Customer Advanced Technologies Program
Technology Evaluation Report

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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

Highbay lighting fixtures with metal halide lamps are commonly used to provide light for larger buildings such as industrial facilities, gymnasiums, big box retailers and home improvement stores. This type of lighting system is energy efficient, long lasting (12,000 to 20,000 hours) and may be used to provide cost effective, high quality illumination. Despite the advantages, however, there are some drawbacks to metal halide lamps, including:

- Limited dimming capability (historically speaking).
- Lose about 40% of their initial light output by the midpoint of their rated life.
- Require several minutes to restart and reach full brightness after being turned off (re-strike period). This significantly limits opportunities to use lighting controls.

In late 2008, SMUD was introduced to HID Lab's SmartPOD™. The SmartPOD (Figure 1) is an electronically ballasted highbay lighting fixture that offers several advantages over conventional metal halide systems. According to HID Labs, when the SmartPOD is used in conjunction with pulse-start metal halide lamps, the result is a dimmable lighting system that is fifteen to thirty percent more energy efficient than probe start metal halide systems. For more information about the SmartPOD system, visit: http://www.hidlabs.com/smartpod_luminaire.

Figure 1: HID Labs SmartPOD fixture

During 2009 Tri Tool Inc., a local manufacturer of precision made industrial tools, agreed to participate in a research project to test the SmartPOD system. The project consisted of replacing seventy 400-Watt highbay fixtures with SmartPOD fixtures, 320-Watt, pulse start metal halide lamps and motion sensor controlled dimming. Ten motion sensors controlled seven SmartPOD fixtures each, and were designed to dim the lights when no one was working in the immediate area. SMUD hired ADM Associates Inc. to monitor the energy consumption of the lighting circuits before and after the retrofit. Results:

- Estimated energy savings is 60,066 kWh per year (31%). Average savings per fixture is 858 kWh per year. It is important to note that Tri Tool's primary objective for this project was to improve the quality of their lighting; energy savings was considered to be a secondary priority.
- Energy savings attributed to the use of the motion sensors is12,784 kWh per year (21% of the total savings). The motion sensors are currently set for a 30-minute delay. This delay may be reduced to obtain additional energy savings in the future.
- Peak electrical demand was reduced by 8.1 kW (24.7%).
- Horizontal illumination levels increased slightly.

- The Project Team observed higher vertical illumination levels and less shadows on the work surfaces. Regrettably vertical illumination measurements were not obtained.
- Indoor temperatures were noticeably cooler after the SmartPOD fixtures were installed.
- Feedback from Tri Tool's executive team and employees was overwhelmingly positive. Tri Tool intends to retrofit the remainder of their facility sometime in the near future.
- Financial summary
    - Project cost: $44,967
    - Estimated utility bill reduction: $6,618 per year
    - Simple payback: $44,967 ÷ $6,618 per year = 6.8 years
    - SMUD research grant: $30,000
    - Simple payback with research grant: $14,967 ÷ $6,618 per year = 2.26 years

SmartPOD is now eligible for energy efficiency incentives under SMUD's Custom Rebate program. For more information, please call SMUD Commercial Services at 1-877-622-7683.

Acknowledgements

While many people contributed to the success of this project, we are particularly grateful to the following individuals:

- Joel Walton (Tri Tool)
- Daniel Mort (ADM)
- Connie Samla (SMUD)

Introduction

The next time you visit a big box retail or home improvement store…look up. Chances are good that you will see lighting fixtures similar to the one shown in Figure 1. These are called "highbay" lighting fixtures and often use metal halide lamps. This type of lighting is commonly used to provide illumination for larger facilities with ceilings of over twenty feet. The advantages of metal halide lamps include:

- High light output in a relatively small package
- Good efficacy (~65 to 115 lumens per Watt)
- Good color rendering (70 to 90 CRI)
- Relatively long rated lamp life (15,000-20,000 hrs.)

Figure 2: Conventional highbay fixtures are often used to provide illumination for large commercial facilities with ceiling heights of over twenty feet.

However, like any other technology, there are also some drawbacks to metal halide lamps, including:

- Very limited dimming capability
- Contain mercury and other heavy metals
- Lose about 40% of their initial light output by the midpoint of their rated life
- Often use magnetic ballasts which tend to be very noisy
- Experience color shifts over time (some lamps will look pinkish while others may be greenish in appearance)
- Require several minutes to restart and reach full brightness after being turned off (re-strike period). This significantly limits opportunities to use lighting controls

During 2009 Tri Tool Inc. agreed to participate in a research project to test HID Labs SmartPOD™ system. The SmartPOD is an electronically ballasted, highbay lighting fixture that offers several advantages over conventional metal halide systems. According to HID Labs, when the SmartPOD is used in conjunction with pulse-start metal halide lamps, the result is a dimmable lighting system that is fifteen to thirty percent more energy efficient than probe start metal halide systems. For more information about the SmartPOD system, visit: http://www.hidlabs.com/smartpod_luminaire/

The project consisted of replacing seventy 400-Watt highbay fixtures with SmartPOD fixtures, 320-Watt, pulse start metal halide lamps and motion sensor controlled dimming. Ten motion sensors controlled seven SmartPOD fixtures each and were designed to dim the lights when no one was working in the immediate area. SMUD hired ADM Associates Inc. to monitoring the energy consumption of the lighting circuits before and after the retrofit.

Showcase Project

Project Location: Tri Tool Inc.
3041 Sunrise Blvd.
Rancho Cordova, CA. 95742

Background Information

Tri Tool Inc. is a portable machine tool company which builds specialized tooling for a wide range of industries. They primarily serve the power generation and petroleum industries. Locally, Tri Tool was involved in the construction and later the decommissioning of Rancho Seco, SMUD's former nuclear power plant.

Tri Tool's facility in Rancho Cordova serves as its corporate headquarters and is home for production facilities, sales, engineering, and other corporate support groups. Originally the facility was used for storage by the previous tenant. When they first moved in, Joel Walton, Manager of the Logistics Division, suspected that they would need new lighting but hoped that the original system might meet their needs (see Figure 3). However, soon after the building was occupied, Mr. Walton started receiving complaints about the lighting and began looking for replacement options (Figure 4).

Figure 3: Tri Tool's facility before moving in. Note how brightly lit the facility looks in this photograph verses the one below.

Figure 4: Soon after Tri Tool moved into their facility, complaints about the lighting system began.

Original Lighting System

In January of 2009, a project team consisting of representatives from SMUD, HID Labs and ADM Associates Inc. (ADM) visited the Tri Tool site to assess the lighting system. Findings included:

- The lighting system for the main production area consisted of seventy highbay fixtures with 400-Watt, probe start, metal halide lamps.
- Since the system was designed to serve a storage facility, it was not adequate for the precision machine work being performed by Tri Tool's staff.
- The spacing of the lights was irregular in some areas. This created dark spots in some locations of the production floor.

- The existing lights produced harsh shadows and glare. This was mainly due to the use of clear lamps and aluminum reflectors.

- All of the lights operated an average of twenty hours per day - even when only some of the areas were occupied. This was mainly due to the re-strike requirements for conventional metal halide lamps and ballasts.

New Lighting System

The project team developed some recommendations and met with Mr. Walton. He chose to install SmartPOD™ fixtures with acrylic lenses. Figure 5 shows a comparison of the ratings for the original lighting system verses the SmartPOD system. Some observations:

- The SmartPOD system uses approximately 20% less power (at full intensity) than the original metal halide system.

- Color rendering is much better for the SmartPod system (CRI of 90 vs. 60). This should improve the lighting quality in Tri Tool's production area.

- Rated life for both lamps is the same.

	Orignal Lighting System (probe-start metal halide lamps)	SmartPod System (pulse-start metal halide lamps)
Lamp Watts	400W	320W
Rated Life	20,000 hrs	20,000 hrs
Initial lumens	36,000	29,000
Mean lumens	23,500	26,100
CCT	4000K	5000K
CRI	65	90
Warm up time	2-4 mins	2-3 mins
Restrike time	7-12 mins	5-8 mins
Fixture Watts	465	320

Figure 5: Comparison of the original vs. the new lighting system.

- Although the initial lumens for the SmartPOD system are lower, the mean (i.e. maintained) lumens are higher.

- Warm up time requirements for both systems are about the same.

- Restrike time requirement for the SmartPOD system is significantly shorter than the probe start lamps.

- The SmartPOD system has dimming capabilities, the original system does not.

- The Tri Tool project included the installation of ten motion sensors and seventy new SmartPOD fixtures. The fixtures were programmed to reduce the lighting levels to 50% during periods when the motion sensors did not detect activity.

Monitoring Results

In March of 2009, ADM installed monitoring equipment and obtained four months of baseline data for the 70 metal halide light fixtures. The data was collected via an Enernet K-20 multi-channel meter recorder in 5-minute intervals. The same circuits were monitored before and after the SmartPOD system was installed. Data for both the existing and new lighting systems was averaged into weekly load profiles and then adjusted to account for holiday periods. The adjusted weekly profiles are shown below in Figure 6.

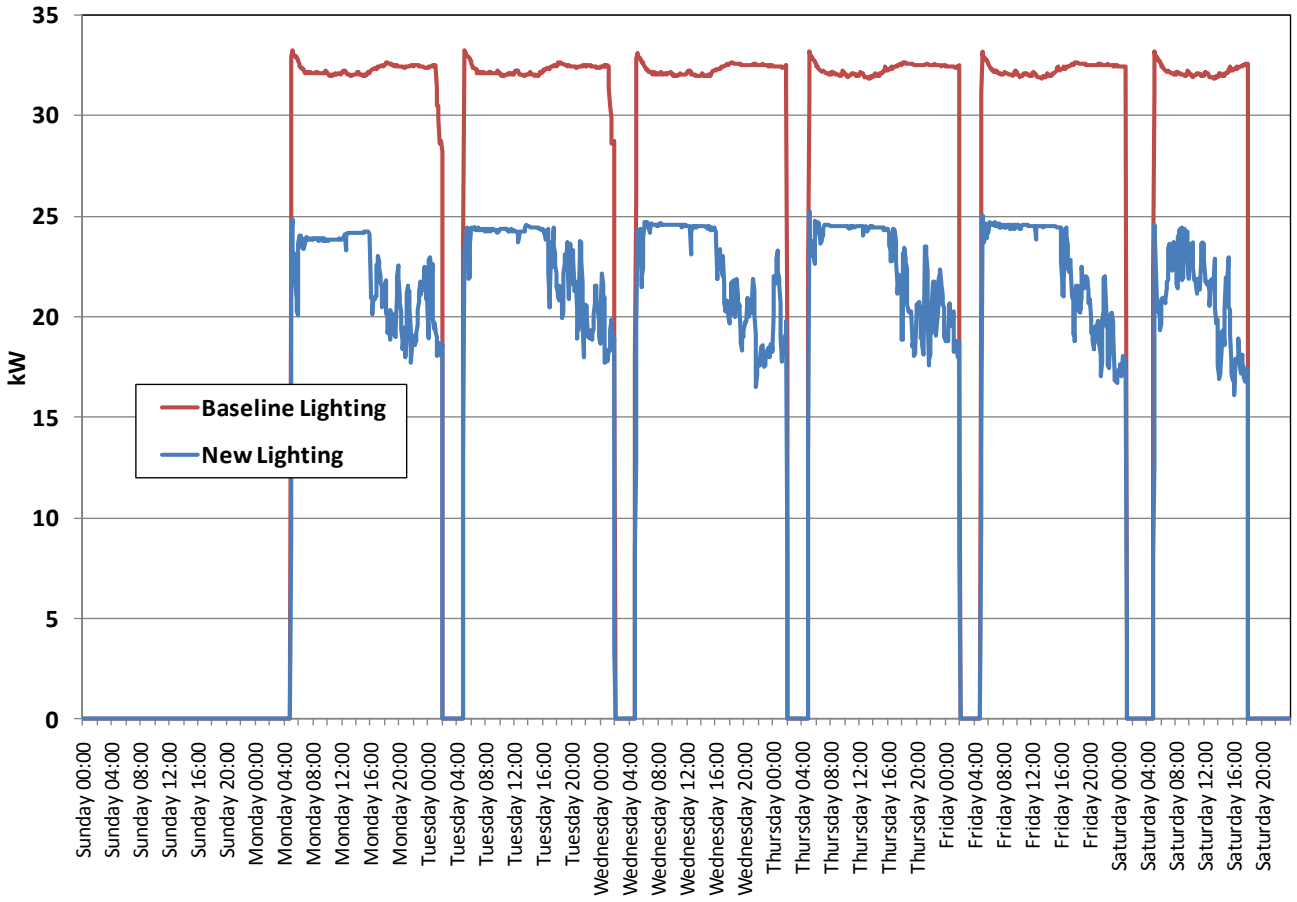

Figure 6: Weekly energy usage profiles for Tri Tool's production area.

Since the motion sensors were installed at the same time as the new lighting fixtures, there was no opportunity to monitor the energy use of the new lighting without the operation of the sensors. ADM used available data to generate a profile of the new lighting without motion sensors. The weekly profile chart presented in Figure 7 shows the estimated lighting profile without motion sensors and plots it along with the lighting profile with the motion sensors.

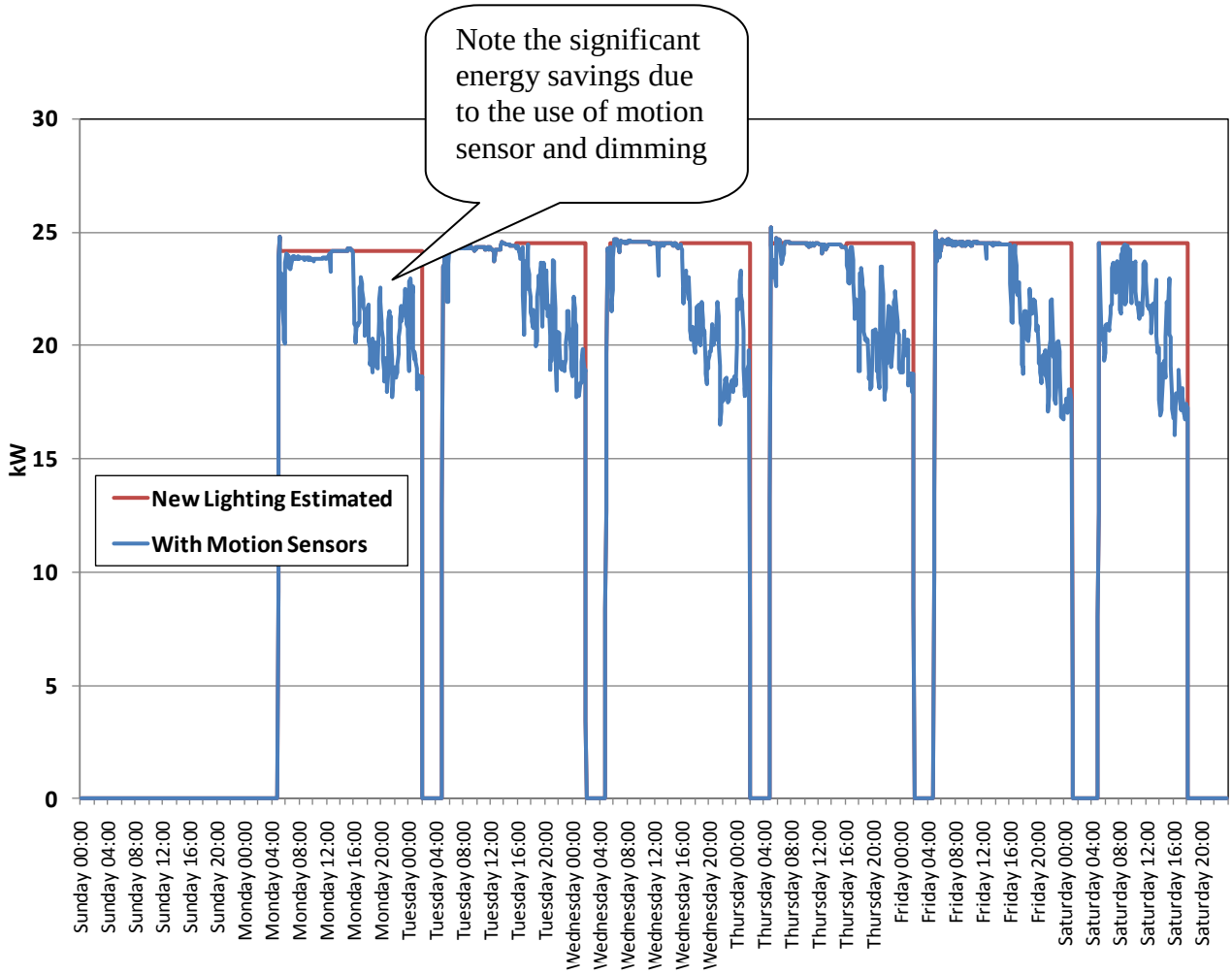

Figure 7: Calculated energy usage profiles for the new lighting system with and without the use of motion sensors.

Energy Savings

The monitoring data was analyzed to provide an estimate of annual savings. Assuming six holidays per year, the following observations can be made:

- Energy use for the original seventy fixtures was 193,939 kWh per year.
- Energy use of the SmartPOD lighting system is 133,874 kWh per year.
- Total annual energy savings is 60,066 kWh per year (31%). Average savings per fixture is 858 kWh per year.
- Energy savings attributed to the use of the motion sensors is12,784 kWh per year (Figure 8). The motion sensors are currently set for a thirty minute delay. This delay may be reduced to further increase savings.

- The motion sensor savings start at about 4 p.m. and continue through the rest of the second shift. The sensors have almost no effect during the first shift.

- Only some of the motion sensors produced energy savings
  - Six of the ten lighting circuits produced most of the motion sensor savings
  - Two circuits showed occasional dimming for short periods
  - Two circuits showed no measurable savings from the sensors.

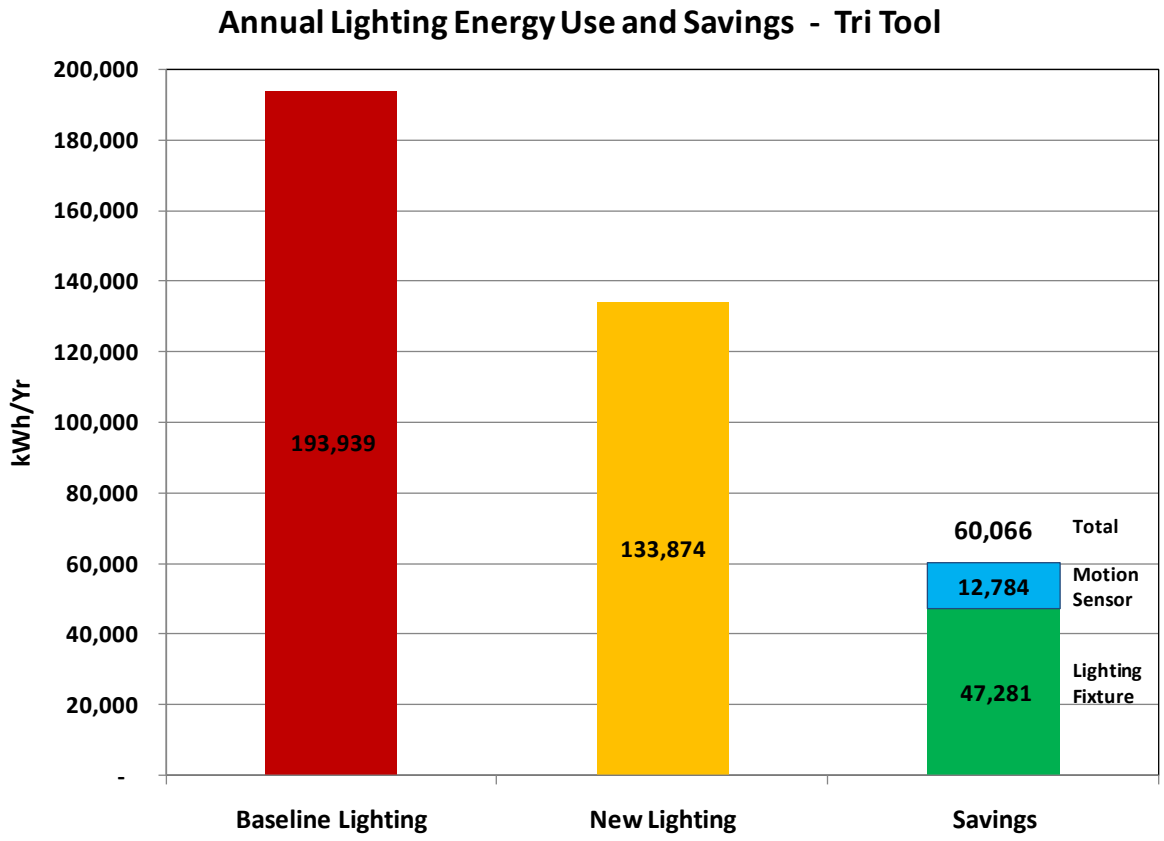

Figure 8 Calculated energy consumption and savings for Tri Tool's production area.

Electrical Demand Reduction

In addition to achieving energy savings, the SmartPOD system retrofit resulted in a peak demand reduction of 8.1 kW (24.7%).

Indoor Temperatures

The main production area of the Tri Tool facility includes a lot of machinery used to fabricate many different components. These parts are later assembled, inspected and then shipped to the customer. Needless to say, a lot of heat is generated by these activities so mechanical cooling is required to maintain acceptable conditions. Since all of the highbay lights in this area are in conditioned space, they also add to the cooling load.

According to HID Labs, since the SmartPOD is more energy efficient than conventional metal halide systems, lower wattage fixtures can often be used. This reduces the amount of heat produced by the lights. During the research project, Tri Tool recorded the indoor temperatures in the production area before and after the SmartPOD system was installed. The results show that the indoor temperatures were noticeably lower – even when the outdoor temperatures were higher

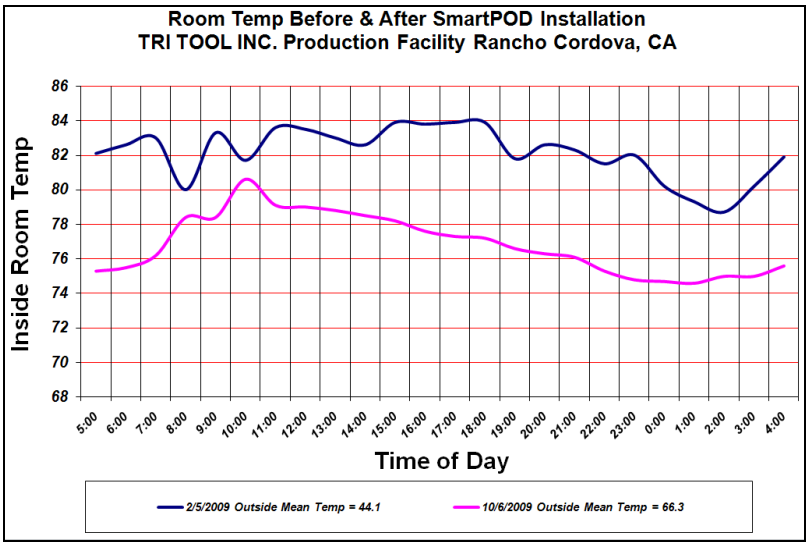

Figure 9: Note that the indoor room temperatures were lower after the SmartPOD installation, even during periods when the outside temperatures were higher

Financial Summary

According to HID Labs, the SmartPOD should extend the life of the metal halide lamps. Although this may be the case, until SmartPOD has established a longer track record, SMUD is reluctant to include any maintenance savings in this report since the rated lamp life is the same for both the probe start and pulse start lamps. Therefore, the savings calculations presented below are based entirely upon predicted kWh and kW savings.

Estimated utility bill reduction*

Energy savings: 60,066 kWh / year x $0.10 / kWh = $6,006 per year

Demand savings: 8.1 kW x $6.30 / kW / month x 12 months / year = $612 per year

Total savings $6,618 per year

Project cost: $44,967

Simple payback: $44,967 ÷ $6,618 per year = 6.8 years

SMUD research grant: $30,000

Simple payback with research grant: ($44,967 – $30,000) ÷ $6618 per year = 2.26 years

*Based upon SMUD Rate Schedule GSS

Customer Feedback

"Our primary objective for this project was to improve the quality of the lighting for our employees. However the energy savings is definitely a nice benefit as well. Before deciding to install the SmartPOD, we explored several other different options including fluorescent highbay fixtures. We didn't like the quality of the light or the idea of having to maintain six lamps per fixture in areas where gaining access to the fixtures is difficult at best. We are happy with the SmartPOD system and intend to replace the rest of our lights sometime in the near future."

Joel D. Walton
Manager Logistics Division
Tri Tool Inc.

Observations

- The combination of the SmartPOD system and pulse-start metal halide lamps offers significant opportunities to save energy and improve lighting quality. However, more time and installations will be necessary to determine the effect upon lamp life.

- Historically speaking commercial and industrial customers tend to shy away from lighting upgrades with simple financial paybacks of more than three years. Since emerging technologies like SmartPOD tend to be expensive, the key will be to find sites with high electric rates, long hours of operation and opportunities to leverage more advanced control strategies such as daylight harvesting. Since the Tri Tool site does not have any windows or skylights, daylight harvesting was not a viable option.

- According to HID Labs, the latest version of the SmartPOD features the ability to control each fixture independently via digital control networks. Combining the SmartPOD with wireless controls could provide unprecedented energy savings potential for applications with highbay HID lighting and variable illumination requirements. For example, high school and college gymnasiums are often used for a wide variety of activities (e.g. PE classes, volleyball games, basketball games, student assemblies, etc.), yet often have highbay fixtures with metal halide lamps and very few lighting control options. If these lights were replaced by SmartPOD fixtures and controlled via a digital wireless network, different control 'scenes' could be implemented to provide just the amount of light needed for each different activity type.

Technology Transfer

SmartPOD is now eligible for energy efficiency incentives under SMUD's Custom Rebate program. For more information, please call SMUD Commercial Services at 1-877-622-7683.