Proposal

MAXIMIZING THE AIR QUALITY, CLIMATE, AND SOCIAL EQUITY BENEFITS OF LIGHT-DUTY VEHICLE INCENTIVE PROGRAMS

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Check if applicable:

Animal subjects _____

Human subjects ___X___

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ABSTRACT

This proposal approaches the two parts of the RFP (*Vehicle Retirement and Replacement Incentives for Low-Income households* and *Advanced Clean Vehicle Incentives)* as linked concepts that can be productively joined to create a comprehensive vision for how to promote near-ZEV and ZEV acquisition and use by households across a wide range of incomes. The bound between "low income" and higher income households is defined as 225 percent of the federal poverty level. The conceptual and analytical approach to joining the two projects is two-fold. In brief, this proposal examines how to increase the ability and opportunity of low-income households to acquire near-ZEVs and ZEVs while at the same time increasing the supply of such used vehicles by addressing the design of incentives for middle- and upper-income households (to buy both new and used near-ZEVs and ZEVs). To accomplish this, we propose to examine suites of existing incentive programs, possible modifications of existing programs, and possible new incentives targeted to different income groups. These could include expansion to alternative mobility options, and not just replacement and/or acquisition of personal vehicles. The analysis will help ARB consider moves into more comprehensive, holistic systems of incentives that help reach their targets in the most cost-effective way possible, while enhancing access to incentives and ZEVs across the population.

The technical plan integrates two parts: Part A covers Data Collection and Analysis and Part B covers Modeling and Scenario Analysis. In Part A, primary consumer data will be collected in two main parts. First, a set of qualitative case studies will be made in cities in northern and southern California. Interviews with individual households and workshops with sets of those interview subjects will be conducted. Second, a statewide survey of all California households will be conducted. The survey instrument will be informed by the case study results. The sample will be stratified to oversample low-income households. As low-income households are less likely to have internet access, this oversampling may require multiple survey distribution media, i.e., it may not be possible to rely solely on internet based survey administration. Construction by respondents of effective suites of incentives and other conditions, e.g., vehicle availability, with which respondents could acquire a near-ZEV or ZEV, will be an explicit task of both data collection phases. Participatory research designs enlist the respondents as designers of the subject of the research. The large sample survey supports understanding of vehicle retirement and replacement motivations and patterns and assessment of the effectiveness of different financial incentive program structures and levels.

Part B will comprise a modeling effort using an upgraded version of the CARBITS model that was developed by David Bunch and used previously in ARB projects. CARBITS already has important features to support analysis of policy impact across household demographic groups (including income levels). The model will be upgraded in two major ways for this analysis: it will be updated, recalibrated, and extended to 2025; and its capabilities will be extended to address clean vehicle market formation processes by drawing on recent modeling work performed for the Energy Commission. Once again, "suites" of incentive types will be explored along with individual incentives of interest to ARB. Several scenarios will be created that can be compared in terms of effectiveness of meeting ZEV targets, equity of impacts across population groups, and economic cost-effectiveness. Potential changes to policies will be explored and "optimal" packages will be recommended as a result of the analysis.

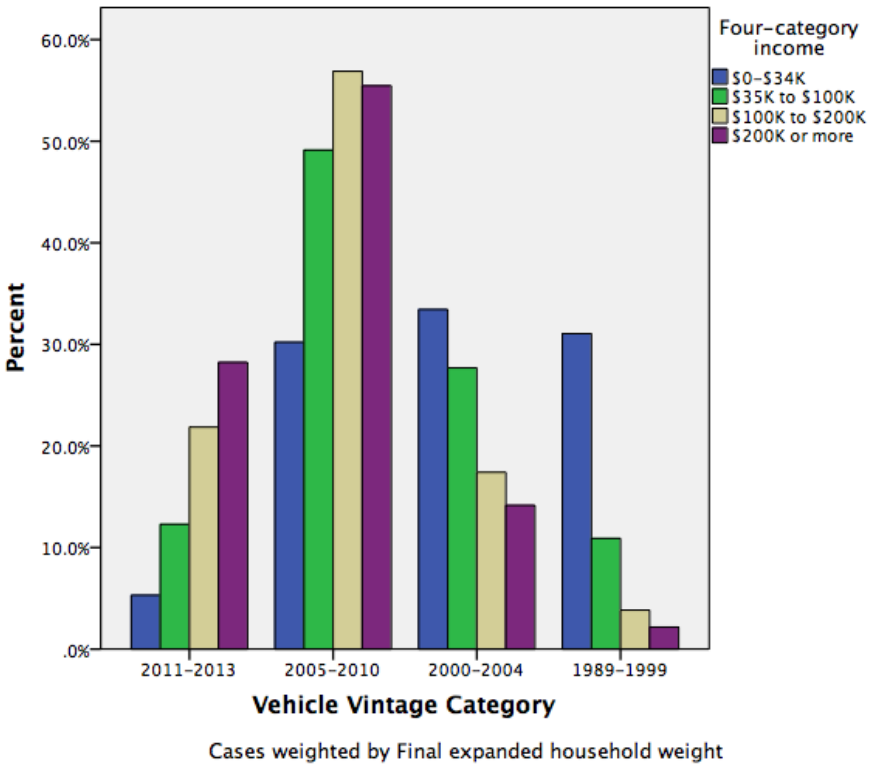
INTRODUCTION

The Air Resources Board (ARB) is responsible for helping California achieve its air quality and climate change goals, for which a transformation of the light- duty vehicle fleet will be necessary. As noted by ARB, "Incentives play an important role by accelerating the retirement and replacement of older, high-polluting vehicles and to increase adoption of advanced clean vehicles," as evidenced by two existing incentive programs: the Enhanced Fleet Modernization Program (EFMP) and the Clean Vehicle Rebate Project (CVRP), respectively. The purpose of this project is to perform research that will help ARB enhance the effectiveness of these types of programs along multiple dimensions, including specific requirements of Senate Bill (SB) 459 and SB 1275 related to impacts on disadvantaged, low- and moderate income communities.

The two major areas discussed in the solicitation, *Vehicle Retirement and Replacement Incentives for Low-Income households* and *Advanced Clean Vehicle Incentives* may seem distinct subject areas—ARB even encourages applicants to choose one or the other. This proposal takes the position that the two components can be productively joined to create a comprehensive vision for how to promote near-ZEV and ZEV acquisition and use by households across a wide range of incomes. The bound between "low income" and higher income households is created by the first described project, "Low-income is defined as 225 percent of the federal poverty level…."[1] Though the second project might be thought to establish the lower bound of an upper income bracket, with the upper bound indeterminate as buyers of plug-in electric vehicles (PEVs) include households with incomes in excess of 1000 percent of the federal poverty level. Between these bounds are the vast majority of automobile owning and driving households without whom efforts to sustainably promote advanced clean vehicles cannot succeed.

Figure 1 demonstrates the variation in car holdings across different income groups in California (using data from the CHTS, 2013). The distribution shows the most recently purchased vehicle in each household, and indicates that for the top income category this is about 30% 3 year old or newer vehicles, and 50% 3-8 year old vehicles. For the bottom income group, the situation is (not surprisingly) very different: over 60% of the most recently purchased vehicles are over 8 years old. Middle income groups fall in between but actually have very low holdings of vehicles over 13 years old, with majority holdings in the 3-8 year old categories. This is the "tip of the iceberg"; a more detailed analysis across income and demographic groups would no doubt reveal that relatively few Californians apart from the lowest (EFMP) and highest (ACV) income groups participate in the two programs. While adhering to the requirements of the RFP, this proposal demonstrates that by treating both problem statements as part of a larger whole, guidance can be provided for nurturing markets for near-ZEVs and ZEVs across a broad spectrum of income.

[1] For 2015, given the average number of ~3 people per household in California, this is ~$45,200 per year. This is not the lowest limit for inclusion in the proposed research, but the income level below which households are eligible to participate in the Enhanced Fleet Modernization Program.



The logic of existing incentive programs is rooted in the fundamental structure of vehicle markets. Vehicles are so-called durable goods with relatively long lifetimes that are bought and sold in a market with particular features: new vehicles are offered annually by manufacturers in a competitive environment characterized by frequent product improvements (and their associated increasing prices in real-dollar terms); once sold, vehicle values can depreciate relatively quickly in the first few years; there is a robust secondary (used vehicle) market due to long operating lives and quickly changing market values; and, after sufficient depreciation/deterioration, vehicles are permanently retired from the market (scrapped). Incentives applied to either "end" of this market dynamic can have an impact on the entire system. In the recent past, the national regulatory environment and local conditions gave rise to a California vehicle fleet with large numbers of older vehicles producing a disproportionately large share of air pollution. For economic reasons, these are frequently in the hands of lower-income households, exacerbating the disproportionate negative impacts of air quality on this population. Vehicle retirement incentives should in theory have salutatory consequences in terms of both direct effects and effects on the entire market dynamic.

On the other "end" of the market (new vehicles), policy motivations are potentially more complicated. The national regulatory environment (following California's lead) places requirements on manufacturers in the form of increasingly stringent emissions standards, which will have market implications. But, for California, analyses have shown that meeting California's ambitious air quality and climate goals will require the introduction and adoption of new clean vehicle technologies, i.e., essentially the creation of a new type of market, which has given rise to a combination of complementary policies programs, including the ZEV mandate, the Air Quality Improvement Program (AQIP), and in particular new vehicle purchase incentives through the Clean Vehicle Replacement Program (CVRP).

In many ways these policies and programs have been successful, in that it can be argued that we are now actually in the early stages of a ZEV market formation process that has been a goal since the 1990's. But with that success there is a track record, and the need to continually update and improve policies to more effectively address a range of policy concerns.

Under the general heading of "incentives," there is always a fundamental pitfall that occurs regardless of the type of consumer behavior that is being targeted: at least some consumers will reap the monetary benefits of an incentive for engaging in behavior that they would have engaged in anyway. This was apparently a documented concern for the EFMP, but has also been a subject of ongoing concern for purchase incentives targeting new car buyers, because they tend to be higher-income households. If these households would have purchased ZEVs anyway, the concern is even greater because of perceived equity issues. A related concern is: a goal of the policy is to improve air quality, and air quality is disproportionately worse in geographical locations where disadvantaged and low-income households reside.

These concerns have given rise to specific new policy requirements in SB 459 and SB 1275 that are related to *social equity*. At the same time, an overall policy goal continues to be the design of complementary programs to support (and, to the degree possible, accelerate) *ZEV market formation* that use scarce funds in an efficient manner.

Taken together, the elements of this situation suggests a range of research needs of varying types that have been enumerated in the project solicitation. Because of both the breadth and depth of the UC Davis research team, including highly relevant and recent ongoing research projects, it is possible for us to provide a research plan that effectively addresses most of these needs. At the same time, it is important to understand that the proposed scope of work is not the result of simply combining issues that might be nominally assigned to the two existing incentive programs (EFMP and CVRP).

In any case it is clear that the project requires an **improved understanding of the purchase behavior of a much wider set of consumers in terms of income (and all those who buy in the secondary markets) and their potential responses to alternative incentive program structures and amounts.** This deeper dive into behavioral issues across the broader car-buying population would address multiple requirements. One aspect is to understand in greater detail what the "behavioral efficiency" of specific incentive program features might be (e.g., tax credits versus onsite dealer-based price reductions) as well as insights into how quantitative modeling tools would need to be modified to more effectively analyze policy options.

OBJECTIVES

The California Air Resources Board has stated the following objective for this research: "to evaluate the light-duty vehicle market and inform ARB decision makers about the potential options for modifying ARB's incentive programs to ensure they make the best use of limited State resources, as well as provide benefits to underserved populations and disadvantaged communities." The stated focus of ARB is on the Enhanced Fleet Modernization Program (EFMP) and the Clean Vehicle Rebate Project (CVRP). We propose other state incentive programs may be, more or less formally, bundled with these incentives to accomplish ARB's

objective. The results inform design and implementation of incentives programs to promote near-ZEVs and ZEVs across a broad spectrum of household incomes.

As described, this research will integrate the study of both the *Vehicle Retirement and Replacement Incentives for Low-Income households* and *Advanced Clean Vehicle Incentives.*

Consistent with ARB's objectives for these two components, the objectives of our study include:

- Understanding the demographics and vehicle retirement and replacement motivations and patterns of eligible participants of EFMP, and
- Helping ARB meet the requirements of Senate Bill (SB) 459 and SB 1275.
- Investigating the impact clean vehicle adoption,
- Assessing the effectiveness of different financial incentive program structures,
- Evaluating efficient incentive funding levels,
- Determining how incentive funding levels should change as production volumes increase and vehicle technologies improve, and
- Describing the conditions under which the market is self-sustaining and incentive funding is no longer necessary.

As an extension, and underpinning these objectives, we will address the following research questions:

1) What incentive structures for both programs would maximize ZEV sales in California through 2025 and help to ensure meeting the ZEV sales targets?
2) How can incentives be structured to be available to more Californians, across demographic and income groups, leading to a maximum penetration of ZEVs across these groups?
3) How can these goals be met in the most cost-effective manner, including $ spent per ZEV vehicle entering the market, and $/tonne of CO2 emissions reduction?

The project will investigate how different incentive strategies perform across these metrics, and identify one or more alternatives that perform strongly in all three respects. It will generate new data sets and build on this to develop analysis that provides answers to these questions.

TECHNICAL PLAN

The following technical plan describes the work effort as a Part A data collection/analysis and Part B model development/scenario analysis. Part A will create critical new data sets and provide a foundational analysis of these; it will also feed into Part B which will involve forward looking modeling and scenario developing out to 2025. The overarching aspects of the project analysis plan are presented first with a discussion of two main areas of focus; this is followed by a presentation of the details of the technical approach and methodology for each of the two parts of our study.

1. Evaluating the impact of policies on market formation and legitimation processes for ZEVs using quantitative models to project dynamic, multi-year market behavior.

First, we propose to examine suites of existing incentive programs, including possible modifications of existing programs and possible new incentives targeted to different income groups. We will estimate the efficacy of such suites of incentives to accomplish the stated objectives of both the *Vehicle Retirement and Replacement Incentives for Low-Income households* and *Advanced Clean Vehicle Incentives* projects as well as the implied objective of sustaining transitions to clean vehicles. The state already spends millions of dollars in different incentive programs, monies that could be used to leverage the effects of one program with the effects of others. Our hypothesis is that there are synergies in certain combinations of incentive programs and that structure matters. This includes elements such as one specifically called out in the RFP: the relative impacts from different incentive distribution structures (tax rebates, credits, registration fee reductions, point of sale incentives, etc.).

An example of such mutual leveraging possibilities—that is of direct applicability to the subject of *Advanced Vehicle Incentives*—is the work at the UCD PH&EV Center on PEV markets and renewable electricity. Axsen and Kurani (2013) estimated a 25% increase in consumer interest in PEVs when consumers could co-design both a PEV and a renewable electricity program for their household compared to only designing the vehicle. The policy or social marketing design that follows from this result would be to more (policy) or less (social marketing) join the state's Advanced Clean Vehicle Incentives (as well as the federal Plug-in Vehicle Tax Credit) with federal, state, and local incentives for home renewable energy installations. Axsen and Kurani's research concludes the resulting suite of incentives provides a far more compelling case for PEV purchase by households and advance the state's larger policy goals by assuring a higher percentage of renewable electricity to charge those PEVs.

Even for incentives focusing solely on vehicles, the strength of such suites of incentives is suggested by the accounts provided by PEV owners of the importance of a wide variety of federal, state, and local incentives for PEV purchase and use to their PEV purchase decisions (Tal and Nicholas, 2013). Kurani et al. (2014a) describe how existing PEV owners construct accounts of all the incentives they accessed when the purchased their vehicles. Tal and Nicholas (2014) study the impact of HOV lane access and explore the potential of combining monitory and non-monetary incentives. The multiple incentives not only far exceed the monetary value of any single incentive, they signal support from multiple levels of government, incentivize both purchase and driving PEVs, and in combination add up to an account of acquiring a PEV as "a smart consumer choice."

One portion of the scope of work goes into some detail discussing different financial incentive "types," and there is an indication that ARB staff expect this to include "rebates, tax credits, feebates, registration fee reductions, point of sale incentives, sales tax exemptions, and/or a combination of incentives." We wanted to highlight the fact that focusing on these specific details is potentially important for understanding what the "implementation efficiency" might be associated with offering an incentive, but that this should be carefully separated from activities that attempt to explore issues such as "when a self-sustaining market may be achieved," or, "how an incentive can be adjusted with potential ZEV technology advances." Specifically, at some

level an incentive effectively lowers the effective purchase price of a vehicle, which then increases the probability of purchase.

2. Evaluating impacts of policies on various demographic groups and communities.

Second, the research emphasizes the role through time of leveraging policy and market mechanisms, with a focus on differentiating between various demographic groups and communitites. In the near term, policy suites involving the *Enhanced Fleet Modernization Program* (EFMP), *Clean Vehicle Rebate Program* (CVRP), and other existing consumer transportation, employment, and energy incentive programs for low-income households may be bundled to increase opportunities for low-income households to acquire—or at least use—near-ZEVs and ZEVs, whether used or new. Over the longer term, *Advanced Clean Vehicle Incentives* available to all households to acquire near-ZEVs and ZEVs may be designed so as to move those vehicles more rapidly into and through the used vehicle market, increasing the supply of more affordable, used near-ZEVs and ZEVs.

Within the structure discussed above, part of the research plan would be to develop a specification of exactly what type of consumer segmentation structure would be required to produce the desired analysis. It is obvious that the segmentation would involve household income categories. The main feature we believe we need to incorporate is the possibility of evaluating policies in which incentive amounts might vary depending on the income of the recipient. The current version of the specific model described above does not currently include income segmentation; moreover, we would expect to produce a version of a model that would rely on the most recent California Household Travel Survey (CHTS). However, we cannot allow income to vary continuously, and the definition of segments needs to be planned in conjunction with specifying what policy options need to be evaluated. Another question that needs to be answered is the role that geographical and/or spatial representation should play. Finally, must be some additional consideration on what possible alternative forms of incentive policies will eventually be considered (e.g., mobility subsidies rather than purchase incentives).

A novel aspect of the work proposed here is to extend this research on PEV markets to household vehicle purchase and use behaviors of low-income households. Most research on low-income households and automobiles deals with the distinction between the presence and absence of automobiles in households (see for examples Pendall et al. (2014); Rice (2004)). As noted by Clifton (2004), most of the work that examines mobility in low-income households focuses on trips to work. We stress the importance of this lack of study of the car buying, owning, and use behaviors of low-income households; almost no systematic examination has been made of what vehicles low-income households buy, why they buy the vehicles they do, how they buy them, and how they use them. What little research that has been conducted on the use of vehicles across low-high income divides indicates differences that may favor the use of plug-in vehicles by lower income households: among car-owning workers in Los Angeles, drivers at or below the poverty level have a shorter average daily travel radius (14 miles) than do workers earning over $100,000 per year (26 miles) (FHWA, 2014). Through its EFMP Assessment, ARB (2013) may have the best available information on vehicles low-income households *once* owned, but the assessment addresses neither how those households came to own those vehicles nor how they used them. Roy et al. (2004) explore the more general value of a low-income household owning at least one car, including the effects on time budgets for the whole household: “A car is not a

luxury, you need it… A car means that time is yours,…." These other values of access to an automobile may reveal other ways to incentivize near-ZEV and ZEV acquisition and use by low-income households.

We propose to examine the purchase and use of automobiles by low-income households in the same comprehensive and holistic manner as our past work has examined new car buying households. Focused research with low-income households will be combined with case studies conducted in a comparison/contrast framework and a comprehensive, market wide study of the effect of incentives on household vehicle transactions, focusing on the effects on bringing near-ZEVs and ZEVs into the vehicle fleet, i.e., new vehicle acquisitions, and throughout the vehicle fleet, i.e., used vehicle acquisitions. Alternatives to private vehicle ownership will be considered too, for example the possibility for shared car programs to substitute for privately owned vehicles among low-income households.

This work will be integrated into a broader survey of the total California car-owning population, with an oversample of low-income households. The purpose of the survey is to test suites of incentives on household's consideration of near-ZEVs and ZEVs and generalize across the population of car-owning households.

Methodology Part A: Consumer data collection and analysis

Primary consumer data will be collected in two main Parts. The first Part will be a set of qualitative case studies using both interviews with individual households and workshops with sets of those interview subjects. The second Part will draw insights from the first to inform the conduct of a statewide survey of all California households. The sample will be stratified to oversample low-income households. As low-income households are less likely to have internet access, this oversampling may require multiple survey distribution media, i.e., it may not be possible to rely solely on internet based survey administration.

Consumer Data Collection and Analysis Task List

Case Studies: Household Interviews and Workshops

1. Identify Case Study Locations
2. Conduct Interviews and Workshops
3. Analyze Interviews and Workshops

Statewide Survey (40% total expenditure)

4. Design Survey Instrument and Administration Plan
5. Administer Survey
6. Analyze Survey

Draft Final and Final Report

7. Synthesize Case Study and Survey Results

Case Studies: Household Interviews and Workshops

Participatory research designs enlist the research respondents as designers of the subject of the research. In this case, the approach to studying suites of incentives is to co-construct with the respondents a representation of their purchase and use of vehicles and use that representation to construct and test suites of incentives.

Task A1. Identify Case Study Cities. (10% of effort)

Two pairs of cities (four cities, total) representing a cross-section of city size, ZEV market activity including local business or government initiatives will be selected. One pair will be in northern California, the other in southern California. In each city, case studies will be made of specific communities. A pair of interview/workshops could be carried out in a high income, high ZEV activity city and a nearby low income/low ZEV activity city. At least one of these sets of interviews and workshops will be conducted in Spanish among an Hispanic community.

Interviews and workshops will be conducted with low-income households who have participated in the EFMP project and households who have not. Another set of interviews and workshops will be held in nearby cities with households who have acquired near-ZEVs and ZEVs (utilizing available incentives) as well as households who otherwise match the socio-economic and car-buying behaviors of these households except they have not acquired near-ZEVs or ZEVs.

Each set of interviews will consist of ten households resulting in 48 total interviews (eight sets of six). Each set of interview respondents will be convened in a workshop (four total). In each city, one set of interviews and workshops will be addressed to the goals of the *Vehicle Retirement and Replacement Incentives for Low-Income households.* People who have and people who have not participated in the EFMP will be recruited. This provides insights into individual household motivations for participating or not participating (interviews) and the opportunity to observe the exchange between peers distinguished by their participation. Similarly, in each city another set of interviews and its workshop will address the *Advanced Clean Vehicle Incentives.* Representatives of two groups of people will be included: a group of existing drivers of PEVs and a second matching their general socio-economic description including new car purchases. The sampling is summarized in the following table.

Illustrative sampling scheme for interviews and workshops

City Pairs	*Vehicle Retirement and Replacement Incentives for Low-Income Households*		*Advanced Clean Vehicle Incentives*	
Northern CA, tbd	Accessed EFMP (6 interviews)	Did not access EFMP (6 interviews)	PEV Buyers: Accessed CVR (6 interviews)	ICEV New car buyers: Did not access CVR (6 interviews)
	1 workshop		1 workshop	

Southern CA, tbd	Accessed EFMP (6 interviews)	Did not access EFMP (6 interviews)	PEV Buyers: Accessed CVR (6 interviews)	ICEV New car buyers: Did not access CVR (6 interviews)
	1 workshop		1 workshop	

For each case study region, a local market research firm will be contracted to recruit, schedule, and pay incentives for interviews and workshops, as well as provide facilities for the corresponding workshops. Local community groups will be consulted regarding recruitment, facilities for events, possible requirements for providing transportation for respondents to and from workshops, and other conditions required to successfully complete the research task.

Task A2. Conduct Household Interviews

Design Interview Pre-Surveys and Protocols

Low Income Households Interviews

- To understand low-income households vehicle purchase histories and vehicle use.
    - What vehicles do they acquire? What vehicles do they aspire to acquire?
    - How do they finance automotive acquisitions?
- How do they view the present EFMP incentive? Why did they or don't they participate?
    - Retirement only; retire and replace.
- How do they use vehicles?
    - How do they imagine they would use a near-ZEV or ZEV?
    - Do they have access to infrastructure to charge an EV or PHEV?
- Construct suites of changes that would be required for these households to participate in:
    1. EFMP programs
    2. Advanced Clean Vehicle markets
        - Identify those changes that are either subject to existing policy or are amenable to policy interventions.

Workshops with the interview subjects.

- Community testing and re-design of incentive suites
- Bring forward ideas from individual household interviews for discussion by communities.

Middle- to high-income households

Household Interviews

Interviews with households who have or have not participated in the market for near-ZEVs and ZEVs.

- To understand higher income households vehicle purchase histories and vehicle use.
    - What vehicles do they acquire? What vehicles do they aspire to acquire?
    - How do they finance automotive acquisitions?
- How do they view the present Advanced Clean Vehicle incentives, including those other than California's CVR? Why did they or don't they participate?
- How do they use vehicles?
    - How do they, or how do they imagine, they would use a near-ZEV or ZEV?
    - Do they have access to infrastructure to charge an EV or PHEV?
- Construct suites of changes that would be required for these households to participate in Advanced Clean Vehicle markets.
    - Identify those changes that are either subject to existing policy or are amenable to policy interventions.

Workshops with the interview subjects.

- Community testing and re-design of incentive suites
- Bring forward ideas from individual household interviews for discussion by communities.

Task A3. Analysis of Interview and Workshop Data

Interview transcripts will be analyzed and summarized to identify 1) themes and 2) suites of incentives. The themes will be compared in particular between the two sets of households that define the main sampling plan, i.e., the groups addressing *Vehicle Retirement and Replacement Incentives for Low-Income households* and *Advanced Clean Vehicle Incentives*. Themes represent common experiences, ideas, and valuations across narratives. Interviews are not subjected to pre-determined themes; rather the themes are allowed to arise from the interviews in a more inductive (than deductive) process. To identify themes a three-step coding process is conducted: 1) open coding on the first read through of the data to locate themes and assign initial codes; 2) axial coding to review, examine, and (if necessary) revise initial themes; and 3) selective coding to look for examples to illustrate themes (Caperello and Kurani, 2011; Neuman, 2003).

Construction of suites of incentives will be an explicit task within each interview through a discussion of the conditions under which each household can imagine it could and would acquire a near-ZEV or ZEV. Note this exercise is still relevant to the groups of PEV buyers, if only to explore whether the incentives available to them are too many and too much.

Statewide Survey

The interview/workshop-based case studies will provide inputs to the design of a survey intended to generalize findings beyond the case study populations and support estimation of overall effects. The survey instrument will be based on a gaming approach deployed by the researchers in several studies of PEV markets (Turrentine and Kurani (1998), Axsen and Kurani, (2009), Axsen and Kurani (2013), Kurani et al (2014b).

Task A4. Design Survey Instrument and Administration Plan

UC Davis will utilize a market research firm for sample management services. UC Davis will provide the vendor with household selection criteria and the target sample size. The firm will invite the participation of new car owning households in California, send reminders to participants, and provide any sample weighting to insure the realized sample of completions represents the target population of new-car buying households.

The market research firm samples from its own databases. The firm will contractually guarantee a minimum number of respondents matching the selection criteria. Eligibility to complete the survey will be confirmed by the market research firm according to criteria supplied by UC Davis. The screening criteria will include household income, motor vehicles (none, used, and new) as well as respondent education, age, ethnicity, and gender. To the extent possible the 2010 US Census and California Statewide Travel Survey will help establish the sampling criteria (noting that neither the Census nor CSTS use income categories that correspond to the target of 225% of the federal poverty level for California as the operating definition of "low-income household" for this study.)

The survey questionnaire will measure awareness, knowledge, attitudes, intentions, valuations, and behaviors pertinent to the three main objectives: household vehicle purchase decision process, barriers and motivations to near-ZEV and ZEV purchase, and the effect of suites of incentives. The survey will assess socio-economic and demographic measures of the respondents and their households. It will assess basic features of their residence (including an assessment of whether they believe the can recharge a PEV at home), travel, and access to mobility tools, including but not limited to number and characteristics of motor vehicles owned or leased by the households and access to co-located parking and electricity at home and common destinations.

Respondents will design the conditions, i.e., the suite of incentives, under which a likely (next) vehicle for their household could be a near-ZEV or ZEV. Parameters that respondents may manipulate in the game include the design of both vehicles and incentive packages. Example vehicle attributes to include:

1. new vs. used,
2. driving range per refueling and/or recharging,
3. home vs. non-home recharging and refueling, without and with work place opportunities,
4. time to recharge or refuel, and
5. equivalent fuel economy for PHEVs operating in charge depleting and charge sustaining operation.

Multiple rounds of designs are created by introducing incentives, i.e., taking respondents from either a condition of considering only vehicles to vehicles and incentives or the opposite. The former builds incentive suites from nothing; the latter "deconstructs" a set of incentives until it is no longer effective.

The games are customized to each participant based on their existing vehicle ownership status and home PEV charging potential.

The results of the design games are respondents' prospective designs for a vehicle they imagine they will buy next and the incentives that make it possible that vehicle is a near-ZEV or ZEV. These prospective designs are not forecasts, but measures of respondents' present propensities. The games, in effect, provide a way for respondents to register their intent whether they are presently willing for their next vehicle to be a near-ZEV or ZEV within the boundaries of the game conditions.

Task A5. Administer Survey

The survey instruments will be distributed to the sample according to the Administration Plan. Results of the Case Studies will inform the Administration Plan, in particular whether it is possible to reach the over-sample of low-income households via the same medium, i.e., an internet based survey, as higher income households. The administration of the survey instrument will be a service purchased with contract funds from one or more vendors as required to meet the project targets.

Task A6. Analyze survey data

Variables to explain differences in vehicle and incentive designs across households include measures of awareness, knowledge, and motivation regarding ZEVs and ZEV-enabling technologies, household resources, and barriers to ZEV charging. They include the following measures:

1. Household resources e.g., income, home ownership, access to recharging infrastructure, education, and household vehicle holdings;
2. Perceptions of the travel, hauling, and towing expectations for the next new vehicle;
3. Motivations, e.g., regarding automobiles and environmental issues or technology; and
4. Perceptions and knowledge of, for example, e.g., household vehicle and energy costs, automobiles, and electric-drive automobiles.

Research results will be presented in two forms.

1. Descriptive statistics, e.g., distributions and summary statistics as appropriate, of the sample, i.e., how many people believe what, do what, etc.; and
2. Multivariate analyses that link past actions with vehicle and incentive designs.

In particular, the vehicle and incentives created by respondents will be tested for correlations with variables describing decision making, barriers and motivations to ZEV purchase, as well as socio-economic descriptors of the households. The analyses will use statistical models appropriate to categorical and mixed categorical and continuous data, e.g., logit and mixed-logit models, as well as logistic regression. Examples of these kinds of analyses of consumer

consideration of conventional gasoline vehicles, alternative fuel vehicles, PHEVs, and EVs may be found in Turrentine and Kurani (1995) and Kurani et al (1996). Further examples of analyses of consumer valuation of conventional vehicles, HEVs, and PHEVs may be found in Axsen and Kurani (2009, 2011).

Logistic regression is used to model the probability of discrete outcomes, e.g., a household designs their next new vehicle *t* be a ZEV or a conventional internal combustion engine vehicle (ICEV). Multinomial logistic regression allows for more than two possible outcomes, e.g., FCV, BEV, PHEV, HEV, or ICEV. The use here is estimate changes in the probability of different vehicle designs, i.e., "non-ZEVs," near-ZEVs, and ZEVs as suites of incentives are introduced.

Multinomial logistic regression uses a function of the following form to predict the probability that observation *i* has outcome *j* (where *j* belongs to the set *J* of all possible outcomes), for example, that a particular household designs their next new vehicle to be a BEV out of the possible outcomes {ICEV, HEV, PHEV, BEV, FCV}:

$$f(j,i) = \beta_{0,j} + \beta_{1,j}x_{1,i} + \beta_{2,j}x_{2,i} + \ldots + \beta_{M,j}x_{M,i},$$

where $\beta_{M,k}$ is the coefficient associated with the *m*th explanatory variable and the *j*th outcome.

In the case of a simple logistic regression, e.g., the only two possible outcomes are the household designs their next new vehicle to be a PEV or an ICEV, *f(j,i)* is written as the ratio of the natural logarithms of the probabilities that either of the two outcomes occurs:

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \cdots + \beta_M x_{M,i}$$

where p_i is the probability that a household designs their next new vehicle to be a PEV (and thus 1-p_i is the probability it is an ICEV).

The interpretation of the estimated parameters β_j is the additive effect on the logarithm of the odds for a unit change in the *j*th explanatory variable. For the simple case of an explanatory variable that has only two values, the parameter estimates the change in the odds of the outcome *i* occurring between those two values. For example, if β_j is the parameter for whether or not the household has a place to charge a PEV at home (coded as no or yes), the parameter estimates the change in the odds of the household designing their next vehicle to be a PEV depending on whether they don't or do have access to vehicle charging at home. If the statistical model is doing a good job of matching the data and our knowledge of the world, we would expect the parameter for access to home charging to be positive and statistically significantly different from zero, i.e., we expect that home access to charging should increase the odds a household would design their next new vehicle to be a PEV compared to an otherwise similar household that does not have access to vehicle recharging at home. Extensions to cases with more than two possible outcomes, i.e., more than two types of vehicle propulsion systems, result in similar interpretations of the model parameters.

Summary results will be presented for the multinomial modeling and in simpler stratified format, for example, enumerating purchase intention toward ZEVs by other measures. Which measures

are used to stratify results cannot be determined until the data are analyzed. Potential measures include measures of awareness and knowledge of ZEVs, attitudes and motivations regarding ZEVs, as well as measures of individuals and households such as income, age, education, and the suitability of their residence for recharging a plug-in vehicle.

Task A7. Synthesize Case Study and Survey Results

The case studies and statewide survey will be presented in an integrated format. While some results of each will stand alone, the intent is to indicate how the results of each either 1) individually answers specific questions stated in the project objectives and 2) combine to answer those questions. For example, questions as to why people—across the income spectrum—buy the vehicles they do, how they decide when to sell, trade, or scrap a vehicle, and why different incentives do or don't move them toward a near-ZEV or ZEV are answered by the interviews and workshops. Insights into why suites of incentives do or don't work inform the design of the survey instrument and the interpretation of the survey results. Those survey results are the aggregate measures—how many more near-ZEVs and ZEVs can be expected to be sold and to whom?

Time and funding are allotted in this task for the preparation of a draft Final report, six-month interval for ARB review, and response to that review.

Methodology Part B: Modeling and Scenario Analysis

This aspect of the project will build upon previous UC Davis studies and other studies and develop an analytical framework appropriate for assessing the key research questions in this study and provide relatively clear, robust answers. The project will be founded on the extensive work already conducted on ZEVs by UC Davis, including the 2008-2012 Feebate study and the range of studies conducted by PH&EV Center that have built an important database on California car buyer attitudes and behaviors. Both the analytical/modeling aspects and data aspects will be strongly enhanced and extended in this study.

The overarching principle is that model structure and specifications need to support the examination of the questions at hand: in this case how incentive policies could be dynamically modified over time. The team has already developed and performed such analyses for the Energy Commission, but the current models would require extension to address issues related to social equity, and vehicle retirement (Yeh, Bunch, et al., 2015). Specifically, the current versions of these models would not support testing incentive programs where the amount of the incentive would vary by income group. Existing models must be extended to cover the full vehicle market (both new and used vehicles), and demographic-based household segments, Bunch developed CARBITS, versions 1, 2, and 3 for the Air Board for the purpose of analyzing the impact of vehicle emissions regulations. In Bunch and Greene (2011), CARBITS 3.0 was used for analyses related to feebates and vehicle emissions standards policies. In that work, we explored social equity issues in a multi-year context that included the impact of diffusion of cleaner new vehicles into the used vehicle market (e.g., by household income segment). However, these particular models do not currently address very new vehicle technologies.

The new modeling work here will oriented to allow a comprehensive study of incentive structures that meet decision-making needs of ARB by addressing critical issues including maximizing ZEV sales, minimizing program (and economic) costs, and reaching the maximum number of the California car-buying population possible. In order to undertake such an assessment and understand the impacts of ZEV and other vehicle incentive programs in California, three is a need to represent car markets and how they may react to changes in market signals when making purchases.

The major effort will be to update and modify the CARBITS model, and conduct the analysis with this tool. The model will be recalibrated to the 2012 CHTS with an emphasis on making it suitable to assess vehicle choices across all California car buyers, not just new car buyers. This will therefore involve studying the *secondary* car markets in the state, understanding how ZEVs are likely to be resold and transferred across population groups in the state, and how this process would be affected by various incentive programs and related policies.

This part of the analysis will be led by Lew Fulton and David Bunch, with one post-doc and one graduate student researcher over the course of the project. Although Lew Fulton will be undertaking his first ARB project, he has worked extensively on the development of models and scenarios generally similar to the types involved in this project (Fulton et al, 2013). David Bunch has been the primary author of the CARBITS model and will lead the model upgrade and recalibration effort, and running the model for the selected scenarios. The post doc and student will assist with all tasks and build capabilities to do analysis with the tools used in the project.

We have substantial past experience in developing and applying models and scenario analysis in sponsored research projects for both the Air Board and the Energy Commission, and addressing the specific objectives of this project would represent an natural extension of existing models we have already developed. We have multiple possible modeling approaches at our disposal (to be discussed later) but at a high level the main 'structural' feature is that these models embed a core consumer behavior module that is used to simulate consumer-segment-level vehicle choices based on preferences for vehicle attributes, including attributes that are a function of vehicle technology characteristics. The details of how segments are defined, and what determines the preferences of individual segments, can be considered as a separate matter. The most recent work performed for the Energy Commission literally focused on how vehicle incentives affected the penetration of ZEVs in a market with competing vehicle technologies including: gasoline ICE, diesel, HEV, fuel cell, BEV-100, PHEV-20, PHEV-40, etc. (for both light duty cars and trucks). Another policy-related factor was the availability of refueling stations (for hydrogen), and recharging infrastructure (work location, and public) for plug-ins (both BEVs and PHEVs). To perform this analysis we developed a California-specific model by adapting an existing model of our colleague David Greene (called MA^{3}T). One important feature of this work addresses a key need of this project: The dynamics of the market formation process included factors related to the number of models offered by manufacturers, and also the different risk perceptions of new vehicle technologies across consumer segments. However, an extremely important conclusion of this work is: When considering the effect of California policies on ZEV market formation processes, one cannot ignore the fact that the larger vehicle market in the rest of the US plays a critical role. The impact of California policies cannot be evaluated in isolation from the rest of the market. It should also be noted that this work already incorporates issues related to vehicle technology forecasts (fuel efficiency, battery properties), potential learning-by-doing effects on

vehicle price, fuel price projections, etc. To conclude: it should be understood that the details of a model like this can vary as a function of the other issues being addressed in the project.

CARBITS Model

The CARBITS Model is a rigorous, quantitative model of California vehicle market behavior useful for evaluating alternative incentive programs under various market scenarios. It is well described in Bunch et al (2011) but can be summarized as follows: The CARBITS model includes a variety of assessment measures that can be broken down by household demographic groups to explore issues related to incentives, vehicle sales, costs/benefits and social equity. By linking the sales of different vehicle types to different consumer groups, CARBITS can track the flow of incentives to different parts of the population. in the case of income CARBITS allows an examination of the social "incidence" of incentive programs from the least well off to the most well off of the income groups (there are currently five income groups with would probably be expanded in this project). And critically, it captures effects due to shifts in vehicle-purchasing decisions by income group as a function of the incentive structure and other factors.

The basic approach to assess incentive schemes can easily be extended to other fiscal approaches. For feebate scenarios, vehicle purchase-related fees impact sales shares, and the incidence of fees across household types can be tracked. Scrappage programs can also be assessed in terms of participation by income group, income generation by group, and the total expenditure requirements for such a program.

For this project, the CARBITS model will be updated and extended as follows:

A) Recalibration to the 2012 CHTS database, with other data updates as needed for the current study; newer data especially for ZEV sales through 2014 or 2015 will be used as available, such as from recent PH&EV center surveys and surveys conducted in Part 1 of this project.
B) The model scenario/projection period will be extended from 2020 out to 2025.
C) Detailed income categories will be introduced into the model and calibrated to the most recent available data, with selection of categories taken with a view toward better characterizing choice behaviors related to the EFMP and those in the second hand vehicle market.
D) A new baseline projection of available vehicle models/configurations through 2025 will be developed using a simplified approach but taking into account expected technology evolution, manufacturer production plans, and current state and Federal policies. The effect of vehicle sales outside of California will be taken into account (and will be important in determining things like the number of ZEV models in production and their prices), but will be treated as exogenous factors in this California-focused study.
E) The model will be made capable of assessing more types of incentive structures than just feebates, including ZEV-focused incentive programs and vehicle retirement programs. It will be adjusted for an increased focus on alternatives that will enable meeting the ZEV targets in CA through 2025. Simplified choice functions will be developed regarding under what conditions households would choose to scrap older vehicles, and/or also purchase ZEVs.

F) There will be development of an enhanced set of linkages between household characteristics and car-buying behaviors relating to both new and second hand vehicles, allowing (for example) the incidence of incentives (and possibly fees) across household types and demographic groups for different vehicle incentive structures, including possible scenarios with incentives on second hand ZEVs.

Overall the changes to the model will be significant but will make it an up-to-date, powerful tool for addressing the questions in this study. The focus will be on enabling a practical comparison of various California ZEV incentive structures, capable of assessing used as well as new cars, and addressing the key questions for both parts of the RFP (CVRP and EFMP aspects).

Specifically, CARBITS will be capable of assessing direct and indirect ZEV sales impacts from various incentive schemes, the incidence of fees/rebates across the population, administrative costs, potential unintended consequences, equity concerns, and overall costs and benefits of alternative program structures. Based on these capabilities, and in consultation with ARB staff, the project will synthesize these research results into an overall evaluation and characterization of candidate incentive program options for ARB's consideration.

Use of the model in this analysis

The analysis will be conducted using this revised CARBITS model, adding the key capabilities needed for this study, and re-calibrated to the latest data available. It will be run as a scenario generation tool and used to explore a number of possible futures to 2025. The basic scenario approach will be to develop a single baseline projection, taking into account the expected evolution of the light-duty vehicle market in CA, including the expected development of new technologies and changes in the offerings of new vehicles including ZEVs, PHEVs, and conventional vehicles through 2025. The baseline scenario will be developed in cooperation with ARB and assessed for its estimates of vehicle sales, technology market shares, purchases across various demographic and income groups, and fuel use and GHG emissions across the fleet of vehicles in the state, 2015-2025.

This baseline scenario is expected to be couched as an "incentive-free" scenario. Alternative scenarios will be developed and compared to this base scenario. The current CA incentive programs (EFMP, CVRP, other relevant programs) would then be overlaid on this base picture as the first of these alternative possible future scenarios. From this, other program designs and incentive structures can be considered. These include incentives that go beyond new vehicles to reach the second hand market. Interactions between broad second-hand market incentives and the EFMP-related incentives can be explored. Incentive structures that are varied across vehicle market classes, and therefore reach different demographic and income groups differently, can be considered and compared. Ultimately perhaps 4 or 5 discrete, fully formulated scenarios will be selected and formally "scored" for their impacts across a wide range of indicators.

Through the comparison of scenarios, some "principles" of good incentive structure will be identified. For example, structures that appear likely to maximize total ZEV sales through 2025 will be identified, as will the best approaches for reaching the maximum number of CA households, and the most cost-efficient approaches. These may prove to be quite different

approaches, though an effort will be made to identify a single hybrid approach that appears to do well across all three of these dimensions.

Task structure

Task B1: Literature and data review

Review the recent literature on incentive programs and the recent experience of ARB in administering its various ZEV incentive programs. Conduct a basic data search and data analysis of available data to establish current California vehicle purchase patterns and demographic variation in these purchases.

Task B2: Determination of incentives to analyze and final model structure

Work with the ARB to determine the approximate forms of incentive that will be evaluated in the study, and the final form of the model that will be needed and achievable to allow these incentives to be best analyzed. All data needed to undertake the scenarios (and their sources) will be identified.

Task B3: Model enhancement and calibration

The CARBITS model will be modified according to plan in order to carry out the analysis. This will include adding the capabilities outlined above and any other capabilities agreed to in Task 2. A new baseline projection will be developed in cooperation with ARB.

Task B4: Conduct modeling and analysis

Up to 5 different types of incentive structures (with possible variants within each) will be run with the model, and a detailed comparison of the various impacts of these scenarios will be made. As described above, tradeoffs between alternative structures will be considered and strengths/weaknesses identified. Preliminary scenarios will be developed and presented to ARB, and (as needed), they will be revised and finalized.

Task B5: documentation of modeling, analysis, and results

A report will be prepared that documents all model development and analysis conducted in the project. It will report our assessment of various incentive structures including impacts on ZEV sales, impacts across the population of Californians, administrative costs, impacts on state revenues, potential unintended consequences, and other policy considerations. This will be combined with the draft final report from Part A to create a complete draft final report. Early versions of these reports may be delivered to ARB separately but will be combined by the official due date of the draft final report.

Data management plan

The primary data development/management work will occur in Part 1 of the project effort. Dr. Kurani will be responsible for formalizing, implementing, and monitoring the data management plan for the consumer data.

Data recording and backup

The data to be collected by the two research activities—interview/workshops and surveys—are of two distinct types requiring slightly different management.

Interview data will largely take the form of digital audio recordings. Workshop data will include audio/video recordings as well as work products of the workshop exercises. The latter will take the form of hard copies and digital images. Handwritten notes by the researchers will augment these data for the interviews and workshops. All these materials will be stored in a locked file cabinet in Dr. Kurani's office. An additional set of hardcopies will be printed and stored in a locked file cabinet in the office of the Analyst primarily responsible for interview analysis.

Survey data will be collected from an online questionnaire, amended by physical questionnaires as required to achieve the oversample of low-income households. Data will be recorded into a standard-format database. The survey database will be copied from the survey host server to another location for archiving. Only copies of the original database will be subjected to cleaning and recoding, though a copy of the final database used for analysis will also be archived. In this way, any decisions about, for example, recoding answers into new categories and aggregations will always be reversible. We will minimize the need for data cleaning through the use of extensive validation tests during the respondents' survey completion process, i.e., not allowing a respondent to continue without completing an item and checking responses for valid replies, e.g., within a valid range of answers or of a valid numeric or text type. Copies of the database will be maintained in the original file format (likely .csv for the original data) and in final forms for specific statistical packages (likely SAS transport for use in SAS and JMP statistical packages).

All these data—original .csv file of the survey data, final cleaned, recoded SAS transport files of the survey data, and the interview and workshop recordings—will be archived onto a server in a separate location.

Because of the IRB requirements to protect the confidentiality of survey respondents, both these servers will be located behind the UC firewall. Anonymity will be protected by assigning a non-personally identifying tag to each data record and stripping personally identifying information from the .csv and SAS transport files, i.e., the contact information provided by respondents willing to be interviewed. Interviewees' interview data will be linked to their survey record using the non-personally identifying tags. The key to these tags will not be stored on any server that also stores the data records themselves.

In addition to backing up data, intermediate and final analysis products will also be backed up in an appropriate format. This will likely be a .jrn journal format inside of SAS or JMP for intermediate products such as tables or graphs being developed during analysis and .rtf or .pdf formats for the project deliverables.

Human Subjects and IRB approval

Human subjects research will be conducted. The population will be all California households. All research methods—interviews, workshops, and survey—will be based on stratified sampling

from distributions of household income, participation in specific incentive programs, i.e., the EFMP and CVR, and primary language spoken at home.

Participants in the EFMP and CVR programs will be recruited from available sampling frames. Non-participants will recruited by local market research firms to match the income, location, vehicle ownership, household ownership, and language of the incentive program participants.

The survey sample will be stratified by income and language spoken at home. A firm that manages survey sampling will be hired to administer the survey including recruitment, completion, and incentive payment.

Both the interviews/workshops and surveys will require IRB approval. The research principals have successfully completed the approval process for similar activities. The approval process will not be started until after the project is awarded as design of instruments such as interview protocols and surveys must be done prior to initiating the approval process and those designs are themselves tasks of this proposal.

For Part 2 of the project (modeling/scenarios), the data generated in Part 1 will be used as it becomes available. The model will be rebuilt and recalibrated during the first year with public data such as from the California Household Travel Survey (CHTS) and using datasets already developed by UC Davis, such as a recent California survey of households that purchased ZEVs in the 2012-2013 time frame (Tal, Nicholas et al, 2014), that has considerable demographic detail. The on-going CVRP data collection system will also be useful for calibration purposes although it does not have much household information. Discussions with ARB could reveal additional datasets that will be useful.

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PROJECT SCHEDULE

PROJECT SCHEDULE, PROJECT PART A

Month	1	2	3	4	5	6	7	8	9	10	11	12	~	18
Task														
Household Interviews/Workshops														
1. Identify Case Study Locations														
2. Design Interview Pre-Surveys and Protocols														
3. Administer Interview Pre-Surveys														
4. Analyze Interview Pre-surveys/prepare materials for interviews														
5. Conduct Interviews														
6. Preliminary Analysis of Interviews														
7. Design Workshop Protocols														
8. Conduct Workshops														
9. Comprehensive Analysis of Interviews and Workshops														
Statewide Survey														
10. Design Survey Instrument including identifying multiple administration pathways to reach intended populations														
11. Administer Survey														
12. Analyze Survey														
13. Synthesize Case Study and Survey Results														
Draft Final Part A Report to ARB														
Final Part A Report to ARB														
Quarterly Project Meeting			Q			Q			Q					

Project Schedule, Project Part B

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	~	30
Task																										
Task 1: Review the recent literature on incentive programs																										
Task 2: Work with the ARB to finalize all plans for study																										
Task 3: Modify Carbits model, update data and calibration																										
Task 4: Run scenarios and conduct analysis																										
Task 5: Prepare all analysis documentation																										
Draft Analysis Report to ARB																										
Final Analysis Report to ARB																										
Quarterly Project Meeting			Q			Q			Q			Q			Q			Q			Q			Q		

CURRICULUM VITAE

LEWIS M. FULTON, Ph.D.

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Summary: twenty-four years professional experience leading research projects in transport, energy and environmental policy. Positions in academia, government, and international agencies, in developed and developing country contexts. Fifteen years experience in development, funding, and management of research projects. Focus in recent years has been on modeling and economic analysis of transport/energy sustainability and policy, including benefit/cost analysis and simulation of energy systems. Subject areas include travel demand and modal shifts, vehicle efficiency and alternative fuels, and transport problems in the developing world. Recent emphasis on long-term projections, modal shift potential, electric vehicles, and transport infrastructure.

Key skills:

- Research project management: development, funding and execution
- Transport/energy technology and policy analysis
- Transport/energy/economic modeling, statistical analysis, projections, scenario development
- Project/staff/financial management
- Strategic planning and leadership
- Excellent writing/communication skills and experience

Personal Information: US Citizenship. English native language, proficient in French.

Education:

University of Pennsylvania, Philadelphia, PA. PhD Degree, 1994, Energy Management and Environmental Policy.

- **Educational Awards:** University fellowship, 1984-1986; awarded highest honors, Ph.D. Qualifying Examination, 1987.
- **Ph.D. Dissertation**: *Alternative Fuel Vehicles and the Energy Policy Act: A Case Study in Technology Policy***.** Advisor: Dr. Mark A. Bernstein.

Acadia University, Nova Scotia, Canada, Bachelor of Science Degree, Geology/Economics, 1984

Professional Experience (past 15 years):

University of California, Davis **Sept. 2012-Present**

Co-director, NextSTEPS Program, Institute of Transportation Studies. Co-direct transport research activities and manage projects in this ITS-Davis research group of over 30 researchers and over 30 graduate students. Primary focus of the group is on transitions to new vehicle and fuel systems, but research also touches on travel demand and behavioral issues. Personal research focus is on regional/global transport/energy modeling, including economic analysis of technologies, cost/benefit analysis, policy analysis, backcasting and target setting, and simulation of energy systems and markets.

IPCC 5th Assessment Report, Working Group 3 (Mitigation) 2011-2013
Served as a Lead Author on Chapter 8 (transport), with primary responsibility for writing the largest chapter section on transport technologies. Work closely with 12 other international experts n this project. Results will provide the IPCC guidance to governments on mitigating GHG emissions from transport.

International Energy Agency, Paris, France **1999 to 2005, 2007-2012**
Transport Technology Team Leader, 2007-2011; Division Head, Energy Technology Policy Division, 2011-2012. Managed IEA's transport technology analysis and outreach activities and as Team Leader, led a 5-person research team; as Division head during my final year at the IEA, Directed the 30 person Energy Technology Policy division. During 12 years at the IEA, authored or co-authored more than 10 major IEA publications (examples below) and represented the IEA in major for a around the world. Also led development of "Mobility Modeling Project" (MoMo), with total funding of over $2 million.

United Nations Environment Program, Nairobi, Kenya **July 2005 to August 2007**
Project Officer, Division of GEF Coordination. The Global Environment Facility (GEF) provides large grants to support global environmental improvements and relevant policy making efforts in developing countries. Served as UNEP's GEF climate change / transport officer, responsible for developing and managing a range of transport implementation projects around the world, working with a range of partners.

Publications: Have written extensively on transport/energy topics, including six books while at the IEA and a wide range of other book chapters, reports and publications including 20 refereed journal arties.

Selected articles and other publications:

Fulton, Lewis, Oliver Lah, François Cuenot (2013), "Transport Pathways for Light Duty Vehicles: Towards a 2° Scenario", *Sustainability* 5 (5), 1863 - 1874

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Transport, Energy and CO_2: Moving Toward Sustainability (book: lead author), 412 pages, October 2009, International Energy Agency, OECD Press, Paris.

Noland, Robert B., William A. Cowart, and Lewis M. Fulton, 2006, "Travel demand policies for saving oil during a supply emergency" *Energy Policy* 34, 2994-3005.

Professional Affiliations and Awards:

Member of U.S. Transportation Research Board, Energy and Alternative Fuels committees. Chairman of the TRB International Subcommittee.Affiliate of International Association of Energy Economists.

Transportation Research Board, Barry McNutt Award for Best Paper in Energy and Alternative Fuels, 2008;

Society of Automotive Engineers, Barry McNutt Award for lifetime contribution to Fuel Economy Policy field, 2011.

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Education

Ph. D., Rice University, 1985 (Mathematical Sciences)
Master in Applied Mathematical Sciences, Rice University, 1981
M. S., Northwestern University, 1979 (Chemistry)
B. A. (cum laude), Rice University, 1978 (Chemistry)

Positions

Professor of Management, UC Davis, July 2000-present
Acting Director, 'Center for New Mobility Studies,' Institute of Transportation Studies, UC Davis, October 1999-August 2000.
Associate Professor of Management, UC Davis, July 1992-July 2000.
Visiting Scholar, Department of Marketing, Faculty of Economics, University of Sydney. July 1997-July 1998.
Assistant Professor of Management, UC Davis. July 1985-June 1992.
Visiting Assistant Professor, UC Davis. July 1984-June 1985.
Associate, Rice Center, Houston, Texas. May 1982-August 1983.
Research Associate, The Institute for Rehabilitation and Research, Houston, Texas. February 1980-January 1982.

Courses taught

Product Management
Marketing for E-Commerce
Marketing Research
Management Policy
Decision Making and Management Science
Marketing Models for New Products
Discrete Choice Analysis
Managerial Decision Making
Systems Analysis and Design
Applied Linear Models for Management
Special Topics in Management of Information Systems
Seminar in Management

Selected Publications and Papers

"Fuel Economy and CO2 Emissions: Standards, Manufacturer Pricing Strategies, and Feebates," with C. Liu and D. L. Greene, under second review, The Energy Journal.

"Numerical Methods for Optimization-based Model Estimation and Inference," Handbook of Choice Modelling, S. Hess and A. Daly, eds., to appear 2013.

"Recent Advances on Modeling Multiple Discrete-Continuous Choices," with C. Bhat and A. Pinjari, Choice Modelling: The State of the Art and the State of Practice, S. Hess and A. Daly, eds., to appear 2013.

"Impacts of Feebates in Combination with Fuel Economy and Emissions Standards on U.S. Light-Duty Vehicle Fuel Use and Greenhouse Gas Emissions," with C. Liu, D. L. Greene, E. C. Cook, Transportation Research Board, Paper 11-2027.

"Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California" (with D. L. Greene, T. Lipman, E. Martin, S. Shaheen), California Air Resources Board, Final Report on Contract UCD 08-312, University of California, Davis, CA, February, 2011.

"Potential Design, Implementation, and Benefits of a Feebate Program for New Passenger Vehicles in California: Interim Statement of Research Findings" (with David L. Greene). Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-10-13

"Follow-on Development of CARBITS: A Response Model for the California Passenger Vehicle Market," Final Report (Contract 05-303) prepared for State of California Air Resources Board, April 30, 2009.

"Exploring the Consumer Valuation of Organic-Related Properties in Fresh Produce Choice," (with Yuko Onozaka and Doug Larsen), Working Paper.

"Theory-based Functional Forms for Analysis of Dissagregated Scanner Panel Data" Working Paper.

"Behavioral Models and Estimates for Leisure-Passenger Value of Travel-Time Saving in Long-Hall Air Travel Markets Using Stated Choice Experiments" Working Paper.

"Behavioral Frontiers in Choice Modeling" (with Wiktor Adamowicz, Trudy Ann Cameron, Benedict G. C. Dellaert, Michael Hanneman, Michael Keane, Jordan Louviere, Robert Meyer, Thomas Steenburgh and Joffre Swait), Marketing Letters, Volume 19, Numbers 3-4 (December, 2008), pp. 215-228.

Dr. Kenneth S. Kurani

Associate Researcher
Institute of Transportation Studies
University of California, Davis
Davis, California 95616
e-mail: knkurani@ucdavis.edu

EDUCATION

Doctor of Philosophy, Civil and Environmental Engineering. University of California, Davis. June 1992. Major: Transportation Planning. Minors: Statistics, and Economics and Development. Dissertation: *Application of a Behavioral Market Segmentation Theory to New Transportation Fuels in New Zealand*.
Master of Science, Civil Engineering. UC Davis. March 1988. Thesis: *The Rise and Fall of Diesel Cars: A Consumer Choice Analysis*.
Bachelor of Science, Civil Engineering. With Honors. UC Davis. June 1982.

CURRENT RESEARCH

- Consumer Behavior, UC Davis' Sustainable Transportation Energy Program (nextSTEPs)
- Consumers response to Low Emission Vehicles
- Fuel economy and energy instrumentation

RESEARCH INTERESTS

- Behavioral theory in transportation and energy research
- Relationship between lifestyle and technology, especially systems of automobility and associated socio-technological systems of vehicles, fuels, and information.
- Gender perspective on sustainable transportation

VEHICLE DEMONSTRATION MANAGEMENT

- Plug-in Hybrid Electric Vehicle Demonstration and Market Research Program, 2007 to 2010: Thirteen Priuses converted to plug-in operation and placed in households; instrumented to record driving, parking, refueling, and recharging.
- Nissan Hypermini City Electric Vehicle Demonstration and Market Research Program, 2001-2002: 12 Nissan Hypermini CEVs used by long-term University placements.
- Neighborhood Electric Vehicle (NEV) Demonstration and Market Research Program, 1992-1994: Three NEVs placed in household trials.

RECENT RELEVANT PUBLICATIONS

Kurani, K.S., N. Caperello, J. TyreeHageman, J. Davies (2014) CHAPTER 6: Fuel Availability and Consumer Choice: Assessment of Refueling and Recharging Infrastructures and the Marketability of Vehicles and Fuels. Draft Report to California Energy Commission.

Caperello, N., J. TyreeHageman, K.S. Kurani, (2014) Engendering the Future of Plug-in Electric Vehicles Institute of Transportation Studies Working Paper UCD-ITS-WP-14-02: http://www.its.ucdavis.edu/wp-content/themes/ucdavis/pubs/download_pdf.php?id=2095

TyreeHageman, J., K. S. Kurani, N. Caperello (2014) What does community and social media use look like among early PEV drivers? Exploring how drivers build an online resource through community relations and social media tools. Transportation Research Part D: Transport and Environment, V. 33, pp. 125-34.

Kurani, K.S., J. TyreeHageman, N. Caperello (2013) Potential Consumer Response to Electricity Demand Response Mechanisms: Early Plug-in Electric Vehicle Drivers in San Diego, California. Institute of Transportation Studies Research Report UCD-ITS-RR-13-12. http://www.its.ucdavis.edu/wp-content/themes/ucdavis/pubs/download_pdf.php?id=1950

Davies, J. and K.S. Kurani (2013) Moving from Assumption to Observation: Implications for Energy and Emissions Impacts of Plug-in Hybrid Electric Vehicles. Energy Policy 62, 550 – 560

Delucchi, M.A., C. Yang, A.F. Burke, J.M. Ogden, K.S. Kurani, J. Kessler, D. Sperling (2013) An Assessment of Electric Vehicles: Technology, Infrastructure Requirements, Greenhouse-Gas Emissions, Petroleum Use, Material Use, Lifetime Cost, Consumer Acceptance and Policy Initiatives. Philosophical Transactions of the Royal Society A 372

Axsen, J. and K.S. Kurani (2013) Hybrid, Plug-in Hybrid, or Electric: What do car buyers want? Energy Policy, 61, 532-43. Available online: http://dx.doi.org/10.1016/j.enpol.2013.05.122

Caperello, N., K.S. Kurani, J. TyreeHageman (2013) Do You Mind if I Plug-in My Car? How Etiquette Shapes PEV Drivers' Vehicle Charging Behavior. Transportation Research Part A 54, 155 – 163

Axsen, J. and K.S. Kurani (2013) Connecting plug-in vehicles with green electricity through consumer demand. Environmental Research Letters v. 8, n. 1. http://dx.doi.org/10.1088/1748-9326/8/1/014045

Axsen, J. and K.S. Kurani (2012) Social Influence, Consumer Behavior, and Low-Carbon Energy Transitions. Annual Review of Environment and Resources. v. 37, pp. 311-40. http://www.annualreviews.org/doi/pdf/10.1146/annurev-environ-062111-145049

Axsen, J. and K.S. Kurani (2012) Developing sustainability-oriented values: Insights from households in a trial of plug-in hybrid electric vehicles. *Global Environmental Change*. v. 23, pp. 70-80. http://dx.doi.org/10.1016/j.gloenvcha.2012.08.002

Axsen, J. and K.S. Kurani (2012) Who can recharge a plug-in vehicle at home? *Transportation Research Part D*. v. 17, pp. 349-53.

Axsen, J., K.S. Kurani, R. McCarthy, C. Yang (2011) Plug-in hybrid vehicle GHG impacts in California: Integrating consumer-informed recharge profiles with an electricity-dispatch model. *Energy Policy* http://dx.doi.org/10.1016/j.enpol.2010.12.038

Caperello, N. and K.S. Kurani (2012) Households' Stories of their Encounters with A Plug-in Hybrid Electric Vehicle *Environment and Behavior A* vol. 44 no. 4 pp. 493-508

Axsen, J., and K.S. Kurani. (2010) Interpersonal influence in the early plug-in hybrid market: Observing social interactions with an exploratory multi-method approach. *Transportation Research Part D: Energy and the Environment* v. 16, n. 2, pp. 150-59. doi: 10.1016/j.trd.2010.10.006

Axsen, J, and K.S. Kurani (2010). Anticipating plug-in hybrid vehicle (PHEV) energy impacts in California: Constructing consumer-informed recharge profiles. *Transportation Research Part D: Transport and Environment*, v. 15, n. 4, pp. 212-219.

Axsen, J, K.S. Kurani, and A. Burke (2010). Are batteries ready for plug-in hybrids buyers? *Transport Policy*, v. 17, n. 3, pp.173-182.

Davies, J. and K.S. Kurani (2010) Recharging Behavior of Households' Plug-In Hybrid Electric Vehicles: Observed Variation in Use of Conversions of 5-kW-h Blended Plug-In Hybrid Electric Vehicle. *Transportation Research Record* No. 2191, pp. 75–83. http://dx.doi.org/10.3141/2191-10

Gil Tal, PhD

Institute of Transportation Studies
University of California, Davis
Davis, CA 95616

gtal@ucdavis.edu

Education

University of California at Davis Ph.D. Transportation Technology and Policy, 2008

The Hebrew University Jerusalem M.A. *'magna cum lauda'* Geography specialization in Environmental Planning and Policy, 2001

B.A. Geography, sociology & anthropology, 1999.

Recent Awards, Grants, and Fellowships

Smartphone International Travel Data Collection. STEPS3 seed grant (PI $24,000)

Neighborhood MUD Smart Charging Solutions Project. California Energy Commission Grant. 2015 (PI share $194,000)

The Dynamics of Plug-in Electric Vehicles in the First and Secondary Market and their Implications for Vehicle Demand, Durability, and Emissions. Air Research Board. Expected to sign on 2014 $300,000. (PI share $200,000)

Davis Alternative Fuel Readiness Plan. California Energy Commission Grant. 2014 $220,000

(PI share $120,000)

Sacramento Area Council of Governments. Plug-in Vehicle Regional Planning. 2013: $123,000 (Principal Investigator)

Selected Publications
Refereed Journals

1. Tal, G., Nicholas, M. A., Davies, J., & Woodjack, J. (2014). Charging Behavior Impacts on Electric Vehicle Miles Traveled. Transportation Research Record: Journal of the Transportation Research Board, 2454(1), 53-60
2. Tal, Gil and Susan L. Handy, (2012) Measuring Non-motorized Accessibility and Connectivity in a Robust Pedestrian Network. *Transportation Research Record: Journal of the Transportation Research Board* 2299, 48 – 56
3. Salon, D., M.G. Boarnet, S. Handy, S. Spears, and G. Tal, (2012) How Do Local Actions Affect VMT? A Critical Review of the Empirical Evidence. *Transportation Research Part D: Transport and Environment* 17, no. 7 : 495-508.
4. Woodjack Justin, Dahlia Garas, Andy Lentz, Tom Turrentine, Gil Tal and Michael Nicholas, (2012) Consumers' Perceptions and Use of Electric Vehicle Range Changes over Time Through a Lifestyle Learning Process *Transportation Research Record 2287, 1 – 8*

5. Tal Gil and Galit Cohen-Blankshtain., (2011) Understanding the Sources of Overestimation Bias in Studies of Travel Demand Management Policies: Optimism Bias Versos Scientific Skepticism, *Transportation Research Part A: Practice and Policy*. 45 (5), 389 – 400.
6. Tal, Gil. and Susan L. Handy., (2010), Travel Behavior of Immigrants: Analysis of 2001 National Household Travel Survey, *Transport Policy*, 17 (2) 85-93.
7. Tal, Gil., (2008) Overestimation Reduction in Forecasting Telecommuting as a TDM Policy, *Transportation Research Record,* 2082 (1) 8-16.
8. Tal, Gil, and Susan L. Handy., (2008) Increasing Children's Biking for Non-School Purposes Lessons from the Davis, CA 'Bike to AYSO' Program, *Transportation Research Record,* 2074 (1) 40-45.

Book Chapters

9. Mokhtarian Pat and Gil Tal., (2013) Impacts of ICT on Travel Behavior: A Tapestry of Relationships, in *Transport Handbook*, Jon Shaw, Jean-Paul Rodrigue and Theo Notteboom (eds). Saga Publication, London.

Selected Reports and Working Papers

10. Tal, Gil and Michael A. Nicholas (2014) Evaluating the Impact of High Occupancy Vehicle (HOV) Lane Access on Plug-In Vehicles (PEVs) Purchasing and Usage in California. Institute of Transportation Studies, University of California, Davis, Working Paper UCD-ITS-WP-14-01
11. Nicholas, Michael, Gil Tal. UC Davis Plug-In Hybrid & Electric Vehicle Research Center. (2013) Charging for Charging: The Paradox of Free Charging and Its Detrimental Effect on the Use of Electric Vehicles. *Working Paper UCD-ITS-WP-13-02*
11. Nicholas, Michael, Gil Tal, Justin Woodjack. UC Davis Plug-In Hybrid & Electric Vehicle Research Center. (2013) Recharging Network Planning Toolbox. *California Energy Commission*. Publication number: CEC -2013.
14. Tal, Gil, Michael A. Nicholas, Justin Woodjack, Daniel Scrivano (2013) Who Is Buying Electric Cars in California? Exploring Household and Vehicle Fleet Characteristics of New Plug-in Vehicle Owners. *Institute of Transportation Studies, University of California, Davis, Research Report UCD- ITS-RR-13-02*
16. Gil Tal, Susan Handy and Boarnet Marlon, (2010) Policies and Practices Related to Passenger Vehicles Greenhouse Gas Reduction – Evidence and Assessment. *Four reports submitted to the California Air Resources Board: Transit Accessibility, Regional Accessibility, Network Connectivity, Bicycle and pedestrian infrastructure.* http://arb.ca.gov/cc/sb375/policies/policies.htm

Invited Lectures and Legislative Testimony

Testimony, California Assembly Transportation Committee, Long Beach CA, December 4th 2013.

Keynote Speaker, Governor's Office Conference "Cost-to-Cost Workshop on e-Mobility" Sacramento CA October 30, 2013

Invited Lectures, 1st Expert Workshop of Smart EV-VC European Commission, Brussels Belgium, 20 March 2013

THOMAS TURRENTINE

EDUCATION AND TRAINING

University of California, Santa Cruz	Latin American Studies	BA 1982
University of California, Davis	Anthropology	MA 1991
University of California, Davis	Anthropology	PhD 1994

APPOINTMENTS

2007- Present Plug-in Hybrid Electric Vehicle Research center at ITS-Davis, Director
2007- Present, Sustainable Transportation Energy Pathways Program, EV Track director
2007- Present, Associate Director of UC Davis Energy Efficiency Center, Transportation Track
1999-2005 Institute of Transportation Studies, Assistant Research Anthropologist
1999-2005 UC Santa Cruz, Director of Classroom Connection
1998-1999 Institute of Transportation Studies, PGR 10

SELECTED PUBLICATIONS

1. Vergis, Sydney, Thomas S. Turrentine, Lewis Fulton, Elizabeth Fulton (2014) Plug-In Electric Vehicles: A Case Study of Seven Markets. Institute of Transportation Studies, University of California, Davis, Research Report UCD-ITS-RR-14-17
2. Woodjack, Justin, Dahlia Garas, Andy Lentz, Thomas S. Turrentine, Gil Tal, Michael A. Nicholas (2012) Consumer Perceptions and Use of Driving Distance of Electric Vehicles: Changes over Time Through Lifestyle Learning Process. Transportation Research Record 2287, 1 - 8
3. McCarthy, Ryan W., Thomas S. Turrentine, Kevin A. Nesbitt, Joshua M. Cunningham, Josh Boone (2011) “Taking Charge: Establishing California Leadership in the Plug-in Electric Vehicle Marketplace.” California Plug-in Electric Vehicle Collaborative, UCD-ITS-RP-10-26
4. Turrentine, Thomas S., D.M. Garas, A.H. Lentz, J.F. Woodjack (2011) “The UC Davis MINI E Consumer Study”, UCD-ITS-RR-11-05
5. T. Turrentine and K. Kurani, "Car Buyers and Fuel Economy?" In Energy Policy 35, January 2007 pp. 1213-1223.

SYNERGISTIC ACTIVITIES

- Turrentine leads a data collection effort called “World EV Cities and Ecosystems” This is a collaboration of 24 cities around the world on their experiences with electrification of personal transport (Is Task 14 Leader for the International Energy Agency Hybrid and Electric Vehicle Implementation Aggreement)
- Turrentine is PI and leads an Interdisciplinary collaboration of Computer Science, Design and the PH&EV Center at UC Davis call the cEnergi project. This group, funded by UCD at $850,000 is focused on radical redesign of consumer energy use interfaces.
- Turrentine is a member of a National Research Council Committee on “Overcoming Barriers to Electric Vehicle Deployment”

- Turrentine is PI and directs the Plug-in Hybrid Electric Vehicle and Electric Vehicle Research Center at UC Davis funded by the California Energy Commission that began February 2007. The PH&EV Center employs 5 full time
- Turrentine leads the Electric Transportation Track for the Sustainable Transportation Energy Pathways Program at the Institute for Transportation Studies. A consortium study funded by 20 major oil, energy and manufacturing companies for 4 years.
- Turrentine is Associate Director of UC Davis Energy Efficiency Center; Transportation Track, I developed interdisciplinary courses at UC Davis on "Energy Policy" and at Princeton University on "Renewable Energy Technologies"

RECENT FUNDING

- P.I. $300,000 California Air Resource Board, Used PEV Market Project. (2014-2016)
- P.I. $650,000 California Air Resource Board, Household PEV User Data Collection Project. (2014-2015)
- P.I. $860,000 UCD Research Investments in Science and Engineering Program, Transforming Consumer Energy Use (2012-2015)
- P.I. $500,000 CEC "Sustainable Cities; PEV Infrastructure Planning" (2011-14)
- P.I. $55,000 Clean Cities Strategies (2012) DOE /ORNL
- P.I. $2.7 million from California Energy Commission for PH&EV Research Center core funding (2010-2013)
- P.I. $576,000 Chrysler PHEV Pick-up Truck Research (2011-2013)
- P.I. $600,000 Ecotality-Nissan Leaf demonstration in San Diego (2011-2012)

COLLABORATORS AND CO-EDITORS

Kenneth Kurani, UC Davis, Institute of Transportation Studies
Richard Forman (and 13 other authors on a collaborative project on road ecology)
David Greene, Oakridge National Laboratories
Martin Lee-Gosselin, Laval University Quebec

GRADUATE AND POSTDOCTORAL ADVISORS

Ben Orlove, Anthropology Dept., Thesis Advisor, UC Davis
Martin Lee-Gosselin, Post-Doctoral Research Advisor, University Laval Quebec
Daniel Sperling, Thesis Advisor, Director, Institute of Transportation Studies, Davis

THESIS ADVISOR AND POSTGRADUATE SCHOLAR SPONSER

Supervising three postdocs: Dr. Michael Nicholas, Dr. Gil Tal, Dr. Angela Sanguinetti
Three PhD students: Justin Woodjack, Transportation Technology and Policy, Eric Cahill, Transportation Technology and Policy, Kadir Bedir, Transportation Technology and Policy

CONFERENCE ORGANIZATION

Co-founder of "Plug-in 2008-2014" Annual Conference
Co-organizer of "World EV Cities and Ecosystems Conference" (May 2012)
Conference Organizer for 2004 "Asilomar Conference"

PRELIMINARY PROJECT BUDGET

Budget: Project Plan Part A (Data Collection and Analysis)

	Year 1	Year 2	TOTAL
Personnel			
Tom Turrentine, Director @ $9,813.32			
12 months @ 20%; 1 month @ 20%	24,259	2,082	26,341
+ Benefits @ 50.4% until 6/30/15, 51.7% until 6/30/16, 52.4% until 6/30/17	12,384	1,084	13,468
Gil Tal, Assistant Researcher @ $6666.67/month			
12 months @ 16.67%; 1 month @ 16.67%	13,736	1,179	14,915
+ Benefits @ 38.3% until 6/30/15, 38.4% until 6/30/16, 38.5% until 6/30/17	5,268	453	5,721
Ken Kurani, Associate Researcher V@ $8758.33/month			
12 months @ 25%; 1 month @ 25%	27,063	2,323	29,386
+ Benefits @ 38.3% until 6/30/15, 38.4% until 6/30/16, 38.5% until 6/30/17	10,379	893	11,272
TBD, Staff Research Associate III @ $5176/mo (Step 13 of 25)			

12 months @ 33.33%; 1 month @ 33.33%		21,323	1,830	23,153
+ Benefits @ 50.4% until 6/30/15, 51.7% until 6/30/16, 52.4% until 6/30/17		10,885	953	11,838
Programmer IV @ $4583.33 ***(min=4024, mid=5634, max=7243)***				
12 months @ 20%; 0 months @ 20%		11,330	-	11,330
+ Benefits @ 50.4% until 6/30/15, 51.7% until 6/30/16, 52.4% until 6/30/17		5,784	-	5,784
TBD, Graduate Student Researcher IV @ $3,665/month:				
3 Summer Months @ 50%		5,498	1,887	7,385
+ Benefits @ 9.6%		528	181	709
9months @ 50%		16,987		16,987
+ Benefits @ 1.3%		221		221
				178,510.00
		$	**$**	**$**
	Personnel Subtotal	**165,644**	**12,866**	**178,511**
Travel				
Travel to Case Study Cities			-	
San Francisco Bay Area		$ 5,090		
Los Angeles		$ 10,880		

Travel Subtotal	**$ 15,970**	**$ -**	
Materials/Misc.			
Plotter printing, office supplies, audio recorders	1,000		
Service Contracts, Case Study Interviews and Workshops, 2 @ $20,000	40,000	-	
Service Contract, Statewide Survey	45,000		
General/Liability insurance (GAEL = $.50/$100 salary)	601	47	**647.49**
In State Fee Remission: 10% per year increase. note: 2013/14 = $16,102.75 less 25% campus buy-down = $12,076.50	13,284	-	
Materials/Misc Subtotal	**$ 99,885**	**$ 47**	**$ 99,932**
Total Direct Costs	**$ 281,499**	**$ 12,912**	**$ 294,412**
Indirect Costs			
Modified Total Direct Costs	268,215	12,912	
Indirect Costs @ 10%	26,822	1,291	
Indirect Costs Subtotal	**$ 26,822**	**$ 1,291**	**$ 28,113**

	$	**$**	**$**
Total Budget	**308,321**	**14,204**	**322,524**

Category Budget	**Year 1**	**Year 2**	**TOTAL**
			$
Direct Labor	120,196	9,302	**129,497**
			$
Fringe Benefits	45,448	3,564	**49,014**
			$
Travel	15,970	-	**15,970**
Equipment	-	-	**$ -**
			$
Materials/Misc	99,885	47	**99,932**
Major Subcontractors	-	-	**$ -**
Minor Subcontractors	-	-	**$ -**
			$
Total Direct Costs	**281,499**	**12,912**	**294,412**
			$
Indirect Costs	26,822	1,291	**28,113**
			$
Total Budget	**308,321**	**14,204**	**322,524**

Project Budget Part B (Modeling and Scenario Analysis)

Personnel	monthly rate	# mos	salary	benefit rate	Fringe costs	TOTAL
Faculty, Summer						
David Bunch, Summer	27,699.79	1.00	27,699.79	18.0%	4,985.96	32,685.75
David Bunch, Summer	28,530.78	1.00	28,530.78	19.0%	5,420.85	33,951.63
			56,230.57		10,406.81	
Other Employees						
Lew Fulton, 10/1/15 -	12,784.00	1.00	12,784.00	53.4%	6,826.66	19,610.66
Lew Fulton, 7/1/16 - 6/	13,167.52	1.00	13,167.52	55.7%	7,334.31	20,501.83
			25,951.52		14,160.97	
Postdoctoral Scholars						
TBN 10/15-6/16, entry	5,166.67	6.00	31,000.02	17.0%	5,270.00	36,270.02
			31,000.02		5,270.00	
Grad Student Researchers/ Undergrad assistant						
	per month, hr	# mos,hrs				
TBN, GSR III, AY 10/15-	3,708.00	9.00	16,352.28	1.3%	212.58	16,564.86
TBN, GSR III, Summer,	3,819.24	3.00	11,457.72	1.3%	148.95	11,606.67
*N/A for Undergrads			27,810.00		361.53	
			140,992.11		30,199.31	

Other Expense						
Travel (See Exhibit A f	1,000.00	> for data collection and field observations				1,000.00
		> describe, if needed				0.00
		> describe, if needed				0.00
	1,000.00					
Supplies (See Exhibit A for Detail)		> EDP				0.00
	100.00	> Copy, Print				100.00
	100.00	>Mail Phone Fax				100.00
		>Materials and Supplies				0.00
		> Transcription services				0.00
	719.06	>Misc. GAEL				719.06
	919.06					
Student Tuition	cost per qtr	# qtrs	total tuition			
AY2015-16, includes 2[5]	4,342.00	3.0	13,026.00			13,026.00
AY2016-17, includes 2[5]	4,559.10		0.00			0.00
AY2017-18, includes 2	4,787.06		0.00			0.00
(5% annual increase)			13,026.00			
Total Direct Cost						**186,136.48**
			Indirect cost base		Indirect cost	
Indirect Costs on MTD	ARB rate:	10.00%	173,110.48		17,311.05	
Total Indirect Costs						**17,311.05**
TOTAL						**203,447.53**
***Modified Total Direct Costs = Total Direct Costs less Student Tuition**						

TOTAL BUDGET, PARTS A and B: $525,972

Budget By Task

Project Part A

Task	Labor	Employee Fringe	Subs, Consultants	Equip	Travel Subsist	EDP	Copy Print	Mail Phone Fax	Materials and	Analyses	Misc.	Overhead	Total
1	$ 10,186	$ 3,971	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 1,107	$ 1,425	$ 16,689
2	$ 28,288	$ 10,642	$ -	$ -	$ 15,970		$ 1,000	$ -	$ -	$ -	$ 43,035	$ 9,599	$ 108,534
3	$ 27,939	$ 9,498	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 2,922	$ 3,753	$ 44,112
4	$ 21,626	$ 9,236	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 2,404	$ 3,096	$ 36,362
5	$ 8,023	$ 2,379	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 45,818	$ 5,549	$ 61,769
6	$ 19,131	$ 7,588	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 2,084	$ 2,681	$ 31,484
7	$ 14,305	$ 5,698	$ -	$ -	$ -		$ -	$ -	$ -	$ -	$ 1,562	$ 2,010	$ 23,574
Total	$ 129,497	$ 49,013	$ -	$ -	$ 15,970	$ -	$ 1,000	$ -	$ -	$ -	$ 98,979	$ 28,178	$ 322,525

Project Part B

Task	Labor	Employee Fringe Benefits	Travel	Photocopying/ Printing	Mail, phone, fax	Misc- GAEL	Student Fee remission	Overhead	Total
1	$7,849	$1,682		$100	$100	$40	$542	$977	$11,290
2	$4,859	$1,319	$300			$25	$108	$650	$7,261
3	$62,280	$12,644	$200			$318	$6,513	$7,544	$89,499
4	$54,793	$11,734	$200			$279	$5,428	$6,701	$79,135
5	$11,212	$2,821	$300			$57	$434	$1,439	$16,263
Totals	$140,993	$30,200	$1,000	$100	$100	$719	$13,025	$17,311	$203,448