History and market of EVs

ECI 189G: Lecture 2

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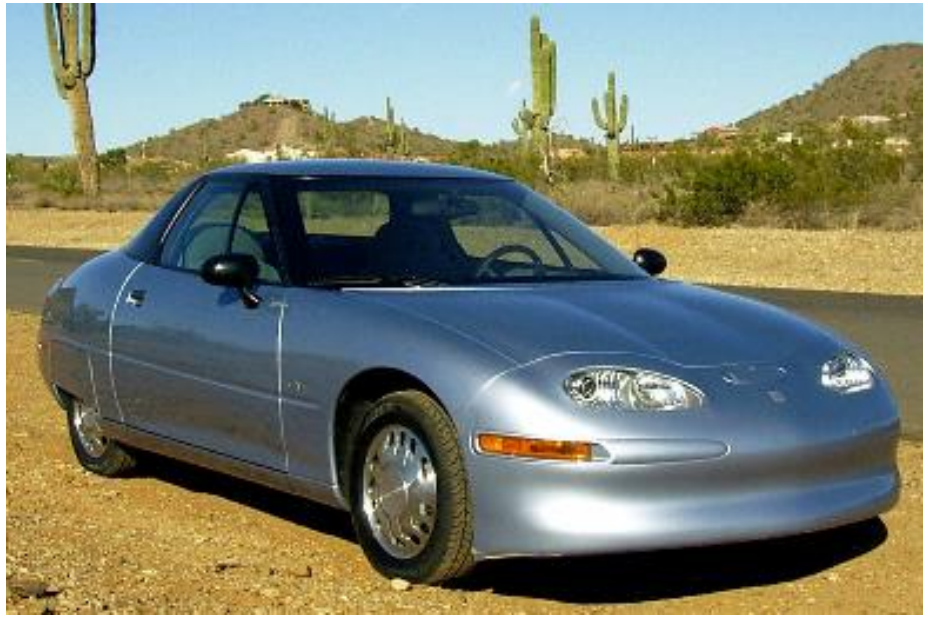
The first electric vehicle

- 1828 – Anyos Jedlik, first electric vehicle
  - EVs fairly popular in the late 1800s, early 1900s
  - Advantage over gasoline diminished by the invention of the electric starter
- First gasoline car wasn’t invented until 1870 by Siegfried Marcus (the “Marcus car”)

The first “modern” electric vehicle

- General Motors produced the EV1 from 1996 to 1999, the first mass-produced electric vehicle
- Earlier versions used 16.5-18.7 kWh lead-acid batteries (55 mi), later versions used a 26.4 kWh nickel metal hydride batteries (105 mi)
- Only available through leases, crushed upon takeback by GM—“self-sabotage”?!
- “Who Killed the Electric Car?”



Revenge of the electric car

- The first* EV to hit the market was the Tesla Roadster (1st gen: 2008 to 2012)
- Built on the Lotus Elise chassis
- First EV sold to use lithium-ion batteries, 53 kWh pack (244 mi)

The first “commercial” electric vehicle

- In December 2010 and January of 2011, the first two commercial markets for mainstream consumers entered the market
- Representing PHEVs: the Chevrolet Volt, a ~40-mile range vehicle
- Representing BEVs: the Nissan Leaf, a ~80-mile range vehicle

Electric vehicle market growth since 2011

- EVs have experienced steady growth over the last decade
- For reference, the US currently sells ~16m passenger vehicles annually
- Lots of concern over stagnant growth in 2019 and 2020 but 2021 returned to substantial growth

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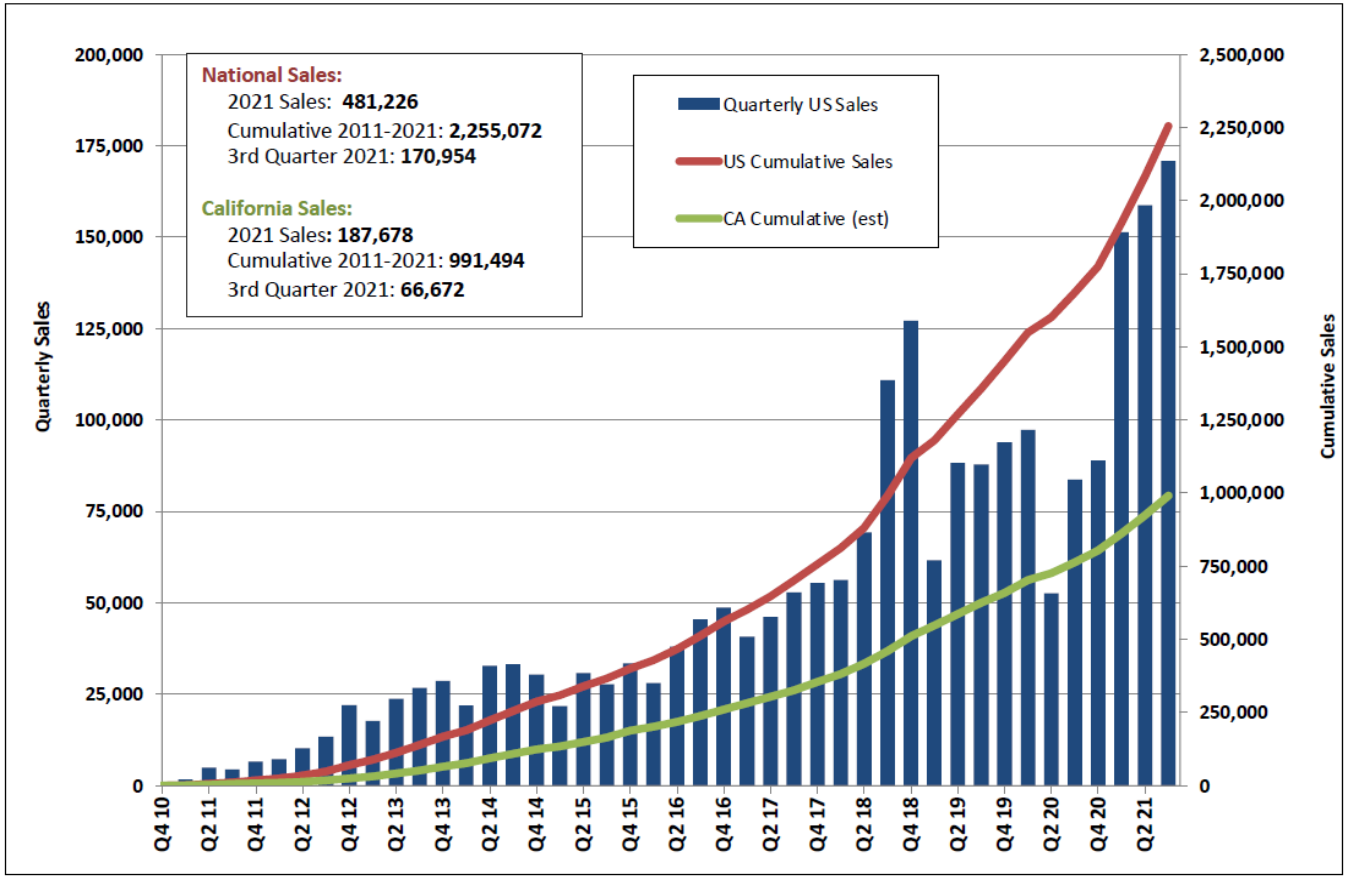
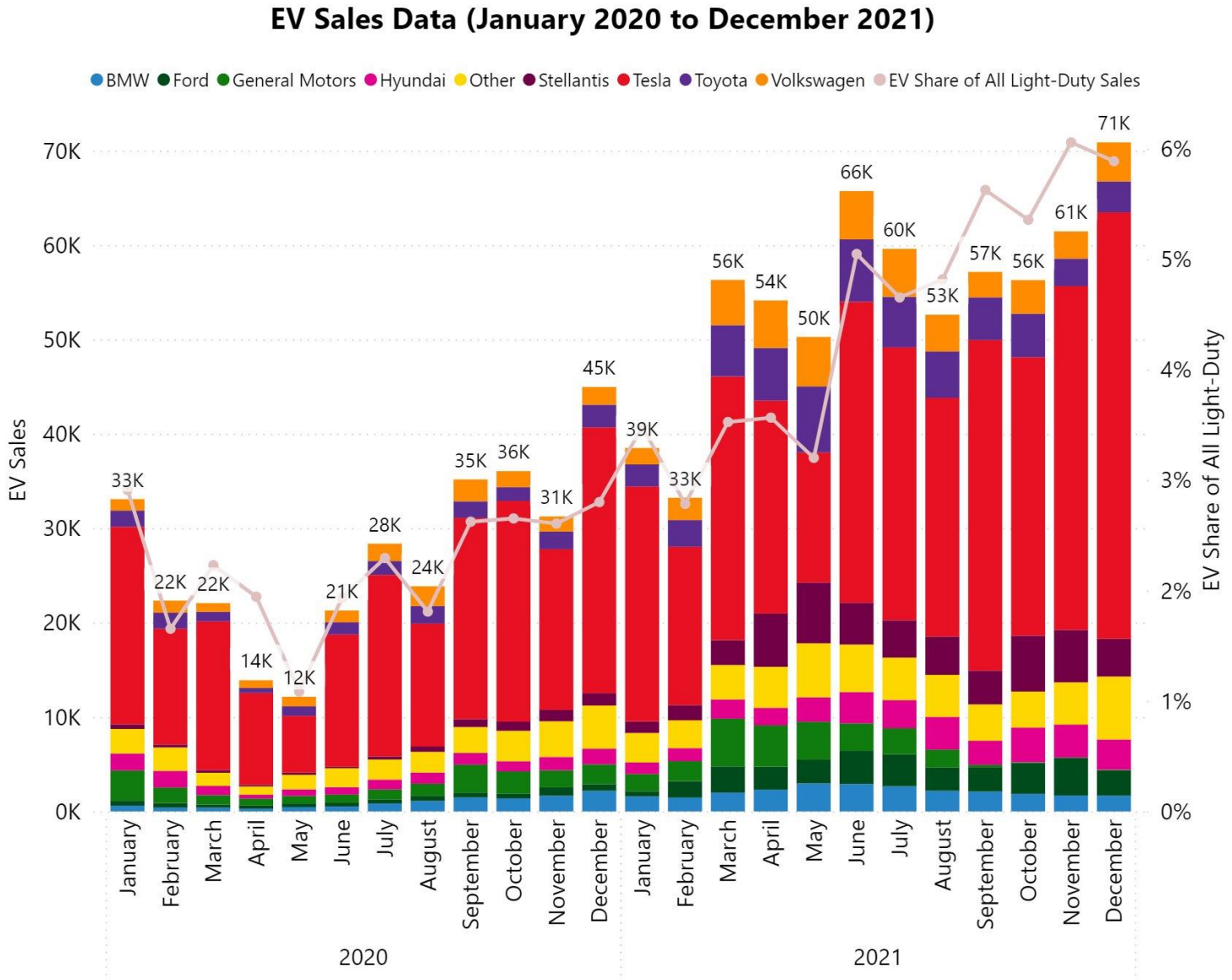
Electric Vehicle Sales in California and the U.S.



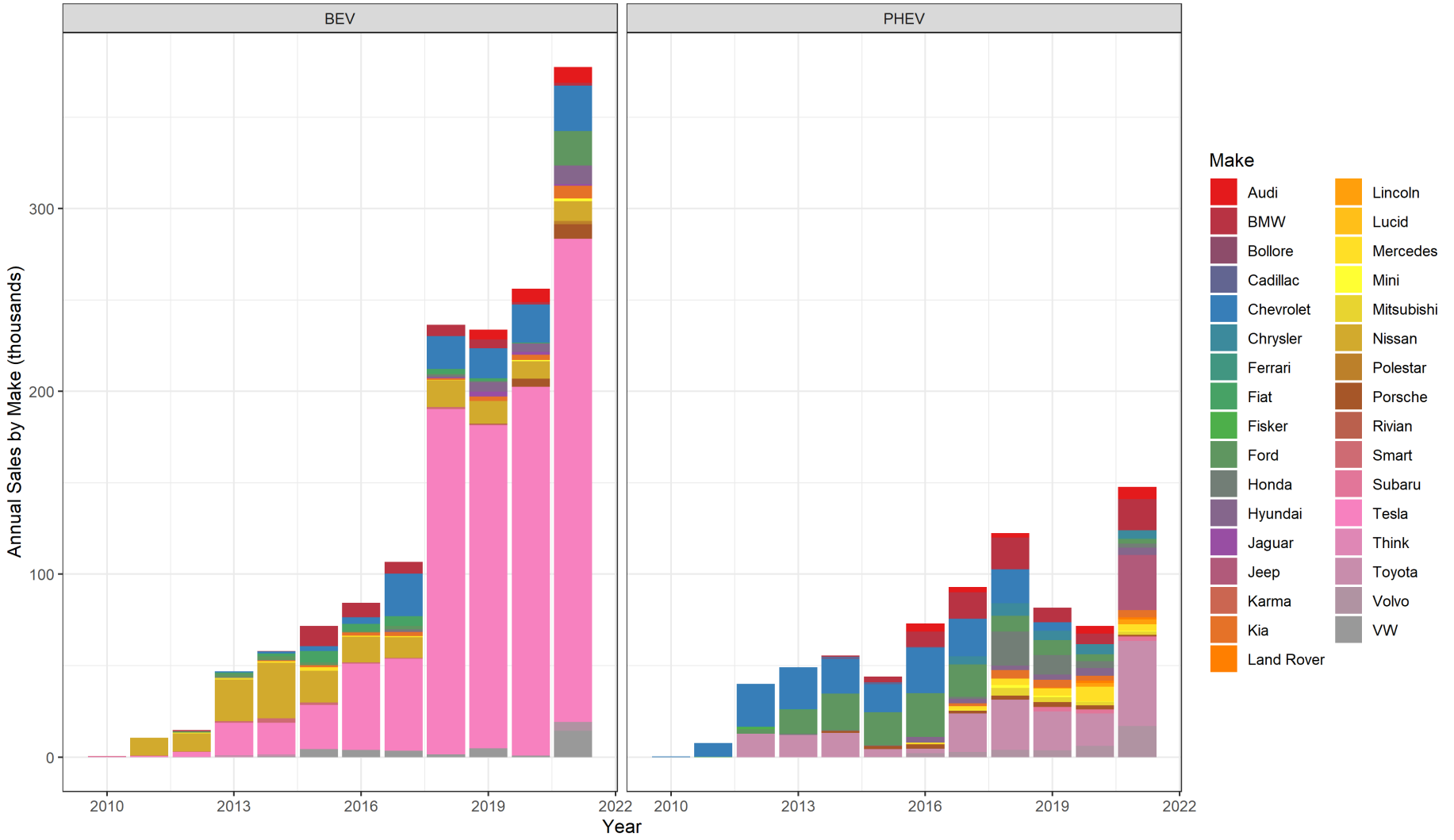
Note: CA sales are 39% of national sales.
Data Source: California Energy Commission (2021).
Retrieved October 30, 2021 from http://www.energy.ca.gov/zevstats

Q3 2021 Data Update.

A sigh of relief for EVs: 2021

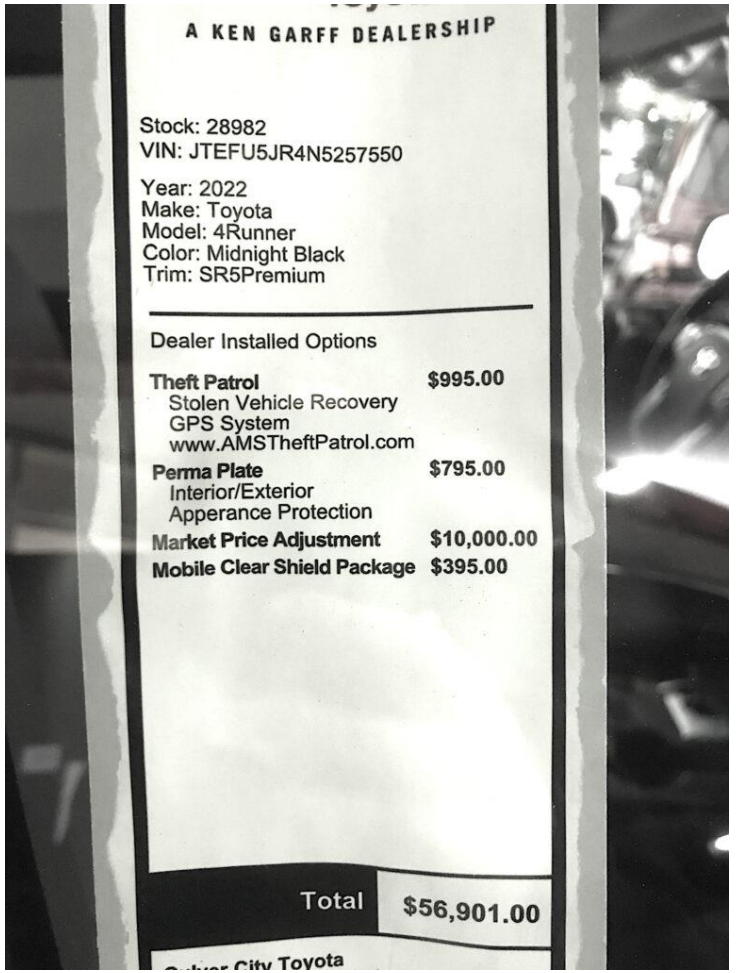


Sales by vehicle model



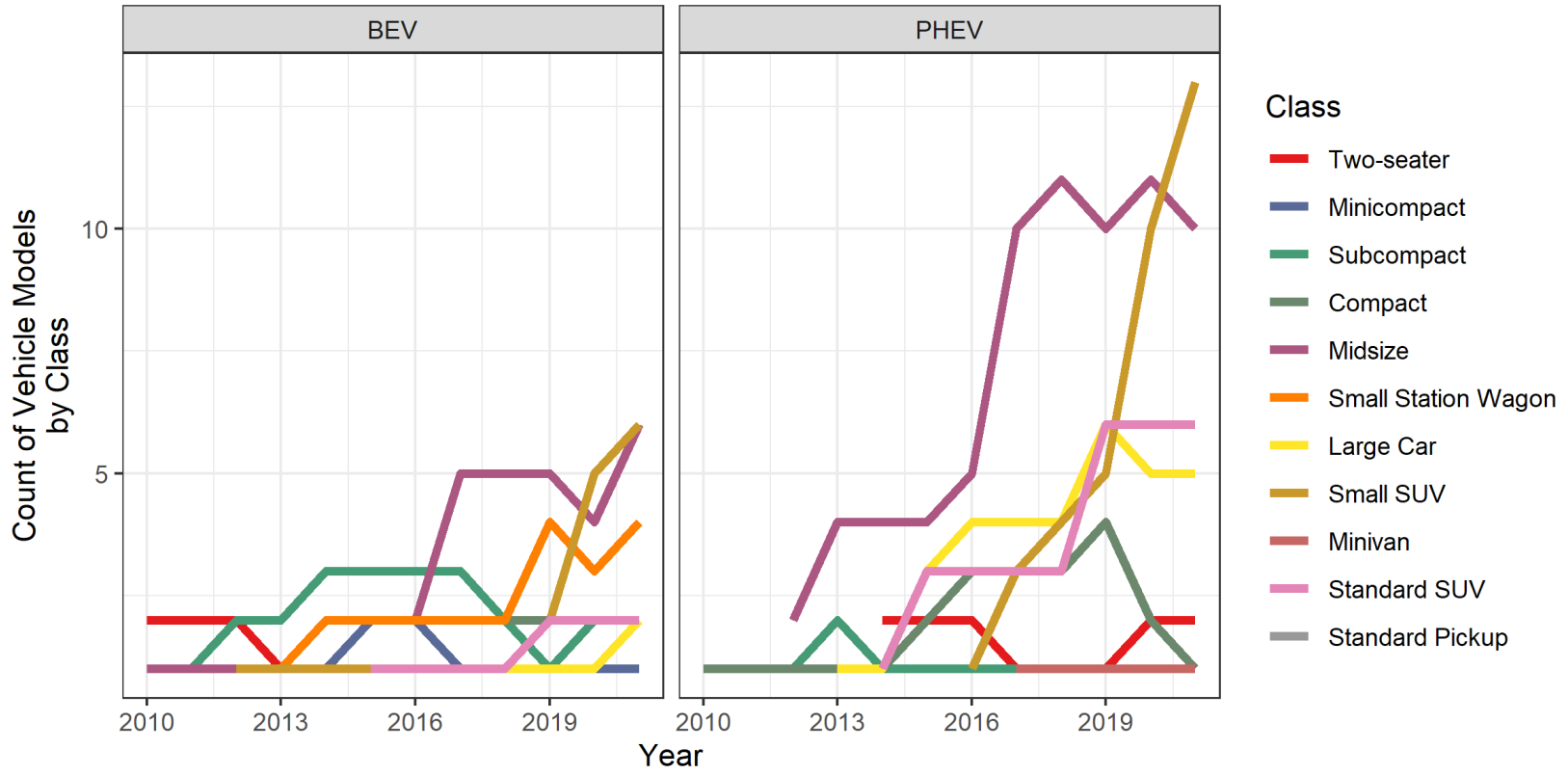
Vehicle supply shortages

- During the early stages of the pandemic, automakers canceled orders for semiconductors
- Getting access to semiconductors has since been difficult since they were reallocated to other consumer electronics
- As a result, many automakers have had to stop or limit production of new cars
- Shortages may not end until 2023!

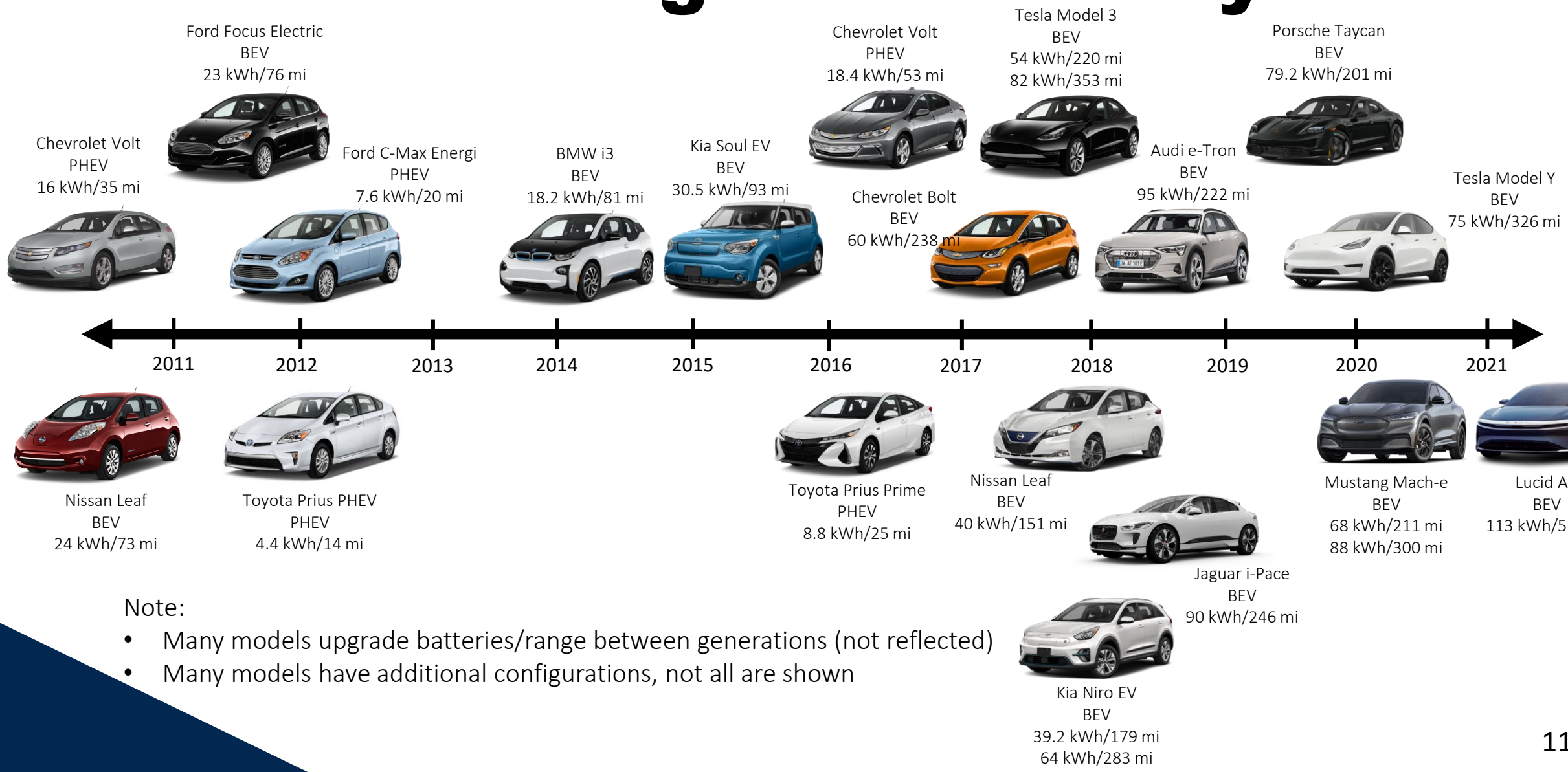


EVs by vehicle segment/class

- Earliest EVs tended to be in smaller vehicle segments
- Increasing segment availability helps appeal to a broader base of customers
- # of cars is increasing but so is diversity in segment, particularly in larger vehicle classes



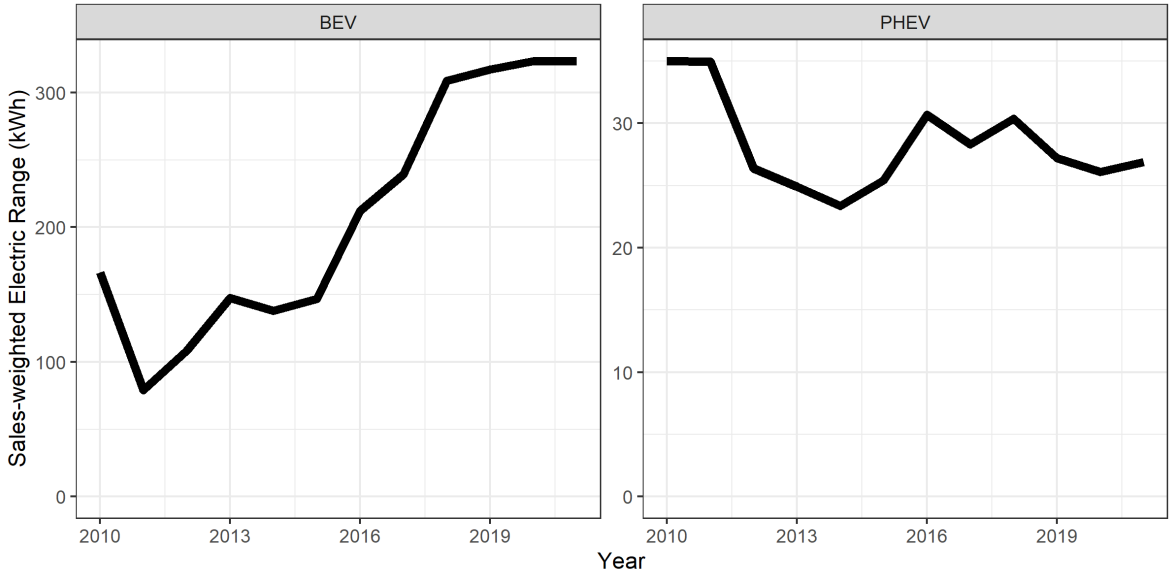
Trends in range and battery sizes

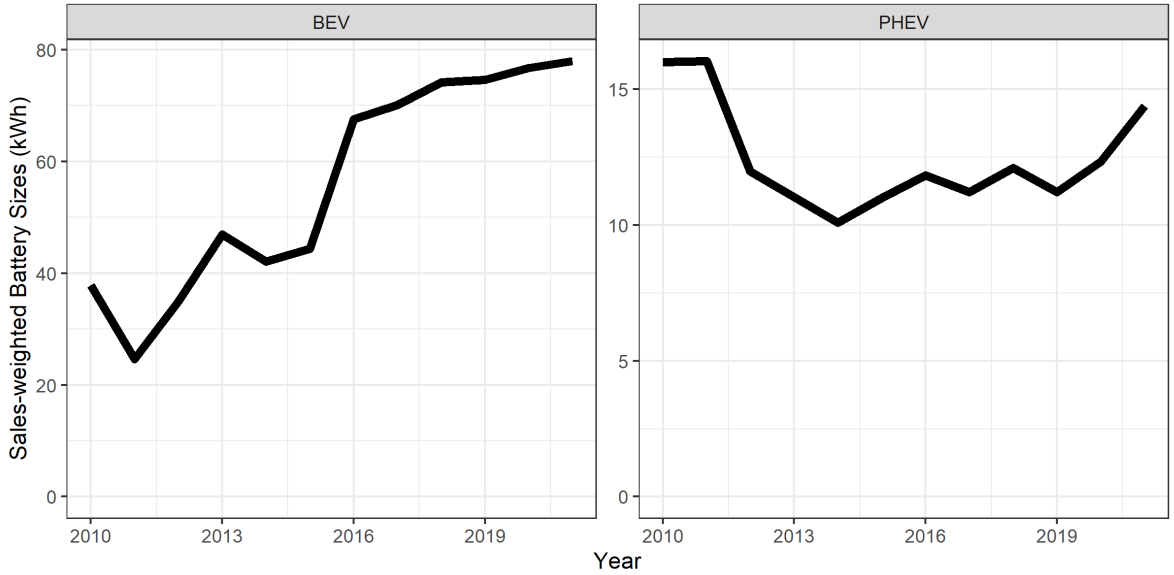


Note:

- Many models upgrade batteries/range between generations (not reflected)
- Many models have additional configurations, not all are shown

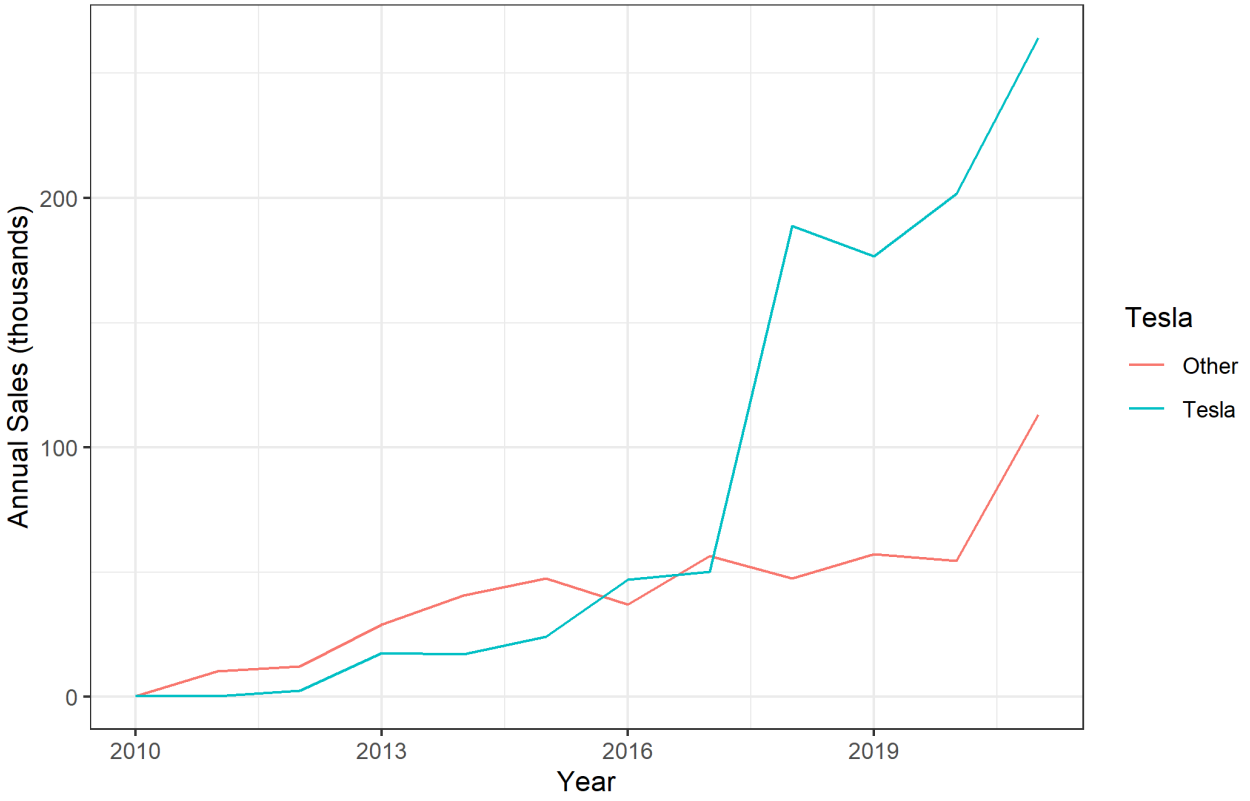
Trends in range and battery sizes (sales-weighted)

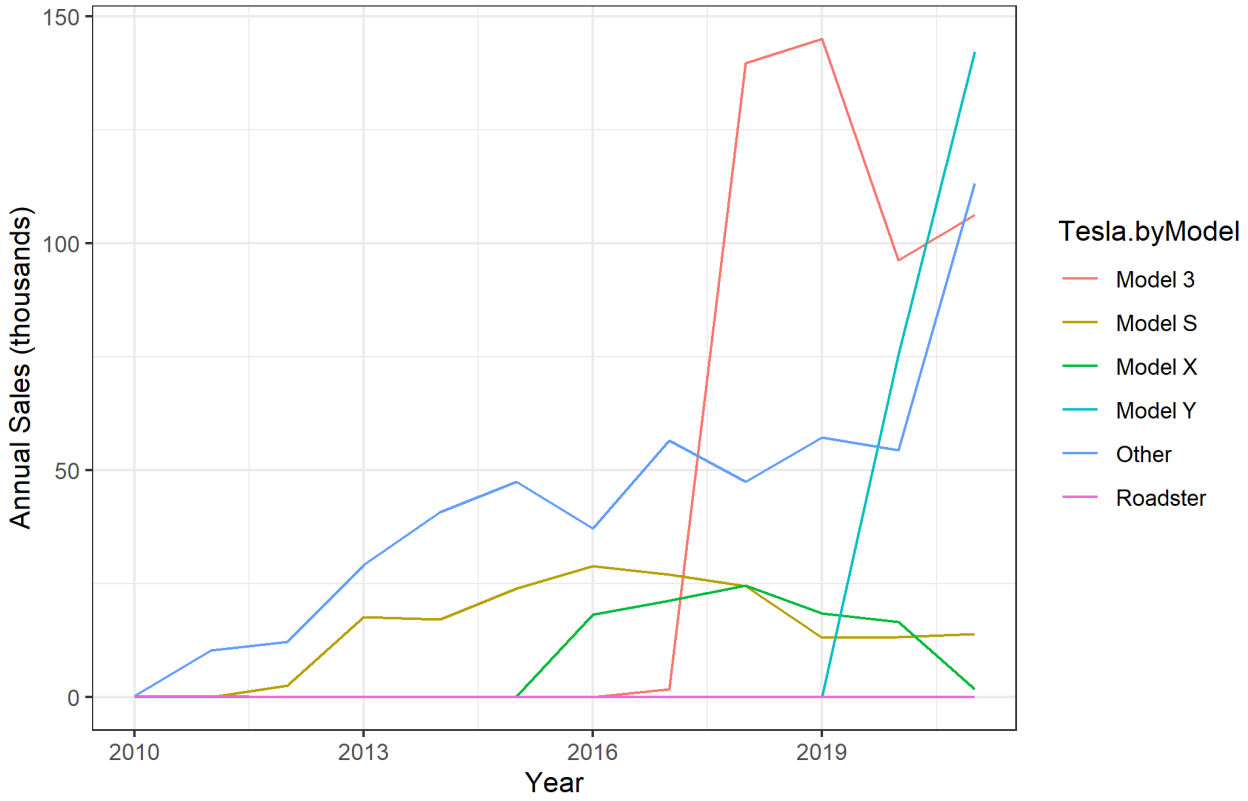




- Both the average battery size and vehicle range have increased over time for BEVs, but the trend has been relatively flat for PHEVs
- Much of the gain in BEVs is due to longer-range Teslas

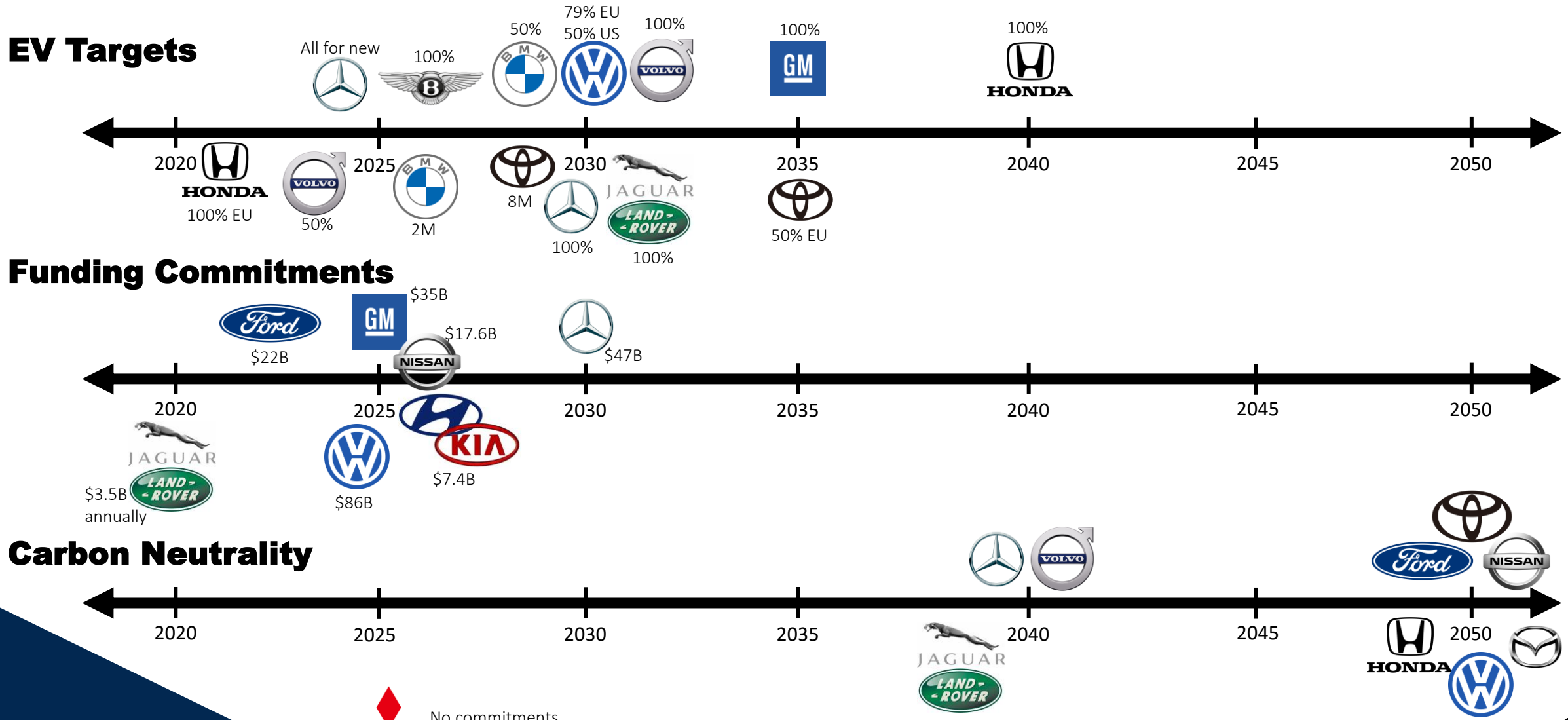
Tesla dominance



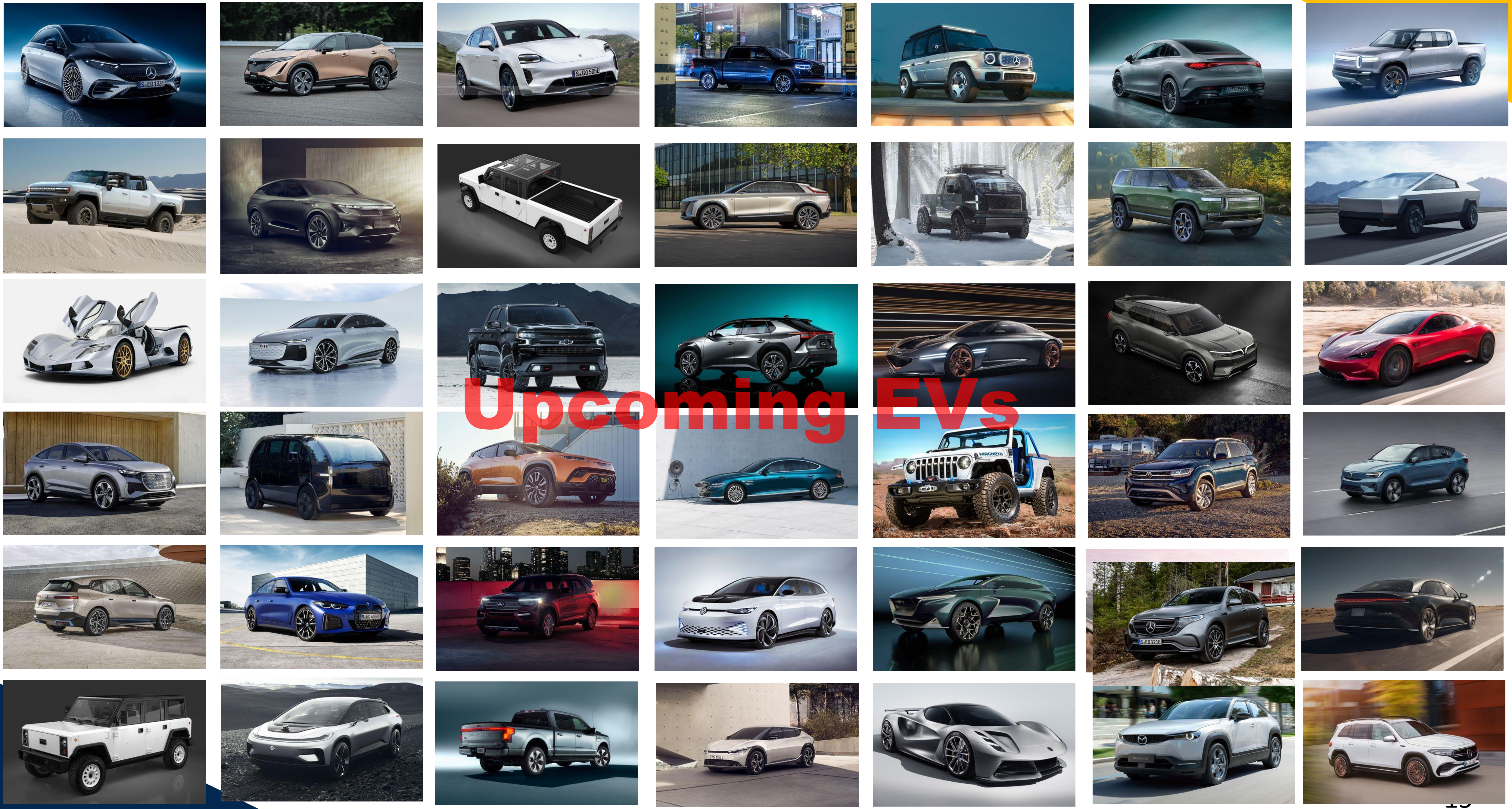


- Luxury vehicles (Model S and X) have relatively lower sales
- Model 3 and Y each rival the entire volume of other EVs combined

Automaker announcements and pledges



Upcoming EVs



California versus the US

- US share is ~3% EVs, CA share is ~10% EVs
- California has been consistently selling about half of all EVs in the US over the last decade
- What are the reasons for CA's success with EVs?

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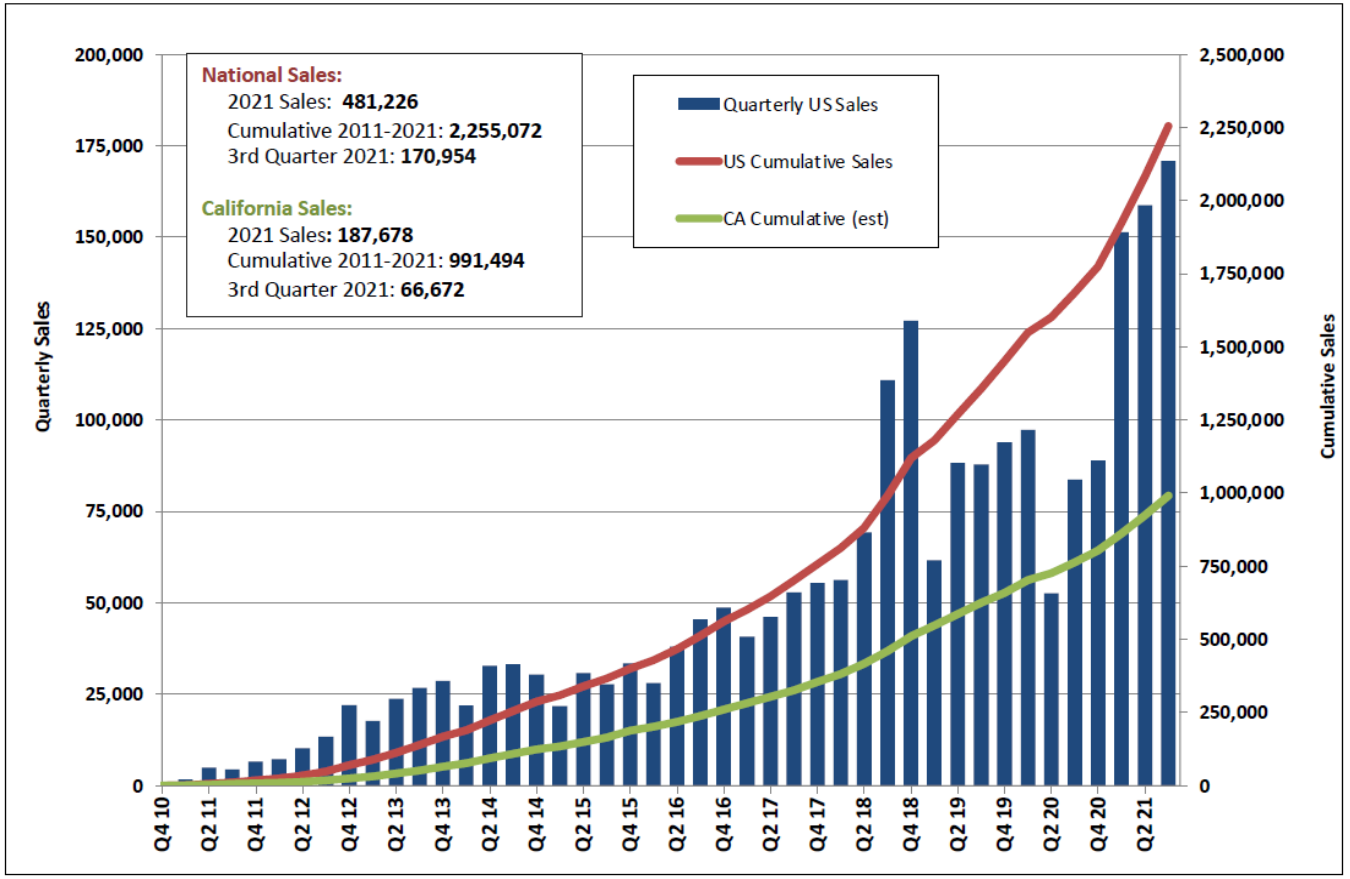

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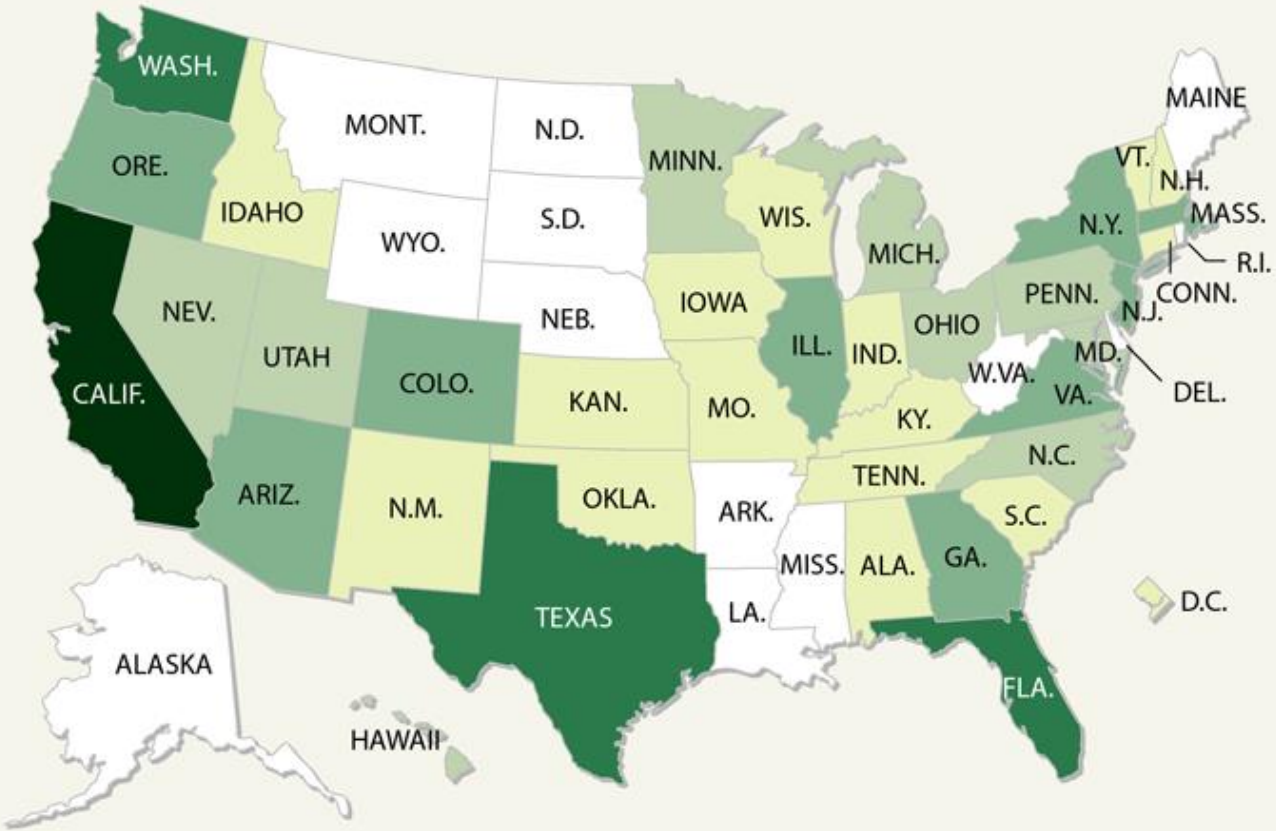
EVs in other states of the US

California Dominates with EV Registrations

California remains far out in front as the state with the most electric vehicle registrations, accounting for 42 percent of the 1.02 million light-duty all-electric vehicles on the country's roads as of the end of 2020.

U.S. ELECTRIC VEHICLES

States ranked by light-duty all-electric vehicle registrations, 2020

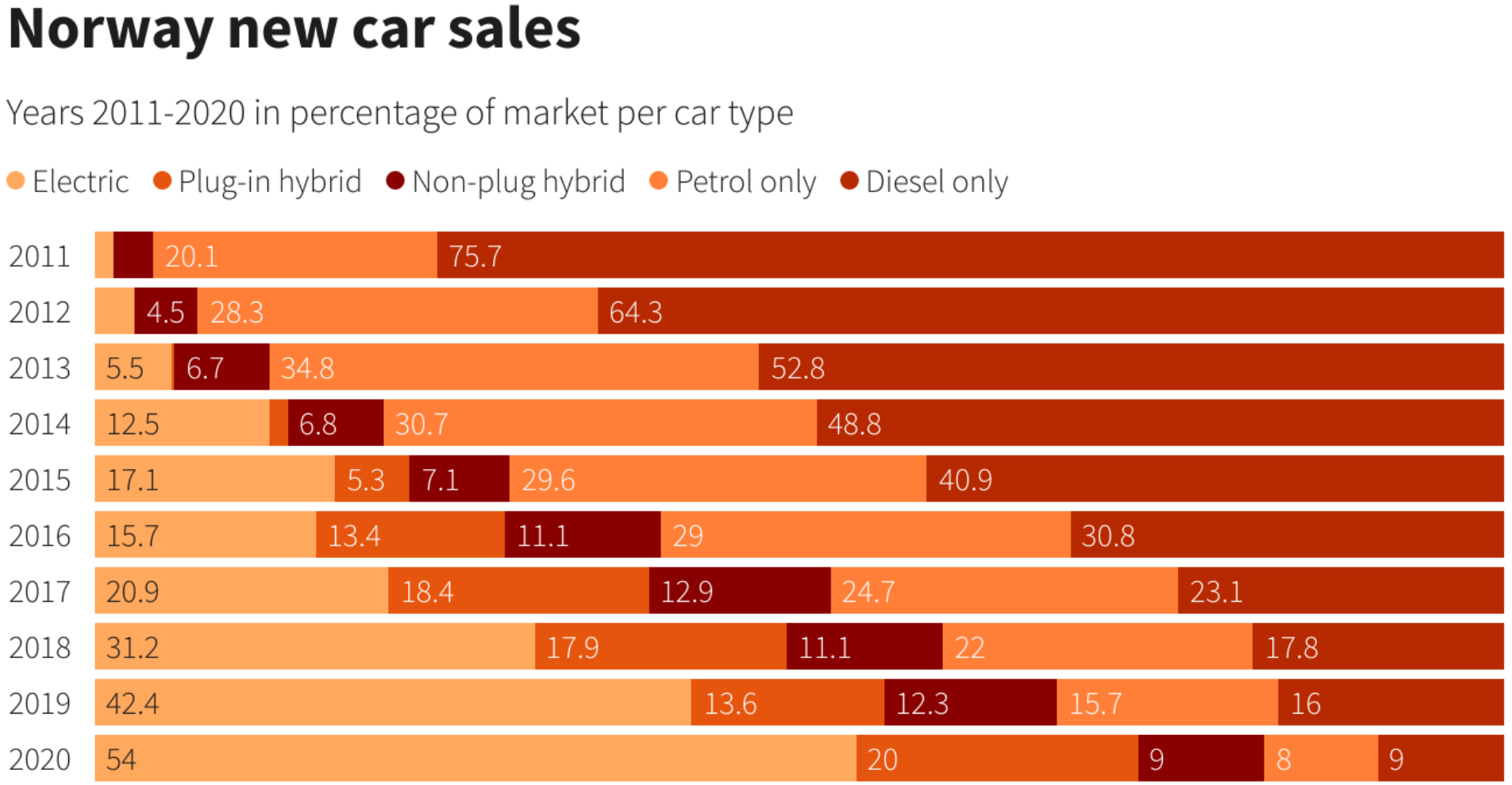


100,000+		50,000-99,999		20,000-49,999		10,000-19,999		2,000-9,999		<2,000	
California	425,300	Florida	58,160	Texas	52,190	Washington	50,520	New York	32,590	New Jersey	30,420
Arizona	28,770	Illinois	26,000	Colorado	24,670	Georgia	23,530	Oregon	22,850	Massachusetts	21,010
Virginia	20,510	Maryland	17,970	Pennsylvania	17,530	North Carolina	16,190	Ohio	14,530		
Utah	11,230	Nevada	11,040	Hawaii	10,670	Michigan	10,620	Minnesota	10,380		
Connecticut	9,040	Tennessee	7,810	Indiana	6,990	Missouri	6,740	Wisconsin	6,310	South Carolina	4,390
Oklahoma	3,410	Kansas	3,130	Alabama	2,890	New Hampshire	2,690	Kentucky	2,650	New Mexico	2,620
District of Columbia	2,360	Idaho	2,300	Iowa	2,260	Vermont	2,230	Delaware	1,950	Louisiana	1,950
Maine	1,920	Nebraska	1,810	Rhode Island	1,580	Arkansas	1,330	Alaska	940	Montana	940
Mississippi	780	West Virginia	600	South Dakota	410	Wyoming	330	North Dakota	220		

SOURCE: U.S. Department of Energy Alternative Fuels Data Center

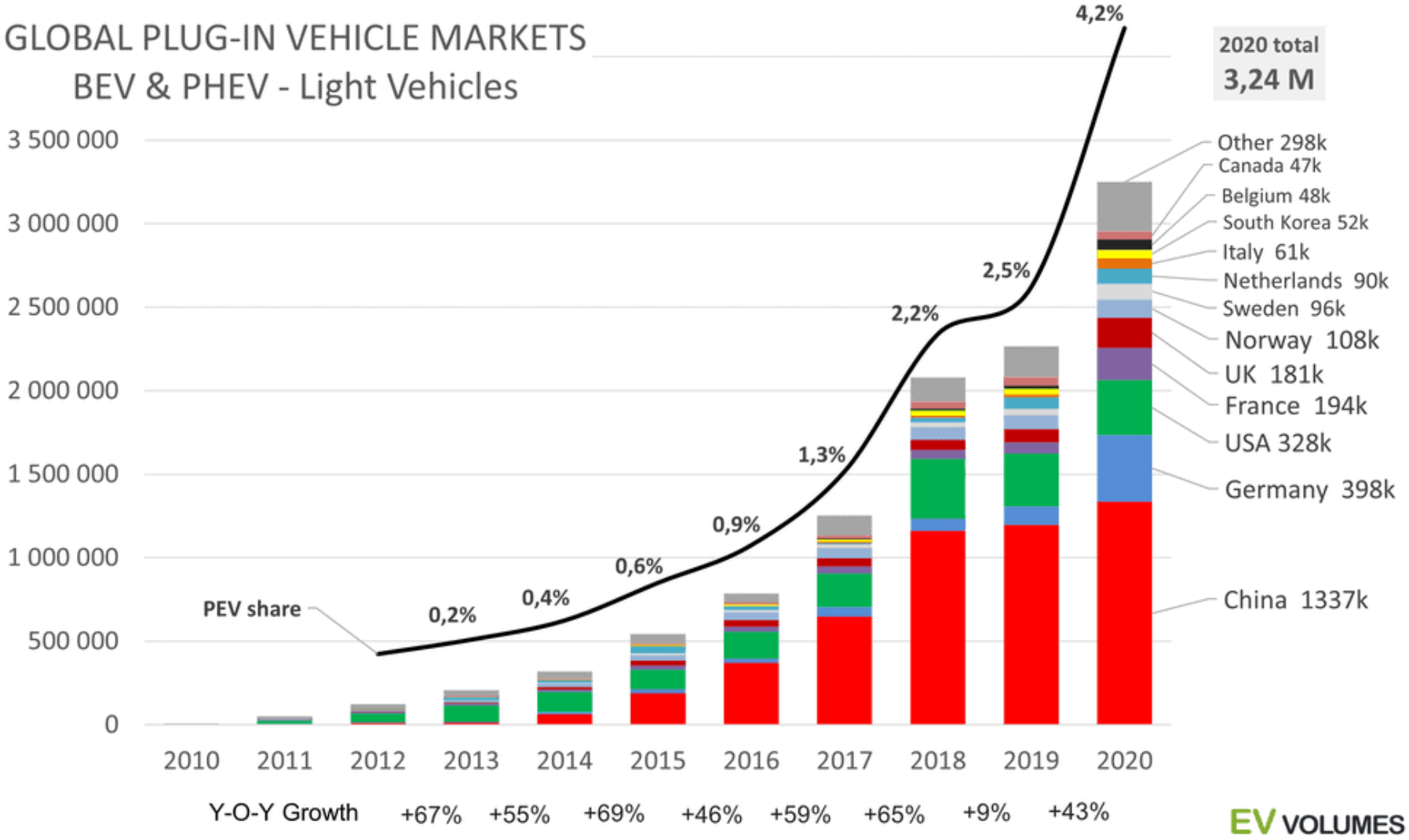
PAUL HORN / Inside Climate News

The Norwegian EV market (highest share of new sales)



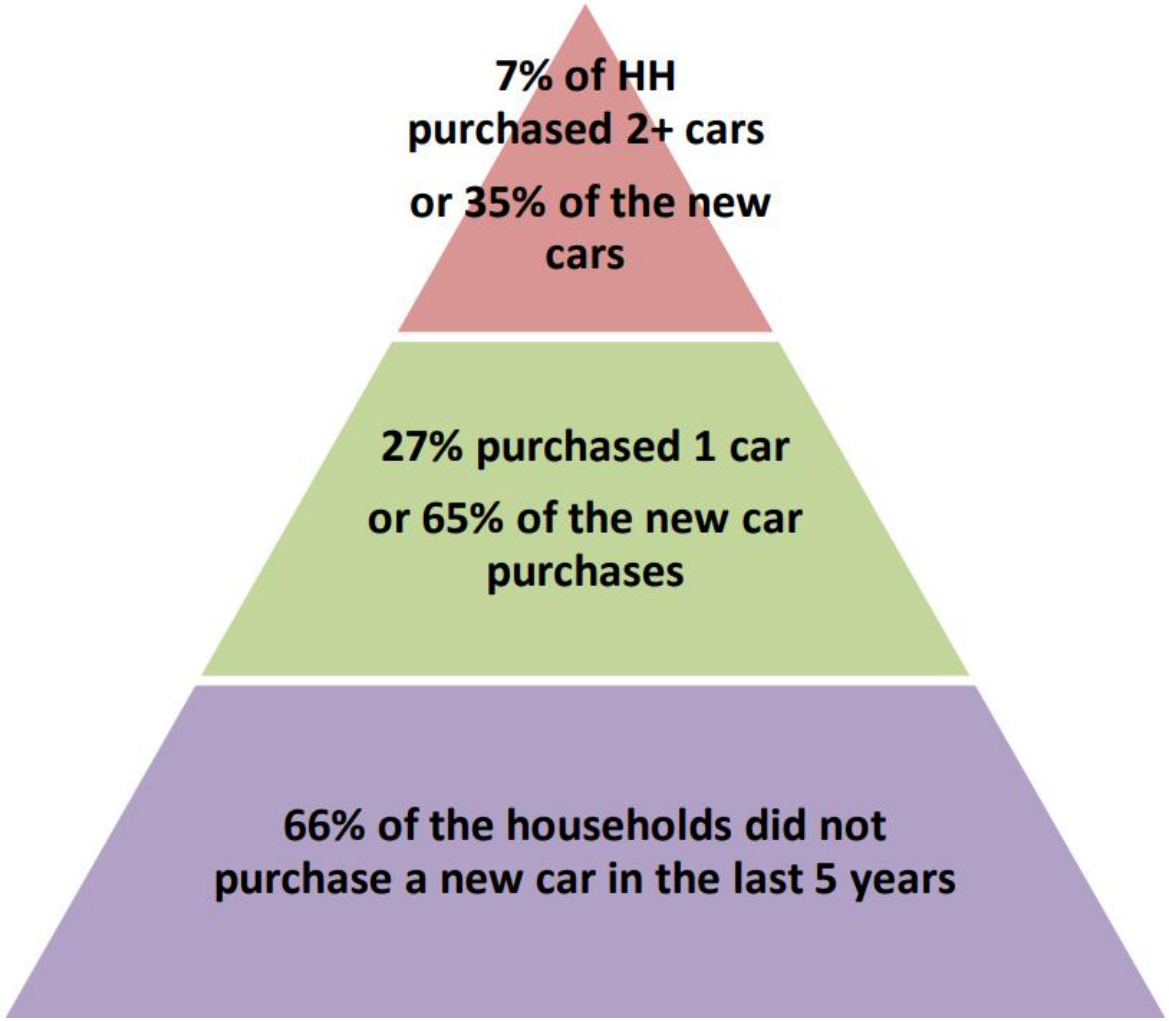
Source: Norwegian Road Federation (OFV)

The Chinese EV market (sells the most in absolute amounts)



Getting EVs into everyone's hands

- 4% of the households are responsible for almost one third of the market in 2010-2012
- Up to 15% of PEV buyers are on their second PEV

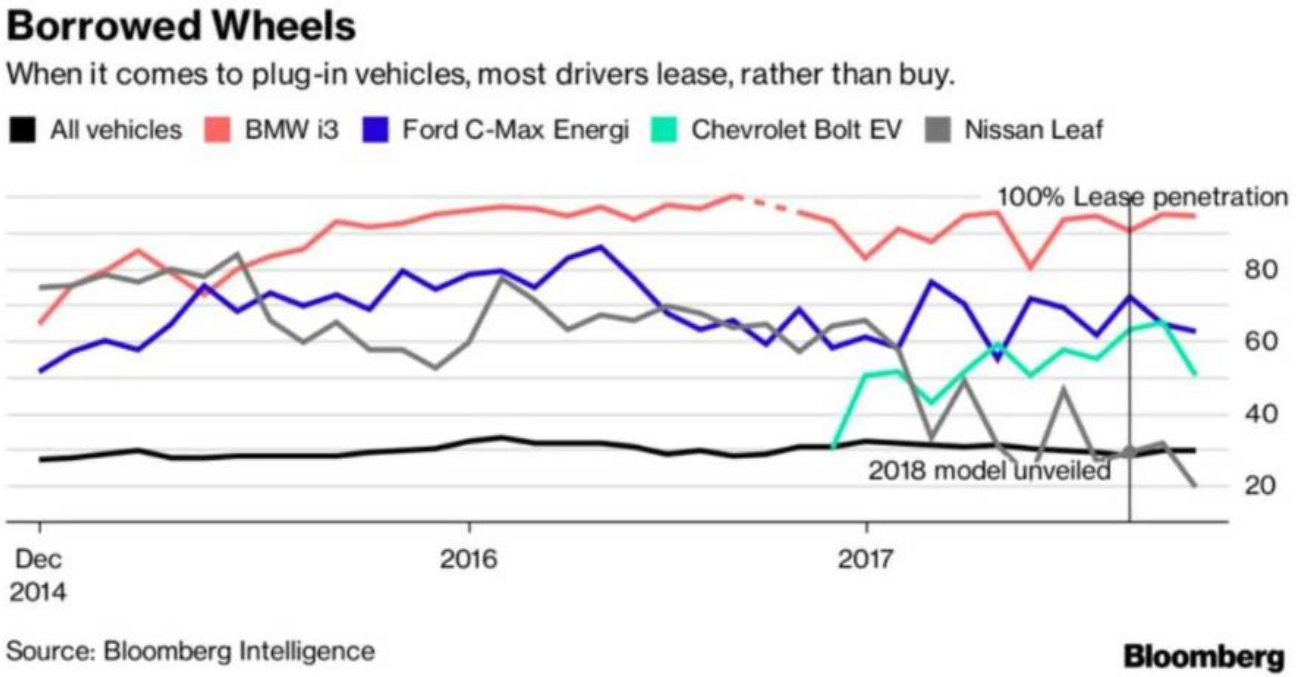


Used Vehicle Market

- Unfortunately, not much is known about the used vehicle market in comparison to new vehicles being sold
- While some used vehicles are tracked in similar channels to new cars, some avenues are much harder to track:
  - Craigslist, Facebook, eBay, etc.
- This is currently a rich area of study as we move out of the early-adopters stage and researchers seek to understand how EVs may trickle down to broader populations through the used vehicle market

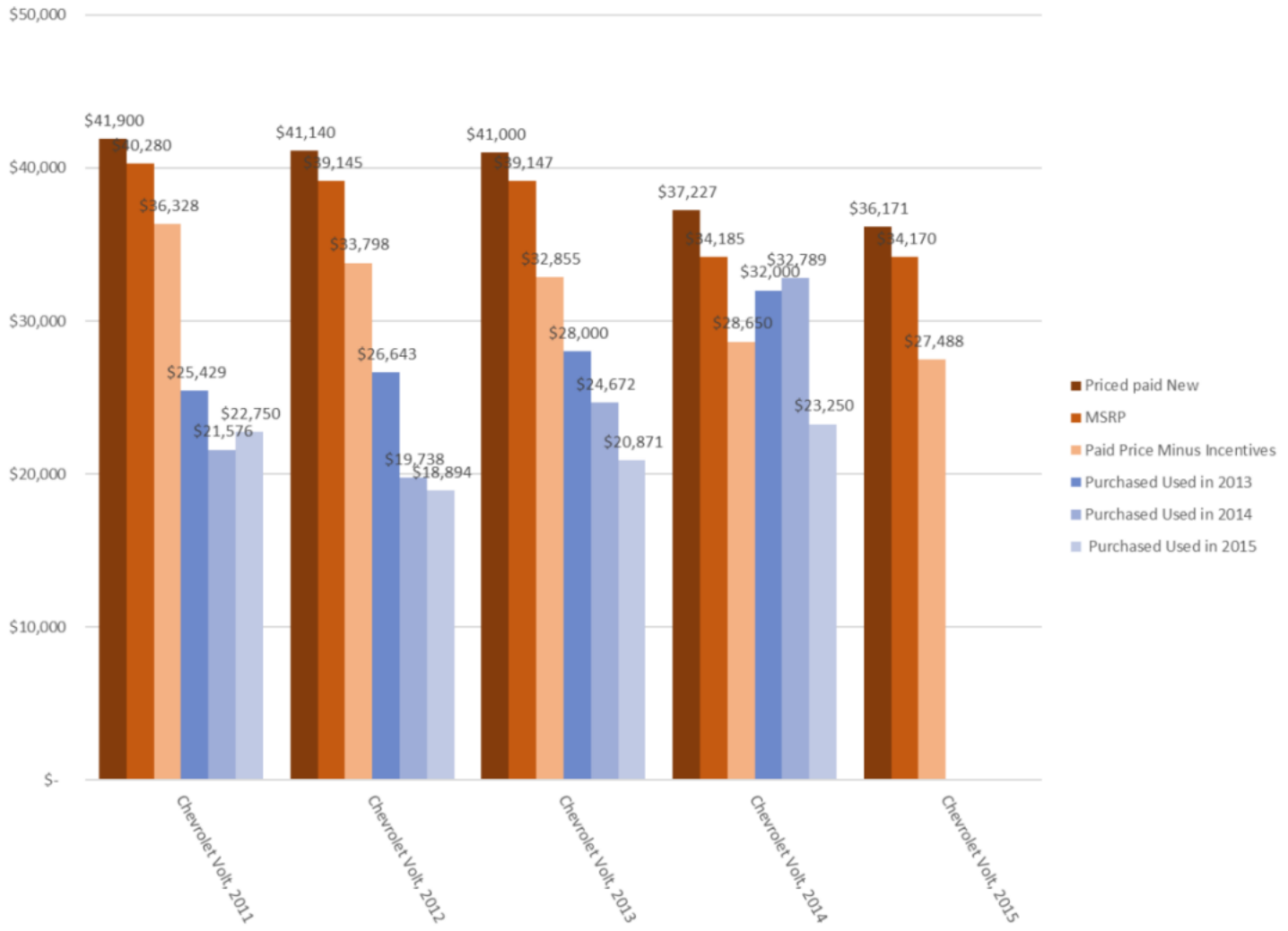
Leasing vehicles and the used market

- Leases are an alternative to buying a vehicle, instead you “rent” the vehicle for 2-3 years
- For EVs, leases are an especially attractive proposition that allows consumers who may be less confident in the technology to “try it out” first
- After a lease, the owner can choose to buy the vehicle, otherwise it goes back to the dealership to enter the market as a used car



Residual values and EVs

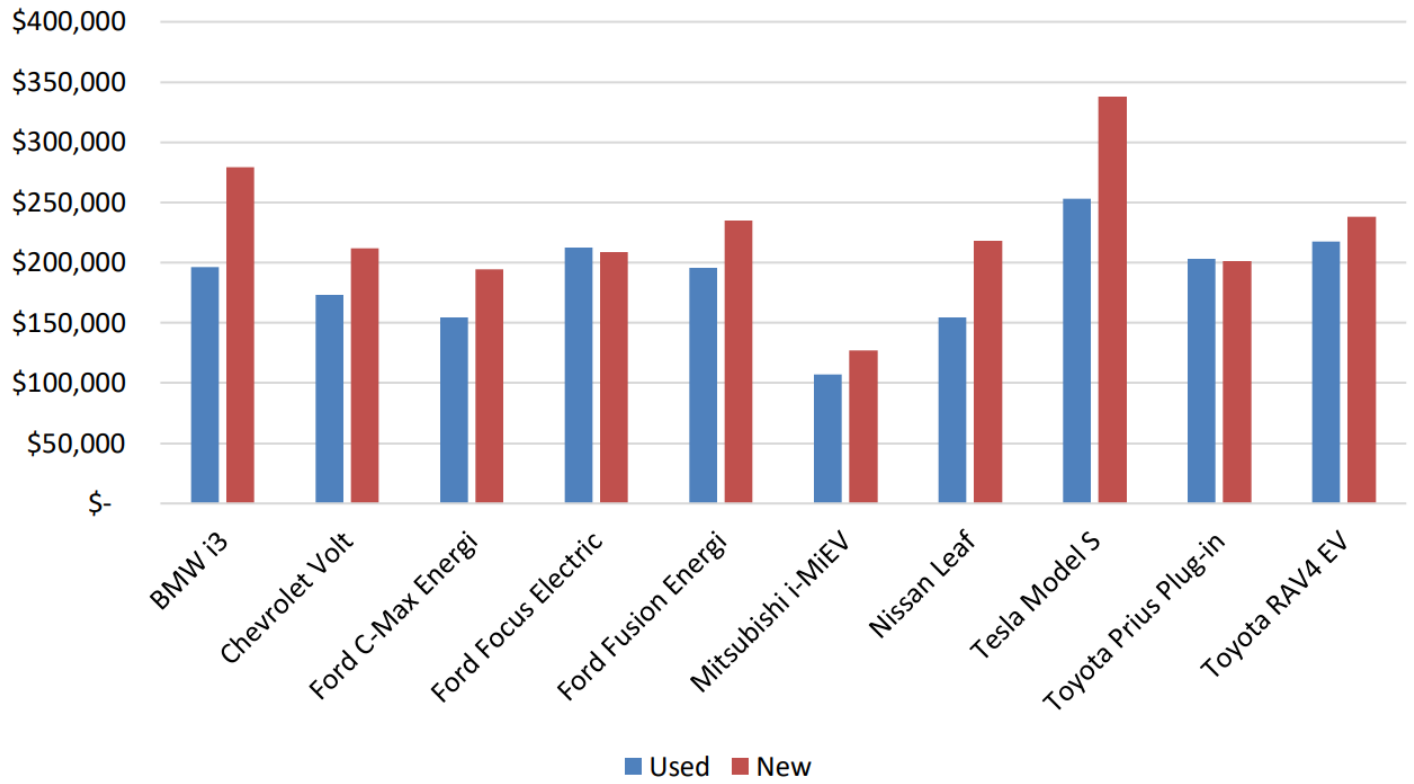
- Residual values describes the “leftover” value of the vehicle after a lease-term—it also acts proxies for how attractive a vehicle is on the used market
- EVs have an artificially low residual value due to incentives
- Consider the 2012 Volt in 2015 (after 3-year lease)
  - Before incentives, the residual value is 46%
  - Accounting for incentives the residual value is 56%



EVs: Equity and access

- Technology shifts to address climate change are important, but if we force everyone to buy an EV, this could place financial burdens and/or be completely untenable for some people!
- Some barriers facing disadvantaged communities:
  - Higher upfront costs of vehicle purchase
  - Access to home charging infrastructure (apartments vs homes)
  - Access to public charging infrastructure
  - Availability of vehicles in local dealerships
  - Lack of knowledge and familiarity with new technology

Does policy support help?



- While buyers of used vehicles tend to have lower income, early stages of the EV market indicate that used buyers are still very wealthy!

Accessibility for lower-income EV owners

- Many EV chargers can only be accessed through memberships and smart phone app access
- Regulatory pressure has led to requirements by charging providers to include credit card readers (bypassing smart phone requirements)