

**PROPOSED**

State of California  
AIR RESOURCES BOARD

**Emerging Technology Zero Emission Vehicle  
Household Travel and Refueling Behavior**

RESEARCH PROPOSAL

Resolution 16-17

**October 20, 2016**

Agenda Item No.: 16-9-1

WHEREAS, the Air Resources Board (ARB or Board) has been directed to carry out an effective research program in conjunction with its efforts to combat air pollution, pursuant to Health and Safety Code sections 39700 through 39705;

WHEREAS, a research proposal, number 2801-285, titled, "Emerging Technology Zero Emission Vehicle Household Travel and Refueling Behavior" has been submitted by the University of California, Davis for a total amount not to exceed \$650,000;

WHEREAS, the Research Division staff has reviewed Proposal Number 2801-285 and finds that in accordance with Health and Safety Code section 39701, the results of this study will be used to improve emissions estimates at the vehicle and household levels, provide insight into potential plug-in vehicle demand on the electrical grid and the need for potential future supporting infrastructure, and will be valuable to ARB's Advanced Clean Cars and vehicle emission inventory programs; and

WHEREAS, in accordance with Health and Safety Code section 39705, the Research Screening Committee has reviewed and recommends funding the Research Proposal.

NOW, THEREFORE BE IT RESOLVED, that ARB, pursuant to the authority granted by Health and Safety Code section 39700 through 39705, hereby accepts the recommendations of the Research Screening Committee and staff and approves the Research Proposal.

BE IT FURTHER RESOLVED, that the Executive Officer is hereby authorized to initiate administrative procedures and execute all necessary documents and contracts for the Research Proposal as further described in Attachment A, in an amount not to exceed \$650,000.

**Resolution 16-17**

October 20, 2016

**Identification of Attachments to Board Resolution 16-17**

**Attachment A:** “Emerging Technology Zero Emission Vehicle Household Travel and Refueling Behavior” Summary and Budget Summary

## ATTACHMENT A

### “Emerging Technology Zero Emission Vehicle Household Travel and Refueling Behavior”

#### Background

During its January 2012 meeting, the Air Resources Board (ARB) resolved to study consumers' actual usage of plug-in electric vehicles. This led to the current research project (contract no. 12-319) titled, “Advanced Plug-in Electric Vehicle (PEVs) Travel and Charging Behavior” that is providing a clearer understanding of the use and benefits of three plug-in hybrid vehicle models (PHEVs), two battery electric vehicle models (BEVs), and one BEV model with a range extending internal combustion engine (BEV<sub>X</sub>). This study is progressing on schedule; however, it raises many questions, such as:

1) how will long-range (>200+ mile) affordable BEVs compare with longer-range PHEVs; 2) will doubling the electric range of a small battery PHEV also double its electric vehicle miles traveled (eVMT); 3) how will the introduction of PEVs with larger body styles, such as minivan and sport utility vehicle (SUV), impact their driving and charging patterns; and 4) how will fuel cell electric vehicles (FCEVs) be used compared with conventional internal combustion engine vehicles and PEVs? As zero emission vehicles (ZEVs) are expected to become an increasing share of the light-duty fleet, understanding how these vehicles are driven and refueled will be important for appropriately projecting fleet emissions and estimating consumer impacts as well as efficiently planning future supporting infrastructure resources.

#### Objective

The goal of this research project is to collect the travel and refueling behavior from all the vehicles within 82 households that own or lease an emerging technology ZEV – specifically Toyota Prius Prime, Chrysler Pacifica, Chevrolet Bolt, or the Toyota Mirai – over the course of twelve months. The data will be analyzed and used to improve emission and eVMT estimates at the vehicle and household levels, assess ZEV infrastructure needs, and inform potential demand on the electrical grid.

#### Methods

The same methodology will be used following the “Advanced Plug-in Electric Vehicle Travel and Charging Behavior” research contract. The primary data collection method will be through instrumentation with a customized data logging device connected through the on-board diagnostics port that captures vehicle location, operations, and charging data every 1 to 30 seconds which is then transmitted to a server via a cellular network. Approximately 82 households will be recruited to participate, owning an estimated 160 ZEV and non-ZEV vehicles total. Data will be collected from all vehicles within the household through two separate twelve-month phases. Given the large volume of data generated from this project, the data will be processed using database software and geographic information systems (GIS).

The in-use vehicle data will be supplemented with two surveys of the participating households. As part of the recruitment effort, the first survey will be administered to all eligible households to gather data on household characteristics, charger availability, important destinations, and expectations about their PEVs. The results of this survey will be used to select households along the various dimensions of interest: PEV technology type, access to workplace charging, geographic diversity, and annual miles traveled, etc. The exit survey will be conducted at the conclusion of the household's data collection period to provide context for interpreting the vehicle data and capture relevant changes to the household (e.g., change in workplace location or household structure) and reflections on their experiences with the vehicle and charging infrastructure.

**Expected Results**

Overall, this project will allow the researchers to describe the current state of ZEV household vehicle use dynamics, their charging behavior, the interaction between charging and hydrogen infrastructure and eVMT, strategies for increasing eVMT, and the need for additional public charging and hydrogen refueling infrastructure. More specifically, this research will produce total and household shares of eVMT for different ZEV types, charging/refueling profiles for vehicles and households, and a host of travel activity and in-use vehicle operations data that will be provided to ARB.

**Significance to the Board**

This research will allow the Board to evaluate the potential environmental benefits of different ZEV types in a comprehensive and systematic manner. The results of this study will improve emissions estimates at the vehicle and household levels, will provide insight into potential zero emission vehicle demand on the electrical grid, and the need for potential future supporting infrastructure, and will be valuable to ARB's Advanced Clean Cars and vehicle emissions inventory programs.

**Contractor:**

University of California, Davis

**Contract Period:**

36 months

**Principal Investigator (PI):**

Dr. Michael Nicholas, Ph.D.

**Contract Amount:**

\$650,000

**Basis for Indirect Cost Rate:**

The State and the UC system have agreed to a twenty five percent indirect cost rate.

**Past Experience with this Principal Investigator:**

Dr. Michael Nicholas is a professional researcher at the Plug-in Hybrid and Electric Vehicle Center at the University of California, Davis' Institute of Transportation Studies. He is a co-Principal Investigator on the currently funded "Advanced Plug-in Electric Vehicle Travel and Charging Behavior" research contract. Dr. Nicholas is also involved with the active ARB sponsored research contract studying the secondary market of plug-in electric vehicles. For over a decade, his research has focused on alternative fuel vehicles and their infrastructure.

**Prior Research Division Funding to the University of California, Davis:**

Year	2015	2014	2013
Funding	\$ 1,468,460	\$ 2,249,136	\$ 1,131,716

## B U D G E T   S U M M A R Y

Contractor: University of California, Davis

“Emerging Technology Zero Emission Vehicle Household Travel and Refueling Behavior”

### **DIRECT COSTS AND BENEFITS**

1.	Labor and Employee Fringe Benefits	\$ 328,472
2.	Subcontractors	\$ 0
3.	Equipment	\$ 0
4.	Travel and Subsistence	\$ 20,464
5.	Electronic Data Processing	\$ 0
6.	Reproduction/Publication	\$ 4,095
7.	Mail and Phone	\$ 3,485
8.	Supplies	\$ 133,040 <sup>1</sup>
9.	Analyses	\$ 0
10.	Miscellaneous	<u>\$ 30,444</u>

Total Direct Costs \$ 520,000

### **INDIRECT COSTS**

1.	Overhead	\$ 130,000
2.	General and Administrative Expenses	\$ 0
3.	Other Indirect Costs	\$ 0
4.	Fee or Profit	<u>\$ 0</u>

Total Indirect Costs \$ 130,000

**TOTAL PROJECT COSTS** **\$ 650,000**

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Note:

<sup>1</sup> Includes \$132,160 for the purchase of 86 specialized vehicle data loggers with a two-year cellular data plan. These loggers will record the driving and refueling behavior at high-resolution from all the vehicles of 82 ZEV households in two one-year phases for a total estimate of 172 vehicles logged. The data collected from these loggers is the foundation of the project.