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Consumer Resistance to Electric Vehicles

Getting to 100 Percent Zero Emission New Car Sales

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16. Abstract Meeting and sustaining a requirement that 100 percent of new passenger vehicle and light-duty truck sales be zero emission vehicles (ZEVs) requires everyone who acquires a new vehicle to only acquire ZEVs. This puts an onus on understanding resistance to ZEVs: who is resistant and why. These questions are addressed using survey data from repeated cross-sectional samples of all-car buying households in California in the years 2017, 2019, and 2021. Concepts of resistance are introduced and provisionally mapped onto *Consideration*, a multidimensional assessment of what consumers have already done vis-à-vis two types of ZEVs: battery and fuel cell electric vehicles (BEVs and FCEVs). Results indicate that active consumer resistance did not abate for BEVs over the study period, and that while it did abate slightly for FCEVs the probability of active resistance became less dependent on assessments of FCEV performance, fuel availability, or comparisons to conventional gasoline-fueled vehicles. Resistance based in political beliefs is extended from ZEVs to the policy requiring ZEVs using data from an additional survey of car-owning households in California from late 2023 to early 2024. The attitude that cost and convenience matter more in daily decisions than do environmental effects has a strong influence on the likeliness of disagreeing with the ZEV sales requirement. Conceptual shortcomings are noted in the mapping of resistance onto *Consideration* which limit the usefulness of *Consideration* as proxy for resistances going forward as is the lack direct measures of political affiliation in the extension to resistance to policy. A comprehensive set of suggestions to improve the direct measurement of different forms of resistance is provided.		
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Consumer Resistance to Electric Vehicle: Getting to 100 Percent Zero Emission New Car Sales

A National Center for Sustainable Transportation Research Report

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Table of Contents

List of Tables

List of Figures

Consumer Resistance to Electric Vehicles: Getting to 100 Percent Zero Emission New Car Sales

Executive Summary

Electrifying transport is necessary to achieve social goals ranging from reductions in pollutants with local, immediate and cumulative effects on human health and well-being, to global effects on long-term sustainability of natural and social systems. The State of California has promulgated a set of zero emission vehicle (ZEV) policies including Advanced Clean Cars II (ACC II), which proscribes increasing percentages of new passenger cars and light-duty trucks sales that must be ZEVs. ZEVs include battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs), and a limited allowance for plug-in hybrid electric vehicles (PHEVs). The new vehicle sales targets rise to 100 percent in the year 2035. Sixteen other states and the District of Columbia adopted the ACC II requirements (Alternative Fuels Data Center, undated-a).

This entire policy framework has now been thrown into doubt by the Trump administration and the 119th U.S. Congress, culminating in President Trump signing joint U.S. House and Senate Resolutions rescinding California's waivers from federal air quality regulations on June 12, 2025. These are the waivers the state has used to set stricter emissions limits and to promulgate its ZEV programs.

Regardless of whether a transition to ZEVs is aided by public policy, meeting and sustaining a goal of 100 percent ZEV sales requires that *everyone* who acquires new cars and light-duty trucks *only* acquires ZEVs. The paired imperatives of everyone, every time compel us to understand resistance to ZEVs: who is resistant; why; and, how might their resistance become commitment?

Several types of resistance based on a review of related literature are defined as well as antecedents to some of them.

- *Active resistance* preceding any hypothetical vehicle acquisition is based in a negative assessment either or both of ZEVs and policies requiring ZEVs.
- *Active resistance* following vehicle acquisition including both complete discontinuance and partial adoption in which a person is willing to continue acquiring ZEVs but not exclusively.
- *Passive resistance*, the antecedents of which include a generalized resistance to any change and simple satisfaction with the status quo.
- *Ambivalence* as a variation on almost any of the prior types as evinced by a person's evaluations exhibiting both strong positive and negative elements.

These types are provisionally mapped into a measure of *Consideration* operationalized here as a multidimensional indicator of whether and the extent to which people have already engaged with ZEVs. This measure has been taken in several prior surveys of car-owning household in California; data from 2017, 2019, and 2021 are analyzed here. Additionally, analysis of political resistance is extended to the ZEV policy itself using data from another survey of car-owning households in California conducted in late 2023 to early 2024.

No other findings presented here are more important than these two:

- Consideration of BEVs did not differ in any statistically significant way ($p \leq 0.05$) between the 2017, 2019, and 2021 surveys and thus we infer no difference in resistance to BEVs.
    - To the extent some categories of the Consideration measure are proxies for several types of resistance, the inference about resistance is that during the period of study the total of all types of resistors to BEVs did not change though there may have been changes in the number of some types of resistors.
- Consideration of FCEVs is slightly higher in later samples but also is less dependent on participants' assessments of FCEVs' performance, fueling, and comparisons to conventional gasoline vehicles as we move from earlier to later survey samples. Negative assessments of FCEVs were associated with similar, low levels of Consideration in all three survey years but in later years positive FCEV assessments had less effect on the probability of higher Consideration.
    - The inference is the total number of resistors to FCEVs declined slightly over the study period but that whether someone may be an FCEV resistor or not became less dependent on their assessment of the performance capabilities of FCEVs.

Generally, the most influential variables affecting both *BEV* and *FCEV Consideration* are measures of participants' specific assessments of each type of ZEV, self-ratings of experience and familiarity of BEVs and FCEVs, and whether anyone in their social networks already has a BEV or FCEV. Participants formal education and age are less influential than measures specific to the vehicle types but are more influential than environmental attitudes vis-à-vis air pollution. Among the least influential variables are measures of household resources and context, e.g., income, daily access to high occupancy vehicle (HOV) lanes, and whether they buy new vehicles.

Political resistance to ZEVs appears to be distinct from but correlated with active resistance based on assessments of ZEVs themselves. The direct effect of disagreement with the general notion that government should offer incentives for alternatives to gasoline and diesel fuel is significant but among the less influential variables in estimating BEV and FCEV Consideration. This direct effect appears concentrated among people who have negative assessments of the vehicles themselves. What, if any, causal relations there may

be between negative assessments of both vehicles and policies is a question for future research. Political resistance extends to the ZEV policy specifically and is associated with those who prioritize private cost and convenience over environmental consequences and live in a place with no or few ZEVs.

We then focus the analysis of political opposition (more generally) on opposition to a specific policy: California's ZEV Mandate. A fourth sample of car-owning households was drawn in late 2023-early 2024. As this survey asked a different set of questions than in the previous three, the analysis of BEV and FCEV Consideration and their antecedents can't be closely simulated with these new data. Regardless, it appears that opposition to the ZEV Mandate is associated with how a person balances environmental impacts versus "cost or convenience" in making daily choices, the potential for indirect experience with ZEVs via the per capita number of ZEVs in the participants Census tract, and whether the participant owns a ZEV. Those who favor convenience or cost, live where there are fewer ZEVs per person, and do not own a ZEV a much more likely to oppose the ZEV Mandate than those who favor environmentalism, live where there are more ZEVs per person, and do own a ZEV.

Whether support-opposition for a specific policy is political is less clear from this analysis. The model of support for the ZEV Mandate contains no direct measure of political orientation. It does contain a few, primarily socio-economic and demographic, variables that correlate with political identification or inclination. The model variables for education, race/ethnicity, and residing in an urban area are all shown by other research to correlate with whether a person considers themselves to be or leans toward being a Democrat or Republican. The direction of the effect of the indicator for whether a person holds a graduate or professional degree is consistent with the idea that agreeing with the ZEV Mandate is "left-leaning" and disagreeing is "right-leaning." The same is true for the indicator for whether a person lives in an urban area. Any case for race/ethnicity is less clear.

The most immediate and actionable recommendation from this research is to broadly deploy direct measures of resistance across studies of all car-buying households especially those outside California. There are several such direct measures to use rather than relying on proxies such as Consideration as was done here. Each of these measures may inform actions to address different groups of people, e.g., the passive resistance of the person who simply isn't open to hearing about ZEVs, the active resistance of the person who is politically opposed to ZEV requirements, the ZEV owner who is happy to continue acquiring ZEVs but feels the need to continue to acquire gasoline-fueled vehicles, and the ZEV owner whose experience put them in a state of mind to quit ZEVs.

Across three samples spanning the five years from 2017 through 2021 there is active resistance to BEVs and FCEVs based in negative evaluations of the vehicles and their charging and fueling infrastructures. From these differences between years, we infer the possibility of changing resistance to acceptance and ultimately commitment if we can

improve those evaluations. This may be accomplished in part via actual improvement in technical performance, reliability, price, and availability—but only if people know these things. This basic level of paying attention to ZEVs may be aided by continuing and increasing efforts to leverage the generally positive social effects of knowing ZEV owners and recognizing the ZEVs in the world around us.

Introduction

Reductions of toxic and climate-forcing emissions are required to attain a wide variety of sustainability goals. Electrifying road transport is one of several necessary strategies to achieve these emissions reductions. Towards this end, California has set the goal that 100 percent of new light-duty cars and trucks sales will be zero emission vehicles (ZEVs) by the year 2035. Before this report was finalized, the 119th Congress of the United States (House and Senate) approved resolutions to revoke the waivers from federal air quality standards that allowed California to set these goals and enact enabling policies. Based on his prior actions (Executive Order No. 14154 90, 2025), the President may be expected to sign the resolution. The Governor and Attorney General of California have stated they will sue the Trump administration to reverse these actions (California Office of the Attorney General, 2025).

Eleven other U.S. states and the District of Columbia had also set this ZEV sales goal and at least through 2024 the number of such states continued to increase (CARB, undated). ZEVs include battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs) and fuel cell electric vehicles (FCEVs).[1] Twenty percent of the ZEV sales requirement may be met with PHEVs that meet minimum all-electric range requirements (RMI, 2023); the remaining 80 percent may be met with any mix of qualifying BEVs and FCEVs.

Achieving and sustaining 100 percent light-duty vehicle ZEV sales will eventually require *everyone* who acquires new light-duty vehicles to *only* acquire ZEVs. *Everyone* and *only* are both necessary conditions to meet the ZEV sales goal but neither is sufficient. This leads to a distinction between behaviors that differ from one person to another (i.e., everyone) versus those that describe one person's behavior over time (i.e., only).[2] Arguably, the policy reversal (or at least, introduction of policy uncertainty) by the second Trump Administration and the 119th Congress increases the importance of understanding the barriers to fulfilling these two necessary conditions.

While there is some prior research on resistance to ZEVs, much of it was conducted in contexts quite different from the present study. Some of this prior research was conducted at the very beginning of the present era of ZEV sales, for example Egbue and Long (2012). Much of the more contemporaneous research has been conducted in contexts of very different levels of automobility, such as Ninh's (2021) research in Vietnam. Very little prior research attempts to assess antecedents of resistance but vests all explanation in attributes of the vehicles and socio-economic descriptors of people, e.g., Ju and Kim

[1] Collectively, BEVs and PHEVs are referred to in this report as plug-in electric vehicles (PEVs).
[2] The relationship between new and used vehicle markets is not discussed here. Even when the 100 percent ZEV new vehicle sales target is met, the market for used internal combustion engine and hybrid vehicles may be a refuge for EV resistors for years. However, the only way a 100 percent ZEV sales goal is sustained over many years is if at some point *everyone* buying vehicles in the used vehicle market *only* acquires ZEVs.

(2022). Xue et al. (2024) do apply a theoretical framework capable of generating hypotheses about antecedents of ZEV resistance, but again in a very different automobility context than the U.S. MacInnis et al.'s (2023) study may be the most directly comparable to this study, as they test a variety of theoretically grounded causes of ZEV resistance within the present automobility and ZEV-sales context of the U.S. Among the differences between that study and this, 1) MacInnis et al.'s (2023) rely on a measure of hypothetical future behavior to assess willingness-resistance to ZEVs rather than the measure of past-present *consideration* of ZEVs as used here; 2) they do not address the concept of passive resistance (Heidenreich et al. 2015, 2016) that will be introduced here; and 3) their analysis is based on single-point-in-time data compared to the multiple years of data analyzed here; however, 4) they address normative causes not addressed in the present study.

Two concepts we use in this analysis of resistance are *consideration* and *engagement*. Narrowly, *consideration* is a measure of deliberation and cognition. More broadly, we take it to also include the emotional energy to impel and sustain an expenditure of cognitive resources. *Engagement* we take to be a summary measure of a person's willingness and actions to increase their awareness, improve their knowledge, and refine their assessments—in short, to build a knowledge and experience base to support the formation of an attitude, where an *attitude* is the set of emotional, cognitive, and behavioral responses to a specific idea, object, person (or people), and action.

We start by introducing a vocabulary of ZEV resistance, i.e., human beliefs and behaviors vis-à-vis ZEV acquisition and use that stand in the way of achieving and sustaining 100 percent ZEV sales. This introduction is followed by a hypothetical mapping of resistance types onto past data on the extent to which people have already considered acquiring BEVs and FCEVs. This mapping organizes the subsequent presentation of results regarding consideration of, and resistance to, BEVs and FCEVs by car-owning households in California based on samples drawn in the years 2017, 2019, and 2021. These measures are either adopted and adapted from prior research that propose theoretical antecedents to resistance, e.g., passive resistance (Heidenreich et al. 2015, 2016) and ambivalence (Priester and Petty,1996; Armitage and Arden, 2007) or developed from the present analysis, e.g., political resistance and commitment.

The necessity to implement direct measures of resistance is highlighted by the unsustainability of continuing to map categories of resistance into other measures—as is done here. The reasons why the present mapping of multiple types of *resistance* onto *consideration* cannot be sustained include: 1) single types of resistance can be mapped into multiple categories of *consideration* and 2) multiple types of resistance can be mapped into a single category of *consideration*. The analyses presented, which rely on this mapping, are meaningful now only because at present the probabilities of these practically occurring (rather than being solely theoretically possible) are still small because the overall market for ZEVs is still small. For example, within the mapping of forms of resistance into *consideration*, "discontinuance" as a type of active resistance cannot be distinguished from "committed adoption" because they both involve the highest level of

consideration. However, so few households have acquired ZEVs that discontinuance remains rare compared to the other forms of active resistance that are mapped into the lowest levels of consideration. Thus, for now, we can talk in a meaningful way about most ZEV resistors and many types of resistance based on the available data, recognizing we need to do better going forward.

The report then continues with an analysis of opposition (which we take here to be synonymous with resistance) to California's ZEV Mandate. The report closes with the presentation of additional measures of different types of resistance and some of their antecedents. These measures are recommended to be implemented in future work on the subject of ZEV Resistance.

A Vocabulary of Resistance

Before we define and describe types of resistance, we note any type of resistance may be, but no type of resistance must be, long-lasting or permanent *within a perso*n even if resistance persists overtime *across a population*. Taking ZEVs as a potential subject of resistance, such resistance is a state of being into and out of which a person may move if that person's engagement, assessment, and experience with ZEVs changes over time, as ZEVs themselves change, as plug-in electric vehicle (PEV) charging and FCEV fueling networks are deployed, if social norms about ZEVs change, or if the symbolic meanings of ZEVs change and multiply.

There is a distinction to be made between resistance on the one hand as a state into which a person may move, exist for some period, leave, and possibly re-enter (and re-exit; repeat) and on the other hand as an observable behavior. The issue is germane to our ability to measure resistances in its many forms, how to measure them, and how many people may be resistors of a type at any point in time. An example is provided in the next section where we define *discontinuance*. We also distinguish between active and passive resistance; each is described next, including elaborations of their causes, forms, and strengths.

Active Resistance

Active resistance is the outcome of attending to and assessing a product, idea, or practice, i.e., forming an attitude:

> *"Active innovation resistance represents a negative attitude formation based on innovation-specific factors that follows the deliberate evaluation of new products." (Heidenreich et al., 2016)*

Note "innovation-specific factors" are not limited to functional, price, value, or risk attributes of new products. Heidenreich and Handrich (2015) argue innovation-specific factors include "psychological barriers (i.e., tradition and image barriers)." Thus, "active resistance" as defined here relies only on the formation of a negative attitude of sufficient strength that an "active resistor" will not voluntarily acquire a ZEV.

Political Resistance

Naming *political resistance* as a form of active resistance may be necessary and useful to a more comprehensive understanding of who resists ZEVs and why. Prospectively, we place *political resistance* within active resistance. As such, political resistance is hypothesized to be resistance to a subject of public policy (such as ZEVs), e.g., laws, regulations, standards, and other acts of government that require, prescribe, proscribe, or forbid behaviors or actions of individuals or collective entities such as corporations and governments, or affect the availability or performance of goods and services available to consumers. As a form of active resistance, political resistance based on an assessment

though not on assessment of the subject of policy but on an assessment of the degree of congruence between the political beliefs or identity of a citizen/consumer or producer and the public policy and policy makers in question. Research on the antecedents of such forms of political resistance is presented in the later section of this report that proposes specific survey questions to implement in future work.

Irrespective of whether automobile manufacturers—either legacy producers of internal combustion engine vehicles (ICEVs) or new market entrants started specifically to produce ZEVs—offer ZEVs to consumers, a 100 percent ZEV sales goal for new vehicles may be seen as having both practical and symbolic or communicative effects. Practically, public policies may be seen to be driving a transition to ZEVs (and away from gasoline and diesel-fueled vehicles) much faster and to many more types of motor vehicle buyers than automobile manufacturers might do so in the absence of such policies. ZEVs convey symbolic meanings associated with the public goods ZEVs provide and the politics of those promoting ZEVs including public administrations, private companies, non-governmental organizations, and individuals. Until possibly very recently, ZEVs have meant "pro-environmental" and "liberal" and thus are open to both acceptance and resistance based on those meanings. Thus, ZEVs may be perceived to be a mix of private and public goods—as both a car or truck to be purchased by a private consumer (including for ZEV's symbolic meanings as items of private consumption) and as a producer of public goods (for examples, reduced emissions of criteria pollutants and greenhouse gases).

Political resistance also demonstrates differences in strength of resistance, ranging from simply not acting on a thing to actively opposing the thing. Political resistance identifies active resistance expressed not merely as refusing to buy ZEVs but also as actions to oppose, even overturn, supporting policies where they do exist, erect policy barriers to the enactment of policies supportive of a transition to ZEV, oust political representatives who support ZEVs, and support those who would roll back or resist such policies. Actions such as blocking PEV charging locations by parking gasoline or diesel-fueled vehicles in them may represent political resistance.

There is comparatively little research to date tying political beliefs to resistance to ZEVs (for a discussion of political partisanship related to energy transitions generally see Mayer (2019) and electric vehicles specifically, Sintov et al. (2020)). For this reason, a more extended discussion of political resistance is presented here. First, evidence of a political divide between those who have and those who have not been acquiring ZEVs is presented. This is followed by a review of the history of policy making vis-à-vis ZEVs at both the federal and state level, i.e., California. This history leads to the present reversal by the federal administration of decades of administrative and legislative actions supporting ZEVs. This break is described in terms of specific actions taken by that administration directly and indirectly affecting ZEVs while at the same time President Trump sought to bolster the fortunes of the BEV manufacturer Tesla as that company's Chief Executive Officer (CEO) was serving as a "special government employee."

Evidence of a Political Divide in ZEV sales in the U.S.

Davis et al. (2025) underscore the importance of understanding the effects of political beliefs on ZEV demand. They remind us of the requirement that "everyone buys a ZEV, every time" includes people of varying political beliefs—yet they point out that may not have been the case so far. Their analysis of the county-level spatial distribution of PEV registrations across the U.S. from 2012 to 2023 shows that, "about half of all new EVs in the United States went to the 10% most Democratic counties, and about one-third went to the top 5%."[3] They further note there appears to be no diminution of this divide over the time period of their analysis and the divide persists even when they control for other possible explanatory variables such as household income, population density, gasoline prices, electricity prices, counts of Tesla-branded fast charging stations, and state-level subsidies.

The evidence that more PEVs are sold in places with higher percentages of voters registered as Democrats is indirect evidence of a political divide in the market for PEVs. Davis et al. (2025) cannot conclude it was mostly Democrats that did the actual acquiring of PEVs even in the most Democratic counties. Direct evidence of a divide based on sampling the population is complicated by the fact that few people of any political identity or party-affiliation have acquired PEVs, that is, it may not be possible to draw strong conclusions about who has acquired PEVs.[4] However, we can draw conclusions at a high confidence level about those who say they would *not* acquire one given there are presently many more people who have not acquired ZEVs than have. According to their survey of adult Americans, Gallup News Service (2023) reported in Spring 2023 that only 17 percent of those who identify as Democrats (and 17 percent who identify as "liberals") say they would not acquire a PEV compared to 71 percent of those who identify as Republicans (and 65 percent of "conservatives").

A Brief History of Administrative and Legislative Support for ZEVs

ZEVs have not always symbolized a political divide, or rather, a political divide based on ZEVs has not always been stoked by actions of a U.S. federal or state government. Dotson (2025) provides a decades-long history of U.S. Congressional actions (as well as related actions of contemporaneous federal administrations) promoting research, development, and demonstration of ZEVs. This history dates to the bipartisan override by the U.S. House of Representatives of a veto by President Ford, a Republican, in September 1976. The veto

[3] Davis et al. (2025) use the acronym "EV" to include both battery and plug-in hybrid EVs. This grouping is referred to by the acronym "PEV" in the present research report.

[4] Gallup (2023) polled adult Americans and reported 6% of those who identified as Democratic owned a PEV while only one percent of those who identified as Republican did—but their sampling error is large enough that we cannot conclude that the 6% is different from the 1% with a 95% confidence level. Further, if the question of who has acquired PEVs is divided by political ideology rather than party identification, the reported differences are even smaller (5% of liberals and 3% of conservatives) and thus we are even less sure there are differences by ideology in who has acquired PEVs.

override resulted in passage of the Electric and Hybrid Vehicle Research Development, and Demonstration Act of 1976.

If California is the progenitor of state ZEV policies in the U.S., those beginnings were generally bipartisan. The California Air Resources Board's (CARB) first Low Emission Vehicle program which included the first requirement for the sale of ZEVs was promulgated during the final year (1990) of the second term of Governor Deukmejian, a Republican. His successor, the Republican Pete Wilson, was governor from 1991 to 1999. Wilson oversaw the state during its initial foray into requiring increasing percentages of new ZEV sales and then the redirection of state policy toward FCEVs in partnership with a fuel cell developer, some automotive Original Equipment Manufacturers (OEMs), and a few large oil companies. The Republican Governor Schwarzenegger (2003-2011) was also an active proponent of FCEVs in the early years of his administration.

Only later did ZEVs come to be identified as "liberal-left" during the federal Democratic Obama-Biden (2009-2017) and Biden-Harris (2021-2025) administrations and the California state administrations of Democratic Governors Brown (2011-2019) and Newsom (2019-present).[5] Indeed, Dotson (2025) notes that every federal administration since 1976 has been supportive of ZEVs (even if different ZEVs, e.g., PHEVs, BEVs, or FCEVs were emphasized at different times) until the first Trump administration (2017-2021) attempted to defund federally-funded research on ZEVs, threatened to repeal the federal tax credit for buying a ZEV, and weaken regulations promoting ZEVs. None of these efforts succeeded during the first Trump presidency.

Federal ZEV Policy Reversal

Dotson's (2025) account of decades of Congressional support for ZEVs stops with the end of the Biden-Harris Administration and the 118th Congress in January 2025. The reversal of decades of federal support for ZEVs by the subsequent Trump-Vance Administration and 119th Congress has been stark.[6] Prior to assuming office, candidate Trump repeatedly assailed ZEVs during his campaign for a second term. For example, in a video posted to his website in July 2023, he said, "[Then U.S. President] Joe Biden is waging war on the U.S. auto-industry with a series of crippling mandates designed to force Americans into

[5] Some have argued that politicization of "EVs" dates to the early 2000s and perceptions of hybrid electric vehicles (HEVs), the Toyota Prius in particular. Heffner et al. (2007) argue that hybrid electric vehicles (HEVs) were "the first vehicles marketed as 'green' vehicles.'" As argued here, HEVs would have then also carried a political meaning to the extent "green" was associated with "liberal" in the early 2000s.

[6] This association of ZEVs with liberal-left politics and values also occurred as the market for ZEVs grew from 2010 to the present and as statements from political representatives and legislative and administrative goals for increasing ZEV sales became more aggressive and pervasive. Whether all these are merely concurrent or whether they share a cause is left for future research.

expensive electric cars, even as thousands of electric cars are piling up on car lots all unsold" (donaldjtrump.com, 2023).

Once inaugurated for his second term, President Trump wasted no time following up on candidate Trump's attacks. On the day he was inaugurated, January 20, 2025, President Trump issued an Executive Order titled "Unleashing American Energy" in which it states, "It is the policy of the United States: …to eliminate the 'electric vehicle (EV) mandate'" (Executive Order 14154). The means to accomplish this stated in the Executive Order include "terminating, where appropriate, state emissions waivers that function to limit sales of gasoline powered vehicles" and "considering the elimination of unfair subsidies and other ill-conceived government-imposed market distortions that favor EVs…" This was followed on January 22, 2025 by a Presidential Memorandum "to deliver emergency price relief for American families and defeat the cost-of-living crisis." Among the purported causes for this "crisis" listed in the Memorandum was, "[t]he unlawful regulatory mandate on companies to eliminate gas-powered vehicles has resulted in artificial price increases in order to subsidize electric vehicles, largely disfavored by consumers" (The White House, 2025a). On May 2, 2025, the Office of Management and Budget delivered the President's budget proposal for 2026 to the U.S. House of Representatives. The proposal includes a call for the cancellation of an already appropriated $5.7 billion for electric vehicle charger grants to states (The White House, 2025b).

The actions of the second Trump administration to eliminate initiatives promoting diversity, equity, and inclusion (DEI) include such initiatives linked to ZEVs. As one example, the university research program that partially funded this report had its federal grant terminated by Trump's Secretary of Transportation Duffy on the basis it was "'accelerating equitable decarbonization' research" (US Department of Transportation, 2025).

Further, President Trump's proposed (and oft revised) tariff proposals may have different effects on different automobile (including ZEV-only) manufacturers—and seem likely to affect different vehicles from the same manufacturer differently (New York Times, 2025b). As a rule, the fact that ZEVs tend to be made up of fewer parts than gasoline, diesel, and hybrid vehicles may make ZEVs assembled in the U.S. less susceptible to tariffs on imported automobile parts. However, some of the specific parts of ZEVs may be targets of tariffs: ZEVs have more semiconductors than conventionally fueled vehicles and thus would likely see larger price increases due to any tariffs on such chips. Electric vehicle charging supply equipment would be similarly affected. The electric motors for ZEVs include minerals that are presently largely produced in China—which in response to the Trump tariff proposals announced an export ban on such minerals to the U.S. (New York Times, 2025b).

If the effects of the Trump tariffs are uncertain and varied, the House of Representatives' budget proposal of May 2025 (House Ways and Means Committee, 2025) is an unambiguous reversal of decades of past support for ZEVs. The proposed House budget would eliminate the federal tax credit for qualified buyers of new and used BEVs thus

effectively raising vehicle prices (New York Times, 2025c). If passed, the elimination of the federal tax credit might result in a short-term boost to vehicle sales, the termination of the credit at the end of the calendar year is likely to lead to a slump in sales. Such an effect would be compounded by if the Trump administration moved forward as planned to ease tailpipe pollution limits for cars and trucks, which would have pushed automakers to sell more electric vehicles.

On May 1, 2025 the U.S. House of Representatives voted to rescind California's two waivers from the federal Clean Air Act that allow California to enact and enforce regulations requiring the sales of zero emission medium and heavy-duty vehicles (H.J.Res.87 - Providing congressional disapproval under chapter 8 of title 5, United States Code, of the rule submitted by the Environmental Protection Agency relating to "California State Motor Vehicle and Engine Pollution Control Standards; Heavy-Duty Vehicle and Engine Emission Warranty and Maintenance Provisions; Advanced Clean Trucks; Zero Emission Airport Shuttle; Zero-Emission Power Train Certification; Waiver of Preemption; Notice of Decision," 2025) as well as California's more stringent limits on nitrogen oxide emission (H.J.Res.89 - Providing congressional disapproval under chapter 8 of title 5, United States Code, of the rule submitted by the Environmental Protection Agency relating to "California State Motor Vehicle and Engine and Nonroad Engine Pollution Control Standards; The 'Omnibus' Low NOX Regulation; Waiver of Preemption; Notice of Decision," 2025). The next day the House voted to rescind California's waiver allowing it to enact and enforce requirements for the sale of light duty ZEVs (H.J.Res.88 - Providing congressional disapproval under chapter 8 of title 5, United States Code, of the rule submitted by the Environmental Protection Agency relating to "California State Motor Vehicle and Engine Pollution Control Standards; Advanced Clean Cars II; Waiver of Preemption; Notice of Decision," 2025).

The U.S. Senate parliamentarian has ruled that the waivers are not regulations (a finding echoed by the Government Accountability Office (GAO)) and thus are not subject to review under the Congressional Review Act (CRA) that the House used to support its action. Disregarding both their own parliamentarian and GAO, the U.S. Senate invoked the CRA and voted to revoke California's waivers. This marks the first time in 50 years that Congress has revoked any of California's waivers. The joint resolutions to revoke the waivers now go to the President for signature he signed on June 12, 2025.

Further, companion bills have been introduced in the House of Representatives ("H.R. 2218—119th Congress: Stop CARB Act of 2025." www.GovTrack.us. 2025) and Senate ("S. 1072—119th Congress: Stop CARB Act of 2025." www.GovTrack.us. 2025.) to revoke California's ability to seek any waiver from federal clean air standards and forbid any other states from adopting any California standard that might differ from federal standards.

What this policy reversal puts at risk is the sort of growth in America's manufacturing base claimed to be a goal of the Trump tariffs: "Jobs and factories will come roaring back into our country…We will supercharge our domestic industrial base" (BBC, 2025; Wall Street

Journal, 2025). The New York Times (2025d) reports, "Perhaps the most visible effect of the Inflation Reduction Act [passed during the Biden-Harris administration] so far has been a surge of domestic manufacturing. Four years ago, the United States had hardly any capacity to build solar panels, wind turbines or lithium-ion batteries." The Atlas Public Policy (2025) reports the tax credits, loan programs, and grant funding made available by the Infrastructure Investment and Jobs Act, "have contributed to the onshoring of manufacturing facilities, motivating automakers to establish their EV and battery production in the United States".

Automakers and the Politicization of ZEVs

The political dimension of resistance to their ZEV offerings has been noted by vehicle manufacturers. Ford Motors Company Executive Chair Bill Ford said in October 2023, "Some of the red states say [ZEVs are] just like the [COVID-19] vaccine, and it's being shoved down our throat by the government, and we don't want it. I never thought I would see the day when our products were so heavily politicized, but they are" (Bloomberg News, 2024). His comments were echoed by General Motors CEO Mary Barra: "I never thought the propulsion system on a vehicle would be [partisan]…We're not telling you what you have to have. We're saying, if you want this, we have it" (Quartz, 2024).

Ford and Barra's remarks foreshadow the experience of the BEV manufacturer Tesla following the appointment of its CEO, Elon Musk, as a "special government employee" of the Trump Administration. Specifically, Mr. Musk was appointed to lead the non-governmental entity called the Department of Government Efficiency. Protests outside Tesla showrooms, vandalism of Tesla vehicles, and anecdotal reports by Tesla drivers of the onset of regret (New York Times, 2025) suggest a backlash of Tesla's previously reliably liberal customers. Data for the complete second quarter of 2025 are not available at the time of this writing, but first quarter 2025 U.S. sales of Tesla vehicles declined. Cox Automotive (2025) estimates the decline to be nine percent compared to first quarter sale in 2024 though other analysis indicates a 15 percent decline (Electrek, 2025). The decline in Tesla sales is despite an increase of approximately 11 percent in the sales of PEVs generally. Tesla sales also declined in Europe, where despite new registrations of all PEVs being up 34% in the most recent reporting, Tesla's declined by half (ACEA, 2025). Tesla's sales decline also includes California where it appears Tesla's year-to-year decline was so large (21.5%) that total new ZEV sales were down in California for the first quarter of 2025 (compared to quarter one of 2024) despite an increase of 14 percent in sales of non-Tesla ZEVs (California Energy Commission, 2025). Numerous possible causes other than a backlash against Tesla have been cited for these declines including increased competition from other manufacturers and a stoppage of Model Y production for a model changeover.

Active Resistance Following Acquisition

Discontinuance is active resistance after the product has been acquired and used for a time. A person or household that has previously acquired a ZEV but subsequently formed a negative attitude toward ZEV such that the person or household intends to not acquire

another ZEV may be said to have discontinued ZEVs. This negative attitude formation may precede a vehicle transaction after acquiring a ZEV, i.e., this negative attitude may be formed even as they continue to own (or lease) and operate their ZEV. As such, discontinuance may not be immediately observed in the overt behaviors of such an individual or household, i.e., someone discontinuing ZEVs may not yet have disposed of their ZEV or shown a pattern of acquiring only internal combustion engine vehicles following the acquisition of an ZEV.

Blended Adoption (or "blended resistance") is the ongoing acquisition and use of both the prior and new product. For ZEVs, blended adoption is an intention to continue to acquire vehicles with internal combustion engine (ICEs) (including both those with only ICEs as well as hybrids with both ICEs and electric motors) and ZEVs.

Committed Adoption is the intention to acquire only ZEVs with no intention of ever acquiring a vehicle with an ICE again.

Passive Resistance

Passive resistance is not attending to, or engaging with, a product. As such, passive resistance is conceptualized as a person's generalized response across new products, ideas, or practices:

> *"Passive innovation resistance represents a predisposition to resist innovations caused by an individual's inclination to resist changes and satisfaction with status quo prior to new product evaluation."*
> *(Heidenreich et al., 2016)*

This definition suggests that passive innovation resistance is a matter of being unaware of ZEVs in this case. To be unaware is to miss the signs and symbols of ZEVs—regardless of relative pervasiveness in the environment—because a person who is unaware is not tuned to perceive them. In effect, passive resistors are not seeing signs of a ZEV transition because they are not looking for them. Hoogland et al. (2024) argue this in their research on who sees public PEV charging and why. They report that whether research participants sampled from all car-owning households in California see public PEV charging has less to do with the density of such charging in their home ZIP code and more to do with their prior interest in PEVs, i.e., their prior interest in looking for charging or at least in recognizing charging when they see it.

Ambivalence

To be *ambivalent* is to be strongly motivated, but by opposing impulses, ideas, or forces. People who are ambivalent about ZEVs would not have middling or unformed attitudes, rather they would have both positive and negative attitudes pulling them both toward and pushing them away from ZEVs.

Data

Most of the results in this report are based on data from three surveys of car-owning households conducted in California in the years 2017, 2019, and 2021. These surveys are part of a series of cross-sectional samples dating back to before 2017. Those older data are not used because despite a preference for maintaining consistency over time, there are too many differences in which questions were asked in the older studies versus the newer ones as well as differences question and answer wording. Differences in question-and-answer wording in one of the three samples used here is also the reason why a separate analysis for PHEVs will not be presented.

All three samples were provided by firms contracted to recruit people to participate in an on-line survey. The samples in each year were drawn from their contemporaneous populations of all-car owning households in California. ("Owning" is used for convenience; households who only lease vehicles are included in the populations.) Prospective participants were not told the study was about EVs (nor was the jargon, "zero emission vehicles" used). That the questions would focus on ZEVs only becomes apparent after participants have started their questionnaire. By way of prior explanation of the purpose of the study, prospective participants were told, "You will assess new ways to power our cars and trucks. Your answers will inform other consumers such as yourself, automobile makers, energy providers, and policymakers." Incentives were offered by the firms in accordance with their practices at the time of each survey. Thus, incentives differed across samples but would have been in keeping with prior expectations of any prospective survey recruit based on their experience completing questionnaires for the respective sample recruitment firms.

These are the sample sizes for each year: 2017, n = 1,681; 2019, n = 3,636; 2021 = 2,994. This yields a combined sample size of n = 8,311. Larger samples were used in 2019 and 2021 so as to stratify those samples by the populations of the five most populous Air Quality Management Districts (AQMDs) (plus a six catch-all category for all the other much smaller and more rural AQMDs) while achieving a minimum sample size in the smallest of the five largest. However, reconciling differences in missing data across different years, culling extreme values, and other data cleaning produce final aggregate sample sizes of n = 6,511 for the BEV Consideration-Resistance analysis and n = 6,192 for the FCEV Consideration-Resistance analysis.

Analysis of a specific measure of political resistance to California's ZEV Mandate among car-owning households in California in the late-2023 to mid-2024 timeframe is also presented in this report. The data are from a survey administered to a random sample of households in California via mail and email between December 2023 and June 2024. The sample size for this analysis is n = 1,389. The 2017, 2019, and 2021 data sets do not have enough variables in common with this 2023-24 data set—most crucially, the measure of

support-opposition for California's ZEV mandate specifically is not available in the older data—to conduct a multi-year analysis including all four data sets.

Results

Analyses of consideration of BEVs and FCEVs by car-owning households in California in the years 2017, 2019, and 2021 are presented next. Those results are used to draw inferences about a subset of the types of resistance just defined based on a provisional mapping of those concepts onto the measure of consideration used here. The provisional mapping of types of resistance onto a measure of consideration is presented first and illustrated using data on a combined measure of consideration of PEVs. The PEV measure takes the higher value of each respondent's responses for BEVs and PHEVs.

Mapping Resistance Types onto Past Measures of Consideration

We have repeatedly asked questions of samples of car-buying households in California over several years about the extent to which survey participants have already considered an EV for their household.[7] Versions of the question have been asked separately for BEVs, PHEVs, and FCEVs. Composite measures for plug-in electric vehicles (PEVs: BEVs and PHEVs) and zero emission vehicles (ZEVs: BEVs, PHEVs, and FCEVs) are constructed by assigning the higher value of BEV and PHEV Consideration to PEV Consideration and the higher value of BEV, PHEV, and FCEV Consideration to ZEV Consideration. This method assumes we are agnostic as to which ZEV a person may have given the highest consideration. The *Consideration* question for BEVs is presented in full here; the questions for PHEVs and FCEVs are similar with appropriate introductory phrases and changes to answer wording.

[7] These questions about consideration were developed based on several studies of household response to hybrid and electric vehicles conducted prior to 2014. These studies included qualitative research such as household interviews and focus groups in which we could listen to the language people use rather than selecting from responses pre-written by researchers. Samples included households with no direct experience of hybrid and electric vehicles, early buyers of these vehicles, participants in demonstration projects that afforded households the opportunity to drive PHEVs for a period of up to six weeks or BEVs for up to one-year. For focus groups with people who have experience of PEVs additional groups were convened of households with no experience of PEVs matched to the cities and general socio-economic description (i.e., ranges of age, whether new car buyers or not, mix of women and men, presence of children in the household, and employment status). The responses to the Consideration question may fail some "rules" of scale construction (as will be described below in the main text) but the goal of the question and response design were 1) verisimilitude assessed against the standard of how people talk about whether they have considered ZEVs and 2) comprehensibility of the question and answers to survey participants. The latter was evaluated during pilot testing of the questions upon their first implementation.

Battery electric vehicles (BEVs) run only on electricity; they plug-in to charge their batteries. Have you considered buying a BEV for your household? Select one.

- ☐ *I (we) have not—and would not—consider buying a BEV.*
- ☐ *I (we) have not considered buying a BEV, but maybe someday we will.*
- ☐ *The idea has occurred, but no real steps have been taken to shop for a BEV.*
- ☐ *Started to gather information about BEVs but haven't really gotten serious yet.*
- ☐ *Shopped for BEVs, including a visit to at least one dealership to test drive.*
- ☐ *I (we) already have, or have had, a BEV.*

We describe the order of the responses as shown above as ranging from lower to higher consideration. We present a provisional mapping of resistor categories defined in the previous section onto the measure used to assess the extent to which survey participants had already considered a PEV, i.e., the higher of their responses to the BEV and PHEV questions, in the 2021 sample (Figure 1).

The statement that a participant has not and would not consider either a BEV or a PHEV contains the suggestion that this is a response to the specific vehicle type. The declaration, "I haven't, *and I won't*," indicates some negative attitude has been formed in response to either or both BEVs and PHEVs. Such a negative attitude is consistent with active resistance as defined above. However, we provisionally qualify our mapping—"Resistance, more likely (than any higher consideration response category) to be active resistance"—as the possibility exists it was our question that triggered this negative attitude formation and that in the absence of our question, the person may have been a passive resistor.

The next higher level of consideration, "Haven't but maybe someday," is a declaration that this person hasn't—for whatever reason, including simple lack of awareness—considered either BEVs or PHEVs. This response also offers that now these vehicles have been pointed out to the participant (by the survey question) the participant might consider such vehicles later. We provisionally map this response into the category of passive resistors.

The next few categories of consideration are difficult to map into any concepts of resistors previously discussed, requiring us to speak in terms of engagement instead. If a person says the idea of acquiring a BEV or PHEV has occurred to them but that they have done nothing about that idea, we can't claim they are passive resistors as they are aware of BEVs or PHEVs. Neither are they active resistors as they are unlikely have formed a negative (or positive) attitude of BEVs or PHEVs if they have taken no steps past awareness. It is possible their nascent awareness has some valence. A negative valence might tend to cut off or minimize any effort to assess BEVs or PHEVs while a positive valence might not be strong enough to overcome the demands of attending to other more pressing matters and interests.

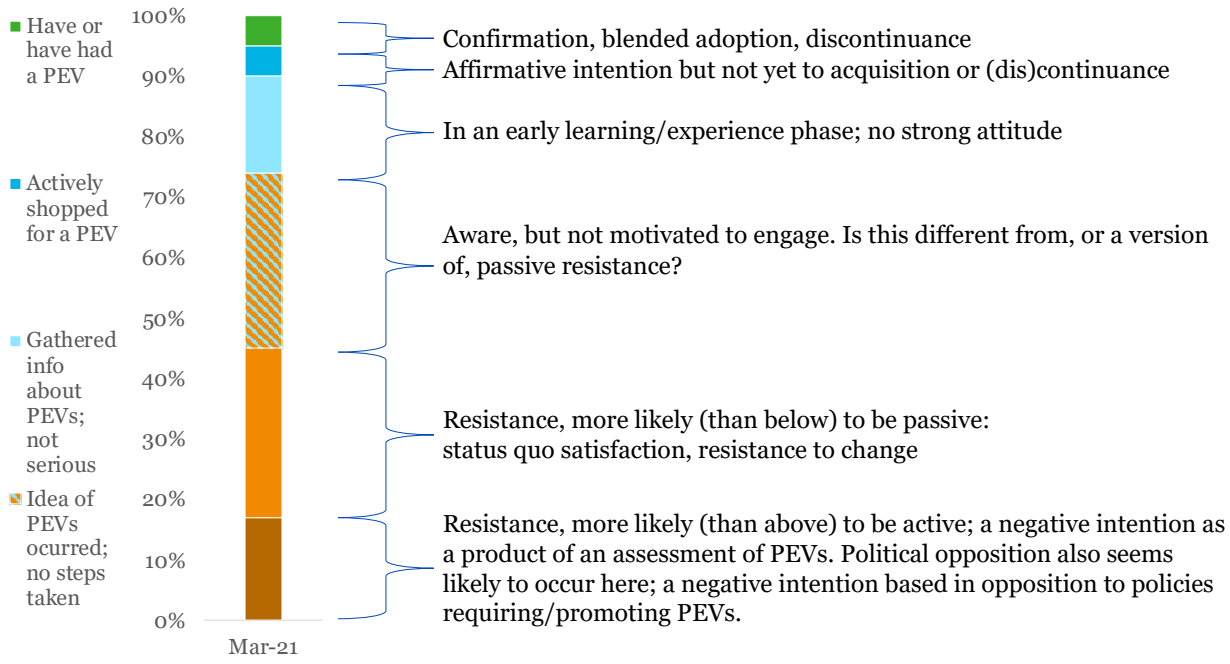

Figure 1. Provisional mapping of resistance onto PEV consideration among a sample of car-owning households in California, 2021.

Similar ambiguity occurs at the next two levels: "gathered information…but not serious yet." However, this level of consideration does indicate a higher level of engagement than the prior level. The same may be said for "Actively shopped for a BEV or PHEV." At the highest level of consideration, "Have or have had a BEV or PHEV," we may find people committed to acquiring only BEVs and/or PHEVs (committed adoption), people who are happy to go on acquiring BEVs and/or PHEVs but are not committed to buying only BEVs and/or PHEVs (blended adoption), as well as people who have discontinued BEVs and/or PHEVs (discontinuance). As discontinuance is a form of active resistance, active resistance is conceptually split between the two ends of Consideration as it is defined here. As an empirical matter, there are so few possible Discontinuers—some fraction of approximately five percent of the sample at the top of the column in Figure 1 compared to the 17 percent at the bottom—that this report will proceed on the basis that for now most active resistance is occurring among those say they haven't acquired any type of ZEV yet and won't do so in the future.

Setting the Contexts for Analyzing BEV and FCEV Consideration

Throughout the time frame of this analysis, there have been fewer FCEVs and hydrogen fueling locations than BEVs and public EV charging locations. At the time of this report, there are far fewer FCEVs in the on-road fleet of light-duty vehicles (0.05%) than BEVs (3.80%) and PHEVs (1.32%) (CEC, 2024). Today there are far fewer make-model variants

presently available as FCEVs (n=2) than BEVs (n>60) or PHEVs (n>45) (CEC, 2024). At present, light-duty FCEVs are available only in California. According to the Alternative Fuels Data Center there are 17,561 Level 2 and/or direct current (DC) Fast charging station locations in California—including public and private chargers (other than home chargers)—as of the date of this report (AFDC, undated).[8] There are 56 public and "non-retail" hydrogen fueling stations in California (ibid.).[9] Most of which are in the populous coastal regions of Los Angeles, Orange, and San Diego counties (31 stations) in southern California and San Mateo, Santa Clara, Alameda, Contra Costa, and Marin counties in the San Francisco Bay Area in northern California (17 stations) (CEC, 2024).

Given the comparatively smaller presence of FCEVs and hydrogen fueling, we hypothesize fewer car buyers across California were aware and knowledgeable of FCEVs than they were with BEVs, more had less favorable or weaker (pro or con) assessments of FCEVs than BEVs, and that fewer had given FCEVs much consideration. The distributions of *FCEV and BEV Consideration* in the three survey samples are shown in Figure 2 as a percentage of each year's sample. Of note, so few car-owning households in California had given high levels of consideration to BEVs or FCEVS in any of the three sample years that any differences between the two is of the same magnitude as the sampling error in each year. In contrast, in all three years, the percentages of participants in the two lowest Consideration categories—"haven't and won't" and "haven't but maybe someday"—is higher for FCEVs than BEVs. In short, any differences in the percentages of participants at the highest levels of Consideration are too small to statistically defend any conclusion about those differences, while at the same time, there is strong evidence that the distributions of *BEV* and *FCEV Consideration* are statistically significantly different and that the differences indicate smaller percentages of car-owning households are at the lowest levels of consideration for BEVs than FCEVs. Chi-square (χ^2) tests reject the hypotheses that the percentages of respondents in each category of *Consideration* are the same for BEVs and FCEVs, both in the aggregate of all three years ($\chi^2 = 1075.24$, degrees of freedom = 5, n = 6342, $p < 0.0001$) and in each of the three sample years 2017 ($\chi^2 = 48.13$, degrees of freedom = 5, n = 673, $p < 0.0001$), 2019 ($\chi^2 = 876.62$, degrees of freedom = 5, n = 3073, $p < 0.0001$), and 2021 ($\chi^2 = 446.04$, degrees of freedom = 5, n = 2596, $p < 0.0001$).

Using the lowest Consideration categories, "haven't and wont" and "haven't but may," as provisional measures of active and passive resistance, it is possible that at least some of the FCEV resistors are not BEV resistors and vice versa. Do FCEVs appeal to active BEV resistors? Or is an inclusive "ZEV resistance" more prevalent, that is, do people who actively resist one type of ZEV (PHEV, BEV, or FCEV) tend to resist all types of ZEVs? Did the relationship between active resistance to FCEVs and to BEVs change over the interval from 2017 to 2021?

[8] Excluding private access locations, the number of PEV charging locations declines to 16,581.
[9] Excluding "non-retail" locations, the number of hydrogen fuel locations in California declines to 53.

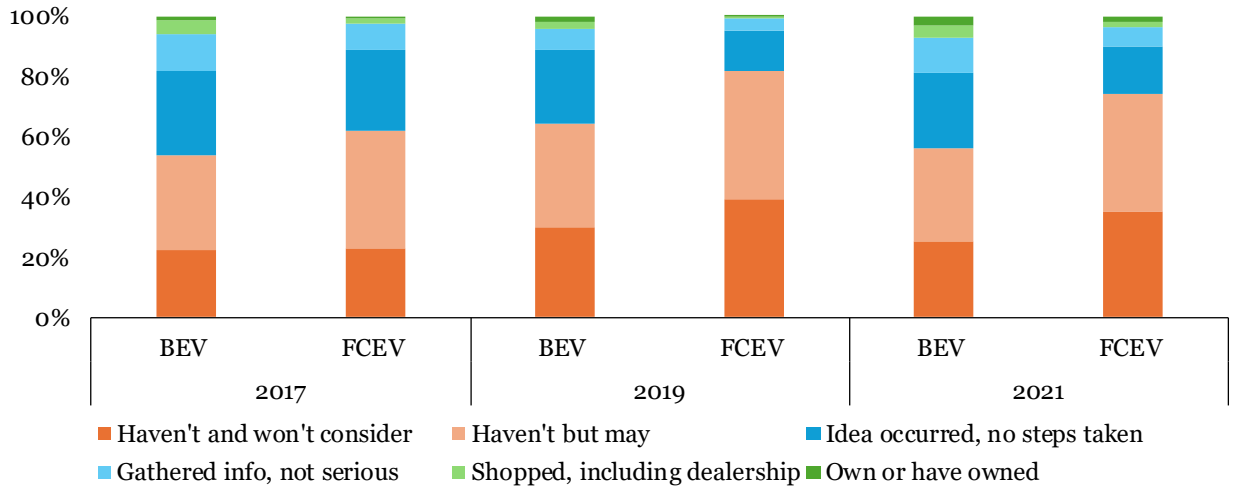

Figure 2. BEV and FCEV consideration in independent cross-sections of all car-owning households in California, 2017, 2019, and 2021. (Percent).

As a first step to answering these questions, we cross-classify *FCEV Consideration* by BEV Consideration for the combined sample from all three survey years, blocking across Year. The results for the combined sample are a statistically significant positive association between *BEV* and *FCEV Consideration*, i.e., low consideration of one is associated with low consideration of the other and high consideration of one is associated with high consideration of the other. Applying our provisional mapping of "haven't and won't consider" into the category of Active Resistance, aggregated across all three survey years, 27 percent of respondents say they haven't and won't consider a BEV, 36 percent haven't and won't consider an FCEV, and 21 percent haven't and won't consider both. While FCEVs represent a plausible alternative for some BEV resistors, it was more likely an active FCEV resistor was also an active BEV resistor (59 percent), and an active BEV resistor was even more likely to be an active FCEV resistor (78 percent). The Cochran-Mantel-Haenszel test for the effect of blocking over the variable Year indicates it is very likely the relationship between *BEV* and *FCEV Consideration* in at least one year is different from other years and/or the aggregate of all years (Correlation of Scores; degrees of freedom = 1, χ^2 = 1221.70, probability > χ^2 = < 0.0001).

BEV and *FCEV Consideration* were cross-classified separately for each survey year (Figure 3). Before we delve into any differences between BEVs and FCEVs or changes across time, let us not bury the lead: as recently as 2021 large majorities of car-buying households in California had not given serious consideration to either BEVs (81 percent) or FCEVs (90 percent). The definition here of "no serious consideration" includes the Consideration levels of "Haven't and won't," "Haven't but may someday," and "Idea has occurred, but no steps taken."

In 2017, BEV and FCEV Active Resistors represented similar percentages of the other's Resistors (~60 percent). This was not the case for 2019 and 2021. In these later years,

FCEV Active Resistors were much more likely to also be BEV Active Resistors than vice versa—though the overall likeliness that a BEV Active Resistor was also an FCEV Active Resistor was similar across all three years. Across the five years covered by the three surveys, more than half of active resistors to either FCEVs or BEVs were also active resistors to the other but there was also higher asymmetry between the two measures of active resistance in the latter two survey years than in the first.

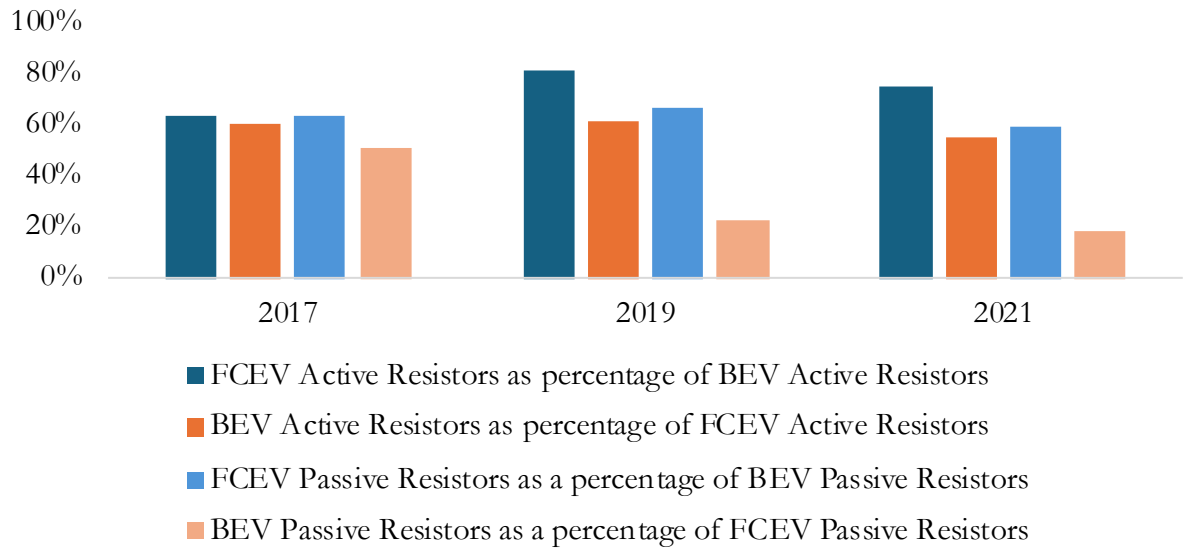

Figure 3. FCEV active and passive resistors as a percentage of BEV active and passive resistors and vice versa for 2017, 2019, and 2021.

The patterns for Passive Resistors over the three samples differs from that of Active Resistors; the differences are consistent with a shift from a more pervasive general ignorance of ZEVs broadly to a more pervasive specific ignorance of either BEVs or FCEVs. For the 2017 sample, the BEV Passive Resistors as a percentage of the FCEV Passive Resistors in the sample is less than the other three comparisons by ten to twelve percentage points. This difference is much greater in both 2019 and 2021, ranging from 37 to 58 percentage points. In the latter two survey samples, fewer BEV Passive Resisters—people who were seemingly unaware of BEVs prior to our asking about them but who are open to some future consideration of them—were a much smaller percentage of contemporary cohorts of people who were similarly unaware of, but possibly open to future consideration of, FCEVs.

Modeling BEV Consideration in 2017, 2019, and 2021

Given our provisional mapping of active and passive resistance, commitment, blended adoption, and discontinuance onto our existing measure of consideration, we present some analysis of whether and how BEV consideration has changed over time, how any such changes relate to measures of respondents' assessments of BEVs, engagement (BEV

awareness, knowledge, and assessment), and participant's environmental and political beliefs, socio-economic, demographic, and contextual measures. Based on this analysis of consideration and the speculative mapping of resistance into consideration, limited and initial extensions to resistance are made.

The model of *BEV Consideration* is an ordinal logistic regression equation. The responses given to the BEV consideration question in samples from all-car owning households in California in the years 2017, 2019, and 2021 are modeled as a function of the variables listed in Table 1 along with a brief statement of the hypothesis they test. The variables are limited to those available in all three years. The explanatory variables are all the variables in Table 1 plus two interactions: the variable *Survey Year* is interacted with *BEV Assessment Factors 1* and *2*. This allows the possibility that the effect of a specific assessment of BEVs may have a different effect on *BEV Consideration* in different years.

To highlight the explanatory variables that are associated with *BEV Consideration* and to simplify presentation of the model results, a series of models is run starting with the model with all explanatory variables. Each subsequent model eliminates the one variable that has the least statistically significant association with *BEV Consideration* in the presence of the other variables that are in the model. This continues until only statistically significant variables remain ($p \leq 0.05$). Two information criteria, AIC_c and BIC, are often used to decide when to stop removing terms from models (Burnham and Anderson, 2004). In this case, these criteria do not agree as to when to stop. AIC_c would have had us stop before removing three variables that are not themselves significant; BIC would have had us stop after removing six more variables, three of which are significant. We've opted for the middle way which retains all statistically significant explanatory variable but only statistically significant variables.

The resulting simplified model is summarized in Table 2 and Table 3. (The full set of parameter estimates and significance measures are Appendix Table A-1. The starting model with all explanatory variables is presented in Appendix C of this report). The Whole Model in Table 2 compares the model with all the retained variables (Full) to a model with only the intercepts (Reduced). The intercepts are parameters for each level of *BEV Consideration* minus one, thus five intercepts. The statistical significance of the Difference between the Full and Reduced model indicates the Full model provides a better fit to the data than does the Reduced model. The R^2 measure reported in Table 2 (and subsequent similar tables) is *McFadden's pseudo* R^2. The measure ranges from zero to one. A value of one would indicate there is no uncertainty in the predicted probabilities of the Full model, i.e., the predicted probabilities exactly match the probabilities observed in the data. Though the range (zero to one) is the same as the R2 reported for models with continuous dependent variables. Notably, observed values of McFadden's pseudo R^2 rarely approach one even for "well-fitting models." The Lack of Fit test in Table 3 indicates whether the Full model is adequate or could be improved by a more complex model. The non-significant Chi-Square value indicates the Full model is adequate as is.

Table 1. Concepts and variables in the model of BEV consideration with their associated hypothesis or rationale.

Concept	Hypothesis/Rationale	Variables
Time	Consideration of BEVs differ by year and those differences are consistent with more people considering BEVs over time	*Year*: the three survey years, 2017, 2019, and 2021 coded as an ordinal number. This coding allows for varying differences between years, i.e., not constrained to the same difference between successive years.
BEV Assessments	Differences in assessments of BEVs are associated with differences in consideration of BEVs. As one form of active resistance is a negative attitude toward BEVs, people with worse assessments are hypothesized to be more likely to indicate they haven't and won't consider BEVs than people with more positive assessments.	Two factor scores calculated from nine individual assessments measured on continuous scales from strongly disagree to strongly agree. Items with a negative phrasing toward BEVs are reverse coded so that a positive score on all items favors BEVs. Paraphrasing, each factor includes the following statements: *Factor 1* • BEVs take too long to charge • BEVs range too short • BEVs higher priced than gasoline vehicles • Gasoline vehicle safer than BEVs • Gasoline vehicles more reliable than BEVs *Factor 2* • I can plug-in a vehicle at home • There are enough places to charge BEVs • BEVs are less damaging to the environment than gasoline vehicles • BEVs are ready for mass markets

Concept	Hypothesis/Rationale	Variables
BEV Knowledge and Experience	People with better knowledge are from the perspective of the researcher at a higher level of consideration. Here these variables assess whether respondents with more knowledge of and experience with BEVs rate themselves as having given greater consideration to BEVs.	*Fueling BEVs*: whether respondent can identify that a thing called a "battery electric vehicle" is fueled only by charging it with electricity; coded Correct or Incorrect. *rKnow a BEV owner*: whether respondent knows someone "by name" who owns a BEV; coded Yes or No. *BEV [Any positive reason]*: does respondent offer any positive reason for why they might acquire a BEV for their household; coded Yes or No. *Familiarity [BEV]*: respondents' self-rating of whether they are familiar enough with BEVs to decide whether one would be right for their household; continuous scale from -3 (no) to +3 (yes). *Driving experience: BEV*: self-rating of how much driving experience respondents have with BEVs, scored on continuous scale from -3 (I have never driven one) to +3 (I have extensive driving experience). *Seen EVSE*: self-rating of whether they have seen EV charging spots in the parking facilities they use, and if so, in how many such places; ordinal categories from I don't know/No; Yes, one; Yes, a few; and Yes, several.
Political beliefs	Political resistance to EVs—as public goods, and "liberal" vehicles—may be linked to support for public incentives.	Single item: *Should government offer incentives* for alternatives to gasoline and diesel. Five initial responses: No; Yes, but only electricity; Yes, but only hydrogen; Yes, both; I don't know. For analysis, all three affirmative responses recoded into a single affirmative response: No, I don't know, Yes.

Concept	Hypothesis/Rationale	Variables
Environmental beliefs	To the extent BEVs are seen as "pro-environmental" vehicles, beliefs about the environment may be associated with either political resistance or other forms of active resistance.	All items scored on continuous scales from. Values of the first two are inverted (*i*) so larger values favor electricity. Values of the second set of three are truncated (*t*) to exclude indicators of non-responses. • *iHuman health*: Where I live, powering a car with electricity poses less risk to human health than gasoline. • *iEnvironment*: Where I live, powering a car with electricity poses less risk to the environment than gasoline. • *tAir pollution: personal worry*: I personally worry about air pollution. • *tAir pollution: regional threat:* Air pollution is a health threat in my region. • *tAirpollution: lifestyle*: Air pollution can be reduced if individuals make changes in their lifestyle.

Concept	Hypothesis/Rationale	Variables
Household and travel context	Contextual variables may be associated differences in BEV consideration as context may open some possibilities and preclude others, for examples, whether someone can charge a vehicle at their residence, their access to automobiles, and their common trips renders their daily mobility amenable to BEVs.	*Residence Type* coded as five categories: Apartments, Attached single family home, Unattached single-family home, Mobile home, Other. *Own/Rent Residence*: coded as Own, Rent/Lease, Other. *Solar PV*: Indicator of photovoltaic energy system on Residence coded as No, Yes. *Vehicles per person* in respondents' households, continuous number. Both counts of vehicles and people are truncated at their top ends; the terminal count is used for both. *New Car Buyer* indicates household has purchased at least one vehicle as new in the seven years prior to their survey) coded as No, Yes. *Only or Either Garage or Carport*: Parking at Residence coded as Yes if either or both the car the respondent drives most often and the most recently acquired car (other than the first) is parked in a garage or carport attached to the residence, or No if not. *rHighest e-access*: assesses whether there is electricity available at the location where the respondents' households park their cars at home. Coded as None or I don't know, 110V, 220V, or EVSE. *Authority to install*: whether respondent could install a new electric outlet at their home parking location on their own authority or if they would need permission from someone else. *Respondent Driving Days per Week* for the survey respondent ranging from 1 to 7. *Respondent Commute* coded as Yes if the respondent commutes to a workplace outside their home, No if not. *High occupancy vehicle (HOV)* indicator of HOV lane access and use assess whether there are high occupancy vehicle lanes on the routes the respondent regularly drives and if so, whether the respondent is generally able to use those lanes. Coded No, Yes, but I am not able to use them, or Yes and I am able to use them.

Concept	Hypothesis/Rationale	Variables
Socio-economic and demographic measures		*Respondent Age* measured in six categories from 19 to 29 up to 70 or older. *Respondent Gender* coded as Female, Male or Non-binary. *Respondent Education* coded in six categories: Less than High School or GED; High School or GED, Some College, College Graduate, Some Graduate or Professional School, Graduate or Professional Degree. *2017-21 Income 100k* coded in ten ordinal categories centered on income categories used in the 2017 survey which were calculated on percentages of the then federal poverty level and scaled to $100k so categories range from 0.2 to 3.5.

Table 2. BEV consideration whole model test.

Model	-Log Likelihood	Degrees of Freedom	Chi-square	Prob. > Chi-square
Difference	1705.96	31	3411.925	<0.0001
Full	7966.44			
Reduced	9672.40			
R^2	0.1764			
AIC_c	16005.3			
BIC	16249.0			
Observations	6511			

Table 3. BEV consideration lack of fit test.

Source	-Log Likelihood	Degrees of Freedom	Chi-square	Prob. > Chi-square
Lack of Fit	7966.44	32519	15932.87	1.000
Saturated	0.00	32550		
Fitted	7966.4	31		

The effect tests, i.e., the overall significance of each explanatory variable, for the Full model are presented in Table 4. (The full set of parameter estimates for the starting model with all variables in Table 1 are in presented in Appendix A. Each variable is identified by name and the values of its test of significance are presented. As noted above, this model represents the sub-set of the initially selected explanatory variables that are statistically significant.

Table 4. BEV consideration effect likelihood ratio tests.

Variable	DF	Likelihood Ratio χ^2	Prob>χ^2
Respondent Age	5	44.09	<0.0001
rRespondent Education	4	24.58	<0.0001
2017-21 Income 100k	1	9.80	0.0017
New Car Buyer	1	4.40	0.0359
rHighest e- access	3	60.457	<0.0001
HOV	2	29.55	<0.0001
tAir pollution: personal worry	1	22.97	<0.0001
iHuman health [Electricity vs gasoline]	1	22.65	<0.0001
Should government offer incentives	2	27.30	<0.0001
Fueling: BEV	1	20.06	<0.0001

Variable	DF	Likelihood Ratio χ^2	Prob>χ^2
rKnow a BEV owner	1	97.265	<0.0001
BEV: [Any positive reason]	1	433.05	<0.0001
Familiarity [BEV]	1	72.616	<0.0001
Driving experience: BEV	1	95.48	<0.0001
Seen EVSE	4	10.42	0.0339
imp BEV 9 assessments 2017-21 Factor1	1	235.76	<0.0001
imp BEV 9 assessments 2017-21 Factor2	1	137.33	<0.0001

Note: The prefixes *r*, *t*, and *imp* indicate variables have been recoded (*r*) into fewer categories or truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

BEV Consideration and Resistance, 2017 to 2021

We focus here on results germane to the types of resistance introduced earlier and to whether and how BEV resistance may differ between the 2017, 2019, and 2021 samples. The data for these years allows us to make some provisional conclusions about active resistance, political resistance, passive resistance, and ambivalence. The data cannot distinguish between committed adoption, blended adoption, or discontinuance.

The first notable conclusions are that neither the variable *Year* nor its interactions with *BEV Assessment Factor 1* or *Factor 2* statistically significant given the other explanatory variables in the model. In the process of eliminating variables one-by-one used to arrive at the model in Table 2, Table 3, and Table 4, *Year* was the second variable to be eliminated suggesting it had nearly the least probability of being associated with *BEV Consideration* of all the proposed variables in the original model. Interactions between *Year* and the two *BEV Assessment* factors were eliminated at the same time as *Year* as neither interaction was statistically significant at this stage and their exclusion improved (decreased) both parameters of overall model fit, AIC_c and BIC. That *Year* is not statistically significant means there is no basis to conclude *BEV Consideration* was different across the three sample years and thus there is no basis to infer *BEV Consideration* changed from 2017 to 2021.

Generally, the most influential variables in estimating the probabilities the survey participants responded to each category of *BEV Consideration* are measures of those participants' specific assessments of BEVs, self-ratings of their experience and familiarity of BEVs, and whether anyone else in their social networks already has a BEV (Table 5). Who participants are in terms of formal education and age are less influential than these specifics but are more influential than environmental attitudes vis-à-vis air pollution. Among the least influential variables are measures of household resources and context (income, daily access to high occupancy vehicle (HOV) lanes and whether they buy new

vehicles), additional specific measures pertaining to BEVs and charging including support for incentives.

Active Resistance to BEVs

We defined *active resistance* as a negative attitude formed, in this case, toward BEVs. We argued that the *BEV Consideration* category, "I have not and would not consider a BEV," would include many if not most active BEV resistors at this time. Given this, we would expect *BEV Assessment Factor 1* and *2* to have a large effect on the estimated probability that a person is in this BEV Consideration category and that, specifically, those with strong negative BEV assessments would be far more likely to respond, "I haven't and wouldn't...," than those with positive BEV assessments.

We observe this in the model results. The parameter size estimates (see Appendix A) are instructive but imperfect guides to which variables have the greatest effect on *BEV Consideration* because the variables are not all measured on identical scales. Still, the fact the parameter estimates for *BEV Assessment Factor 1* and *Factor 2* are larger (in absolute value) than almost any (except for the intercepts) suggests these variables are comparatively very influential to understanding *BEV Consideration*. The range of estimated probabilities a respondent is in the "haven't...wouldn't consider a BEV" category in Table 5 for *BEV Assessment Factor 1* is the largest (43.7 percentage points) attributable any one variable. The range for *BEV Assessment Factor 2* is the third largest range (after the variable indicating whether the survey participant offers any positive reason why they might consider a BEV). Having the worst assessments of whether a respondent has the ability to charge a BEV at home, there are enough places to charge BEVs, BEVs are better for the environment, and BEVs are ready for mass marketing (*BEV Assessment Factor 2*) produces a higher estimated probability a respondent says they haven't and won't consider a BEV, but having stronger positive assessments on these dimensions does less to reduce that probability than do the same changes in *BEV Assessment Factor 1*.

Who are BEV Resistors?

Another perspective on the influence of *BEV Assessment Factors 1* and *2* on estimating probabilities of *BEV Consideration* comes by assessing whether there are clusters of respondents who more closely share a pattern of responses across all nine BEV Assessment items than other respondents and if so, is membership in those clusters associated with *BEV Consideration*. The first step is to perform a k-means clustering on the nine BEV Assessment items. The k-means clustering algorithm requires we specify the number of clusters *a priori*. Generating solutions for two through six clusters indicated five clusters was a suitable solution across that range. In general, values of the cubic clustering criterion (CCC) (SAS Institute Inc., 1983) were used first to assess whether there were clusters of participants in the data. Then, the author's qualitative judgment of the interpretability of and differences between cluster means on the BEV assessment items were used to select a useful, i.e., suitable number of clusters. The mean BEV assessment scores for the five-cluster solution are shown in Figure 4.

Table 5. Modeled probability of "haven't and wouldn't consider a BEV" across the range of each explanatory variable, table sorted from variable having the largest effect across its range to the least effect.

Variable	Value producing highest probability	Highest estimated probability	Value producing lowest probability	Lowest estimated probability	Percentage point difference between highest and lowest probabilities
BEV Assessment 1	-1.752 (Most unfavorable)	88.2	2.841 (Most favorable)	44.5	43.7
BEV [Any reason]	No	76.1	Yes	38.9	37.2
BEV Assessment 2	-2.373 (Most unfavorable)	90.2	1.652 (Most favorable)	60.5	29.7
Driving Experience: BEV	-3 (None)	79.4	3 (Extensive	58.9	20.5
rHighest e- access	None/I don't know	76.1	EVSE	56.0	20.1
Know BEV Owner	No/Not sure	76.1	Yes	63.8	12.3
Familiarity: BEV	-3 (Least familiar)	82.8	3 (Most familiar)	71.5	11.3
Respondent Education	Less than High School or GED	76.1	Some Grad. School	66.1	10.0
Respondent Age	70 or older	82.3	30 to 39	73.2	9.1
tAir pollution: personal worry	-3 (Not worried)	81.7	3 (Very worried)	73.4	8.3
iHuman health: electricity vs. gasoline	-3 (Gasoline better)	81.2	3 (Electricity better)	72.9	8.3
Household Income	0.2 ($20k)	77.7	3.5 (≥$350k)	69.7	8.0
HOV	Yes, unable to use	77.2	Yes, able to use	70.0	7.2
Should gov. offer incentives	No	76.1	Yes	69.5	6.6
Seen EVSE	Not Sure	76.1	Yes, a few places	69.9	6.2
Fueling: BEV	Incorrect	76.1	Correct	70.8	5.3
New Car Buyer	No	76.1	Yes	74.1	2.0

Cluster 1 (dark blue bars in the figure) has the most negative (or least positive) mean scores for every BEV assessment statement except one—and that one (BEV: Gasoline safer) is close to the most negative. The only positive means score (BEV: BEV less damage to the environment) is the least positive of any cluster and not much more than zero (0.27 on a scale from -3 to +3). These consistently poor assessments (both absolutely and in comparison to other clusters) indicate a negative attitude toward BEVs we would expect of "active resistors."

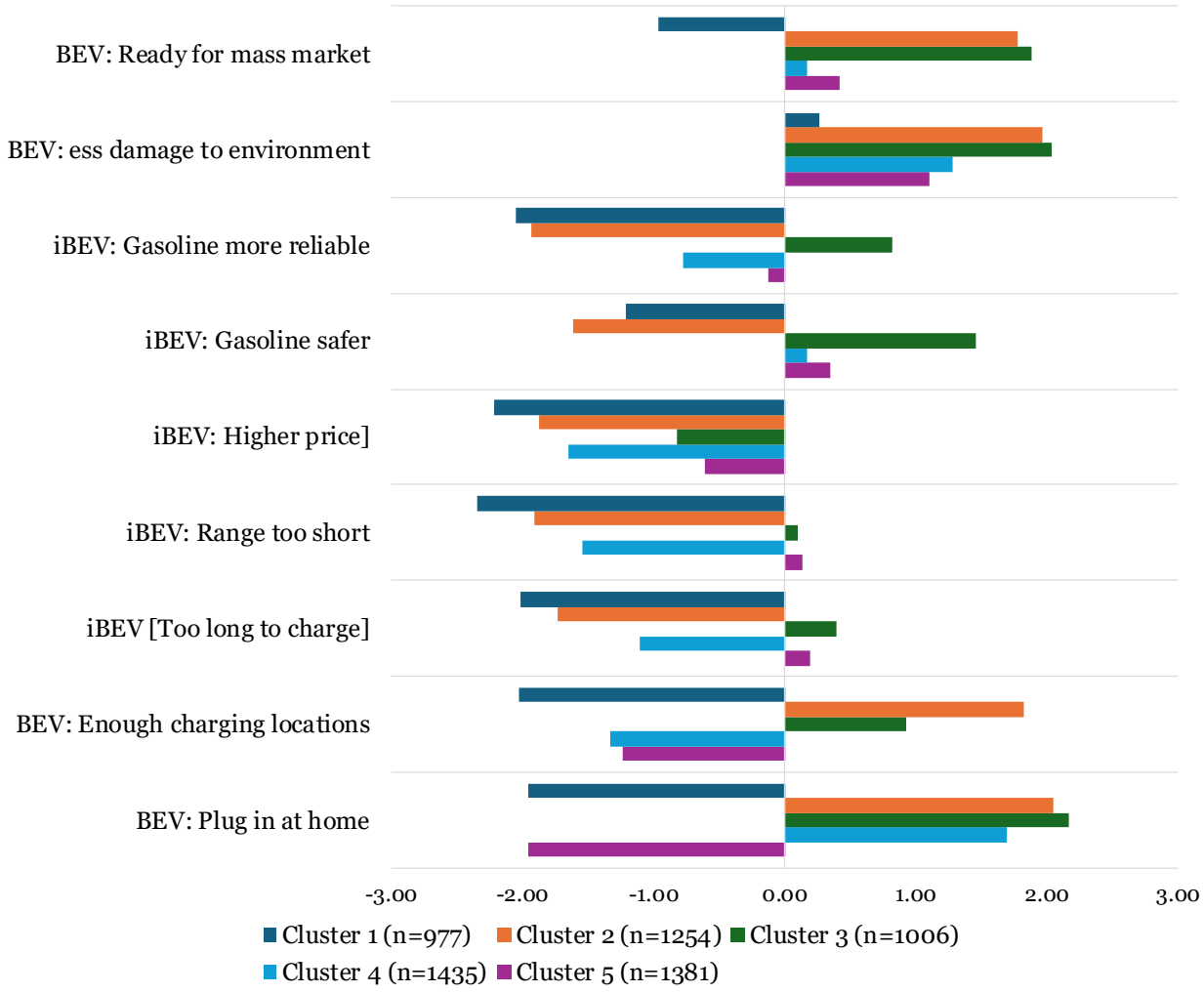

Figure 4. Mean cluster values for a five-cluster solution on nine BEV assessments.

In contrast, Cluster 3 (green bars) has the most positive means scores for six BEV assessments and only one mean BEV assessment score that is negative (iBEV: BEV higher price) and for that one it is nearly the least negative (-0.83 compared to -0.61 for Cluster 5). If negative assessments cause a person to stop giving further consideration to BEVs, then this pattern of generally positive assessments is one we might expect to see among people

at higher levels of BEV consideration, possibly reaching the point they have shopped (or are shopping) for a BEV or have or have had a BEV.

Cluster 2 (orange bars) is the most ambivalent group; they've strong negative and positive BEV assessments. On average, they strongly agree they can charge a BEV at home and there are enough places to charge (both facilitating conditions for BEV ownership and use) and have nearly the highest average agreement in support of the environmental benefits of BEVs and the readiness of BEVs for mass markets. However, they have strong negative assessments of BEV charging times and driving ranges as well as their price, safety, and reliability compared to gasoline vehicles. Only Cluster 1 has consistently more negative mean scores for these latter four assessments.

Cluster 4 (light blue) may also be ambivalent, but in their case their positive draws to BEVs are perceived environmental benefits and their comparative surety they could charge a BEV at home. Cluster 4's mean scores on many other assessments pertaining to the performance of BEVs such as driving range, charging duration, number of places to charge, and price are negative—if not as negative as Clusters 1 and 2.

Finally, Cluster 5 (purple bars) does not conform to our definitions of either active resistance or ambivalence. This cluster has the mean scores closest to zero—indicating weaker negative or positive assessments than other Clusters. It is one of only two clusters to register a, barely, positive mean assessment of both BEVs driving range and charging duration. Perhaps the most distinguishing feature of Cluster 5 is their strong negative assessment of their capability to charge a BEV at home. Such a general lack of strong positive or negative assessments may indicate passive resistance if the cause of the lack strong assessment is unawareness of BEVs.

To test the expectations that Cluster 1 is associated with active resistors and Cluster 3 with those who have shopped for, had, or have had a BEV as well as to further explore how the other clusters relate to *BEV Consideration* we cross-classify Cluster membership by *BEV Consideration* (Figure 5). The color index column at the right of the figure illustrates both the color scale and the distribution of all respondents (regardless of Cluster membership). The column heights of the main graphic sum to 100 percent and the height of each color block in a column corresponds to the percentage of people in each cluster who are in each BEV Consideration category. Further, the column widths are proportional to how many respondents are in each cluster. The test for homogeneity of proportions on the underlying data rejects the hypothesis that the distributions BEV Consideration are the same across all Clusters. Thus, we conclude *BEV Consideration* and membership in the BEV Assessment Clusters are associated with each other (n = 6,053; degrees of freedom = 20; χ^2 = 1,448.45, $p < 0.0001$), i.e., people in different clusters are distributed differently across *BEV Consideration*.

We observe respondents in Cluster 1—with the most negative assessments of BEVs—are by far most likely (64 percent) to indicate they have not and would not consider a BEV and that those in Cluster 3—with the most positive assessments of BEV—are by far the least

likely (6 percent) to indicate they have not and would not consider a BEV. Still, Cluster 1 includes only a minority (37 percent) of all the people who say they, "haven't and won't consider a BEV.

Cluster 2 shows ambivalence; a strong pull in two directions would explain their distribution on the BEV Consideration scale—for some people the strength of their positive assessments is enough to pull them toward higher consideration despite their misgivings while for others the opposite may be true. If we assume the three highest levels of consideration (the three green blocks) can be grouped together as a measure of who is engaged with BEVs, a nearly identical percentage (22 percent) of respondents in Cluster 2 are in this meta-category of consideration as are in the lowest, "haven't…and wouldn't consider a BEV" (21 percent). Further, nearly identical percentages are in the negative "middle" category ("haven't but maybe someday," 30 percent) and the positive "middle" category ("The idea has occurred, but no real steps taken…," 26 percent).

Cluster 3 illustrates that even uniformly positive assessments of BEVs don't assure a high level of consideration had been given to BEVs within the time frame of this study. While Cluster 3 contains half of all respondents who were at the highest level of Consideration, only eight percent of Cluster 3 is at this highest level. Combining them with those who have shopped for a BEV and those who have "started to gather information, about BEVs, but haven't really gotten serious yet," just about one-third of respondents in Cluster 3 had invested time and energy in the question of whether a BEV is right for their household.

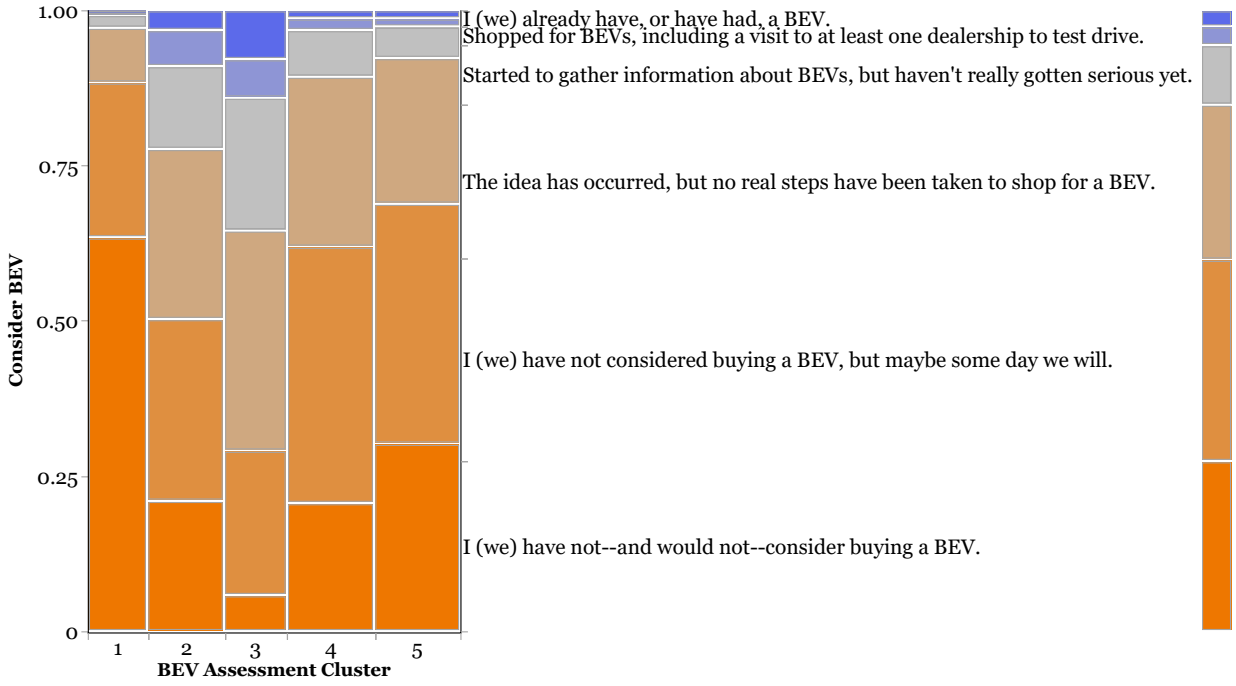

Figure 5. Cross-classification of BEV consideration by BEV Assessment Cluster.

Combined, Clusters 4 and 5 account for 48 percent of all those who say they haven't and wouldn't consider a BEV. As noted above, Cluster 5 seems to have the weakest assessments (values nearest zero) of BEVs except for their very negative assessments of their capability to charge at home (mean score = -1.95 on a scale that only goes to -3). In contrast, Cluster 4 is as sure they can charge a BEV at home as Cluster 5 is sure they can't. However, Cluster 4 has much stronger negative assessments of BEVs linked to the capabilities of the cars themselves (driving range, charging duration) and their price, reliability, and safety compared to gasoline vehicles.

Political Resistance to BEVs

The 2017, 2019, and 2021 data sets contain only one common measure related to political beliefs: do respondents agree or disagree governments should offer incentives for alternatives to gasoline and diesel. Whether this question relates to differences in political identity will be examined in future research. For now, we note that the variable is statistically significant in our model of BEV Consideration though its effect is less than that of the socio-economic and demographic descriptors respondent age and education as well as household income. Agreeing that government should be offering incentives is associated with higher levels of *BEV Consideration*. Holding all other variables constant at the values shown in Appendix B, the difference in estimated probability of being in the "haven't and wouldn't consider a BEV" category is 6.6 percentage points lower among those who agree the government should be offering incentives (69.5%) than among those who disagree (76.1%).

Another view of political resistance is presented in Figure 6 via the cross-classification of the question of whether governments should offer incentives by membership in the five BEV Assessment clusters. The test of homogeneity of proportions on the underlying data rejects the hypothesis these two are not associated with each other (n = 6,053; degrees of freedom = 8; $\chi^2 = 838.30$; $p < 0.0001$).

Of the respondents in Cluster 1—the cluster which consistently has among the most negative assessments of BEVs—36 percent disagree governments should be offering incentives compared to only 14 percent of the entire sample. In Cluster 3—which consistently has among the most positive assessments of BEVs—only three percent indicate governments should not be offering incentives. In no other cluster do more than 16 percent of respondents reject the idea of government incentives.

The results in Figure 6 suggest the possibility that two forms of active resistance to the socio-technical system of BEVs are related to each other. On the technical side is a negative attitude toward the performance capabilities of BEVs as cars and trucks as summarized by the BEV Assessment variables, factors and clusters. On the social side is a negative attitude toward government policy interventions in the "private" market for cars and trucks. Given the limited measure of political resistance, we provisionally observe the relative effects of "technical" resistance is the larger of the two. Using the mean *BEV Assessment Factor* 1 and *Factor 2* scores for Clusters 1 and 3 and the No and Yes values of

Should government offer incentives, the probability a respondent is assigned to the "Haven't and wouldn't consider a BEV" category is higher by 19.1 percentage points for Cluster 1 as it is for Cluster 3 (again, holding all other variables constant at the values in Appendix B). The percentage point difference between not supporting government incentives ("No") and supporting government incentives ("Yes") is about one-third as large (6.6 percentage points).

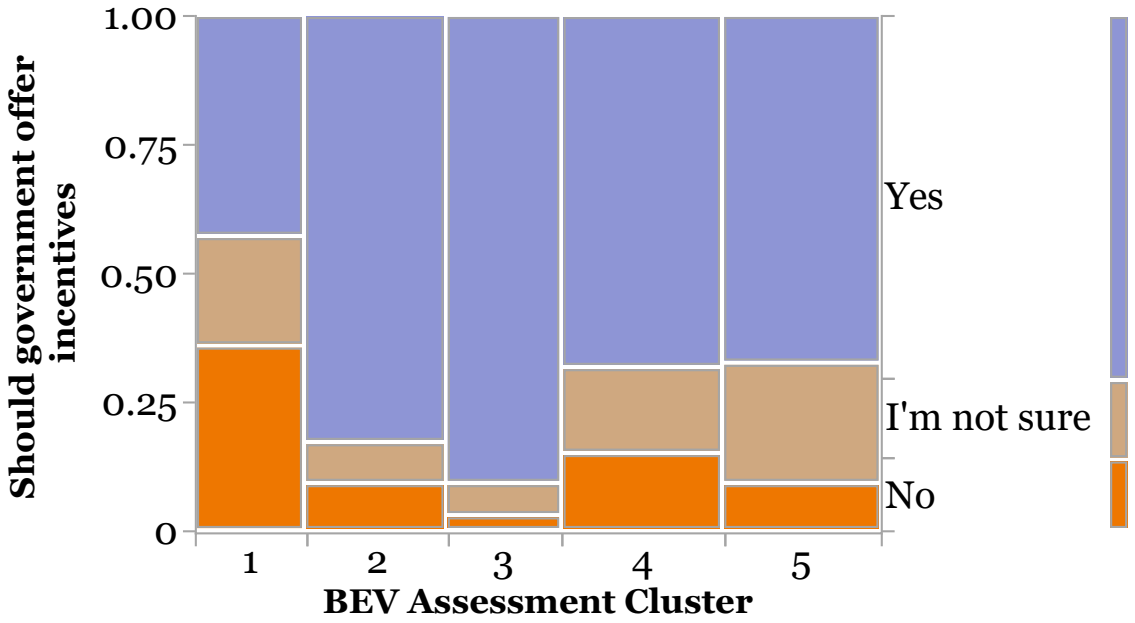

Figure 6. Agreement with governments offering incentives to gasoline and diesel cross-classified by BEV Assessment Cluster.

Modeling FCEV Consideration: 2017, 2019, and 2021

The search for descriptions and explanations of resistance to FCEVs proceeds in a parallel manner as previously presented resistance to BEVs. An initial list of variables that are hypothesized to be related to *FCEV Consideration* is established. The hypothesized relationships are tested simultaneously using ordinal logistic regression. The data sources are the same three surveys of car-buying households in California conducted in 2017, 2014, and 2021. The list of potential explanatory variables for *FCEV Consideration* is provided in Table 6. In addition to the variables listed, interactions between FCEV Assessments and Year are also included in the initial model. The same process to reduce the complexity of the initial model is applied to the model of *FCEV Consideration* as was done for the model of BEV Consideration. As with the BEV Consideration model, the stopping rules (minimum AIC_c and minimum BIC) don't converge on a single *FCEV Consideration* model. As was done for the *BEV Consideration* model, a model between a more complex model containing non-significant variables (i.e., $p \geq 0.05$) indicated by the

minimum AIC_c and a simpler model the excludes some significant variables as indicated by the minimum BIC is selected.

The resulting simplified model is summarized in Table 7 and Table 8; the initial model with all explanatory variables is presented in Table D1. The statistical significance of the Difference between the Full and Reduced model indicates the Full model of *FCEV Consideration* provides a better fit to the data than does the Reduced model. Further, the results of the Lack of Fit test in Table 7 indicates the Full model is adequate as is—no additional terms are likely to make in improvement. The effect tests, i.e., the overall significance of each explanatory variable, for the Full model are presented in Table 9. As in Table 2, the R^2 measure reported in Table 8 is *McFadden's pseudo* R^2.

The direct effect of the independent variables on the estimated probability of "haven't and won't consider an FCEV" are sorted from greatest to least effect in Table 10. Note that in Table 10, the base variable values used to calculate the probabilities of a participant respondent, "haven't and wont' consider…," generally produce the highest possible probabilities. Thus, the probabilities in Table 11 in no way represent most participants; only those with the highest probability of being at this lowest level of *FCEV Consideration*. The total effects of *Year* and *FCEV Assessment Factor 1*, including both simple and interaction effects, are summarized in Table 11 and Figure 7.

The variable *Year* is statistically significant in the model of *FCEV Consideration* unlike the model for *BEV Consideration*. Further, the interaction effect between *Year* and *FCEV Assessment Factor 1* is also statistically significant. (The same assessments load on both *BEV* and *FCEV Assessment Factors 1*, Table 1 and Table 6.) Notably, the effects of *Year*, *FCEV Assessment Factor* 1, and their interaction do not entirely favor the argument that survey participants became less likely to say they, "haven't and won't consider an FCEV" over the interval from 2017 to 2021.

This small direct effect is of *Year* on *FCEV Consideration* is both amplified and made more complicated by the interaction of *Year* and *FCEV Assessment Factor 1*. The direct effect of *Year* appears to be associated with an increasing probability a survey participant "hasn't and won't consider an FCEV" from 2017, to 2019, and to 2021. The interaction amplifies the effect of *Year* because the effect of *FCEV Assessment Factor 1* is the largest of any single variable in the model (Table 10). The effect of *Year* is made more complicated because the interaction effect (Table 11, Figure 7) is such that differences in the value of *FCEV Assessment Factor 1* make less difference to the probability a 2021 participant "hasn't and won't consider an FCEV" than it made in 2019 and even less difference than it made in 2017.

Table 6. Concepts, hypotheses and motivating rationales, and variables in models of FCEV consideration.

Concept	Hypothesis/Rationale	Variables
Year	Consideration of FCEVs differ by year, and those differences are consistent with more people considering FCEVs over time.	*Year*: the three survey years, 2017, 2019, and 2021 coded as an ordinal number. This coding allows for varying differences between years, i.e., not constrained to the same difference between successive years.
FCEV Assessments	Differences in assessments of FCEVs are associated with differences in consideration of FCEVs. As one form of active resistance is a negative attitude toward FCEVs, people with worse assessments are hypothesized to be more likely to indicate they haven't and won't consider FCEVs than people with more positive assessments.	Two factor scores calculated from nine individual assessments measured on continuous scales from strongly disagree to strongly agree. Items with a negative phrasing toward FCEVs are reverse coded so that a positive score on all items favors FCEVs. Paraphrasing, each factor includes the following statements: *Factor 1* • FCEVs take too long to fuel • FCEVs range too short • FCEVs higher priced than gasoline vehicles • Gasoline vehicle safer than FCEVs • Gasoline vehicles more reliable than FCEVs *Factor 2* • There are enough places to charge FCEVs • FCEVs are ready for mass markets Note the FCEV Assessment "FCEVs are less damaging to the environment than gasoline vehicles" does not load on either Factor 1 or 2. Nor does it load onto a third factor if a three-factor solution is computed. Thus, the values of that assessment are used in the initial model rather than factor scores.

Concept	Hypothesis/Rationale	Variables
FCEV Knowledge and Experience	People with better knowledge are from the perspective of the researcher at a higher level of consideration. Here these variables assess whether respondents with more knowledge of and experience with FCEVs rate themselves as having given greater consideration to FCEVs.	*Fueling FCEVs*: whether respondent can identify that a thing called a "battery electric vehicle" is fueled only by charging it with electricity; coded Correct or Incorrect. *rKnow a FCEV owner*: whether respondent knows someone "by name" who owns a FCEV; coded Yes or No. *H2 [Any positive reason]*: does respondent offer any reason for why they might acquire a hydrogen-fueled FCEV for their household; coded Yes or No. *Familiarity [FCEV]*: respondents' self-rating of whether they are familiar enough with FCEVs to decide whether one would be right for their household; continuous scale from -3 (no) to +3 (yes). *Driving experience: FCEV*: self-rating of how much driving experience respondents have with FCEVs, scored on continuous scale from -3 (I have never driven one) to +3 (I have extensive driving experience). *Note:* There is no analog to the variable assessing whether survey participants have seen EVSE at the places they travel for hydrogen fueling stations.
Political beliefs	Political resistance to EVs—as public goods and "liberal" vehicles—may be linked to whether people support public incentives for FCEVs.	Single item: *Should government offer incentives* for alternatives to gasoline and diesel. Responses recoded from five to three: No; I don't know; Yes
Environmental beliefs	To the extent FCEVs are seen as "pro-environmental" vehicles, beliefs about the environment may be associated with either political resistance or other forms of active resistance.	All items scored on continuous scales from. Values of the first two are inverted (*i*) so larger values favor electricity. Values of the second set of three are truncated (*t*) to exclude indicators of non-responses. • *tAir pollution: personal worry*: I personally worry about air pollution. • *tAir pollution: regional threat:* Air pollution is a health threat in my region. • *tAirpollution: lifestyle*: Air pollution can be reduced if individuals make changes in their lifestyle.

Concept	Hypothesis/Rationale	Variables
Residential, vehicle, and travel context	Contextual variables may be associated differences in FCEV consideration as context may open some possibilities and preclude others, for examples, whether someone can charge a vehicle at their residence, their access to automobiles, and their common trips renders their daily mobility amenable to FCEVs.	*Residence Type* coded as five categories: Apartments, Attached single family home, Unattached single-family home, Mobile home, Other. *Own/Rent Residence*: coded as Own, Rent/Lease, Other. *Solar PV*: Indicator of photovoltaic energy system on Residence coded as No, Yes. *Vehicles per person* in respondents' households, continuous number. Both counts of vehicles and people are truncated at their top ends; the terminal count is used for both. *New Car Buyer* indicates household has purchased at least one vehicle as new in the seven years prior to their survey) coded as No, Yes. *Only or Either Garage or Carport*: Parking at Residence coded as Yes if either or both the car the respondent drives most often and the most recently acquired car (other than the first) is parked in a garage or carport attached to the residence, or No if not. *rHighest e-access*: assesses whether there is electricity available at the location where the respondents' households park their cars at home. Coded as None or I don't know, 110V, 220V, or EVSE. *Authority to install*: whether respondent could install a new electric outlet at their home parking location on their own authority or if they would need permission from someone else. *Respondent Driving Days per Week* for the survey respondent ranging from 1 to 7. *Respondent Commute* coded as Yes if the respondent commutes to a workplace outside their home, No if not. *HOV* indicator of HOV lane access and use assess whether there are high occupancy vehicle lanes on the routes the respondent regularly drives and if so, whether the respondent is generally able to use those lanes. Coded No, Yes, but I am not able to use them, or Yes and I am able to use them.

Concept	Hypothesis/Rationale	Variables
Socio-economic and demographic descriptions		*Respondent Age* measured in six categories from 19 to 29 up to 70 or older. *Respondent Gender* coded as Female, Male or Non-binary, *Respondent Education* coded in six categories: Less than High School or GED; High School or GED, Some College, College Graduate, Some Graduate or Professional School, Graduate or Professional Degree. *2017-21 Income 100k* coded in ten ordinal categories centered on income categories used in the 2017 survey which were calculated on percentages of the then federal poverty level and scaled to $100k so categories range from 0.2 to 3.5.

Note: The prefixes *r*, *t*, and *imp* indicate variables have been recoded (*r*) into fewer categories or truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Table 7. FCEV consideration Whole Model Test.

Model	-Log Likelihood	Degrees of Freedom	Chi-square	Prob. > Chi-square
Difference	1199.764	37	2399.528	<0.0001
Full	6737.390			
Reduced	7937.154			
R^2	0.1512			
AIC_c	13559.4			
BIC	13841.5			
Observations	6192			

Table 8. FCEV consideration Lack of Fit test.

Source	-Log Likelihood	Degrees of Freedom	Chi-square	Prob. > Chi-square
Lack of Fit	6737.390	30918	13474.78	1.000
Saturated	0.000	30955		
Fitted	6737.390	37		

Table 9. FCEV consideration Effect Likelihood Ratio tests.

Variable	DF	Likelihood Ratio χ^2	Prob>χ^2
Year	2	15.12	0.001
Respondent Age	5	14.95	0.011
rRespondent Education	4	19.75	0.001
Respondent Gender	1	14.16	0.000
Residence Type	4	21.16	0.000
rHighest e- access	3	24.93	0.000
Authority to install	1	8.87	0.003
Vehicles per person	1	2.61	0.106
Respondent driving days	1	15.69	0.000
Respondent Commute	1	3.23	0.072
HOV	2	15.02	0.001
tAir pollution: lifestyle	1	3.88	0.049
tAir pollution: personal worry	1	9.18	0.002
Should government offer incentives	2	43.45	0.000
rKnow a FCEV owner	1	47.03	0.000
H_2: [Any positive reason]	1	605.66	0.000

Variable	DF	Likelihood Ratio χ^2	Prob>χ^2
Familiarity [FCEV]	1	88.03	0.000
Driving experience: FCEV	1	11.30	0.001
impFCEV 8 assessments 2017-21 Factor 1	1	26.82	0.000
impFCEV 8 assessments 2017-21 Factor 2	1	58.59	0.000
imp FCEV 8 assessments 2017-21 Factor 1 * Year	2	11.30	0.004

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories or truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

The difference in the estimated probabilities of "haven't and won't consider an FCEV between a survey participant with the worst FCEV Assessment Factor 1 score and the best score declined from 58 percentage points in 2017 (92 percent to 34 percent) to only 22 percentage points in 2021 (86 percent to 64 percent). It is tempting to conclude based on Figure 7 that the good news is at least the participants with the worst FCEV Assessment 1 scores in 2021 are slightly less likely to be predicted to say they "haven't and won't consider an FCEV." However, even this only holds true up to an *FCEV Assessment Factor 1* value of about -1.5 to -0.5; these values approximate the 10th and 25th percentiles of the distribution of participants' scores on this factor. In short, for at least three-fourths of the 2021 sample, not even increasingly positive assessments of FCEV's driving range, fueling duration, safety, reliability, and price don't change the result that the most recent sample is more likely to refuse to consider FCEVs than were earlier their peers in earlier samples.

As was the case for the model of *BEV Consideration*, the most influential variables in estimating the probabilities the survey participants responded to each category of *FCEV Consideration* are measures of those participants' specific assessments of FCEVs, self-ratings of their experience and familiarity of FCEVs, and whether anyone else in their social networks already has an FCEV (Table 10). Participants' formal education and age are less influential than these specific *FCEV Assessments* but are more influential than environmental attitudes vis-à-vis air pollution. Among the least influential variables are measures of household resources and context (daily access to HOV lanes, whether the respondent commutes to a workplace, and have the authority to install infrastructure upgrades to their residence).

Table 10. Modeled probability of "haven't and wouldn't consider an FCEV" across the range of each explanatory variable sorted from variable having the largest effect (across its range) to the least effect.

Variable	Value producing highest estimated probability	Highest estimated probability	Value producing lowest estimated probability	Lowest estimated probability	Percentage point difference between highest and lowest probabilities
FCEV Assessment 1*	-1.927 (Most unfavorable)	86.4	2.961 (Most favorable)	34.2	52.2
H^2 [Any positive reason)	No	70.2	Yes	34.5	35.7
FCEV Assessment 2	-1.874 (Most unfavorable)	80.6	2.158 (Most favorable)	55.0	25.6
Driving Experience: FCEV	-3 (None)	79.4	3 (Extensive	58.9	20.5
Know FCEV Owner	No/Not sure	70.2	Yes	49.0	21.2
Familiarity: FCEV	-3 (Least familiar)	75.8	3 (Most familiar)	59.4	16.4
Residence Type	SFH	73.4	Other	62.3	11.1
Should gov. offer incentives	No	70.2	Yes	60.0	10.2
Respondent Education	Less than High School or GED	70.2	Some Grad. School	61.5	10.0
rHighest e- access	None/I don't know	70.2	220v	61.1	9.1
Vehicles per Person	4.0	76.4	0.125	68.7	7.7
Respondent driving days per week	0	74.9	7	67.4	7.5

Variable	Value producing highest estimated probability	Highest estimated probability	Value producing lowest estimated probability	Lowest estimated probability	Percentage point difference between highest and lowest probabilities
tAir pollution: personal worry	-3 (Not worried)	75.2	3 (Very worried)	67.9	7.3
Year*	2021	77.3	2017	70.1	7.2
Respondent Age	70 or older	75.3	30 to 39	68.1	7.2
HOV	Yes, unable to use	72.2	Yes, able to use	66.1	6.1
tAir pollution: lifestyle	-3 (Not worried)	75.0	3 (Very worried)	69.0	6.0
Respondent Gender	Female	70.2	Male or Other	65.8	4.4
Authority to Install	Need permission	70.2	Own authority	66.1	4.1
Respondent commute	No	70.2	Yes	67.9	2.3

Note: The prefixes *r*, *t*, and *imp* indicate variables which have been recoded (*r*) into fewer categories or truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

* The effect sizes shown in Table 10 are the simple effects of variables ignoring interactions. The total effect of *FCEV Assessment Factor 1* and *Year*, including their interaction effect, are show in Table 11 and Figure 7.

Table 11. Effect of interaction between FCEV Assessment Factor 1 and year on estimated probability a survey participant "hasn't and won't consider an FCEV."

	FCEV Assessment 1 Score						
Year	-3	-2	-1	0	1	2	3
2017	0.916	0.868	0.798	0.703	0.586	0.460	0.338
2019	0.908	0.871	0.823	0.763	0.689	0.604	0.513
2021	0.866	0.839	0.808	0.773	0.734	0.691	0.644

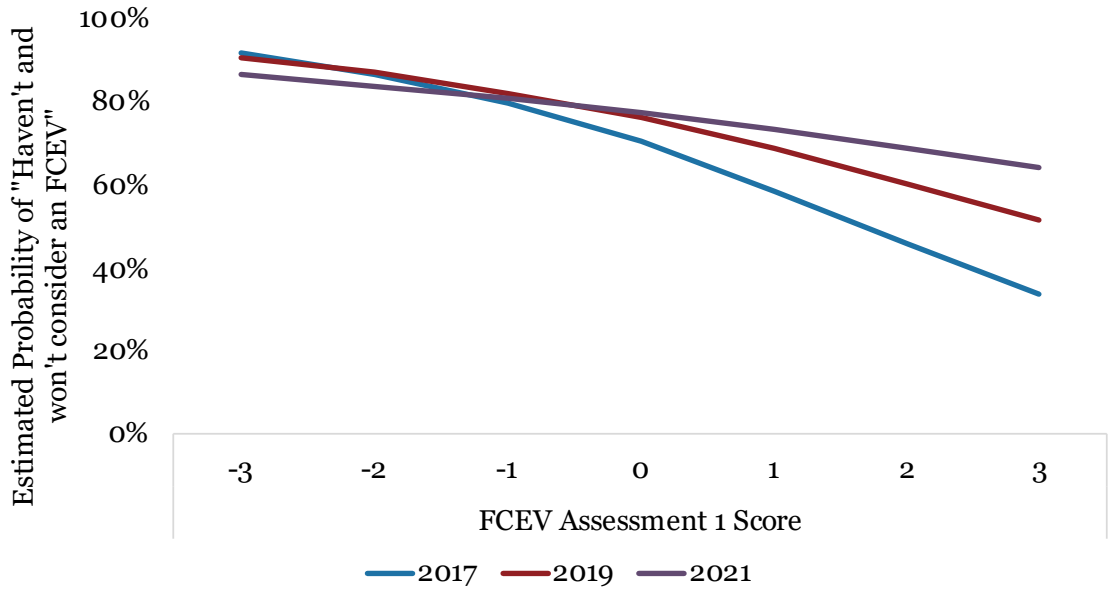

Figure 7. Effect of the interaction between FCEV Assessment Factor 1 and year on estimated probability of "haven't and won't consider an FCEV."

Who are FCEV Resistors?

As was done for BEV Consideration, another perspective on the relationship between specific assessments and FCEV Consideration is gained by testing for whether participants can be grouped together into an interpretable number of clusters that also explain much of the variation within the individual assessments. Noting that in the case of FCEVs there are eight, not nine as in the case of BEVs, assessment statements a k-means clustering indicates a five-cluster solution for FCEV assessments is suitable as was a five-cluster solution for BEV assessments. As done for BEV Assessment Factor clusters, the CCC was used to assess whether it can be concluded there are clusters of participants based on their responses to the FCEV Assessment Factors. Then rather than relying on a threshold value of the CCC, the number of clusters selected for presentation relies on the author's judgment of how many clusters provide usable insight. Recall that regardless of whether agreement with the assessment statements as presented to the participants favored FCEVs or not, all statements have been recoded so that positive values on the scale in Figure 8 represent positive assessments.

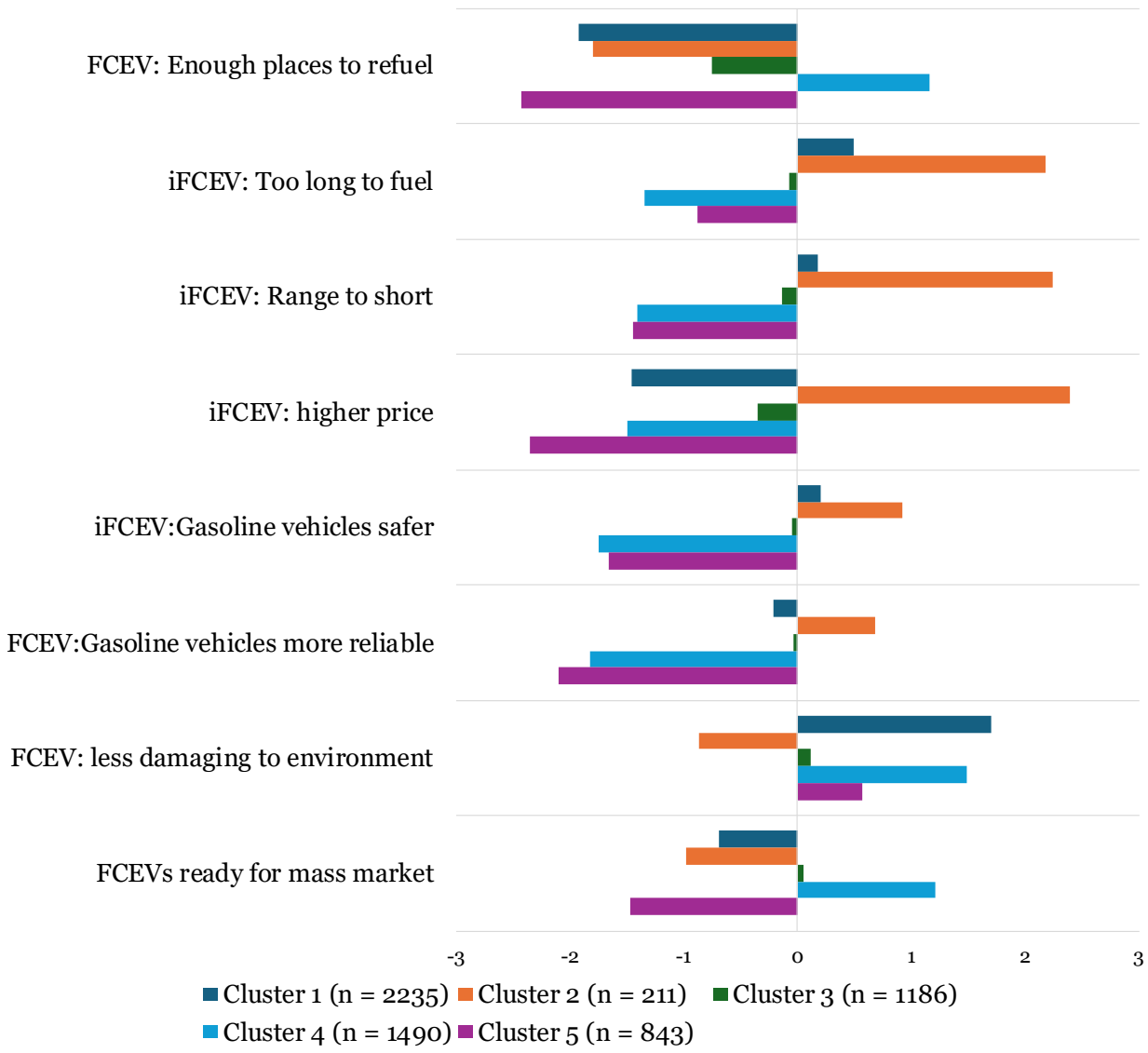

Figure 8. Mean cluster values for a five-cluster solution on eight FCEV assessments.

There is no FCEV Assessment Cluster like BEV Assessment Cluster 3 in which the mean assessment scores are positive for nearly all statements. (No BEV Cluster had a positive mean score for the price of BEVs relative to gasoline vehicle.) The most consistently positive assessments of FCEVs are given by Cluster 2. However, these positive assessments are not uniform across all statements suggesting some level of ambivalence. This cluster is more negative about whether there are enough places to fuel with hydrogen than every other cluster except Cluster 5. Within the provisional mapping of resistance of the categories of Consideration in Figure 1, we hypothesize that those in Cluster 2 should be the least likely to indicate they haven't and won't consider an FCEV (provisionally, active resistance) and haven't but may consider FCEVs someday (provisionally, passive resistance).

The mean assessment scores for Cluster 5 are negative for all assessments except a slight positive nod to FCEVs being less damaging to the environment. For five of their seven negative assessments, Cluster 5's mean score is the most negative of any cluster. To the extent these strong negative assessments may be the result of evaluation and deliberation of FCEVs themselves, i.e., these negative assessments may indicate a form of active resistance. We hypothesize members of Cluster 5 are more likely than members for other clusters to indicate they haven't and won't consider an FCEV.

Both Clusters 1 and 4 have patterns of strong positive and strong negative assessments, i.e., ambivalence, though beyond the generalization that they both exhibit ambivalence, they differ from each other. While Cluster 1 has nearly the most negative mean score for whether there are enough places to refuel FCEVs, Cluster 4 is the only one with a positive mean score. Both Clusters 1 and 4 have strong negative assessments (exceeded only by Cluster 5) of the relative price of FCEVs. These two clusters have the two most positive mean score for FCEVs environmental effects. Other than the assessment scores already note for Cluster 4, it has nearly the smallest absolute mean scores. In contrast, Cluster 4's other assessment scores all have similar absolute values. Its negative scores are for those items most proximate to the practical daily experience of an individual consumer/driver: fueling duration, driving range, vehicle price, safety, and reliability. Two of its three positive scores are less proximate to practical individual experience: environmental performance and readiness for mass markets. We have not included ambivalence in provisional mapping in Figure 1 and do not formulate a specific hypothesis as to where participants who have both relatively (compared to their own other assessments) strong negative and positive assessments may fall in the Consideration categories.

Finally, Cluster 3 uniformly has the lowest absolute value mean assessment scores, i.e., scores closest to zero. Such scores may indicate little or no prior consideration which in turn may indicate passive resistance—participants in Cluster 3 may have no strong assessments because they have no information or engagement with the idea of FCEVs prior to taking our survey. This series of suppositions leads to the hypothesis that participants in Cluster 3 are more likely than other clusters to have given no prior consideration but still be open to future consideration.

We test our hypotheses about FCEV Assessment cluster membership and FCEV resistance by cross-classifying the two variables in Figure 10. The figure is interpreted as is its analog Figure 2 in which we tested similar hypotheses for BEV Assessment cluster membership and BEV resistance. The statistical significance of the cross-classification ($n = 5{,}965$; degrees of freedom = 20, $\chi^2 = 554.3$, $p < 0.0001$) provides confidence the two variables are related to each other to an extent that exceeds chance alone. (Note that despite the absence of a label for the highest level of Consideration—have or had an FCEV—from the graphic's legend that category is included. The missing label is an artifact of the graphing software attributable to the very small number of people in that category.)

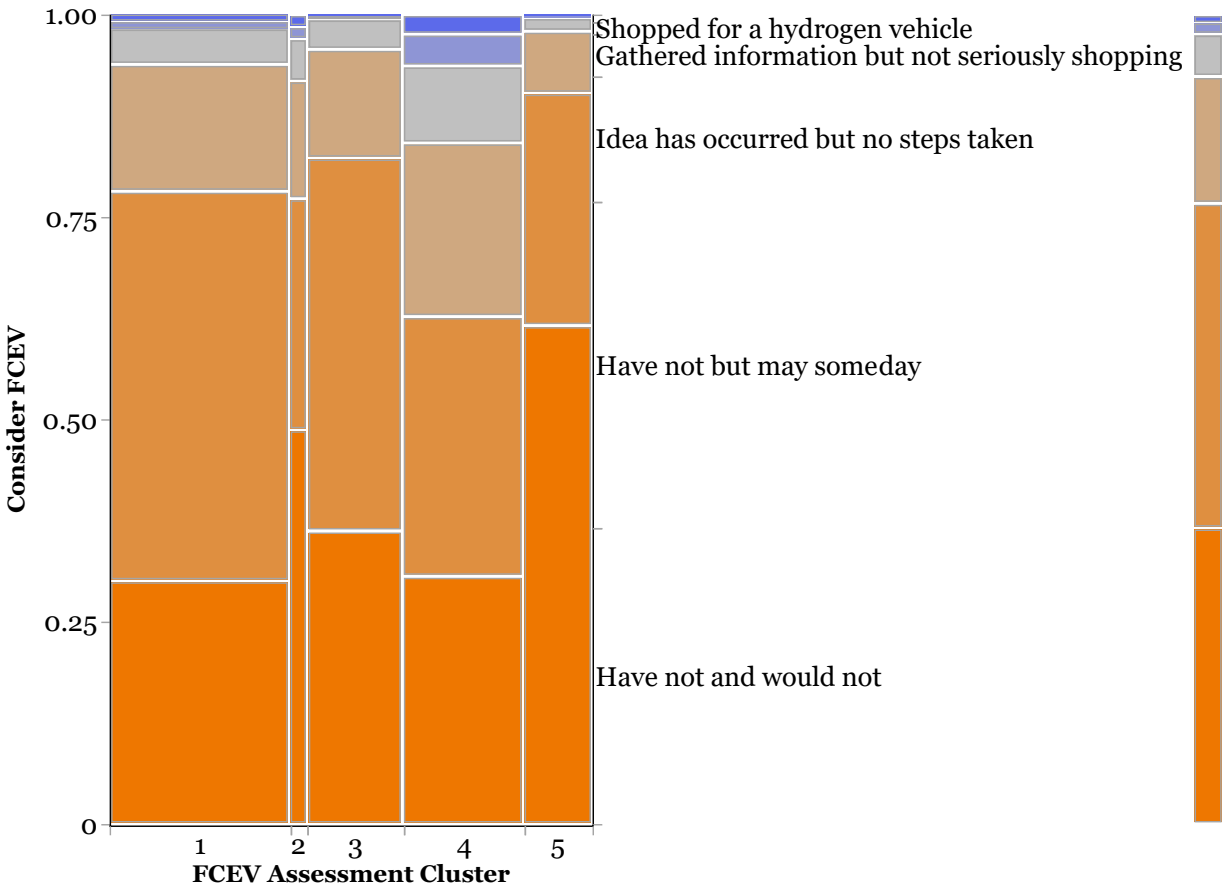

Figure 9. Cross-classification of Consider FCEV by FCEV assessment cluster.

The hypothesis that participants in Cluster 2 are least likely to be active or passive resistors of FCEVs is not supported by this analysis but the hypothesis that participants in Cluster 5 are most likely to be active resisters is supported. Regarding Cluster 2, the result is mixed; it is the cluster least likely (28.4%) to say they have not considered an FCEV but may someday (i.e., to be passive resisters according to our provisional mapping) but are the second most likely (48.8%) to say they haven't and won't consider an FCEV. The result for Cluster 5—the cluster with the lowest assessment score—is unambiguous: nine-of-ten participants in this cluster are also in the two categories of consideration we've mapped with active or passive resistance and nearly two-thirds (61.7%) would be typed as active resistors.

No cluster may be said to be associated with the highest consideration of FCEVs, but those participants in Cluster 4 are the most likely. Still, only about six percent of this cluster indicates they either shopped for an FCEV or have or had one.

Political Resistance to FCEVs

Whether respondents agree governments should offer incentives for alternatives to gasoline and diesel is statistically significant in the model of *FCEV Consideration*. It is more influential in the FCEV model that in the BEV model. Agreement that governments should offer incentives is associated with lower estimated probabilities of being at the lowest level of *FCEV Consideration*. Holding all other variables constant, the difference in estimated probability of being in the "haven't and wouldn't consider an FCEV" category is lower by 10.2 percentage points among those who agree the government should be offering incentives (60.0%) than among those who disagree (70.2%).

Another view of political resistance is presented in Figure 10 via the cross-classification of the question of whether governments should offer incentives by membership in the five FCEV Assessment clusters. The test of homogeneity of proportions on the underlying data rejects the hypothesis these two are not associated with each other (n = 5,965; degrees of freedom = 8; χ^2 = 185.92; $p < 0.0001$).

Most participants support government incentives regardless of their FCEV Assessment cluster. However, for the most negative cluster (Cluster 5) this is a bare majority. Despite their ambivalence, both Clusters and 1 and 4 have the high rate of support for incentives, exceeding 75 percent. Strong positive assessments of FCEVs (Cluster 2) seem no more likely to be associated with support for government incentives than is a near complete absence of strong assessments, whether positive or negative (Cluster 3).

The cluster descriptions and the association of clusters with support for incentives suggest a less clear account of whose resistance to FCEVs may a matter of a negative purchase intention based on an assessment of the technical system of FCEVs and their fueling infrastructure vs. resistance based in political beliefs. For all their other differences in their evaluations of FCEVs and hydrogen fueling availability, participants in Clusters 1 and 4 give relatively high positive scores to the environmental performance of FCEVs and are the most likely of any cluster to concur with the idea of government incentives to support alternatives to gasoline and diesel.

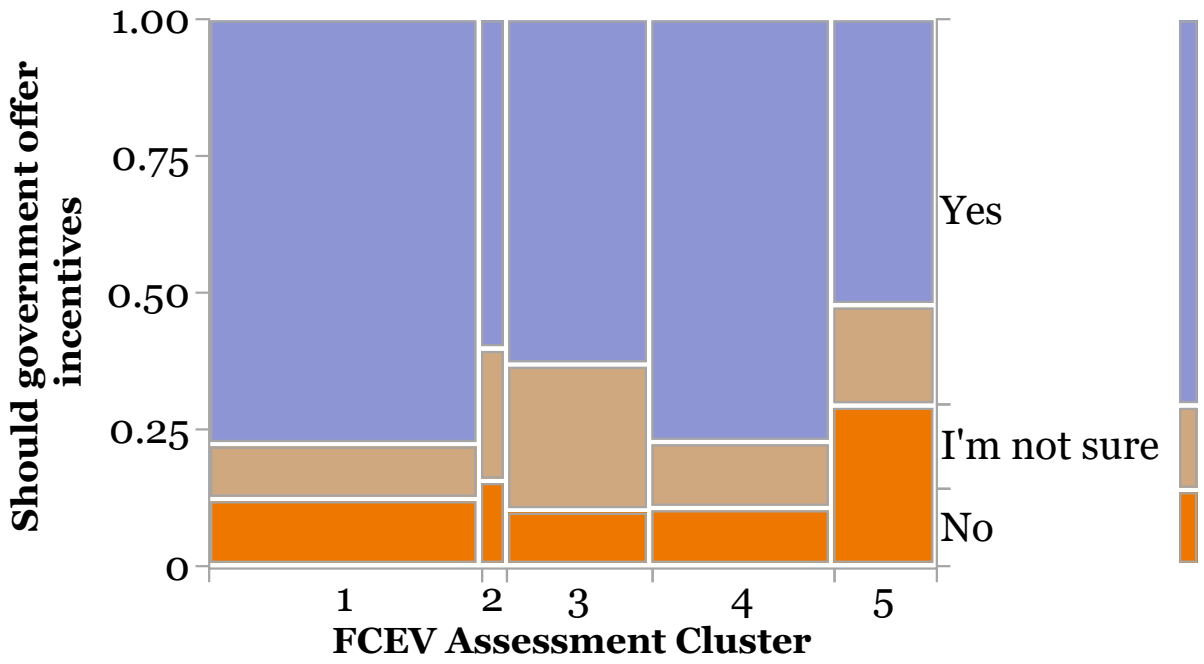

Figure 10. Cross-classification of Support for Government Incentives by FCEV assessment cluster.

Discussion: Comparing the BEV and FCEV Consideration Models

A summary comparison of statistically significant variables in the models of *BEV* and *FCEV Consideration* is shown in Table 12. Green shading indicates the variable was statistically significant and included in the final model. Red shading indicates a variable was statistically non-significant and omitted from the final model. Blue shading indicates the variable was not statistically significant in the final model estimation but was retained as its removal caused a statistically significant decrease in the Whole Model test.

Table 12. BEV and FCEV consideration model comparison of statistically significant variables.

Variable	BEV Consideration	FCEV Consideration
Year	Non-significant, omitted	Significant
Personal and Household Demographics and Socioeconomics		
Respondent Age	Significant	Significant
Respondent Education	Significant	Significant
Respondent Gender	Non-significant, omitted	Significant
Household Income	Significant	Non-significant, omitted
Residential, vehicle, and travel context		
Residence Type	Non-significant, omitted	Significant
Residential Tenure	Non-significant, omitted	Non-significant, omitted
Residential Solar PV	Non-significant, omitted	Non-significant, omitted
Vehicles per person	Non-significant, omitted	Non-significant; retained
New Car Buyer	Significant	Non-significant, omitted
Attached Residential Parking	Non-significant, omitted	Non-significant, omitted
Highest Electricity Access	Significant	Significant
Authority to Install new electric service	Non-significant, omitted	Significant
Respondent driving days per week	Non-significant, omitted	Significant
Respondent commutes	Non-significant, omitted	Non-significant; retained
HOV	Significant	Significant
Environmental Beliefs		
Human health risk: electricity vs. gasoline	Significant	N/A
Environment risk: electricity vs. gasoline	Non-significant, omitted	N/A
Environmental Beliefs (continued)		
Air pollution: personal worry	Significant	Significant
Air pollution: regional threat	Non-significant, omitted	Non-significant, omitted

Variable	BEV Consideration	FCEV Consideration
Air pollution: lifestyle	Non-significant, omitted	Significant
Political belief		
Government incentives for substitutes to gasoline and diesel	Significant	Significant
xEV Knowledge and Experience[1]		
Fueling xEVs[1]	Significant	Non-significant, omitted
Know an xEV owner	Significant	Significant
xEV Any positive reason	Significant	Significant
Familiarity with xEV	Significant	Significant
Driving experience in xEV	Significant	Significant
Seen BEV EVSE	Significant	N/A
xEV Assessment		
BEV Assessment Factor 1[2]	Significant	N/A
BEV Assessment Factor 2[3]	Significant	N/A
FCEV Assessment Factor 1[2]	N/A	Significant
FCEV Assessment Factor 2[3]	N/A	Significant
FCEV Assessment: Environmental	N/A	Non-significant, omitted
xEV Assessment * Year		
BEV Assessment Factor 1 * Year	Non-significant, omitted	N/A
BEV Assessment Factor 2 * Year	Non-significant, omitted	N/A
FCEV Assessment Factor 1 * Year	N/A	Significant
FCEV Assessment Factor 2 * Year	N/A	Significant
FCEV Assessment Environment * Year	N/A	Non-significant, omitted

Notes:

1. In the "xEV" notation, x is replaced by B (battery) or FC (fuel cell) for the corresponding models, e.g., Fueling BEVs for the *BEV Consideration* model and Fueling FCEVs for the *FCEV Consideration* model.
2. For xEV Assessment Factor 1 similar concepts load on this factor for both BEVs and FCEVs: charging/fueling duration, driving range, as well as price, reliability, and durability compared to gasoline vehicles. However, the assessment statements are written specifically for each vehicle type, e.g., BEV charging time and FCEV fueling time.
3. For xEV Assessment Factor 2, two of three similar concepts load on the factor: "Enough places to charge/fuel xEVs" and "xEVs are ready for mass markets." A third BEV Assessment statement loads on BEV Assessment Factor 2 ("BEVs are less damaging to the environment than gasoline vehicles"). The analogous FCEV Assessment statement does not load an any factor thus it is entered directly as a variable in the *FCEV Consideration* model.

As mentioned in the previous section, among the notable differences between the two models is the non-significance of the variables *Year* and its interaction effects with either *BEV Assessment Factor* in the BEV model vs. the significance of both *Year* and its interaction with *FCEV Assessment Factor 1* in the FCEV model. The results are that these samples of car-owning households in California show:

- No evidence of difference in the percentage households who "haven't and won't consider a BEV" from 2017, to 2019, to 2021,
- While slightly fewer households claimed they "haven't and won't consider an FCEV" in 2021 than in 2017 and 2019, positive assessments of several aspects of FCEVs had declining effect from 2017 to 2021 on the probability of being in this lowest category of FCEV Consideration, and
- For BEVs and FCEVs, the larger effect of participants' specific assessments on the probability a person is in the lowest category of Consideration supports the provisional mapping of active resistance onto that category, i.e., the largest explanatory effect on the probability a participant hasn't and won't consider a BEV or an FCEV is a negative attitude toward BEV and FCEV performance, fueling, and comparative safety, reliability, and price vis-à-vis gasoline vehicles.

Given the differences flowing from the statistically significant relationship between *FCEV Consideration, Year,* and *FCEV Assessment Factor 1*, in the broadest terms both the BEV and FCEV Consideration models indicate some measure(s) of personal and household socio-economic and demographics, personal and household residential, vehicle, and travel context, environmental and political beliefs, and specific measures of engagement with and assessment of BEVs in the one case and FCEVs in the other are associated with the estimated probability a person states they haven't and won't consider such vehicles for their household.

Updating and Extending Political Resistance to Policy Requiring Zero Emission Vehicles

Support for California's Zero Emission Vehicle Regulation circa late-2023 to early 2024.

This analysis extends the prior discussion of support for the more generic "government incentives promoting alternatives to gasoline and diesel" to the more specific support for California's ZEV regulation for light-duty cars and trucks. The analysis examines opposition and support among car-owning households in California to the State's regulation requiring a transition to a 100 percent ZEV requirement on new car sales by the year 2035. The data are from a survey administered to a random sample of households in California via mail and email between December 2023 and June 2024. After a brief description of the ZEV regulation, participants were asked the extent to which they opposed or supported it on a five-point scale ranging from strongly oppose (1) to strongly support (5). Further, participants were asked to provide a brief text description of why they oppose or support the regulation. We interpret "opposition" to mean the same thing as "resistance" as used so far in this report. See Nordhoff and Hardman (submitted) for additional details.

The measure of support for general "government incentives for alternatives to gasoline and diesel" for the years 2017, 2019, and 2021 (as used in prior sections on political resistance to BEVs and FCEVs) is compared to support for California's ZEV regulation in 2023-24 in Figure 11. The general proposition of government incentives receives support from much higher percentages of survey participants than does the more specific statement regarding California's ZEV mandate (ranging from a difference of 20 to 40 percentage points). Resolving the causes of these differences—general versus specific policies, incentives versus requirements, the passage of time, or any other—is left to future research.

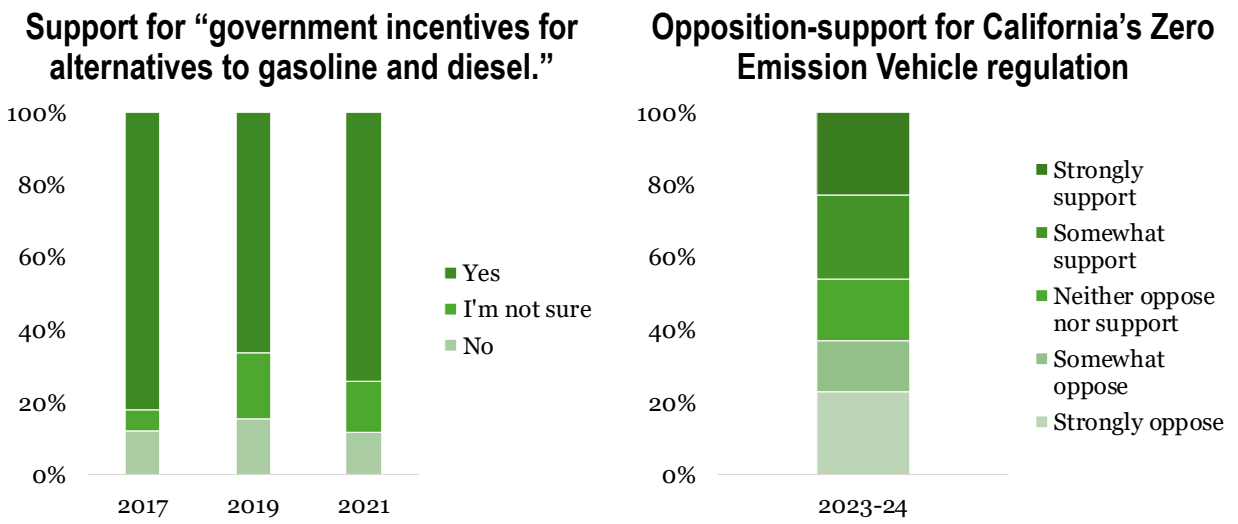

Figure 11. Comparison of responses to support for the generic proposition of government incentives for alternatives to gasoline and diesel (in the years 2017, 2019, and 2021) to support specifically for California's ZEV regulation (2023-24).

An ordinal logistic regression model is estimated on the five-point measure of support for California's ZEV regulation. Thus, in contrast to the use of a measure of political resistance as an independent variable in the earlier models of *Consideration*, in this analysis the measure of political resistance is the dependent variable we seek to understand through its associations with a set of independent variables. These independent variables are described in Table 13. They include personal and household socio-economic and demographic measures, attitudinal statements from Shaw (2021), as well as objective characteristics of the built environment measured for the Census tract in which each participant resides.

Variables for the personal and household descriptors and vehicle characteristics are identical or similar to those used in the prior modeling of *BEV* and *FCEV Consideration*. However, the attitudinal variables used here are not like those used earlier. The attitudinal statements used in the 2023-24 questionnaire are adapted from an unrelated effort to harmonize attitudinal questions used across a wide variety of travel behavior studies (Shaw, 2019). A few of these attitudinal statements used by Nordhoff and Hardman (submitted) may tap into concepts related to a few of the BEV and FCEV assessments and attitudes in the models of *BEV* and *FCEV Consideration*. These possible associations are shown in Table 14.

Table 15 presents abbreviated results from the model estimation, limiting the presentation to those descriptive variables estimated to have a statistically significant relationship to support for the ZEV regulation at $\alpha \leq 0.05$[10]. Table 15 includes unit odd ratios and the percent change in the odds a person is one-unit higher on the opposition-support scale across the whole range of values of each statistically significant independent variable. A unit odds ratio is the change in the odds a person is in a higher category of support for each one unit change in the independent variable. If the independent variable is coded as only two values, e.g., 0 or 1, then there can be only one single unit change in the value of the variable and the unit odds ratio is also the measure of the total change in the odds of being one unit higher on the opposition-support scale for that variable. However, if the variable has more than two values, the total effect across that variables entire range of possible values is estimated based on how many unit changes are possible.

If an independent variable has a unit odds ratio greater than 1.00, that variable is positively associated with support for the ZEV regulation: as the value of the independent variable goes up so do the odds the participant is at a higher category of ZEV policy support than at a lower category, holding all other variables constant. A unit odds ratio less than 1.00 indicates a negative correlation—as the value of the independent variable goes up, the odds of being at a higher level of support go down (or conversely, the odds of being at a lower level go up).

[10] Results in Table 15 are selected from a model estimation containing all the independent variables, including those with non-significant associations with support for the ZEV regulation. The complete model from Nordhoff and Hardman (submitted) is presented in Appendix F of this report.

Table 13. Variables used in the ordinal regression model and response coding.

Concept	Variable	Response coding[1]
Socio-economic and demographic variables	Respondent [Age]	1 = 14 or younger 2 = 15 to 18 3 = 19 to 29 4 = 30 to 39 5 = 40 to 49 6 = 50 to 59 7 = 60 to 69 8 = 70 to 79 9 = 80 or older
	Respondent Gender: Female	1 = Yes, 0 = No
	Respondent Education: Highest-level of completed	Masters, Doctorate, or Professional Degree; 1 = Yes, 0 = No
	Respondent Race or ethnicity: Five variables. White/Caucasian Hispanic/Latino Asian Black/African American Other (incl. American Indian, Alaska Native, Middle Eastern/North African, and Native Hawaiian)	Each variable coded as 1 = selected, or 0 = not selected
	Respondent Employment Status	1 = Yes, 0 = No
	Residential tenure: Homeowner.	1 = Yes, 0 = No
	Household income	1 = Less than $10,000 2 = $10,000 - $24,999 3 = $25,000 - $49,999 4 = $50,000 - $74,999 5 = $75,000 - $99,999 6 = $100,000 - $124,999 7 = $125,000 - $149,999 8 = $150,000 - $174,999 9 = $175,000 - $199,999 10 = $200,000 - $224,999 11 = $225,000 - $249,999 12 = $250,000 or more
Household vehicles	Number of household vehicles	0, 1, 2, 3, 4, 5 or more
	Main car a ZEV[2]	1 = Yes, 0 = No

Concept	Variable	Response coding[1]
Attitudes	Five attitude statements assessed on a five-point scale:	1 = Strongly Disagree 2 = Disagree 3 = Neither Agree nor Disagree 4 = Agree 5 = Strongly Agree
	• I like the idea of having stores, restaurants, and offices mixed among the homes in my neighborhood • Learning how to use new technologies is often frustrating for me • Cost or convenience takes priority over environmental impacts (e.g. pollution) when I make my daily choices	
	• Having to wait is an annoying waste of time • I generally enjoy the act of traveling itself • I definitely want to own a car	
Built environment	Participant resides in an urban area. Census tract type based on Year 2010 boundaries.[2]	1 = Urban, 0 = Rural
	Self-reported access to home charging; Level 1 or 2	1 = Yes, 0 = No
	ZEV per 1000 Households (using 2010 census tract boundaries)[3]	Numeric: Min = 0, Max = 406.48
	Number of Level 1 charging stations within 15-minute drive from respondent's home location	Numeric: Min = 0.75, Max = 372.66
	Number of DC Fast Charging stations within 15-minute drive from respondent's home location	Numeric: Min = 0, Max = 355

Notes

1. The response coding of several variables is simpler than the original response options provided to participants. See Nordhoff and Hardman (submitted) for details of the original response options.

2. "ZEVs" include plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs).

3. The CalEnviroScreen tool used to identify disadvantaged communities still uses 2010 Census tract boundaries rather than the 2020 boundaries. Thus the 2010 boundaries were used for survey sampling purposes, thus imposing the corresponding 2010 Census tract values on some variables. The counts of vehicles and chargers are contemporaneous with the 2023-24 survey; those counts are apportioned to 2010 Census tracts.

Three independent variables exert the greatest effect on participants' support for California's ZEV Mandate:

1. The attitudinal statement, "Cost or convenience takes priority over environmental impacts (e.g., pollution) when I make my daily choices."
2. The number of ZEVs per 1,000 households in the Census tract in which the participant resides
3. Whether the participant owns a ZEV.

As the attitude statement balancing environmental performance vs. convenience and cost is scored on a five point scale (and thus has a total of four possible one-unit changes), based on its unit odds ratio (0.588) a person who strongly *agrees* that cost and convenience take precedence over environmental considerations in their daily choices has odds approximately 165 percent greater of being at a lower level of support of ZEV mandate support (or a higher level of opposition) than a person who strongly *disagrees* with the statement.

Table 14. Possible associations between BEV (FCEV) assessment and attitudinal statements from the analysis of BEV and FCEV consideration (2017, 2019, and 2021) and attitudinal statements from Nordhoff and Hardman (submitted) (2023-24).

BEV and FCEV Assessment and Attitude Statements, 2017, 2019, and 2021		**Attitude statements from Nordhoff and Hardman (submitted), 2023-24**
Statement type	Statement	Attitude Statements
BEV Assessment	BEVs are less damaging to the environment than gasoline vehicles.	Cost or convenience takes priority over environmental impacts (e.g. pollution) when I make my daily choices.
FCEV Assessment	FCEVs are less damaging to the environment than gasoline vehicles.	
BEV and FCEV Environmental Attitude	Personal worry about air quality in the region the participant lives.	
BEV Assessment	BEVs take too long to charge.	Having to wait is an annoying waste of time
FCEV Assessment	FCEVs take too long to charge.	

The effect of whether the people living around study participants own ZEVs (across the entire range of ZEV population density) is on par with the effect of whether participants own a ZEV themselves. Though the unit odds ratio for the variable *ZEVs per 1,000 households per 2010 Census tract* is barely above 1.0 (yet is statistically significant), the range of values of this variable is so large (zero to ~406) that its total hypothetical effect on the odds a person living in a Census tract with the highest observed density of ZEVs is at a higher (more positive) level of agreement with the ZEV Mandate are approximately 162 percent higher than a person living in a Census tract with zero ZEVs per 1000 households. For comparison, a participant who is a ZEV owner has odds of more strongly supporting the ZEV Mandate that are approximately 158 percent higher than one who does not own a ZEV. We note that most people do not live in Census tracts with the high extreme ZEV density value and thus as a practical matter the effect of owning a ZEV is likely larger than that of the density of ZEVs in the Census tract in which a person resides.

Table 15. Odds ratios for the statistically significant independent variables in the ordinal logistic regression model of support for California's ZEV regulation.

Independent variables		Unit Odds ratio	Absolute Value of Total δ in Odds across range of Independent Variables, %
Household and participant characteristics	Graduate or Professional Degree	1.356	35.6
	Race/Ethnicity: White	2.325	132.5
	Race/Ethnicity: Hispanic/Latino	1.998	99.8
	Race/Ethnicity: Asian	1.987	98.7
	Number of vehicles in the household	0.789	105.5
	Main car a ZEV	2.585	158.5
Attitudes	I like the idea of having stores, restaurants, and offices mixed among the homes in my neighborhood	1.486	48.6
	Cost or convenience takes priority over environmental impacts (e.g. pollution) when I make my daily choices	0.588	164.8
	Having to wait is an annoying waste of time	0.874	50.4
	I definitely want to own a car	0.880	48.0
Built environment and infrastructure access	Living in urban area	1.454	45.4
	ZEVs per 1000 households	1.004	162.0
	Self-reported access to home charging (L1 + L2)	1.368	41.6
Intercepts Reference Category: 1 = Strongly Opposed.	Intercept (2 = Somewhat oppose)	0.056	
	Intercept (3 = Neither oppose nor support)	0.135	
	Intercept (4 = Support)	0.265	
	Intercept (5 = Strongly support)	1.044 (n.s.)	
Number of observations	1308		
Degrees of freedom	28		
Log likelihood	-1845.314		
Pseudo R^2	0.25		

The next most influential variables are the race/ethnicity indicators. Participants who selected White, Hispanic/Latino or Asian have odds of higher support for the ZEV Mandate that are about 100 percent higher than those who did not select these options. (Race/ethnicity indicators for Black and Other (including American Indian, Alaska Native, Middle Eastern/North African, and Native Hawaiian) were not statistically significant.) We have no specific hypotheses about the role of race/ethnicity in support for the ZEV Mandate, but note the described effects are statistically significant even in the presence of other variables correlated with race/ethnicity, e.g., participant education and household income.

The remaining attitudinal variables are all in a group of the third most influential variables with differences in the odds ratios between those participants with the strongest disagreement scores and those with the strongest agreement scores of approximately 45 to 50 percent. The belief that waiting is a waste of time is associated with lower odds of supporting the ZEV mandate, wanting to live in a place with a mix of land uses in the neighborhood is associated with greater odds, and wanting to own one's own cars is associated with lower odds of supporting the ZEV Mandate.

The least influential variables are participants' self-reported access to the capability to charge an EV at their residence (whether Level 1 or Level 2 having access increases the odds of supporting the ZEV mandate) and whether participant possesses a professional or graduate degree (those who do have higher odds of supporting the ZEV Mandate).

Support for the Assertion that Opposition to the ZEV Mandate is a form of Political Resistance

The analysis of support for California's ZEV Mandate interprets political resistance with respect to a single policy, though a policy freighted with broader political meanings: the role and extent of government regulation of producers (automobile manufacturers), the objects of that policy (automobiles), the pervasive place in the lives of most of the citizenry of automobiles, and the confluence of public (government) action regarding social goods (reducing emissions of criteria pollutants and climate forcing compounds) commonly associated with "environmentalism" that is perceived by some to conflict with private, i.e. consumer or "private market" goals. Via such meanings, pro-environmental policies have come to be largely associated with the political left in contemporary American politics and opposition to such policies to be largely associated with the political right. These associations are evinced in recent analyses of which U.S. states do or do not have robust Renewable Portfolio Standards (Haseloff, 2024). To the extent that either the Democratic or Republican Parties in the U.S. represent consistent sets of principled beliefs, agreement and disagreement with the ZEV Mandate may be expected to reflect such political differences. Noting that agreeing with the ZEV Mandate is also political, disagreeing with the ZEV Mandate is 1) political and 2) and expression of resistance to a prevailing policy and its supporting politics.

The model of support for the ZEV Mandate contains no direct measure of political orientation to test the preceding argument. It does contain a few primarily socio-economic and demographic variables that correlate with political identification or inclination. The model variables for education, race/ethnicity, and residing in an urban area are all correlated with whether a person considers themselves to be or leans toward being a Democrat or Republican according to the Pew Research Center (2024). Pew's (ibid) study of U.S. adult population reports people with a higher level of formal education are more likely to consider themselves to be or to lean toward being Democrats. Thus, the direction of the effect of the independent variable indicating whether a person holds a graduate or professional degree is consistent with the idea that agreeing with the ZEV Mandate is "left-leaning" and disagreeing is "right-leaning." The same is true for the independent variable indicating whether a person lives in an urban area. The case for race/ethnicity is less clear cut. The independent variable for White/Caucasian has the greatest effect in favor of agreeing with the ZEV Mandate of any of the race/ethnicity categories in our data but is the only race/ethnicity group that—nationally—is more likely to be or to lean toward being a Republican than a Democrat.

The estimated parameters for the environmental attitude statements in the model of support for the ZEV Mandate further back the interpretation that agreement and disagreement with the ZEV Mandate may be interpreted as being, at least in part, political. As discussed above, those who disagree they place cost and convenience over environmental consequences are more likely to support the ZEV Mandate and those who agree they place cost and convenience over environmental consequence are more likely to oppose. Recall, this variable is among the most influential in the model.

Discussion: Comparing Resistance to ZEVs and Resistance to ZEV Policy

Associations between Variables in the Models of BEV and FCEV Consideration and those in the Model ZEV Policy Support

We observe that perceptions of the environmental importance of ZEVs are important correlates of both whether car-owning households in California have considered a ZEV for their household—including whether they say they won't ever do so—and support for the state policy requiring the sale of ZEVs. As noted in Table 14, the attitude statement, "Cost or convenience takes priority over environmental impacts (e.g. pollution) when I make my daily choices," from the model of ZEV policy support may be related to three statements regarding the effects of BEVs and FCEVS on the environment compared to gasoline vehicles and personal worry about air quality in the models of BEV and FCEV Consideration. We surmise a person who has a stronger positive assessment of the environmental performance of BEVs and FCEVs and is more worried about air quality has more to weigh against cost and convenience. Though it is notable that the newer attitude statement from Shaw (2019) may sway participants to presume that better environmental performance comes with lower convenience and higher costs. Regardless, the

assessments of whether BEVs or FCEVs are better for the environment than gasoline vehicles each load onto an assessment factor that is the most influential variable in their respective models of *BEV* and *FCEV Consideration*. The variable for personal worry is much less influential in both these models.

Measures of Resistances

The analysis of data from car-owning households in California in 2017, 2019, 2021, and 2023-34 support some inferences about different forms of resistance to ZEVs: active, passive, ambivalence, and political resistance. While this analysis of past data provides some insights, improvements can be made over the provisional mapping of different concepts of resistance onto the available measure of Consideration as presented here. The mapping of resistance onto Consideration cannot directly assess two hypothesized causes of passive resistance (*status quo* satisfaction and general resistance to change) since all passive resistance is provisionally mapped into a single Consideration category. Commitment (i.e., the opposite of resistance), blended adoption, and discontinuance can't be distinguished from each other in this analysis—again, because these are all mapped into a single category of Consideration. Active resistance suffers the opposite problem as it maps into two categories of Consideration at both extremes of that measure.

It might seem possible to more accurately identify people as passive resistors, active resistors, political resistors, discontinuers, blended adopters, committed adopters, or ambivalent by observing their vehicle purchases over time. However, simply observing which vehicles people acquire does not tell us why those vehicles were acquired (nor does it tell us why those that were not acquired, were not). In addition to any observable actions, resistance is a complex of cognitions, emotions, and symbolic or communicative states. For example, observing people *not* acquiring BEVs doesn't and can't distinguish between active resistance, passive resistance, and ambivalence. This section presents additional measures of several forms of resistance and hypothesized antecedents for some of them.

Passive Resistance

As discussed in the opening section of this report, passive resistance has been hypothesized to be of distinct types each with its own cause: 1) a generalized resistance to change of any kind and 2) satisfaction with the way things are. Heidenreich et al. (2015, 2016) provide the following items to assess these two antecedents of passive resistance.

Resistance to Change

The following items assess a generalized resistance to change. Each item is scored on a scale from 1 = Strongly Disagree to 7 = Strongly Agree.

- *I am generally cautious about accepting new ideas.*
- *I am suspicious of new inventions and new ways of thinking.*
- *I rarely trust new ideas until I see whether most people around me accept them.*
- *I am usually one of the last people in my group to accept something new.*

- *I am reluctant to adopt new ways of doing things until I see them working for people around me.*
- *I find it stimulating to be original in my thinking and behavior.*
- *I tend to feel that the old way of living and doing things is the best way.*
- *I am challenged by ambiguities and unsolved problems.*
- *I must see other people using new innovations before I will consider them.*
- *I often find myself skeptical of new ideas.*

Status Quo Satisfaction

The following items assess satisfaction with the way things are. Status quo satisfaction is itself hypothesized to have four dimensions: routine seeking, emotional reaction, short-term thinking, and cognitive rigidity. Each of these four dimensions is assessed by four items. Each item is scored on a scale from 1 = Strongly Disagree to 6 = Strongly Agree.

Routine Seeking

- *I generally consider changes to be a negative thing.*
- *I'll take a routine day over a day full of unexpected events any time.*
- *I like to do the same old things rather than try new and different ones.*
- *Whenever my life forms a stable routine, I look for ways to change it.*

Emotional Reaction

- *If I were to be informed that there's going to be a significant change, I would probably feel stressed.*
- *When I am informed of a change of plans, I tense up a bit.*
- *When things don't go according to plans, it stresses me out.*
- *If I were to be informed that there's going to be a change of plans, prior to knowing what the change actually is, I would probably presume that the change is for the worse.*

Short-term Thinking

- *Changing plans seems like a real hassle to me.*
- *Often, I feel uncomfortable about changes though they may potentially improve my life.*
- *When someone pressures me to change something, I tend to resist it even if I think the change may ultimately benefit me.*
- *I sometimes find myself avoiding changes that I know will be good for me.*

Cognitive Rigidity

- *I often change my mind.*
- *Once I've come to a conclusion, I'm not likely to change my mind.*
- *I don't change my mind easily.*
- *My views are very consistent over time.*

Active Resistance

Active resistance is based on a negative attitude toward a specific idea, product, or behavior. Therefore, the estimation of active resistance will continue to follow the lines of inquiry laid out in the analysis in this report. However, recognizing that any innovation may face psychological barriers rooted in tradition, image, and other sources and having argued that among these barriers to EVs are political barriers, additional questions will be added to a future questionnaire (or reintroduced from past questionnaires).

Political Resistance

Some political researchers argue political beliefs may be identified by asking people which position they support on a variety of issues (see for example, Yeung (2022)). This approach depends on one of two possible ways of identifying liberal and conservative positions on the issues. One would state a few basic tenets of liberalism and conservatism and argue from these as to "what a liberal would do" and "what a conservative would do." Another argues that identifying liberals and conservatives is a matter of values. This approach relies less on support for liberal versus conservative policy positions than on an examination of whether any policy position can be expressed within the value systems that liberals tend to hold versus those conservatives tend to hold. For example, Wolsko et al. (2016) conclude, "conservatives shifted substantially in the pro-environmental direction after exposure to a binding moral frame, in which protecting the natural environment was portrayed as a matter of obeying authority, defending the purity of nature, and demonstrating one's patriotism to the United States." As such, neither political liberals nor conservatives are immutably for or against, for example, innovations that reduce greenhouse gas emissions. However, for a liberal or conservative to consider that innovation, the innovation must be capable of being described in terms of values liberals or conservatives tend to hold.

A third approach argues that people, in general, do not have consistent core political beliefs but rather their politics are tribal, or identity-based. In this view, people take on the beliefs of those they perceive to be or anoint as the leader of their "tribe." One basis for such tribalism may be moral frames. For example, Lakoff (2016) argues political conservatives and liberals are each more likely to ascribe to a particular moral view of the world; the "authoritarian father" in the case of conservatives and the "nurturing parent" in the case of liberals. Haidt and Graham (2007) and Haidt (2012) argue that liberals and conservatives can be reliably identified using five moral judgements—harm, fairness, ingroup (i.e., loyalty and group identity), authority, and purity. Liberals tend to appeal more

to moral assessments based on harm and fairness; conservatives, to ingroup, authority, and purity.

From Barber and Pope (2018), "Using a research design that employs actual "conservative" and "liberal" policy statements from President Trump, we find that low-knowledge respondents, strong Republicans, Trump-approving respondents, and self-described conservatives are the most likely to behave like party loyalists by accepting the Trump cue—in either a liberal or conservative direction. These results suggest that there are many party loyalists in the United States, that their claims to being a self-defined conservative are suspect, and that group loyalty is the stronger motivator of opinion than are any ideological principles." This is not only a recent phenomenon. In 2003, Cohen reported, "Four studies demonstrated both the power of group influence in persuasion and people's blindness to it. Even under conditions of effortful processing, attitudes toward a social policy depended almost exclusively upon the stated position of one's political party."

For continuing research on political resistance to EVs, we follow this third approach. We further incorporate insights from Keith et al. (1986) that people who profess to be Independents when asked if they have any affiliation with a political party are more likely to act in a more partisan manner than people who state an affiliation with one of the two dominant political party. Given this, we recommend modified versions of the questions used by the Pew Research Center (Pew, 2024). Based on recent research arguing political beliefs are more tribal and identity-driven than grounded in philosophical differences, these questions about identification with political parties will be added.

In politics today, do you consider yourself to be a…

- ☐ *Republican*
- ☐ *Democrat*
- ☐ *Independent*
- ☐ *Other [Text box]*
- ☐ *Decline to state*

If they answer Independent, Other, or Decline to state, follow-up:

As of today, do you lean more to…

- ☐ *The Republican Party*
- ☐ *The Democratic Party*
- ☐ *Decline to state*

The following two questions have been asked in past surveys by the author and will be reintroduced to future surveys. Both are scored on a scale from 1 = Strongly disagree to 7 = Strongly agree. Even if modern politics in America are more tribal than philosophical, these two questions address two ideas that do seem to animate tribal distinctions. The first item

addresses the difference between the ability of "markets" to produce the "right" types of goods and services vs. the need for social and public forces codified in "government" to guide markets to "right" types of goods and services. The second specifically addresses whether the "right" goods include replacements for petroleum-based fuels without specifying a reason or reasons why that might be.

If government did not intervene, the market would produce electric vehicles if we needed them.

There is an urgent need to replace gasoline and diesel fuels with other sources of energy.

Ambivalence

In addition to the search for clusters of people who have both strong positive and strong negative assessments of EVs such as was done for the EV assessment items in the Results section of this report, scales to measure ambivalence more directly may also be used. These include one set of three related items and another set of two related items. The first set is related to *felt ambivalence*. It asks respondents to consider the question of whether they will be acquiring an EV and to evaluate how they feel about the question and their answer. Based on the work of Priester and Petty (1996) and Armitage and Arden (2007), the following questions address the extent to which felt ambivalence may play a role in active resistance, discontinuance, and blended adoption.

Regarding my answer to the question of whether I will be acquiring and driving an electric vehicle, I feel

1 = no conflict at all to 10 = very conflicted

1 = no indecision at all to 10 = very indecisive

1 = completely one-sided reactions to 10 = very mixed reactions

The second set of questions are related to *potential ambivalence*. These items are scored on slider from +1 = Not at all negative to +7 = Extremely negative.

Consider for now only those things about acquiring and driving an electric vehicle that you feel or think are negative and ignoring the positive things. How negative are those things?

Consider for now only those things about acquiring and driving an electric vehicle that you feel or think are positive and ignoring the negative things. How positive are those things?

Higher scores on all these items indicate greater ambivalence.

Commitment

Survey participants whose most recently acquired vehicle was a BEV may be asked questions about their commitment to acquire only BEVs for the foreseeable future. The version here is for BEVs, and versions for PHEVs, FCEVs, or for all types of ZEVs may be asked as appropriate:

Are you committed to buying only BEVs for the foreseeable future?

- ☐ *Yes, I am (we are) committed to buying only BEVs for the foreseeable future.*
- ☐ *No, I am (we are) not committed to buying only BEVs for the foreseeable future.*

If they indicate they are not committed to acquiring only BEVs, they may then be asked:

What types of vehicles do you image you will continue to buy in the future? Please select all that apply.

- ☐ *Vehicles powered by gasoline or diesel fuel*
- ☐ *Hybrid vehicles*
- ☐ *Plug-in hybrid vehicles*
- ☐ *Battery electric vehicles*
- ☐ *Hydrogen fuel cell electric vehicles*

Those who have acquired a BEV in the past but whose most recent acquisition was a conventional or hybrid gasoline vehicle may be asked a different version of the two questions about their commitment to BEVs. The first establishes whether the recent acquisition of gasoline-fueled vehicle signals a commitment to such vehicles, then if not, a follow-up to assess commitment to BEVs.

You have previously acquired a BEV, but more recently you acquired a vehicle powered by gasoline or diesel. Are you committed to buying only vehicles powered by gasoline or diesel fuel for the foreseeable future? Please choose only one of the following:

- ☐ *Yes, I am (we are) committed to buying only vehicles powered by gasoline or diesel fuel for the foreseeable future.*
- ☐ *No, I am (we are) not committed to buying only gasoline or diesel fuel for the foreseeable future.*

If they select the second response, they may then be asked:

What types of vehicles do you image you will continue to buy in the future? Please select all that apply.

- ☐ *Vehicles powered by gasoline or diesel fuel*
- ☐ *Hybrid vehicles*
- ☐ *Plug-in hybrid vehicles*
- ☐ *Battery electric vehicles*
- ☐ *Hydrogen fuel cell electric vehicles*

Finally, because it is possible that a person or household that has not already acquired an EV might feel committed to doing so in the future, households with no history of acquiring EVs may be asked these two questions.

Are you committed to buying only some type of electric vehicle for the foreseeable future? Select one.

- ☐ *Yes, I am (we are) committed to buying only electric vehicles for the foreseeable future.*
- ☐ *No, I am (we are) not committed to buying only electric vehicles.*

If they select the second response, they are then asked:

What types of vehicles do you image you will continue to buy in the future? Please select all that apply.

- ☐ *Vehicles powered by gasoline or diesel fuel*
- ☐ *Hybrid vehicles*
- ☐ *Plug-in hybrid vehicles*
- ☐ *Battery electric vehicles*
- ☐ *Hydrogen fuel cell electric vehicles*

Conclusions

While the analysis informs the discussion of consumer resistance to BEVs and FCEVs in the timeframe from 2017 to 2021 and extends a select finding regarding political resistance to 2023-24, it also highlights the need for additional measures to extend, refine, and update our understanding of people who have not acquired BEVs or FCEVs or more broadly, have not committed to only acquiring ZEVs. Before reviewing the main analytical findings, we summarize the terminology of resistance used throughout.

Types of Resistance

This report describes a vocabulary of resistance behaviors, maps resistance to EVs into a measure of consideration of EVs asked in past surveys of car-owning households, and concludes with several suggested measures to include in future survey efforts to more accurately describe who is resistant to EVs, why they are resistant, and whether their resistance can be assigned to these types:

- *Active resistance* based on evaluation of a specific "attitude subject." Here, that attitude subject is EVs. The analysis tying resistance to Consideration more narrowly focuses on resistance to either or both BEVs and FCEVs.
    - Political resistance as developed here is a type within active resistance. Political resistance arises from the politicization of the goals for vehicle electrification, lawmaking and regulation to support electrification, EVs, and ultimately the people who do—or more to the point, don't—buy them. Here, the attitude subject is the symbolic and communicative—and thus, social, elements of the socio-technical system of EVs.
- *Commitment* may be the opposite of resistance, but commitment may be only partial and may turn to resistance.
    - *Partial commitmen*t describes the state of continuing acquisition and use of both the old and the new, i.e., gasoline vehicles and EVs.
    - *Discontinuance* is commitment that turns to active resistance arising after a person has acquired and used an EV and in doing so forms an attitude to not do so again.
- *Passive resistance* is taken to be a general state in which no or limited attention to any signs a change may be happening or desirable. Two antecedents are proposed for passive resistance:
    - *Resistance to change*
    - *Status quo satisfaction*

Either way, passive resisters to EVs have nothing against EVs but also nothing in favor of EVs as they aren't paying enough attention to have formed any attitude.

- *Ambivalence* is possessing both a strong negative and strong positive attitude toward a subject at the same time. Active resistance to EVs may not be required to keep someone from acquiring an EV; ambivalence may be enough.

Measuring Consideration, Inferring Resistance to ZEVs: 2017, 2019, 2021

For purposes of this report, the reanalysis of past data to explore resistance to ZEVs is limited to the cases of BEVs and FCEVs. The limitation on including PHEVs is a difference in survey design that omitted some variables for PHEVs in one year. Samples of car-owning households in California were asked the extent to which they have already considered a BEV "for their household" and again for FCEVs. These measures of *BEV* and *FCEV Consideration* were analyzed using responses from the years 2017, 2019, and 2021. A provisional mapping of active and passive resistance onto these *Consideration* variables allows new inferences than offered in prior analyses of these data.

One result should not be lost in the details: when data from 2017, 2019, and 2021 are combined in an ordinal logistic regression model of *BEV Consideration*, the variable identifying the survey year is not statistically significant. Given the other explanatory variables in the model, this multi-year analysis provides no reason to believe that the prevalence of different levels of consideration of BEVs differs between the three survey years.

Whether FCEV Consideration differs across the three survey years is more complicated. Slightly fewer households are in the lowest level of FCEV Consideration in 2021 than in 2017 and 2019. However, any positive assessments participants may have had of several aspects of FCEVs had a declining effect on the probability of being in this lowest category of FCEV Consideration in 2021 than in 2019 and less still than in 2017.

Given the differences flowing from the statistically significant relationship between *FCEV Consideration, Year,* and *FCEV Assessment Factor 1*, in the broadest terms both the BEV and FCEV Consideration models indicate some measure(s) of personal and household socio-economic and demographics, personal and household residential, vehicle, and travel context, environmental and political beliefs, and specific measures of engagement with and assessment of BEVs in the one case and FCEVs in the other are associated with the estimated probability a person states they haven't and won't consider such vehicles for their household.

Active Resistance to BEVs and FCEVs

Active resistance to BEVs and FCEVs results from negative attitudes toward those vehicle types. We assess active resistance using nine statements pertaining to BEVs and eight pertaining to FCEVs. (The statement included for BEVs but omitted for FCEVs asks respondents to assess whether they can charge a vehicle at their residence.) The nine BEV statements are combined via factor analysis into two BEV Assessment factors. The seven of the eight FCEV statements are combined in a separate factor analysis into two FCEV Assessment factors while one FCEV Assessment statement is held out as an independent assessment.

BEV Assessment Factor 1 includes the extent to which respondents disagree or agree with these (paraphrased) statements:

- BEVs take too long to charge
- BEVs range too short
- BEVs higher priced than gasoline vehicles
- Gasoline vehicle safer than BEVs
- Gasoline vehicles more reliable than BEVs

BEV Assessment Factor 2 includes these:

- I can plug-in a vehicle at home
- There are enough places to charge BEVs
- BEVs are less damaging to the environment than gasoline vehicles
- BEVs are ready for mass markets

A negative attitude toward BEVs is measured by negative scores on these factors; conversely, positive scores indicate positive attitudes. These two BEV Assessment factors have the strongest effects of any variables in the model that estimates probability a respondent is in any given *BEV Consideration* category. We have argued that active resistance is associated with the *BEV Consideration* category, "hasn't and wouldn't consider a BEV," while positive assessments are associated with higher levels of BEV consideration, e.g., "have shopped for a BEV…," and "Have or have had a BEV."

Still, at present just having even very positive BEV assessments does not guarantee a person is paying any real attention to BEVs. In addition to a strong, positive assessment of BEVs, the respondents who "have or have had" a BEV also are able to offer reasons why they would acquire a BEV, they have some personal worry about the effects of air pollution and a belief that where they live that powering a vehicle with electricity is better for the environment than doing so with gasoline or diesel, have supportive contexts including electricity available at the location they park their vehicles at home, knowing (another) BEV owner, and higher household incomes. They have, to date, also tended to be younger and have more formal education.

A second analysis of the nine BEV assessment statements addressed the question of whether there are identifiable clusters of people who respond similarly to the BEV assessments and whether such clusters can be associated with resistance and consideration. The answers appear to be, yes.

One cluster contains people who, on average, give the worst assessments to BEVs on almost all nine assessment statements. This is the negative attitude toward BEVs expected of active resistors. Another cluster contains people who generally provide the most positive assessments. A third cluster has the mix of strong positive and negative assessments expected of people who are ambivalent. As a rule, this cluster has high scores on the assessments in Factor 2, i.e., positive assessments of their ability to charge a BEV at home and that there are enough places to charge BEVs as well as of the environmental benefits and marketability of BEVs. However, they tend to have strong negative assessments on the statements in Factor 1, i.e., the performance measures more closely tied to BEVs themselves, e.g., driving range, charge duration, and price, safety, and reliability compared to gasoline cars.

Another cluster may be ambivalent, but their only positive assessments are that BEVs are better for the environment than gasoline vehicles and their confidence they could charge one at home; all other assessments are negative, if not as negative as the first cluster are ready for mass marketing. The last cluster does not match definitions of active resistance, any form of commitment, or ambivalence. They have no particularly strong assessments, neither negative nor positive. Perhaps this is a sign of hesitancy or uncertainty among passive resistors stirred for the first time to consider BEVs by our surveys.

FCEV Assessment Factor 1 is analogous to BEV Assessment Factor 1 as it includes analogs of the same five statements:

- FCEVs take too long to fuel
- FCEVs range too short
- FCEVs higher priced than gasoline vehicles
- Gasoline vehicle safer than FCEVs
- Gasoline vehicles more reliable than FCEVs

FCEV Assessment Factor 2 is partially analogous to BEV Assessment Factor 1 as it includes two of the four analog statements:

- There are enough places to charge FCEVs
- FCEVs are ready for mass markets

The FCEV Assessment “FCEVs are less damaging to the environment than gasoline vehicles” does not load on either of these two factors. Nor does it load onto a third factor if a three-factor solution is computed. Thus, the original values of this FCEV Assessment are used in the initial model of FCEV Consideration.

Similar to the model of *BEV Consideration*, the most influential variables in the model of *FCEV Consideration* are participants' specific assessments of FCEVs, and whether they could provide any positive reason they might consider and FCEV. That all these are based on assessments specifically of FCEVs is consistent with the provisional mapping of (most) active FCEV resistors into the lowest category of *FCEV Consideratio*n.

The second analysis of the FCEV assessment statements (i.e., testing for the presence of clusters of people who share close patterns of assessment scores rather than testing for a smaller number of assessment factors that combine, assessment statements yet still account for much of the variation in the originals) also supports the provisional mapping of people with low assessments of FCEVs into the lowest category of *FCEV Consideration*. The result for FCEV Cluster 5—the cluster with the lowest assessment scores—is unambiguous: approximately 62 percent of participants in this cluster also say they have not and would not consider an FCEV.

Political Resistance to ZEVs

We've identified the possibility of a specific form of active resistance based on the politicization of ZEVs based on differences in beliefs about the role of government and ZEVs symbolized values. However, we have only a single survey item repeated in all three survey years to inform an analysis of political resistance—a question about whether people believe governments should be offering incentives to people to buy vehicles powered by alternatives to gasoline and diesel.

The variable for this item is statistically significant in the models of *BEV* and *FCEV Consideration*. People who do not believe the governments should be offering incentives are more likely to be in the "haven't and wouldn't consider a BEV" category than are people who believe governments should be offering incentives. It is also the case that support for government incentives is associated with the BEV Assessment clusters: non-supporters of incentives are more likely than expected to be in the cluster with the worst BEV assessments while supporters are more likely than expected to be in the cluster with best assessments. The results from the *FCEV Consideration* model are similar. If there is any difference, it is that support of government incentives in general has a larger effect on the probability a person is at the lowest level of consideration for FCEVs (~10 percentage point difference) versus BEVs (~seven percentage point difference).

Given this limited measure of political resistance, we provisionally offer that active resistance based in the attributes of BEVs, their comparison to gasoline vehicles, and the supporting system of charging has a larger effect on the extent to which people have considered BEVs than does political resistance.

Extending Political Resistance from the Objects of Policy to the Policy Itself

Extending discussion of political resistance to policy itself was done using more recent data (late 2023 to early 2024) from car-owning households in California. These data do not contain the same variables as in the data from 2017, 2019, and 2021. However, they do contain data on the extent to which respondents disagree or agree with California's ZEV Mandate. Interpreting disagreement as resistance and agreement as support gives us a direct measure rather than the proxy measures of BEV and FCEV Consideration.

Arguments are presented as to why we may expect that differences between disagreement and agreement with the ZEV Mandate are—at least in part—political. Though recent political events are disrupting widely held beliefs, it may be said that differences in belief in a limited and conservative role for government vs. belief in a more expansive and progressive role still distinguishes people who are more likely to be right-leaning, and/or identify as a member of the Republican party from those who are left-leaning and/or identify as a member of the Democratic Party. Further, within contemporary American politics, "environmental" issues also tend to align with political party affiliation/leaning. Democrats more likely to believe such issues are real and that government can or must have a positive role. Republicans more likely to deny the reality of some environmental issues and to deprioritize others in relation to economic development and private profit. The most influential variable associated with disagreement-agreement with the ZEV Mandate is an attitudinal statement weighing "cost or convenience" versus "environmental impacts in making daily choices. Based on these arguments and the results of the analysis, we have reason to support continued examination of political resistance as one mode in which some people will resist both the purchase of a ZEV as a private consumer and oppose public policy supporting or especially requiring ZEVs supplant conventionally-fueled vehicles.

Recommendations

The use of a specific proxy measure, such as *Consideration*, for several types of resistance has provided some actionable insights to address resistance to ZEVs. However, the most immediate and actionable recommendation from this research is to broadly deploy direct measures of resistance across studies of all car-buying households especially those outside California. This report has described several such direct measures. Each of these measures informs actions to address different groups of people, e.g., the passive resistance of the person who simply isn't open to hearing about ZEVs, the active resistance of the person is politically opposed to ZEV requirements, the ZEV owner who is happy to continuing acquiring ZEVs but feels the need to continue to acquire gasoline-fueled vehicles, and the ZEV owner who's experience has put them in the state of mind to quit ZEVs.

Across three samples spanning the five years from 2017 through 2021, we infer there is active resistance to BEVs and FCEVs based in negative evaluations of the vehicles and their charging and fueling infrastructures. From these differences, we infer the possibility of changing resistance to acceptance and ultimately commitment if we can improve those evaluations. This may be accomplished in part via actual improvement in technical improvement in performance, reliability, price, and availability—but only if people know these things. This basic level of attending to ZEVs can be aided by continuing and increasing efforts to leverage the generally positive social effects of knowing ZEV owners and recognizing the ZEVs in the world around us.

As political resistance is not about the vehicles themselves (even if it appears to be correlated with negative assessments of the vehicles and their charging and fueling infrastructures) finding ways that allow those whose resistance to ZEVs is political to find their way to acceptance and commitment may require opening the meanings of ZEVs to others than the historically predominant "environmental" and thus liberal meanings and creating politically conservative framings.

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Data Summary

Products of Research

No data were collected for this project, rather this project is based on new analysis of four data sets collected as part of four other projects. All four of the data sets were collected from samples of all car-owning households in California via on-line questionnaires. The samples were collected in 2017, 2019, 2021, and late-2023 to early-2024.

Data Format and Content

Describe the format or file type of the data, and the contents of each file.

The data have been archived in text files (.txt); variables are comma-delimited and cases are separated by carriage returns. The archived data includes the variables and cases required to recreate the analysis throughout this report. In general, the data include.

- year in which data were collected,
- socio-economic and demographic descriptors of respondents or their households,
- measures of daily travel context such as the number and types of vehicles each respondent's households own, where they park vehicles at their residence, and whether they commute to a workplace outside the home,
- descriptions of their residences such as availability of electricity at the locations they park their vehicles,
- attitudes pertaining to
    - beliefs about environmental issues such as air quality,
    - political beliefs,
    - attitudes related to vehicle ownership, desired land use mix, time use, and others hypothesized to correlate with support for policy requiring the sale of zero emission vehicles,
- knowledge of, experience with, and assessments of both battery and fuel cell electric vehicles,
- extent to which each of the respondent's households has considered acquiring either a battery or fuel cell electric vehicle, and
- degree of opposition or support for policy requiring the sale of zero emission vehicles.

Data Access and Sharing

The final data of this project are subject to the University of California, Davis's Institutional Review Board (IRB) guidelines on the treatment of human subject data. Requests for data may be directed to the Principal Investigator.

Reuse and Redistribution

The final data of this project are subject to the University of California, Davis's Institutional Review Board (IRB) guidelines on the treatment of human subject data. For all purposes allowed by the IRB guidelines, there are no further restrictions to the use of the data. Data can be reused and redistributed with credit to this report and the authors of the research and to the funding agency that funded the original data collection.

Appendix A: Parameter Estimates for Final Logistic Regression of BEV Consideration

Table A1. Parameter estimates for the final ordinal logistic regression equation in Tables 2, 3, and 4.

Term	Estimate	Std Error	χ^2	Prob > χ^2
Intercept[I (we) have not--and would not--consider buying a BEV.]	-0.43	0.114	14.29	0.0002
Intercept[I (we) have not considered buying a BEV, but maybe someday we will.]	1.598	0.116	190.28	<.0001
Intercept[The idea has occurred, but no real steps have been taken to shop for a BEV.]	3.362	0.121	778.08	<.0001
Intercept[Started to gather information about BEVs but haven't really gotten serious yet.]	4.732	0.13	1334	<.0001
Intercept[Shopped for BEVs, including a visit to at least one dealership to test drive.]	5.71	0.144	1566.8	<.0001
Respondent Age[30 to 39-19 to 29]	-0.15	0.085	3.17	0.0751
Respondent Age[40 to 49-30 to 39]	0.146	0.082	3.17	0.0748
Respondent Age[50 to 59-40 to 49]	0.06	0.085	0.49	0.4858
Respondent Age[60 to 69-50 to 59]	0.159	0.078	4.13	0.0422
Respondent Age[70 or older-60 to 69]	0.167	0.081	4.23	0.0398
rRespondent Education[Some College-Less than and High School Graduate or GED]	-0.176	0.085	4.33	0.0375
rRespondent Education[College Graduate-Some College]	-0.16	0.062	6.66	0.0099
rRespondent Education[Some Graduate School-College Graduate]	-0.153	0.108	2.03	0.1538
rRespondent Education[Masters, Doctorate, or Professional Degree-Some Graduate School]	0.171	0.112	2.3	0.1291
2017-21 Income 100k	-0.126	0.04	9.79	0.0018
New Car Buyer[No]	0.053	0.026	4.32	0.0377

Term	Estimate	Std Error	χ^2	Prob > χ^2
rHighest e- access[110 Volt-None; don't know]	-0.131	0.06	4.7	0.0302
rHighest e- access[220 Volt-110 Volt]	-0.231	0.062	13.67	0.0002
rHighest e- access[EVSE-220 Volt]	-0.554	0.118	22.13	<.0001
HOV[No]	0.081	0.034	5.62	0.0178
HOV[Yes; unable to use]	0.146	0.036	16.79	<.0001
tAir pollution: personal worry	-0.081	0.017	23.19	<.0001
iHuman health [Electricity vs gasoline]	-0.079	0.016	23.43	<.0001
Should government offer incentives[No]	0.117	0.057	4.23	0.0397
Should government offer incentives[I'm not sure]	0.1	0.051	3.81	0.051
Fueling: BEV[Incorrect]	0.134	0.029	20.81	<.0001
rKnow a BEV owner[No/Unsure]	0.294	0.03	96.84	<.0001
BEV: [Any positive reason][No]	0.803	0.039	422.01	<.0001
Familiarity [BEV]	-0.108	0.013	72.44	<.0001
Driving experience: BEV	-0.165	0.016	104.83	<.0001
Seen EVSE[I'm not sure whether I've seen any or not.]	0.196	0.099	3.94	0.047
Seen EVSE[No. I haven't seen any.]	0.023	0.052	0.2	0.6574
Seen EVSE[Yes. I've seen them at one place.]	-0.102	0.071	2.06	0.1516
Seen EVSE[Yes. I've seen them at a few places.]	-0.117	0.046	6.63	0.01
imp BEV 9 assessments 2017-21 Factor1	-0.486	0.032	236.65	<.0001
imp BEV 9 assessments 2017-21 Factor2	-0.447	0.038	139.24	<.0001

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories, values have been truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Appendix B: Base Values of Variables in the Final Model of BEV Consideration for Comparisons

Table B1. Values of the variables that serve as the basis for comparison of the effects of changes in any one of them.

Variable	Value
Respondent Age	19 to 29
Respondent Education	Less than High School or GED
Household Income	0.9339 ($93,339)
New Car Buyer	No
rHighest e⁻ access	None or I don't know
HOV	No
tAir pollution: personal worry	1.2315
iHuman health: electricity vs. gasoline	0.9066
Should government offer incentives	No
Fueling: BEV	Incorrect
rKnow a BEV Driver	No/Unsure
EV: [Any positive reason]	No
Familiarity: BEV	0.8297
Driving Experience: BEV	-1.8202
Seen EVSE	Not Sure
BEV Assessment Factor 1	0.011
BEV Assessment Factor 2	0.0183

Appendix C: Results for Initial Logistic Regression Model of BEV Consideration

The initial model is the starting version of the logistic regression model including all variables in Table 1.

Table C1. Whole Model Test of Initial Logistic Regression Model of BEV consideration.

Model	-LogLikelihood	Degrees of freedom	χ^2	Prob>χ^2
Difference	1721.10	53	3442.19	<0.0001
Full	7951.30			
Reduced	9672.40			
RSquare (U)	0.1779			
AICc	16019.7			
BIC	16411.0			
Observations	6511			

Table C2. Lack of fit.

Source	-LogLikelihood	Degrees of freedom	χ^2	Prob>χ^2
Lack Of Fit	7951.30	32497	15902.61	1.0000
Saturated	0.0000	32550		
Fitted	7951.30	53		

Table C3. Effect Likelihood Ratio tests.

Source	Degrees of Freedom	Likelihood ratio χ^2	Prob > χ^2
Year	2	3.017	0.2212
Respondent Age	5	31.763	<0.0001
rRespondent Gender	1	1.637	0.2007
rRespondent Education	4	23.480	0.0001
2017-21 Income 100k	1	9.180	0.0024
Residence Type	4	8.461	0.0761
Own Rent Residence	2	0.102	0.9504
Solar PV	1	0.196	0.6577
Vehicles per Person	1	0.000	0.9875
New Car Buyer	1	4.376	0.0364
Only or either car garage or carport	1	0.877	0.3490
rHighest e- access	3	52.064	<0.0001
Authority to Install	1	0.000	0.9866
Respondent days driving per week	1	3.388	0.0657
Respondent Commute	1	0.590	0.4426
HOV	2	26.659	<0.0001
tAir pollution: lifestyle	1	0.373	0.5415
tAir pollution: personal worry	1	11.727	0.0006
tAir pollution: regional threat	1	1.979	0.1595
iHuman health [Electricity vs gasoline]	1	3.840	0.0500
iEnvironment [Electricity vs gasoline]	1	1.425	0.2326
Should government offer incentives	2	23.079	<0.0001
Fueling: BEV	1	18.047	<0.0001
rKnow a BEV owner	1	99.537	<0.0001
BEV: [Any positive reason]	1	425.656	<0.0001
Familiarity [BEV]	1	63.919	<0.0001
Driving experience: BEV	1	95.797	<0.0001
Seen EVSE	4	8.796	0.0664
BEV 9 assessments 2017-21 Factor1	1	56.579	<0.0001
BEV 9 assessments 2017-21 Factor2	1	9.654	0.0019
BEV 9 assessments 2017-21 Factor1*Year	2	3.834	0.1471
BEV 9 assessments 2017-21 Factor2*Year	2	2.986	0.2247

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories, values have been truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Table C4. Parameter estimates.

Term	Estimate	Std Error	χ^2	Prob>χ^2
Intercept [I (we) have not--and would not--consider buying a BEV.]	-0.416	0.159	6.84	0.0089
Intercept [I (we) have not considered buying a BEV, but maybe someday we will.]	1.620	0.160	101.99	<.0001
Intercept [The idea has occurred, but no real steps have been taken to shop for a BEV.]	3.390	0.164	427.58	<.0001
Intercept [Started to gather information about BEVs but haven't really gotten serious yet.]	4.762	0.171	776.50	<.0001
Intercept [Shopped for BEVs, including a visit to at least one dealership to test drive.]	5.739	0.182	989.59	<.0001
Year[2019-2017]	0.119	0.079	2.29	0.1305
Year[2021-2019]	0.018	0.056	0.10	0.7489
Respondent Age[30 to 39-19 to 29]	-0.132	0.085	2.40	0.1216
Respondent Age[40 to 49-30 to 39]	0.131	0.082	2.55	0.1100
Respondent Age[50 to 59-40 to 49]	0.056	0.086	0.42	0.5172
Respondent Age[60 to 69-50 to 59]	0.155	0.080	3.74	0.0532
Respondent Age[70 or older-60 to 69]	0.169	0.083	4.18	0.0409
rRespondent Gender[Female]	0.033	0.026	1.64	0.2009
rRespondent Education[Some College-Less than and High School Graduate or GED]	-0.178	0.085	4.35	0.0370
rRespondent Education[College Graduate-Some College]	-0.161	0.063	6.60	0.0102
rRespondent Education[Some Graduate School-College Graduate]	-0.150	0.108	1.93	0.1647
rRespondent Education[Masters, Doctorate, or Professional Degree-Some Graduate School]	0.178	0.113	2.49	0.1144

Term	Estimate	Std Error	χ^2	Prob>χ^2
2017-21 Income 100k	-0.125	0.041	9.18	0.0024
Residence Type[Apartments]	0.029	0.078	0.14	0.7060
Residence Type[Attached SFH]	-0.168	0.077	4.75	0.0293
Residence Type[Mobile home]	-0.171	0.114	2.26	0.1330
Residence Type[Other]	0.323	0.190	2.87	0.0900
Own Rent Residence[Other]	0.000	0.099	0.00	0.9966
Own Rent Residence[Own]	-0.011	0.060	0.04	0.8497
Solar PV[No]	0.015	0.034	0.20	0.6522
Vehicles per Person	0.001	0.059	0.00	0.9873
New Car Buyer[No]	0.054	0.026	4.30	0.0382
Only or either car garage or carport[No]	-0.025	0.026	0.87	0.3505
rHighest e- access[110 Volt-None; don't know]	-0.117	0.066	3.16	0.0754
rHighest e- access[220 Volt-110 Volt]	-0.226	0.063	12.91	0.0003
rHighest e- access[EVSE-220 Volt]	-0.535	0.119	20.31	<.0001
Authority to Install[Need permission]	0.001	0.032	0.00	0.9865
Respondent days driving per week	-0.023	0.013	3.46	0.0628
Respondent Commute[No]	-0.022	0.028	0.59	0.4417
HOV[No]	0.075	0.034	4.80	0.0285
HOV[Yes; unable to use]	0.142	0.036	15.39	<.0001
tAir pollution: lifestyle	-0.015	0.025	0.38	0.5389
tAir pollution: personal worry	-0.070	0.020	11.92	0.0006
tAir pollution: regional threat	-0.026	0.019	1.98	0.1591
iHuman health [Electricity vs gasoline]	-0.050	0.025	4.05	0.0441
iEnvironment [Electricity vs gasoline]	-0.031	0.025	1.49	0.2215

Term	Estimate	Std Error	χ^2	Prob>χ^2
Should government offer incentives[No]	0.116	0.058	4.05	0.0442
Should government offer incentives[I'm not sure]	0.087	0.051	2.84	0.0917
Fueling: BEV[Incorrect]	0.129	0.030	18.72	<.0001
rKnow a BEV owner[No/Unsure]	0.299	0.030	99.07	<.0001
BEV: [Any positive reason][No]	0.802	0.039	414.47	<.0001
Familiarity [BEV]	-0.103	0.013	63.93	<.0001
Driving experience: BEV	-0.169	0.016	105.17	<.0001
Seen EVSE[I'm not sure whether I've seen any or not.]	0.179	0.099	3.25	0.0715
Seen EVSE[No. I haven't seen any.]	0.019	0.052	0.13	0.7164
Seen EVSE[Yes. I've seen them at one place.]	-0.091	0.071	1.65	0.1984
Seen EVSE[Yes. I've seen them at a few places.]	-0.109	0.046	5.68	0.0171
imp BEV 9 assessments 2017-21 Factor1	-0.635	0.084	56.64	<.0001
imp BEV 9 assessments 2017-21 Factor2	-0.294	0.094	9.71	0.0018
(imp BEV 9 assessments 2017-21 Factor1-0.01065)*Year[2019-2017]	0.153	0.093	2.69	0.1013
(imp BEV 9 assessments 2017-21 Factor1-0.01065)*Year[2021-2019]	0.028	0.060	0.21	0.6464
(imp BEV 9 assessments 2017-21 Factor2-0.02032)*Year[2019-2017]	-0.178	0.102	3.06	0.0804
(imp BEV 9 assessments 2017-21 Factor2-0.02032)*Year[2021-2019]	0.037	0.066	0.32	0.5713

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories, values have been truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Appendix D: Parameter Estimates for Final Logistic Regression of FCEV Consideration

Table D1. Parameter estimates for the final ordinal logistic regression equation in Tables 7, 8, and 9.

Term	Estimate	Std Error	Chi-square	Prob>Chi-Square
Intercept[I (we) have not—and would not—consider buying a vehicle that runs on hydrogen]	-0.835	0.169	24.325	0.000
Intercept[I (we) have not considered buying a vehicle that runs on hydrogen—but maybe someday we will]	1.510	0.170	78.498	0.000
Intercept[The idea has occurred, but no real steps have been taken to shop for one]	3.091	0.174	316.898	0.000
Intercept[Started to gather some information, but haven't really gotten serious yet]	4.434	0.186	567.580	0.000
Intercept[Shopped for a hydrogen vehicle, including a visit to at least one dealership to test drive]	5.450	0.214	650.427	0.000
Year[2019-2017]	0.309	0.095	10.607	0.001
Year[2021-2019]	0.062	0.057	1.178	0.278
Respondent Age[30 to 39-19 to 29]	-0.099	0.090	1.224	0.268
Respondent Age[40 to 49-30 to 39]	0.181	0.086	4.399	0.036
Respondent Age[50 to 59-40 to 49]	-0.085	0.090	0.879	0.348
Respondent Age[60 to 69-50 to 59]	0.116	0.084	1.920	0.166
Respondent Age[70 or older-60 to 69]	0.144	0.087	2.730	0.099
rRespondent Gender[Female]	0.101	0.027	14.210	0.000

Term	Estimate	Std Error	Chi-square	Prob>Chi-Square
rRespondent Education[Some College-Less than and High School Graduate or GED]	-0.203	0.089	5.154	0.023
rRespondent Education[College Graduate-Some College]	-0.159	0.065	5.938	0.015
rRespondent Education[Some Graduate School-College Graduate]	-0.025	0.113	0.047	0.828
rRespondent Education[Masters, Doctorate, or Professional Degree-Some Graduate School]	0.086	0.118	0.535	0.464
Residence Type[Apartments]	0.117	0.079	2.177	0.140
Residence Type[Attached SFH]	0.033	0.080	0.168	0.682
Residence Type[Mobile home]	-0.191	0.117	2.663	0.103
Residence Type[Other]	-0.237	0.197	1.440	0.230
Vehicles per Person	0.100	0.062	2.631	0.105
rHighest e- access[110 Volt-None; don't know]	-0.208	0.067	9.623	0.002
rHighest e- access[220 Volt-110 Volt]	-0.196	0.066	8.798	0.003
rHighest e- access[EVSE-220 Volt]	0.173	0.121	2.060	0.151
Authority to Install[Need permission]	0.093	0.031	8.882	0.003
Respondent days driving per week	-0.052	0.013	16.042	0.000
Respondent Commute[No]	0.053	0.030	3.249	0.071
HOV[No]	0.030	0.036	0.694	0.405
HOV[Yes; unable to use]	0.130	0.038	11.718	0.001
tAir pollution: lifestyle	-0.050	0.025	4.002	0.045
tAir pollution: personal worry	-0.060	0.020	9.386	0.002

Term	Estimate	Std Error	Chi-square	Prob>Chi-Square
Should government offer incentives[No]	0.168	0.059	8.178	0.004
Should government offer incentives[I'm not sure]	0.115	0.053	4.661	0.031
rKnow FCEV owner[No/Unsure]	0.448	0.062	53.011	0.000
Reason H2: Any[No]	0.748	0.031	584.229	0.000
tFamiliarity [FCEV]	-0.127	0.013	89.702	0.000
tDriving Experience: FCEV	-0.075	0.021	12.530	0.000
imp FCEV 8 assessments 2017-2021 Factor1	-0.511	0.095	29.104	0.000
imp FCEV 8 assessments 2017-2021 Factor2	-0.304	0.039	59.216	0.000
(imp FCEV 8 assessments 2017-2021 Factor1-0.00943)*Year[2019-2017]	0.139	0.102	1.838	0.175
(imp FCEV 8 assessments 2017-2021 Factor1-0.00943)*Year[2021-2019]	0.160	0.061	6.862	0.009

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories, values have been truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Appendix E: Base Values of Variables in the Final Model of FCEV Consideration

Table E1. Values of the variables that serve as the basis for comparison of the effects of changes in any one of them.

Variable	Value
Year	2017
Respondent Age	19 to 29
rRespondent Gender	Female
rRespondent Education	Less than or High School Graduate or GED
Residence Type	Apartment (any number of units)
rHighest e- access	None; don't know
Authority to install	Need permission
Vehicles per Person	0.8362
Respondent Driving Days per Week	4.5467
Respondent Commute	No
HOV Lane Access	No
tAir Pollution: lifestyle	1.9045
tAir Pollution: personal worry	1.2513
Should government offer incentives for alternatives to gasoline and diesel	No/Unsure
Reason H2 [Any]	No
Familiarity FCEV	-0.745
Driving Experience FCEV	-2.2069
Imp FCEV 8 Assessments 2017-2019 Factor 1	0.0094
Imp FCEV 8 Assessments 2017-2021 Factor 2	0.00

Note: The prefixes *r*, *t*, and *imp* variables indicate variables have been recoded (*r*) into fewer categories, values have been truncated (*t*) to omit outliers, or some values have been imputed (*imp*).

Appendix F: Full Estimation Results for the Model of Support for California's ZEV Mandate, late 2023 to early 2024

Table F1. Whole Model test.

Whole Model Fit	
Sample Size	1324
Log likelihood	-1867.49
Degrees of Freedom	28
Pseudo R^2	0.25

Table F2. Unit odds ratios.

Independent variables		Unit odds ratios	Std. Err	*p* > |z|	95% Confidence intervals	
					Lower	Upper
Household and participant characteristics	Age	0.932	0.040	0.076	0.862	1.007
	Gender (1 = Female, 0 = No)	0.965	0.106	0.736	0.784	1.188
	Employment (1 = Yes, 0 = No)	1.048	0.123	0.704	1.215	1.335
	Having a Masters, Doctorate, or Professional Degree (1 = Yes, 0 = No)	1.356	0.118	0.010*	1.076	1.709
	Owning home (1 = Yes, 0 = No)	1.110	0.135	0.437	1.174	1.446
	Number of vehicles in the household	0.789	0.053	<0.001***	0.711	1.143
	Owning a ZEV (1 = Yes, 0 = No)	2.585	0.142	<0.001***	1.956	3.414
	Annual household income	0.966	0.022	0.111	1.080	1.008
	Living in urban area (1 = Yes, 0 = No)	1.454	0.164	0.022*	1.055	2.004
	White (1 = Yes, 0 = No)	2.325	0.174	<0.001***	1.654	3.271
	Hispanic/Latino (1 = Yes, 0 = No)	1.998	0.196	<0.001***	1.361	2.933
	Black African American (1 = Yes, 0 = No)	1.313	0.279	0.330	1.317	2.270
	Asian (1 = Yes, 0 = No)	1.987	0.207	<0.001***	1.323	2.983
	Other racial or ethnic group (1 = Yes, 0 = No)	0.655	0.278	0.129	0.379	1.131

Independent variables		Unit odds ratios	Std. Err	$p > \|z\|$	95% Confidence intervals	
					Lower	Upper
Attitudes	Tech savvy: Learning how to use new technologies is often frustrating for me	0.952	0.049	0.313	0.865	1.048
	Modern urbanite: I like the idea of having stores, restaurants, and offices mixed among the homes in my neighborhood	1.486	0.048	<0.001***	1.354	1.631
	Contra-environmental: Cost or convenience takes priority over environmental impacts (e.g. pollution) when I make my daily choices	0.588	0.052	<0.001***	0.530	1.534
	Low waiting tolerance: Having to wait is an annoying waste of time	0.874	0.056	0.016*	0.783	1.024
	Liking travel: I generally enjoy the act of traveling itself	0.942	0.054	0.266	0.847	1.047
	Pro-car owning: I definitely want to own a car	0.880	0.060	0.033*	0.783	1.010
Built environment and infrastructure access	2010 EV per 1000 households	1.004	0.002	0.026*	1.001	1.008
	Number of Level 1 charging stations within 15-minute-drive	1.000	0.000	0.254	1.000	1.001
	Number of DC fast charging stations within 15-minute drive	0.999	0.001	0.415	0.368	1.001
	Self-reported access to home charging (L1 + L2) (1 = Yes, 0 = No)	1.416	0.114	0.002**	1.132	1.770
Intercepts	Intercept (Somewhat oppose) = 2	0.066	0.546	<0.001***	0.023	5.176
	Intercept (Neither oppose nor support) = 3	0.157	0.543	<0.001***	0.054	2.203
	Intercept (Support) = 4	0.311	0.541	0.031*	0.108	1.112
	Intercept (Strongly support) = 5	1.220	0.541	0.714	2.368	3.525