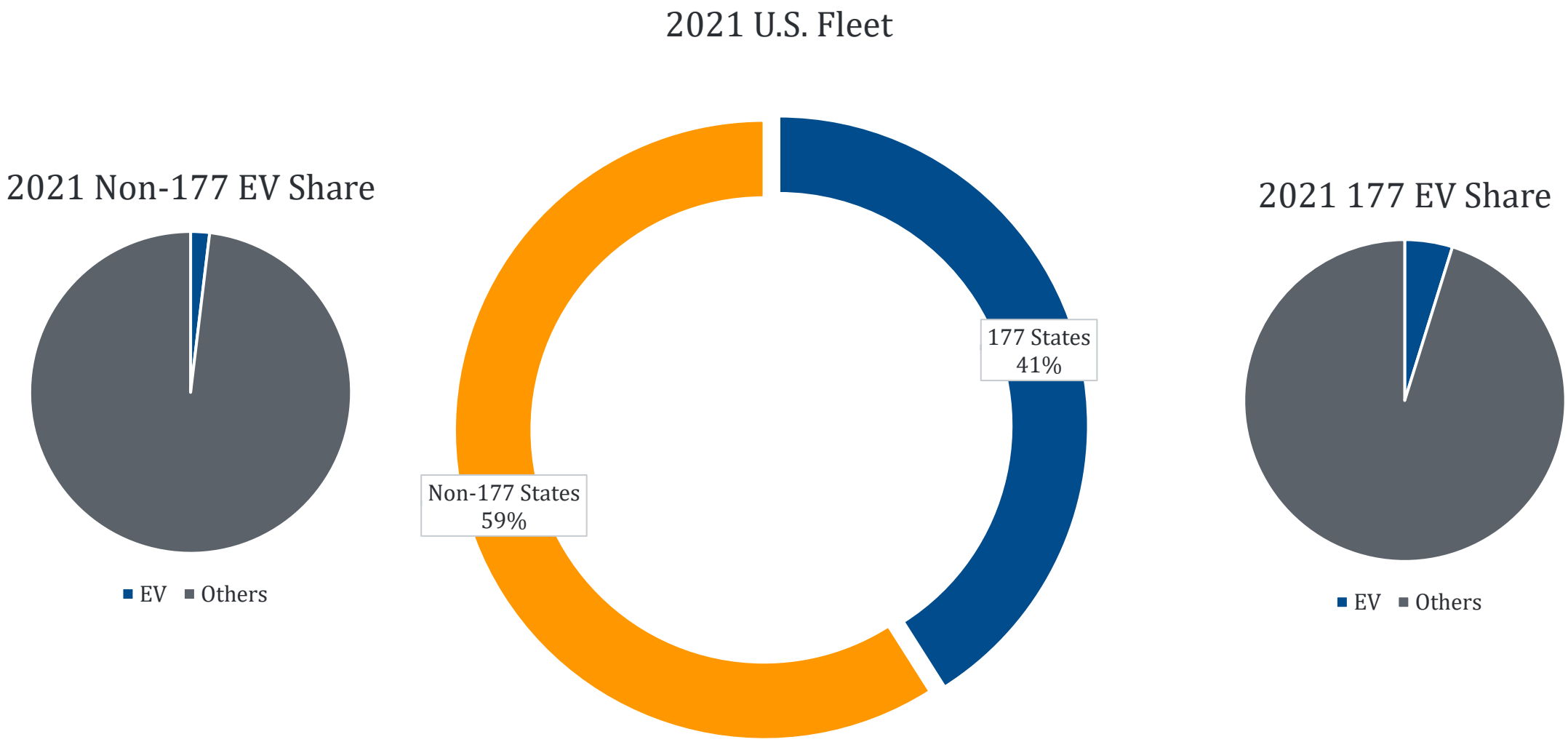
- Massachusetts, New York, Oregon, Vermont, and Washington are all likely to adopt the more stringent rules outlined in ACC II.
- Colorado and Pennsylvania, however, are likely not to adopt the additional rules outlined in ACC II.
- Minnesota and Virginia remain unsure surrounding their stake in the matter.

Implications of OEMs increasing ZEV production to comply with federal requirements

ACC II IMPACT ON FEDERAL COMPLIANCE AND EV TARGETS

Section 177 states were ~40% of total vehicle sales in 2021

With 2.5 times the adoption rate for EVs



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Section 177 States adopting ZEV requirements will need to reach 100% EVs by 2035

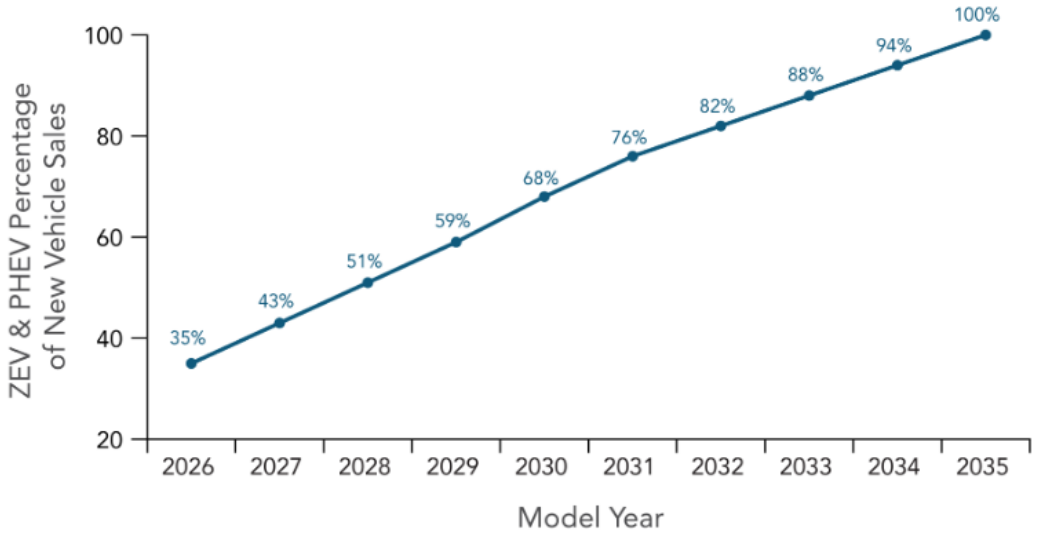
May 13, 2022

States that have Adopted California's Vehicle Standards under Section 177 of the Federal Clean Air Act

The States listed below have adopted California's Low-Emission Vehicle (LEV) criteria pollutant and greenhouse gas (GHG) emission regulations and Zero-Emission Vehicle (ZEV) regulations under Section 177 of the Clean Air Act (42 U.S.C. §7507) beginning with the model year (MY) as shown below. Table current as of May 13, 2022.

State	Applicable MY			State's share (%) of U.S. New Light-Duty Vehicle Sales*
	LEV Regulations		ZEV Program	
	Criteria Pollutant Regulation	GHG Regulation		
California	1992	2009	1990	11.0%
New York[1]	1993	2009	1993	6.1%
Massachusetts[2]	1995	2009	1995	2.1%
Vermont[3]	2000	2009	2000	0.3%
Maine[4]	2001	2009	2001	0.4%
Pennsylvania[5]	2001	2009		3.9%
Connecticut[6]	2008	2009	2008	1.0%
Rhode Island[7]	2008	2009	2008	0.3%
Washington[8]	2009	2009	2025	1.7%
Oregon[9]	2009	2009	2009	1.0%
New Jersey[10]	2009	2009	2009	3.5%
Maryland[11]	2011	2011	2011	1.9%
Delaware[12]	2014	2014		0.3%
Colorado[13]	2022	2022	2023	1.5%
Minnesota[14]	2025	2025	2025	1.5%

State	Applicable MY			State's share (%) of U.S. New Light-Duty Vehicle Sales*
	LEV Regulations		ZEV Program	
	Criteria Pollutant Regulation	GHG Regulation		
Nevada[15]	2025	2025	2025	0.8%
Virginia[16]	2025	2025	2025	2.3%
New Mexico[17]	2026	2026	2026	0.5%



- ACC II EV introduction requires 100% of new vehicle sales are EVs by 2035.
- Modeling for 177 states will assume that ACC II requirements are met.
  - EV share for 177 states is ~5% for 2021
  - Non-177 states is ~2%

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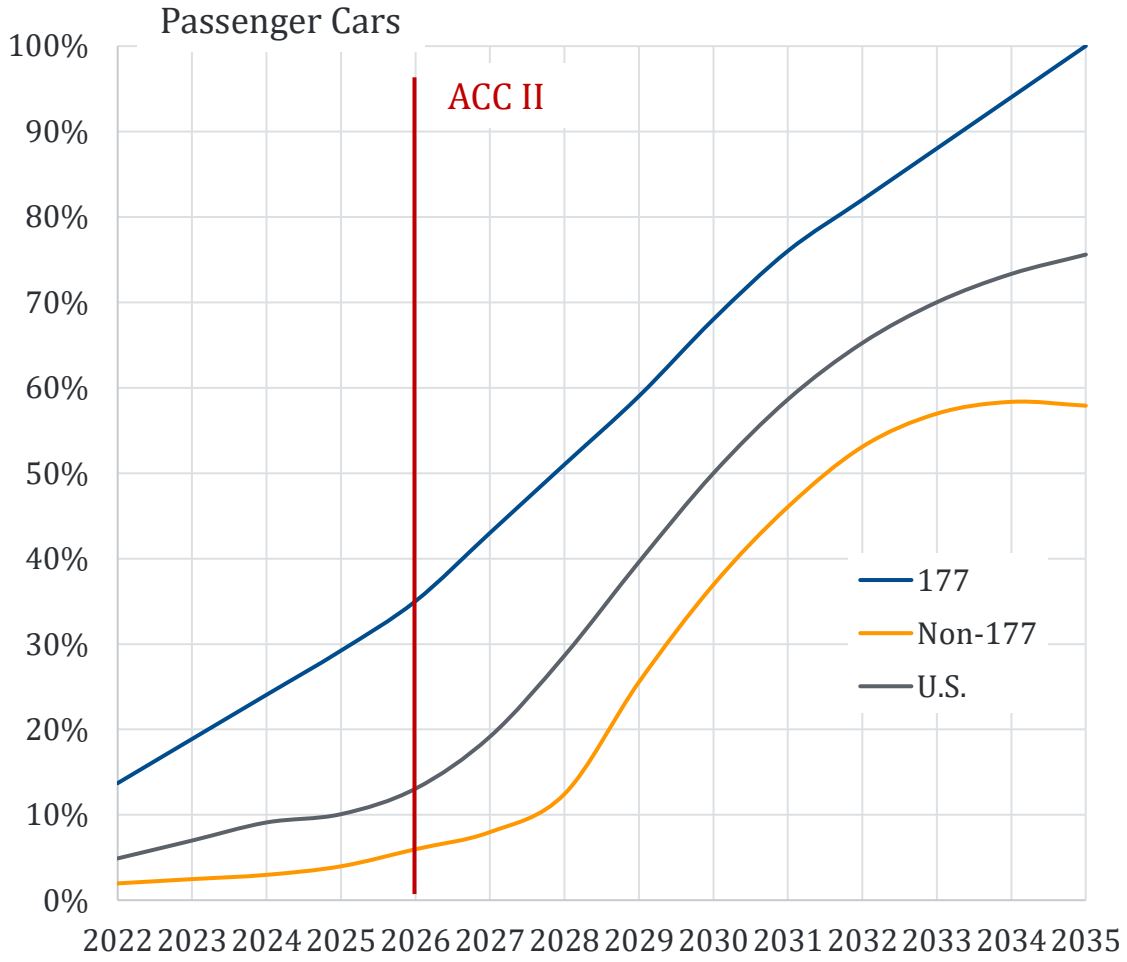
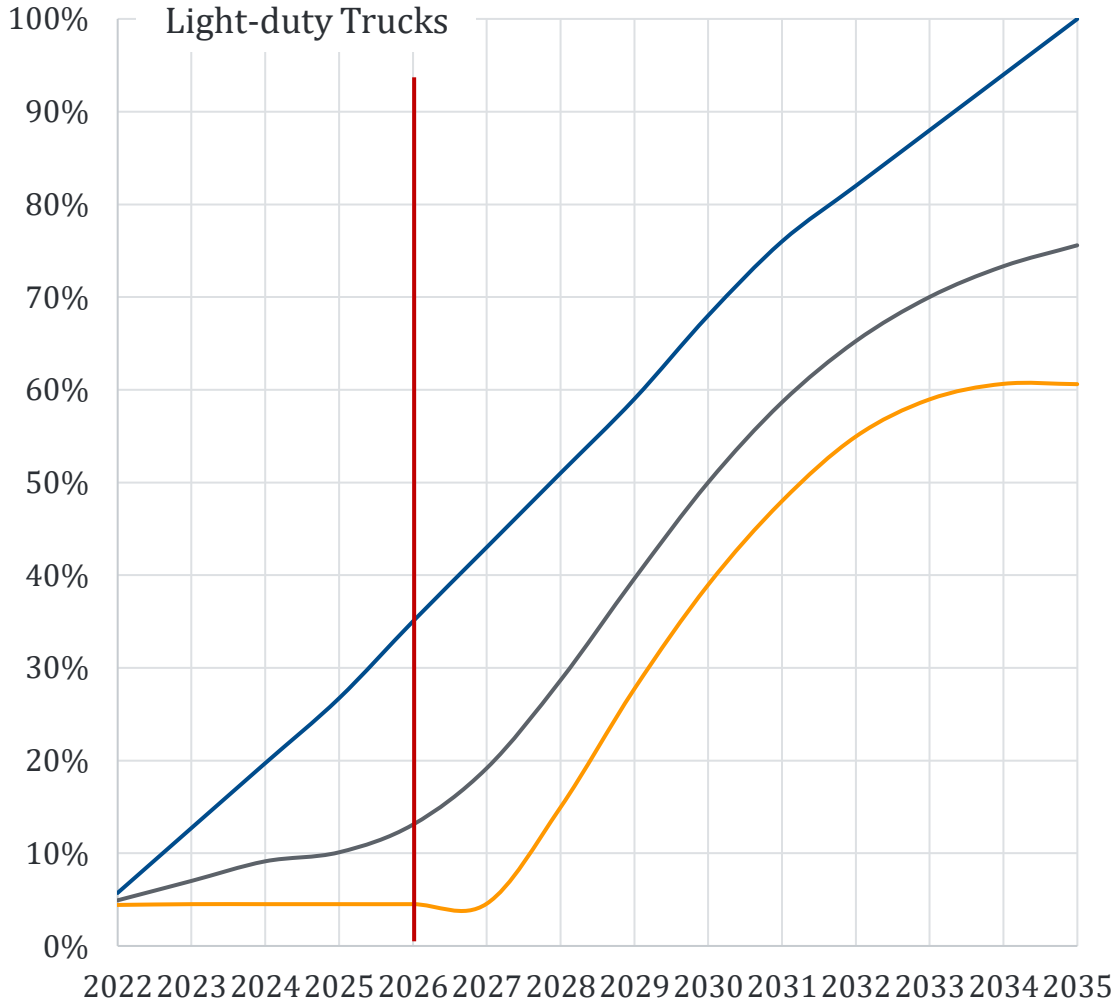
If Section 177 States Achieve Compliance with ACC II

Aggressive EV Scenario Implications





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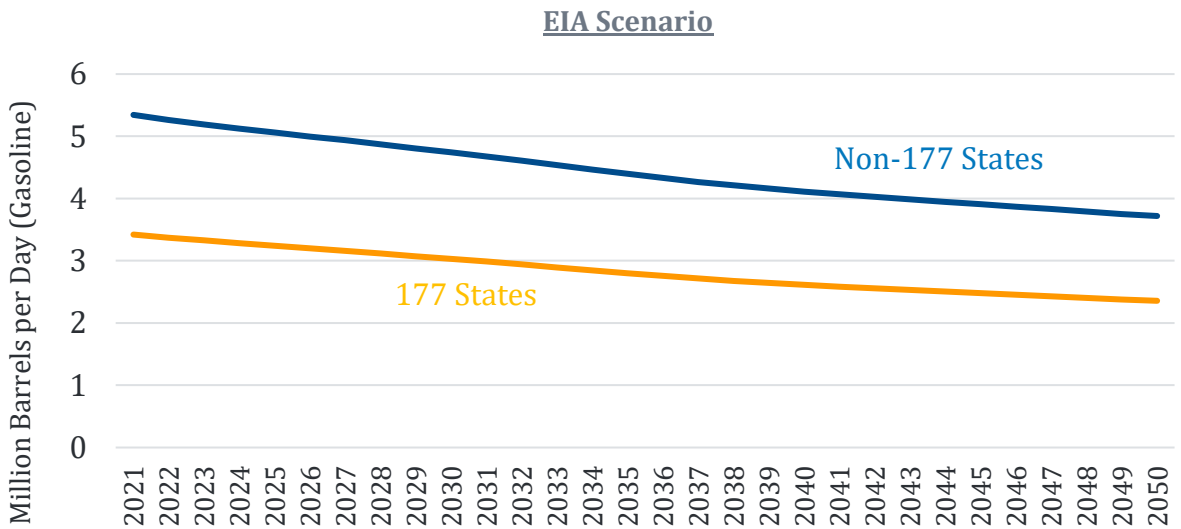
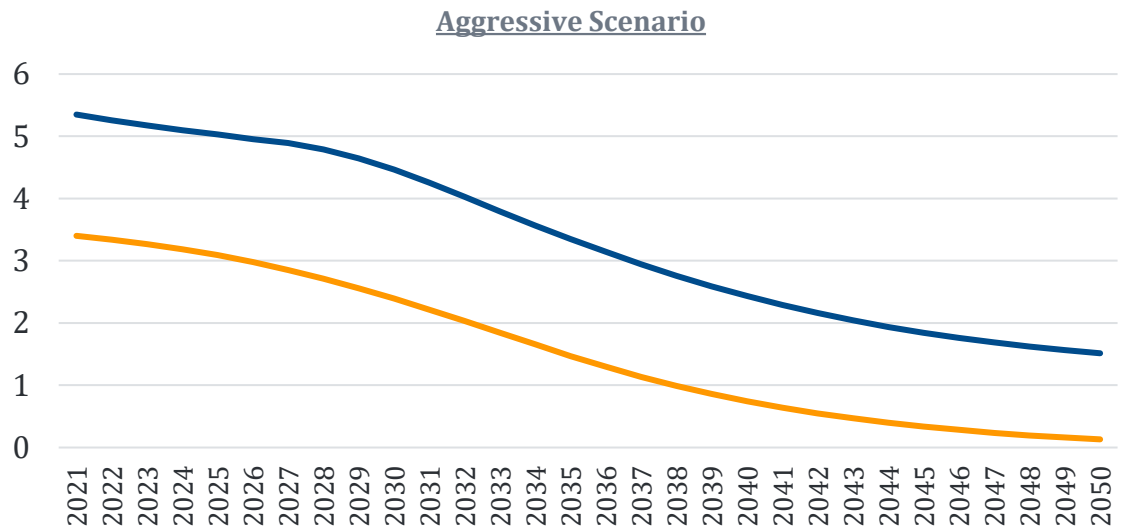
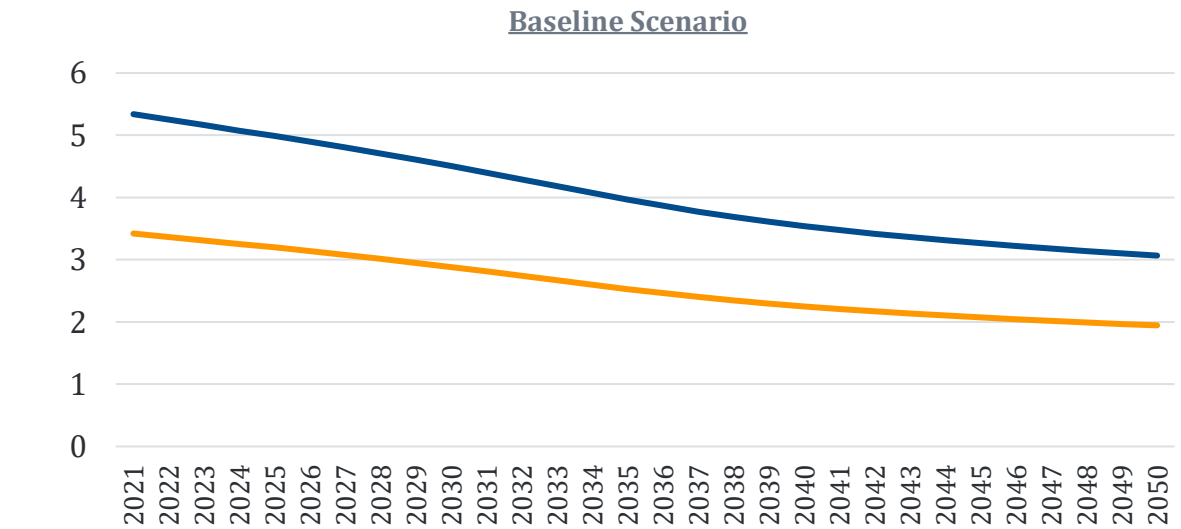
Regional Fuel Demand Based on Model Output







- EIA and Baseline scenarios follow the same EV introduction rates as in the U.S. market scenarios
- The Aggressive scenario follows the ACC II EV introduction requirements leading to 100% EVs by 2035.
    - In this scenario the fuel demand for Section 177 states is near zero by 2050

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Implications of the IRA

IRA Criteria	2023	2024	2025	2026	2027	2028	2029-2032
North America "Clean Vehicle" Assembly	REQUIRED AS OF AUGUST 16, 2022 PHEV, BEV, Fuel Cell Vehicle with battery capacity > 7kWh						
Critical Mineral Requirement credit = $3,750	40%	50%	60%	70%	80%	80%	80%
Battery Component Requirement credit = $3,750	50%	60%	60%	70%	80%	90%	100%
Adjusted Gross Income limitations for credit (New Car Purchase)	<$300,000 Joint Return <$225,000 Head of Household <$150,000 Individual Filer						
MSRP Price Limitations for credit (New Car Purchase)	<$80,000 Van, Pickup, or SUV <$55,000 Passenger Car						
Used EV Purchase Credit	The lesser of $4,000 or 30% of sales price Sale price cannot exceed $25,000 and must be at least 2 years old						

$270 billion for overall budget

- Two-year certification deadline to get facility upgraded or fully built

$10 billion for the advanced manufacturing tax credit

- Starting January 1, 2023, battery cell makers can receive $35/kWh of capacity
- Subsidy applies to cells produced: new/upgraded facilities only
- Battery packing facilities can receive up to $10/kWh of capacity

Foreign Entity of Concern rule:

- After calendar year 2023, NO battery components manufactured
- After calendar year 2024, NO battery minerals extracted, refined or manufactured

All of these incentives are designed to drive investment in U.S. based battery and component manufacturing supporting EVs

- Key challenge is that ~80-90% of the battery capacity is currently held by Chinese companies

SUMMARY OF FINDINGS & PATH FORWARD

Summary of Findings

- The switch to electric vehicles will have a dramatic effect on the consumption of gasoline in the U.S.
    - 25-40% reduction in fuel requirements by 2050 under the more conservative scenarios studied
    - 80% reduction in the most aggressive scenario studied

- Several Section 177 states are weighing the impact of ACC II on their state
    - Virginia, Minnesota, Pennsylvania, and Colorado are most likely to shy away from the more aggressive electrification requirements

- Section 177 states meeting ACC II requirements will essentially eliminate the need for gasoline in their states by 2050
    - Due to the 177 electric vehicle requirement, states not following 177 will generally have lower adoption of electric vehicles
    - Under the aggressive scenario studied, these non-177 states would be about 95% of the total gasoline consumed in the U.S. by 2050

Path Forward

- Address any questions or feedback from today's call
- Address any open items within the scope of work
- Anticipated completion date: End of January