Assessing Progress Toward Equitable Access to EVs with Incentive Program Metrics

Lessons Learned from CVRP and NY DCRP Using Program Data and Baselines of Comparison

CARB Clean Transportation Equity Incentives Symposium

April 10th, 2025 (presentation version 4/11/25)

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with particular thanks to Nick Pallonetti, Latrice Puckett, John Anderson, and others at CSE

and to the CARB and NYSERDA staff who manage the CA CVRP and NY DCRP statewide EV rebate programs

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Discussion Questions: What Works For/Across Different Programs?

- Which of these lessons/metrics apply to your program?
- How do things differ?
- How do you define your program's particular role in the portfolio needed to achieve different kinds of equity?
- What are one or two steps you might take toward measuring progress?
  - Outputs, outcomes, impacts
  - Context

For example (partial list simply to get us thinking about the diversity – tell us what is challenging/important to evaluate about yours)…

Incentives
California E-Bike Incentive Project
Clean Cars 4 All
Clean Vehicle Rebate Project
Driving Clean Assistance Program
Enhanced Fleet Modernization Program
etc.

Schools
¡Adelante Watsonville!
A Transformative Clean Mobility Pilot
California Capital Pilot Project
Clean Transportation and Enhanced Access for All Porterville Students
East San Jose Mobility Project
Getting Stockton to Zero Emissions: Clean Air for Our Community
Lincoln High School Clean Mobility in Schools Pilot
Safe Routes and Active Transportation for Schools and Underserved Communities in Hayward
etc.

And the list goes on: **Clean Mobility Options, Community Resources/Outreach, …**

Outline

I. Welcome

II. Equity Evaluation Approaches & Resources

III. Equity Evaluation Challenges and Pitfalls

IV. Equity Evaluation of CA's CVRP & NY's DCRP: Illustrative Examples

- Geographic Equity
- Income & Other Sociodemographic Equity
- Targeting Outreach & Other Support Through Consumer Segmentation
- Additional Examples

V. Discussion & Application to Other Programs

Appendix

Equity Evaluation
Approaches & Resources

What are some of the different ways we can evaluate equity?

1. **Equity Metrics**
   - Consumer Characteristics: Where is progress being made, and where is there a longer road ahead?
2. **Equity in Context**
   - How does program context and case-specific data improve evaluation?
   - What role does a program play in the overall portfolio needed?
3. **Strategic Consumer Segments**
   - How can we amplify good things (EV conversion, adoption by priority populations)?
   - What is the path forward to the mainstream and beyond to widespread & equitable access to EVs?
4. **Incentive Influence & Free Rider Abatement**
   - Who is the most influenced by rebates and the federal tax credit?
   - How can program design help exclude free riders and max. cost-effectiveness within a budget constraint?
5. **Affordability Analysis** (discussed at a previous event)

Which programs have we evaluated?: Select State EV Rebate Programs (as of June 2023, in order of launch)

		CALIFORNIA CLEAN VEHICLE REBATE PROJECT	MOR-EV Massachusetts Offers Rebates for Electric Vehicles	CHEAPR Connecticut Hydrogen and Electric Automobile Purchase Rebate	NEW YORK STATE	OREGON CLEAN VEHICLE REBATE PROGRAM	chargeup New Jersey
Rebate Amounts	Fuel-Cell EVs	$4,500 (+3,000*)	$3,500	$7,500 (+$2,000*)	≥ 200 e-miles: $2,000 ≥ 40 e-miles: $1,000 < 40 e-miles: $500 Base MSRP > $42k: $500	≥ 10 kWh: $2,500 (+$5,000*) < 10 kWh: $1,500 (+$5,000*)	--
	All-Battery EVs	$2,000 (+5,500*)	$3,500	$2,250 (+$2,000*)			$25/e-mile: $2k max for MSRP < $55k; $4k max for MSRP < $45k
	Plug-in Hybrid EVs	BEVx = $2,000 Others = $1,000 (+$5,500*)	BEVx = $3,500 Others = $1,500	$750 (+$1,500*)			--
	Zero-Emission Motorcycles	$750	--	--	--	$750 (and NEVs)	--
Program Design Elements	Rebate Adder	*Income-qualified	--	*Qualified by proxy, income, or location	--	*Income-qualified	--
	Point-of-Sale	--	--	Point-of-sale	Point-of-sale	Point-of-sale option	Point-of-sale
	Price Cap	Base MSRP: - Large PEVs ≤ $60k - Car PEVs ≤ $45k	Purchase price: - PHEVs ≤ $50k - BEVs/FCEVs ≤ $55k	Base MSRP ≤ $50k	Base MSRP > $42k = $500	Base MSRP ≤ $50k	Trim-specific MSRP < $55k
	E-range Min.	≥ 30 e-miles	≥ 25 e-miles	--	--	--	--
	Misc.	Income cap Preapproval option for income-qualified in San Diego County or SJ Valley	--	Used EV program ($7.5k/$3k/$1.125k with point-of-sale option) $125/$75 dealer sales incentive	--	Used EVs also qualify Program suspended as of 5/1/2023	Program suspended as of 4/17/2023

Electric miles (e-miles) are U.S.-EPA-rated all-electric miles. BEVx = range-extended battery electric vehicle (BMW i3 REx). NEV = Neighborhood EV.

Free EV Equity Resources: Select Publications

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- ❖ Expanding Electric Vehicle Adoption in Disadvantaged Communities. *Transportation Research Record: Journal of the Transportation Research Board*. https://doi.org/10.1177/03611981241242753. Paper. CSE posting. Open-access data-summary appendix. TRB 2024 slides.
- ❖ Assessing progress and equity in the distribution of electric vehicle rebates using appropriate comparisons, *Transport Policy*, *137*, 141–151. https://doi.org/10.1016/J.TRANPOL.2023.04.009. Paper. CVRP posting. CSE posting. Precursor video. Precursor slides.
- ❖ New York State's Drive Clean Rebate for Electric Vehicles: Measures of Impact. *36th International Electric Vehicle Symposium (EVS36)*, EDTA, Sacramento CA, USA. Paper. Slides. CSE posting.
- Lessons Learned About Electric Vehicle Consumers Who Found the U.S. Federal Tax Credit Extremely Important in Enabling Their Purchase. *35th International Electric Vehicle Symposium (EVS35)*, Session H3, AVERE. Slides.
- Targeting Incentives Cost Effectively: "*Rebate Essential*" Consumers in the New York State Electric Vehicle Rebate Program. *35th International Electric Vehicle Symposium (EVS35)*, Session A3, AVERE. Slides.
- Brief: PHEV Consumers Most Highly Influenced by the U.S. Federal Tax Credit. *Program Reports,* Clean Vehicle Rebate Project.
- Evaluating the Cost-Effectiveness of Greenhouse Gas Emission Reductions Associated with Statewide Electric Vehicle Rebate Programs in California and Massachusetts in 2019. *International Energy Program Evaluation Conference* (1st COVID reschedule). Related video. Related resource compilation.
- ❖ *An Electric-Vehicle Consumer Segmentation Roadmap: Strategically Amplifying Participation in the New York Drive Clean Rebate Program*. NYSERDA Report 21-30.
- Strategically Targeting Plug-in Electric Vehicle Rebates and Outreach Using Characteristics of "*Rebate-Essential*" Consumers in 2016–2017. *31st Int. Electr. Veh. Symp. (EVS31)*, Society of Automotive Engineers of Japan, Inc., Kobe, Japan.
- ❖ *Summary of Disadvantaged Community Responses to the Electric Vehicle Consumer Survey, 2013–2015 Edition*, *Program Reports*, *Clean* Vehicle Rebate Project, San Diego CA, 2018.

Reverse chronological as of 5/2024; key sources marked with a diamond bullet. Additional related items.

Free EV Equity Resources: Select Presentations

- CVRP 2022 Data Brief: Consumer Characteristics & Equity Metrics. RG posting. CVRP Posting. (2024, Oct.)
- Evaluating and Advancing the Equity of Electric Vehicle Adoption: Opening Remarks and Lessons from State Rebate Programs. RG posting. TRB posting. (2024, Aug.)
- ❖ Amplifying Electric Vehicle Adoption in Disadvantaged Communities, Consumer Segmentation Roadmaps, and Additional Equity Considerations TRB posting. (2024, Jan)
- Resource Compilation: CVRP Emission Impacts and Cost-Effectiveness (2023, Dec.)
- CVRP 2021 Data Compilation: Incentive Influence and MSRP Considerations (2023, Oct.)
- ❖ B.D.H. Williams (2023, Oct. 25), Panel: "E-Mobility Research and Data Analytics," National E-Mobility Diversity, Equity, & Inclusion Conference 2023, EV Noire, Washington DC, USA.
- NY Drive Clean Rebates: Select Impacts Through 2021. Paper. CSE posting. (2023, Jun.)
- ❖ Data from Statewide Electric Vehicle Rebate Programs: Vehicles, Consumers, Impacts, and Effectiveness (2021, Jul.)
- EV Purchase Incentives: Program Design, Outputs, and Outcomes of Four Statewide Programs with a Focus on Massachusetts (2020, Dec.)
- ❖ Electric Vehicle Incentives and Policies (2019, Nov.)
- ❖ EV Rebates: Demographic Update, Program Design Features, and Paths Forward for Broadening Participation (2019, Aug.)
- ❖ Electric Vehicle Rebates in Disadvantaged Communities: Evaluating Progress with Appropriate Comparisons (2016, Oct.)
- CVRP Income Cap Analysis: Informing Policy Discussions (2016, Aug.)
- Implementation Status Update (2015, Dec.)

Reverse chronological as of 10/2024; key sources marked with a diamond bullet. Additional related items.

Free EV Equity Resources: Video & Additional Resources

Video

- HEC Video: "HEC 2022 Panel - Electrification and Transportation," opening presentation minutes 2–10; 40-minute panel total. Slides. (2022, May)

❖ CARB Video: "CVRP 2020 Data Brief: Consumer Characteristics," time 1:05:43–1:26:09. Slides. (2022, Mar.)

- Yale Webinar: "Supporting EV Commercialization with Rebates: Statewide Programs, Vehicle & Consumer Data, and Findings," 58 minutes. Slides. (2017, Apr.)

Dashboard

❖ Equity Tab, Rebate Statistics Dashboard, Clean Vehicle Rebate Project, administered by the Center for Sustainable Energy on behalf of the California Air Resources Board (CARB).

Infographic

- CSE (2017, Jan.), Infographic: Plug-in Electric Vehicle Owners in California's Disadvantaged Communities, *Program Reports,* Clean Vehicle Rebate Project.

Other

- P. Slowik (2019), Expanding Zero-Emission Mobility Equity and Access Workshop Report, ZEV Alliance and the ICCT.

Reverse chronological as of 8/2022; key sources marked with a diamond bullet. Additional related items.

Equity Evaluation
Challenges & Pitfalls

Challenges Third-party Researchers Encounter Evaluating EV Incentives for Equity

[emphasis added]

1. **Adapting** traditional equity evaluation **frameworks and terminology** from centrally awarded funding to consumer “hand raiser” programs, especially if first-come/first-served.
2. Avoiding perpetuating conclusions based on **early-market data**
3. Making **implicit judgements** explicit, preferably quantitative (e.g., what is “high” income or “low” income?)
4. Providing **context**, **normalizing results**, and/or constructing **appropriate bases of comparison** against which to judge the findings.
5. **Balancing** simple, **intuitive indicators that are empowering** to a conversation with diverse values **against** the benefits of more **complex assessment** that provides “definitive answers” but depends on analyst judgements.

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Assessing progress and equity in the distribution of electric vehicle rebates using appropriate comparisons

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Equity
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ABSTRACT

To meet aggressive transportation-electrification goals, electric-vehicle (EV) sales must expand deeper into mainstream markets. To address equity concerns, EV sales must go beyond the mainstream to increase access to EV benefits. To support needed expansion in sales and equity, this research examined the characteristics of California consumers that claimed the statewide rebate for EVs purchased/leased in 2017–2020. It weighted a ~ 32,524 survey responses to represent N ~ 193,167 rebate recipients and focused on 2020 adoption, trends over time, and differences between consumers of battery and plug-in hybrid EVs. Importantly, incentive-recipient characteristics were compared using Market-Majority Metrics to those of California new-vehicle buyers as a more appropriate baseline. Results raise the possibility that findings about the equity of EV-rebate-recipient incomes based upon comparisons to Census data could largely and more simply be findings about new-car buying, rather than particular to EV-incentive recipients. Rebate-recipient incomes continued to progress toward the mainstream despite the dominance of Tesla consumers and COVID. The distribution of rebate funding by income is now roughly comparable to new-vehicle buyers. Indeed, fewer rebated PHEV consumers (52%) had household incomes greater than $100,000 than even new-vehicle buyers (56%). Except for age, PHEV consumers are more similar to typical vehicle buyers than BEV consumers are. The characteristics most distinguishing of EV consumers are now home ownership and male sex/gender identification. Market-Majority Metric “heat map tables” are developed as an intuitive but quantitative tool to highlight the length of the road ahead that EV markets must travel toward the mainstream and beyond to priority populations.

1. Introduction

1.1. Problem & research aims

Significant public investments are being made to incentivize the purchase or lease of plug-in electric vehicles (EVs). Questions are frequently raised about the beneficiaries of these investments: Who is receiving EV incentives? Is the distribution of EV incentives equitable? Headlines raise concerns about progress—e.g., “Silicon Valley dudes buying Teslas”: California struggles to expand electric car market” (Gardiner, 2020).

Discussion about these important topics typically suffers from one or more challenges, including: 1) lack of a quantitative basis and clear definitions upon which to ground specific issues, 2) lack of access to pertinent data that adequately characterize a dynamically evolving nascent EV market, and/or 4) lack of appropriate baselines of comparison that provide meaningful context. For example, it is well established that early EV adoption was associated with “high income” (e.g., (Brückmann et al., 2021; Hardman et al., 2016)). However, determining what is “high”—let alone how concerning we should consider incentive-recipient incomes to be—turns out to be surprisingly difficult. This, in turn, complicates the development of optimal strategies to effectively address legitimate concerns about equity and public investment.

> “If we could first know where we are, and whither we are tending, we could better judge what to do, and how to do it” -Abraham Lincoln (“House Divided Speech - Lincoln Home National Historic Site,” n.d.)

This research aims to aid the discussion by 1) updating the characterization of EV incentive recipients with relatively recent data, 2) exploring trends over time, and 3) calibrating the conversation about inequities with appropriate bases of comparison. The purpose is not to make final proclamatory determinations, but rather to develop and discuss simple yet illuminating metrics that can inform and empower evaluations of market status, equity, and the road ahead.

Specifically, the characteristics of consumers that have received

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B.D.H. Williams (2023, Apr.), Assessing progress and equity in the distribution of electric vehicle rebates using appropriate comparisons, Transport Policy, 137, 141–151. DOI: 10.1016/J.TRANPOL.2023.04.009. Paper. CVRP posting. CSE posting. Precursor video. Slides.

Overcoming Challenges: Solutions Attempted

1. Indirectly, through **attention to terminology** choices and **framing**.

2. By helping to update EV-market characterizations using **relatively recent data** and **iterating!**

3 & 4. **Construct and judge** results **relative to baseline metrics** for vehicle buyers.

5. Using percentage-point-difference **"heat map tables" to highlight the "length of the road ahead" for EV markets**

from: Assessing progress and equity in the distribution of electric vehicle rebates using appropriate comparisons, *Transport Policy*, *137*, 141–151.

Additional point for evaluation across multiple programs:

- **Multi-criteria analysis** particularly important to balance different approaches that meet different goals/needs **within a portfolio**

Equity Evaluation
Illustrative Examples

Geographic Equity

Mejía-Duwan et al. 2023 (UC Berkeley research published in PLOS Climate)

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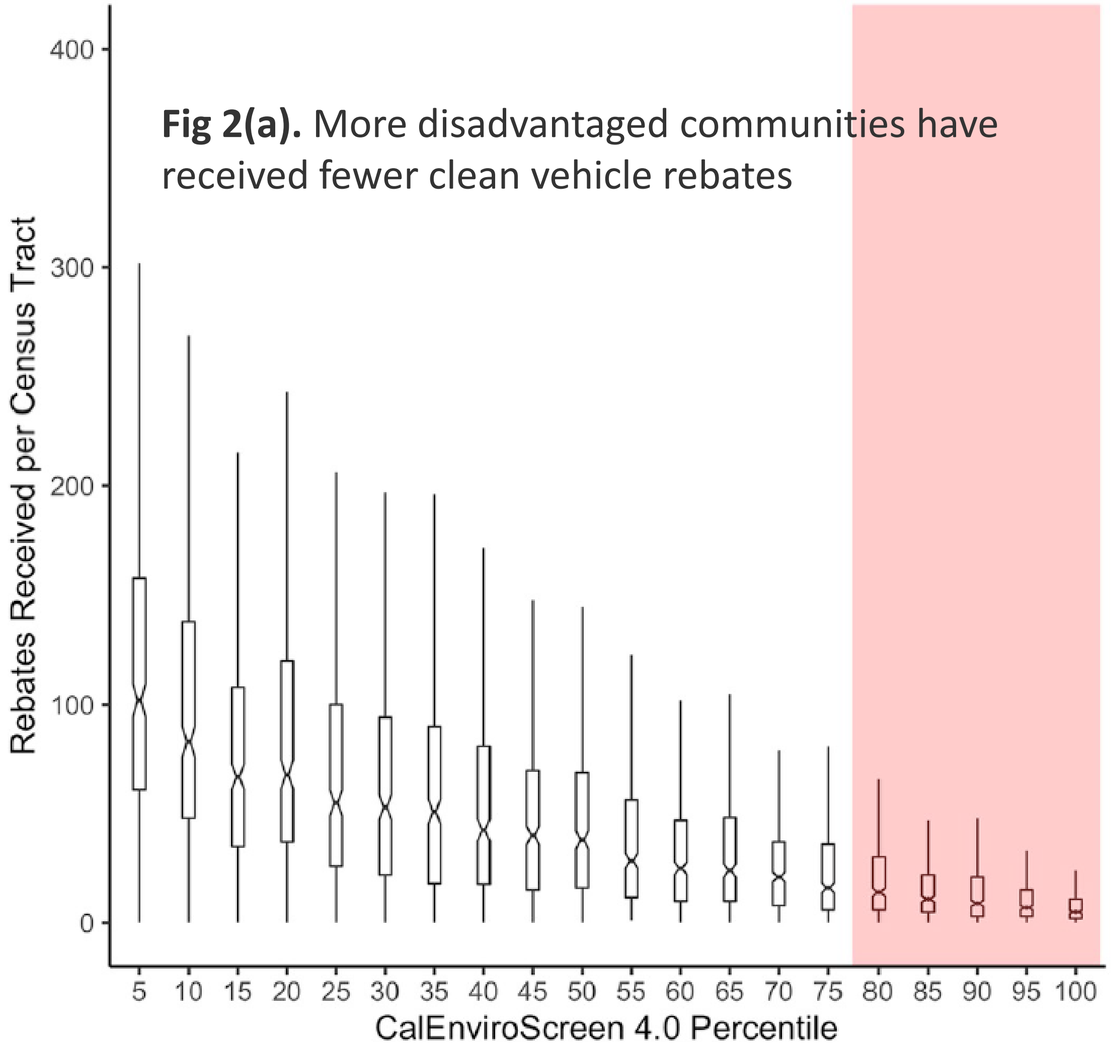


Fig 2(a). More disadvantaged communities have received fewer clean vehicle rebates

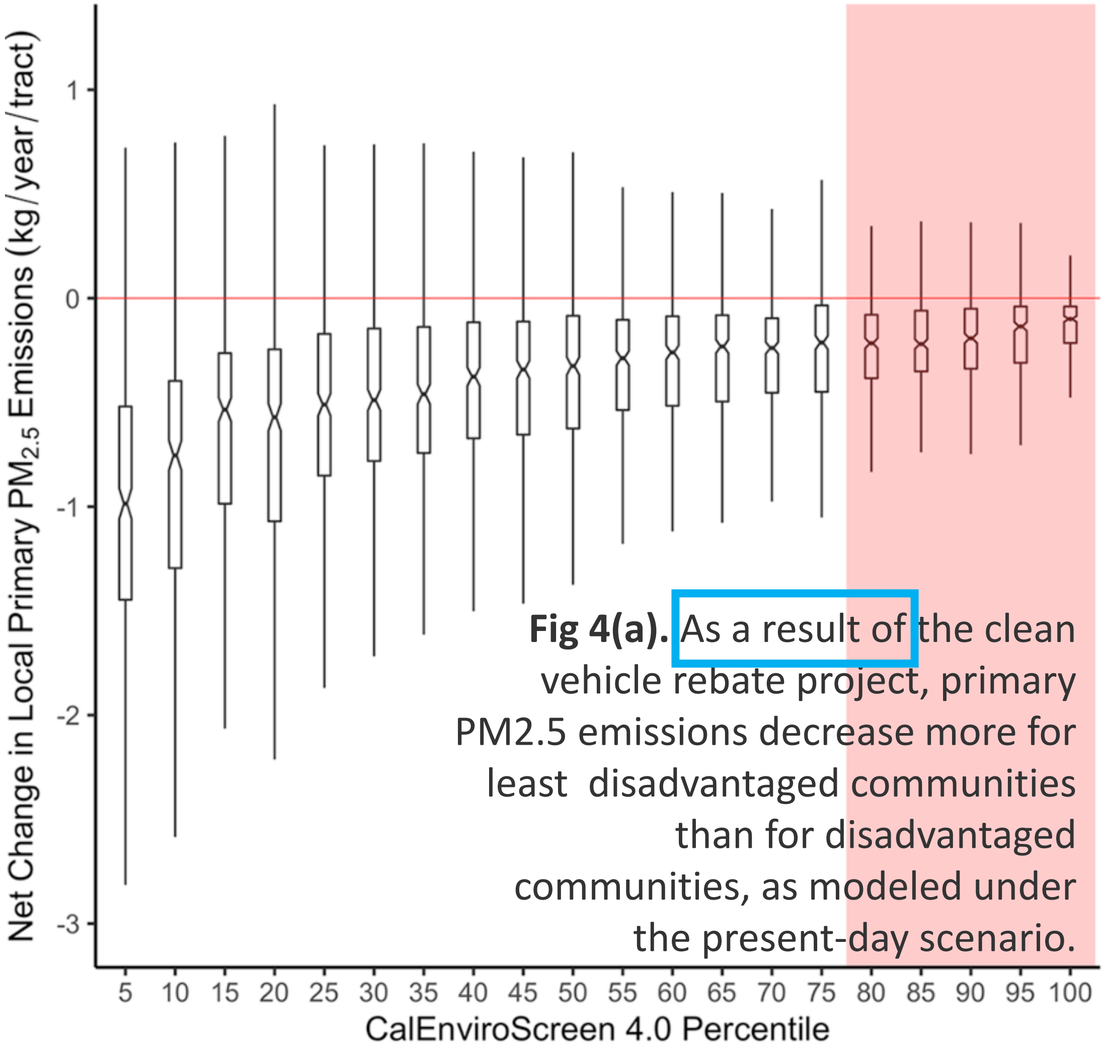
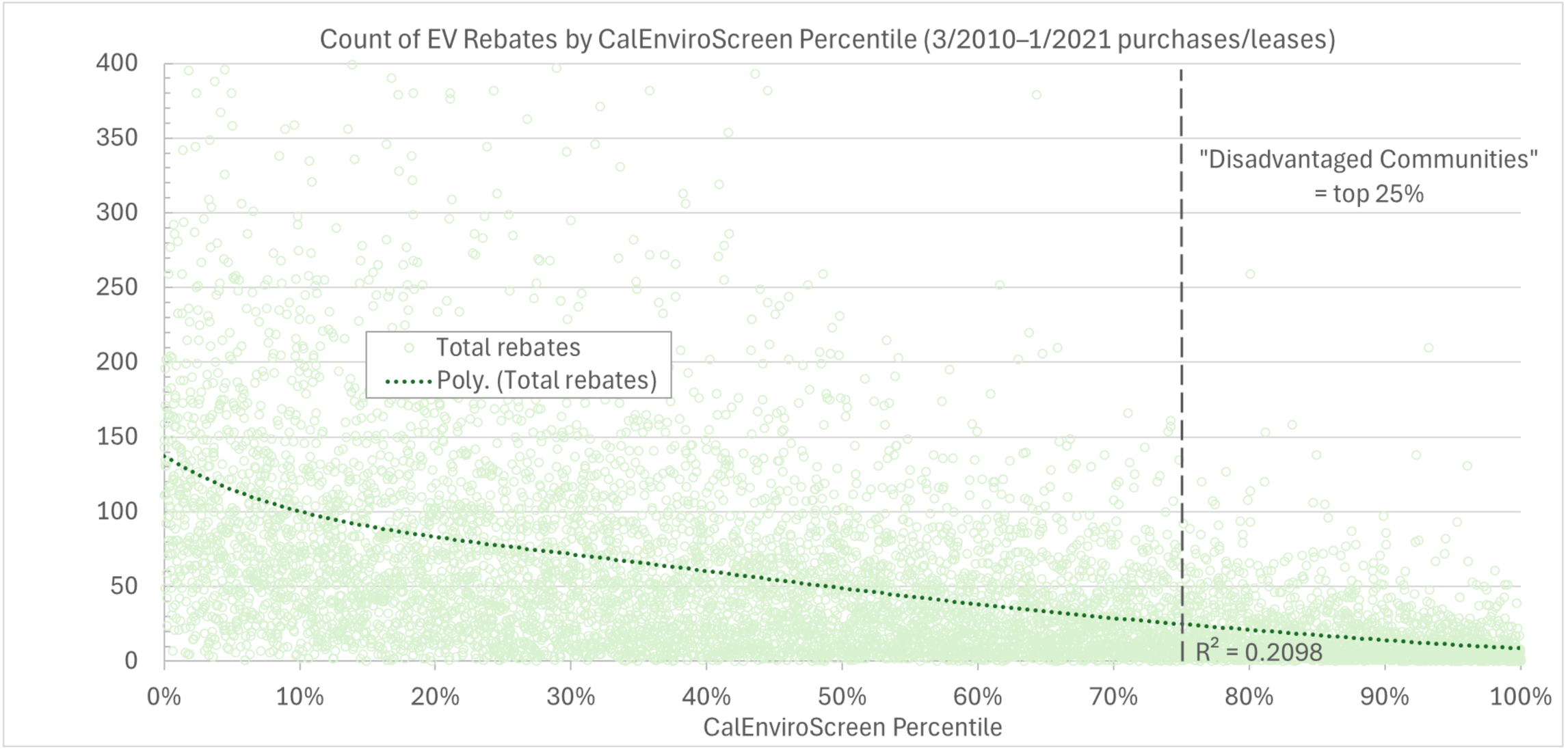


Fig 4(a). As a result of the clean vehicle rebate project, primary PM2.5 emissions decrease more for least disadvantaged communities than for disadvantaged communities, as modeled under the present-day scenario.

Geographic Equity (post hoc): Rebates Did Decrease with CES Score

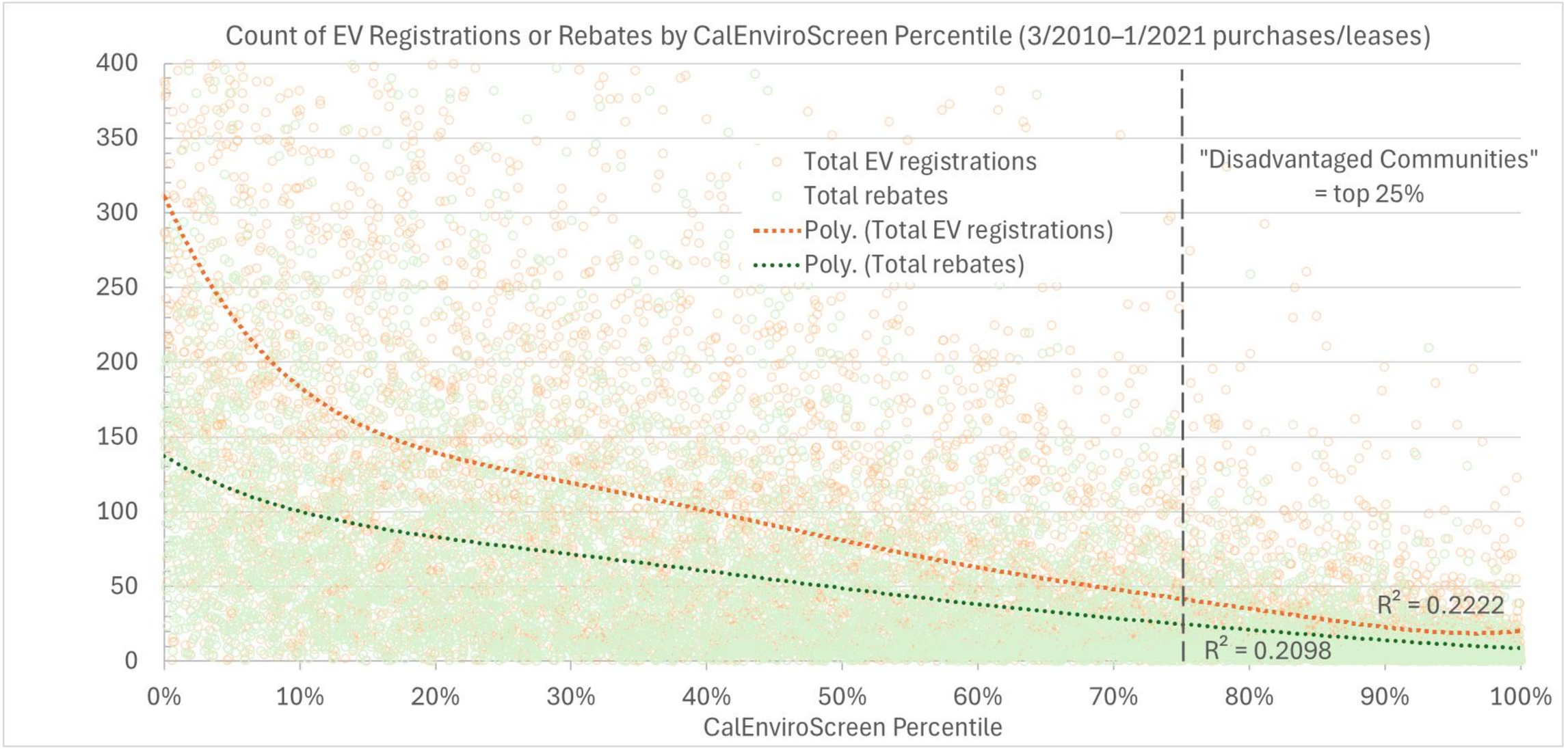
3/2010–1/2021 (to make comparable to other analysis)



Contains content from S&P Global (formerly IHS Markit) © 2024. 6th-order polynomial fit.

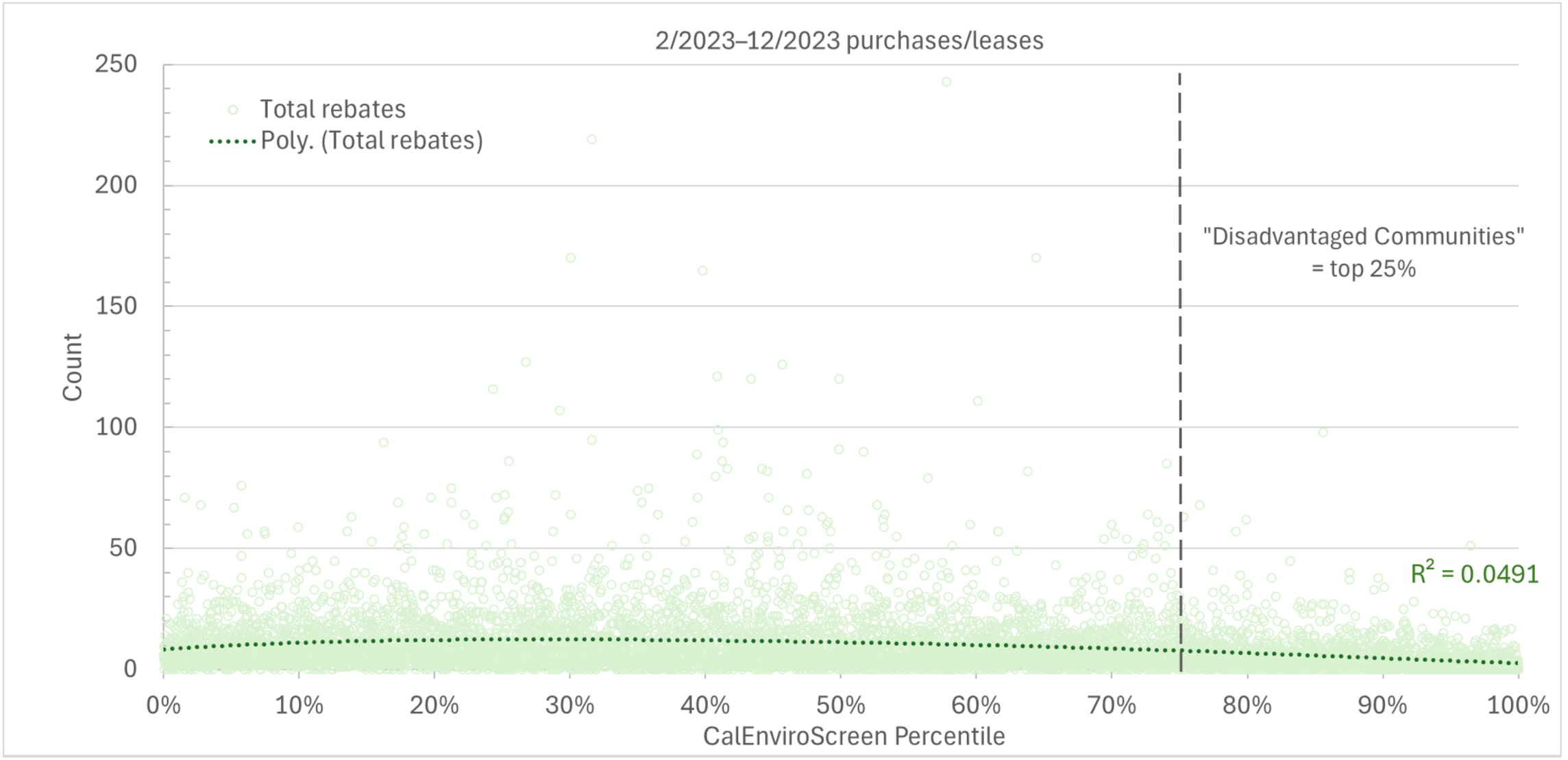
However, EV Sales Overall Decreased Even More

(3/2010–1/2021)



Contains content from S&P Global (formerly IHS Markit) © 2024. 6th-order polynomial fits.

Later, things looked differently
(most recent program era)



Contains content from S&P Global (formerly IHS Markit) © 2024. 6th-order polynomial fit.

Later, things looked differently, but more so for the program than the market
(most recent program era)

 6th-order polynomial fits.

Geographic Equity

	Paper timeline	Life of program	Most recent program design
	3/2010–1/2021	3/2010–12/2023	2/2023–12/2023
DACs (% of Rebates)	8%	10%	15%

Paper: Mejía-Duwan, et al. (2023) in PLOS Climate. Additional percentages calculated following the approach in Mejía-Duwan et al. (2023) using publicly-downloadable rebate-application dates as a proxy for purchase/lease dates.

Geographic and Income Equity

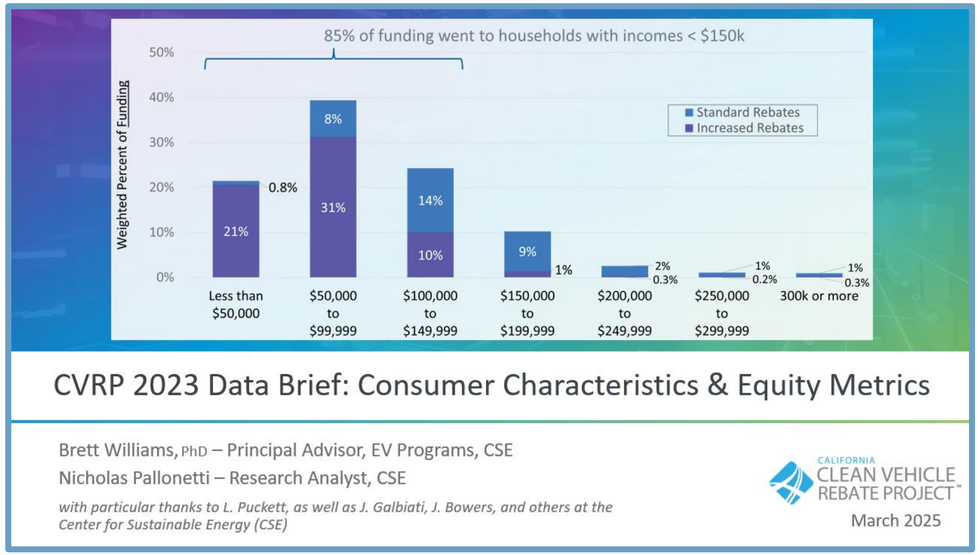
	Paper timeline	Life of program	Most recent program design	
	3/2010–1/2021	3/2010–12/2023	2/2023–12/2023	
DACs (% of Rebates)	8%	10%	15%	
DACs (% of Funding)	9%	11%	17%	→ nearly 2x increase
Increased Rebates for Lower-Income Consumers (% of Rebates)	6%	11%	28%	
Increased Rebates for Lower-Income Consumers (% of Funding)	10%	24%	58%	→ nearly 6x increase

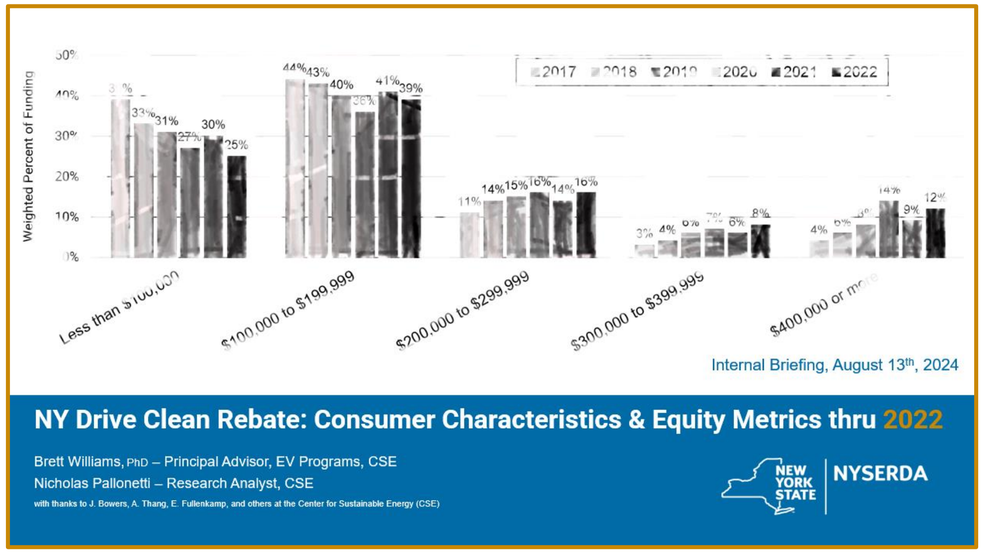
Paper: Mejía-Duwan, et al. (2023) in PLOS Climate. Additional percentages calculated following the approach in Mejía-Duwan et al. (2023) using publicly-downloadable rebate-application dates as a proxy for purchase/lease dates.

Income & Other Sociodemographic Equity

Rebated EV Consumer Characteristics & Equity Metrics CA & NY (& CT & MA)

Excerpts from evaluations for CA & NY:





	CA	NY
Vehicle purchase/lease dates	Jan. 2023 – ~Sep. 2023 †	Mar. 2017– Dec. 2022
Survey responses (*n*)*	10,208	19,513
Program population (*N*)	77,135	85,166

**Subsequently weighted to represent the program population along the dimensions of vehicle technology (PHEV vs. BEV), model, buy vs. lease, and county (and rebate type in CA). Further data details provided in subsequent slides.*

† Due to the program closing: 6 survey responses and 21 rebates in the dataset have purchase dates after Sept. 2023.

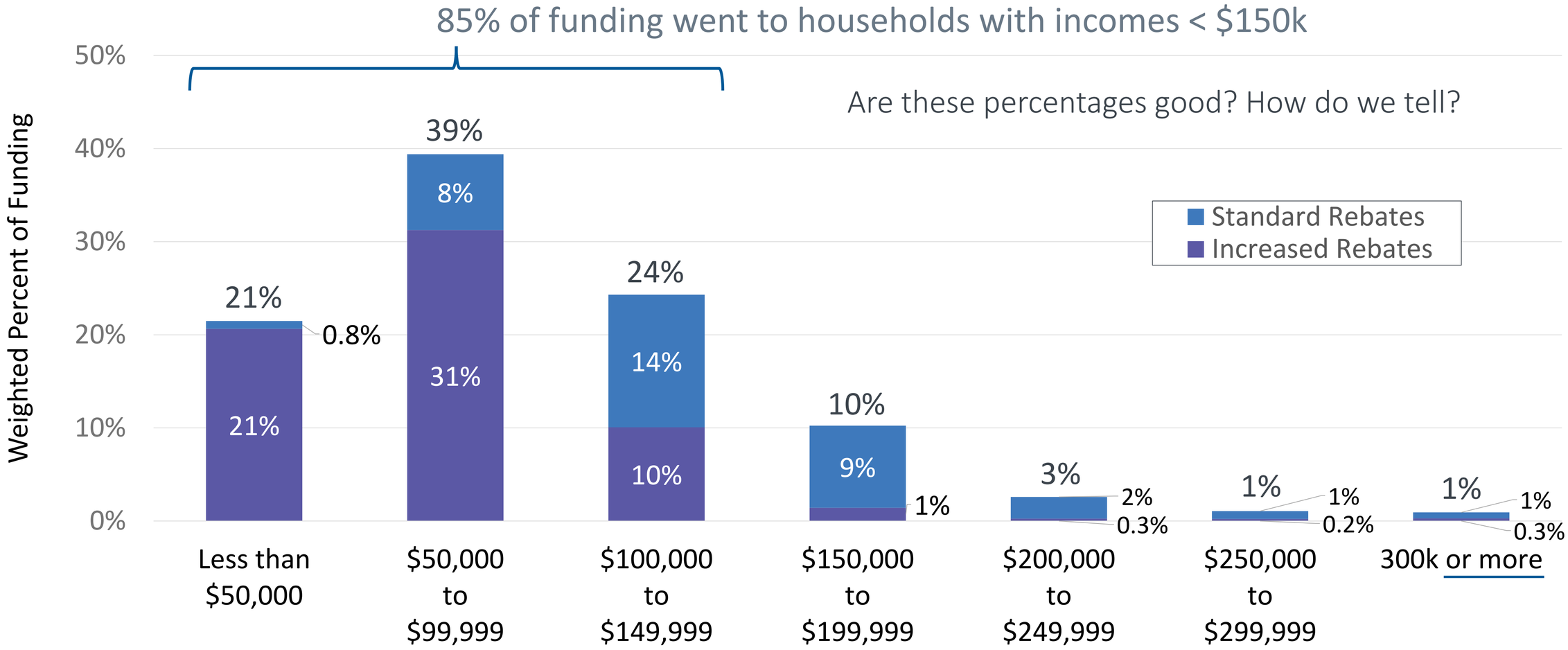
Where do we start?

- A typical place, in evaluation terms, is “program outputs.”
  - E.g., “Who/what benefitted from the program?
    - E.g., “What was the household income of program participants?”…

Distribution of Funding for Plug-In EV Rebates by Household Income

2023 Purchases/Leases

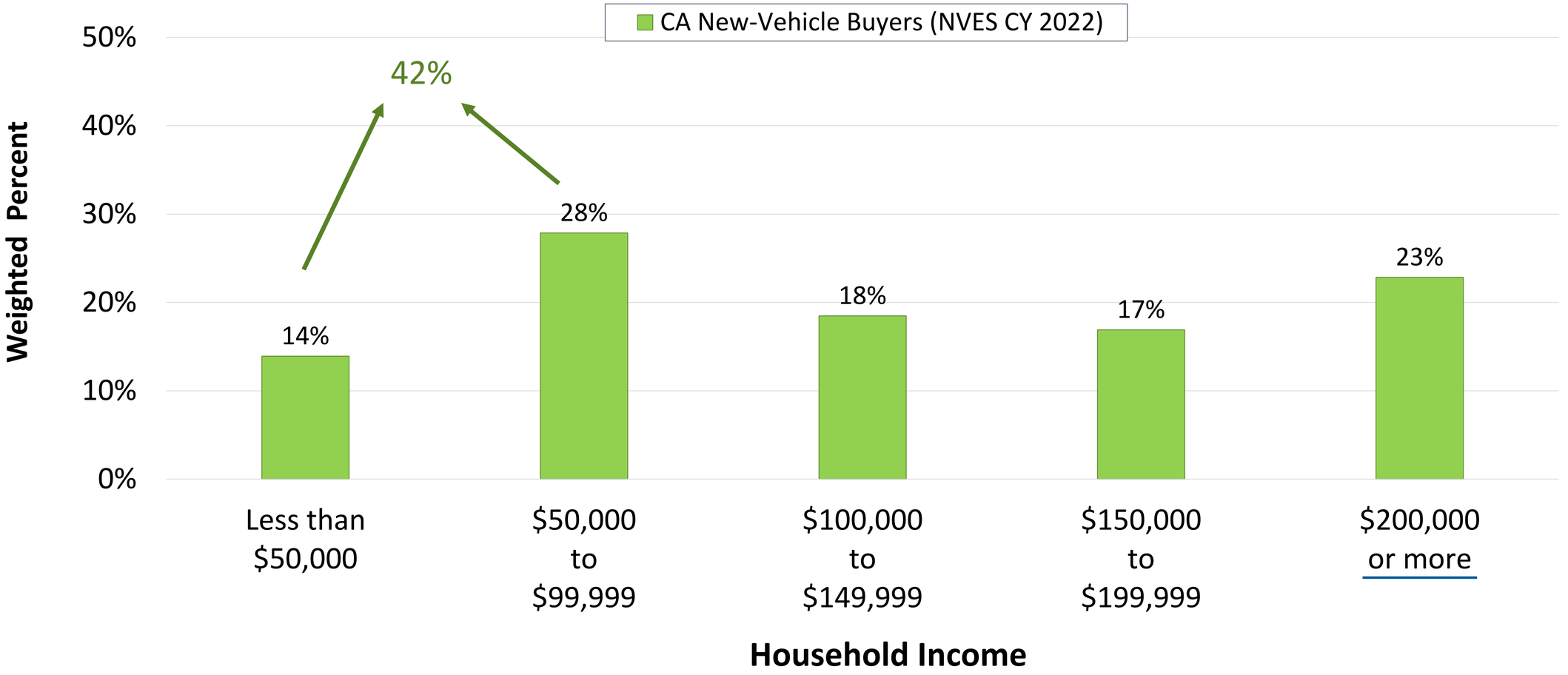
Note: statistical sense of term vs. usual equity sense of centralized decision-making and allocation



Percentages are of the CVRP program total.

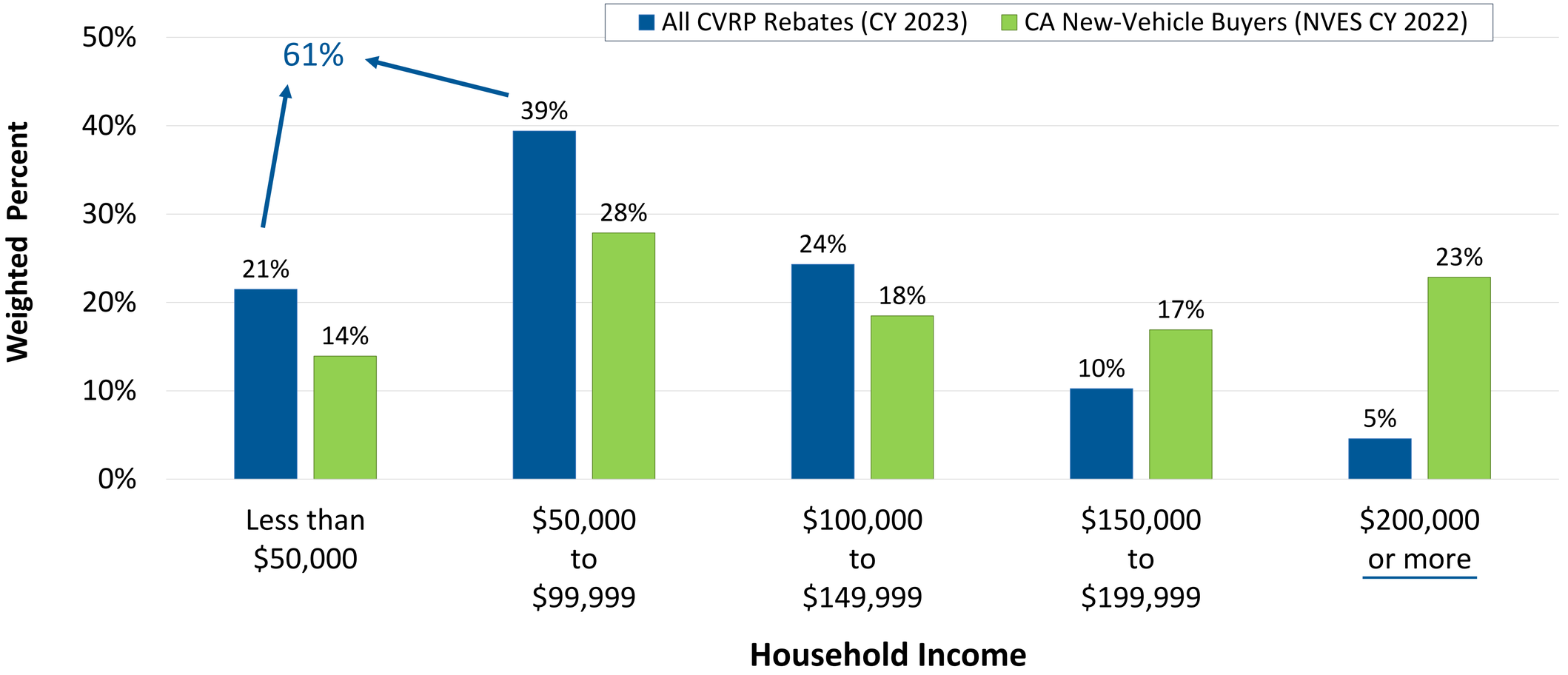
CVRP Consumer Survey, 2023 Dataset. Filtered, question-specific n = 9,416.

Households with income < $100k are just 42% of new-vehicle buyers.



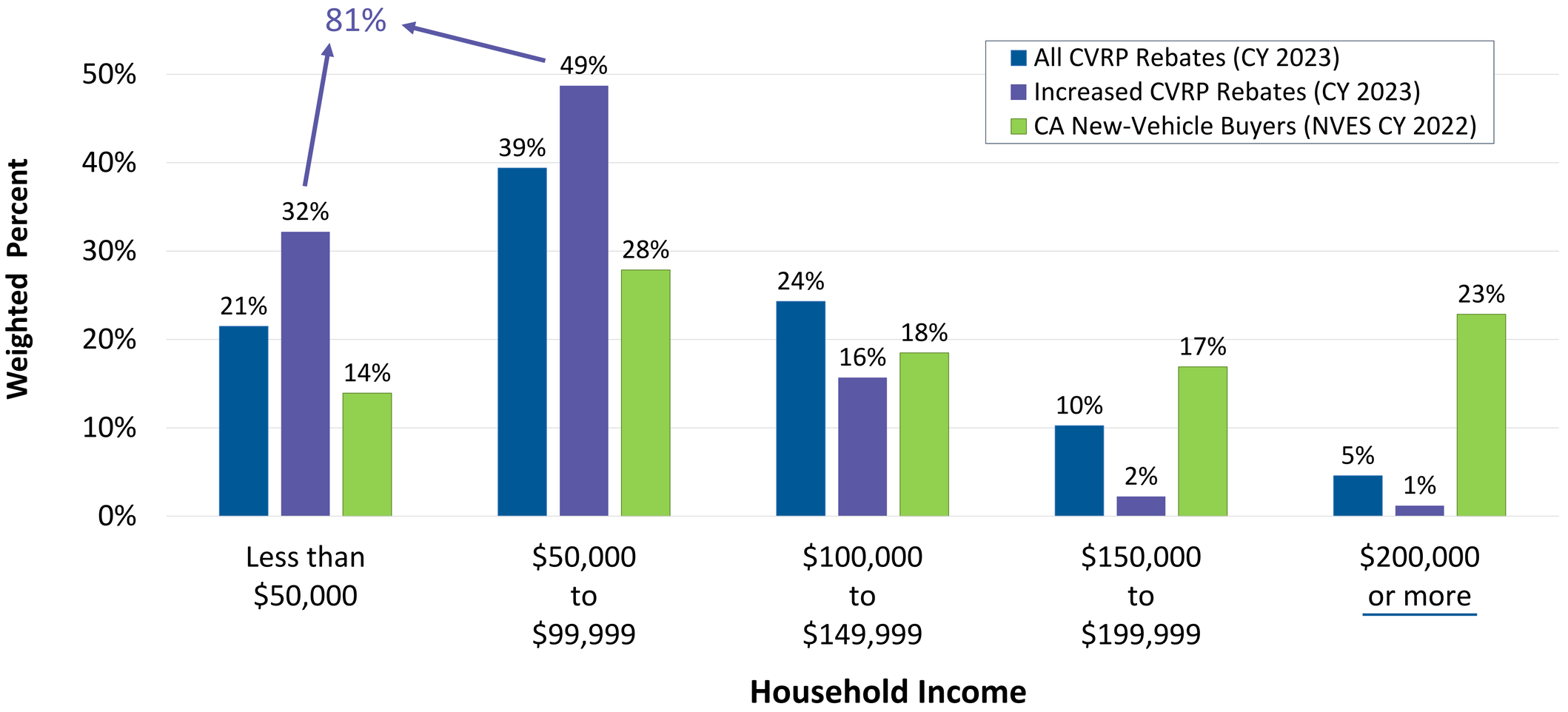
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: No Tesla consumers are in the NVES sample. Total rebate funding for 2023 purchases/leases = $285.5M.

Households with income < $100k are just 42% of new-vehicle buyers, but claimed 61% of funding.



CVRP Consumer Survey, 2023 Dataset. Filtered, question-specific n = 9,416.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers are in the NVES sample. Total rebate funding for 2023 purchases/leases = $285.5M.

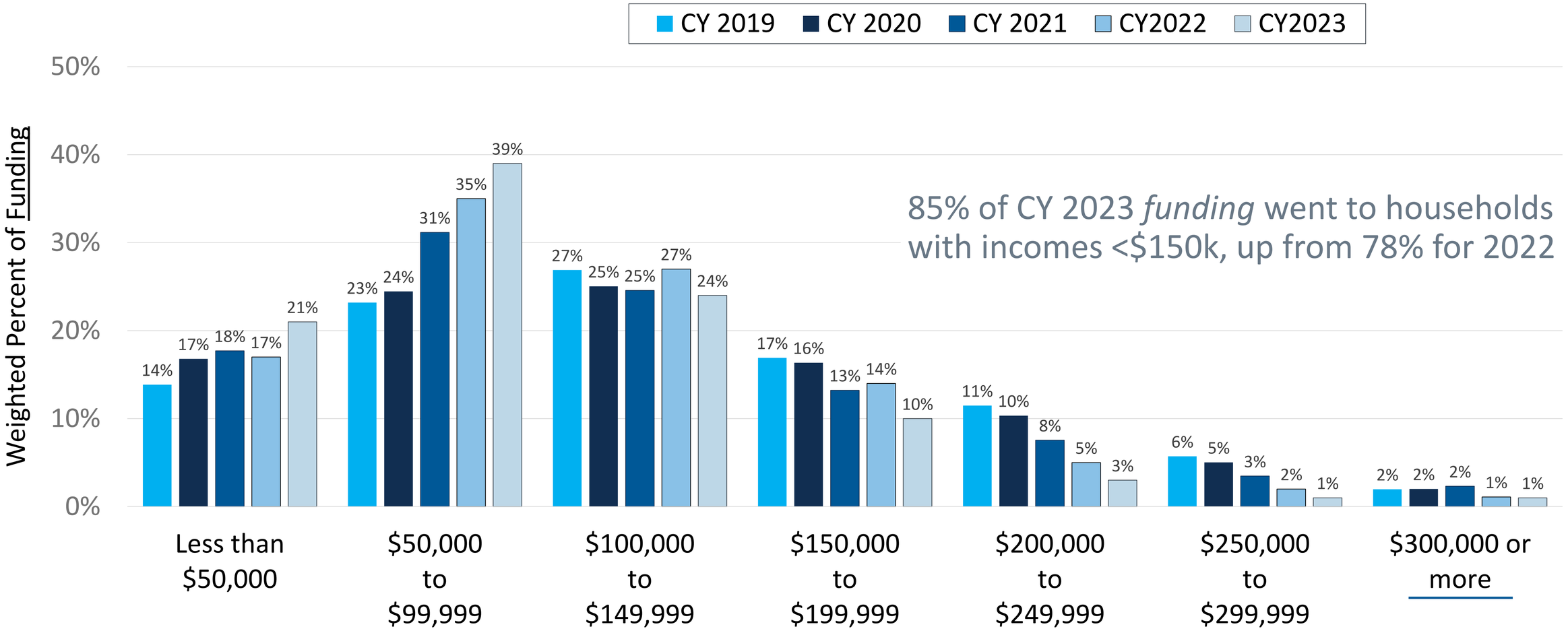
Households with income < $100k are just 42% of new-vehicle buyers, but claimed 81% of Increased Rebate funding.



CVRP Consumer Survey, 2023 Dataset. Filtered, question-specific n = 9,416.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers are in the NVES sample. Total rebate funding for 2023 purchases/leases = $285.5M.

Things Change: Despite COVID-19, funding shifted toward lower-income households.

(with a countercurrent in 2022, possibly due to high prices)



CVRP Consumer Survey, 2017–2020 Edition: 2019 n = 7,992; 2020 n = 3,831. 2020–2022 Interim Dataset: 2021 n = 6,874. 2022 Interim Dataset: 2022 n = 6,108. 2023 Dataset: n = 9,416. n-values are filtered and question-specific.

Let’s flip the script to track metrics of potential concern and broaden the questioning…

- Is the program disproportionately benefiting the majority?
- Where is it making progress, and where is there road yet to travel?
- How long is the road ahead?

Are rebates disproportionately benefiting the majority?

Step 0: Who is the majority?

The majority of new-car buyers
Selected male
≥ Bachelor's degree
Own residence
≥ 40 years old
≥ $100k household income
Selected solely white/Caucasian

Based on Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Are rebates disproportionately benefiting the majority?

Step 1: Measure the share of rebate recipients falling into “Market-Majority” characteristics.

The majority of new-car buyers	CVRP Plug-in EV Funding 2023
Selected male	63%*¶
≥ Bachelor’s degree	65%
Own residence	65%
≥ 40 years old	53%*
≥ $100k household income	39%
Selected solely white/Caucasian	21%*

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*

¶ 100% includes non-binary options

“Prefer not to answer,” “I don’t know,” and similar responses are excluded throughout.

Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Are rebates disproportionately benefiting the majority?

Step 2: Measure what "mainstream" looks like.

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	CA New-Vehicle Buyers (NVES) 2022
Selected male	63%*¶	58%
≥ Bachelor's degree	65%	60%
Own residence	65%	62%
≥ 40 years old	53%*	66%
≥ $100k household income	39%	58% §†
Selected solely white/Caucasian	21%*	44%

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*
§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).
"Prefer not to answer," "I don't know," and similar responses are excluded throughout.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Are rebates disproportionately benefiting the majority?

Step 3: Compare

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	**Difference** (percentage points, ppt)	CA New-Vehicle Buyers (NVES) 2022
Selected male	63%*¶	← 5% →	58%
≥ Bachelor's degree	65%	← 5% →	60%
Own residence	65%	← 3% →	62%
≥ 40 years old	53%*	← -13% →	66%
≥ $100k household income	39%	← -19% →	58% §†
Selected solely white/Caucasian	21%*	← -23% →	44%

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*
§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).
"Prefer not to answer," "I don't know," and similar responses are excluded throughout.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Are EVs going mainstream? In some ways more than others.

And in some ways, the program has gone beyond (green shading).

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	**Difference** (percentage points, ppt)	CA New-Vehicle Buyers (NVES) 2022
Selected male	63%*¶	← 5% →	58%
≥ Bachelor's degree	65%	← 5% →	60%
Own residence	65%	← 3% →	62%
≥ 40 years old	53%*	← -13% →	66%
≥ $100k household income	39%	← -19% →	58% §†
Selected solely white/Caucasian	21%*	← -23% →	44%

Let's examine another state using the same techniques…

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*
§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).
"Prefer not to answer," "I don't know," and similar responses are excluded throughout.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Quantifying the Road that Remains to the Mainstream (DCRP)

Rebate (2022) Percentage-Point Differences from the New-Vehicle-Buyer Baseline

Rebated EV consumers are most distinguished by male gender and higher income but identify as white less frequently.

The majority of new-car buyers	**Drive Clean Rebate Program** Rebates **2022** purchases/leases *n* = 5,472	**Difference** (percentage points, ppt)	**NY New-Vehicle Buyers** (2017 NHTS) Latest Available MYs (2016–17)
Selected solely white/Caucasian	68%	← -7 ppt →	75%
≥ 40 years old	71%	← 1 ppt →	70%
Own residence	86%	← 11 ppt →	75% §
≥ Bachelor's degree	80%	← 15 ppt →	65%
Selected male	71%	← 20 ppt →	51%
≥ $100k household income	78%	← 27 ppt →	51% §

§ Based upon household-level data.

"Prefer not to answer," "I don't know," and similar responses are excluded throughout. NHTS weighted to represent population, not new-vehicle subset. New-vehicle buyers identified by within-100-mile match between odometer and miles driven while owned.

Quantifying the Road that Remains to the Mainstream **& Beyond**

Assessing Priority Populations

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	**Difference** (percentage points, ppt)	CA New-Vehicle Buyers (NVES) 2022	**Difference** (percentage points, ppt)	CVRP Increased Rebate Funding 2023
Selected male	63%*¶	← 5% →	58%	← 3% →	61%*¶
≥ Bachelor's degree	65%	← 5% →	60%	← -1% →	59%
Own residence	65%	← 3% →	62%	← -3% →	59%
≥ 40 years old	53%*	← -13% →	66%	← -14% →	52%*
≥ $100k household income	39%	← -19% →	58% §†	← -39% →	19%
Selected solely white/Caucasian	21%*	← -23% →	44%	← -26% →	18%*

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*
§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).
"Prefer not to answer," "I don't know," and similar responses are excluded throughout.
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. Note: no Tesla consumers were in the NVES sample.

Assessing Differences with Appropriate Comparisons

Population statistics do not tell the story accurately because car buyers are already different.

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	CA New-Vehicle Buyers CY 2022 (Strategic Vision NVES)	≠	CA Population 2018–2022 (Census 2022)
Selected male	63%*¶	58%		50%
Own residence	65%	62%		55% §
≥ Bachelor's degree	65%	60%		26%
≥ 40 years old	53%*	66%		46%
Selected solely white/Caucasian	21%*	44%		36%
≥ $100k household income	39%	58% §†		42% §

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*

§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES uses income > $100k (not ≥).

"Prefer not to answer," "I don't know," and similar responses are excluded throughout. Census 2022: 2018–2022 American Community Survey, PUMS.

Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. No Tesla consumers are in the NVES sample.

Breaking Inequities Into Two Components

Structural Inequities in New-Vehicle Buying and Those Particular to EVs

The majority of new-car buyers	CVRP Plug-in EV Funding 2023	Portion of total difference attributable to EVs	CA New-Vehicle Buyers CY 2022 (Strategic Vision NVES)	Portion of total difference explained by car buying	CA Population 2018–2022 (Census 2022)
Selected male	63%*¶	← 38% →	58%	← 62% →	50%
Own residence	65%	← 30% →	62%	← 70% →	55% §
≥ Bachelor's degree	65%	← 13% →	60%	← 87% →	26%
≥ 40 years old	53%*	← -186% →	66%	← 286% →	46%
Selected solely white/Caucasian	21%*	← -(153%) →	44%	← -(-53%) →	36%
≥ $100k household income	39%	← -(633%) →	58% §†	← -(-533%) →	42% §

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*

§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES uses income > $100k (not ≥).

"Prefer not to answer," "I don't know," and similar responses are excluded throughout. Census 2022: 2018–2022 American Community Survey, PUMS.

Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. No Tesla consumers are in the NVES sample.

Breaking Inequities Into Two Components (DCRP)

Structural Inequities in New-Vehicle Buying and Those Particular to EVs

A large portion of the differences reported in research and the media based on Census data are findings about structural inequities in new-car buying in general.

The majority of new-car buyers	**Drive Clean Rebate Program** Rebates **2022** purchases/leases *n* = 5,472	Portion of total difference attributable to EVs	**NY New-Vehicle Buyers** (2017 NHTS) Latest Available MYs (2016–17)	Portion of total difference explained by car buying	**NY Population** **2017–2021** (Census 2021)
Selected male	71%	← 91% →	51%	← 9% →	49%
≥ $100k household income	78%	← 68% →	51% §	← 32% →	38% §
Own residence	86%	← 34% →	75% §	← 66% →	54% §
≥ Bachelor's degree	80%	← 29% →	65%	← 71% →	29%
≥ 40 years old	71%	← 5% →	70%	← 95% →	49%
Selected solely white/Caucasian	68%	← -54% →	75%	← 154% →	55%

§ Based upon household-level data.

"Prefer not to answer," "I don't know," and similar responses are excluded throughout. NHTS weighted to represent population, not new-vehicle subset. New-vehicle buyers identified by within-100-mile match between odometer and miles driven while owned. Census 2021: 2017–2021 American Community Survey, PUMS.

Rebates and Funding to Different Racial and Ethnic Identities [check all that apply]

Progression Away from the Majority

Racial Identity [check all that apply]	CVRP Plug-in EV Rebates *2021* All application data *n* = 39,464	CVRP Plug-in EV Rebates *2022* All application data *n* = 29,203	CVRP Plug-in EV Funding *2022* All application data *n* = 29,203	CVRP Plug-in EV Funding *2023* All application data *n* = 66,881
American Indian or Alaskan Native	1%	1%	1%	1%
Black or African American	4%	4%	4%	3%
East Asian	18%	20%	22%	25%
Middle Eastern or North African	3%	3%	3%	4%
Native Hawaiian or other Pacific Islander	2%	2%	2%	2%
South Asian	7%	7%	7%	9%
Southeast Asian	14%	14%	14%	18%
white or Caucasian	43%	41%	39%	29%
“Other”	12%	12%	13%	13%
Ethnicity-Question Identification	*n* = 42,928	*n* = 31,988	*n* = 31,988	*n* = 73,413
Identifies as Hispanic or Latino(a)	16%	16%	17%	17%

“Prefer not to answer,” “I don’t know,” and similar responses are excluded throughout.

Assessing Progress
Funding

Green = Already beyond the mainstream
Yellow = Road yet to travel but progressing
Red = Detours

CALIFORNIA CLEAN VEHICLE REBATE PROJECT™

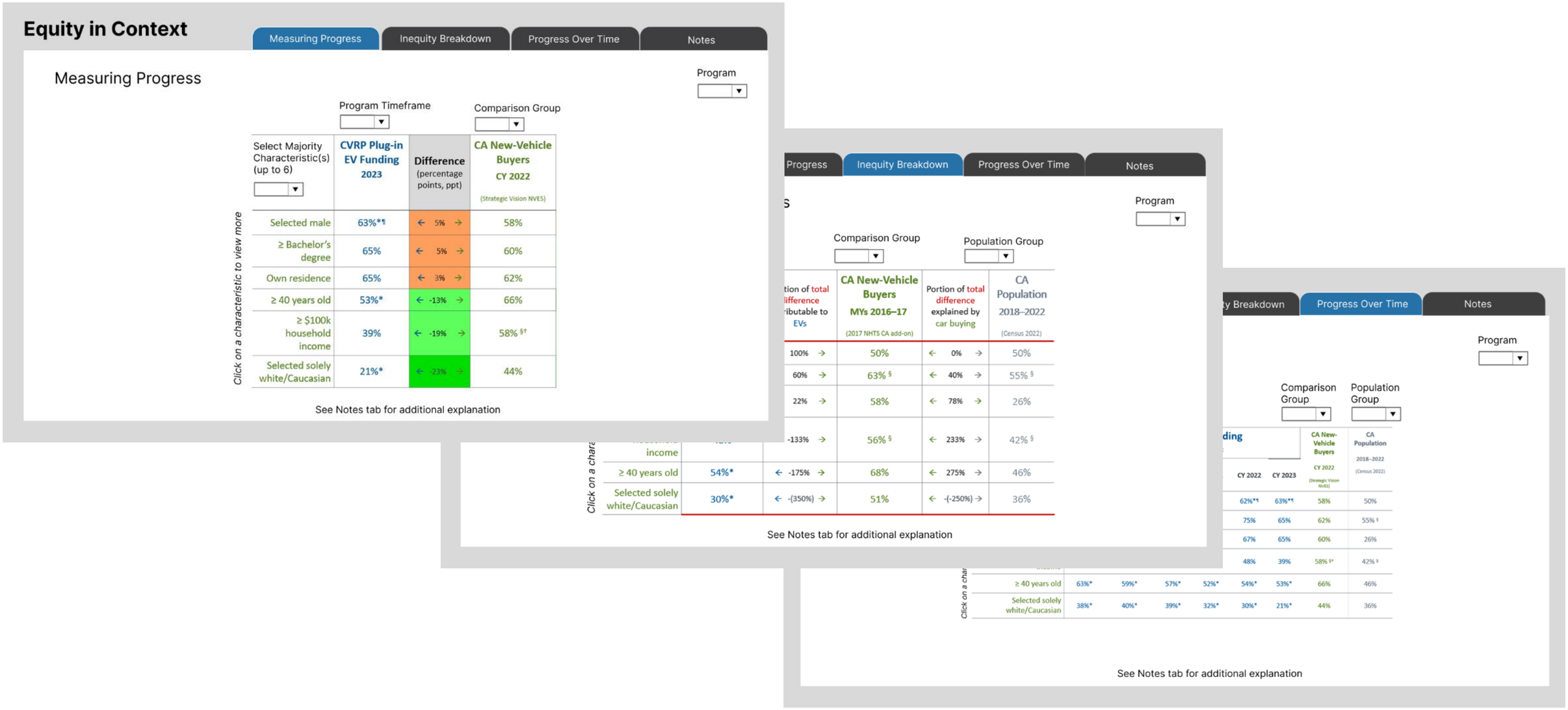
The majority of new-car buyers	CVRP Plug-in EV Funding Purchase/Lease Dates: CY 2018	CY 2019	CY 2020	CY 2021	CY 2022	CY 2023	CA New-Vehicle Buyers CY 2022 (Strategic Vision NVES)	CA Population 2018–2022 (Census 2022)
Selected male	71%*	69%*¶	65%*¶	63%*¶	62%*¶	63%*¶	58%	50%
Own residence	83%	78%	78%	73%	75%	65%	62%	55% §
≥ Bachelor's degree	83%	81%	77%	69%	67%	65%	60%	26%
≥ $100k household income	70%	63%	59%	51%	48%	39%	58% §†	42% §
≥ 40 years old	63%*	59%*	57%*	52%*	54%*	53%*	66%	46%
Selected solely white/Caucasian	38%*	40%*	39%*	32%*	30%*	21%*	44%	36%

* Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.

§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).

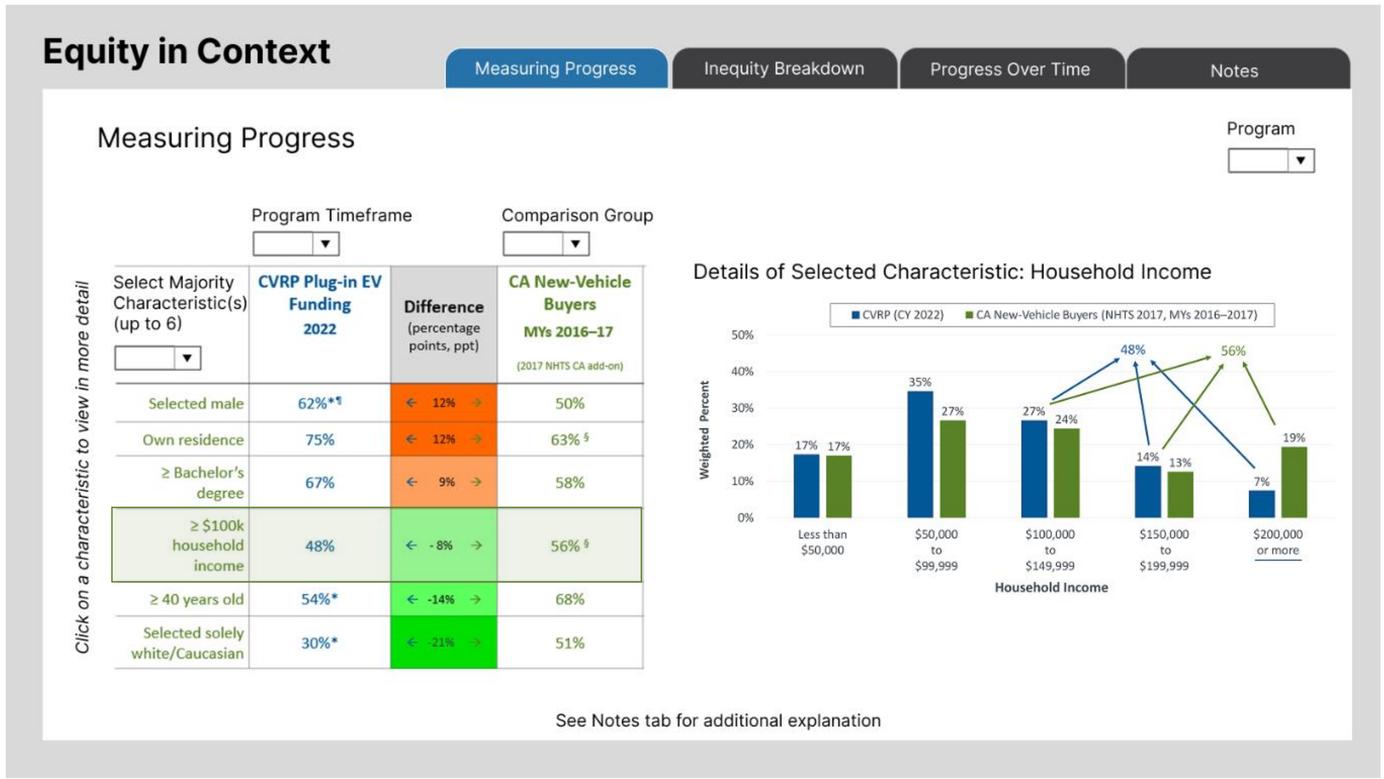
"Prefer not to answer," "I don't know," and similar responses are excluded throughout. Census 2022: 2018–2022 American Community Survey, PUMS. Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. No Tesla consumers are in the NVES sample.

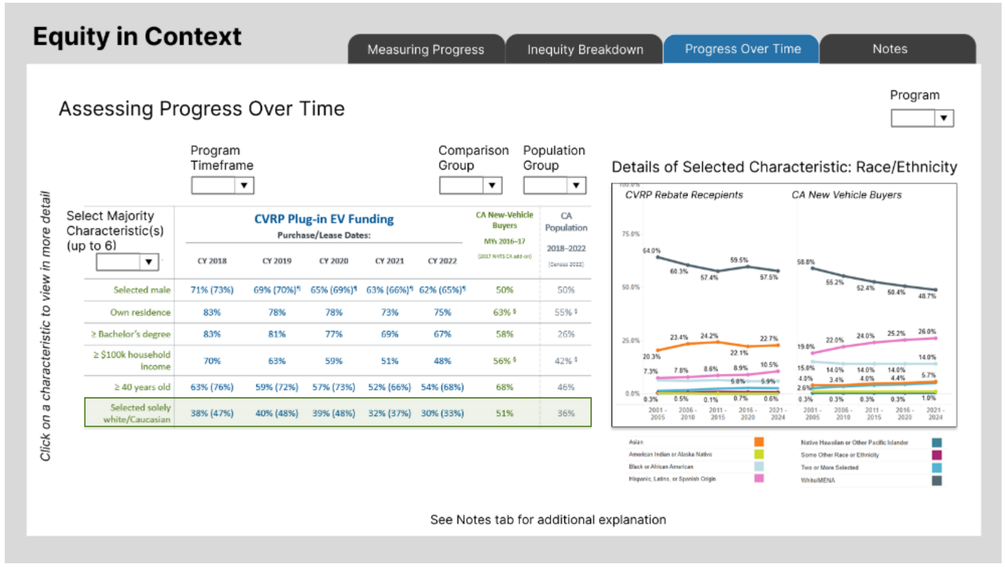
Next Step: Calibrating the Conversation with Program Dashboards



Mockup (wireframe) of program dashboard tabs incorporating metrics of progress, inequity decomposition, and trends over time

Program Dashboards with Row Selected for Additional Detail





Mockup (wireframe) of program dashboard tabs for illustration: not all numbers are accurate

Targeting Support Through Consumer Segmentation
CA & NY

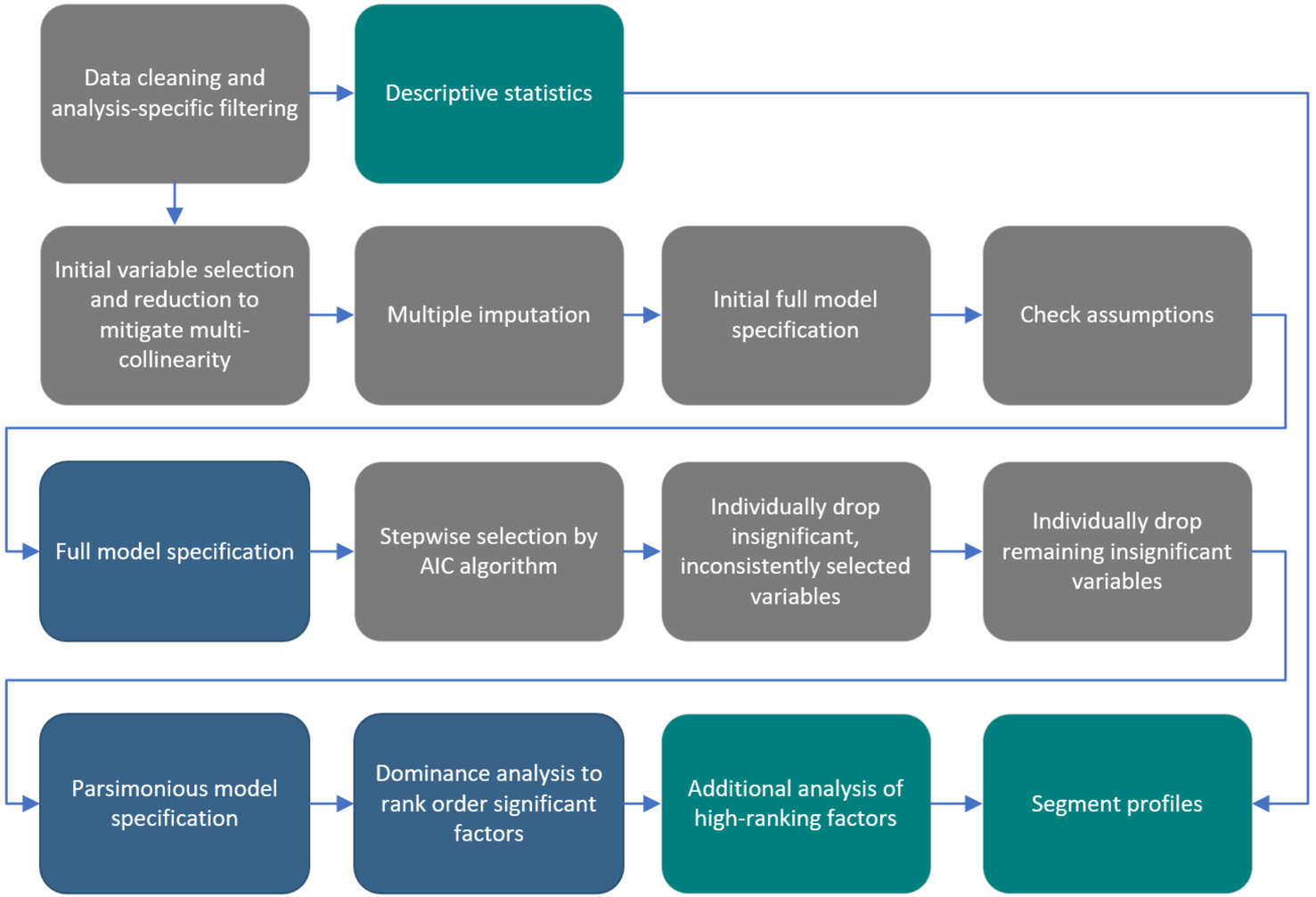
Consumer Segmentation Roadmap Purpose

To understand and amplify participation by a segment of the program that supports a variety of goals:

1. Existing adopters: **Scale** and accelerate EV adoption 
2. *Rebate Essentials*: Increase program **cost-effectiveness** 
3. *EV Converts*: Move EV markets **toward mainstream consumers** 
4. Priority Populations: Go beyond the mainstream to improve **equitable access** to EVs  

Expanding Electric Vehicle Adoption in Disadvantaged Communities. Transportation Research Record: Journal of the Transportation Research Board. https://doi.org/10.1177/03611981241242753. Paper. Open-access data-summary appendix. TRB 2024 slides.

Method: Descriptive & Logistic Statistics to Identify Factors, Dominance Analysis to Rank-Order Them



Expanding Electric Vehicle Adoption in Disadvantaged Communities. Transportation Research Record: Journal of the Transportation Research Board. https://doi.org/10.1177/03611981241242753. Paper. Open-access data-summary appendix. TRB 2024 slides.

Recommendations for Supporting Equity in Disadvantaged Communities

Signs of two types of DAC adoption (e.g., in the income distribution) call for a **two-pronged** approach including:

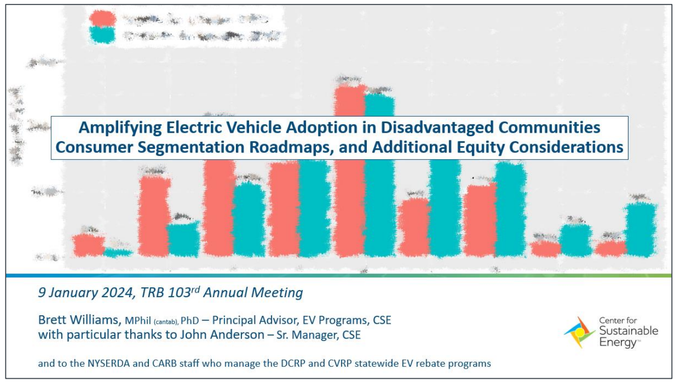
Amplify (meet DAC adoption "where it is")

- **Target** supportive resources strategically based on findings
  - e.g., "top 10" factors and other characteristics identified
- **Tailor messaging**, e.g., to motivations (environmental impacts and convenience of charging, not energy independence).

Bust Barriers (unlock more diverse adoption)

- Increase awareness, incentive amounts, financing, access to charging, and other *enablers* established elsewhere to break down barriers to adoption that is trying to emerge.

Both likely needed to expand access

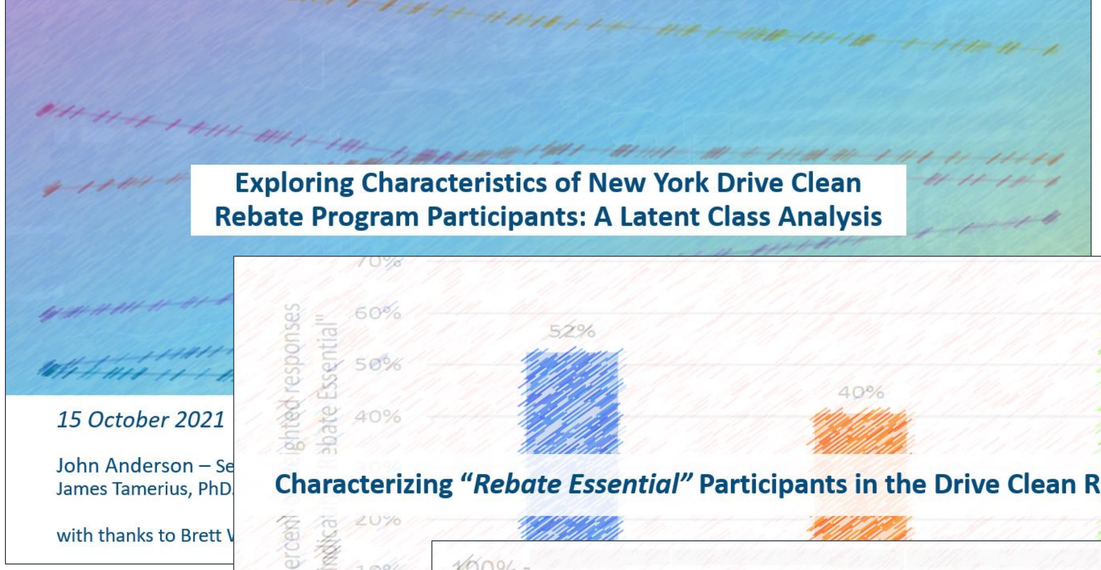


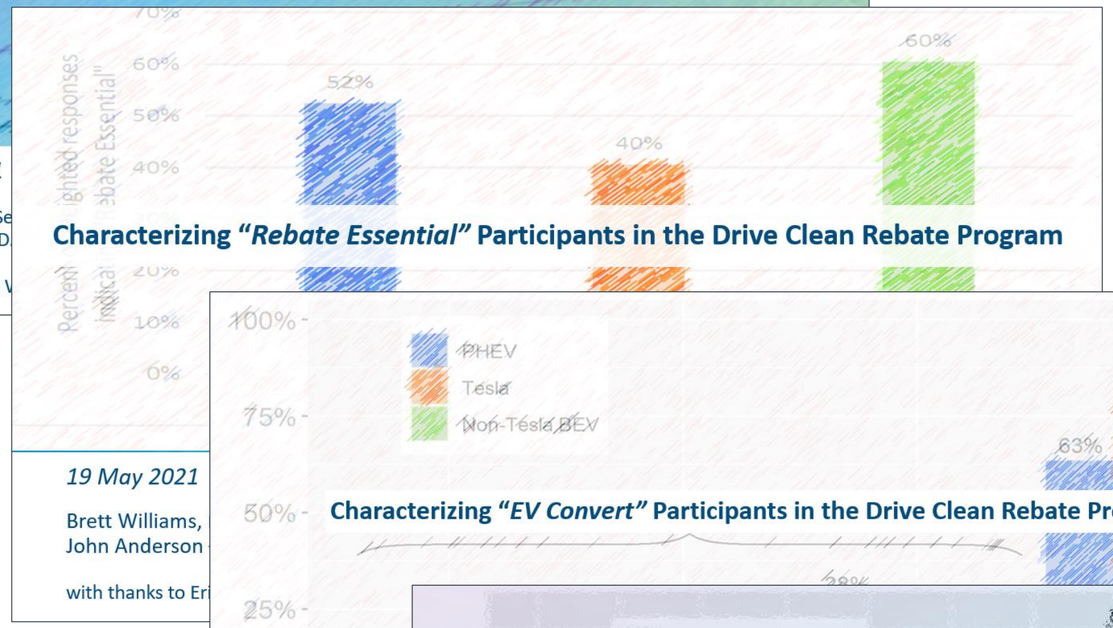
TRB presentation

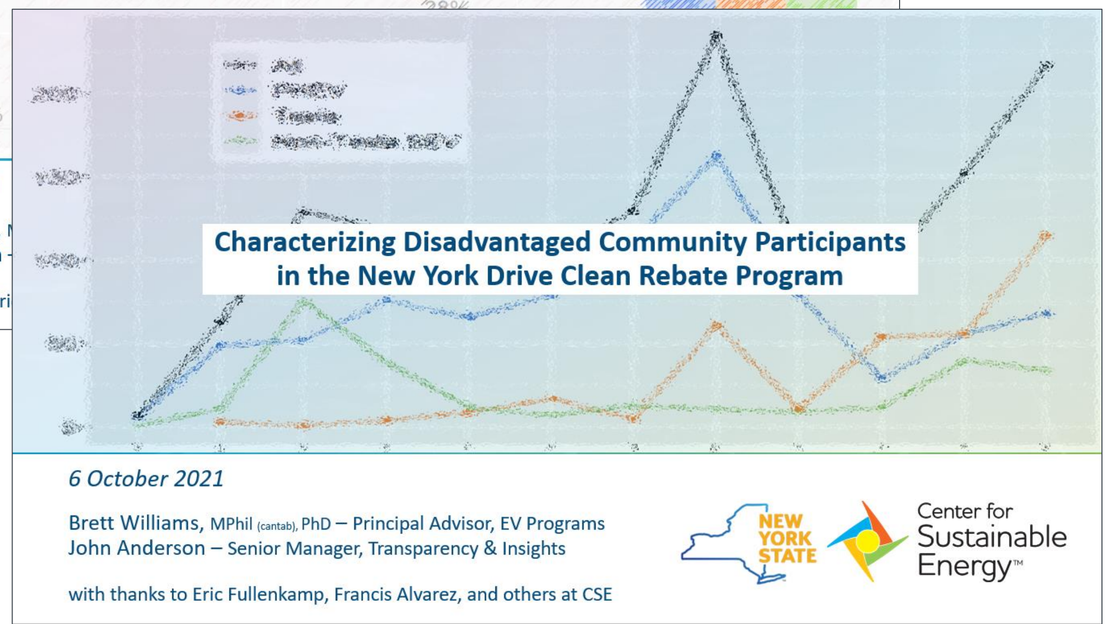
TRR article

EV Consumer Segmentation Roadmap

- 4 stand-alone research projects
- Integrated into a sequence of consumer-segment steppingstones to mainstream markets and beyond







→ EVS35 conference paper and slides.

→ TRR article and appendix

→ TRR article and TRB slides 2024

B.D.H. Williams, *An Electric-Vehicle Consumer Segmentation Roadmap: Strategically Amplifying Participation in the New York Drive Clean Rebate Program*, Report 21-30, *Clean Transportation Reports*, NYSERDA.

The Path Forward: Strategic Consumer Segmentation (2017–2019)

Percentage-Point Differences from the New-Vehicle Baseline[§]

New-Vehicle Buyer Majority Characteristic	All DCRP	*Rebate Essentials*	*EV Converts*	NY New-Vehicle Buyers†	DAC Participants
Household Size ≤ 3	+4%	+2%	+1%	0%	+7%
≥ 40 Years Old	+6%	+3%	+3%	0%	-11%
Selected solely White	+7%	+6%	+6%	0%	-4%
≥ 2 Household Cars	+9%	+10%	+8%	0%	-8%
≥ 2 Household Drivers	+10%	+10%	+10%	0%	-1%
≥ Bachelor's Degree	+12%	+12%	+8%	0%	+4%
Own Home	+14%	+13%	+12%	0%	-9%
≥ $100k HH Income	+16%	+14%	+11%	0%	-1%
Selected male	+21%	+23%	+16%	0%	+20%
total points:	+95%	+91%	+74%	0%	-10%
progression from step:		-4%	-17%	-74%	-10%
progression from starting point:		-4%	-21%	-95%	-105%

[§] Table 7 from: B.D.H. Williams (2021), An Electric-Vehicle Consumer Segmentation Roadmap: Strategically Amplifying Participation in the New York Drive Clean Rebate Program, NYSERDA Report 21-30.

† New York State responses to the 2017 National Household Travel Survey (NHTS). NHTS is weighted to represent its population, not the new-vehicle subset. New-vehicle buyers were identified by the authors based on a within-100-mile match between odometer and miles driven while owned.

Paths Forward
Funding (2023)

The majority of new-car buyers	Low-Hanging Fruit (Existing Adopters) CY 2023	Difference (percentage points)	*"Rebate Essentials"* CY 2023 *n* = 10,177 **Weighted results**	Difference (percentage points)	*"EV Converts"* CY 2023 *n* = 10,170 **Weighted results**	Difference (percentage points)	**CA New-Vehicle Buyers** CY 2022 (Strategic Vision NVES)	Difference (percentage points)	Increased Rebate Recipients CY 2023
Selected male	63%*¶	← 5% →	TBD	← TBD →	TBD	← TBD →	58%	← 3% →	61%*‡
≥ Bachelor's degree	65%	← 5% →	66%	← 6% →	62%	← 2% →	60%	← -1% →	59%
Own residence	65%	← 3% →	63%	← 1% →	62%	← 0% →	62%	← -3% →	59%
≥ 40 years old	53%*	← -13% →	TBD	← TBD →	TBD	← TBD →	66%	← -14% →	52%*
≥ $100k HH income	39%	← -19% →	35%	← -23% →	37%	← -21% →	58% §†	← -39% →	19%
Selected solely white/Caucasian	21%*	← -23% →	TBD	← TBD →	TBD	← TBD →	44%	← -26% →	18%*

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*

§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).

"Prefer not to answer," "I don't know," and similar responses are excluded throughout.

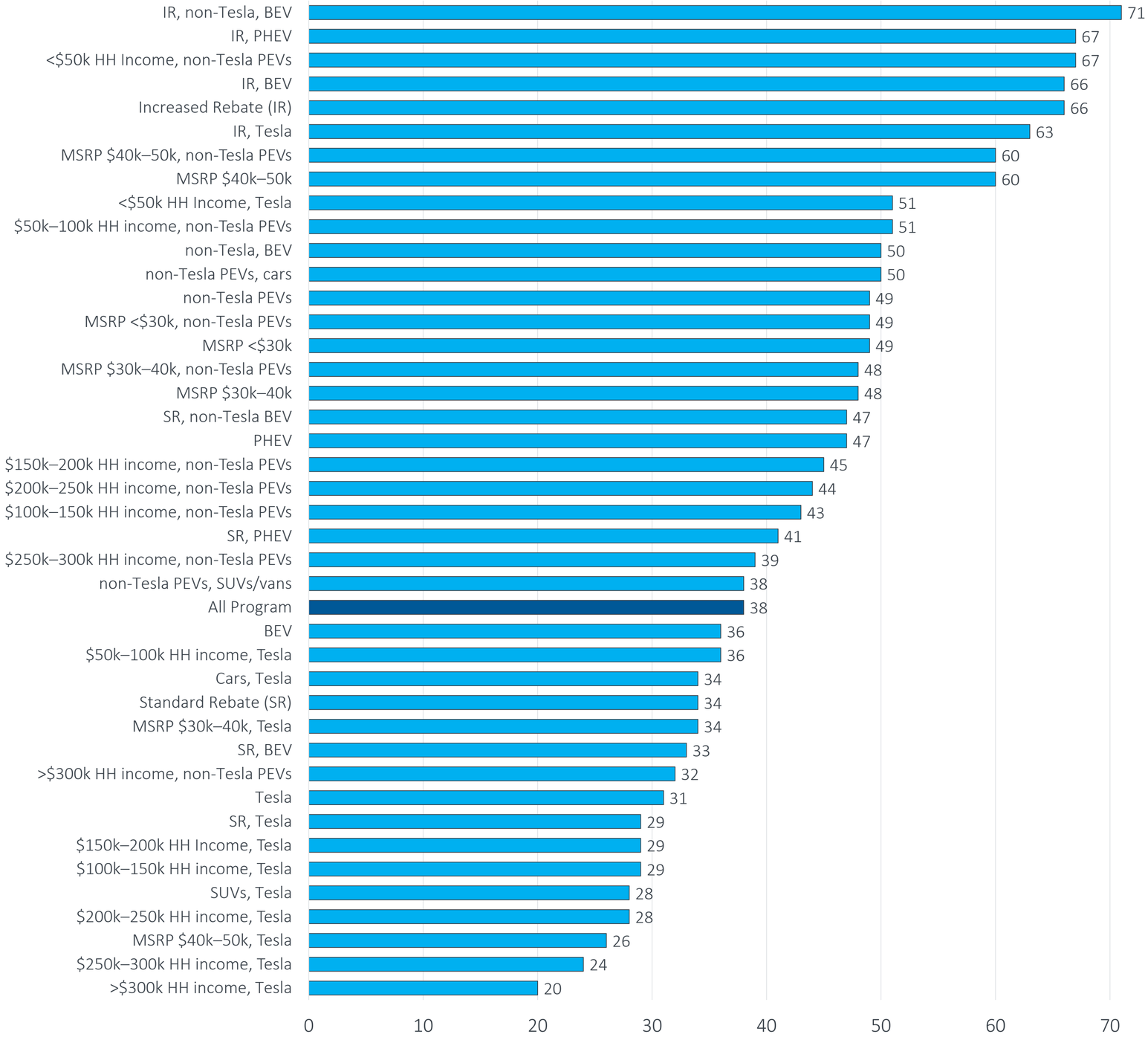
Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. No Tesla consumers are in the NVES sample.

Additional Examples

Free-Rider Hunting:

Rebate Essentiality %

(2020 Purchases/Leases)



Summarizes findings [here](#) (May 2022)

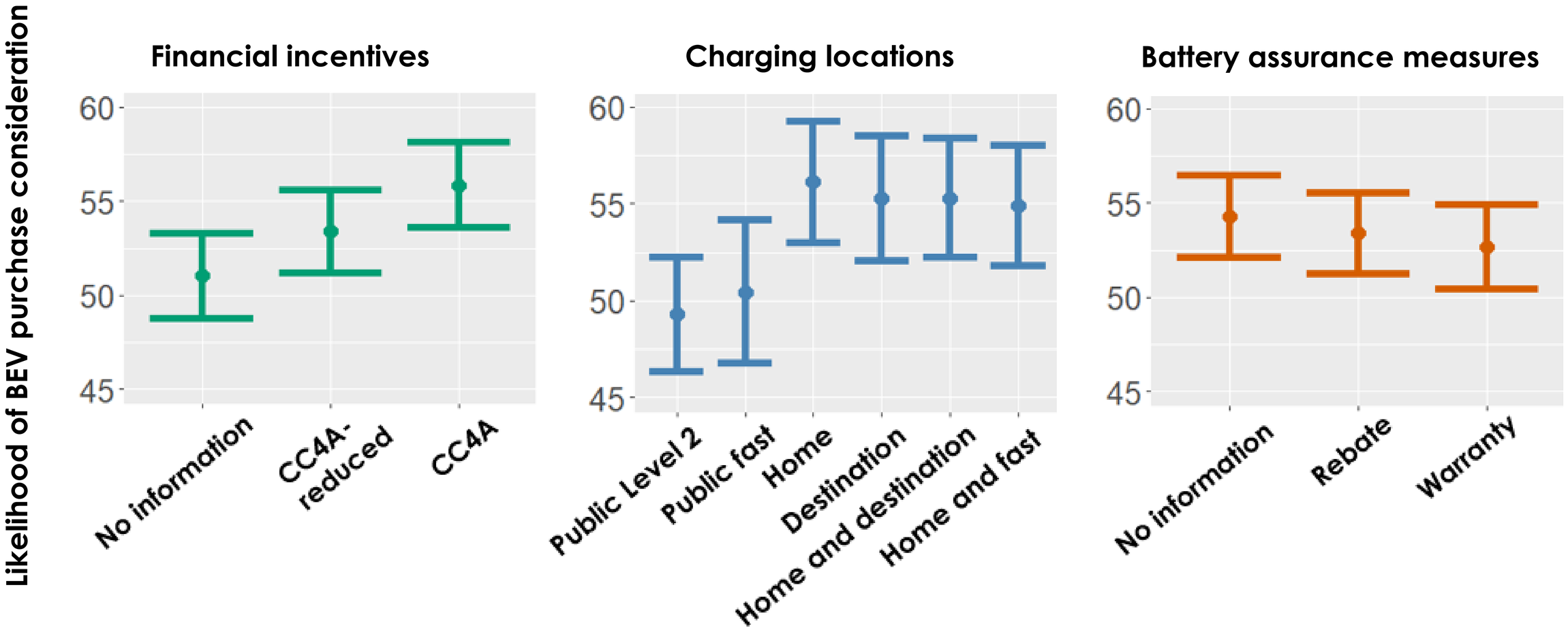
From: https://trb.secure-platform.com/a/solicitations/161/sessiongallery/2161

What policy interventions increase BEV consideration among priority populations?

Kelly Hoogland & Scott Hardman

2024 TRB Denver Symposium

Marginal effect of interventions on likelihood to consider buying a BEV



From: https://trb.secure-platform.com/a/solicitations/161/sessiongallery/2161

Evaluating Cumulative Emissions Exposure and Equity Outcomes of Different Transition Pathways to an Electric Vehicle Fleet

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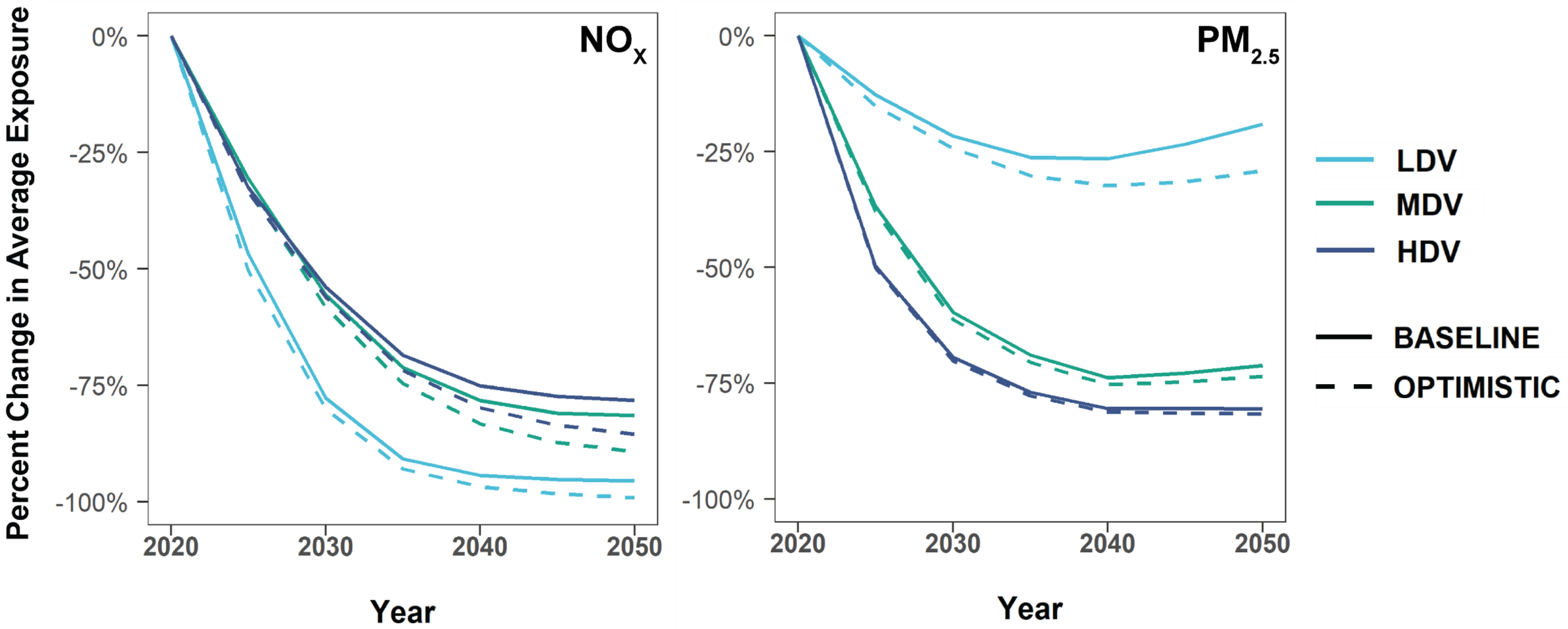
THE UNIVERSITY OF VERMONT
TRANSPORTATION
RESEARCH CENTER

TRB's Transportation Symposium on Environment, Energy, and Livable Communities
August 27th, 2024
Denver, Colorado

BASELINE VS. OPTIMISTIC



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Discussion & Application to Other Programs

Discussion Questions

- Which of these lessons/metrics apply to your program?
- How do things differ?
- How do you define your program's particular role in the portfolio needed to achieve different kinds of equity?
- What are one or two steps you might take toward measuring progress?
  - Outputs, outcomes, impacts
  - Context

Discussion Questions: What Works For/Across Different Programs?

- Which of these lessons/metrics apply to your program?
- How do things differ?
- How do you define your program's particular role in the portfolio needed to achieve different kinds of equity?
- What are one or two steps you might take toward measuring progress?
  - Outputs, outcomes, impacts
  - Context

For example (partial list simply to get us thinking about the diversity – tell us what is challenging/important to evaluate about yours)…

Incentives
California E-Bike Incentive Project
Clean Cars 4 All
Clean Vehicle Rebate Project
Driving Clean Assistance Program
Enhanced Fleet Modernization Program
etc.

Schools
¡Adelante Watsonville!
A Transformative Clean Mobility Pilot
California Capital Pilot Project
Clean Transportation and Enhanced Access for All Porterville Students
East San Jose Mobility Project
Getting Stockton to Zero Emissions: Clean Air for Our Community
Lincoln High School Clean Mobility in Schools Pilot
Safe Routes and Active Transportation for Schools and Underserved Communities in Hayward
etc.

And the list goes on: **Clean Mobility Options, Community Resources/Outreach, …**

Appendix

Program Design Shapes Outcomes

Color coding:
2023 highlights
Also in effect during 2023

CALIFORNIA CLEAN VEHICLE REBATE PROJECT™

For personal rebates:

as of Mar. 2010
- Incentive stacking permitted
- 36-month ownership requirement
- Rebates per year limit = 20

as of Dec. 2013
- Rebates per year limit = 2

as of May 2014
- 18-month application window

as of Dec. 2014 / Jan. 2015
- 30-month ownership requirement (retroactive)
- Total rebate limit = 2

as of Mar. 2016
- $250k–$500k income cap (PEVs)
- +$1,500 for income-qualified households (≤ 300% FPL), excluding ZEMs

as of Nov. 2016
- $150k–$300k income cap (PEVs)
- ≥ 20 UDDS electric miles
- +$2,000 for income-qualified households (≤ 300% FPL), excl. ZEMs

as of Jan. 2018
- $150k–$300k income cap on stacking HOV decal (only binding on FCEVs)
- Rebate Now San Diego County preapproval pilot with point-of-sale option

as of Jan. 2019
- Stacking with CVAP grant not permitted (retroactive)

as of Dec. 2019
- Total rebates limit = 1 §
- Base MSRP ≤ $60k (PEVs)
- 3-month application window ‡
- ≥ 35 UDDS electric miles
- +$2,500 † for income-qualified households (≤ 300% FPL), excl. ZEMs

as of Apr. 2020
- Stacking with CVAP grant permitted

as of Jan. 2021
- +$2,500 for income-qualified households, ≤ 400% FPL, excl. ZEMs

as of Apr. 2021
- ≥ 30 U.S. EPA electric miles (45 UDDS)
- Rebate Now preapproval option limited to income-qualified households, expanded from San Diego to include San Joaquin Valley

as of Feb. 2022
- Base MSRP: ≤ $60k for Large Vehicles*, ≤ $45k for Cars*
- $135k–$200k income cap (PEVs)
- $135k–$200k income cap on stacking HOV decal (only binding on FCEVs)

as of Jul. 2022
- $150k–$300k income cap on stacking HOV decal (only binding on FCEVs)

as of Feb. 2023
- +$3,000–$5,500 for income-qualified households, ≤ 400% FPL, excl. ZEMs

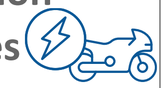
as of Aug. 2023
- $2,000 EV Charge Card for income-qualified households, ≤ 400% FPL (PEVs)

PEVs = plug-in EVs. FPL = Federal Poverty Level. ZEMs = zero-emission motorcycles. UDDS = Urban Dynamometer Driving Schedule. HOV = high-occupancy-vehicle. FCEVs = fuel-cell EVs. CVAP = Clean Vehicle Assistance Program. MSRP = manufacturer suggested retail price.

*§ A second rebate can be approved for a FCEV if the first rebate was for a PEV. ‡ COVID exemptions on application window effectively delayed implementation until 4/15/2021. † Change due to $500 decrease in standard rebate amounts (previous slide). * Large Vehicles include minivans, pickups, and SUVs; Cars include all other light-duty vehicle classes (e.g., hatchbacks, sedans, wagons, and two-seaters).*

Base Rebate Amount for Most Individuals **At Lowest Levels, Increased Rebate At Highest**

CALIFORNIA CLEAN VEHICLE REBATE PROJECT™

	as of Mar. 2010	as of Jun. 2011	as of Jul. 2013	as of Jun. 2014	as of Mar. 2016	as of Nov. 2016	as of Dec. 2019	as of Feb. 2023
Fuel-Cell EVs 	$3,000–$5,000 ‡	$1,500–$2,500 ‡	$2,500	$5,000	$5,000 §	$5,000 ¶	$4,500 *	$4,500 **
Battery EVs † 	$3,000–$5,000 ‡	$1,500–$2,500 ‡	$2,500	$2,500	$2,500 §	$2,500 ¶	$2,000 *	$2,000 **
Plug-in Hybrid EVs 	$3,000	$1,500	$1,500	$1,500	$1,500 §	$1,500 ¶	$1,000 *	$1,000 **
Zero-Emission Motorcycles 	$1,500	$900	$900	$900	$900	$900	$750	$750
Neighborhood EVs	$1,500	$900	$900	$900	$900	None eligible	None eligible	None eligible
Commercial Zero-Emission Vehicles	$20,000							

† Range-extended battery electric vehicles were given the BEV rebate amount.

‡ Amounts varied by ZEV type. For definitions, see CCR 1962.1.

§ Income-qualified consumers eligible for an additional $1,500.

¶ Income-qualified consumers eligible for an additional $2,000.

** Income-qualified consumers eligible for an additional $2,500.*

*** Income-qualified consumers eligible for an additional $3,000 - $5,500.*

Funding Availability Had Been Regularly Disrupted
(as of Dec. 2022)

CALIFORNIA CLEAN VEHICLE REBATE PROJECT™

Table 4: CVRP Waitlists

Waitlist Year	Start Date	End Date	Length in Days
2011*	Jun. 20	Sept. 30	102
2013*	May 1	Jun. 30	60
2014	Mar. 28	Jul. 22	116
2016	Jun. 11	Sept. 28	109
2017**	Jun. 30	Nov. 20	143
2019**	Jun. 5	Sept. 23	110
2021	Apr. 23	Sept. 15	145

** Dates approximate.*

*** For standard applications only; no waitlist for income-qualified increased rebates.*

***Note**: Tesla MSRP exceeded cap, became ineligible 3/15/2022.*

Table adapted from https://cleanvehiclerebate.org/sites/default/files/attachments/Disruptions_Fact_Sheet_9_2021.pdf

CVRP Consumer Survey Editions

(shows rebates to individuals for plug-in EVs* only)

	2013–2015 Edition	2015–2016 Edition	2016–2017 Edition	2017–2020 Edition	2020–2023 Edition	2023–Close Edition	Total
Vehicle Purchase/ Lease Dates	Sep. 2012 – May 2015	April 2015 – May 2016	May 2016 – May 2017	June 2017 – Nov. 2020	Dec. 2020 – Jul. 2023	Aug. 2023 – ~Sep. 2023†	Sep. 2012 – ~Sep. 2023†
Survey Responses (total *n*)**	19,460	11,611	8,957	32,524	24,069	1,601	98,222
Program Population (*N*)***	91,081	45,685	46,839	193,167	142,003	13,257	532,032

**Plug-in EVs (PEVs) include PHEVs and BEVs.*

*** Subsequently weighted to represent the program population, see "CVRP Consumer Survey: Weighting Detail" slide for further detail.*

**** Small numbers of rebated vehicles are not represented in the time frames due to application lags. Numbers may not be exactly comparable due to evolving weighting practices.*

† 6 survey responses and 21 rebates have purchase dates after Sept. 2023.

Consumer Survey Design Changes: Home Ownership

Source	CVRP Consumer Survey, 2017–2020 Edition	CVRP Consumer Survey, 2020–2023 & 2023–Close Editions	NHTS 2017	NVES 2022	Census 2022
Question Language	Do you own or rent your residence?	Do you own or rent your residence?	Do you own or rent your home?	Which statement best describes how you pay for your residence?	Is this house, apartment, or mobile home – Mark (X) ONE box.
Response Options	• Own • Rent • Prefer not to answer	• Own • Rent • Neither rent nor own • Prefer not to answer	• I don't know • I prefer not to answer • Own • Rent • Some other arrangement	• I pay a mortgage / own my residence • I am renting / do not own my residence	• Owned by you or someone in this household with a mortgage or loan? Include home equity loans. • Owned by you or someone in this household free and clear (without a mortgage or loan)? • Rented? • Occupied without payment of rent?

Question Language: Gender Identification

Source	CVRP Consumer Survey, 2017–2020 Edition	CVRP Application 3/16/2017 thru 1/14/2019	CVRP Application as of 1/15/2019	CVRP Consumer Survey, 2023–Close Edition	NHTS 2017	NVES 2022	Census 2022
Question Language	How do you prefer to describe your gender?	Please indicate your gender	How do you prefer to describe your gender?	How do you prefer to describe your gender?	Gender:	You are:	What is Person 1's sex?
Response Options	• Female • Male • Transgender • Not listed: • Prefer not to answer	• Female • Male • Prefer not to answer	• Female • Male • Nonbinary • Transgender • Not listed • Prefer not to answer	• Female • Male • Nonbinary • Transgender • Not listed, please specify: • Prefer not to answer	• Female • Male • I prefer not to answer • I don't know	• Male • Female	• Male • Female

Question Language: Race

Source	CVRP Consumer Survey, 2017–2020 Edition	CVRP Application 3/16/2017 thru 1/14/2019	CVRP Application as of 1/15/2019	CVRP Consumer Survey, 2023–Close Edition	NHTS 2017	NVES 2022	Census 2022
Question Language	How do you prefer to describe your racial/ethnic identity? [check all that apply]	How do you prefer to describe your racial/ethnic identity? [check all that apply]	How do you prefer to describe your racial identity? [check all that apply]	How do you prefer to describe your racial/ethnic identity? [check all that apply]	Which of the following describes your race? Please SELECT ALL that apply.	How would you classify yourself? (Select all that apply)	What is Person 1's race? Mark one or more boxes AND print origins. (Census recoded)
Response Options	• Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern • Native American or Alaska Native • Native Hawaiian or other Pacific Islander • South Asian • White or Caucasian • Other, please specify • Prefer not to answer	• American Indian or Alaska Native • Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern • Native Hawaiian or other Pacific Islander • South Asian • White or Caucasian • Other, please specify • Prefer not to answer	• American Indian or Alaska Native • Black or African American • East Asian • South Asian • Southeast Asian • Middle Eastern or North African • Native Hawaiian or other Pacific Islander • White or Caucasian • Other • Prefer not to answer	• Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern or North African • American Indian or Alaska Native • Native Hawaiian or other Pacific Islander • South Asian • Southeast Asian • White or Caucasian • Not Listed, please specify • Prefer not to answer	• American Indian or Alaska native • Black or African American • Asian • Native Hawaiian or other Pacific islander • White • Some other race • I don't know • I prefer not to answer	• African American/black • Hispanic/ Latino • Asian • Caucasian/white • Native American • South Asian • Pacific Islander • Middle Eastern • Other	• American Indian alone • Alaska Native alone • American Indian and Alaska Native tribes specified; or American Indian or Alaska Native, not specified and no other races • Black or African American alone • Asian alone • Native Hawaiian and Other Pacific Islander alone • White alone • Some Other Race alone • Two or More Races

Question Language: Ethnicity

Source	CVRP Consumer Survey, 2017–2020 Edition	CVRP Application 3/16/2017 thru 1/14/2019	CVRP Application as of 1/15/2019	CVRP Consumer Survey, 2023–Close Edition	NHTS 2017	NVES 2022	Census 2022
Question Language	How do you prefer to describe your racial/ethnic identity? [check all that apply]	How do you prefer to describe your racial/ethnic identity? [check all that apply]	Are you Hispanic or Latino?	How do you prefer to describe your racial/ethnic identity? [check all that apply]	Are you of Hispanic or Latino origin?	How would you classify yourself? (Select all that apply)	Is Person 1 of Hispanic, Latino, or Spanish origin?
Response Options	• Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern • Native American or Alaska Native • Native Hawaiian or other Pacific Islander • South Asian • White or Caucasian • Other, please specify: • Prefer not to answer	• American Indian or Alaska Native • Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern • Native Hawaiian or other Pacific Islander • South Asian • White or Caucasian • Other • Prefer not to answer	• Yes • No • Prefer not to answer	• Black or African American • East Asian • Latino(a) or Hispanic • Middle Eastern or North African • American Indian or Alaska Native • Native Hawaiian or other Pacific Islander • South Asian • Southeast Asian • White or Caucasian • Not Listed, please specify • Prefer not to answer	• Yes, Hispanic or Latino • No, Not Hispanic or Latino • I don’t know • I prefer not to answer	• African American/black • Hispanic/ Latino • Asian • Caucasian/white • Native American • South Asian • Pacific Islander • Middle Eastern • Other	• No, not of Hispanic, Latino, or Spanish origin • Yes, Mexican, Mexican Am., Chicano • Yes, Puerto Rican • Yes, Cuban • Yes, another Hispanic, Latino, or Spanish origin

Funding to Different Racial and Ethnic Identities [check all that apply]: 2022

Different Data Sources

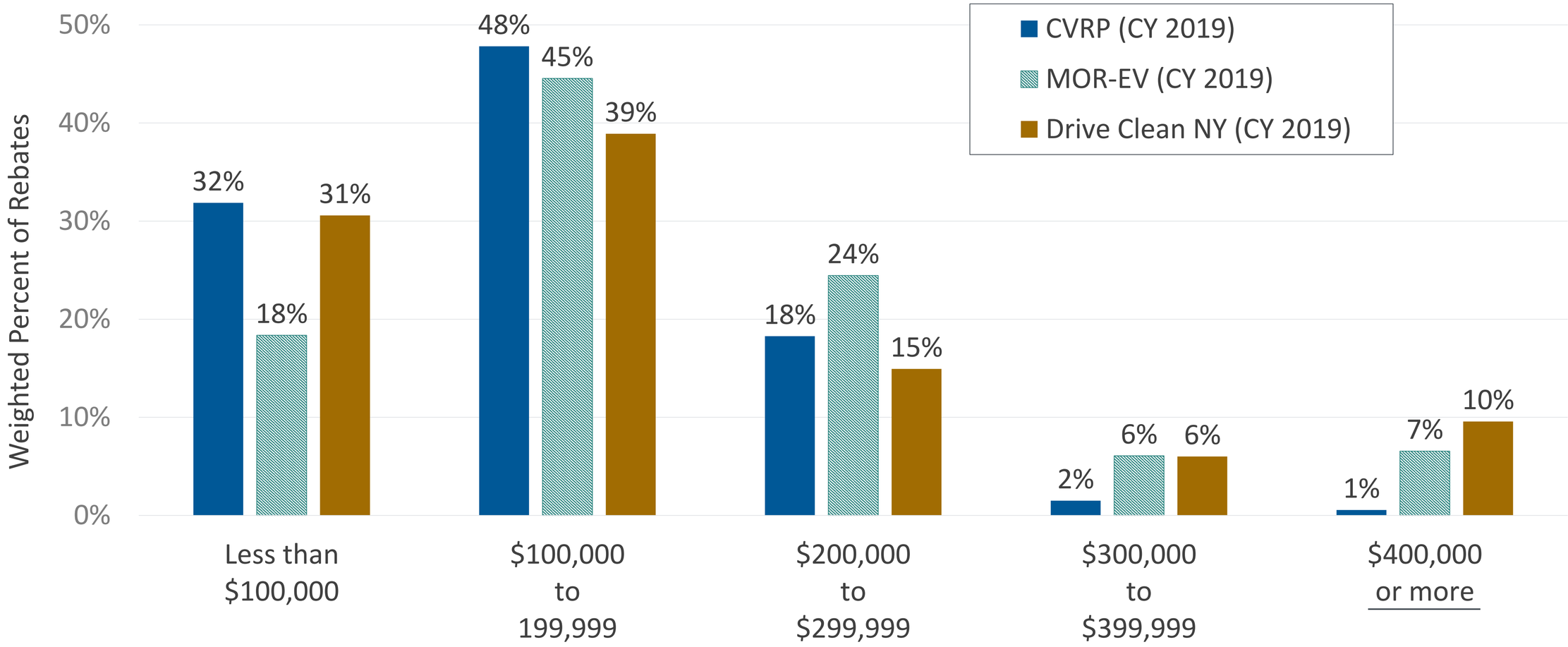
Racial Identity [check all that apply]	**CVRP Plug-in EV Funding** **All application data** *n* = 29,203	Difference	**CVRP Plug-in EV Funding** **Weighted subset of Application data*** *n* = 5,980
American Indian or Alaskan Native	1%	← –0.02% →	1%
Black or African American	4%	← –0.6% →	4%
East Asian	22%	← 2.4% →	19%
Middle Eastern or North African	3%	← 1.1% →	2%
Native Hawaiian or other Pacific Islander	2%	← –0.2% →	2%
South Asian	7%	← 1.1% →	5%
Southeast Asian	14%	← –1.7% →	16%
white or Caucasian	39%	← –3.2% →	42%
"Other"	13%	← 1.3% →	12%
Ethnicity-Question Identification	*n* = 31,988	Difference	*n* = 6,418
Identifies as Hispanic or Latino(a)	17%	← 0.4% →	16%

** CVRP results are created with weighted data from the application using the subset of program participants that responded to the survey.*

"Prefer not to answer," "I don't know," and similar responses are excluded throughout.

Household Income Distribution:

CA, MA, and NY Plug-in EV Rebates (pre-COVID)



CVRP Consumer Survey: 2017–2020 Edition. Filtered, question-specific n = 7,992.
MOR-EV Consumer Survey: 2014–2020 Edition. Filtered, question-specific n = 508.
Drive Clean NY Consumer Survey: 2017–2019 Edition. Filtered, question-specific n = 1,817
Multistate data summary: https://cleanvehiclerebate.org/sites/default/files/attachments/2020-CVRP-Consumer-Characteristics-Data-Brief_2022-03.pdf

What Are the Paths Forward?

Expanding Market Frontiers Through Strategic Segmentation

Existing Adopters: Market Acceleration

Characterize existing, generally enthusiastic and pre-adapted consumers, to target similar consumers who have the highest likelihood of adoption and maximize scale

"Rebate Essential" Consumers: Minimizing Free Ridership

Characterize adopters most highly influenced by supportive resources to join the EV market, to improve the cost-effectiveness of outreach and program design

"EV Converts": Moving Mainstream

Characterize EV consumers with low initial interest in EVs, to look for additional opportunities to expand into the mainstream

Priority Populations: Increasing Equity

1. Characterize adoption by priority populations, to understand & reinforce adoption that is successfully overcoming hurdles
2. Identify and break down barriers, to further diversity and expand access

Paths Forward
Funding (2023)

The majority of new-car buyers	Low-Hanging Fruit (Existing Adopters) CY 2023	*"Rebate Essentials"* CY 2023 *n* = 10,177 **Weighted results**	*"EV Converts"* CY 2023 *n* = 10,170 **Weighted results**	**CA New-Vehicle Buyers** CY 2022 (Strategic Vision NVES)	Increased Rebate Recipients Low-/Moderate-Income CY 2023
Selected male	63%*¶	TBD	TBD	58%	61%*‡
≥ Bachelor's degree	65%	66%	62%	60%	59%
Own residence	65%	63%	62%	62%	59%
≥ 40 years old	53%*	TBD	TBD	66%	52%*
≥ $100k HH income	39%	35%	37%	58% §†	19%
Selected solely white/Caucasian	21%*	TBD	TBD	44%	18%*

** Asterisks indicate values created using application data due to unavailability of survey questions; other values created with weighted survey data per usual.*

§ Based upon household-level data. ¶ 100% includes non-binary options. † NVES represents income > $100k (not ≥).

"Prefer not to answer," "I don't know," and similar responses are excluded throughout.

Strategic Vision New Vehicle Experience Survey (NVES) weighted to represent CA light-duty new-vehicle population. No Tesla consumers are in the NVES sample.

DAC Definition Based on Income, Environmental Justice, and Opportunity-Zone Criteria

NY State interim criteria: DACs are either…

1. within NY Opportunity Zones

or

2. within census block groups that:
   - are in NY Environmental Justice (EJ) Areas

   and
   - < 50% area-mean-income (AMI) threshold*

** Set by the U.S. Housing and Urban Development Agency (HUD)*

Summary Profile: Select Stats & Ranked Predictors

20% of new light-duty vehicles, and 15% of new EVs, sold in New York 1/2016–1/2021 were in census tracts containing DAC block groups.* DAC participants claimed 6.1% of rebates for EV purchases/leases through 2019.

Relative to new-vehicle buyers (and EV other adopters):

- Least frequently identify as solely white/Caucasian [71%]
- Younger [63% < 50 y.o.]
- Smaller households [69% ≤ 3 people]
- Smaller household fleets [81% ≤ 2 cars]
- Lowest access to charging at home [19% without]

Distinguishing Factors (ranked logistic-regression results):

1. Live in **multi-unit apartments/condo** [28%] or **attached home** [17%]
2. Residence **renter** [34%]
3. Household income **less than $100,000** [50%]
4. Live in **New York City counties** [32%]
5. EV is their **first-ever vehicle** [7%] or an **additional vehicle** [16%], vs. a replacement [73%]
6. Rate **convenience of charging extremely important** [34%] (vs. not at all [2%]) or **very important** [38%] (vs. ext. important)
7. Rate reducing **environmental impacts extremely important** [64%] (vs. not at all [1%]) **or very important** [18%] (vs. ext. important)
8. Rate **energy independence not at all important** [7%] (vs. ext. important [38%])
9. Acquire a **non-Tesla BEV** [19%] (vs. a PHEV [55%]) or a PHEV [55%] (vs. a Tesla [26%])
10. EV was **purchased** [63%] (vs. leased)

** Based on calculations using registration data licensed from IHS Markit.*

Percentages weighted to represent the program population along the dimensions of technology type (PHEV vs. BEV), vehicle model, purchase vs. lease, and residence county.

Summary of Non-Significance (controlling for other factors)

- In logistic regressions, DAC participants were <u>not</u> particularly distinguished by:
  - **white vs. non-white race**
  - the presence of absence of **solar**
  - **what has enabled them to adopt** to date
  - **giving greater importance to financial incentives**
  - disproportionate **lack of charging access**
  - **lower EV awareness** compared to non-DAC adopters.
- This is not to say, e.g., DAC participants do not place high importance on rebates; they do.
  - Controlling for income and other factors, the *way* they do is ***consistent with non-DAC consumers—and therefore not distinguishing***.

Caveats

- This work is centered on consumers who overcame their barriers to adoption, purchased/leased an EV, and participated in the DCRP.
- Extrapolating these findings should be done with caution. Additional research is required to understand consumers who have not overcome their barriers to acquiring an EV.
- Over time, things will change. For example, charging access is likely to become important, due to the high incidence of renters and multi-unit dwellers.

Previous DAC Analysis

Previous analysis of DACs in California: Sources (chronological)

- B.D. Williams, Presentation: “Zero-Emission Vehicle (ZEV) Markets in California: Disadvantaged Communities & the State Overall,” in: Energy, Utility, and Environment Conference, EUEC, San Diego CA, 2016.
- B.D. Williams, J.B. Anderson, Presentation: “Electric Vehicle Rebates in Disadvantaged Communities: Evaluating Progress with Appropriate Comparisons,” in: Evaluation 2016 Conference, American Evaluation Association (AEA), Atlanta GA, 2016.
- CVRP, Infographic: Plug-in Electric Vehicle Owners in California’s Disadvantaged Communities, Clean Vehicle Rebate Project, Center for Sustainable Energy, San Diego CA, 2017.
- B.D. Williams, J. Orose, M. Jones, J.B. Anderson, Summary of Disadvantaged Community Responses to the Electric Vehicle Consumer Survey, 2013–2015 Edition | Clean Vehicle Rebate Project, Center for Sustainable Energy, San Diego CA, 2018.
- Canepa, K., Hardman, S., & Tal, G. (2019). An early look at plug-in electric vehicle adoption in disadvantaged communities in California. Transport Policy.

DACs in CA are defined by CalEnviroScreen, which combines measures of socioeconomic vulnerability and exposure to pollution

Previous pertinent analysis of DACs by others: Summary

- DAC adopters tend to adopt **lower-priced EVs** (several non-Tesla BEV examples given)
- Connecting this to earlier, small-sample analysis of “high-end” (e.g., Tesla) vs. **“low-end” (e.g., Nissan LEAF) BEV adoption (but not in DACs specifically),** the two groups were found to be similar in terms of gender (predominantly male) and cost-saving motivations, but “low-end” EV consumers were more likely to have lower incomes, be **younger, be more motivated by environmental reasons, and be less motivated by performance and prestige.**
  - Concern highlighted that dissatisfaction with low-end EVs could slow market transformation

Canepa, K., Hardman, S., & Tal, G. (2019). An early look at plug-in electric vehicle adoption in disadvantaged communities in California. Transport Policy.

Hardman, S., & Tal, G. (2016). Exploring the Decision to Adopt a High-End Battery Electric Vehicle: Role of Financial and Nonfinancial Motivations. Transportation Research Record: Journal of the Transportation Research Board, 2572(1), 20–27.

Previous analysis of DACs by the authors: Summary

- DACs constituted 25% of California population but bought/leased only 17% of state's light-duty vehicles (LDVs) in 2014 and 18% in 2015.
- About half of all consumers intending to buy a new vehicle in the 2012 California Household Travel Survey had household incomes less than $75,000 per year, compared to about three-quarters in DACs.
- The EV market share (EVs per LDV) in DACs was about two-fifths that of the state overall in 2014 and one-third in 2015.
- DACs typically **bought proportionately more PHEVs relative to BEVs** (e.g., 57% of plug-in EVs registered in DACs through 2015 were PHEVs vs. 50% of plug-in EV registrations overall).
- Similarly, a proportionately larger share of rebates went to PHEVs in DACs (46%) than in the state overall (41%).
- Like for the state overall, when compared to non-Tesla BEVs, **rebated PHEVs more frequently replaced a household vehicle** rather than represented an addition to the household fleet.
  - Interestingly, this **replacement rate was lower in DACs (68%) than the state overall (72%).**

B.D. Williams, Presentation: "Zero-Emission Vehicle (ZEV) Markets in California: Disadvantaged Communities & the State Overall," in: Energy, Utility, and Environment Conference, EUEC, San Diego CA, 2016.

B.D. Williams, J.B. Anderson, Presentation: "Electric Vehicle Rebates in Disadvantaged Communities: Evaluating Progress with Appropriate Comparisons," in: Evaluation 2016 Conference, American Evaluation Association (AEA), Atlanta GA, 2016.

CVRP Survey Summary, 2013–15 Edition: DACs (1 of 3)

Statistically significant differences ($p < 0.05$) between rebated DAC and non-DAC respondents:

- **Vehicle details**: EVs more frequently an *added vehicle* in DAC households (39%) than non-DACs (35%).
- **Initial interest in EVs**: DAC consumers had *lower initial interest* at the beginning of their car search.
- **Sources of information** and **exposure**: DAC consumers had contact with fewer EV owners prior to their purchase/lease (e.g., 50% had contact with zero EV owners, vs 37% for non-DAC consumers), fewer of those contacts lived within one mile of the DAC consumer's home, fewer EVs were in the neighborhood, and fewer co-workers drove EVs.
  - Relatedly, those rebated DAC consumers that did adopt despite lower exposure more frequently appeared to not find it necessary to talk to other EV owners.
- **Importance of factors to the decision to acquire an EV**: DAC consumers placed *higher average importance on saving money on fuel costs, increased energy dependence, a desire for the newest technology, vehicle performance, and supporting the diffusion of EV technology* than non-DAC consumers.
- **Importance of enablers that made it possible to adopt an EV**: DAC consumers placed *higher average importance on federal tax incentives, the state rebate, the option to lease an EV, access to workplace charging, and other incentive programs* than non-DAC consumers.

CVRP Survey Summary, 2013–15 Edition: DACs (2 of 3)

Statistically significant differences ($p < 0.05$) between rebated DAC and non-DAC respondents (cont.):

- The **percentage who would not have adopted their EV without the rebate** was higher in DACs (51%) than the state overall (46%) [both absolute percentages and the differences between DACs and non-DACs have grown in subsequent years].
- **Purchase timeline**: Less time passed between when DAC consumers began to seriously consider an EV and when they acquired it.
- **Time spent researching**: DACs reported spending more time learning about: financial aspects and incentives, warranties, electricity rate plans, availability of public and workplace charging, and vehicle maintenance than non-DAC consumers.
- **Tesla retail stores**: DAC consumers *less frequently visited a Tesla retail* store.
- **Value of information at the dealership/retail store**: DAC consumers rated as more valuable having a dealer or retail representative knowledgeable of total cost of ownership, electricity rates, home and away-from-home charging, government incentives, and nonfinancial incentives.

CVRP Survey Summary, 2013–15 Edition: DACs (3 of 3)

Statistically significant differences ($p < 0.05$) between rebated DAC and non-DAC respondents (cont.):

- **Value of dealership/retail services**: DAC consumers rated as more valuable the option to rent or use an EV before buying/leasing, having an EV specialist for questions, facilitation of home charging installation, tutorials for new owners, assistance submitting incentive applications, access to reduced-cost car share or rental cars, and assistance enrolling in charging networks.
- **Access to dealership/retail services**: DACs reported lower availability of EV specialists and home-charging facilitation than non-DACs.
- **Access to workplace charging**: DACs reported **having access as frequently (41%)** but report not having access more frequently (50%). Non-DACs report *not working or working from home less frequently*.
- **Housing**: DACs reported living in *rented and/or multi-family units more frequently*; reported parking at home in carports and/or uncovered driveways more frequently and in *garages less frequently*; and reported having *solar less frequently*.
- **Demographics**: DAC consumers were, on average*, younger, more frequently female, and less frequently White/Caucasian*. They had *fewer postgraduate degrees and had lower incomes*.

Recommended citation

B.D.H. Williams (2025, Mar.), Presentation: “Assessing Progress Toward Equitable Access to EVs with Incentive Program Metrics: Lessons Learned from CVRP and NY DCRP Using Program Data and Baselines of Comparison,” for CARB Clean Transportation Equity Incentives Symposium, Sacramento CA.

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