# Considerations for improving fuel economy, 2025-2035

Alan Jenn, PhD
Research Scientist
Plug-in Hybrid and Electric Vehicle Center
Institute of Transportation Studies
University of California, Davis

# Fuel economy standards and alternative fuel vehicles

# Fuel economy and emissions rates are no longer tied together

- Federal regulation on vehicle efficiency are harmonized through NHTSA's CAFE standards and EPA's GHG emission standards
- This pairing is anachronistic for alternative fuel vehicles (particularly electricity and $H_2$)

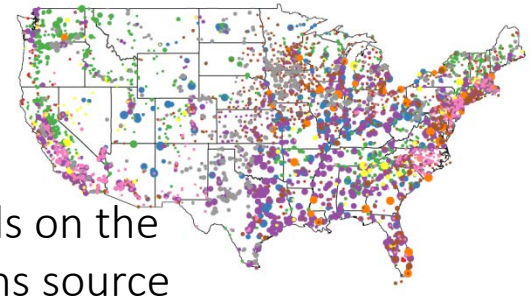
<u>Efficiency</u> <u>Emissions Rates</u>

Toyota Prius

55 MPG ⟷ 160 g $CO_2$/mi

Tesla Model 3

0.29 kWh/mi ⟷



Depends on the emissions source

# AFV incentives: weights and multipliers

- Weights: multiplicatively affect emissions rate for alternative fuel vehicles
- Multipliers: Increase the accounting of sales for alternative fuel vehicles

AFV Incentives in 2017-2025

| Vehicle Type | Proportion Operating on Alternative Fuel | Multiplier (2017-2019) | Multiplier (2020) | Multiplier (2021) | Multiplier (2022-2025) | Weighting Factor |
|---|---|---|---|---|---|---|
| ICV | 0 | 1 | 1 | 1 | 1 | 1 |
| FFV | 0.15 | 1 | 1 | 1 | 1 | 1 |
| CNG | 1 | 1.6 | 1.45 | 1.3 | 1 | 1 |
| BEV | 1 | 2.0 | 1.75 | 1.5 | 1 | 0 |
| PHEV | 0.29-0.66 | 1.6 | 1.45 | 1.3 | 1 | 0 |
| FCV | 1 | 2.0 | 1.75 | 1.5 | 1 | 0 |

# Current CAFE regulation doesn't differentiate PEVs

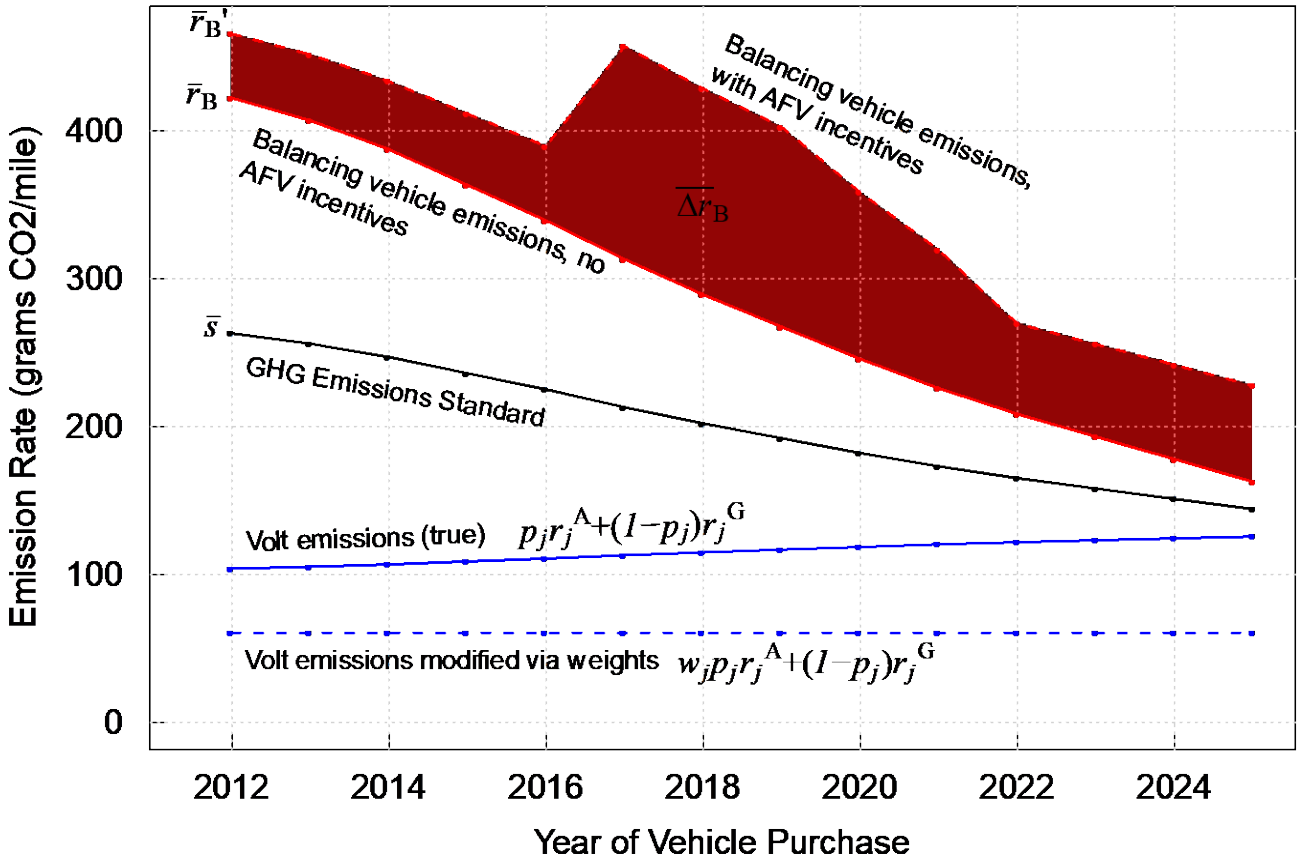

Hyundai Ioniq (BEV)
25 kWh/100 mi

Jaguar i-Pace (BEV)
44 kWh/100 mi

Despite the i-Pace consuming 76% more energy, fuel economy regulations consider these vehicles the "same". Automakers are not being given policy signals to improve the efficiency of PEVs.

# Implications of AFV incentives on fuel economy

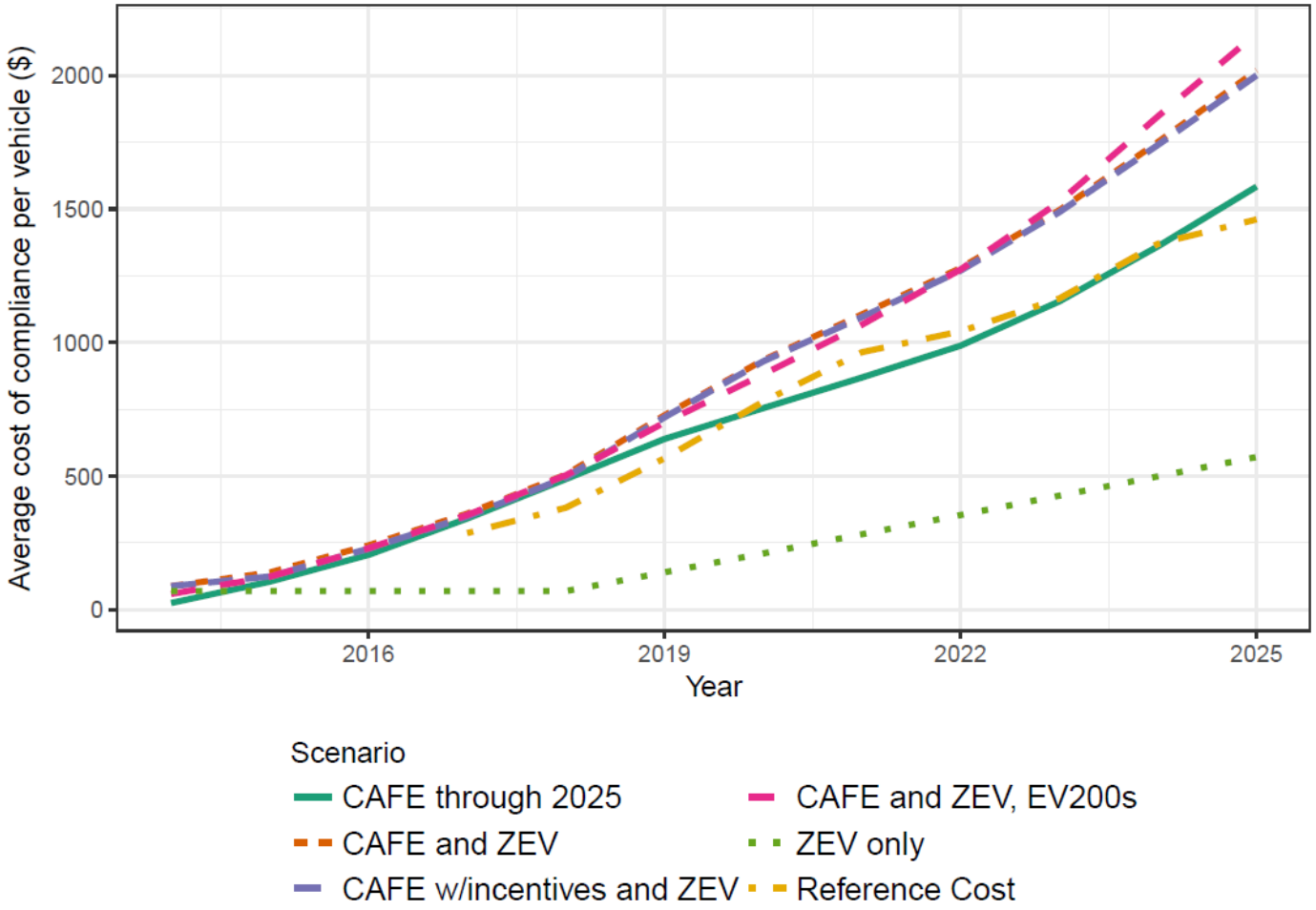
- Selling PEVs increases overall emissions when CAFE is a binding constraint
- Through 2025, the effect is relatively small: a 1-2% decrease in stringency of standards (footprint gamification and market trends was more significant at ~6%)




Jenn, Alan, Inês ML Azevedo, and Jeremy J. Michalek. "Alternative fuel vehicle adoption increases fleet gasoline consumption and greenhouse gas emissions under United States corporate average fuel economy policy and greenhouse gas emissions standards." *Environmental Science & Technology* 50, no. 5 (2016): 2165-2174.

# ZEV requirements affect CAFE compliance costs

- We replicated the OMEGA model using identical cost inputs as the 2016 TAR (with scenarios using both RPE and ICM costs)
- Minimized cost of compliance for each automaker with additional constraint of satisfying ZEV
- We are able to measure the incremental cost of compliance when automakers are required to meet ZEV
- These costs will likely increase as more ZEVs are adopted




Jenn, Alan, Scott Hardman, Sanya Carley, Nikolaos Zirogiannis, Denvil R. Duncan, and John Graham. "Cost implications for automaker compliance of Zero Emissions Vehicle requirements." *Environmental science & technology*(2018).

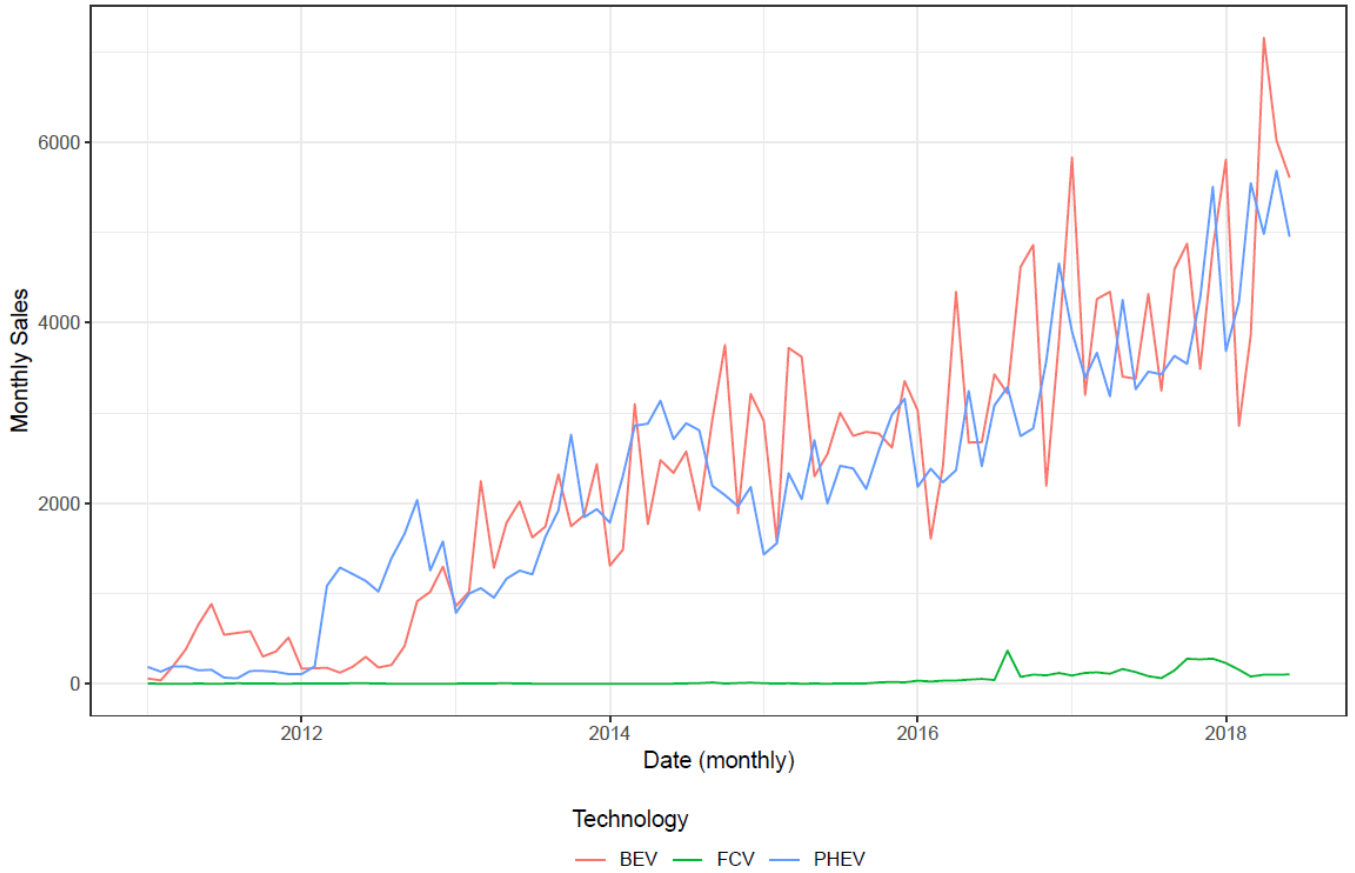
# Key questions for future of regulation

- Can NHTSA and EPA standards remain harmonious with increased adoption of electric vehicles?
- How will regulation treat upstream emissions?  If these effects are ignored, how will agencies evaluate the tradeoffs in weakening standards?
- How can the proper regulatory signals be provided to improve PEV efficiency?

# Trends in electric vehicle market and usage

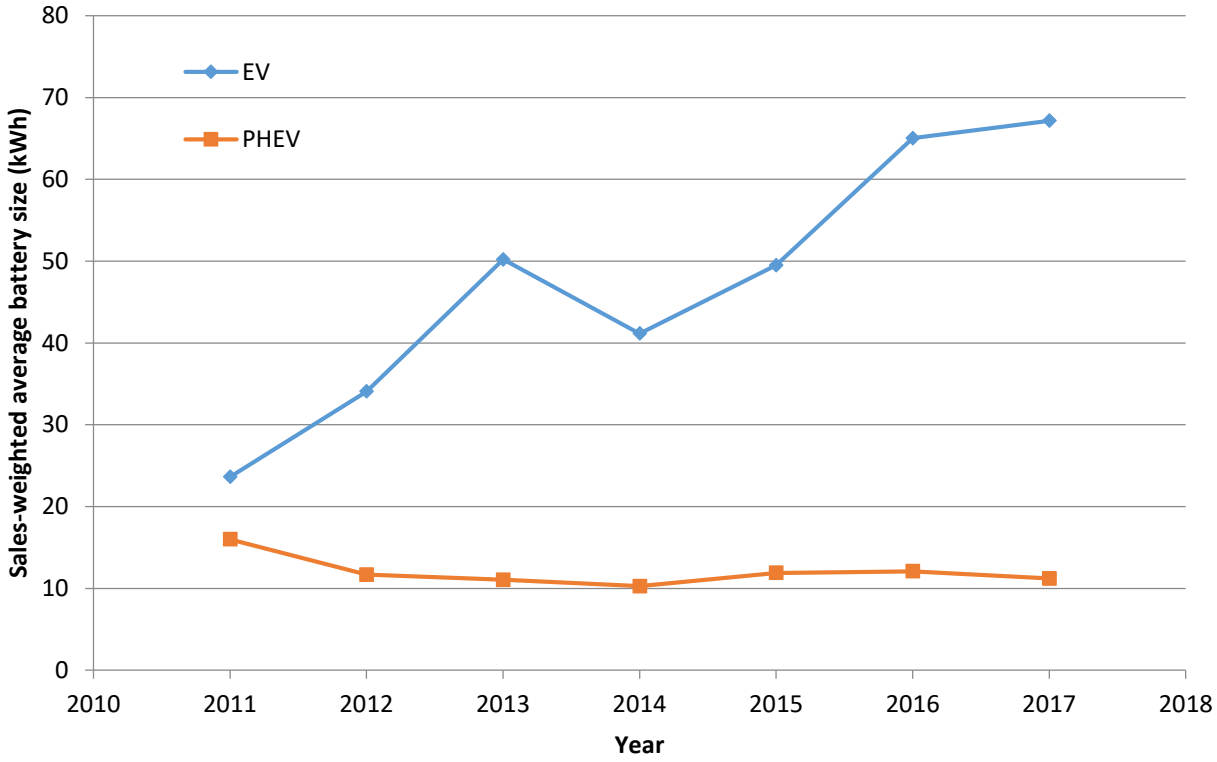
# Electric vehicle market growth

- We know that market will continue to grow
- In California:
  - 1-1.5 million PEVs by 2025
  - Target 5 million PEVs by 2030 (questionable)
- Other states:
  - Colorado's governor just issued executive order to join ZEV mandate
  - Washington state will introduce a ZEV mandate bill this year
  - 177 Travel Credit provisions expired last year



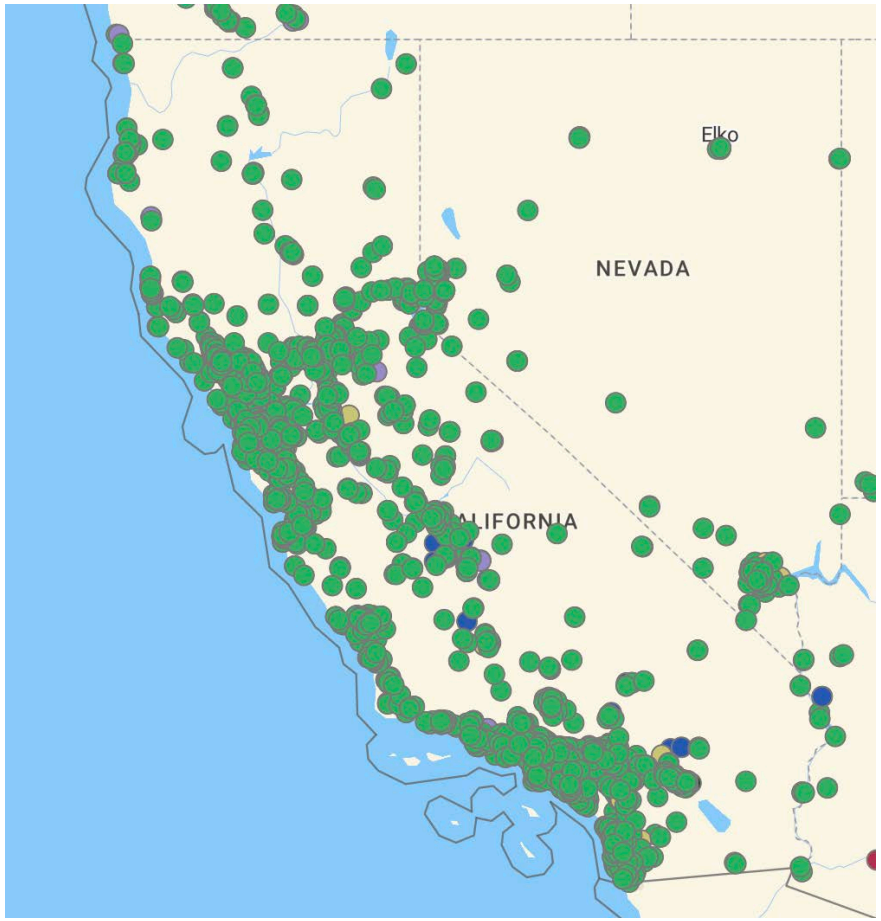
# Battery sizes are getting progressively larger

- Batteries are getting larger, particularly for full BEVs
- PHEVs are slightly deceptive: vehicle model updates have all resulted in battery size increases but introduction of new models (with smaller batteries) has depressed the average
- What is the right size battery? When will batteries be “too big”? Current standards ignore relationship between fuel economy and battery size.

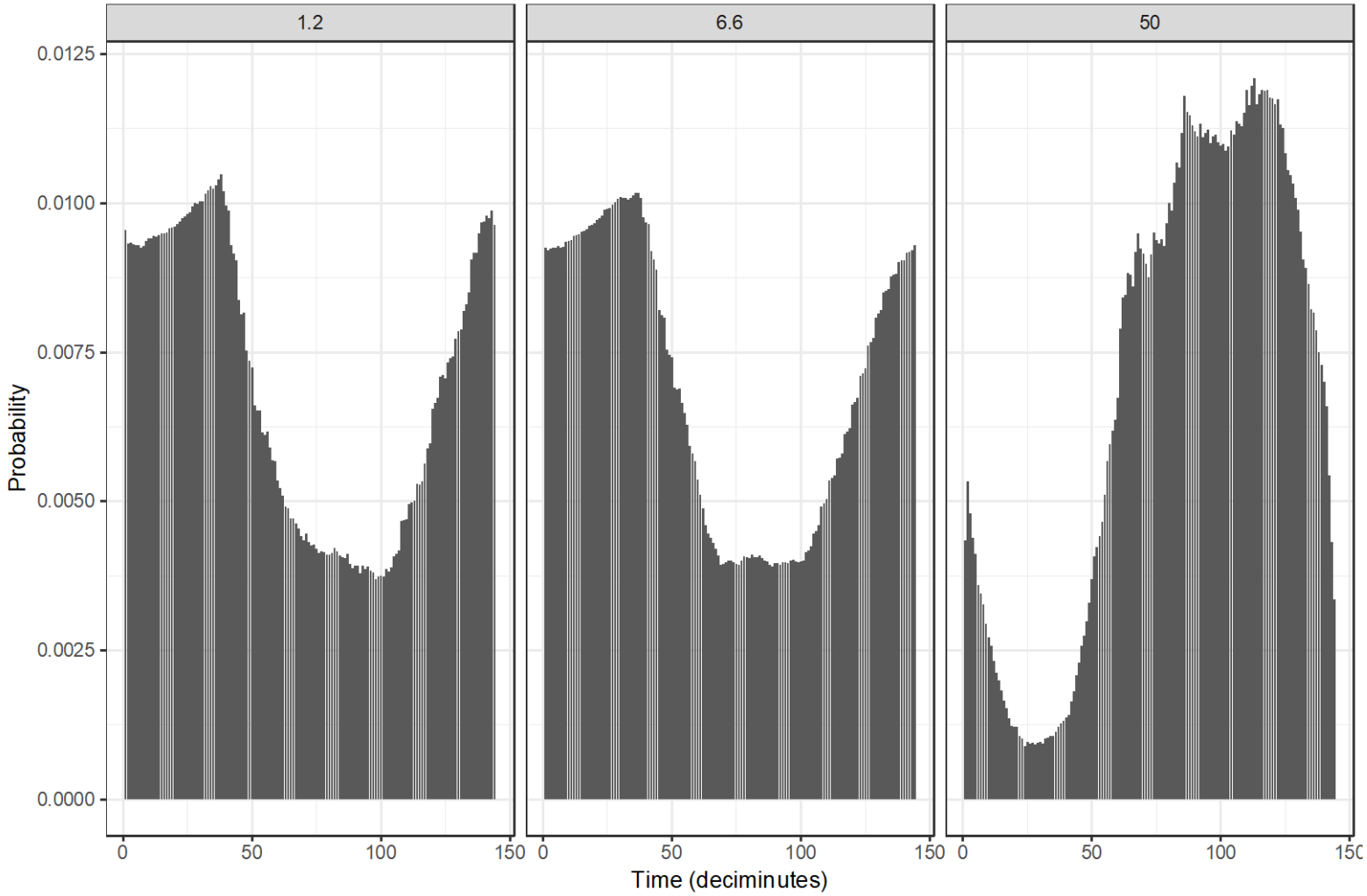


# Charging infrastructure network

- Perception for enabling market *is different* than what people actually use
- 15000+ chargers in California today with pursuit of 250,000 public chargers in 2025
- Strong movement to pursue extreme fast charging (350+ kW chargers)



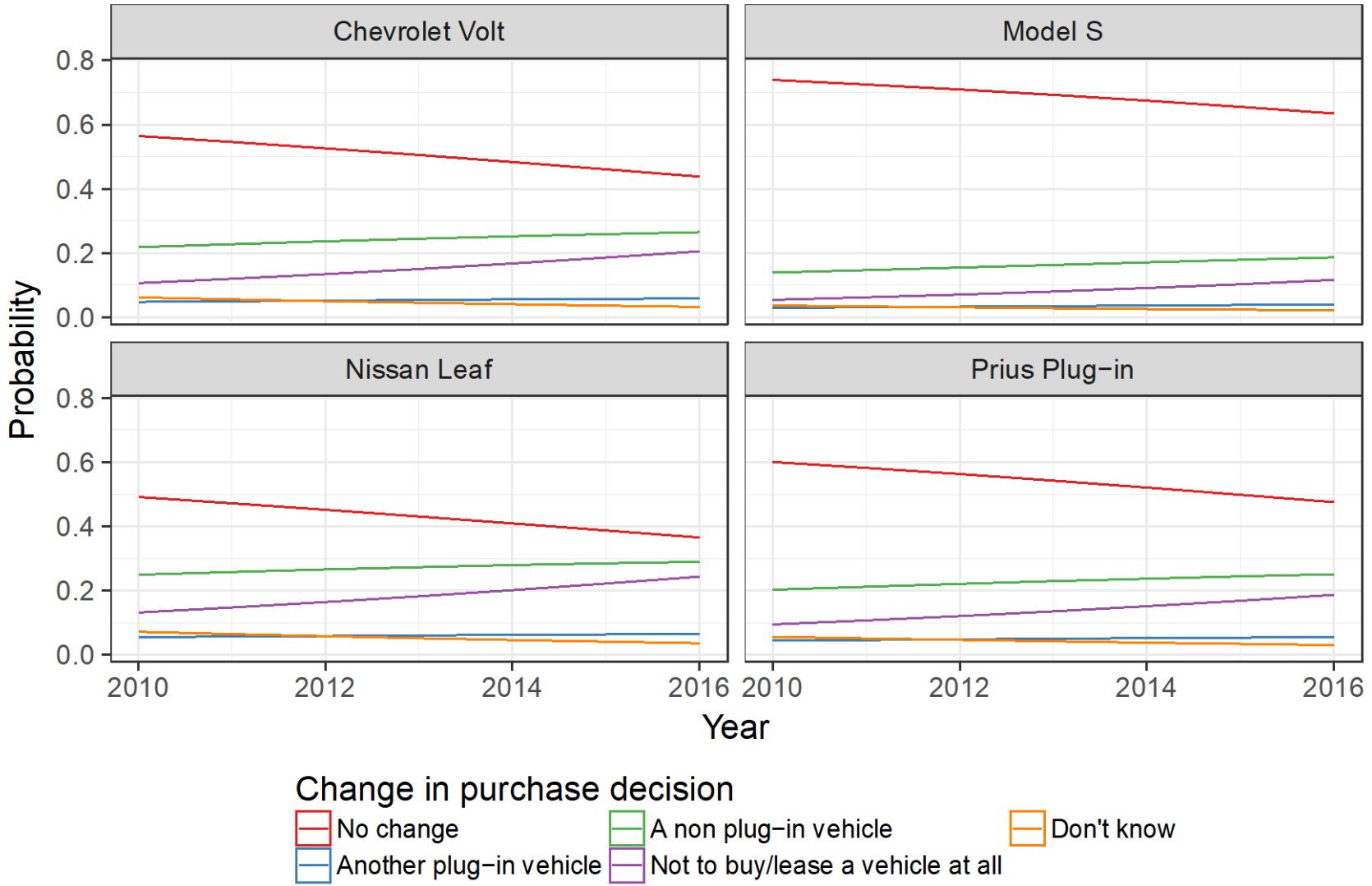
# When do PEV drivers charge?



# Charging behavior findings

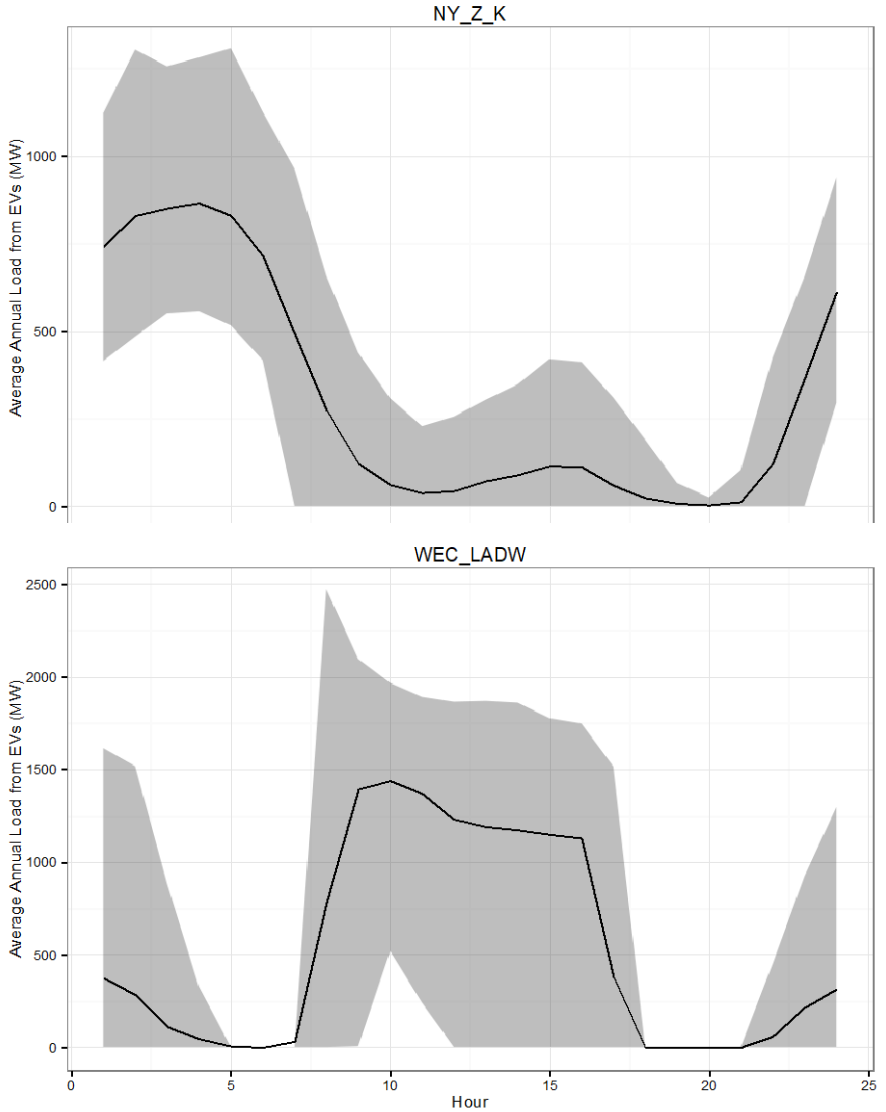
- 85% of charging occurs at home
- Of those that DC fast charge (70% those who are capable), the average charging is once every 2-3 weeks* (non-Tesla)
- Median distance from home that DC fast charging occurs: 4-7 miles (depending on sub-population of vehicles)—these are not long distance trips

# Incentives are becoming more important over time

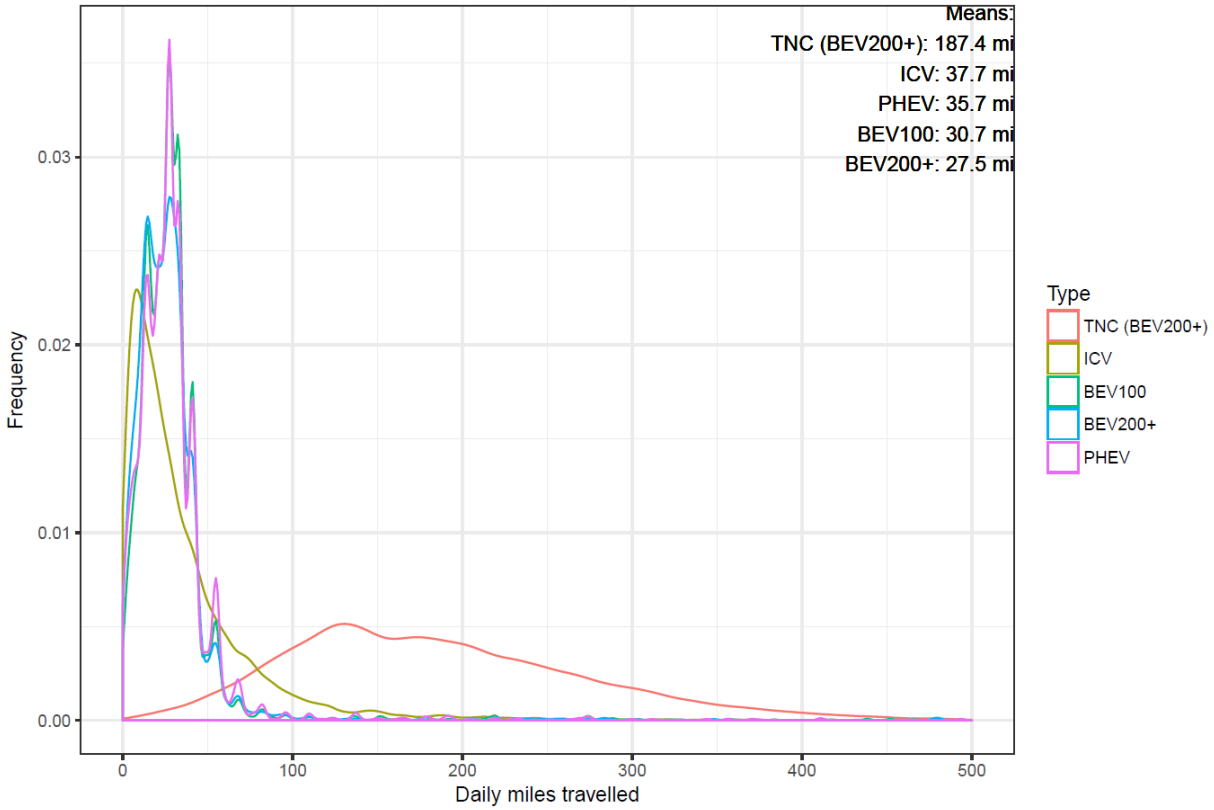


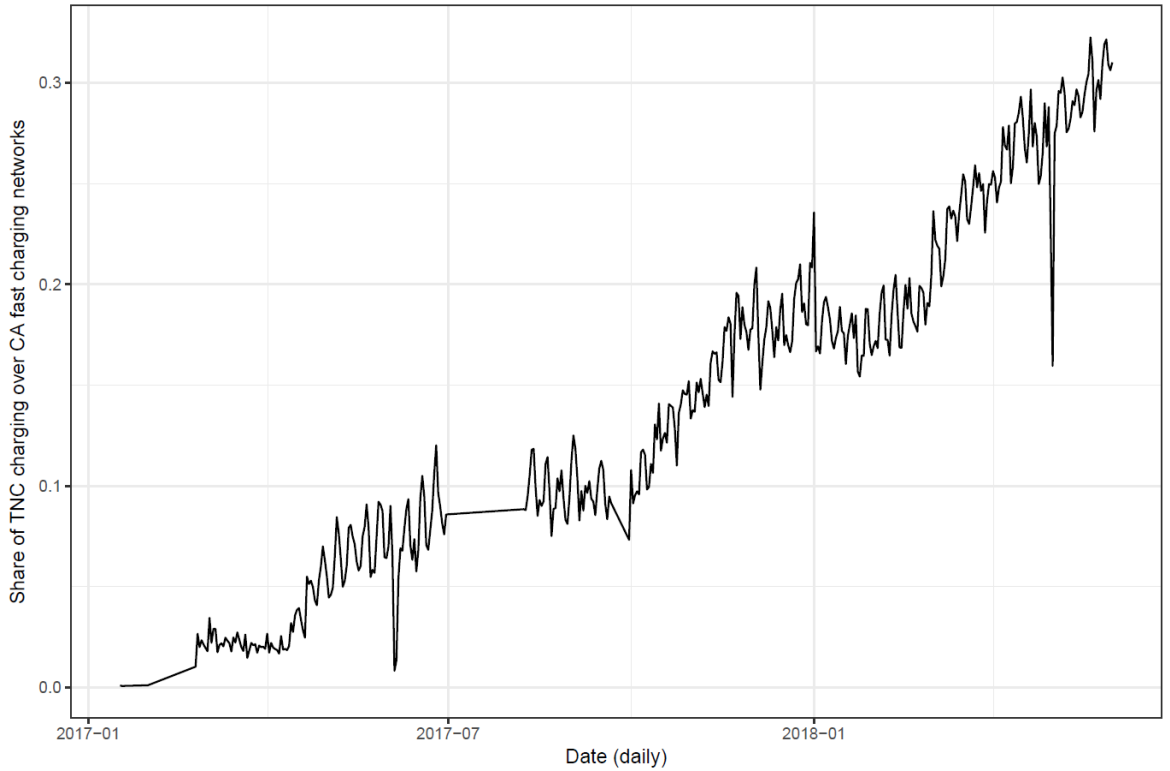
# Off-cycle credits—for emissions

- With a suite of policies to 1) clean the grid, 2) induce adoption of electric vehicles, and 3) increase efficiency of electric vehicles—the next largest opportunities to address emissions is in charging behavior
- One idea is to provide off-cycle credits to automakers that install hardware in PEVs that enable smart charging schemes
- Smart charging doesn't mean lower emissions



# Deployment of PEVs in new mobility services




Full-time TNC drivers drive and charge a lot!

# Comparative emission savings

- TNC EV emission savings is the difference between:
  - EV – calculated as before
  - ICV – assumed 30 MPG
- Regular EV emission savings is the difference between:
  - ICV – actual trip data from CHTS with corresponding fuel efficiencies
  - EV – assumed highest efficiency (28 kWh/100 mi) and lowest emission rates (180 g/kWh)