State of California
AIR RESOURCES BOARD

RESEARCH PROPOSAL

Resolution 11-4

February 24, 2011

Agenda Item No.: 11-1-1

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 2713-269, entitled "Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior at Work and Beyond," has been submitted by the University of California, Berkeley;

WHEREAS, the Research Division staff has reviewed and recommended this proposal for approval; and

WHEREAS, the Research Screening Committee has reviewed and recommends for funding:

> Proposal Number 2713-269 entitled "Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior at Work and Beyond," submitted by the University of California, Berkeley, for a total amount not to exceed $184,260.

NOW, THEREFORE, BE IT RESOLVED that ARB, pursuant to the authority granted by Health and Safety Code section 39703, hereby accepts the recommendation of the Research Screening Committee and approves the following:

> Proposal Number 2713-269 entitled "Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior at Work and Beyond," submitted by the University of California, Berkeley, for a total amount not to exceed $184,260.

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 effort proposed herein, and as described in Attachment A, in an amount not to exceed $184,260.

I hereby certify that the above is a true and correct copy of Resolution 11-4, as adopted by the Air Resources Board.

Mary Alice Morency, Clerk of the Board

ATTACHMENT A

"Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior at Work and Beyond"

Background

Between 2000 and 2008, energy consumption in California's commercial building sector jumped 20 percent to reach 14 MMTCO2e. This trend must be reversed if the S tate is to meet its climate change goals. Specifically, the AB 32 Scoping Plan specifies 20 MMTCO2e of emissions reductions from existing buildings and voluntary actions by 2020.

The persistent gap between expected and actual energy use in even the highest-performing buildings has prompted consideration of building occupant behavior in energy and green house gas (GHG)-related research, although research has historically focused on efficient building technology and renewable energy strategies as a means of reducing GHG emissions. Information systems to guide building operators have been developed, but there are no systems that offer occupants information regarding building energy consumption and performance while simultaneously monitoring occupant behaviors. This bidirectional data flow is essential to understanding how building occupants can be motivated to conserve energy, particularly in commercial environments where their engagement has been minimal.

Objective

This project will:

- Identify the kinds of energy conservation-related information most likely to motivate occupants and assist operators;
- Design and prototype an information system for application in commercial buildings;
- Quantify the degree to which the system's information affects the energy-conservation beliefs and actions at work and beyond;
- Quantify the GHG emissions reductions associated with the stated behaviors;
- Investigate the willingness of building operators to implement similar systems.

Methods

Investigators will:

1. Develop a Building Information Feedback System (BIFS) that offers information to occupants as well as messages to encourage them to conserve energy.
2. Select a pool of test buildings for the BIFS.
3. Program systems and set up hardware. This technical task will integrate the occupant feedback system developed under this contract into a simpler BIFS developed under a Public Interest Energy Research (PIER) contract with the California Energy Commission (CEC). Development of middleware, or software to connect various computer-related components, will also be undertaken to connect submeters with associated hardware. Finally, the research team will install required metering at test sites and verify all components' connectivity.
4. Collect data on occupants' behaviors before, during, and after interaction with the BIFS at a pilot building as well as at two experimental sites. Surveys will also be

administered to gauge occupants' beliefs and attitudes regarding energy consumption as well as reported behaviors outside of work.

5. Analyze data to illuminate magnitude and persistence of effects; influence of energy-related perspectives, demographics, and organizational placement on occupant effects; and suitability of the work environment as a place to message for influence on behaviors outside of the workplace.
6. Through an exit interview, elicit owner and operator feedback that is relevant to industry acceptance of the BIFS.

Expected Results
The proposed project supports mitigation of the information gap that often hinders building staff and occupants from acting to conserve energy through development of a prototype system to provide the requisite information. Project results will directly support ARB's broader goal to support emissions reductions from California's buildings.

Significance to the Board
The AB 32 Scoping Plan specifies 20 MMTCO2e of emissions reductions from existing buildings and voluntary actions by 2020. Study results will directly support these emissions reductions.

Contractor:
University of California, Berkeley

Contract Period:
20 months

Principal Investigator (PI):
Edward Arens, Ph.D.

Contract Amount:
$184,260

Basis for Indirect Cost Rate:
The State and the UC system have agreed to a ten percent indirect cost rate.

Past Experience with this Principal Investigator:
Professor Edward Arens and John Goins of the Center for the Built Environment have extensive experience with the CEC and the federal Department of Energy and extensive experience with the Lawrence Berkeley National Laboratory. ARB has not previously contracted with this research team, but expects good results based on feedback from colleagues at the CEC as well as Lawrence Berkeley National Laboratory.

Prior Research Division Funding to the University of California, Berkeley:

Year	2009	2008	2007
Funding	$1,507,702	$1,140,572	$1,350,484

BUDGET SUMMARY

Contractor: University of California, Berkeley

"Using Feedback from Commercial Buildings to Support Energy-Conserving Behavior at Work and Beyond"

DIRECT COSTS AND BENEFITS			
1.	Labor and Employee Fringe Benefits	$ 107,511	
2.	Subcontractors	$ 0	
3.	Equipment	$ 30,000[1]	
4.	Travel and Subsistence	$ 2,760	
5.	Electronic Data Processing	$ 0	
6.	Reproduction/Publication	$ 0	
7.	Mail and Phone	$ 0	
8.	Supplies	$ 30,000[2]	
9.	Analyses	$ 0	
10.	Miscellaneous	$ 530	
	Total Direct Costs		$170,801
INDIRECT COSTS			
1.	Overhead	$ 13,459	
2.	General and Administrative Expenses	$ 0	
3.	Other Indirect Costs	$ 0	
4.	Fee or Profit	$ 0	
	Total Indirect Costs		$13,459
TOTAL PROJECT COSTS			**$184,260**

Notes:

1. Equipment costs comprise three base building information systems (hardware and software) that will build on current systems to extend their capabilities ($30,000).

2. Supplies include nine electricity submeters so that investigators can gather data about plug loads and other end uses ($13,500), three supervisory monitoring system for the building operators ($3,600), monitoring hardware ($7,000), a software development environment that the programmer will use to create middleware ($2,900), a statistical analysis software license ($1,000), and visualization software ($2,000).