

# UC Berkeley

## Planning & Evaluation

### Title

SMUD 2005 Technology Development: LED Freezer Case Lighting and Office of the Future Laboratory

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# **SMUD 2005 Technology Development: LED Freezer Case Lighting and Office of the Future Laboartory**

Final Report

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The California Lighting Technology Center's mission is to stimulate the development and application of energy-efficient lighting. CLTC was established as a collaborative effort between the California Energy Commission and UC Davis.

## INTRODUCTION

Sacramento Municipal Utility District (SMUD) partnered with CLTC in 2005 on two projects:

- Exploratory study of LED-based retrofit lighting system for freezer and cooler case applications.
- Office of the Future Laboratory development

California Lighting Technology Center (CLTC) staff completed these projects and presented interim results to SMUD staff several times during the year, culminating in a final presentation on December 9, 2005. This report summarizes the project's activities.

## LED FREEZER CASE LIGHTING

### *Background*

SMUD funded CLTC to investigate the energy savings opportunities that LEDs presented in grocery store applications of refrigeration and freezer cases. This area has the potential to be an area of early adoption for LED technologies for a variety of reasons, including the cases' cool ambient temperatures (which are problematic for fluorescent, but ideal for LEDs). Additional drivers for LEDs in these applications are potential maintenance benefits and the potential for better optical control from the LED sources. These factors make possible the near-term application of LED systems that provide superior illumination of case products with at significantly reduces lighting loads.

### *Project Review*

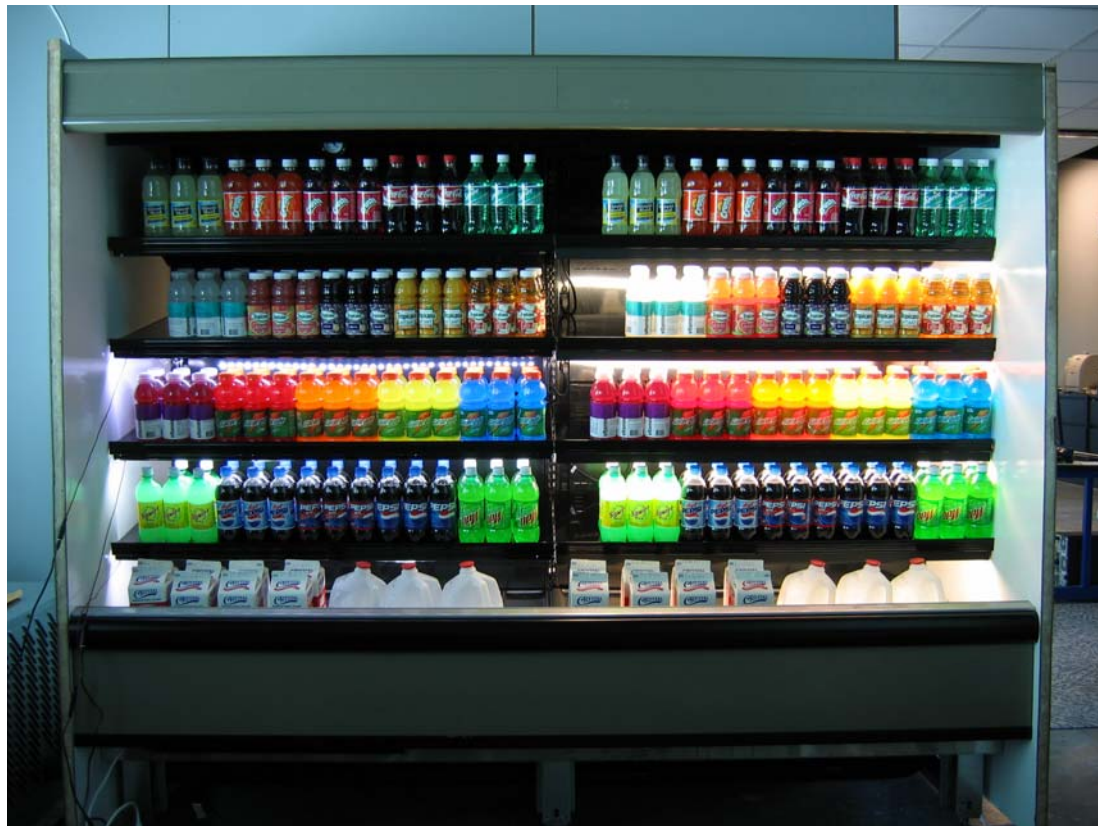
The original vision of the project was to work with local grocers in SMUD territory to understand the opportunities for LED illuminated cases and to develop initial concepts for prototype LED systems. A demonstration at a local grocery store was planned to follow the development effort in order to field test these new designs in real world applications.

SMUD conducted an extensive outreach effort to identify an interested grocer partner and ultimately found a very strong and interested partner in the Sacramento Co-op. SMUD also brought to the partnership the local representative from Hussmann, an industry leading refrigerator/freezer case manufacture. Through a series of conversations and site visits with the project partners, it became clear that many near-term opportunities existed to develop and demonstrate new LED case-lighting systems.

During these discussions, Hussmann's local representative became aware of an existing effort within Hussmann to explore LED case lighting systems. Hussmann's main research and development group was evaluating proposals and products from a number of LED manufacturers for new case lighting systems. The CLTC and Hussmann had a number of conference calls to determine how to best coordinate these two efforts. Ultimately it was decided that the CLTC would directly support Hussmann's evaluation of the LED systems that they were considering. This agreement benefited CLTC/SMUD as their effort would now have

national rather than local significance, and would benefit Hussmann as they would gain access to CLTC's lighting expertise that they did not have internally.

Following the establishment of this agreement between Hussmann and the CLTC, Hussmann prepared and shipped an 8-foot refrigerator case to the CLTC for evaluation. Local Hussmann representatives installed this unit at the CLTC – including all of the associated cooling equipment, because the photometric analysis is thermally sensitive and must be conducted at standard operating temperatures. The lighting systems included both a standard fluorescent lighting system and prototype LED arrays, as shown in Figure 1.



*Figure 1: Prototype LED systems (left, bottom 2 shelves) compared to fluorescent systems (right)*

### **Next Steps**

SMUD funded the CLTC to continue assisting Hussmann with LED refrigeration case lighting in 2006. Hussmann will be visiting the CLTC in late January 2006 to review this project. Prior to this meeting we plan to:

- Provide electrical hook-up to refrigerator case cooling system.
- Perform a complete photometric evaluation of the fluorescent (baseline) system.
- Perform a complete photometric evaluation of the LED systems.
- Prepare recommendations of product modifications for LED lighting systems.

## OFFICE OF THE FUTURE DEVELOPMENT

### **Background**

SMUD funded the CLTC to support the construction of the Office of the Future. This facility, now nearly complete, allows CLTC researcher to mock-up new energy-efficient lighting systems in a wide variety of “office” applications for demonstration and analysis. This facility is embedded with a wide variety of sensors and meters, allowing for an exceptional level of analysis of the performance of the lighting systems installed within it. Consistent with SMUD’s request, the first full-scale, side-by-side mock-up of an electrical lighting system comparison was done with one office illuminated with scotopically-rich lighting and a second office illuminated with photopically-rich lighting (see Figure 2).

### **Facility Overview**

The Office of the Future laboratory has the following elements:

- Two 10’x20’ ceilings that are movable from 8’ to 10’ ceiling height.
- Three rows of modular walls construct in 4’x10’6” sections. These walls can be arranged in a variety of ways to simulate various room geometries.
- A flexible electrical hook-up apparatus that allows for a variety of ceiling fixtures (including dimming and fixed-output systems) to be quickly and easily installed.
- An electrical dimming panel that bridges the electric lighting systems to the computer controlled lab data acquisition system.
- A computer controlled data acquisition system allowing users to control all lighting in the Office of the Future (including ceiling fixtures and task lighting) and monitor all pertinent photometric and electrical characteristic of the lighting systems (more detail on this provided below)
- Two sets of identical office furniture arrangement for “A vs B” comparisons.



*Figure 2: A scotopically-rich lighting system (left) is compared to a photopically-rich lighting system (right).*

## Control and Measurement Capabilities

CLTC established a LabView-based control and data acquisition system to completely control the lighting systems in the Office of the Future (see Figure 3). This computer interface gives users total control over every light point within the facility. Additionally this same interface monitors all key photometric and electrical properties of the facility and displays them in real time of screen. Specifically the system measures and displays:

- Horizontal illuminance and multiple user defined points
- Average Horizontal illuminance in the space
- Vertical illuminance and multiple user defined points
- Average Vertical illuminance in the space
- Instantaneous electrical draw of all lighting systems
- Power density
- Luminance distributions (all surfaces in space)
- Spectral power distributions (see Figure 4)

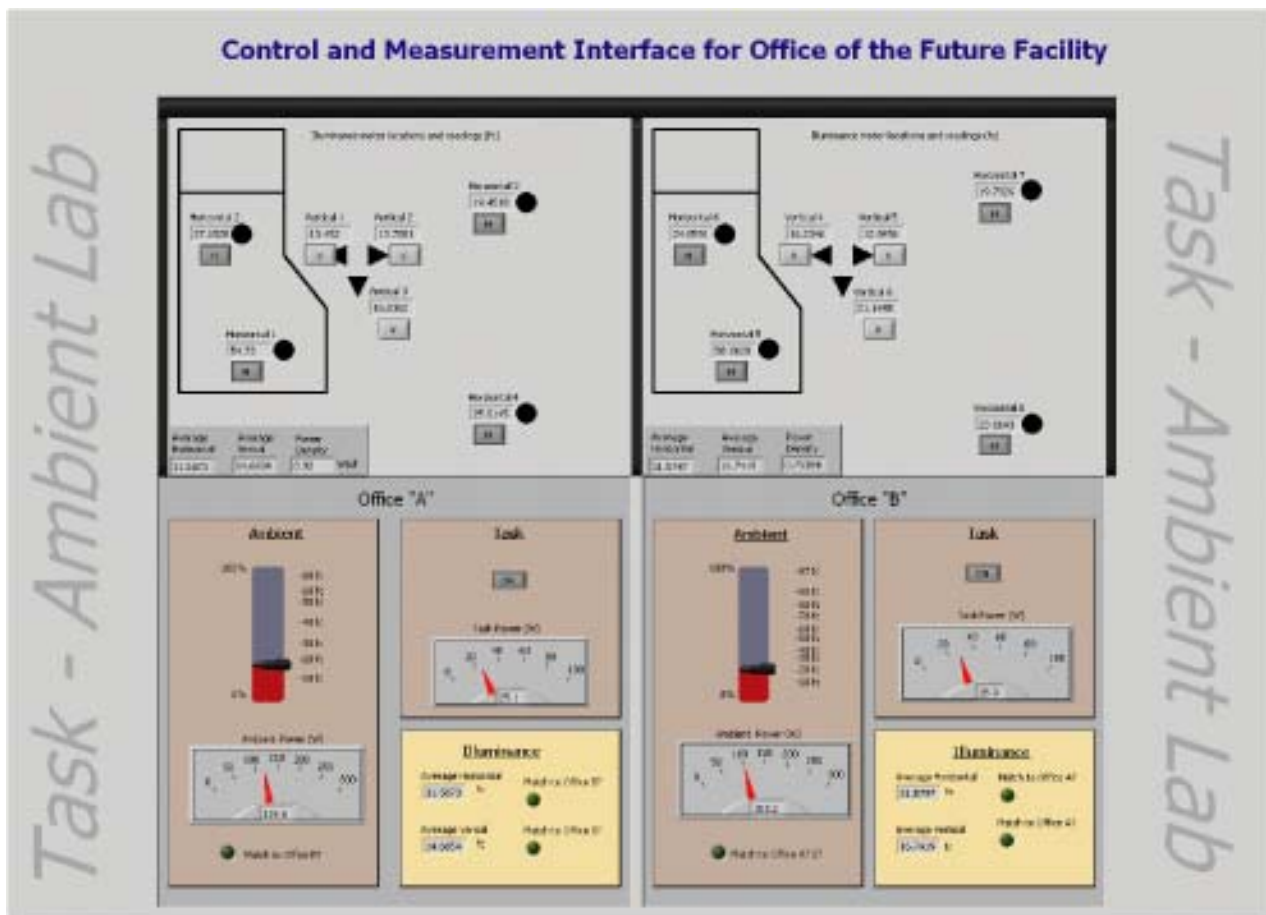
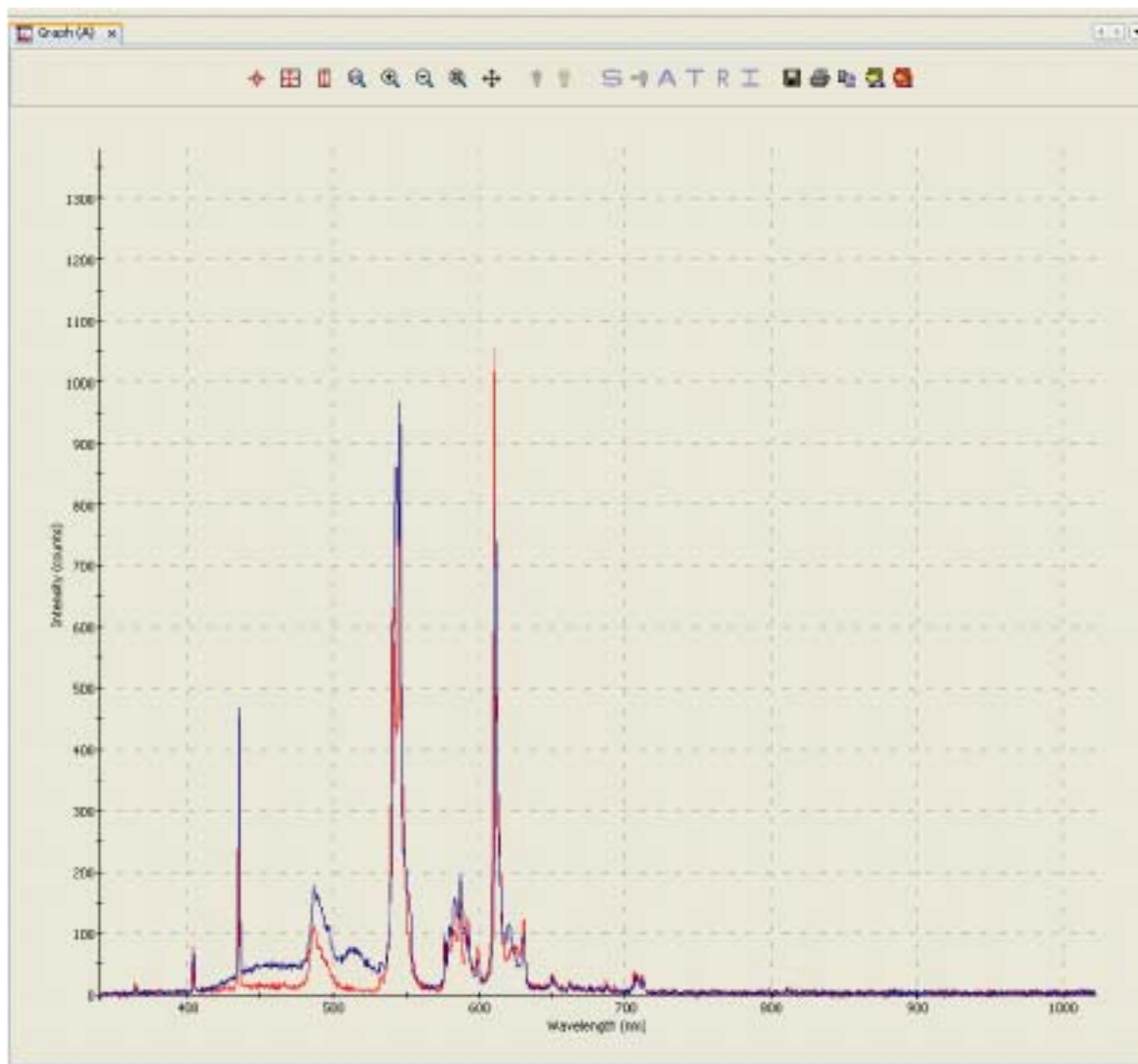


Figure 3: The control and measurement interface can control all light-points within the lab, as well as monitor all critical operational parameters such as power and illuminance.



*Figure 4: Real-time spectral power distributions are collected and displayed from multiple sources within the Office of the Future.*

### **Next Steps**

CLTC will use the facility to support future projects and demonstrations with SMUD, the California Energy Commission, and other organizations.

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