Backlit Menu Board Demand Response Field Evaluation

DR12SCE2.22

Prepared by:

Design & Engineering Services
Customer Service
Southern California Edison

December 2012

SOUTHERN CALIFORNIA EDISON®
An EDISON INTERNATIONAL® Company

Acknowledgements

Southern California Edison's (SCE's) Design & Engineering Services (D&ES) group is responsible for this project in collaboration with the Tariff Program & Services (TP&S) group. It was developed as part of SCE's Demand Response Emerging Markets & Technology program under internal project number DR12SCE2.22. D&ES project manager Doug Avery conducted this project with overall guidance and management from Carlos Haiad of D&ES and Carl Besaw of TP&S. For more information on this project, contact doug.avery@sce.com.

Disclaimer

This report was prepared by Southern California Edison (SCE) and funded by California utility customers under the auspices of the California Public Utilities Commission. Reproduction or distribution of the whole or any part of the contents of this document without the express written permission of SCE is prohibited. This work was performed with reasonable care and in accordance with professional standards. However, neither SCE nor any entity performing the work pursuant to SCE's authority make any warranty or representation, expressed or implied, with regard to this report, the merchantability or fitness for a particular purpose of the results of the work, or any analyses, or conclusions contained in this report. The results reflected in the work are generally representative of operating conditions; however, the results in any other situation may vary depending upon particular operating conditions.

Executive Summary

This study conducted field measurements to evaluate the Demand Response (DR) capabilities of four different lighting controllers when applied to existing backlit menu boards with dimmable lighting. This evaluation is for interior menu boards in fast food restaurants. The DR study was managed by Southern California Edison's (SCE) Design and Engineering Group.

The primary goals of the project were to:

- Determine whether the advanced lighting control systems can be scheduled for reliable control of backlit menu boards as part of a Manual Demand Response test
- Determine whether the advanced lighting control systems can be scheduled for reliable control of backlit menu boards as part of an Automated Demand Response (ADR) test
- Determine demand reductions that can be achieved

The study was conducted at five fast food restaurants. The interior backlit menu boards at the sites had previously been upgraded to dimmable lighting. The interior lighting at the sites had previously been upgraded to dimmable Light Emitting Diodes (LEDs) with occupancy and daylighting controls. The DR was expected to be an added benefit to the selection of the lighting control systems. The four lighting control systems evaluated for this test were: WattStopper, Enlighted, Daintree Networks, and Acuity nLight. Two sites had the Enlighted controller.

Power monitoring of the backlit menu boards was conducted for this study. Manual DR testing implemented by the manufacturer's representative was conducted on three separate days. The testing planned to change the DR level to five different settings: 15%, 20%, 25%, 30%, and 50% reductions in power from the commissioned level. Each setting was held for one hour, after which it was returned to the baseline DR level of 0%. These tests were conducted in October and November 2012. In late November 2012, SCE conducted ADR tests.

One of the Enlighted controllers in combination with dimming ballasts on fluorescent lamps was able to successfully reduce demand during manual DR testing. The measured demand reduction was 0.11 kilowatt (kW) at the 50% DR level. This was a reduction of the menu board load of 35%. A graph of the demand reduction from the manual DR events is presented in Figure 1. The controller at this site was not successful in implementing the ADR test for the backlit menu boards.

The other four sites had dimmable LEDs and were unable to successfully integrate the menu board dimming with the interior lighting controller. These sites were unable to shed load for either the manual DR events or the ADR events.

The backlit menu board wattage provides a limit to the maximum load that can be shed during a DR event. Table 1 lists the rated menu board load and the demand reduction achieved by manual and ADR. The results show that both the total available load and total achieved load reductions are very small in these cases.

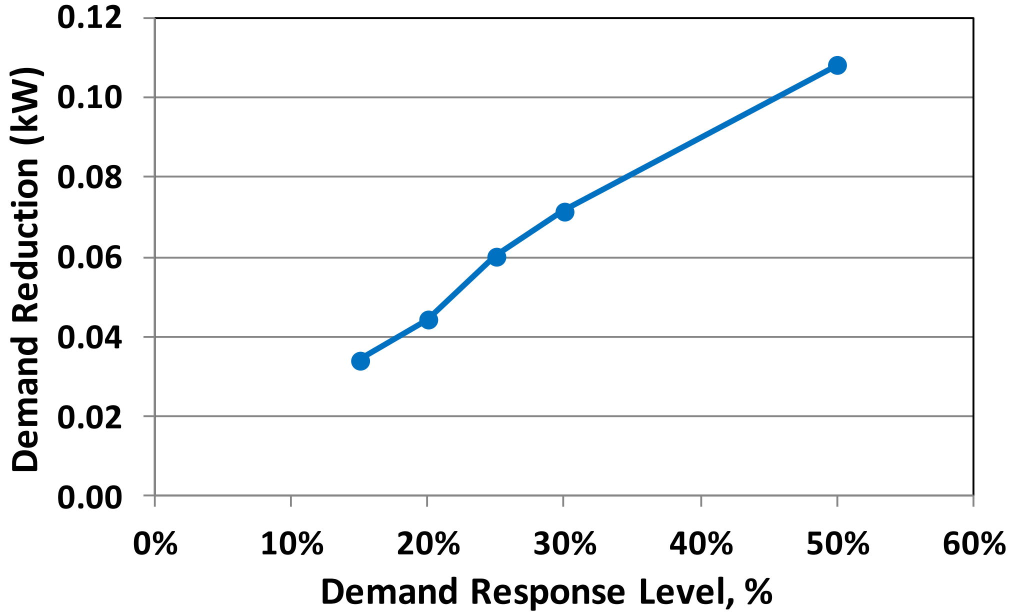


Figure 1. Menu Board Lighting Manual DR Demand Reduction at Selected DR Levels

Table 1. Summary of Controllers, Menu Board Rating, and Demand Reduction Achieved

Controller Manufacturer	Rated Menu Board Watts	Manual DR, W	ADR, W
WattStopper	153	0	0
Enlighted, Inc.	299	108	0
Enlighted, Inc.	108	0	0
Daintree Networks	235	0	0
Acuity nLight	149	0	0

The material and labor costs for the controller at the successful manual DR test site was $9,100. The cost may be lower for other projects if utility program incentives are received. It should be noted that these are very costly systems for small facilities that are able to shed only a fraction of a kW from the menu boards. It is expected that the DR capability would be an added bonus where cost-effectiveness is determined by the energy savings that the control system can provide. This will be assessed in an additional analysis for these sites in a separate report.

This study provides insight into potential areas of further research related to the evaluated technologies. Further studies would be required to determine whether there is a way to easily integrate dimmable LED lighting into advanced lighting control systems in order to achieve DR benefits. If small loads will always be a factor in ADR programs, these systems must integrate easily, quickly, and cost-effectively.

Abbreviations

ADR	Automated Demand Response
ALCS	Advanced Lighting Control System
CT	Current Transducer
DR	Demand Response
kW	Kilowatt
LED	Light Emitting Diode
OpenADR	Open Automated Demand Response
RMS	Root mean square
SCE	Southern California Edison
W	Watts

Contents

Figures

Tables

Introduction

This field study evaluated the demand response (DR) capability of advanced lighting control systems (ALCS) acting on backlit menu boards. Four types of ALCS were installed in five fast food restaurants. The ALCSs were from Daintree Networks, Enlighted, Acuity nLight, and WattStopper. Two sites used the Enlighted product. The study involves in-situ testing of the products to measure the demand reduction from manual DR and automated DR (ADR). These real-world settings also allow testing the compatibility of systems produced by separate manufacturers.

In recent years, many advanced lighting systems have become available, including new technologies for controls, metering, and remote communications. These technologies can provide dimming to fluorescent lighting with dimmable ballasts and to Light Emitting Diodes (LEDs) if they are compatibly controlled. One of the challenges is to integrate systems from different manufacturers.

Background

Demand reduction is needed when the electrical grid is constrained, when demand exceeds supply or when electricity costs are high. These conditions tend to occur during hot summer afternoons.

Peak electricity demand has been managed by Southern California Edison (SCE) customers participating in DR program offerings such as:

- Demand Bidding
- Capacity Bidding
- Critical Peak Pricing
- Real-Time Pricing
- Summer Discount Plan

SCE continues to investigate the DR potential of several new technologies in order to reduce the peak demand on its electric grid. SCE customers will benefit from these new technologies as they have the potential to achieve large demand reductions either by substantially reducing loads at a few major facilities or by performing smaller demand reductions at a large number of facilities, which should increase customer participation in DR programs.

Assessment Objectives

SCE has implemented lighting retrofits in interior backlit menu boards at five fast food restaurants. This study evaluated the addition of these loads to a portfolio of lighting options at fast food restaurants that are controlled by an ALCS with ADR capabilities.

The main objectives of the project were to:

- Determine whether ALCSs can be scheduled for reliable control of backlit menu boards as part of a Manual Demand Response test
- Determine whether ALCSs can be scheduled for reliable control of backlit menu boards as part of an ADR test
- Determine demand reductions that can be achieved

To achieve the project objectives, electric load monitoring was conducted for the interior menu boards in each participating facility. A schedule of manual DR and ADR testing was conducted. Following the tests, monitored data was analyzed to verify the implementation of the test signals and quantify the demand savings. Savings for each successful product controller are reported.

Technology/Product Evaluation

This is a field study of four different lighting control products used to provide dimming, daylight harvesting, and demand response control of interior lighting. The study attempts to integrate existing dimmable backlit menu boards into the ADR capabilities of the lighting controllers.

Five fast food restaurants in the Inland Empire region were selected by SCE for the study. The same fast food chain was selected for all field test sites because this helps achieve uniformity in conditions and minimizes the number of variables affecting results.

The lighting control products evaluated in this study are listed in Table 2. These controls provide signals to the interior lighting installed at these sites in order to dim the lighting to almost any level. In these cases, demand response is an added benefit that would not be affordable on its own. DR periods can be scheduled in advance as part of the control to lighting levels. The most effective way the utility can implement DR for many sites with small loads is by using the Open Automated Demand Response (OpenADR) communication standard. OpenADR was developed by Lawrence Berkeley National Laboratory to promote a common communication standard for DR programs and technology manufacturers. The WattStopper, Enlighted, and Daintree controllers are compatible with OpenADR.

TABLE 2. SUMMARY OF INTERIOR LIGHTING CONTROL PRODUCTS BY LOCATION

CONTROLLER MANUFACTURER	MODEL	LOCATION (CITY – STREET)
WattStopper	DLM	Corona – Magnolia Ave.
Enlighted, Inc.		Corona – Temescal Canyon
Enlighted, Inc.		Upland
Daintree Networks	WAC50	Rancho Cucamonga
Acuity nLight		Montclair

The backlit menu boards dimmable lighting products installed at the five sites are listed in Table 3.

TABLE 3. SUMMARY OF MENU BOARD LIGHTING PRODUCTS, INSTALLED LOCATION, AND RATED WATTS

LAMP TECHNOLOGY	PRODUCT MFG	MODEL #(S)	CITY – STREET	NOTES	TOTAL MENU RATED WATTS
LED	C3 Lighting	RE-2024	Corona – Magnolia Ave.		153 W
Fluorescent	Daintree	WA100 / Ecolux HE T5	Corona – Temescal Canyon	Dimmable Ballast	299 W
LED	TylerCo, Inc.	Sign-Lite™	Upland	Translucent Panel	108 W
LED	Mobootic	TDH_KRL_LED3	Rancho Cucamonga	MeanWell CLG-150-12A	235 W
LED	GE Tetra	GEWWSSP3-41K	Montclair	Tetra® PowerStrip 12V	149 W

OPERATING HOURS

The posted operating hours for the five locations are relatively similar, as shown in Table 4. The table also displays the calculated operating hours for each restaurant per week. Typically, the menu boards are turned on only during operating hours; however, they are manually turned on and off at the beginning and end of daily shifts and do not strictly operate in concordance with the posted schedule. For example, the Rancho Cucamonga site frequently leaves the menu board illuminated at night while the restaurant is closed.

TABLE 4. POSTED RESTAURANT OPERATING HOURS BY DAY OF WEEK AND SITE

SITE LOCATION	MON-THU	FRI	SAT	SUN	HOURS/WEEK
Corona – Temescal Canyon	6AM-11PM	6AM-Midnight	6AM-Midnight	6AM-11PM	121
Corona – Magnolia Ave.	6AM-11PM	6AM-Midnight	6AM-Midnight	7AM-10PM	119
Rancho Cucamonga	6AM-Midnight	6AM-Midnight	24 hrs	24 hrs	138
Montclair	6AM-Midnight	6AM-Midnight	24 hrs	24 hrs	138
Upland	6AM-Midnight	6AM-Midnight	24 hrs	24 hrs	138

Technical Approach/Test Methodology

To characterize the demand reductions resulting from the field tests, a measurement and verification plan was prepared and adapted to each facility.

This study planned to test five different backlit menu boards with ALCS, where one unique new lighting technology solution was installed at each site. The sites were chosen because they had similar menu boards and operating conditions. All five sites were the same fast foodrestaurant, which are owned and operated by two independent franchises, and located within 30 miles of each other. Some characteristics varied, including the number of illuminated menu panels and overall hours of operation.

The methodology for the study was to monitor the demand of the menu board lighting systems before, during, and after DR events. During a previous phase of the evaluation of these sites, a dimming capability was added to the lighting of all the menu boards. This earlier phase attempted to integrate the dimming capabilities of the menu board with the ALCS installed for the interior lighting system. Initially, many of the menu boards only had local control for dimming of the backlights. A schedule of DR tests was developed to show that the systems can respond to demand reduction requests and are able to quantify the achievable demand savings. Although each of the technologies installed has a dimming capability that can be used for energy savings, this study focused only on the demand savings resulting from DR testing. The next section describes the metering equipment used in the field for this study.

Metering Equipment and Data Acquisition

Enernet K-20 multi-channel meter recorders (Figure 2) were used to monitor power consumption of the menu board lighting systems. These recorders monitor electric energy, analog signals, and digital pulses. For this study, the recorders were used to monitor true root mean square (RMS) kilowatt (kW) power of the circuit feeding the main interior menu board lights. The logger accuracy for power measurements is ±0.5% from 1 to 100% of full scale. Current transducer accuracy is ±1% from 10% to 100% of full scale, ±3% at 5% of full scale, and ±5% at 2% of full scale. Split-core current transducers (CTs) (Figure 3) with 5 Amp primary ratings were used for the menu board lighting load. One channel on each logger was used to measure kW. The meter samples the full 60 Hertz waveform once every 5 to 9 seconds, and the data samples are averaged and recorded in 1-minute intervals for the test days. During the site visit, the meter recorder box was mounted near the electrical panel. One-time power measurements were taken using an AEMC 3910 true RMS power meter to confirm calibration of the data logger and to assure proper installation. Data were collected remotely via telephone land lines at each site and modems in each of the loggers. A central computer retrieved data daily.

FIGURE 2. K20 POWER LOGGER MOUNTED NEXT TO ELECTRIC PANELS

FIGURE 3. CURRENT TRANSDUCER MOUNTED INSIDE ELECTRIC PANEL

Prior to installing monitoring equipment, the lighting power for each interior menu board was traced. Four of the sites had one wire in a 120V electric panel that exclusively served the menu board lighting. One CT was installed to monitor the power of the individual circuit. It should be noted that Figure 3 displays two wires connected to one breaker, but only the wire powering the menu board is monitored. A fifth site had additional loads on the circuit in the panel. For this site, the CT was mounted inside the menu board where power entered the interior menu board. Monitoring equipment installation occurred during the period from February 18, 2012, to March 14, 2012.

TEST PROCEDURES

Two general test approaches were planned. One used manual DR testing, which was implemented by the lighting controller representatives, while the other used ADR implemented by SCE personnel. All computers, equipment, and loggers were intended to be synchronized to clocks on Pacific Time, as obtained from the National Institute of Standards and Testing[1] website.

Manual DR testing was scheduled to be conducted on the same business hours over three separate days at each of the five sites. Recording intervals were set at 1 minute during the test periods. The testing procedure included changing the lighting level to five different settings: 15%, 20%, 25%, 30%, and 50% below the commissioned level. Each test was scheduled to last for one hour, after which the setting was returned to the baseline DR level of 0%. Table 5 shows the actual schedule of the lighting tests. DR testing of the menu boards did not begin until late October 2012.

[1] NIST web link: http://nist.time.gov/timezone.cgi?Pacific/d/-8/java

TABLE 5. LIGHTING MANUAL DEMAND RESPONSE TEST SCHEDULE

DR LEVEL, %	CONTROL SYSTEM TIMING
15%	10:00 a.m. – 11:00 a.m.
0%	11:00 a.m. – 11:30 a.m.
20%	11:30 a.m. - 12:30 p.m.
0%	12:30 p.m. - 1:30 p.m.
25%	1:30 p.m. - 2:30 p.m.
0%	2:30 p.m. – 3:00 p.m.
30%	3:00 p.m. - 4:00 p.m.
0%	4:00 p.m. - 4:30 p.m.
50%	4:30 p.m. - 5:30 p.m.

The above table represents a slight deviation from the planned schedule

ADR testing was scheduled to occur on only one day. The planned schedule is shown in Table 6.

TABLE 6. LIGHTING AUTOMATED DEMAND RESPONSE TEST SCHEDULE

DR LEVEL, %	DR LEVEL REQUEST	CONTROL SYSTEM TIMING
15%	Low	9:30 a.m. – 10:30 a.m.
0%		10:30 a.m. – 11:00 a.m.
20%	Medium	11:00 a.m. - 12:00 p.m.
0%		12:00 p.m. - 2:30 p.m.
30%	High	2:30 p.m. - 3:30 p.m.

SCE conducted the one day ADR testing for the ALCS that controlled the menu boards as well as the interior lighting for each site.

Data Analysis and Results

This section presents and discusses the data collected from monitoring the illuminated interior menu boards. Data were processed to determine demand for the baseline periods and the DR periods. An analysis of the data determined demand savings for the project.

Data Analysis

One channel of menu board lighting power was recorded for each site. Data were recorded as average kW demand over 1-minute intervals. For the Corona site on Temescal Canyon, three days of manual DR test data were available for analysis. Monitored data were available for the other four sites, but the control systems could not successfully reduce the demand in response to a demand request either manually or through the automated system operated by SCE. The demand reduction calculated for each DR level was averaged across all three days for the successful Temescal Canyon site, with results presented as a table and charts in this chapter. Additional charts showing daily profiles for this site for each of the test days and a non-test day are presented in Appendix B.

To calculate the average demand reduction for a given DR level period, the average demand during the period was calculated and subtracted from the average demand for the preceding baseline period. Close examination of the data was conducted to ensure the 1-minute periods during the transition were not included in the average.

There are no data for the ADR testing because none of the sites were able to successfully integrate the menu board dimming controls with the interior lighting control system.

Results – Manual DR

Table 7 provides a summary of the average demand reduction for the manual DR tests, showing the kW demand reduction for each DR level. These values are not normalized but show the raw demand reduction. The measured demand reduction is 0.11 kW or 35% at the 50% DR level.

Table 7. Demand Reduction in kW and Percent for Selected DR Levels at Corona-Temescal Canyon

DR% Level	Demand Reduction, kW	Measured Percent Reduction, %
15%	0.034	10.9%
20%	0.044	14.3%
25%	0.060	19.5%
30%	0.071	23.2%
50%	0.108	35.1%

Figure 4 illustrates the demand reduction data from Table 7. The demand reduction has a strong linear correlation with DR % level. The measured demand reduction percentage is graphed in Figure 5.

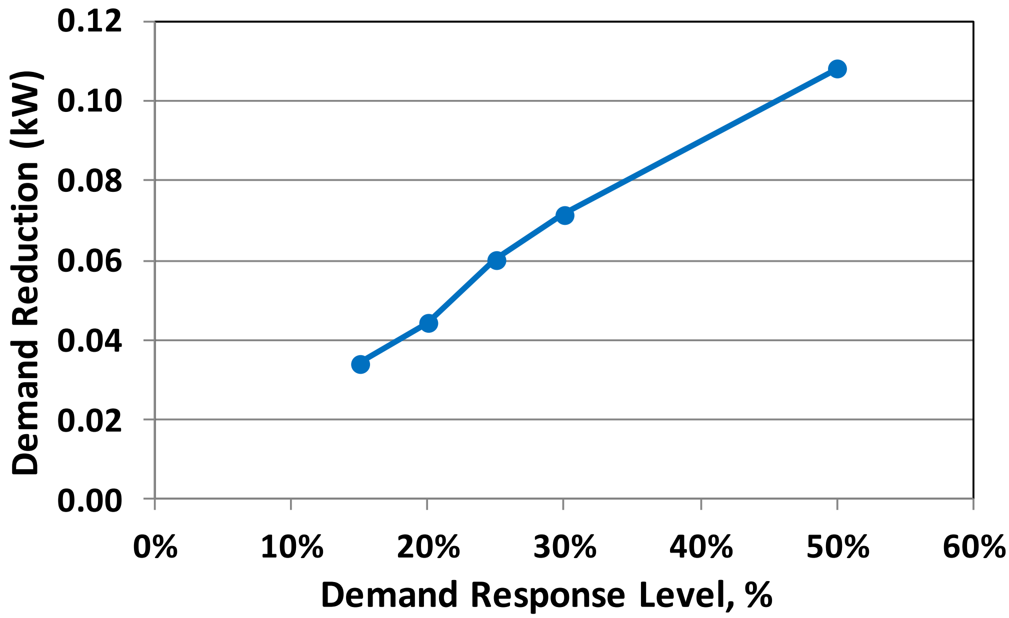


FIGURE 4. MENU BOARD LIGHTING DEMAND REDUCTION AT SELECTED DR LEVELS

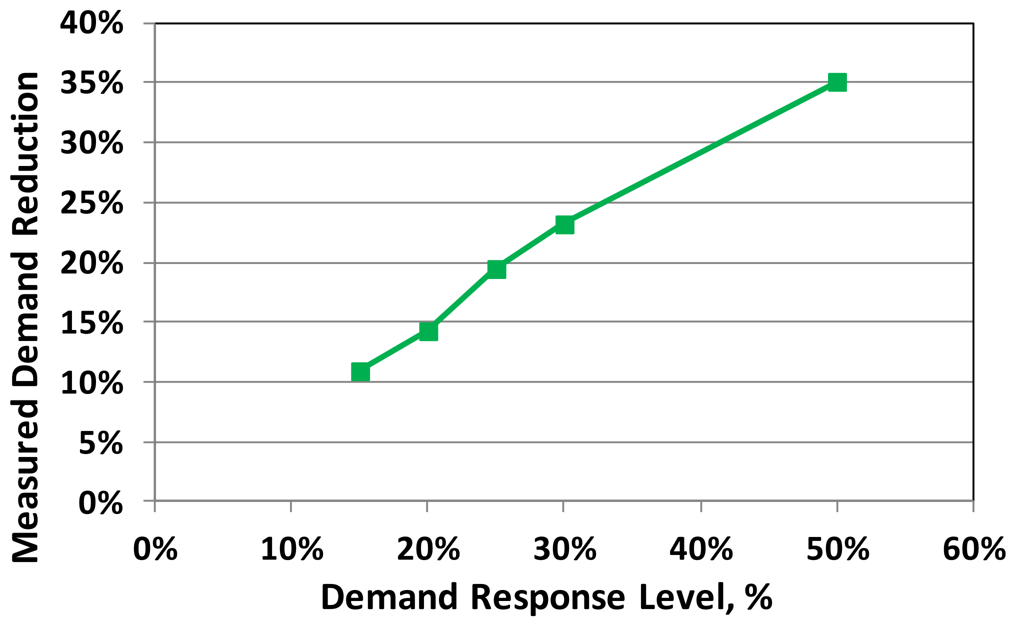


FIGURE 5. MENU BOARD LIGHTING DEMAND MEASURED PERCENT REDUCTION AT SELECTED DR LEVELS

ECONOMICS

The material and labor costs for the controller at the successful manual DR test site was $9,100. The cost may be lower for other projects if utility program incentives are received. It should be noted that these are very costly systems for small facilities that are only able to shed a fraction of a kW from the menu boards. It is expected that the DR capability would be an added bonus where cost-effectiveness is determined based on the energy savings that the control system can provide. This issue will be analyzed for these sites in a separate report.

Discussion

This project implemented new technology to provide DR capability and savings to a focused customer segment. As fast food restaurants typically have backlit illuminated menu boards, the results of this study may be applicable to the general fast food business sector.

The single successful product combination provided 0.11 kW of demand reduction at 50% DR level, but only succeeded during the manual DR testing. None of the units provided ADR demand reductions. Further studies would be required to determine if this is a technical issue that can be addressed in order to provide backlit signs as a source for DR marketing.

In order for the menu boards to be dimmed they must have dimmable lighting installed. The new dimmable lighting uses much less wattage, which means that the DR capacity is very small. In isolation this type of demand response is not cost-effective and it may only be an option if a system is being installed for energy savings and has ADR.

This study did not attempt to compare light output of the product during various dimming levels, and does not conclude whether the dimming is acceptable to the store managers. Setting the initial dimming to a commissioned level of 80% reduces total lighting load available to be dimmed during a DR event.

The technology tested in this study can also be used to control lighting in other business types and applications.

Conclusions

The main objectives and conclusions of the project are:

1. *Determine whether the advanced lighting control systems can be scheduled for reliable control of backlit menu boards as part of a Manual Demand Response test:*

   Only one ALCS (Enlighted) could be set to reliably reduce lighting loads by means of a manually initiated test.

2. *Determine whether the ALCSs can be scheduled for reliable control of backlit menu boards as part of an ADR test:*

   None of the ALCSs could be reliably set up to respond to the ADR signal.

3. *Determine demand reductions that can be achieved:*

   The manual demand reduction for the Corona site using the Enlighted ALCS had a demand reduction of 0.11 kW at the 50% DR level. No demand reduction for the menu boards was available using the ADR signal.

The tested systems did not identify straightforward, off-the-shelf solutions that could be integrated into an existing dimmable lighting system. The study results indicate that significant investigating would be needed to find a solution that would provide reliable ADR savings.

Recommendations

The results of this field evaluation indicate that there are barriers to integrating dimmable backlit sign lighting into an ADR-compatible ALCS. Furthermore, the benefit from a successful implementation may only be 0.1 kW, which is very low.

Further study of interior backlit signs with dimming controls could be considered for DR applications. Although these measures may not provide large kW savings individually, they may be combined with other dimming lighting at a facility to increase the overall demand reduction capacity.

Another research area to consider involves the possibility of integrating the menu board lighting dimming system with the interior lighting ALCS at these five sites. Assuming the devices are interoperable, this may present a means to reduce cost, as only one ALCS would be needed for the entire store.

Because many lighting solutions are new, installers should learn how to properly install and integrate them in order to provide an effective product to the customer.

References

[CEUS] Itron, 2010, California End Use Survey Results March 2006 prepared for the California Energy Commission retrieved 3/5/10 at http://capabilities.itron.com/CeusWeb/Chart.aspx

Backlit Signs and Menu Boards Lab Evaluation. Southern California Edison, Design & Engineering Services ET11SCE1010 Report. December 31, 2011.

Backlit Sign Market Assessment Report. Southern California Edison, Design & Engineering Services CS 09.19 Report. December 31, 2009.

Backlit Signs and Menu Boards: Technology Development Support Project. Southern California Edison, Design & Engineering Services ET10SCE5010 Report. 2010.

Backlit Signs and Menu Boards Field Evaluation. Southern California Edison, Design & Engineering Services ET11SCE1011 Report. June 2012.

Illuminated Signage Monitoring: Southern California Edison, Design & Engineering Services, Report. Project Number ET 03-02, June 2006.

Commercial Signage and Lighting Controls: Statewide Codes & Standards Program, Southern California Edison, Design & Engineering Services, Project Number CS 05-11, Report. December 2005.

Southern California Edison, December 2005, "Demand Response Technology Evaluation, Ganahl Lumber", Emerging Technology Program, DR 05.11

Southern California Edison, November 2005, "Demand Response Technology Evaluation, LA County Internal Services Division", Emerging Technology Program, DR 05.01.

Southern California Edison, November 2011, "Demand Response Tests at a Typical Office Space in a Federal Building", Demand Response Program, DR 09.09.

Southern California Edison, November 2011, "Demand Response Technology Evaluation of Office Corridor Lighting", Demand Response Program, DR 05.02.

Southern California Edison, November 2011, "Demand Response Strategies for Typical Executive Suites Class A Office Space", Demand Response Program, DR10SCE2.02.

Southern California Edison, November 2011, "Demand Response Tests of Lighting in a Typical College Corridor", Demand Response Program, DR11SCE05.01.

Appendix A – Controller Literature

The WattStopper control system installed at Corona Magnolia Ave.

DIGITAL LIGHTING MANAGEMENT

DLM: for a room, a building or an entire campus

Digital Lighting Management (DLM) is an intelligent, distributed control system that automatically maximizes lighting energy efficiency. Its powerful features provide a higher return on investment (ROI) than any other lighting control solution.

DLM is designed to scale from stand-alone control of individual rooms to centralized control of a floor, a building, or an entire campus. With DLM, you layer your choice of control strategies to meet project goals, from energy code compliance to building aesthetics, simplified maintenance and enhanced energy performance.

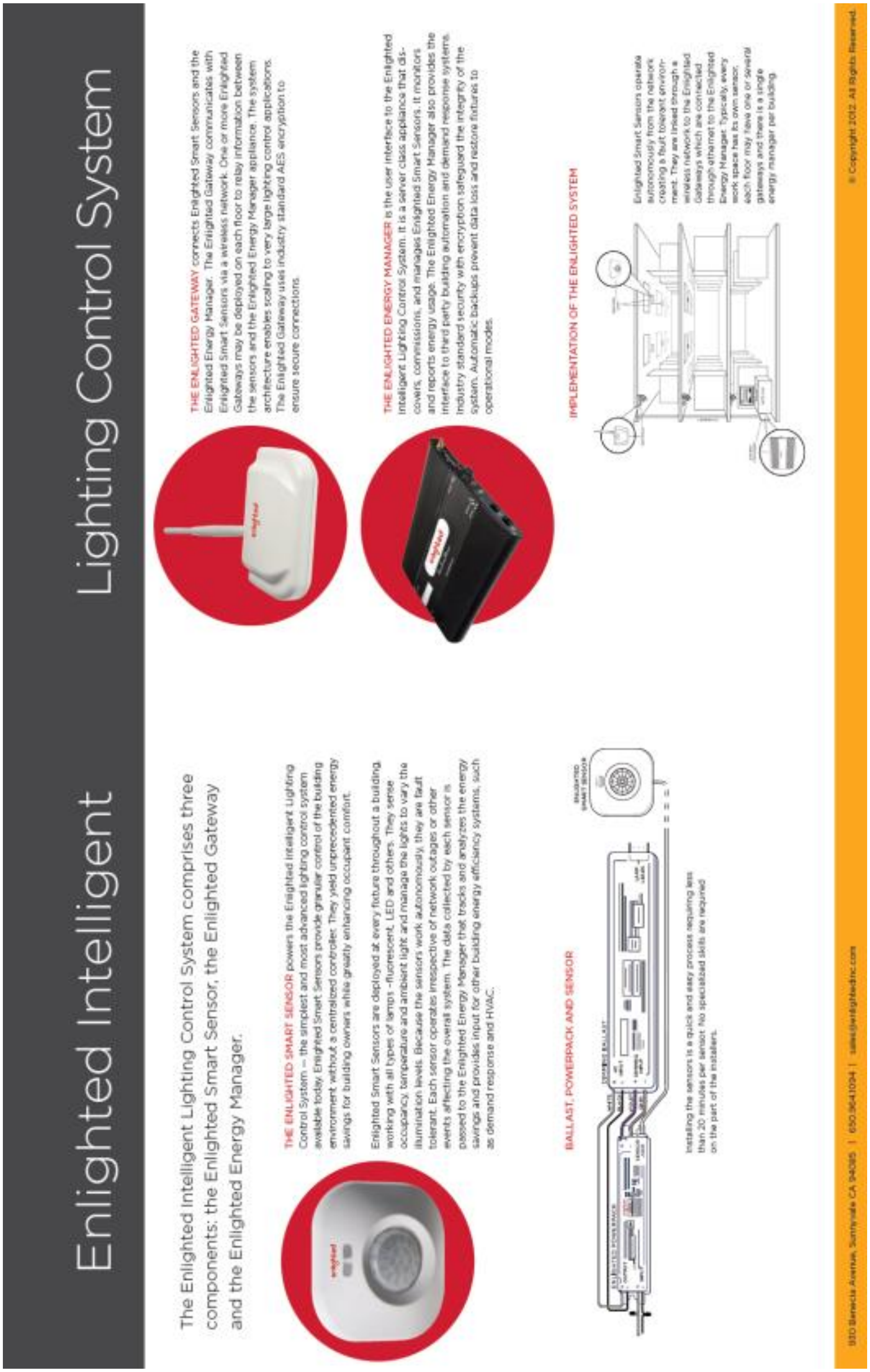
Control options include: room controllers for switched or dimmed lighting loads, or for plug loads; digital occupancy sensors; sleek switches and handheld remotes; versatile daylighting sensors; lighting control panels; tools for remote configuration, scheduling and system management; and interfaces providing connectivity to third party devices.

Digital occupancy sensors include **pushbuttons** and **LCD screens** for changing settings. A handheld remote allows ladder-free configuration.

A3

www.wattstopper.com
800.879.8585

The Enlighted control system installed at Corona Temescal Canyon and Upland.



The Daintree Networks control system installed at Rancho Cucamonga.

DaintreeNetworks

Wireless Area Controller – WAC50

Product Overview

Daintree Networks' Wireless Area Controller (WAC) is the key hardware component of Daintree-based solutions that enable powerful, simple and low-cost access to energy saving control strategies such as daylighting, occupancy sensing and demand response. It is designed to deliver intelligent local control across a large area for many dozens of interoperable wireless control devices from Daintree partners.

Built on Daintree's ControlScope™ wireless platform, the WAC collapses complex control panels, gateways and miles of wires into a single powerful controller. Using open and interoperable ZigBee® standards-based technology, the WAC communicates with standards-compliant sensors, switches, ballasts and LED drivers to transform basic room controls into a complete wireless control solution. A WAC can independently control a single extended area, and multiple WACs can be connected together through an Ethernet network to scale the system to many hundreds or thousands of lights across a distributed enterprise.

Specifications	
Dimensions	9.4" H x 8" W x 1.2" D
Weight	1.06lb (480g)
Operating Environment	32°F to 104°F (0°C to 40°C) Indoor, dry location (Install in non-metallic waterproof enclosure for outdoor applications)
Status Indicator	Green (Normal Operation) Orange (Attention Required) Red (Error Condition)
I/O	2 10/100 Mbps Ethernet 2 USB Type-A (host) 1 USB Mini-B (device) 1 microSD memory card 1 2.1mm barrel (power) 2 Button (configuration)
RF	2.4GHz ISM Band 100mW (+20dBm)
Power	5V DC 1.5A
Power Consumption	2.8W (network joined)
Warranty	5 Years Annual Support Plan

Specification Data	
Job Name	
Job #	
Catalog #	
Comments	

Product Number	Product Description
WAC50-N25	Wireless Area Controller (25 wireless node license)
WAC50-N50	Wireless Area Controller (50 wireless node license)
WAC50-N100	Wireless Area Controller (100 wireless node license)

Daintree Networks, Inc.
1503 Grant Road, Suite 202
Mountain View, CA 94040 U.S.A.

Phone: +1 (650) 965-3454
email: sales@daintree.net
www.daintree.net

Copyright © Daintree Networks, 2004–2012. Specifications Subject to Change. 120416.
ZigBee is a trademark of the ZigBee Alliance. 802.15.4 is a trademark of the Institute of Electrical and Electronics Engineers

The Acuity nLight control system installed at Montclair.

LIGHTING CONTROL : EVOLVED

What is *nLIGHT*?

nLIGHT is a revolutionary digital architecture and networking technology that cost-effectively integrates time-based, daylight-based, sensor-based, and manual lighting controls. Designed to function standalone in an individual zone or networked together across an entire facility or campus, ***nLIGHT*** is an easy-to-use, easy-to-install system that can cut energy consumption and enhance occupant convenience.

DISTRIBUTED INTELLIGENCE

nLIGHT offers "distributed intelligence," meaning that every device in every zone or network is digitally addressable. However, unlike other digital lighting control systems, every ***nLIGHT*** device is empowered to make its own switching and dimming decisions. So, instead of just room controllers, network servers, or centralized panels having intelligence, every ***nLIGHT*** device with a relay or dimming component has the intelligence to make its own control decisions. This enables designs where relays and dimming outputs can be located within sensors, photocells, and wall stations – not just in relay-only devices, such as room controllers or panels. This unmatched design flexibility allows for more elegant and cost-effective designs that minimize device count and wiring.

How *nLIGHT* Works...

nLIGHT connects together intelligent digital devices, including occupancy sensors, photocells, power/relay packs, wall switches, dimmers, panels, and now even luminaires. Combined, this creates a system with "distributed intelligence" that can be configured in limitless ways to meet lighting needs and codes.

2

Appendix B – Enlighted, Temescal Canyon

In this section, the backlit menu board lighting profiles at the restaurant in Corona on Temescal Canyon Rd. are displayed in daily charts. A non-DR test day, which is representative of typical lighting power use, is presented in Figure 6. The electrical use data series illustrates the minute-to-minute electrical usage of the interior menu boards. The shaded vertical portions of the graph show the scheduled periods when power is reduced on test days.

Figures 7 through 9 illustrate the three days of manual DR testing, with the DR level percentages labeled above the shaded areas. The figures show distinctive drops in demand when the power level settings were reduced as per the DR testing schedule. There are minor start and stop time differences associated with the manual initiation of the DR periods.

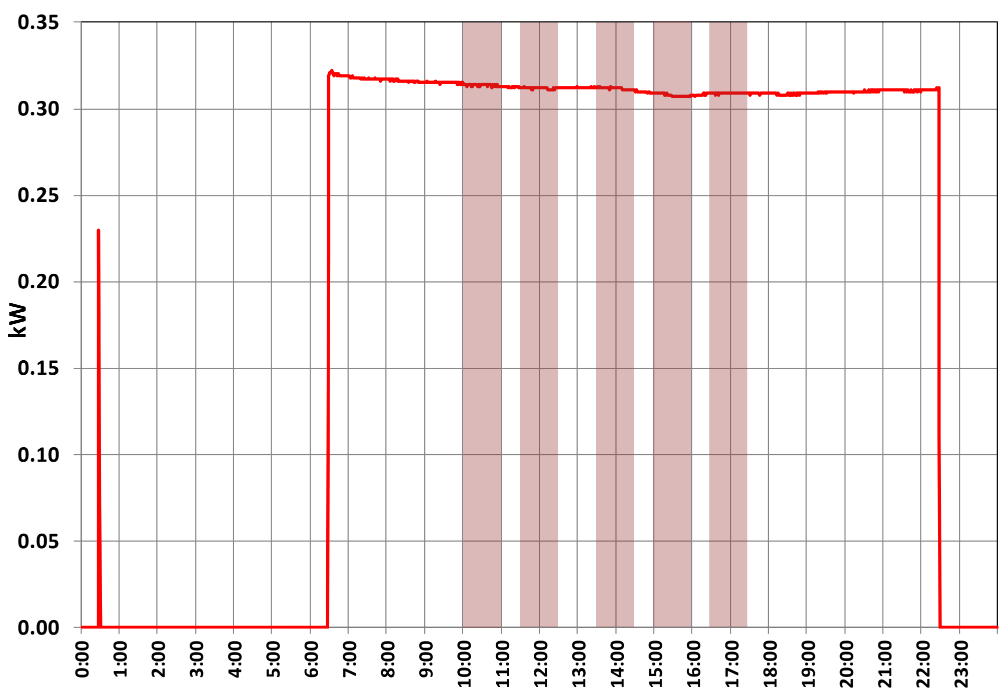


FIGURE 6. MENU BOARD LIGHTING DURING A NON-TEST DAY - THURSDAY NOVEMBER 1ST

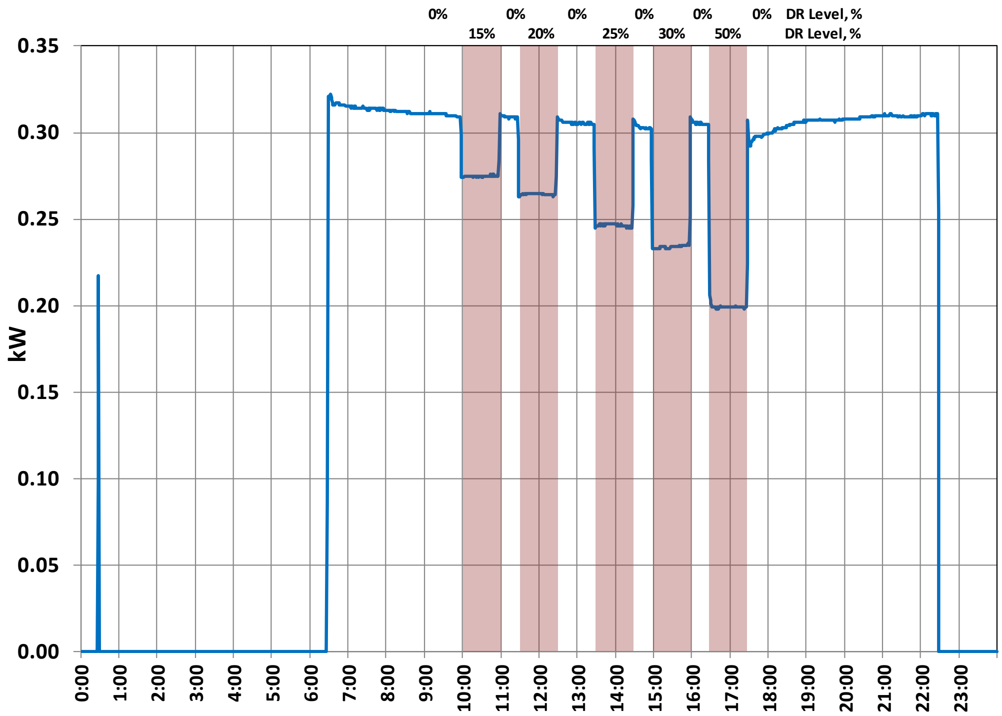


FIGURE 7. MENU BOARD LIGHTING DURING A MANUAL DR TEST DAY - MONDAY OCTOBER 29TH

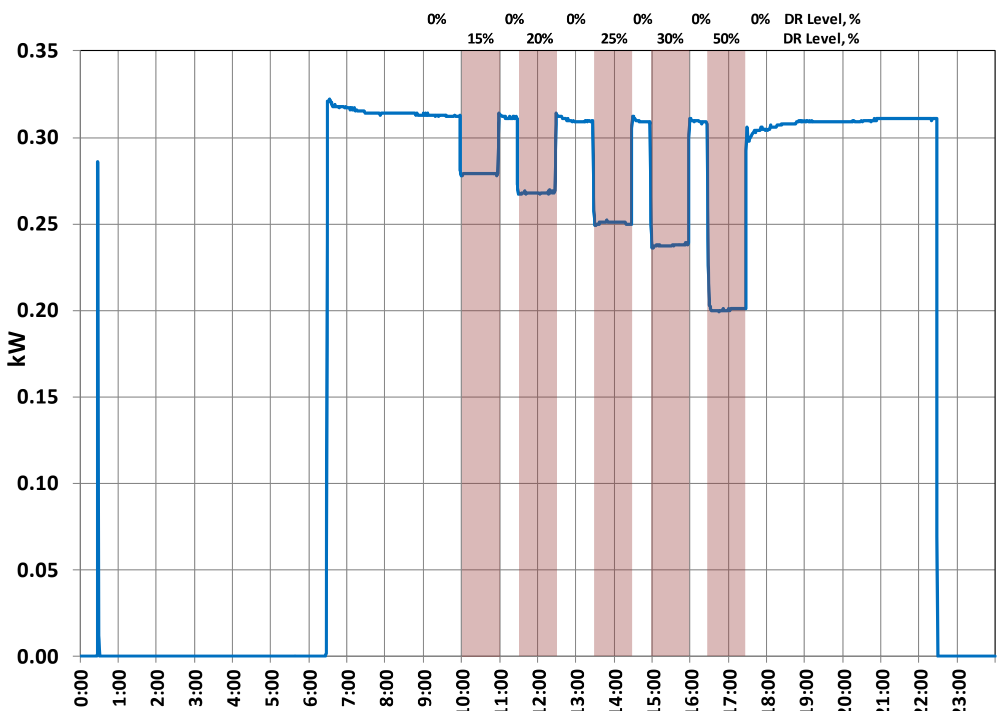


FIGURE 8. MENU BOARD LIGHTING DURING A MANUAL DR TEST DAY - WEDNESDAY OCTOBER 31ST

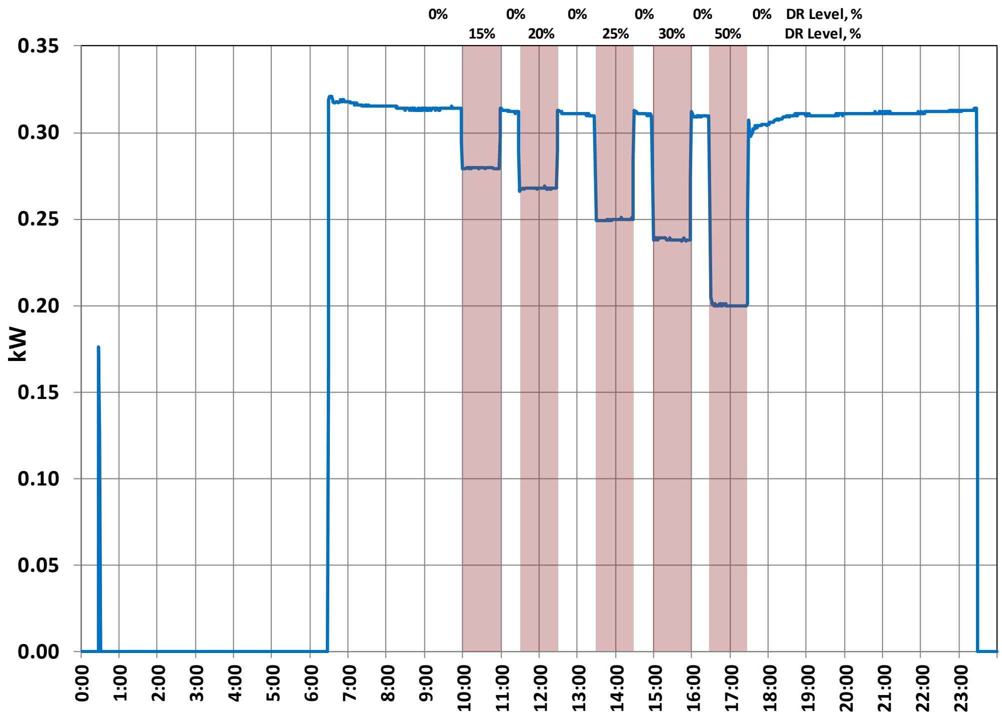


FIGURE 9. MENU BOARD LIGHTING DURING A MANUAL DR TEST DAY - FRIDAY NOVEMBER 2ND

Appendix F – Embedded Data File

Raw and processed data collected for the evaluation of this project can be found in the embedded Excel files. There is one file for the one site with manual DR test data. The file contains the charts used in this report in the event that they need to be reformatted.

CJTC Menu Board DR Appx.xlsx