# Evaluating the Cost-Effectiveness of Greenhouse Gas Emission Reductions Associated with California's Statewide Electric Vehicle Rebate Program in 2020
(with a Discussion of Two-State Results in 2019)

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*and to client state agencies including CARB & MA DOER*

CALIFORNIA CLEAN VEHICLE REBATE PROJECT℠

MOR-EV
Massachusetts Offers Rebates for Electric Vehicles

# Introduction

## Context

– Reducing emissions is a primary motivation of investment in EV adoption

– Results of EV emissions studies range widely due to differing goals, scopes, models, scales, timespans, and datasets used[1]

## Research Questions

– What impact can context- and case-specific analyses have on understanding GHG savings and cost-effectiveness of EV rebate programs like California's Clean Vehicle Rebate Project (CVRP)?

– What can be learned from trying to compare GHG outcomes for two states?

Disclaimer: this study was conducted by the enter for Sustainable Energy to inform CVRP and MOR-EV. It does not necessarily represent the views of California Air Resources Board (CARB) or Massachusetts Department of Energy Resources (MA DOER) staff, nor does it represent a final determination for project-reporting purposes. We thank CARB and DOER for the opportunity to contribute to the conversation.

[1] https://sgp.fas.org/crs/misc/R46420.pdf

# Statewide EV Rebate Program Designs
## During Study Period

| | CALIFORNIA CLEAN VEHICLE REBATE PROJECT℠<br>**2020 purchases/leases** | MOR-EV Massachusetts Offers Rebates for Electric Vehicles<br>**2019 purchases/leases** |
|---|---|---|
| **Fuel-Cell EVs** | $4,500<br>*(+2,500*)* | $1,500<br>(FCEVs unavailable in MA) |
| **All-Battery EVs** | $2,000<br>*(+2,500*)* | $1,500 |
| **Plug-in Hybrid EVs** | BEVx = $2,000<br>Others = $1,000<br>*(+$2,500*)* | BEVx only = $1,500 |
| **Zero-Emission Motorcycles** | $750 | $450 |
| **Program Design Elements** | * Rebate adder: income-qualified | -- |
| | Base MSRP: PEVs ≤ $60k | Purchase price ≤ $50k |
| | ≥ 35 e-miles | -- |
| | Income cap | -- |



Electric miles (e-miles) based on the Urban Dynamometer Drive Schedule (UDDS). BEVx = range-extended battery electric vehicle (BMW i3 REx).

# Program Application & Survey Data Summary

## CVRP Application Data, 2020 purchases/leases

| Rebate/ Technology type | Rebate counts | Total rebate dollars |
|---|---|---|
| **All** | **37,201** | **$82,019,025** |
| **Standard** | 32,416 (87%) | $61,515,025 (75%) |
| **Increased*** | 4,785 (13%) | $20,504,000 (25%) |
| **PHEV** | 6,348 (17%) | $9,639,000 (12%) |
| **BEVx** | 141 (0.4%) | $344,500 (0.4%) |
| **BEV** | 29,966 (81%) | $68,394,625 (83%) |
| **FCEV** | 746 (2%) | $3,640,900 (4%) |

* Increased rebates (+$2,500) available to income-qualified consumers.

## CVRP Consumer Survey Data, 2020 (Jan.–Nov.) purchases/leases

| Survey responses | Weighted† to represent (program population) |
|---|---|
| *n* = 4,445 | *N* = ~27,100 |

† Survey data weighted to represent the program population along the dimensions of technology type, vehicle model, county and buy vs. lease using iterative proportional fitting (aka raking method).

# Methodology

## Approach

- Use case-specific program data with the latest California-specific inputs.

$$\textbf{Case-Specific GHG Reductions} = Baseline\ Emissions - Rebated\ EV\ Emissions$$

$$\textbf{Baseline or Rebated EV Emissions} =$$

$$Fuel\ Carbon\ Intensity * \ Fuel\ Consumption\ Rate * Vehicle\ Miles\ Traveled$$

## Quantification Period

- First-year GHG reductions are **scaled** to **100,000 miles** (typical EV battery warranty)

# Per-rebated-vehicle GHG reduction and cost-effectiveness estimates
## by technology/rebate type

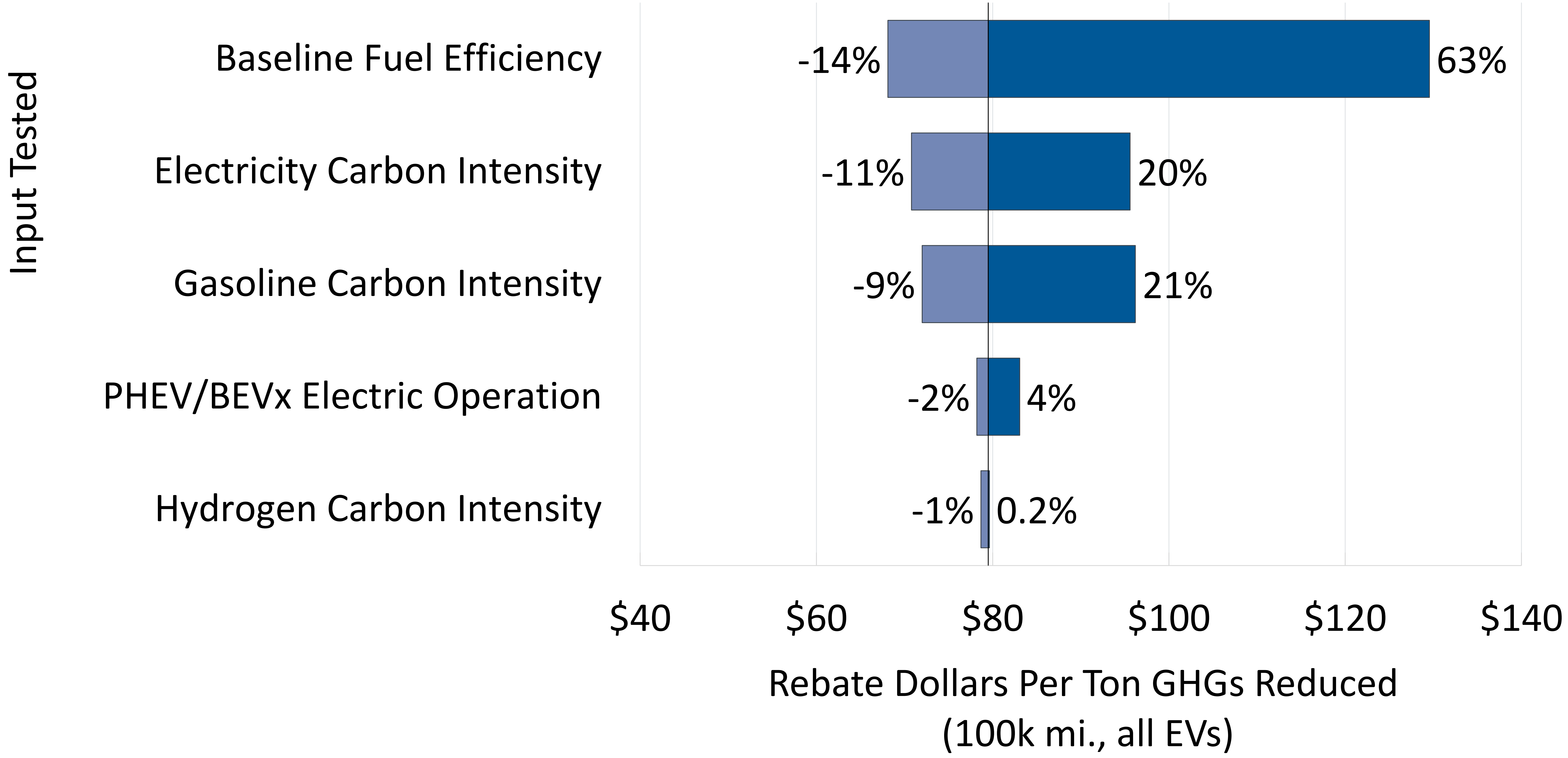
| Technology/Rebate type | Average 100k mi. GHG reductions per vehicle (tons) | Rebate dollars per 100k mi. ton GHGs reduced |
|---|---|---|
| PHEV | 23 | $67 |
| BEVx | 26 | $93 |
| BEV | 29 | $78 |
| FCEV | 16 | $304 |
| Standard Rebate | 28 | $68 |
| Low-/Moderate-Income Increased Rebate | 27 | $157 |
| **All** | **28** | **$79** |

**1,061**
**incandescent lamps switched to LEDs**
(U.S. Grid Mix, 1 year)

ton GHGs = metric ton $CO_2$-equivalent emissions
U.S. EPA GHG equivalency from: https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

# Sensitivity Analysis

## Results are particularly sensitive to uncertainty in baseline fuel efficiency




ton GHGs = metric ton of $CO_2$-equivalent emissions

# Sensitivity Analysis: Quantification Period

CALIFORNIA CLEAN VEHICLE REBATE PROJECT

| Quantification period | Average GHG reductions per vehicle (tons) | Rebate dollars per ton GHGs reduced |
|---|---|---|
| Primary (100,000 miles) | 28 | $79 |
| 2.5-year rebate “project life” (CARB 2019) | 9 (-68%) | $245 (+208%) |
| 100,000-/150,000-mile battery warranty life | 30 (+7%) | $74 (-7%) |
| 11.2-year average CA vehicle age (Auto Innovators 2021) | 40 (+45%) | $55 (-31%) |
| 150,000 miles | 42 (+50%) | $53 (-33%) |
| 15-year project-comparison life (CARB 2019) | 54 (+95%) | $41 (-49%) |
| 200,000 miles | 55 (+100%) | $40 (-50%) |

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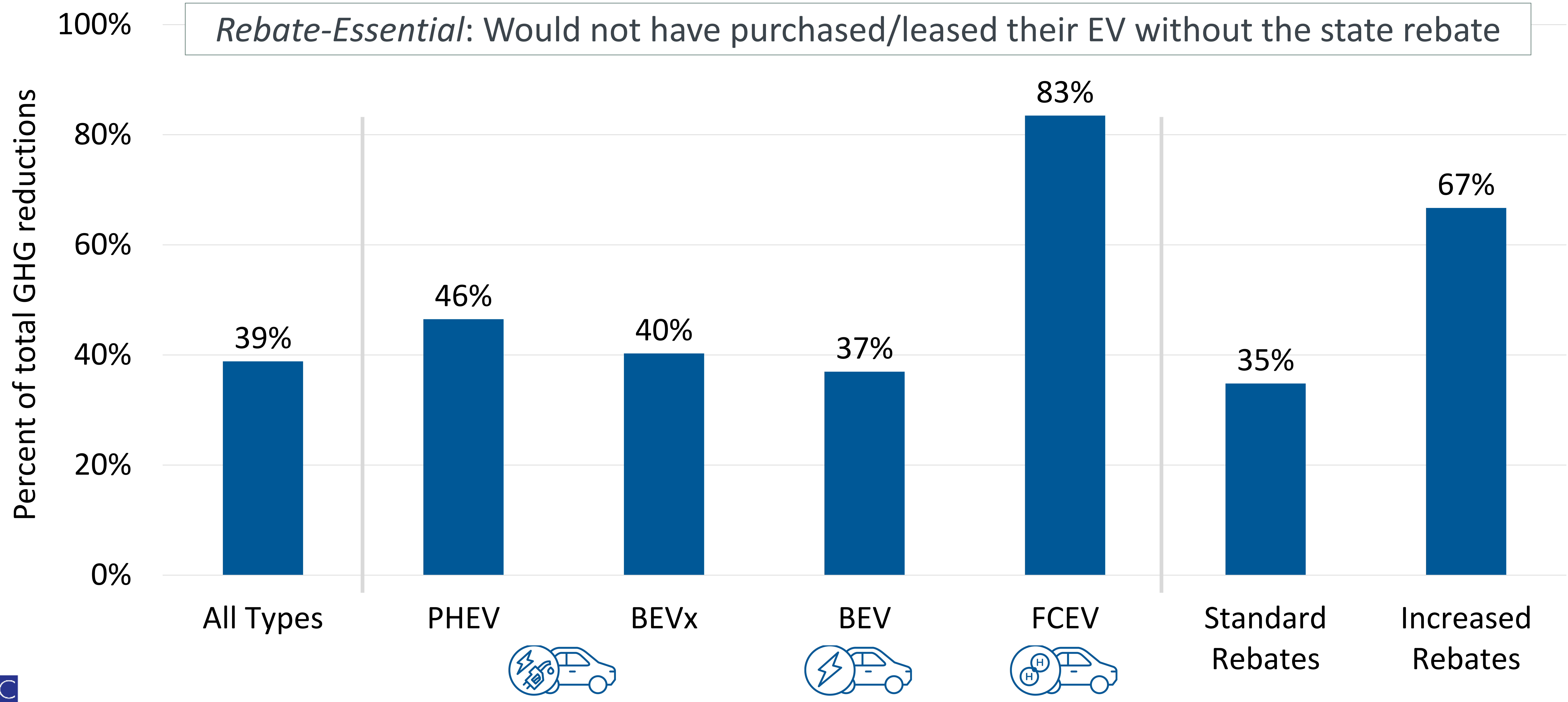
ton GHGs = metric ton of $CO_2$-equivalent emissions.
References provided in the IEPEC paper.

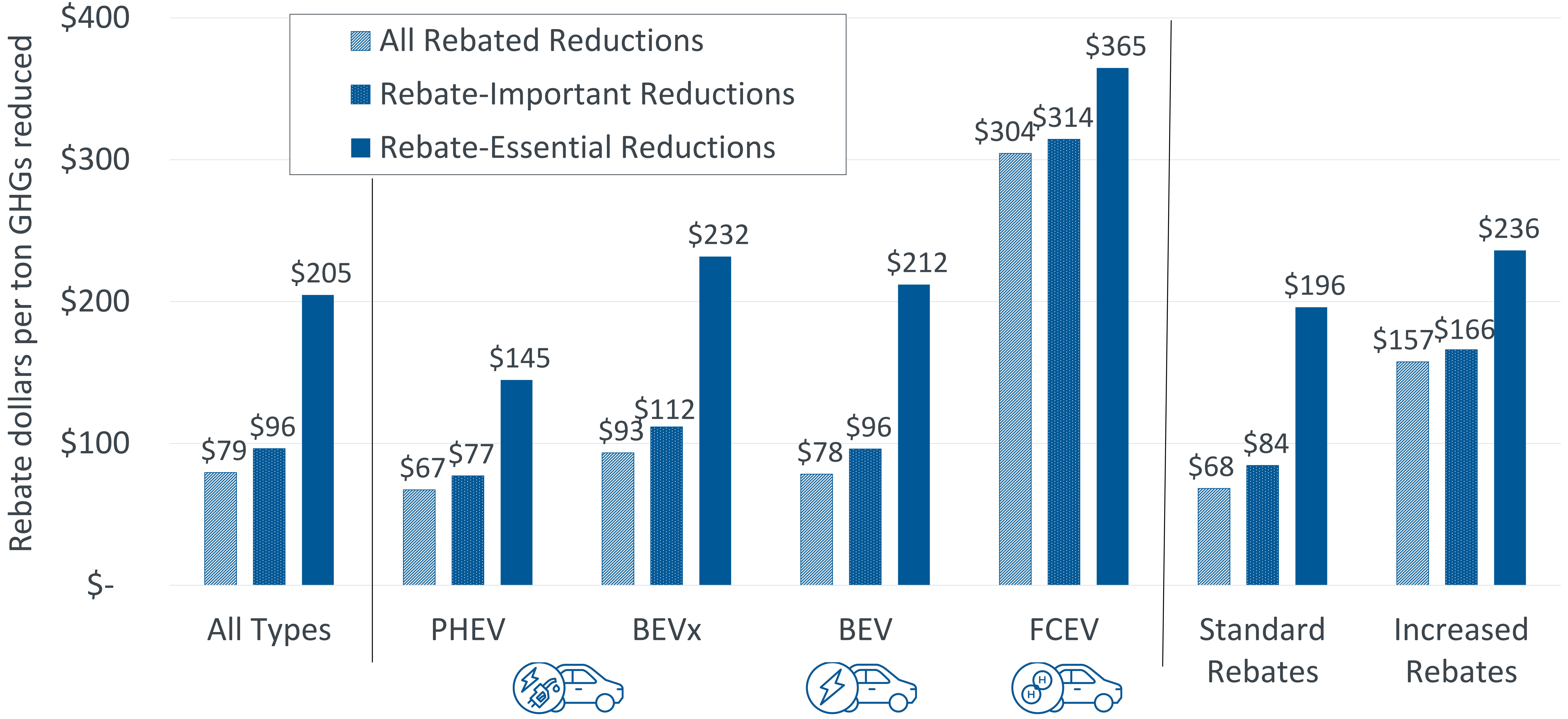
# *Rebate-Essential* GHG Reductions

2020 Purchases/Leases, 100k mi.



# Cost-Effectiveness & Rebate Influence

2020 Purchases/Leases, 100k mi.

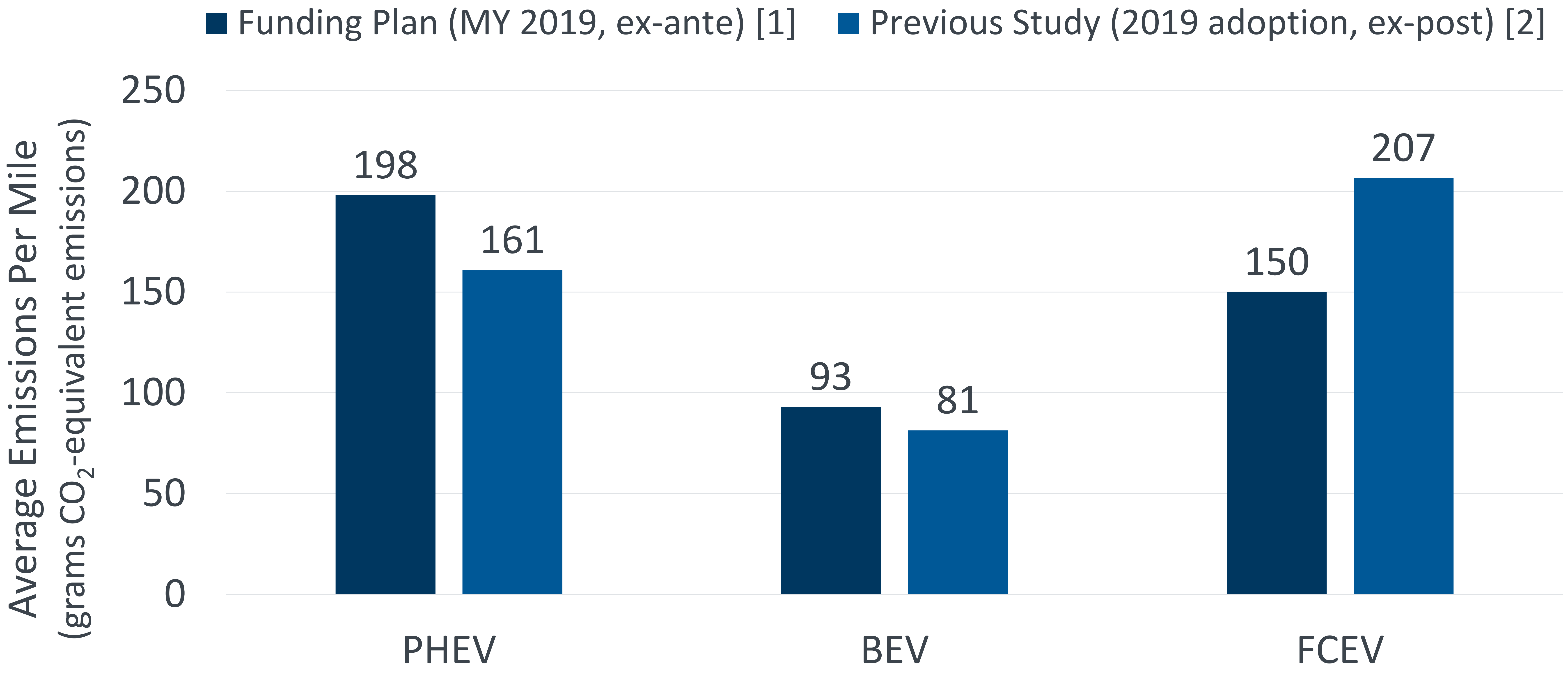



ton GHGs = metric ton of $CO_2$-equivalent emissions

# Cross-Study Comparisons

EV emissions, grams/mile

## Use of case-specific program data with context-specific inputs can enhance the understanding of EV impacts

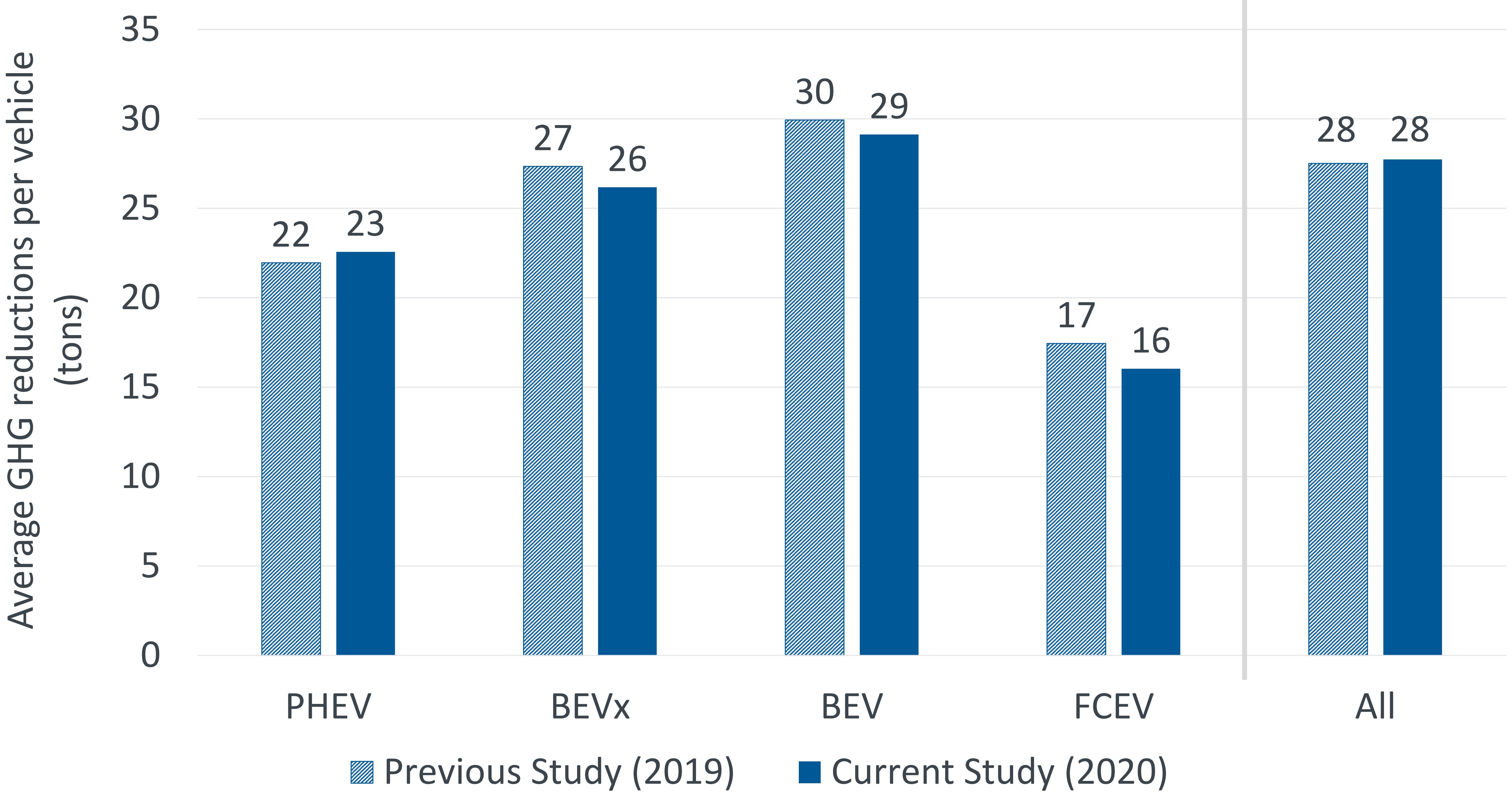



Changes previous estimates from **-19% to +38%**

[1] https://ww2.arb.ca.gov/resources/documents/low-carbon-transportation-investments-and-aqip-funding-plan-archive
[2] https://cleanvehiclerebate.org/en/content/evaluating-cost-effectiveness-greenhouse-gas-emission-reductions-associated-statewide

# Results Over Time

2019[1] vs. 2020 adoption, 100k mi.




- PHEV increase largely from improving fuel efficiency
- BEVx, BEV and FCEV decreases largely from an improving gasoline baseline
- All increased slightly due to increased proportion of BEVs in the mix

[1] https://cleanvehiclerebate.org/en/content/evaluating-cost-effectiveness-greenhouse-gas-emission-reductions-associated-statewide

ton GHGs = metric ton of $CO_2$-equivalent emissions

# Two-State Estimates[1]

(2019 purchases/leases)

## Using the best available inputs to optimize the analysis for each state in isolation complicates comparisons

| | Average GHG reductions per BEV (100k mi.) | Data | Inputs |
|---|---|---|---|
| CALIFORNIA CLEAN VEHICLE REBATE PROJECT | 30 tons | Case-specific program data | California-specific |
| MOR-EV Massachusetts Offers Rebates for Electric Vehicles | 28 tons **(preliminary)** | Case-specific program data | Regional or national |

- **Differing input sources** appear to impact results as much as substantive differences
  - Standardizing inputs reduces accuracy, but reveals that the ~2-ton difference can best be explained by the baseline fuel efficiency input

IEPEC

[1] https://cleanvehiclerebate.org/en/content/evaluating-cost-effectiveness-greenhouse-gas-emission-reductions-associated-statewide

# Conclusion

- Context-specific analyses can enhance the understanding of EV impacts:
  - Substantively changes prior GHG estimates
  - Enables evaluation of recent trends
- Comparing states can be a challenge:
  - Optimizing the analysis for each state in isolation complicates comparisons
  - Differing input sources can influence results as much as substantive differences
- Ongoing opportunity to further refine analysis and broaden scope:
  - Results particularly sensitive to baseline vehicle fuel efficiency (and VMT/quantification period)
  - Limitations and next steps detailed in paper

Recommended citation:

N. Pallonetti and B.D.H. Williams (2022). Presentation: “Evaluating the Cost-Effectiveness of Greenhouse Gas Emission Reductions Associated with California’s Statewide Electric Vehicle Rebate Program in 2020 (with a Discussion of Two-State Results in 2019),” given November 2nd to the 2022 *International Energy Program Evaluation Conference (IEPEC),* San Diego, CA.

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