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Institute of Transportation Studies Webinar:

California's Electric Vehicle Incentives: What do we Know?

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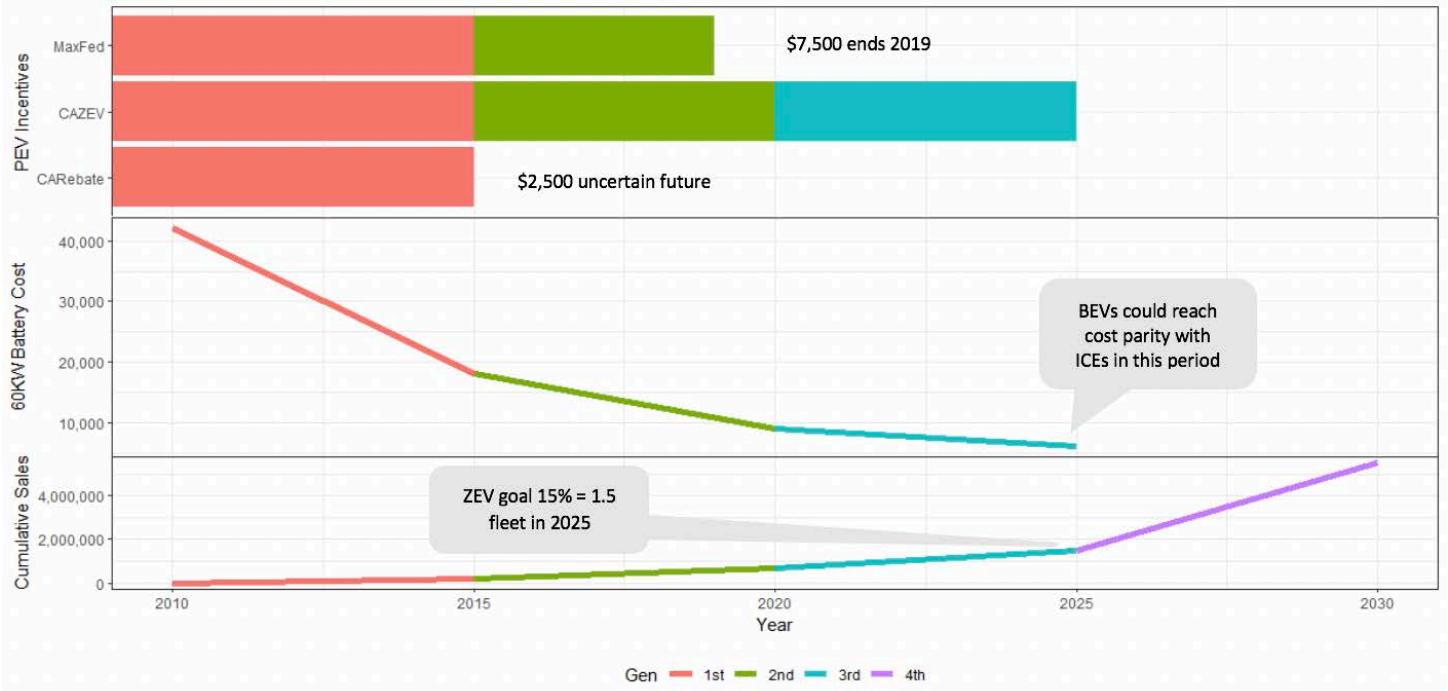
Notes and Acknowledgements

- This is a summary of research in progress and may be updated as the papers are finalized
- We are extremely grateful to the California Air Resources Board and the Center for Sustainable Energy for project support, review, and expert input
- This webinar also highlights findings from a study made possible through funding received by the UC Institute of Transportation Studies from the State of California via the Public Transportation Account and the Road Repair and Accountability Act of 2017 (Senate Bill 1)
- Results will also be published in a series of whitepapers. Final publication timing is not known at this time.

Motivation: California's PEV Market 2010-2030



	1st Gen Innovators	2nd Gen Innovators & Followers	3rd Gen Innovators & Followers Next Purchase
PHEV Miles Traveled	10 – 40	15 – 50	50+
BEV Miles Traveled	80 – 250	150 – 300	200+
# of Models	20 – 30	30 – 100	200+
Designs	Compact, Subcompacts	Crossover, Midsize Sedans	Full-sized Vehicles

From Turrentine 2018

California Clean Vehicle Rebate Project (CVRP)

- Created by AB 118 in 2007
  - First come, first served—funded through 2015
- No means-testing
  - No income caps, same rebate for all income levels
- SB 1275 (2014) changed CVRP to attempt to increase reach for low-income consumers
- In Mar/Nov 2016 CARB implemented:
  - Income cap
  - Increased rebates for low- and moderate-income consumers
  - Increased outreach efforts

Topics

- Series of whitepapers on each aspect of the CVRP changes
  - Income cap
  - Increased rebates
  - Increased outreach
- Quantification of emissions reductions

Project Goals

1) Synthesize the best published and on-going research available on the topic
2) Highlight important research gaps
3) Provide a framework for understanding the various dimensions of the topic
4) Make a clear link between research findings and policy implications
5) Be accessible to an informed and interested, but non-technical audience

Findings

Impact of CVRP Income cap

- This paper reviews and summarizes the research surrounding CVRP's income cap.
- Due to the recent nature of the program, no peer-reviewed research has been published about the specific effects of CVRP.
- Income cap changes implemented in 2016:
- March 2016 (SB 1275)
  - Income caps for participants set at:
    - $250K single
    - $340K head of household
    - $500K joint
- November 2016 (SB 859)
  - Reduced income caps for participants to:
    - $150K single
    - $204K head of household
    - $300K joint

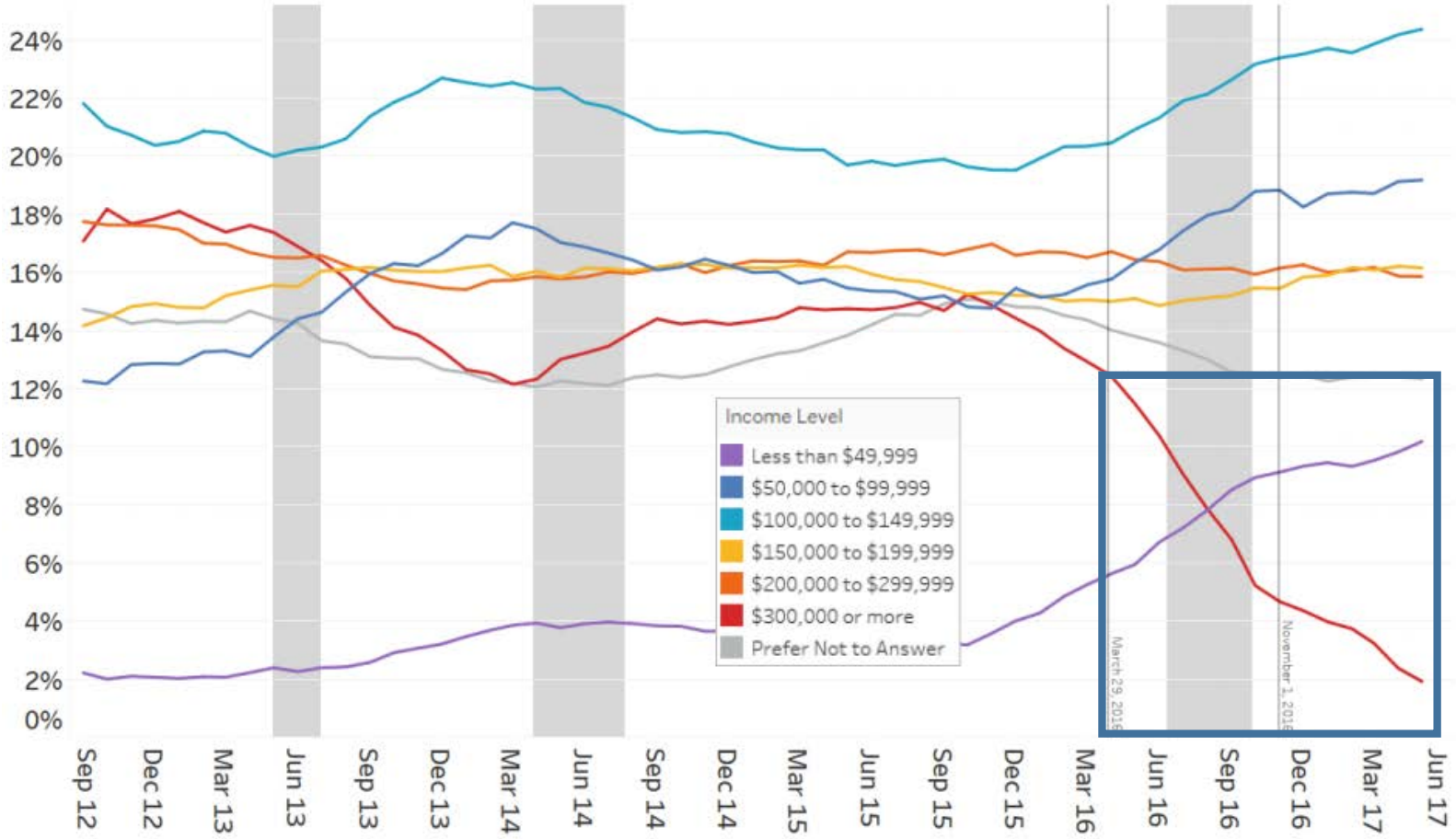
Key Findings

- New buyers of ZEVs tend to be higher income than average buyers of new cars. This is shifting over time—likely because of changes in policy, such as income caps and increased rebates.
  - (Borenstein & Davis 2016; Helveston et al. 2015)
- Past hybrid electric vehicle (HEV) and ZEV subsidies predominantly went to higher-income buyers and many who would have purchased EVs anyway.
  - (Chandra et al. 2010; Diamond 2009; Helveston et al. 2015; Hardman & Tal 2016; Rubin & St. Louis 2016)
- The purchase decisions of higher-income car buyers are far less sensitive to ZEV rebates than the purchase decisions of low- to moderate-income car buyers.
  - (Diamond 2009; Hardman & Tal 2016; Helveston et al. 2015)

Key Findings

- Rebate recipients are becoming increasingly demographically similar to new car buyers overall, according to rebate program data.
  - No conclusive causality between income caps and a more equitable rebate distribution, but the correlation in data is high.
  - The share of rebate recipients earning more than $300,000 annually (household income) has dropped from ~16% to ~2%
  - While the share of rebate recipients with lower than $50,000 nearly doubled (~5% to ~10%).
- Rebate importance/essentiality has increased since the enactment of income caps and increased rebates, as more price-sensitive buyers have entered the market.

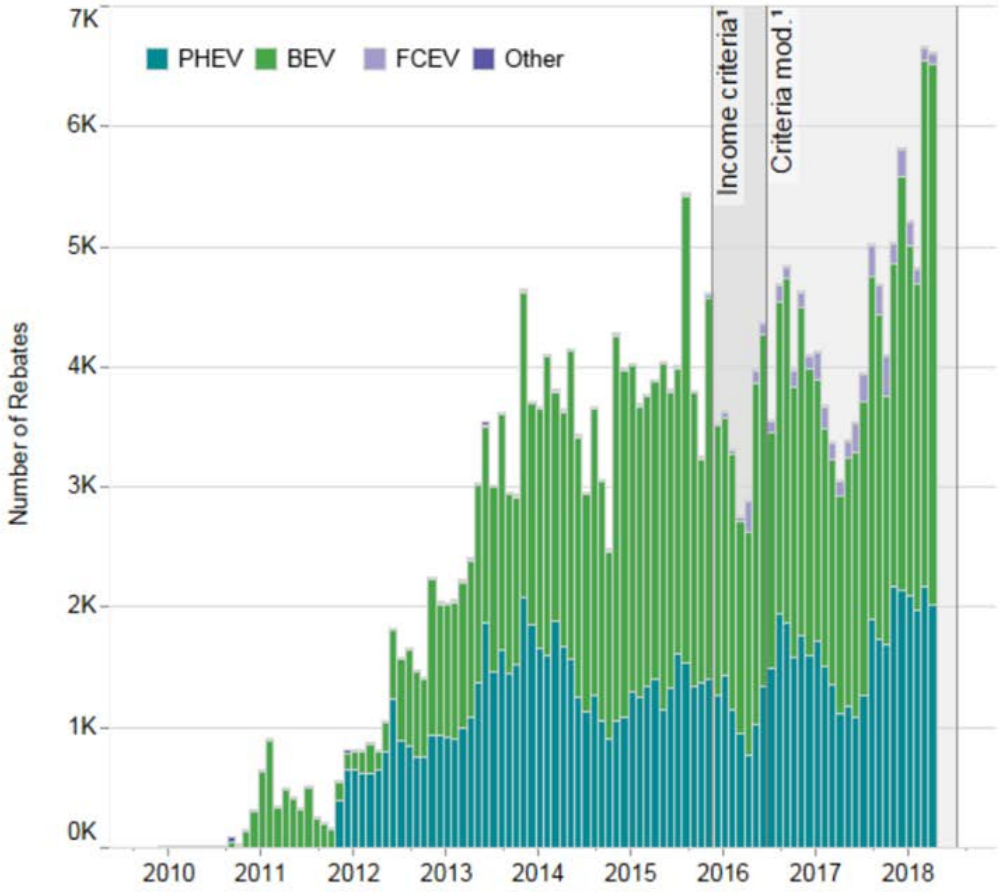
CVRP Rebates by Income



From Williams 2018

CVRP Rebate Totals

CVRP Rebates	
2010	135
2011	4,521
2012	11,219
2013	29,152
2014	43,702
2015	46,543
2016	44,455
2017	47,762
2018 *(thru Aug.)*	42,970
Total	270,459



From Williams 2018

Key Gaps

- Modeling for the expected total market effects of different income caps
  - Especially how this is expected to change over time with new model introduction
- Explicit analysis of the effect of CVRP's income cap
  - Need better causal inference than simple before-and-after comparisons
  - Analyze if high-income purchasers (w/o CVRP) decreased after the income cap's implementation

Policy Implications

- Because higher-income buyers are less sensitive to the rebate, an income cap is expected to reduce free ridership while not reducing sales significantly.
- Sales of EVs in California have continued to grow despite income caps going into effect.
- Because rebate importance has increased over time, availability of rebates will likely be an important determinant of future EV adoption rates.

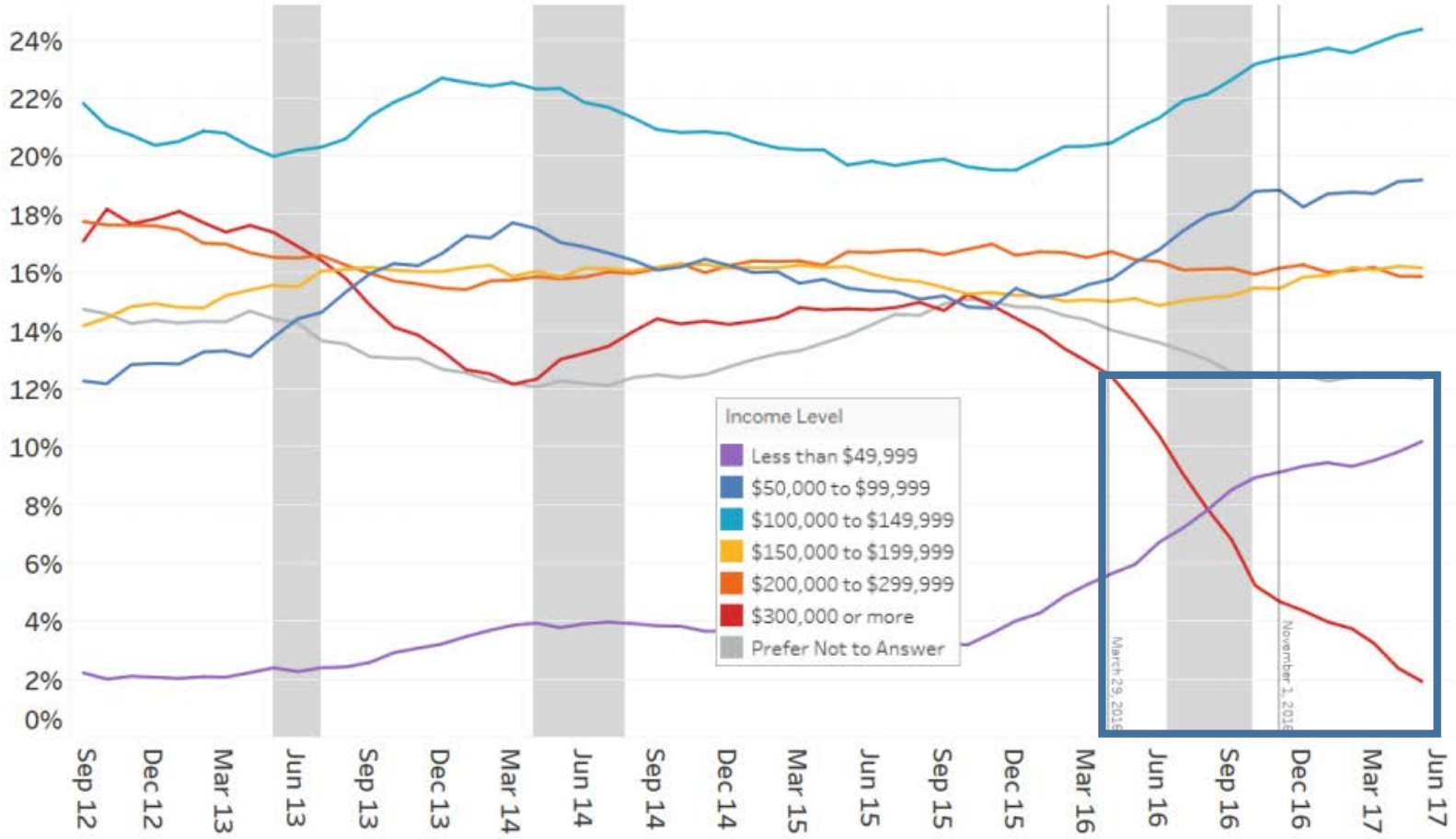
Impact of CVRP Increased Rebates

- This paper reviews and summarizes the research surrounding CVRP's increased rebates.
- Due to the recent nature of the program, no peer-reviewed research has been published about the specific effects of CVRP.
  - Some research speaks directly to rebates for low- and moderate-income individuals as part of other programs, such as the Enhanced Fleet Modernization Program (EFMP)
- Increased rebate changes implemented in 2016:
- March 2016 (SB 1275)
  - Increased rebate of $1,500 for lower-income consumers (income < 300% of FPL)
- November 2016 (SB 859)
  - Added $500 to the increased rebate for lower-income consumers for a total of $2,000

Key Findings

- Price is an important determinant of EV demand among low- and moderate- income consumers. Muehlegger and Rapson 2018 find that a 10 percent decrease in the price of a ZEV leads to a 39 percent increase in quantity of ZEVs purchased among this subpopulation.
- Individuals who purchase vehicles with a lower MSRP and lower-income individuals, in general, state that rebates are more important to their decision (Williams 2018).
- Steep progressive rebates based on income may induce larger increases in demand than the status quo—a single increase for low-income and an income cap—in California (DeShazo et al. 2017).
- Recent CVRP changes were effective in increasing the share of rebates received by the lowest-income households. (Williams 2018)

CVRP Rebates by Income



From Williams 2018

Key Gaps

- Explicit analysis of the effect of the increased rebates.
- Analysis of the change in affordability of upcoming models (which may have lower MSRP).
- Need to use better econometric methods than simple before-and-after comparisons understand the true causal effect of these programs.
- Analyze if more segmentation of the rebate amounts based on income would be more effective.

Policy Implications

- Researchers have argued for modification of incentives to target specific purchaser types (e.g. DeShazo 2010, Skerlos and Winebrake 2010)
- Incentives can have higher social benefits for a given cost if targeted to lower income communities and groups
- A more progressive rebate, with more income brackets could be even more effective in increasing EV adoption
- Availability of rebates will likely be an important determinant of future ZEV adoption

Impact of Increased Outreach through CVRP

- This paper reviews and summarizes the research surrounding CVRP's increased rebates.
- Due to the recent nature of the program, no peer-reviewed research has been published about the specific effects of CVRP.
- CSE ""hired additional staff with experience in outreach to disadvantaged populations and developed a set of outreach and education activities to meet the needs of this population."
  - CVRP outreach increased from 3,600 direct interactions with stakeholders in 2013 to 13,000 in 2014.
- In 2018, CA-DMV and CARB used mailers to inform 700,000 individuals of CVRP.

Key Findings

- Awareness of electric vehicles is low, even in California
  - Awareness in California has not increased between 2014 and 2017
- Outreach investment likely needs to be significantly higher than current levels to be significant compared to general vehicle advertising expenditures
- Dealers have very low levels of knowledge and interest in selling EVs
  - They could have a positive sales impact, but currently are negative

Key Findings (continued)

- Usage of EVs (e.g. test drives) increased positive impressions. In some studies, it increases purchase intentions
  - In another study it found a decrease in purchase intentions, however
- Range anxiety is a significant detractor
  - One study found that usage decreased range anxiety—individuals overestimate their actual range needs
- "Green" characteristics of EVs only address a small segment of consumers and general uncertainty about EVs deters potential buyers
  - Providing full-cost of ownership (over only fuel-costs) for EVs vs. ICEVs is most effective information in increasing adoption

Research Gaps

- Scientific evaluation of past and ongoing outreach investments (like nonprofit ZEV promoters).
- Research on best practices to inform dealers about EVs and incentivize selling.
- Further study of how to best ameliorate EV anxieties (e.g., range & high purchase costs).
- Direct cost-effectiveness evaluation of California's investments in outreach.
  - Data collected from the 2018 campaign can serve as a baseline

Policy Implications

- Low awareness is a key barrier to EV deployment, increasing the importance of outreach.
  - This fits with basic economic logic of the need for "complete information" for individual's to make the "best" decision.
- Focusing on EV-associated cost savings may help spur EV purchases for those who are already aware of Evs.
- Because so little is known regarding the effectiveness of specific approaches, evaluation should be included in outreach efforts.

Quantification of Emissions Reduction

- This related paper reviews and summarizes the research estimating the net changes to emissions from EVs
- Studies attempting to quantify emissions reductions typically fall into one of two methodological categories.
  - Economy-wide analyses attempt to assess emission changes across the stock of vehicles, incorporating all relevant economic sectors.
  - Life Cycle Assessments (LCAs), which represent the vast majority of studies, focus on emission changes along different stretches of the vehicle supply chain.

Key Findings

- *Do EVs reduce GHG emissions?*
  - This question is well addressed in the literature and the findings are conclusively: yes.
  - However, different energy mixes, policies, and technologies of vehicles/charging can either moderate or increase these effects significantly.
- *Do EVs reduce emissions when their entire lifespan is considered? How significant are production and retirement emissions in comparison to operation emissions?*
  - While many LCAs have broad scopes, many focus on only specific aspects of the EV lifecycle. Bicer and Dincer (2017) and Hawkins et al. (2013) are notable counterexamples.
  - This highlights the need for more inclusive studies that consider a broad scope and a wide range of emissions to ensure that EV schemes do not have unintended and harmful consequences (Hawkins et al. (2012)).
  - There has been little consideration of vehicle lifetime and battery replacement assumptions and how they influence emissions.

Key Findings

- *How do common driving patterns and conditions affect EV emissions?*
  - Vehicle usage and weather conditions can have considerable impacts on an EVs battery capacity and lifespan, and hence emissions.
  - Changes in driving patterns can have positive or negative effects on EV emissions. Overnight charging consistently increases emissions relative to daytime charging since the marginal electricity source tends to be baseload fossil fuels.
- *How do EV emission estimates change with differing electricity emission intensities? Is there a preferred type or methodology for generating emission intensities?*
    - Attributional versus consequential. The former are estimates procured from other studies or databases, while the latter rely on sophisticated simulation or regression techniques.
    - Average versus marginal. Both may be appropriate, depending on whether the location and timing of vehicle charging is thought to be important. If so, marginal emission factors tend to be the better option.
  - While there is no definitive consensus, using marginal consequential emissions may be the most robust way to estimate electricity emission factors.

Interpretation

- Two stated goals for EV policy in California are:
  - Cost-effectiveness: ensure that rebates go (to the extent possible) to those who would not have otherwise purchased an EV
  - Equity: a sense of fairness in the distribution of rebate recipient attributes with the goal of evenly distributing incentives across a range of demographics, especially income
- Based on a body of analogous studies and data so far, changes appear likely to improve both of these metrics
  - That doesn't mean we have the levels exactly right, this will take continued research and meticulous policy
- Outreach remains a key component that is poorly understood in terms of effectiveness of specific programs
- The used vehicle (secondary market) and repeat EV buyers will become an increasingly important group as sales increase
  - This is an understudied topic

Selected Bibliography

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Borenstein & Davis 2016 "The Distributional Effects of US Clean Energy Tax Credits"

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Thank You
Questions?

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