Draft Proposal

Modeling ZEV Sales Determinants in California

A Framework for Policy Analysis and Market Prediction

Prepared for:
State of California Air Resource Board
Research Division
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RESEARCH SUBCATEGORY: Support for Advanced Clean Cars: New car market trends

Proposed research does not use human or animal subjects.

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2 Abstract

Consumers face an unprecedented and diverse set of zero-emission-vehicle (ZEV) model choices. Through the end of 2012, the U.S. fleet of over 71,000 plug-in electric vehicles (PEVs) is 65% plug-in-hybrid EVs (PHEVs) despite consisting of 9 major battery-EV (BEV) models and only 3 PHEV. The accelerated adoption of these clean vehicles is critical to achieving Advanced Clean Car Program goals and implementing Executive Order B-16-2012. However, the vehicles and their evolving mix in the California fleet embody a range of characteristics that could not have been anticipated during the development of the ZEV and related regulations. To assess the ongoing impact of the Advanced Clean Car program and better understand likely compliance over time, ARB staff must understand an increasingly complex consumer response to this evolving market.

The proposed project would model the determinants of ZEV sales over time across California using panel data models with high spatial and temporal resolution. ZEV sales would be represented by monthly ZEV registrations by Census tract. The proposed modeling would allow the testing of numerous pertinent hypotheses about ZEV market growth and produce the magnitude and directional effects of a wide variety of explanatory variables. For example, by testing hypotheses about the magnitude of the effects of the ARB's own policies (e.g., ZEV credits, vehicle rebates, and HOV-lane access), it will help ARB staff refine these policies in the future. The project would also test hypotheses about the effects of factors that are beyond the ARB's control but which are likely to critically shape the development of California's clean-car market. It could also evaluate how other state and regional policies that influence the drivers' access to residential, workplace, and publicly-accessible charge stations has affected demand for these vehicles. Together, the testing of these hypotheses would deepen the ARB's knowledge of how socio-demographic, built-environment, land-use, and fuel-price factors, as well as state and local policies, have spurred or inhibited clean-car adoption.

In addition, the proposed modeling would provide the ARB with a predictive tool for policy and market analysis. By incorporating these factors into a statistically valid model, the ARB would be able to not only answer critical questions about the size and directional effects of specific factors, but also predict how the size and composition of this market will grow under different scenarios. These scenarios may involve changes to the future portfolio of clean cars that auto manufacturers offer, changes in rebate levels, access to HOV lanes, and changes in future electricity and gasoline prices. The scenarios may also involve predicting the effects of factors on clean-car adoption that change more gradually over longer periods of time, such as household income and size, average local commuting distance, and housing stock (which affects the cost of charging installations).

This project would allow use of a wide variety of rich data that can help frame and explain ZEV purchases to date. The project would describe the evolving market relative to the Advanced Clean Cars Program, both from the perspective of the program as a determinant to the supply and characteristics of available PEVs, as well as to explore the implications of recent consumer response for expected compliance with the program in the future.

BUDGET and CO-FUNDING:
The total requested funding is $265,446 for a project spanning 24 months (e.g., 1 July 2013 through 30 June 2015). Total project budget is $347,037, including in-kind resources. The proposed work leverages past and current research, capabilities, and data assets described herein.

RESEARCH SUBCATEGORY
Support for Advanced Clean Cars: New car market trends

3 Introduction

Consumers face an unprecedented and diverse set of zero-emission-vehicle (ZEV)[1] model choices. Through the end of 2012, the U.S. fleet of over 71,000 plug-in electric vehicles (PEVs) is 65% plug-in-hybrid EVs (PHEVs) despite consisting of 9 major battery-EV (BEV) models and only 3 PHEV. Overall, the PEV fleet has a sales-weighted average battery size of 19 kilowatt-hours, electric range of 51 e-miles and electric fuel economy of 97 miles-per-gallon-equivalent (mpge). More than 20,000 such ZEVs have been purchased or leased by Californians, and this number will exceed 35,000 by the end of 2013 if current sales rates are maintained. The accelerated adoption of these clean vehicles is critical to achieving Advanced Clean Car program goals and implementing Executive Order B-16-2012. However, the vehicles and their evolving mix in the California fleet embody a range of characteristics that could not have been anticipated during the development of the ZEV and related regulations. To assess the ongoing impact of the Advanced Clean Car program and better understand likely compliance over time ARB staff must understand an increasingly complex consumer response to this evolving market.

3.1 Gaps in the Existing Literature on Advanced Clean Car Market Growth.

The scope, approach and research method proposed below fill a critical gap in the literature. None of the existing studies have used actual PEV market data to exploit spatial and temporal variation in factors that may help explain actual adoption, the rate of growth, and the composition of the clean car fleet. The existing literature on the determinants of advanced clean car adoption can be grouped into three approaches. The earliest approach was to use stated-preference studies to evaluate survey respondents' intention to purchase hypothetical ZEVs [1-4]. A second approach was to carefully study the attitudes, needs, and behaviors of a very small group of potential and early adopters of alternative-fuel and advanced vehicles [5-10]. A third approach is not focused on explaining clean car adoption as much as understanding who the early adopters of ZEVs have been [11-13].

While each of these three approaches has made important contributions, many important gaps remain in our knowledge of advanced car adoption and aggregate market dynamics. First, none of these studies focus on explaining actual market sales and market dynamics of advanced clean cars, the acceleration of which is the ultimate focus of the ARB [14]. Second, so far researchers have largely focused on all-battery EV owners, who are a minority owner type in the current market dominated by plug-in hybrid sales. Third, while researchers have evaluated the directional effects of a limited number of factors on vehicle adoption (e.g., price, battery range, etc.), they have often not been able measure the magnitude of those factor effects on vehicle adoption in actual markets because of their choice of research design [4, 15].

4 Proposed Research Objectives and Benefits for ARB Staff

The existing market data on clean-car adoption represent a valuable research opportunity for identifying the importance of factors that have influenced both the rate of growth and composition of the clean car fleet in California. We propose developing fixed-effects panel-data models—i.e., models that are multidimensional and longitudinal—that explain the adoption of

[1] Consistent with the Advanced Clean Car Program, ZEV is defined herein to include plug-in-hybrid, all-battery, and fuel-cell electric vehicles.

these clean cars as a function of factors that vary both spatially and temporally for the entire state of California from December 2010 through the end of 2013. We can obtain unprecedented spatial (geographical) and temporal resolution by using monthly clean car registration data by census tract and matching it with a rich set of explanatory variables that also vary over time and/or space.

Building on detailed ZEV registration data already acquired by UCLA Luskin for PEV Readiness Planning in California, we will purchase supplemental data to construct our dependent variable based on vehicle adoption by census tract. This data is more informative than Clean Vehicle Rebate Program data; a preliminary comparison described in subsection 5.1.1 indicates significant variability in the percentage of rebates compared to registrations, and PHEV percentages in particular have been relatively low. The explanatory variables will include changes in the portfolio of ZEVs offered by automakers over time, local household socio-demographics, the local mix of housing stock (which influences the type and cost of residential charge-station installation), local commuting distances, local electricity and gasoline price trends, access to local HOV lanes and publicly-accessible charging stations, utilization of vehicle rebates, and environmental attitudes, among several others variables.

The modeling and analysis proposed herein seeks to achieve two overall objectives, described in further detail in section 5. The first objective is to test several exploratory hypotheses about factors and determinants affecting vehicles sales. The second objective is to incorporate these determinants into a predictive statistical model that can be used for both policy analysis and ZEV market forecasting.

4.1 Benefits to the Air Resources Board.

First, the proposed modeling will facilitate the testing of numerous hypotheses that will identify the size and directional effects of a larger set of factors on clean-car market growth. By testing the hypothesis about the magnitude of the effects of the ARB's own policies (e.g., ZEV credits, vehicle rebates and HOV-lane access), it will help ARB staff refine these policies in the future. We will also test hypotheses about the effects of factors that are beyond the ARB's control but which are likely to critically shape the development of California's clean-car market. We can also evaluate how other state and regional policies that influence the drivers' access to residential, workplace, and publicly-accessible charge stations has affected demand for these vehicles. Together, the testing of these hypotheses will deepen the ARB's knowledge of how socio-demographic, built-environment, land-use, and fuel-price factors, as well as state and local policies, have spurred or inhibited clean-car adoption.

Second, the proposed modeling will provide the ARB with a predictive tool for policy and market analysis. By incorporating these factors into a statistically valid model, the ARB will be able to not only answer critical questions about the size and directional effects of specific factors but also predict how the size and composition of this market will grow under different scenarios. These scenarios may involve changes to the future portfolio of clean cars that auto manufacturers offer, changes in rebate levels, access to HOV lanes, and changes in future electricity and gasoline prices. The scenarios may also involve predicting the effects of factors on clean car adoption that change more gradually over longer periods of time, such as household income and size, average local commuting distance, and housing stock (which affect the cost of charging installations).

A great time to learn. This learning opportunity and modeling tool comes at a critical time for both the clean car market and the ARB. This study will evaluate the market from its resurgence in December of 2010 with the release of the Nissan LEAF and Chevy Volt through the end of 2013. Over this period, the composition of the clean car market has shifted from predominantly BEVs through early 2012 to predominantly PHEVs since then. 2013 will provide further illumination of market trends and durability as the effects of initial, pent-up enthusiasm fade and the market for ZEVs becomes increasingly mainstream and subject to the preferences of perhaps more-demanding majority adopters. This analysis provides the best opportunity to answer pertinent questions, such as those about the impacts of introducing PHEVs on the demand for ZEVs. Automakers will also have introduced an unprecedented range of model types into the market, perhaps doubling the number of available models during the study period and tripling it shortly thereafter. This analysis will be able to describe the effects of the added model variety on changes in both the rates of adoption and the types of drivers adopting clean cars. Finally, as 2015 approaches, the ARB will be evaluating what existing policies to continue and refine as well as whether new policies might be needed. This research will provide information on the critical role that ARB policies and other factors have played in the evolution of the advanced clean cars market.

Broadly speaking, the proposed research aims to contribute to efficient planning, decision-making, and regulation by improving understanding of the recent consumer response to PEVs and the extent and nature of likely future PEV market penetration in California. In doing so, we hope to support the Advanced Clean Cars Program and help the state meet its air-quality, greenhouse-gas-reduction, energy-use, and economic-vitality goals.

5 Technical plan

5.1 Research methods

In order to enhance understanding of ZEV adoption, the proposed project would model the determinants of ZEV purchases over time across California. It would do so from December 2010 (the release of the Nissan LEAF and Chevy Volt) through the end of 2013 and with high spatial resolution (by Census tract, with various regionally aggregated scenarios including the state as a whole). With over three years of registration data likely available upon project start, the analysis of the variability across Census tracts would be supplemented with an analysis of variability within Census tracts over time (e.g., using panel models), enhancing the characterization of trends and their possible determinants. This would allow use of a wide variety of rich data that can help explain and frame ZEV purchases to date, including socio-economic (Census), driving behavior (commute, travel-model), and housing-type and employment (land-use, built-environment, industrial codes) data. These provide important context for the selection and use of ZEVs and their infrastructure. Together, they paint an up-to-date and rich picture of the market, drivers, their vehicles, their driving, and their nighttime and daytime physical environments. The project would describe the evolving market relative to the Advanced Clean Cars Program, both from the perspective of the program as a determinant to the supply and characteristics of available PEVs, as well as to explore the implications of recent consumer response for expected compliance with the program over time.

Using high-resolution, geographical ZEV registration data covering the period December 2010 through the end of 2013 (purchased from RL Polk & Co, from which we have already acquired

2010-2012 ZEV registrations), ZEV purchases modeled as a function of a variety of possible explanatory variables, described next. Additionally, Clean Vehicle Rebate Program uptake data would be compared to registrations to explore the differences between those that buy PEVs but do not apply for the rebate and those that do.

5.1.1 Specific research objectives and hypotheses

The research proposed herein seeks to achieve two overall objectives. The first objective is to test several exploratory hypotheses about factors and determinants affecting vehicles sales. The second objective is to incorporate these determinants into a predictive statistical model that can be used for both policy analysis and ZEV market forecasting.

Testing exploratory hypotheses about factors affecting vehicle sales.

We propose prioritizing three groups of exploratory hypotheses. The first group of hypotheses evaluates the effects of ARB and other government policies that are designed to influence the composition and growth rate of the advanced clean car market. The second group of hypotheses concerns price variables (e.g., for vehicles, gasoline and electricity) that are beyond the direct influence of California policymakers but will bring about changes in sales within the ZEV market. Knowing the magnitude and directional effect of these factors can better define the important sources of uncertainty in ZEV forecasts. In the final grouping are those factors that over time either change very slowly or not at all, but still exert significant influences on ZEV sales. Knowing these variables helps to not only define the market context, but also statistically isolate[2] the effects of the factors of greatest interest to both policy analysis and market forecasts.

Policy-relevant variables and hypotheses. Policymakers have sought to 1) affect the type and number of ZEVs that automakers produce for sale, 2) lower the costs and increase the benefits of purchasing and driving ZEVs, and 3) reduce the costs of charging ZEVs. Our hypothesis testing will explore questions about the magnitude of all three types of policies.

The ARB has sought to influence the type and number of ZEVs that automakers produce for sale through the design of its ZEV credit program, which gives various credits for different types of ZEVs[16]. Given this program, a critical question is, “How have changes in the portfolio offered by ZEV automakers affected the rate of sales and the composition of the purchased fleet over time?” Our exploratory analysis will explain the trends in BEV sales by census tract. We will also explore how these factors differ from those that explain PHEVs sales. Within the same geographic market, we will evaluate how much the introduction of PHEVs affected the sale of BEVs.

Given that the ARB staff would like to increase the sales of ZEVs, in particular “pure” ZEVs like BEVs, this analysis will provide valuable insights into which factors are likely to increase or retard BEV sales in the future. We will also attempt to identify the factors associated with the average battery size that drivers have chosen for PHEVs within a census tract. Finally, we will explore

[2] In the case of explanatory variables, it is important to note that the goal, limited by resource constraints, is to be comprehensive to reduce the risk of omission bias in the modeling. Thus, even though some of the explanatory variables may not all be of the same interest, so long as they have reasonable potential to help explain PEV purchases and can be characterized relatively inexpensively, they should be initially included in the analysis.

how much of the rates of growth in ZEV sales can be attributed to the increased availability of the wider range of body and vehicle types. By controlling for the timing of the introduction of ZEVs that are different from those found in the existing fleet, we can identify how adding variety to the vehicle choice set better accommodates segments of the markets that were previously denied access to ZEVs. Such information is not only important to understand the evolution of the existing market, but also helps to explain what will happen to market growth rates when automakers choose to stop selling specific types of ZEVs. This information would be used to modify future credit systems.

The ARB also provides vehicle rebates and ZEV access to HOV lanes. Our analysis will explore the affects of each of these policies in different ways. Our preliminary analysis reveals that while nearly all BEV drivers apply for their vehicle rebates, there is considerable variation in how many PHEV drivers apply for rebates. For example, for the period spanning March 2012 (the first full month when the qualifying Volt was available) through the end of October 2012 (the most recent registration data available at the time of this preliminary analysis), the number of BEV rebates was 85% of the number of BEVs registered, whereas the percentage was 65% for PHEVs. Preliminary review of data also indicates tremendous geographic variation across counties in the PHEV rebate applications. We can use the variations in this PHEV rebate data to test the hypothesis that lower rebate application percentages are associated with lower sales-rate growth because the population is ignorant of the ZEV policies. We can also test to see if lower uptake rates are associated with the purchase of ZEVs with lower rebate levels.

With respect to HOV lane access, we can use the natural spatial variability in the distribution of the HOV lanes to measure the size of the policy benefits. We would do this by identifying the number of miles of HOV within a commuting distance of a drivers living within all census groups. We can then calculate how much sales increase when drivers are able to take advantage of the HOV policy on a daily basis. This information will help the ARB staff to anticipate what will happen to ZEV sales in different locations if this policy is discontinued.

Finally, several policymakers—such as the California Energy Commission, the Air Quality Management Districts, and local utilities—have implemented a range of policies aimed reducing the costs of charging ZEVs. These policies have sought to either 1) lower the costs of installing charge stations or 2) lower the cost of the electricity that is used as transportation fuel. We can evaluate the extent to which either of these types of policies has appreciably increased ZEV sales since the onset of these policies. Specifically, we can investigate if, as the number of publicly-accessible charging stations within commuting distance from a census tract increases, ZEV sales increase. We can do this because we know when each charge station began operation (from the U.S. DOE AFDC database), and, by using GIS methods, we can calculate the numbers of stations within commuting distance of the census tract. We can also assess the impacts of time-of-use electricity rates and equipment rebate programs that are offered by utilities by controlling for which census tracts are in the various utility service areas.

Price variables and hypotheses. A wide range of prices can affect the economics of buying and driving a ZEV[17, 18]. The proposed research can investigate how much of the variation in ZEV sales patterns can be explained by spatial and time trending differences in gasoline and electricity prices. The price of gasoline has fluctuated by over 30%, ranging from an average of \$3.50 to over \$4.50 over the period of study thus far, while spatial-specific ranges have varied over 40%. The off-peak price of residential electricity can vary by over 50%, for example ranging spatially from lows of $0.12 per kWh to highs of $0.17 kWh. Nearly all investor-owned utilities (IOUs) and major privately-owned utilities (POUs) have sought and received approvals for further price increases, making electricity prices even more important to understand in the future. The after-rebate price of ZEVs that are made available by automakers may also change over the three years of study. While we may not expect price gaps between ZEVs and conventional vehicles with similar attributes to close dramatically over this time period, even modest changes may influence sales. Any after-rebate price calculation would also need to account for inflationary erosion of the real value of the rebates.[3]

ZEV geography: household, built environment and land use variables. Why do sales tend to vary so greatly by geography? Which factors that vary geographically best explain the adoption patterns of BEVs and PHEVs? These are the types of questions that exploratory hypotheses testing can answer with great specificity. For example, central questions will be 1) how much of the adoption patterns can be explained by variations in the socio-economics, such as income[19] and employment levels, which change moderately over time, and 2) how much variation can be explained by family size and structure [20, 21] and the ethnicity, age, and attitudes of drivers, which change relatively more slowly over time?

It is widely recognized now that PEV charging is more cost-effective in detached single-family homes as compared with condos and apartments[22]. How much of the variation in adoption patterns can be explained by local differences in the built residential housing environment? Also, many ZEV owners currently commute at or below regional average distances. How much of the observed variation in type of vehicle can be explained by differences in regional commuting patterns?

Additionally, using what essentially amounts to a neighborhood as the unit of analysis allows exploration of geographic contagion effects, i.e., clustering of adoption behavior.

A model for policy analysis and market forecasting

The second overarching objective is to develop a spatial and temporal model capable of undertaking both ZEV policy scenario analysis as well as ZEV market forecasting. This model would be based on the careful selection of variables discussed above with the spatial units of analysis being the census tracts and the temporal units being months.

ZEV policy scenario analysis. The objectives of the policy scenario analysis would be to undertake both a retrospective and prospective analysis of the impacts of existing policies on the growth rate and composition of ZEV sales[23]. The analysis would explain and predict how the ZEV sales growth rates and fleet composition varied with the factors and determinants:

- Diversification of types of ZEV offered by automakers, including:
    - BEVs versus PHEVs,
    - diversification in the electric ranges / battery sizes for PHEVs across and within vehicle types,

[3] For example, at 3.3 percent annual inflation, a rebate worth $2,500 in 2010 would be worth nearly $247.5 less in real terms at the end of the 2013. To see this, note that the three year cumulative inflation rate would be 0.099 multiplied by a rebate $2,500, yielding a $247.5 reduction in the real value of the rebate.

    - variation across and within ZEV body types, and
    - diversification of vehicle purchase prices across and within vehicle types for ZEVs.
- Reduction in ZEV purchase prices.
- Local utilization of the rebates for PHEVs.
- Local access to HOV lanes.
- Local access to publicly-accessible electric charge stations.
- Access to PEV time-of-use electricity rates and equipment rebates by utilities.
- The imposition of an electric transportation fuel tax.

ZEV market forecasting tool. The objectives of the market forecasting tool are to predict the growth in ZEV sales for anticipated market conditions. While these market conditions could involve changes in gasoline and electricity prices, they could also involve more gradual changes in socio-economic variables such as income and employment, or even more slowly changing variables such as the built environment and land use patterns. Although the CARBITs model can forecast ZEVs as a vehicle category, currently a model does not exist that is based on actual ZEV sales that varies over time and space at such high level of resolution. A range of specific types of forecasts could be available depending upon the statistical performance of the variables within the model. These might include[4]:

- Number and distribution of ZEV models
- Number and distribution of PEV types (BEV vs. PHEV)
- Level and distribution of ZEV price (e.g., MSRP)
- Distribution of, and sales-weighted average, electric range by BEV and PHEV
- Distribution of, and sales-weighted average, battery size by BEV and PHEV
- Distribution of, and sales-weighted average, electric fuel economy

5.1.2 Methodology: statistical modeling.

To achieve the objectives of this research we will use two types of panel data models. Panel data allows researchers to control for variables we cannot observe or measure—e.g., household preferences for vehicle attributes across communities (census tracts)—or variables that change over time but not across census tracts—e.g., unobserved local policies, land-use characteristics, etc. We will employ both fixed-effects and random-effects modeling [24, 25].

Fixed-Effects Panel-Data Model

Researchers use fixed-effects models whenever they are interested in analyzing the impact of only explanatory variables that vary over time, such as temporal changes in the types and prices of ZEVs, the introduction of new ZEV policies, gasoline and electricity prices, etc. These models will be used to explore the relationship between our dependent variables—ZEV sales—and such explanatory variables within a census tract. Each census tract "entity" will have its own individual characteristics that may or may not influence ZEV sales.

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[4] *Scope options:* This list could be expanded to include additional metrics of interest to CARB. Additionally, it should be notes that the methods proposed allow this project to be expanded beyond ZEVs to include trends in all new cars with a relatively modular though significant increase in budget to accommodate the wider scope of data acquisition, handling, and analysis requirements.

The equation for the fixed-effects model is:

$$Y_{it} = \beta X_{it} + \alpha_i + u_{it}$$

Where:
– $i=1,2,\ldots,n$ (corresponding to n different entities, e.g., census tracts).
– α_i is the unknown intercept for each entity (i.e., there are n entity-specific intercepts).
– u_{it} is the census tract's error term
– Y_{it} is the dependent variable, where i = entity and t = time.
– X_{it} represents one explanatory variable (there can be many).
– β is the coefficient for that explanatory variable.

Fixed-effects models remove the effect of time-invariant characteristics from the ZEV sales variables so we can assess the explanatory variables' net effect. An important assumption of this model is that those time-invariant characteristics are unique to the census tract and should not be correlated with other census tract characteristics. Each census tract is different, and therefore the census tract's error term and the constant (or intercept, which captures census-tract characteristics) should not be correlated with the others. If the error terms are correlated, then inferences may not be correct and this model is not suitable. In this case, a random-effects model (discussed below) may be appropriate. A Hausman test (also discussed below) helps determine whether fixed- or random-effects models should be utilized.

Fixed-effects models cannot be used to investigate time-invariant causes of the dependent variables. (Technically speaking, time-invariant characteristics of the census tracts are perfectly collinear with census-tract dummy variables.) Fixed-effects models are designed to study the causes of changes within a census tract. A time-invariant characteristic cannot cause such a change, because it is constant for each tract.

Random-Effects Panel-Data Models

The rationale behind a random-effects model is that, unlike the fixed-effects model, the variation across census tracts is assumed to be random and uncorrelated with the dependent variables (ZEV sales) or other explanatory variables included in the model. As noted by Green, "…the crucial distinction between fixed and random effects is whether the unobserved individual effect embodies elements that are correlated with the regressors [explanatory variables] in the model, not whether these effects are stochastic or not" [[24], p. 183]. If researchers have reason to believe that differences across entities have some influence on the ZEV sales dependent variables then random effects should be used. An advantage of random effects is that we can include time invariant variables (e.g., characteristics of households, the built environment, and land use). In the fixed-effects model these variables are absorbed by the intercept.

The random effects model is:

$$Y_{it} = \beta X_{it} + \alpha + u_{it} + \varepsilon_{it}$$

Where variables are defined as before, with the addition of an error term for the explanatory variable, ε_{it}.

Random effects assume that the entity's error term is not correlated with the explanatory variables' error terms, which allows for time-invariant variables to play a role as explanatory variables. In random-effects models, we need to specify those census tract characteristics that may or may not influence the ZEV sales variables.

To decide between fixed or random effects we will run a Hausman test where the null hypothesis is that the preferred model is random-effects and the alternative the fixed-effects model [24]. This enables us to test whether the unique errors (u_i) are correlated with the regressors' [explanatory variables']. The null hypothesis is that they are not.

Additional UCLA statistical resources: http://www.ats.ucla.edu/stat/

5.2 Tasks

The project is proposed to consist of 5 major tasks:

1. Project management (including project start-up, quarterly reporting and regular meetings with ARB staff)
2. Data collection and preparation
3. Data analysis
4. Draft report writing and continuing data analysis
5. Report revision and finalization

Please see Section 6 for a task timeline and schedule of deliverables. Further task details are described next.

5.2.1 Task 1: Project management

Project management consists of two major subtasks: meetings with ARB staff and reporting and invoicing.

Meetings with ARB

Per the solicitation, the target date for a finalized contract and project initiation is 1 July 2013. Project start-up will begin with an in-person meeting between project investigators and ARB staff in Sacramento, to be completed within the first two weeks of the project.

Thereafter, regular meetings are planned with ARB approximately 1 month after submission of quarterly reports (described below and detailed in Section 6). It is proposed that most meetings are via telecommunications, with in-person meetings proposed for project initiation, annual review, discussion of the draft report, and project finalization (e.g., for a Chairman's Technical Seminar if desired). Travel is budgeted for each of these trips.

Reporting and invoicing

Quarterly progress reports will be submitted within 2 weeks of the end of quarters 3Q'13, 4Q'13, 1Q'14, 2Q'14, 3Q'14, and 1Q'15. The draft report will serve as the quarterly report for 4Q'14 and the final report for 2Q'15. Quarterly invoicing will accompany all reports

Quarterly reports will: review the work conducted and describe any problems encountered during the reporting quarter; discuss the work to be conducted in the next quarterly period; and present the funds expended and assess the status of the project with respect to being on time and within budget.

The draft final report will be written in accordance with the ARB guidelines. This will consist of the following main components:

- Description of the objective and approach
- A summary and discussion of the data collected and estimates of precision and accuracy
- Discussion of the data analysis (modeling)
- Summary and conclusions.

Additional electronic versions of the data and analysis tools will be provided to the ARB as appropriate.

Per the solicitation, the draft final report will be provided to ARB staff 6 months before contract completion. The final report will address comments provided by the ARB after reviewing the draft final report.

Furthermore the intent of the investigators is to publish at least one article regarding this study in a peer-reviewed journal.

5.2.2 Task 2: Data collection and preparation

After project start-up, the project team would begin collection and preparation of the following types of data described above: ZEV registrations, ZEV vehicle characterizations and specifications, ZEV credits and rebates by vehicle type, CVRP applications, HOV lane-miles, recharging infrastructure installations and incentives, TOU electricity rate plans, electricity prices, gasoline prices, PEV prices, socio-economics, housing type, commute distances, etc.

As data are collected, extensive preparation will likely be required to assimilate them into a database matching the structure of the PEV registrations (by month and census tract). For example, geographical data preparation will require calculation of distances related to HOV lanes, coding the various fields above by census tract, etc.

Per the project schedule in section 6, this phase of the project is proposed to span roughly nine months (e.g., roughly the first 8.5 months of the project, reserving some capacity for additional data collection and preparation in the latter stages of analysis as needs and feedback indicate).

Per the budget description in section 8, key personnel in this phase include Norman Wong, UCLA data and GIS specialist, PhD Student Tamara Sheldon, and an undergraduate research assistant, coordinated and assisted by EV Program Manager and Asst. Adj. Prof. Dr. Williams and supervised and guided by Center Director and Professor Dr. DeShazo.

5.2.3 Task 3: Core data analysis

Utilizing the valuable data resources assembled in Task 2, PhD student Tamara Sheldon will assemble the econometric models necessary to explore and test the types of hypotheses described above, managed by and in collaboration with Dr. Williams and guided by Dr. DeShazo. Core modeling and hypothesis testing will take place during this phase, expected to last 9 months total (3 overlapping and integrated with the data collection and preparation phase, and nearly 3 overlapping with draft report preparation—reserving some core analysis capacity for additional data collection and preparation in the latter stages of analysis as needs and feedback indicate).

5.2.4 Task 4: Draft report preparation and ongoing analysis

Task 4 of the project will transition core model development into ongoing analysis targeted at, and integrated with, draft project report preparation. Dr. Williams will play a major role this task, with significant support by PhD student Sheldon and high levels of engagement by Dr. DeShazo for the econometric analysis, theory, and discussion.

This phase is expected to span 6 months, overlapping and integrated in early months with the core model development and analysis phase and culminating in draft report delivery to CARB before the end of month 18 (e.g., December 2014, assuming a 1 July 2013 start date).

As the core model development and analysis wraps up in roughly month 14, an in-person annual meeting with ARB staff is proposed to discuss any additional analysis needs and draft report preparation.

5.2.5 Task 5: Report revision and finalization

Per solicitation guidelines, the phase will span 6 months from delivery of the draft project report through report finalization and contract termination (proposed to conclude by the end of month 24, or June 2015, assuming a 1 July start date). This phase is proposed to include an in-person meeting with ARB staff to discuss the draft proposal (allowing roughly one month for ARB staff review), providing a major event to facilitate incorporation of feedback into the final report. This phase explicitly includes modest additional budgetary support for editing and layout of the final report (e.g., by someone outside of the core project team.) Additionally, at project conclusion, this phase is proposed to include at in-person meeting at ARB facilities to present the research, as desired by ARB staff.

5.2.6 Existing resources and experience

As part of the University of California, Los Angeles (UCLA), the Luskin Center for Innovation is part of a long traditional of high-caliber research in the public interest. The UCLA Luskin Center for Innovation aims to unite the intellectual capital of UCLA with civic leaders to address the most pressing issues confronting our community, state, and world. The Center is organized around initiatives that seek to translate world-class research and expertise into real-world policy solutions. Faculty and staff from a variety of academic disciplines across campus conduct research in partnership with civic leaders who use the research to inform policy and organizational innovations.

Given the interdisciplinary nature of the Center, its research capacities are broad and deep but focus on bringing economic and social-science research methodologies to bear on environmental, energy and transportation technology, planning, and policy applications. In the past year, the Luskin Center partnered with dozens of local, regional, state, and federal agencies on over 25 research projects that have resulted in research products that have informed policy, planning and organizational innovations for these agencies. Partners have ranged from the Southern California Association of Governments to the U.S. Environmental Protection Agency.

The Luskin Center for Innovation's EV Program and researchers has conducted several major research projects relating to ZEVs of all types (for more information, please see www.luskin.ucla.edu/ev) and is the prime research contractor for DOE- and CEC-funded PEV Regional Readiness planning in the Southern California Association of Governments region [26-28]. As part of those activities, it has developed various data assets and experience relating to the, tracking, mapping, characterization, and analysis of PEV and charge-station introduction, employment, travel-behavior, and housing stock in the region. This has included assembling, geo-coding, and analyzing databases similar to what will be required in the proposed research. Project personal have strong backgrounds and/or training in Econometrics (in particular, Dr. DeShazo and PhD student Sheldon), Policy Analysis (Drs. DeShazo and Williams), and ZEV Technology and Policy (Drs. Williams and DeShazo).

Key related references

DeShazo, J., A. Ben-Yehuda, B. Williams et al. (2012). Southern California Plug-in Electric Vehicle Readiness Plan; UCLA Luskin Center for Innovation: Los Angeles, luskin.ucla.edu/ev

UCLA Luskin Center for Innovation (2012). Southern California Plug-in Electric Vehicle Readiness Atlas; UCLA Luskin Center for Innovation: Los Angeles, luskin.ucla.edu/ev

Williams, B., J. DeShazo, et al. (2012). Early Plug-in Electric Vehicle Sales: Trends, Forecasts, and Determinants; d04; Univeristy of California, Los Angeles Luskin Center for Innovation: Los Angeles, http://luskin.ucla.edu/ev

Dubin, J., R. Barney, et al. (2011). Realizing the Potential of the Los Angeles Electric Vehicle Market; UCLA Luskin Center for Innovation: May. http://luskin.ucla.edu/sites/default/files/LA%20EV%20Final%20Report%20-%20Formatted%20-%20Final%20-%20High%20Quality%20for%20printing.pdf

Dubin et al. [29] characterized and modeled PEV adoption in Los Angeles by zip code. It incorporated a stated-preference survey, an analog of which is being conducted by the Luskin Center and would be available to supplement the other data sources described above if desired.

5.3 Data management plan

Collecting, constructing and assembling data for analysis is the most labor-intensive aspect of the research activities proposed herein.

5.3.1 Data to be collected

We propose collecting a wide range of data that will need to be carefully integrated into a cross-sectional (by census tract) and longitudinal (by month and year) format.

ZEV registrations by census tract, month, and type of vehicle. We propose utilizing registration data purchased from RL Polk & Co. In the context of the proposed research, this data provides similar information as would DMV data that CARB has in house. However, it avoids the privacy concerns[5] and constraints involved with granting UCLA Luskin access to DMV data, and allows UCLA to enrich the registration information at the Census tract level with the wide variety fuel-price, policy, socio-demographic, land-use, charging-station, and other data described next.

Further, in the course of our Regional PEV Readiness Planning for the Southern California Association of Governments (as part of statewide efforts funded by the DOE and CEC), we have already acquired December 2010 through December 2012 ZEV registrations, and would only need to purchase the remainder of the data (see budget description in section 8). Combining this data with additional in-house detailed knowledge and tracking of ZEV introductions by UCLA

[5] It should be noted some Census tracts continue to contain a very small number of PEV registrations, increasing the risk that individually identifiable information would be involved in the use of DMV data.

Luskin (e.g., as illustrated in part in [28]), these data allow us to describe, by census tract and month:

- Number of ZEV models
- Number and distribution of PEV types (BEV vs. PHEV and body type)
- Price level and distribution of ZEVs (e.g., MSRP)
- Distribution and sales-weighted average of electric range by BEV and PHEV
- Distribution and sales-weighted average of battery size by BEV and PHEV
- Distribution and sales-weighted average of electric fuel economy

Gasoline price data are available from vendors such as Gas Buddy and Oil Price Information Service (OPIS). A preliminary quote from OPIS indicated that monthly data for three years of their 1,270-zip-code "markets" across California would cost approximately $6,350. Alternatively, as described in the budget description, $5,700 is requested to purchase gasoline-price data from Gas Buddy for 37 months to match the period of vehicle registration data (12/2010 through 12/2013). This has been estimated based on roughly 25 cents per area per month for over 600 areas across California (e.g., 10% of 6,612 California zip codes or 661 aggregated areas across the state).

In either case, zip-code data can be converted to census-tract data via a geo-coding procedure already utilized by UCLA Luskin in regional PEV Readiness planning.

Additional data for California as a whole, Los Angeles, and San Francisco are available for free form the U.S. Energy Information Administration and can be found at http://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_sca_w.htm.

Electricity price trend data will be constructed from the residential rate schedules of the state's utilities. Utility service areas would then need to be downscaled to the census tract level.

Electrical utility ZEV related policy data has already been collected for the IOUs and POUs in Southern California. These variables would need to be collected for utilities in the central and northern part of the State. Utility service areas would then need to be downscaled to the census tract level.

Household demographic data would be obtained at the census tract and block group level from the American Community Survey. See http://www.census.gov/acs/www/data_documentation/data_main/. From this data source, we can obtain variables on: age and sex, ancestry, education, employment, family/relationships, income and earnings, language, population change, poverty, and race and ethnicity.

Environmental attitudes data will be by voting precinct level for Proposition 23 and Proposition 39. See http://www.sos.ca.gov/elections/statewide-elections/. Voting precinct level would then need to be downscaled to the census tract level.

Local built environment and commuting distance data would be obtained at the census tract and block group level from the American Community Survey. See http://www.census.gov/acs/www/data_documentation/data_main/ From this data source we can obtain variables on: commuting to work, housing financial characteristics, and housing physical characteristics.

Vehicle rebate uptake data would be obtained from the California Center for Sustainable Energy at either the zip-code or census-tract level. See https://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project.

Spatial access to HOV lanes data will constructed by using spatial analysis to determine the number of HOV lane miles within the average commuting distance for each census tract. The locations of the HOV lanes in California can be found at http://www.dot.ca.gov/dist07/resources/hov/.

Spatial access to publicly accessible electric charging stations data will constructed by using spatial analysis to determine the number of publicly-accessible charging stations within the average commuting distance for each census tract. The locations of the electric charging stations in California can be found at http://www.afdc.energy.gov/locator/stations/.

5.3.2 Sample size necessary to assure statistical validity

The proposed research will involve using not a sample of census tracts but the entire population of census tracts within California. Further data on all ZEVs registered since 2010 will be utilized. As such, the statistical relationships identified will represent the best that existing data can provide given the over 7,000 census tracts in California and ZEV market growth up to the end of 2013 (estimated to be between ~25,000–35,000 ZEVs). Because of the longitudinal nature of the analysis and the on-going ZEV market growth, we do expect to be able to add to this data set beyond the scope of the proposed research ending in 2013, perhaps supporting the ARB staff even once this initial research is complete.

5.3.3 Equipment used

Computers hosting GIS and statistical programs are the only equipment that will be used.

5.3.4 Approach to addressing quality assurance of data

We will utilize the best existing data available. Since we will not be collecting original data, many of the standard data quality issues, such as measurement error, sample selection bias, heteroskedasticity, and others, are beyond our direct control. We will however test for the presence of all standard biases.

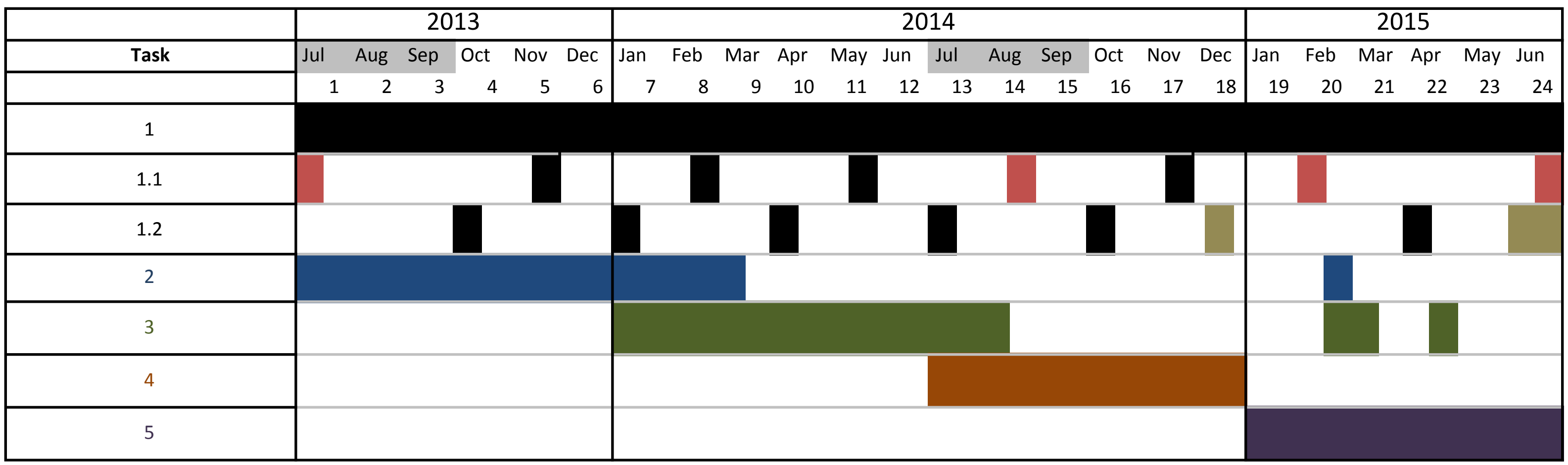
We will endeavor to validate our model in several ways. One is the simple standard test of internal test of accuracy. A second approach involves using a split-sample methods. This approach involves estimating the model using one-half of the time period and then predicting the ZEV sales for the second half. We could then compare those predicted sales to the actual sales as measure of model accuracy.

5.4 Human or animal subjects

No human or animal subjects will be used.

6 Project schedule

Task 1		Project management
	1.1	Meetings with ARB staff (calls in black, in-person in red)
	1.2	Reporting and invoicing (progress reports in black, project reports in tan)
Task 2		Data collection and preparation
Task 3		Data analysis
Task 4		Draft report writing and analysis
Task 5		Report revision and finalization



Task Number	Task(s) Deliverable(s)	Tasks				Deliverables		
		Planned		Actual				
		Start Date	End Date	Start Date	End Date	Planned Due Date	Current Due Date	Actual Received Date
1	Project start-up and management	7/1/13	6/30/15					
1.1	Meetings with ARB staff (calls in black, in-person in red)	7/1/13	6/30/15					
	Start-up meeting (in person)					7/15/13		
	Call #1					11/30/13		
	Call #2					2/28/14		
	Call #3					5/31/14		
	Annual meeting (in person)					8/31/14		
	Call #4					11/30/14		
	Draft report meeting (in person)					2/15/15		
	Final report presentation (in person)					6/30/15		
1.2	Reporting and invoicing (progress reports in black, project reports in tan)	10/1/13	4/15/15					
	1Q'13 progress report and invoice					10/15/13		
	2Q'13 progress report and invoice					1/15/14		
	1Q'14 progress report and invoice					4/15/14		
	2Q'14 progress report and invoice					7/15/14		
	3Q'14 progress report and invoice					10/15/14		
	Draft project report and 4Q'14 invoice					12/31/14		
	1Q'15 progress report and invoice					4/15/15		
	Final project report and final invoice					6/30/15		
2	Data collection and preparation	7/1/13	2/28/15					
3	Data analysis	1/1/14	4/30/15					
4	Draft report writing and analysis	7/1/14	12/31/15					
5	Report revision and finalization	1/1/15	6/30/15					

For task and deliverable description, please see subsection 5.2.

7 Résumés of key scientific personnel

7.1 Principal Investigator: Prof. JR DeShazo, PhD

Summary

J.R. DeShazo, Director of the Luskin Center for Innovation and Professor and Vice Chair of the Department of Public Policy in the Luskin School of Public Affairs at UCLA, is an expert in economics, public finance, and organizational governance. He holds a Ph.D. in Urban Planning from Harvard University and a M.Sc. in Economics from Oxford University. His current research with electric vehicles and alternative fuels is in partnership with the Southern California Association of Governments' Electric Vehicle Readiness Project that is developing a plans for siting electric vehicle charging stations in six Southern California counties. Dr. DeShazo's recent research has also focused on local public finance, regulatory reform, climate change policy, and solar energy policy. He advises the Los Angeles City Council and the Metropolitan Water District of Southern California, among key agencies. He has previously advised the US Environmental Protection Agency and the United Nations, among others.

Education

Ph.D., Harvard University (1997) Urban Planning, Economics concentration;
M.Sc., Oxford University, St. Antony's College (1991) Development Economics, Rhodes Scholar
B.A., College of William and Mary (1989) Economics and History (Interdisciplinary) with honors

Professional Experience

2012 – Present	Professor, Department of Public Policy, UCLA
2009 – Present	Director, Luskin Center for Innovation, UCLA
2007 – 2011	Director, Ralph and Goldy Lewis Center, Luskin School of Public Affairs, UCLA
2007 – Present	Vice-Chair, Department of Public Policy, UCLA
2006 – 2012	Associate Professor, Department of Public Policy, UCLA
1997 – 2006	Assistant Professor, Department of Public Policy, UCLA
2000 – 2007	Faculty Associate, Harvard Institute for International Development, Harvard University
1993 – 2000	Urban/Environmental Economist, Harvard Institute for International Development

Select Publications
Referred Articles – Under Revision

1. "A Comprehensive Assessment of Selection in a Major Internet Panel for the Case of Attitudes toward Government Regulation." T.A. Cameron and J.R. DeShazo. *Survey Methodology*. (Revise and re-submit)

2. "Willingness to Pay for Health Risk Reductions: Differences by Type of Illness." T.A. Cameron and J.R. DeShazo. *Journal of Health Economics.* (Revise and resubmit)
3. "Subjective Choice Difficulty in Stated Preference Surveys." Eric Duquette, T.A. Cameron, and J.R. DeShazo. *Journal of Choice Modeling*. (Revise and resubmit)
4. "Willingness to Pay for Public Health Policies to Treat Illnesses." R. Bosworth, T.A. Cameron, and J.R. DeShazo. *Journal of Health Economics*. (Revise and resubmit)

In Print or Forthcoming

5. "Demand for Health Risk Reductions." T.A. Cameron and J.R. DeShazo. *Journal of Environmental Economics and Management*. (August 2012)
6. "Scenario Adjustment in Stated Preference Research." T.A. Cameron, J.R. DeShazo, and E.H. Johnson. *Journal of Choice Modelling.* (November 2010)
7. "Differential Attention to Attributes in Utility-theoretic Choice Models." T.A. Cameron and J.R. DeShazo. *Journal of Choice Modelling.* 3(3) 73-115 (November 2010)
8. "Demand for Health Risk Reductions: A Cross-national Comparison between the U.S. and Canada." T.A. Cameron, J.R. DeShazo, and P. Stiffler. *Journal of Risk and Uncertainty.* 41(3) 245-273 (December 2010)
9. "Is An Ounce of Prevention Worth a Pound of Cure? Comparing Demand for Public Prevention and Treatment Policies." R. Bosworth, T.A. Cameron, and J.R. DeShazo. *Medical Decision Making.* 30(4): E40-E56 (2010)
10. "The Effect of Children on Adult Demands for Health-risk Reductions." T.A. Cameron, J.R. DeShazo, and E.H. Johnson. *Journal of Health Economics.* 29(3): 364-376 (May 2010)
11. "Demand for Environmental Policies to Improve Health: Evaluating Community-level Policy Scenarios." R. Bosworth, T.A. Cameron, and J.R. DeShazo. *Journal of Environmental Economics and Management.* 57(3): 293-308 (2009)
12. "The Effect of Consumers' Real-world Choice Sets on Inferences from a Stated Preference Field Experiment." J.R. DeShazo, T.A. Cameron, and M. Saenz. *Environmental and Resource Economics.* 42(3):319-343 (2009)
13. "The Environmental Consequences of Decentralizing the Decision to Decentralize." W.B. Cutter and J.R. DeShazo. *Journal of Environmental Economics and Management.* 53 (1): 32-53 (2007)
14. "Persistent Market Failures in the Chemical Sector: Consequences for Health and Product Innovation." J.R. DeShazo and M. Cohen. Report prepared for the California Department of Toxic Substances Control. (2007)
15. "Activities in Models of Recreational Demand." W.B. Cutter, L. Pendleton, and J.R. DeShazo. *Land Economics.* 83(3): 370-381 (2007)
16. "Timing and Form of Federal Regulation: The Case of Climate Change." J.R. DeShazo and J. Freeman. *University of Pennsylvania Law Review.* 155:1499-1558 (2007)
17. "Evaluation Reforms in the Implementation of Hazardous Waste Policies in California." W.B. Cutter and J.R. DeShazo. *California Policy Options.* (2006)

Non-peered Reviewed Articles and Book Chapters

18, "Southern California Plug-in Electric Vehicle Readiness Plan." J.R. DeShazo and A. Ben-Yehuda. UCLA Luskin Center for Innovation Report for Southern California Association of Governments. (2012)

19. “Southern California Plug-in Electric Vehicle Atlas.” J.R. DeShazo and A. Ben-Yehuda. UCLA Luskin Center for Innovation Report for Southern California Association of Governments. (2012)
20. “Climate Action Planning in Southern California.” J.R. DeShazo and Juan Matute. UCLA Luskin Center for Innovation Report (2012)
21. “Empowering LA's Solar Workforce: New Policies that Deliver Investments and Jobs.” J.R DeShazo, M. Pastor, and M. Auer. Produced by the LABC Institute, City of Los Angeles, JP Morgan Chase & Co., Global Green USA, UCLA Luskin Center, and USC Program for Environmental and Regional Equity. (2011)
22. “Towards Measuring Green House Gases from Local Jurisdictions.” J.R. DeShazo and J. Matute. Oxford Handbook of Urban Planning. (In press, Oxford University Press)
23. “Making a Market: Multifamily Rooftop Solar and Social Equity in Los Angeles.” J.R. DeShazo, M. Pastor, M. Auer, V. Carter, and N. Vartanian. UCLA Luskin Center for Innovation Report. (April 2011)
24. “Los Angeles Solar Atlas.” J.R. DeShazo, R. Matulka, and N. Wong. Produced by the UCLA Luskin Center for Innovation with financial and data support from Los Angeles County, the Los Angeles Business Council, and the UCLA Lewis Center. (2011)
25. “Best Practices for Implementing a Feed-in Tariff Program.” J.R. DeShazo and R. Matulka, UCLA Luskin Center for Innovation Report. (2010)
26. “Bringing Solar Energy to Los Angeles: An Assessment of the Feasibility and Impacts of an In-basin Solar Feed-in Tariff Program.” J.R. DeShazo and R. Matulka, UCLA Luskin Center for Innovation Report. (2010)
27. “Designing an Effective Feed-in Tariff for Greater Los Angeles.” J.R. DeShazo and R. Matulka. UCLA Luskin Center for Innovation Report. (2010)

7.2 co-PI: Asst. Adj Prof. Brett Williams, MPhil (cantab), PhD

Summary

As a researcher, speaker, and adviser with training from universities in the U.S. and U.K. and a mixed science/technology, innovation, and policy perspective, Brett has worked for 20 years with leading companies, government agencies, and academic researchers in the U.S. and Europe to investigate the wide, rapid, and responsible commercialization of electric-drive vehicles, alternative fuels, and efficient, green power systems.

Major research activities have included: 1) exploring plug-in-vehicle and electric-fuel policy implementation in California, including PEV Regional Readiness Planning; 2) analyzing workplace charging 3) evaluating plug-in-vehicle battery secondary use (e.g., post-vehicle repurposing into stationary energy-storage appliances to supply grid-support services) for NREL and in collaboration with UC Davis, CCSE, San Diego Gas & Electric, and AeroVironment; and 4) working in partnership with Toyota, government agencies, and other organizations on projects involving demonstration and study of Toyota-made plug-in-hybrid and fuel-cell vehicles.

Professional Preparation

Pomona College (Claremont, CA)	Physics/Public Policy Analysis	BA (thesis with distinct.)
Cambridge University (UK)	Environment & Development	MPhil (1st-equiv. thesis)
University of California, Davis	Graduate School of Management	Business Develop. Cert.
University of California, Davis	Transportation Technology & Policy	PhD
University of California, Berkeley	Transp. Sustainability Research Cntr.	Postdoctoral Scholar

Appointments

- Assistant Adjunct Professor of Public Policy and Luskin Center EV Program Director, University of California - Los Angeles
- Senior Researcher, Electric-Drive Vehicles & Energy / Assistant Research Engineer, Transportation Sustainability Research Center, University of California - Berkeley
- Postdoctoral Scholar, Transportation Sustainability Research Center, University of California - Berkeley
- Instructor, Co-Instructor, and Teaching Assistant for Transportation Technology & Policy and Civil & Environmental Engineering/Environmental Science & Policy courses, University of California - Davis
- Vehicle & Fuel Analyst, Ford Motor Company at the California Fuel Cell Partnership
- Senior Research Associate, Rocky Mountain Institute

Select Publications

Williams, B. "Plug-In-Vehicle Battery Second Life: the Effect of Post-Vehicle, Distributed-Grid-Energy-Storage Value on Battery-Lease Payments." *Transportation Research Record* **2012,** 2287, 64–71.

Williams, B. D.; DeShazo, JR; Ben-Yehuda, A. *Early Plug-in Electric Vehicle Sales: Trends, Forecasts, and Determinants;* Deliverable 04 to the Southern California Association of Governments, 2012.

Williams, B. D.; Martin, E.; Lipman, T.; Kammen, D. "Plug-in-Hybrid Vehicle Use, Energy Consumption, and Greenhouse Emissions: An Analysis of Household Vehicle Placements in Northern California." *Energies* **2011,** 4, (3), 435-457.

Lipman, T. E., M. Witt, B. D. Williams, and M. Bomberg (2011). Electric-Fuel Scale-Up in California: Policy and Regulatory Support; TBD (forthcoming); California Energy Commission: August.

Williams, B. D.; Lipman, T. E. "A Strategy for Overcoming Plug-In-Hybrid Battery Cost Hurdles in California: Integrating Post-Vehicle Secondary Use Values." *Transportation Research Record* **2010**, (2191), 59–66.

Williams, B. D. and K. S. Kurani (2007). "Commercializing light-duty plug-in/plug-out hydrogen-fuel-cell vehicles: “Mobile Electricity" technologies and opportunities," *Journal of Power Sources*, vol. 166, pp. 549–566.

Williams, B. D. and K. S. Kurani (2006). "Estimating the early household market for light-duty hydrogen-fuel-cell vehicles and other “Mobile Energy” innovations in California: A constraints analysis," *Journal of Power Sources*, vol. 160, pp. 446–453.

Williams, B. D. and B. Finkelor (2004). “Innovative Drivers for Hydrogen-Fuel-Cell-Vehicle Commercialization: Establishing Vehicle-to-Grid Markets,” in procs. *Hydrogen: A Clean Energy Choice* (15th Annual U.S. Hydrogen Meeting), Los Angeles CA, National Hydrogen Association.

Williams, B. D., T. C. Moore, and A. B. Lovins (1997). “Speeding the Transition: Designing a Fuel-Cell Hypercar,” in procs. *8th Annual U.S. Hydrogen Meeting*, Alexandria VA, National Hydrogen Association.

Select Other

- Brett has presented his work dozens of times to conferences (including as an event chair, and in invited and plenary speaker roles), to corporations in the U.S., Europe, and Japan, and to government agencies (including a member of the European Commission).
- He has contributed to and been quoted on radio and for other media such as *Wired* and *E* magazines, the *Wall Street Journal*, *Environmental Health Perspectives, New York Times Online, New Scientist Online, Business Week Online,* ABCNews.com, and *greentechgrid*.
- California Plug-In Electric Vehicle Collaborative, Workplace Charging Working Group, Research Working Group (WG5), Volunteer.
- Friend of Transportation Research Board Energy and Alternative Fuels Committees.
- Regular peer reviewer for the *Journal of Energy Policy*.

7.3 Tamara Sheldon

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☎ (303) 931-2028
✉ tsheldon@ucsd.edu

Tamara Sheldon

Education

2010–Present **Ph.D. in Economics**, *University of California, San Diego*, Expected 2015.

2004–2008 **B.S. Environmental Engineering**, *Massachusetts Institute of Technology*.

Research Interests

Environmental and Energy Economics, Climate Change

Honors and Fellowships

2012–2013 **NSF IGERT Climate Change Fellowship**, *Scripps Institute of Oceanography*.

2012 **Teaching Assistant Excellence Award**, *University of California, San Diego*.

2011 **Graduate Research Summer Fellowship**, *University of California, San Diego*.

2007–2008 **Chi Epsilon Honors Society**, *Massachusetts Institute of Technology* .

Experience

2012 **Research Assistant**, under Richard Carson (UC San Diego) and JR DeShazo (UCLA).

2010–2012 **Teaching Assistant**, *UC San Diego*.
(Energy Economics, Environmental Studies, Development Economics, Microeconomics)

2008–2010 **Financial Analyst**, *Lehman Brothers, Barclays Capital*.
Structured volatility desk: created, priced and sold structured equity derivatives

Conference Presentations

Spring 2012 **Renewable and Sustainable Energy Technology Workshop**, *UCLA*.

Fall 2011 **Environmental Economics Seminar**, *University of California, San Diego*.

Research in Progress

Effects of the business cycle on carbon dioxide emissions.

Forecasting carbon dioxide emissions has significant implications for climate change predictions, setting goals for international mitigation agreements, and setting caps for both international and regional emissions trading schemes. GDP growth is one of the most important inputs into emissions forecasting models, however, these models typically consider only *average* economic growth. This paper develops a simple forecasting model and adjusts the model to incorporate the business cycle. Using this model, I find that globally and for many countries, including the United States, emissions fall more sharply during a downturn than they rise during an upturn. It appears that gasoline pump prices, differential changes in electricity fuel sources and private sector mix are predictive of the observed asymmetry. The asymmetry is likely driven by an asymmetric price elasticity of demand for energy, which is consistent with relevant literature. During an upturn, as energy prices rise, demand for energy usage and emissions responds elastically to the price increase, moderating the increase in energy usage and emissions. During a downturn, as energy prices fall, if demand is less elastic in the fall in energy price, then there is no moderating effect, and the decrease in energy usage and emissions is stronger. Lastly, I show that taking the asymmetry into account will produce significantly different emissions forecasts. On average, long term carbon dioxide emissions forecasts will be lower than the baseline case, but will have a drastic increase in uncertainty. This means that, holding growth constant, there is additional uncertainty around the *path* of economic growth, which could have significant implications on optimal policy and investment.

Clean Vehicle Demand in Southern California, *with Richard Carson and J.R. DeShazo*.
We have designed a stated preference experiment, sponsored by the California Air Resource Board, to be implemented in January 2013. We will estimate demand for clean vehicles, especially plug-in hybrid electric vehicles, as well as demand for associated infrastructure in southern California.

Professional Activities

Journal Referee **Resource and Energy Economics**.

University Service **Graduate Student Representative to the Campus Advisory Committee on Sustainability**.

8 Preliminary cost proposal

The total requested funding is $265,446. With an additional $81,591 in expected in-kind contribution provided by the Luskin Center ($74,174 direct and $7,417 indirect), the total project budget is $347,037.

		Personal Services	Operating Expenses					Other	
		Salary & Benefits	Subcontractors*	Travel	Equipment	Materials & Supplies	Misc.	Indirect Costs	Total
	Tasks								
Task 1	Project management	40,863		3,768				4,463	49,094
Task 2	Data collection and preparation	63,033				20,700		8,373	92,106
Task 3	Data analysis	41,949						2,537	44,486
Task 4	Draft report writing and ongoing analysis	49,991					600	5,059	55,650
Task 5	Report revision and finalization	21,518					400	2,192	24,110

	Salary & Benefits	Subcontractors	Travel	Equipment	Materials & Supplies	Misc.	Indirect Costs	Total
Sum	$217,354	$0	$3,768	$0	$20,700	$1,000	$22,624	$265,446

8.1 Budget description

8.1.1 Direct costs

Salary and benefits

$200,776 is requested for salary and benefits, to be supplemented with $55,174 in pro bono effort by the Luskin Center. Table 8-1 summarizes the proposed level of effort by project participant by task, in term of full-time month equivalents.

Table 8-1: Level of effort by project personnel by task (full-time month equivalents)

SALARIES:	Mgt Task 1 (24 mo.)	Data prep Task 2 (9 mo.)	Data analysis Task (9 mo.)	Draft report Task 4 (6 mo.)	Final report Task 5 (6 mo.)	Total (24 mo.)
Name and Payroll Title	Full-time month equivalents					
JR DeShazo, Professor	0.3	0.2	0.2	1.2	0.2	2.1
Brett Williams, Asst. Adj. Professor	2.40	0.90	1.35	3.00	1.20	8.85
Norman Wong	0.0	3.6	0.2	0.2	0.1	4.1
Tamara Sheldon (UCSD), GSR IV, acad yr	0.00	2.25	2.25	1.20	0.30	6.00
Tamara Sheldon (UCSD), GSR IV, summer	0.00	1.80	3.60	0.60	0.00	6.00
TBN, Underg. Student Res., acad yr	1.2	0.9	0.0	0.2	1.5	3.8
TBN, Underg. Student Res., summer	2.4	0.9	0.0	1.2	0.0	4.5
Susan Woodward, Admin. Specialist	1.8	0.0	0.0	0.0	0.0	1.8
Colleen Callahan, Asst. Director	0.6	0.0	0.0	0.0	0.0	0.6
						37.8
	18.8%	29.0%	19.3%	23.0%	9.9%	100%

Professor DeShazo will actively oversee the entire project, providing management and intellectual contributions throughout. In particular, he will take the lead role related to guiding and writing-up the portion of the project most directly related to the fixed effects panel data methodology and analysis, estimated to require the average of one day per week over task 4. His time, roughly 2 months-equivalent in total, will be provided in-kind by the Luskin Center.

Asst. Adj. Professor Williams will take the lead role managing the project, interacting with ARB staff, drafting and finalizing the report. Under the guidance of Prof. DeShazo, he will work with project staff and researchers to oversee and implement data collection, preparation, and model development and will play an active role in data analysis, particularly during Tasks 4 and 5.

Norman Wong, Luskin School of Public Affairs data and GIS specialist, will play a major role in data collection and preparation, including geographic coding, and will provide data visualization (e.g., maps) and other products throughout.

PhD student Tamara Sheldon will be the primary econometrician, collecting and preparing data and developing the econometric models and conducting the core model runs. As a graduate student researcher, she will be available 100% during summer months and 50% during the academic year, through summer 2014.

An undergraduate student researcher (USR), working 50% throughout the project, will assist in data collection and preparation, support the development of project-management products (reports, meeting preparations, presentations), and help coordinate interactions between project personnel and ARB staff.

Acting as office manager and executive assistant, Susan Woodward would lead project administration (including invoicing), help supervise USR work, coordinate project activities and personnel, and support report and other deliverable preparation. Her time, nearly 2 months-equivalent, will be provided in-kind by the Luskin Center.

As Center Deputy Director, Colleen Callahan would assist with project management, provide feedback on reports, and coordinate project outreach. Her time, roughly 0.6 months-equivalent, will be provided in-kind by the Luskin Center.

Tuition remission

One year (2013–14) of tuition remission is requested for PhD student Tamara Sheldon, for a total of $16, 578.

Travel

$3,768 is requested for 4 trips for 2 people to Sacramento, as described in the Task 1 description for start-up, annual-report, draft-project-report, and final-report meetings.

Data acquisition (materials and supplies)

$20,700 is requested for data acquisition. $7,000 is requested to supplement over 2 years of existing PEV registration data with data for 2013. $5,700 is requested to purchase gasoline-price data for 37 months to match the period of vehicle registration data (12/2010 through 12/2013). This has been estimated at roughly 25 cents per area per month for over 600 areas across California (e.g., 10% of 6,612 CA zip codes or 661 aggregated areas across the state). $8,000 is requested to supplement primarily southern California land-use data already in use at the Luskin School of Public Affairs, the latter of which is estimated to be worth roughly $5,000 in cost share, for a total of roughly 19,000 in matching data assets provided by the Luskin Center.

Misc. expenses

$1,000 is requested to assist in draft report editing ($400) and layout ($200) and final report editing ($300) and layout ($100).

Direct-expense totals

Direct expenses requested thus total $242,822, to be supplemented by $74,174 in resources provided by the Luskin Center.

8.1.2 Indirect expenses

Per ARB requirements for UC proposals, a 10% overhead rate was used an applied to all direct costs with the exception of tuition remission ($16,578).

Indirect costs thus total $22,624 for requested funds (and $7,417 for in-kind resources).

8.1.3 Budget totals

Requested funds thus total $265,446 and in-kind resources total $81,591, for a project total of $347,037.

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