Customer Advanced Technologies Program
Technology Evaluation Report

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Sacramento Municipal Utility District
July 25, 2008

Report # ET07SMUD1003

Contents

About the Customer Advanced Technologies Program

SMUD's Customer Advanced Technologies (C.A.T.) program works with customers to encourage the use and evaluation of new or underutilized technologies. The program provides funding for customers in exchange for monitoring rights. Completed demonstration projects include lighting technologies, light emitting diodes (LEDs), indirect/direct evaporative cooling, non-chemical water treatment systems and a wide variety of other technologies.

For more program information, please visit: http://www.smud.org/education-safety/cat.html.

Executive Summary

During 2007, SMUD worked with Raley's Corporation, the California Lighting Technology Center, Hussmann Corporation and ADM Associates to develop and test an LED freezer case lighting system. This innovative new system includes motion sensors and dimming power supplies and is designed to save energy by automatically dimming the lights when no one is near the freezer cases. In addition to monitoring energy savings, the project team tracked sales data and interviewed over 100 shoppers to get their opinions. The new LED system:

- ✓ Reduced lighting energy consumption by an impressive 68% (compared to T8 fluorescent lamps and electronic ballasts (see Figure 1).
- ✓ Reduced the low temperature refrigeration system energy consumption by 20%.
- ✓ Was acceptable to the majority of surveyed customers.
- ✓ Had no measurable effect upon product sales.

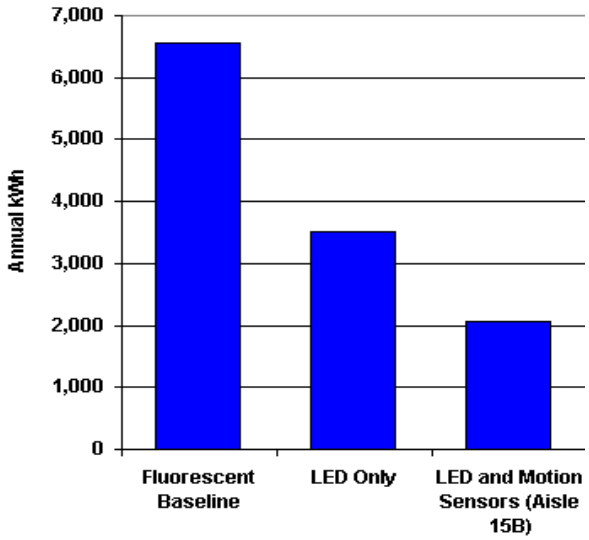


Figure 1: Savings comparison for freezer cases illuminated with Hussman Corporation's new LED lighting system with and without motion sensors.

Although Raley's uses an energy management system to turn off the case lights when the store is closed, the motion sensors still produced dramatic savings – even during peak shopping periods.

This report focuses on the potential benefits and some valuable lessons learned about using LED lighting for commercial freezer cases.

Introduction

Chances are when you hear the term LED (light emitting diode), you probably think of the little indicator lights in video equipment, battery chargers, telephones, cameras, clocks, appliances, electronic toys and other gadgets. This type of LED is known as an "indicator" and has been around for decades. Indicator LEDs are characterized by their very low wattage and light output – which makes sense considering how they are used.

Around five years ago, however, another type of LED known as an "illuminator" (Figure 2) started to make some headway into the lighting scene – especially in the areas of high-end architectural and commercial landscape lighting systems. Unfortunately, these LEDs were very expensive, had relatively low efficacies (lighting geek terminology for efficiency) and were hard to find. Because of these factors, projects featured in SMUD's 2003 LED technology report were all limited to niche market applications.

Today, LEDs seem to be showing up just about everywhere: in cars, trucks, signs, flashlights, traffic signals, street lights, parking garage lights and residential downlights (to name just a few). But did you know that LEDs may even be hiding in the freezer case next to the frozen pizzas and ice cream? In fact, several major retail chains have completed demonstration projects and are now making the switch to LEDs, including Wal-Mart, who in 2007 announced they would convert 500 of their U.S. stores to LEDs.[1]

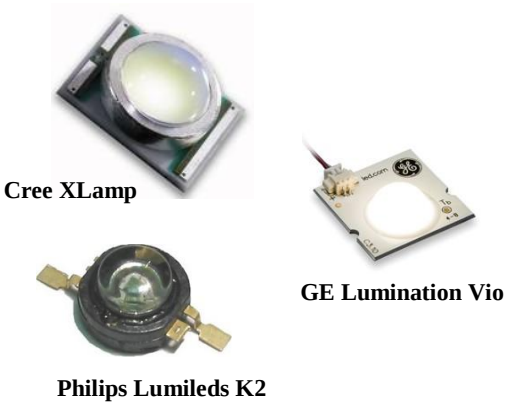


Figure 2: Examples of Illuminator LEDs Courtesy of U.S. Department of Energy[2].

Although others have done excellent work researching LED lighting systems, Hussmann's new system includes motion sensors and **dimming** power supplies, which is designed to save energy by automatically dimming the lights when shoppers are not near the freezer cases. In addition to monitoring energy savings, the project team tracked sales data and interviewed over 100 shoppers to get their opinions. After all, what good are energy savings to a grocery store if no one wants to buy their products? The result: The new system reduced lighting energy consumption by an impressive **68%** and was acceptable to the majority of customers.

This report focuses on the potential benefits and some valuable lessons learned about using LED lighting for commercial freezer cases. For more detailed information about how LEDs actually work, please download SMUD's 2003 report entitled: "Light Emitting Diode (LED) Lighting Systems" from the Customer Advanced Technologies Web page: http://www.smud.org/education-safety/cat.html.

Are LEDs a Good Choice for Freezer Cases?

Problems with Fluorescent Lamps

When it comes to office lighting, high-quality fluorescent lamps are hard to beat. They offer good lighting quality, long life and excellent energy efficiency. However, there are drawbacks to using fluorescent lamps in commercial freezer cases.

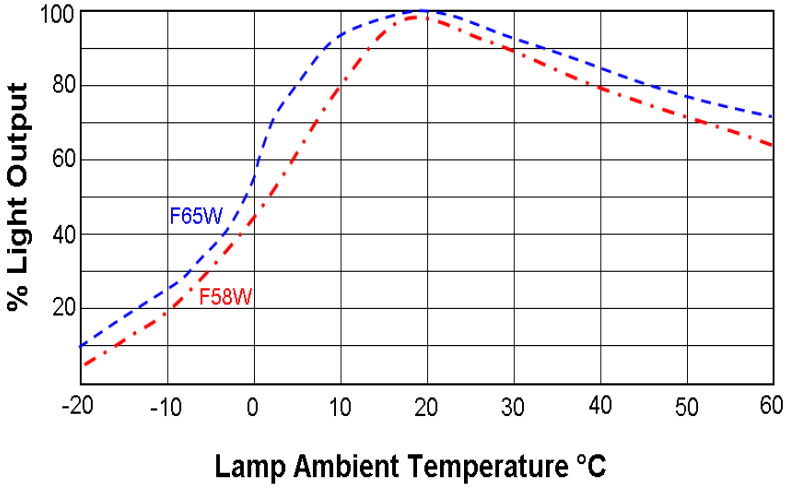


Figure 3: Percentage of light output verses temperature for a five-foot, 58 Watt T8 lamp (commonly used for freezer cases).[3]

Fluorescent lamps do not like cold environments: As the temperature drops, so does the efficacy of fluorescent lamps. For example, a typical T8 fluorescent lamp rated at 90 lumens per Watt (LPW) at room temperature (25°C)

[1] GE Press Release, available June 4, 2008 via http://www.geconsumerproducts.com/pressroom/press_releases/lighting/gelcore/Walmart_LED_display.htm

[2] Reprinted with permission from "Are LEDs Ready for Prime Time?" a presentation by Stan Walerczyk, Lighting Wizards

[3] Re-created based upon graph contained in "Energy-Efficient Lighting Alternative for Commercial Refrigeration," Rensselaer Polytechnic Institute Lighting Research Center

may actually drop 60% when operating in cold temperature environments (Figure 3). Although higher priced specialty lamps such as GE's Arctic Cold Lamp™ are available, many grocery stores still use traditional T12 or T8 fluorescent lamps.

Glare: Since fluorescent lamps emit light in all directions, they can produce a significant amount of glare when used in unshielded fixtures. At certain angles this glare could obscure the view of the products being sold.

Wasted light: Some of the light produced by tubular fluorescents is trapped by the mullion of the freezer case door frame (see Figure 4). While it is true that some of these losses can be reduced by using fixtures with reflectors, some wasted light is inevitable.

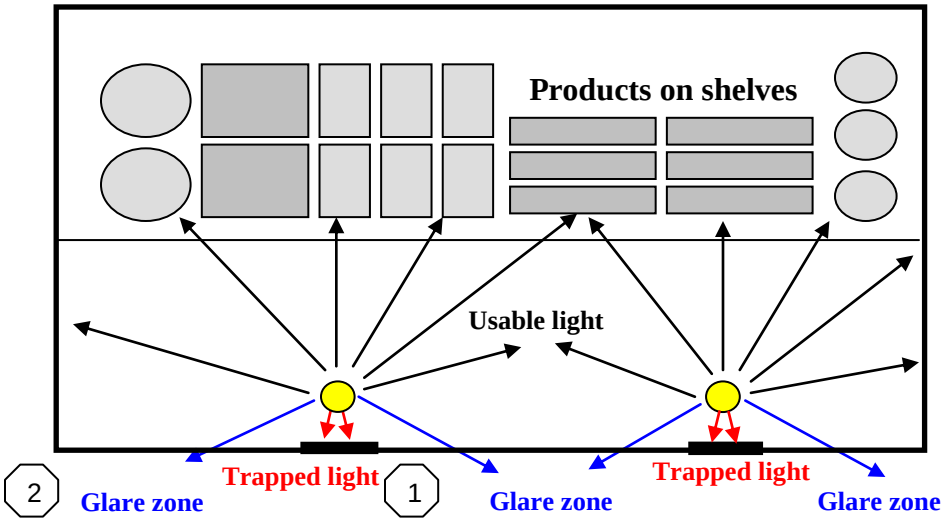


Figure 4: Simplified top view sketch of a freezer case. Note: (1) light trapped by the door mullion and (2) at certain angles, fluorescent lamps can produce veiling glare that could obscure the view of the products being sold.

Uneven illumination: The distance between the lamps and the shelves on which products are displayed within a freezer case tends to be between four and nine inches. This presents a severe optical challenge for fluorescent lamps and results in uneven illumination levels. As part of our research project, scientists from the California Lighting Technology Center (CLTC) used special cameras to create luminance maps for freezer cases before and after the LED retrofit. The results are shown below in Figure 5. Values shown in Figure 5 are expressed in Candela per Square Meter (cd/m^2).

- **Fluorescents (left image):** In most cases, average illumination levels for the products on the center of the shelf were only about half of those on the sides.
- **LEDs (right image):** The LED system produced much more even illumination than the fluorescent system.

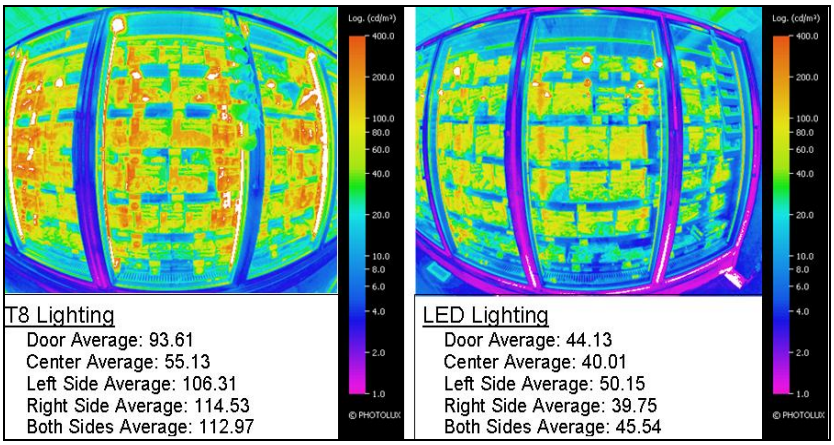


Figure 5: Photographic image showing illumination levels for a freezer case illuminated by fluorescent lamps. Source: California Lighting Technology Center.

Hazardous waste: Fluorescent lamps contain mercury. Consequently, when the lamps burn out, users must follow hazardous waste disposal laws. To be fair, it is important to note that hazardous chemicals are used in the manufacturing of LEDs, so more research is needed to fully compare the environmental impacts of using LEDs to replace fluorescent lamps.[4]

Expensive ballasts: Some freezer cases require special ballasts (due to physical space constraints and low operating temperatures). These ballasts may cost $45 to $75 to replace – more than three times the cost of conventional fluorescent lighting ballasts.

Looking Beyond Cut Sheets

Since the most efficient white LED systems are currently rated at only about 45 to 55 LPW, it is tempting to dismiss them outright. But hold on. As we've seen, manufacturer cut sheets do not tell the whole story. Due to the cold temperatures, wasted light and poor positioning within the case, conventional T8 lamps and electronic ballasts may operate at a total *system* efficacy of only 40-45 LPW.[5]

Another important factor to consider is that well designed LED fixtures are able to deliver very even illumination. In a recent study conducted by Rensselaer's Lighting Research Center over one hundred shoppers were asked to compare freezer cases illuminated by LEDs and fluorescent lights. The majority of shoppers preferred the LEDs and said that the cases were brighter – even though the LEDs actually produced less light. Rensselaer believes the main reason shoppers preferred the LED system was more even light distribution.[5]

Finally, LEDs provide exciting new control options such as motion sensors and dimming. This combination of technologies will open the door to reduce energy consumption by well over 60% (more on this later).

All of these factors sound good on paper and seem to indicate that LEDs may indeed be a good choice for freezer cases…but what about their performance in the real world? The next section of this report describes the results of the 2007 technology demonstration project.

[4] "Are LEDs Ready for Prime Time?" presentation by Stan Walerczyk, Lighting Wizards
[5] Energy-Efficient Lighting Alternative for Commercial Refrigeration, Rensselaer Polytechnic Institute Lighting Research Center, available at http://www.lrc.rpi.edu/programs/solidstate/pdf/FreezerLighting-FinalReport.pdf

Showcase Project: Raley's

Project Location: Raley's Store # 443
4900 Elk Grove Blvd.
Elk Grove, CA 95757

Figure 6: Freezer cases illuminated with Hussmann Corporation's new LED lighting system.

Background: In 1935, founder Tom Raley opened his first store in Placerville, California. Today the Raley's family of stores includes Raley's, Bel Air Markets, Nob Hill Foods and Food Source. In all, Raley's Corporation currently operates a total of 141 stores in California and northern Nevada.

This project first began in 2006 when Hussmann Corporation started working with the California Lighting Technology Center (CLTC) and SMUD to develop LED lighting fixtures. In early 2007 the first prototype freezer case lighting fixtures were designed and bench tested. Soon afterwards the search for a demonstration site began in earnest.

Raley's has a well-deserved reputation for being active in energy efficiency and being open to trying new technologies, so when they learned about SMUD's research opportunity, they readily agreed to participate. In July of 2007, the first fixtures and sensors were installed.

Project Description: The main objective of this project was to develop and test an LED freezer case lighting system in a real world application to determine the following:

- ✓ Lighting system savings
- ✓ Refrigeration system savings
- ✓ Luminance levels
- ✓ Reaction from shoppers
- ✓ Impacts upon product sales

The project was implemented in three distinct phases:

1. Replace existing fluorescent fixtures in one aisle with new LED fixtures. Measure energy consumption and survey customers.

2. Install and test motion sensors on three freezer cases. Determine energy consumption and usage patterns.

3. Evaluate results from phase one and two. If results are positive, retrofit remaining cases with LED fixtures and sensors. Monitor impacts upon product sales and the refrigeration system.

Base Case: The existing freezer case lighting system consisted of five-foot T8 fluorescent lamps and electronic ballasts designed for low temperature applications. Each five-door case consumed a total of 352 Watts. The demonstration site has a total of twenty-one 5-door cases and five 2-door cases (115 doors total). Operating hours for the case lighting was from 5 a.m. to 11 p.m. on weekdays and 6 a.m. to 11 p.m. on weekends (total of 6,205 annual hours). The case lights are turned off when the store is closed through the use of an energy management system.

LED System: Hussmann's Always*Bright LED light fixtures are available in two configurations – End Light Bars and Center Light Bars. Performance ratings for T8 systems and the Always*Bright system are shown below. Although the efficacy of the LED system (26 LPW) is indeed low compared to fluorescents, LEDs waste very little light and therefore still provide excellent opportunities for saving energy:

T8 Fluorescent Verses Hussmann Always*Bright LED

Description	Average Rated Life (hours)	Mean Lumen Output	CRI	Color Temp (K)	Typical input Watts
T8 Fluorescent lamp	15,000-20,000	4,680	85	3500 / 4100	60
Hussmann Always*Bright LED System (end bar)	50,000	500	75	3500 / 4100	18
Hussmann Always*Bright LED System (center bar)	50,000	1000	75	3500 / 4100	38

Typical Freezer Case Lighting Input Wattage

System	5-door	4-door	3-door	2-door	1-door
T8 Fluorescent lamps	360	300	240	180	120
Hussmann Always*Bright LED System	187	150	112	75	38

Figure 7: Performance data tables for Hussmann's Always*Bright LED Lighting System. Although the efficacy (26 LPW) is indeed low compared to fluorescents, LEDs waste very little light and therefore still provide excellent opportunities for saving energy. Source: Hussmann Corporation.

The new LED system also includes dimming power supplies controlled by motion sensors. When no one is near the freezer case for a period of thirty seconds or longer, the LEDs are dimmed down to approximately twenty percent of maximum output. When a shopper approaches the case, the LEDs smoothly ramp up to full output. The project team believes that ramping is a much better strategy since abruptly switching between high and low output may startle and distract shoppers. This was confirmed in our interviews. Eighty percent of the shoppers we talked to said that they did not notice the dimming, and the majority of the ones who did notice said that it did not bother them. The prototype motion sensors were mounted to a decorative façade on top of the freezer cases, while the production units are mounted directly to the frame of the freezer case (see Figure 8).

Monitoring Results - Lighting

SMUD hired ADM Associates Inc. (ADM) to monitor energy consumption and usage patterns for the original fluorescent lights as well as the new LED system with and without motion sensors. ADM used a combination of light loggers and power monitoring equipment to accomplish this task. Figure 9 shows the calculated annual energy savings for one aisle (three 5-door freezer cases). The new LED system reduced lighting energy consumption by a whopping **68%!**

Figure 8: The prototype sensor (left) was mounted to a decorative façade above the freezer case. The final version of the sensor (right) was mounted directly to the frame of the freezer case.

The monitoring data revealed some interesting trends. Originally, most of the project team believed that the motion sensors would only produce minimal savings, since Raley's already uses an energy management system to turn off the case lights when the store is closed. Fortunately we were wrong. The graphs on the next page (Figure 10) show typical energy consumption profiles for one aisle during both weekdays and weekends. The results were startling. The sensors produced dramatic savings – even during peak shopping periods.

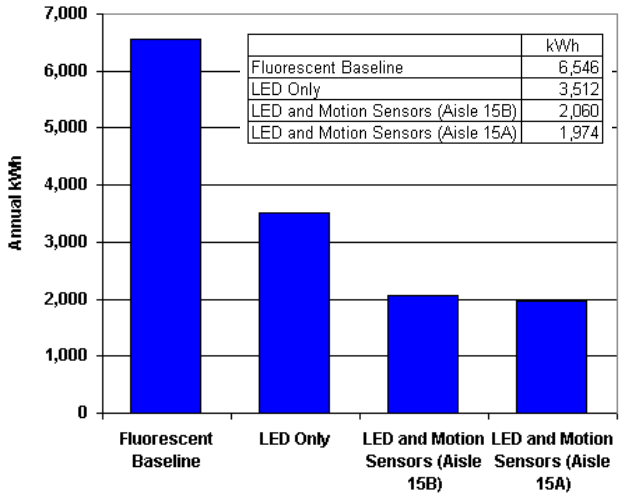
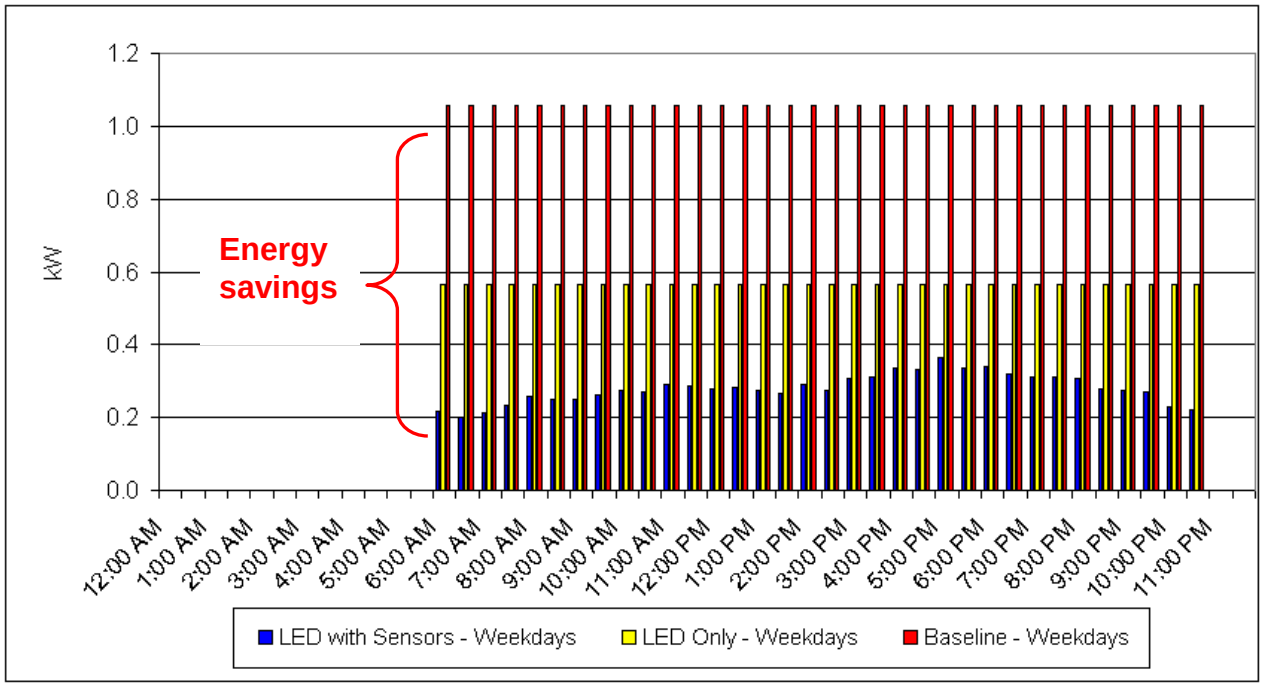
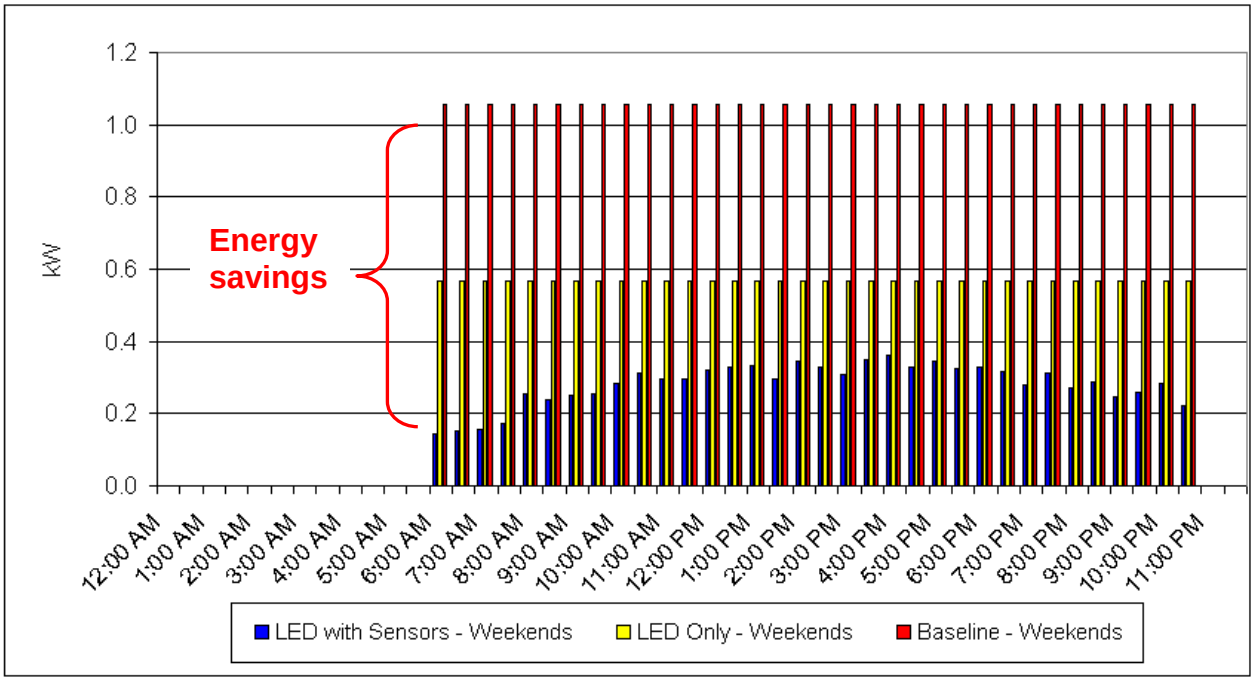


Figure 9: The combination of LEDs and motion sensors reduced energy consumption by over 68% for the cases with the prototype sensors (Aisle 15A) as well as the production sensors (Aisle 15B). Each aisle has three 5-door freezer cases.

Another interesting (albeit less surprising) discovery was that the savings for the freezer cases in the center of the aisles was greater than units on the ends of the aisle (Figure 11, page 9). This makes sense since the sensors on the end cases sometimes detect shoppers who do not fully enter the aisle.

Typical Energy Consumption Profiles for Raley's Freezer Cases





System	kWh
Fluorescent Baseline	6,546
LED Only	3,512
LED and Motion Sensor	1,974

Figure 10: Energy consumption profile for one aisle (three 5-door freezer cases) during a typical weekday and weekend. The blue bars show energy consumption after the cases were retrofitted with LEDs and motion sensors. Note the dramatic energy savings – even during peak shopping periods. Source: ADM Associates Inc.

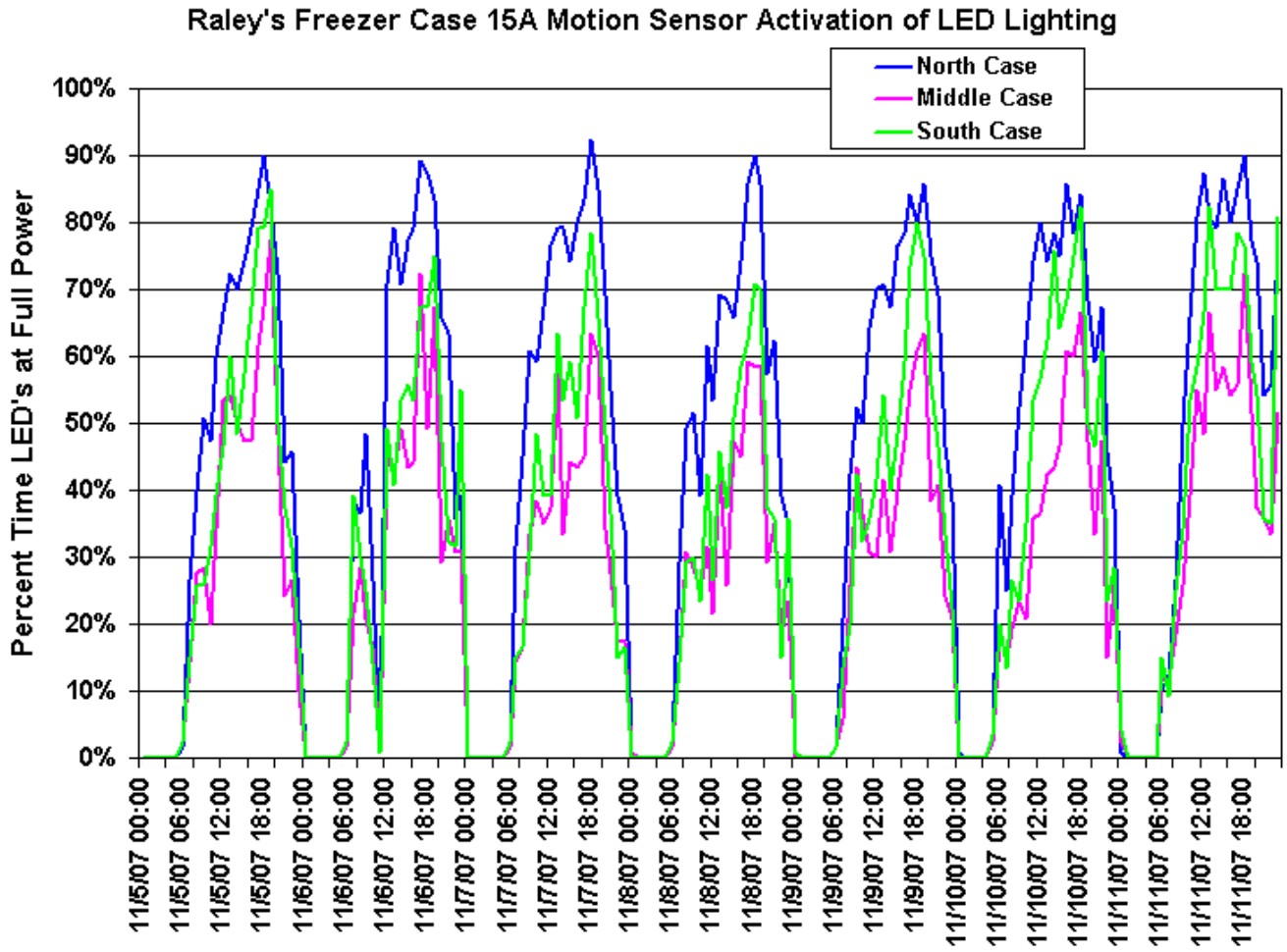


Figure 11: Graph showing amount of time the LED systems were at full power during a typical week. The North Case is located on the end of the aisle near the front of the store. The South Case is located at the other end of the aisle near the center of the store. These patterns seem to indicate the sensors on the North Case may have detected some shoppers who did not fully enter the aisle. Source: ADM Associates Inc.

Lighting energy and electrical demand savings for the LED freezer case lights was 46%. Savings for the LEDs and the motion sensors was over 68%. For more details please refer to Figure 12.

Lighting Energy Comparison (main aisles)	T8 lamps	LED	LED with Sensors
Watts per freezer case (5-door)	352	189	189
Estimated kWh (5-door freezer case)	2,182	1,171	672
Estimated kWh savings (5-door freezer case)	n/a	1,011	1,510
Total kW (21 freezer cases)	7.4	4.0	4.0
Total estimated kWh (21 freezer cases)	45,824	24,584	14,122
Total estimated annual kWh savings	n/a	**21,240**	**31,702**

Lighting Energy Comparison (end caps)	T8 lamps	LED*
Watts per freezer case (2-door)	141	76
Estimated kWh (2-door freezer case)	873	468
Estimated kWh savings (2-door freezer case)	n/a	405
Total kW (5 freezer cases)	0.70	0.38
Total estimated kWh (5 freezer cases)	4,364	2,341
Total estimated annual kWh savings	n/a	**2,023**

* The end cap fixtures (2-door) do not have sensors

Figure 12: Lighting energy and demand savings.

Monitoring Results – Refrigeration

According to Rensselaer, every kWh saved by switching to LEDs results in an additional 0.45 kWh in refrigeration savings[6]. While the primary reason is obvious – reducing wattage within a refrigerated space means less load on the refrigeration system, the secondary cause is much more subtle: Fluorescent lamps produce infrared light and LEDs do not (Figure 13). When the infrared light from the fluorescent lamps strikes the products, it is converted to heat. Although LEDs produce heat, most of it can be conducted outside of the freezer case (via contact with the door frame), so the load on the low-temperature refrigeration system is reduced.

POWER CONVERSION FOR 'WHITE' LIGHT SOURCES

	Incandescent† (60W)	Fluorescent† (Typical linear CW)	Metal Halide‡	LED
Visible Light	8 %	21 %	27 %	15-25 %
Infrared	73 %	37 %	17 %	~ 0 %
Ultraviolet	0 %	0 %	19 %	0 %
Total Radiant Energy	81 %	58 %	63 %	15-25 %
Heat (Conduction + Convection)	19 %	42 %	37 %	75-85 %
Total	100 %	100 %	100 %	100 %

† IESNA Lighting Handbook – 9th Ed.

‡ Osram Sylvania

Figure 13: Fluorescent lamps produce a significant amount of infrared light. When the infrared light from the fluorescent lamps strikes the products, it is converted to heat. While it is true that LEDs produce a lot of heat (75 to 85% of input wattage), most of it can be conducted outside of the freezer case via contact with the door frame) so the load on the low-temp refrigeration system is reduced. Source: Stan Walerczyk[7]

Raley's Energy Manager decided to test this hypothesis by conducting an experiment using a twenty door freezer case. The experiment consisted of the following steps:

- ✓ The freezer cases were emptied of product and the refrigerant flow was shut off. The fans and the anti-sweat heaters were also turned off.
- ✓ The ambient room temperature was maintained at 73°F.
- ✓ The factory installed T8 lamps were left on for a period of 24 hours and the interior air temperature of the freezer case was measured.
- ✓ The T8 lamps and ballasts were replaced with non-dimming LED lamps and power supplies
- ✓ The LEDs were left on for 24 hours and the interior air temperature of the freezer case was once again measured.

The result? The average air temperature within the freezer case with the T8 lamps operating was 118°F, while the average temperature with the LEDs was only 98°F – a reduction of 20°F! Although this test obviously did not reflect operating conditions, it conclusively demonstrated a significant reduction in heat gain resulting from using LEDs.

[6] Energy-Efficient Lighting Alternative for Commercial Refrigeration, Rensselaer Polytechnic Institute Lighting Research Center, available at http://www.lrc.rpi.edu/programs/solidstate/pdf/FreezerLighting-FinalReport.pdf

[7] Reprinted with permission from "Are LEDs Ready for Prime Time?" a presentation by Stan Walerczyk, Lighting Wizards

Raley's refrigeration system consists of a centralized system with six direct drive compressors, in three suction groups in a staged configuration, driven by premium efficient motors. During this project, Raley's used its energy management system to track refrigeration system savings.

Shortly after the freezer cases were retrofitted with LEDs, Raley's refrigeration technicians noticed something very unusual: the mechanical room was eerily quiet because both 30 horsepower (HP) compressors serving the low temperature cases were off. Since this almost never happens, the technicians thought something had gone wrong and checked the power and controls before discovering the true cause – the freezer cases had reached the desired temperatures so the compressors were not needed. Subsequent monitoring revealed that the secondary compressor was cycling on and off on a fairly frequent basis (see Figures 14 & 15). Since Raley's was concerned about cycling a 30 HP refrigeration compressor too often, they decided to add variable frequency drives to both compressors. The variable frequency drives allowed Raleys to run one compressor at 110% speed and turn off the second compressor. The result: Compared to a sister store with identical refrigeration equipment and T8 fluorescent lights, the combination of the LED and VFD retrofits reduced energy consumption of the low temperature refrigeration system by over 20%!

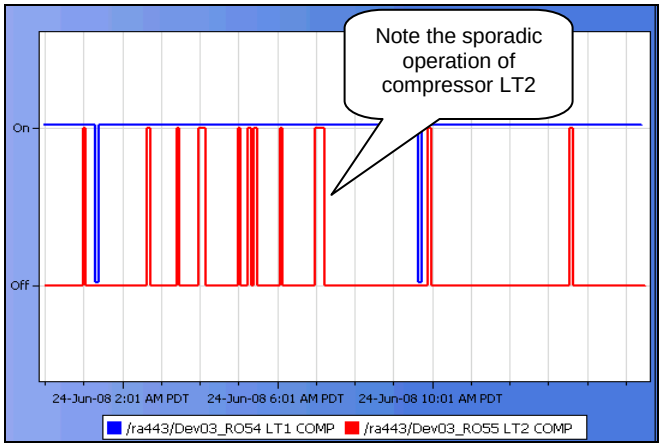


Figure 14: Compressor cycles after LED retrofit but before installation of the variable frequency drives. Note the sporadic operation of LT2 – a 30 HP compressor.

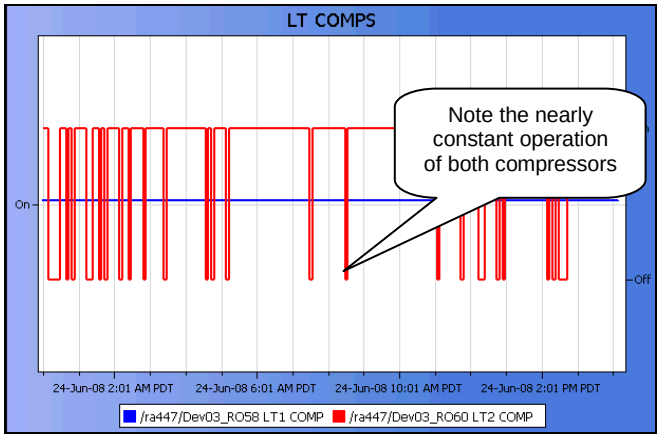


Figure 15: Compressor cycles for a sister store with T8 fluorescent lamps. Note the nearly constant operation of both 30 HP compressors.

Customer Survey Results

Two separate surveys were conducted as part of this study. The first survey asked shoppers to compare the fluorescent lamps to the LED fixtures (first prototype with no motion sensors). The second survey was completed after all freezer cases had been retrofitted with LEDs and motion sensors. In each survey, over one hundred shoppers were surveyed. Key findings are presented below:

- 66% of surveyed customers did not notice that the fluorescent lights had been replaced with LEDs.

- Customer reaction to the first generation of LED fixtures was mixed – primarily due to the fact that the first prototype fixtures produced shadows on the center of the product shelves (please see the section regarding optics on page 12).

- 26% of surveyed customers said they would “definitely not buy” any products from a frozen food door with its light out. 59% said that they would “probably not buy” any products from a frozen food door with its light out. Customers explained that if the light was out, they were concerned about whether or not the food was safe to eat. This should serve as a wake-up call to grocery store operators and lighting professionals regarding the importance of prompt lamp replacements.

- 50% of surveyed customers said that they would “probably or definitely be more likely” to shop at a store if they knew the retailer was trying to be more energy conscious.

- 80% of surveyed customers did not notice the dimming system. Of the 20% percent who did notice, most said it would not affect their shopping experience.

In addition to surveying customers, Raley’s tracked product sales to see what effect the LEDs would have upon shoppers. The LED system had no discernable effect upon product sales.

Optics, Optics, Optics

It has been said there are three important factors in real estate: Location, location, location. With LEDs, it’s optics, optics, optics! The first prototype fixtures for this project yielded mixed results. The photos shown in Figure 16 were taken shortly after the first prototype fixtures were installed. Although the fixtures were identical for all cases, the LEDs provided even illumination for some freezer cases yet produced pronounced shadowing on other cases. The reason? The distance between the fixtures and the shelves on which the products were displayed for some of the cases was between 6 to 9 inches, while the distance for other cases was only 4 inches. This revelation led to a concerted effort to design a fixture that would be suitable for a wide variety of freezer cases.

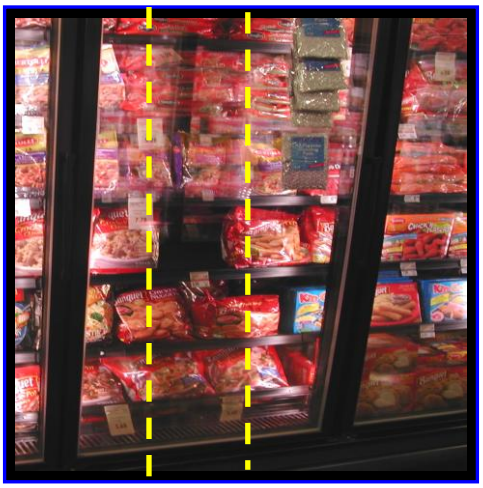


Figure 16: Site photos taken shortly after the first prototype LED fixtures were installed. Note the dark shadows (yellow lines) in the center of the shelves.

After several months of development and testing, the redesigned fixtures were installed. The new fixtures provide even illumination for all of the freezer cases while minimizing glare (Figure 17). This experience suggests the following:

1. Fixtures must be carefully selected for freezer cases - it is not enough to simply replace fluorescent lamps with LED replacement tubes.

2. Customers should retrofit at least one freezer case of each type before committing to a full scale retrofit. Remember – what works for one case may produce unacceptable results for another case – even though both freezer cases may be from the same manufacturer.

Figure 17: The new LED fixtures provide very even illumination for all of the freezer cases at this store while minimizing glare.

Financial Summary

- Energy savings

Lighting energy savings:	33,725 kWh per year
Refrigeration energy savings*:	74,996 kWh per year
Estimated total energy savings:	108,721 kWh per year

* As mentioned previously, the refrigeration savings are a result of the combination of the LED retrofit **and** the installation of variable frequency drives. Refrigeration savings are usually closer to 0.45 kWh per lighting kWh saved for low temperature systems and 0.31 kWh per lighting kWh saved for medium temperature systems.

- Electrical demand savings (lighting only): 3.75 kW

- Estimated annual cost savings

Energy:	$10,872 per year*
Demand:	$348 per year**
Maintenance:	$1,200 per year***
Total cost savings:	$12,420 per year

* Based upon monitoring and a hypothetical energy rate of $0.10 per kWh
** Lighting savings only. Based upon monitoring and a hypothetical demand rate of $7.75 per kW
*** Based upon an interview with Raley's Energy Manager

- Project cost (LED lighting system and sensors only): $53,640. Although the cost for this project was quite high ($466 per door), the fixtures and sensors were prototypes - Hussmann Corporation predicts the price for the commercialized fixtures and sensors will be significantly lower.

- Simple payback: 4.3 years

Customer Feedback

"When SMUD approached me about the LED case project I was excited to be on the team. SMUD has always been on the forefront of energy efficiency. Although Raley's already had installed several LED case lights in our stores, I wanted more than the wattage savings I was using in my ROI calculations, since LEDs have been a hard sell. So being on the team I wanted to see the actual wattage / kWh savings verified by an organization that wasn't distributing or servicing the lights and any other savings including refrigeration and maintenance.

"My first goal was to verify savings and to make sure the lights were appealing to our customers without flashing or having direct sight of the LEDs. This took some re-engineering but the outcome was worth it. I am completely satisfied with the new system including the color and light distribution.

"My second goal was to verify the actual refrigeration and maintenance savings the LEDs would have on the cases. The maintenance savings would be from the monthly service fees my Lighting Service Companies were charging Raley's to maintain the store's lighting - especially the case lighting. Raley's requires any light within a case to be repaired within 24 hours. Since LEDs have an estimated life span of 50,000 hours compared to T-8 fluorescents at 15,000 hours, my monthly service fees have dropped at this store by 20%.

"The refrigeration savings were a bit more challenging to quantify. The actual reduction of heat between LEDs and the T-8s allowed our system to run less - saving on energy consumption of our compressors. When we compared run times for the same ice cream case before and after the LED retrofit, we discovered the run time averaged 6.08 hours less per day for the 20-door case line up. At 1,405 Btu per door cost to run, this equates to around $150.00 a month savings for our complete frozen case line-ups of 115 doors. This was outstanding.

"My first thoughts about the motion detectors were that they would not save as much as it cost to install them. I was wrong, and the slow ramp up / down of the lights is not annoying like I thought they would be, if fact the customers actually like it.

"In conclusion, I believe the project team did a thorough job of fact finding and adapting to my constant changes and requests, customer surveys and quantifying all savings. I now have a complete picture of the actual savings I will achieve changing out the T-8s to LEDs, so this ROI will be a lot easier to sell in the future."

Randy Walthers, LC
Energy Manager
Raley's Family of Fine Stores

Conclusions

Even though LEDs are still a relatively inefficient light source (in terms of lumens per watt), they appear to be a viable, cost-effective technology for freezer case applications – especially when combined with motion sensors and dimming power supplies. Furthermore, projections from the U.S. Department of Energy state that commercially available white LEDs may achieve efficacies of well over 150 lumens per Watt within the next eight years (Figure 18, page 15). If these projections hold true, LEDs will become a contender for virtually all lighting applications.

In the meantime, the main challenges for LEDs are:

- Significantly higher retrofit costs: LED systems cost much more than fluorescent systems. Although according to a recent report by PG&E, Anthony International, the world's largest manufacturer of commercial glass refrigerator and freezer doors, is now offering LED systems as a standard option, so hopefully the costs will come down.[8]

- Lack of clear performance standards: Since LEDs are relatively new to the lighting scene, many of the performance and reliability standards are still under development. Until these standards are in place, customers are urged to only do business with established companies with proven track records.

[8] Application Assessment Report # 0722, LED Refrigerated Case Lighting, Costco, Northern California , Pacific Gas & Electric (PG&E) Emerging Technologies Program, http://www.etcc-ca.com/database/summary.php?id=469

- Optical challenges: Freezer cases present a difficult optical challenge for all types of lighting systems. Simply encasing LEDs in a five-foot tube and installing them in a freezer case may lead to some disappointing results. Customers should retrofit at least one freezer case of each type before committing to a full scale retrofit.

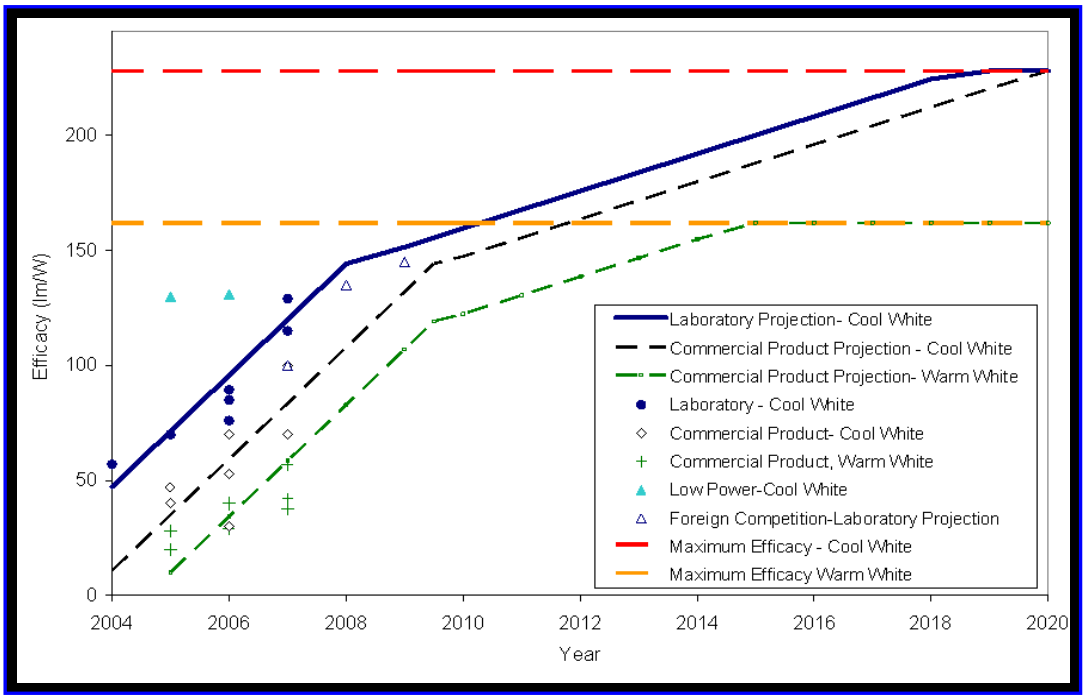


Figure 18: Projections from the U.S. Department of Energy state that commercially available white LEDs may achieve efficacies of well over 150 lumens per Watt within the next eight years.[9]

LED fixtures for freezer cases are commercially available from several manufacturers including:

- Hussmann Always*Bright LEDs
- GE Lumination
- Philips Affinium LED freezer lights
- LED Power

Again, regardless of the LED lighting system or manufacturer, SMUD highly recommends asking the vendor to retrofit one or two freezer cases before committing to a storewide retrofit.

The results of this project have been forwarded to SMUD's Program Planning Department. Development of energy efficiency incentives (rebates) for qualifying LED lighting systems is now in progress. For more information, please contact SMUD's Commercial Contact Center at 1-877-622-SMUD (7683) or send an e-mail to commercial@smud.org.

[9] Reprinted with permission from "Are LEDs Ready for Prime Time?" a presentation by Stan Walerczyk, Lighting Wizards

Acknowledgements

We gratefully acknowledge the contributions made from the following:

Randy Walthers, Raley's Corporation.
Stan Walerczyk, Lighting Wizards.
Keith Graeber, California Lighting Technology Center.
Daniel Sullentrup, Hussmann Corporation.
Daniel Mort, ADM Associates Inc.
U.S. Department of Energy.

Additional Recommended Resources

- ✓ Application Assessment Report # 0608, LED Supermarket Case Lighting, Pacific Gas & Electric (PG&E) Emerging Technologies Program, http://www.etcc-ca.com/database/summary.php?id=204.

- ✓ Application Assessment Report # 0722, LED Refrigerated Case Lighting, Costco, Northern California , Pacific Gas & Electric (PG&E) Emerging Technologies Program, http://www.etcc-ca.com/database/summary.php?id=469

- ✓ U.S. Department of Energy Solid State Lighting Program http://www.netl.doe.gov/ssl/