Stairwell Lighting Report

The Fillmore Center
San Francisco, California

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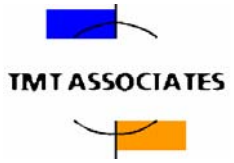
Pacific Gas & Electric Company



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Executive Summary

This report presents the results of an energy efficiency study of the stairwell lighting in a multi-story residential building located at 1475 Fillmore Street in San Francisco, CA. PG&E sponsored the study on behalf of The Fillmore Center, who recently upgraded the lighting in a number of stairwells.

The Fillmore Center complex includes upscale high rise residential apartments in a busy urban setting. While no demographic information is available, most of the residents appear to be young professionals. The 20-story towers comprising the majority of the living spaces have centrally located elevators that are used by the majority of the residents. Each tower is also served by two stairwells located at opposite corners of each building.

The new stairwell lighting system in the Fillmore Center consists of retrofit luminaires with integral occupancy sensors that reduce the light levels when the stairwells are vacant. Each fixture contains a switchable 30-watt primary fluorescent lamp, and an integral five-watt compact fluorescent lamp that remains on all the time and keeps a low level of light in the stairwell.

TMT Associates measured the performance of the new lighting installation as part of a study to investigate emerging energy-efficient lighting technologies. The purpose of the project was to estimate the energy and demand savings potential of the newly installed stairwell luminaires on the site. TMT Associates installed lighting data loggers in two different stairwells. The loggers measured the total time that the lights were on over a fourteen-day period. Data from the loggers was downloaded into spreadsheets and extrapolated to estimate annual energy and cost savings made possible by the installation of this equipment.

The results of the study are summarized in Table 1.

Table 1: Fillmore Center Dimmable Stairwell Lighting Study Results
(Results are per fixture averages)

Lighting Fixture	Est. Annual Energy Use	Annual Energy Cost	Demand	Upgrade Cost	Simple Payback
Standard 4ft fluorescent F32T8 lamp	263 kWh	$43.79	30 W		
Retrofit Dimmable w/F32T8 & 5W standby CFL lamps	90 kWh	$14.99	15 W	$185.00	**6.4 yrs**
Savings	**173 kWh (66%)**	**$28.80**	**15 W Coin. Peak (50%)**		

Notes
1. The project monitored 99 light fixtures in two stairwells.
2. Costs are based on an average electricity price of $0.167/kWh.
3. Upgrade cost includes removal of existing fixtures and replacement with new luminaires, including parts and labor.
4. The incremental cost in new construction of $67 is significantly less than the upgrade cost, providing a simple payback of 2.3 years.

The results are significant. Lights in the commonly used lower levels of the facility were on for a maximum of only 35% of the time. In the less commonly used areas on the intermediate and higher floors (where most of the lights are), luminaires were on for less than 3% of the time. The average on-time for all luminaries was a mere 3.3%.

In this project, the occupancy sensor control enabled overall stairwell lighting energy savings of 66% and coincident peak demand savings of 50%. A simple payback for this project based on a retrofit of the lighting system is 6.4 years. For the dimmable fixture used in new construction, the payback period is much faster at 2.3 years. These results will vary by application.

If there is a drawback to using this type of lighting and control system, it is that the frequent switching of the luminaires causes lamps to burn out at a higher rate than one would ordinarily experience. This report contains information that allows users of dimmable stairwell lighting systems to investigate methods of addressing this problem.

Project Background

PG&E retained TMT Associates to perform a study on a recently-installed stairwell lighting system in a high rise residential facility owned by the Fillmore Center in San Francisco. The stairwell lighting system allegedly saves energy by reducing lighting power when the stairwells are unoccupied.

Using occupancy sensor controlled stairwell luminaires can save a tremendous amount of lighting energy and greatly reduce building operating costs. Most building and electrical codes require that stairwells be illuminated at all times for exit and/or emergency egress. Until recently, this meant that luminaires used to light stairwells were on 24/7/365. However, new products are emerging that keep a partial level of illumination on at all times while going to full light output only when needed. These products use integral occupancy sensor motion detectors to monitor the stairwell. When occupancy is detected, the lights go to full level. When the space has been vacated after a programmed period of time, the fixture goes to a minimum level. The delay to off period is variable, based on how the occupancy sensor is commissioned. The sample luminaires had delay times of approximately 20 minutes.

There are two luminaire types currently used to enable occupancy sensor control of stairwell fixtures while maintaining a low level of light at all times. The first luminaire type, used at the Fillmore Center, provides a low level of illumination at all times through the use of a low wattage compact fluorescent or cold cathode lamp. This lamp remains on at all times. When occupancy is detected in the stairwell, the main lighting source (usually a four-ft F32T8 lamp) is energized to provide full light. The system shuts off the main source after the stairwell has been vacated for a designated period of time.

One drawback to this system is that the luminaire manufacturer usually supplies these fixtures with instant start electronic ballasts. Instant start is one of the most energy efficient starting methods available for F32T8 lamp operation. Unfortunately, starting the lamp in this manner has a tendency to shorten the lamp's service life by 25% or more. Rapid switching cycles, such as those that occur when controlling luminaires with occupancy sensors, can exacerbate this problem considerably. We observed this to be the case at the Fillmore Center, where many of the stairwell lights were burned out. Our observation was confirmed by discussions with facility maintenance and management personnel who complained that they spend a lot more time relamping luminaires than they used to. A second drawback to this luminaire is that the 5W CFL lamp has a rated lamp life of only 10,000 hours, so it must be replaced often. Accordingly, we noted a number of luminaires with burned out CFL lamps in this facility.

There are a couple of different approaches to overcome these problems. First, much longer lamp life can be achieved through the use of programmed rapid start electronic ballasts, which use a "soft" circuit to start the lamps. Longer lamp life with reduced relamping maintenance costs can be achieved in most any application with this technology. A potential drawback is that the lamps may not come up to full brightness as quickly as they do with instant start systems. Rapid start systems typically require about a second to come to nominal light output. In instant start systems, full brightness occurs almost immediately.

A second, more comprehensive approach to this engineering issue involves the use of a different type of fixture altogether. The Public Interest Energy Research (PIER) Program, initiated by the California Energy Commission has encouraged several lighting manufacturers to develop cutting edge lighting products that will reduce lighting demand and energy use. One of these products is a stairwell and corridor luminaire developed by Lamar Lighting. Like the Wellmade fixture installed at the Fillmore Center, this luminaire uses an integral occupancy sensor to control a fluorescent lamp or lamps within. However, in this case, the fixture contains a bilevel ballast that *dims* the luminaire when the space is vacant, as opposed to shutting it off. The lamp never goes completely out (to comply with building and safety code issues), so there is no need for a short-lived compact fluorescent light to maintain a semblance of illumination. Since the lamps are never shut off and on, they have a tendency to last for a very long time, minimizing maintenance costs.

A number of demonstration projects using the bilevel stairwell luminaire indicate energy savings of 50% to 80%. We feel it may turn out to be a much better option than having a fixture with two lamp types and a tendency to burn out either the primary T8 or standby 5W CFL lamps. Another attractive feature of the high-low stairwell fixture is that it is available in both 1-lamp and 2-lamp versions, providing more design flexibility and making it easier to comply with the recent ANSI standard requiring 10 footcandles (fc) when

stairwells are in use, instead of the 5 fc recommendation by IESNA, which is commonly used by designers and engineers.[1]

Project Objective

The purpose of this study of the stairwell lighting system at the Fillmore Center was to estimate the energy savings potential of using occupancy sensors to control lighting systems that are normally in continuous operation. Positive results could be used to justify rebating this type of technology in future energy-related incentive programs administered by PG&E and other utilities.

TMT Associates reviewed the lighting installation and installed lighting data loggers to monitor a large sample of fixtures earlier this year. Logger data was extracted into MS Excel spreadsheets and analyzed to determine the energy savings that have occurred as a result of using the occupancy sensors in the stairwell luminaires. Data from the sample period was extrapolated to determine annual energy use and operating costs. This in turn was compared with the energy performance of a base case lighting system operating continuously to predict annual energy and operating cost savings.

The major purpose of this report is to communicate the results of the study and subsequent analysis and to address any potential barriers to implementing this technology on a wide-spread basis. This report describes the study methodology in some detail, while providing information about alternatives that may prove to be more feasible in this arena.

Study Description

This section of the report details the monitoring process designed to assess the performance of the occupancy sensor controlled stairwell lighting at the Fillmore Center. TMT Associates designed the study to control as many variables as possible to generate data that can be used successfully to predict the long-term success of this technology.

Methodology & Equipment

TMT Associates installed lighting data loggers in two of the Fillmore Center's high rise stairwells. A total of 48 loggers were installed in the luminaires of Stairwell #1 of the T-1 building and Stairwell #2 of the T-2 building.

Logger Description

The lighting data loggers are designed to measure the accumulative time that the lights are on in a given luminaire. Each logger has an integral photocell that monitors when the primary light source is on. When the light turns off, the logger stops recording. A digital readout indicates the total time that a light on situation occurs. An integral LED indicates when the logger is detecting light within its range. The photocell is directional, and the sensitivity can be tuned to eliminate false recording of extraneous light. The sample stairwells are not daylighted, so that was not a concern.

The loggers are backed with a magnetic strip that allows them to be mounted to metallic surfaces. This made it a simple matter to install the loggers inside the stairwell luminaires, out of the view of the public.

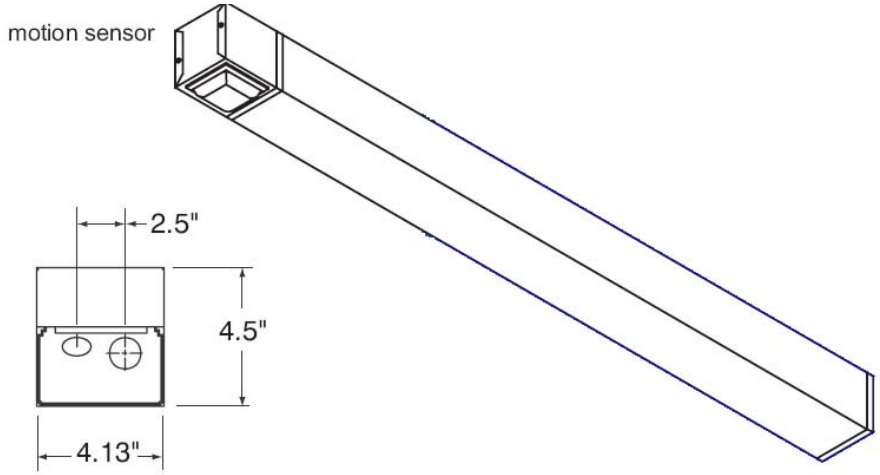
[1] The ANSI Standard was introduced in response to the World Trade Center disaster on 9/11/01. It has been incorporated into the most recent versions of the NFPA codes. Adoption of the Standard into local codes depends on the local jurisdiction; however it is anticipated that this will be adopted throughout California in the near future.

Stairwell Luminaires

The new stairwell light fixtures look very much like typical one-lamp, “wraparound” style stairwell/corridor luminaires, with the exception of the passive infrared motion detector attached to one end (see Figure 1). The fixture is manufactured by Wellmade Products, though it was supplied to the Fillmore Center by a vendor. The luminaire uses a four-foot F32T8 lamp as its main illumination source. Night light illumination is provided by a 5W compact fluorescent (CFL) lamp that remains on all the time. The motion detector affects only the F32T8 lamp, energizing the lamp when occupancy is detected in the stairwell.

All the stairwell luminaires are this type. According to the vendor, they were installed at a cost of approximately $185.00 per luminaire. By comparison, standard four ft one-lamp corridor fixtures of the type most commonly specified in stairwells typically cost $50-$100 installed.

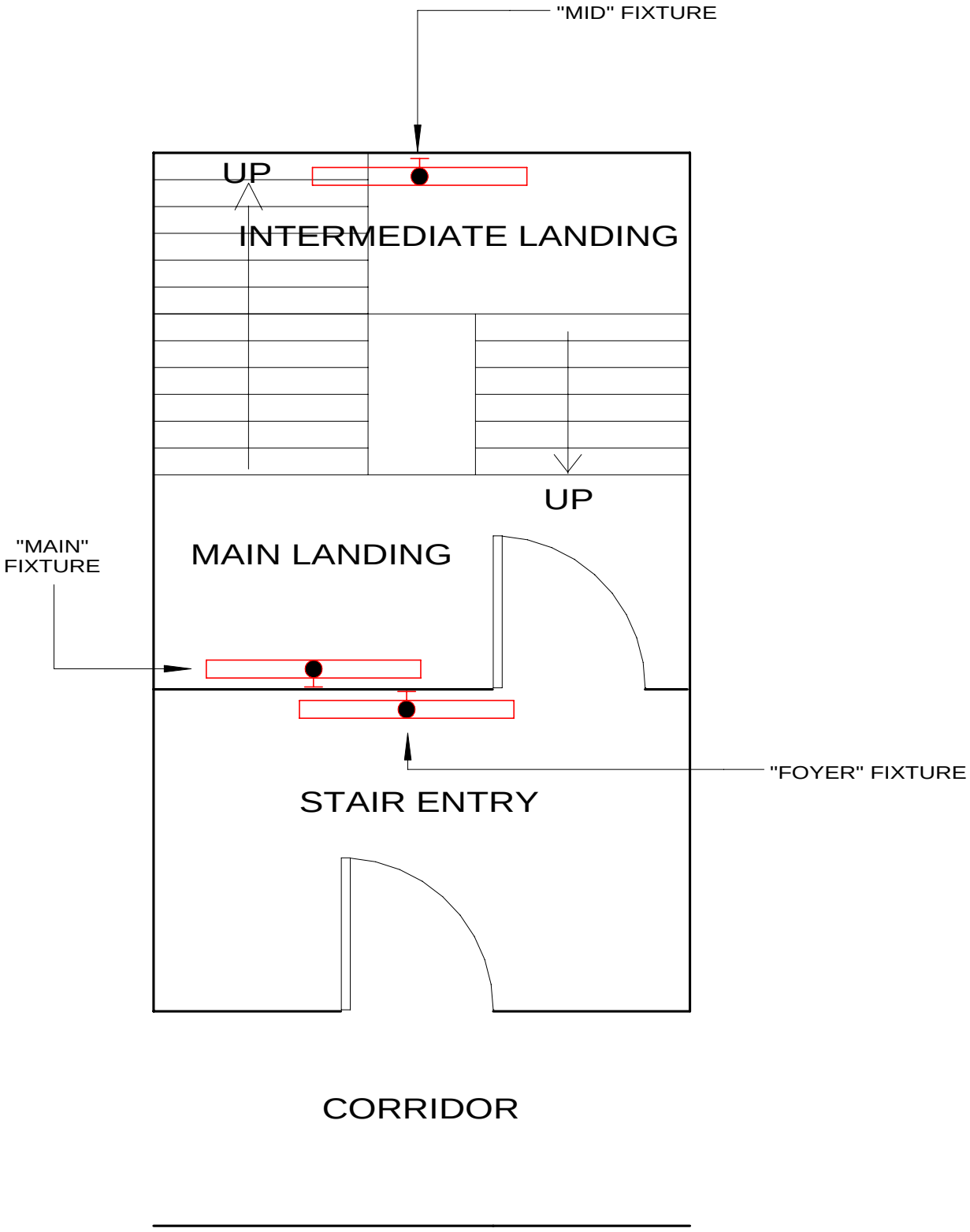
Figure 1: Stairwell Fixture with Integral Motion Detector and CFL Night Light



Stairwell Lighting Layout

The Fillmore Center stairwell lighting layouts are consistent from floor to floor. Three fixtures light the stairwell and entry on each floor. One fixture is immediately inside the door leading from the corridor to the stairwell. The second fixture is mounted immediately inside the fire door on the stair landing. The third fixture lights the intermediate landing between floors. Figure 2 on the next page illustrates the lighting layout.

Figure 2: Stairwell Lighting Layout



Logger Installation and Removal

All loggers were number and location coded using stick-on labels. We installed a total of 48 loggers in the two sample stairwells of the Fillmore Center. For most of the floors we placed a light logger inside the "main" fixture on each floor, located on the main landing. For the main entry floors (3rd Floor) leading to the facility's common area plazas, we placed both primary and redundant light loggers in all three of the fixtures. We also did this for the top floor in each tower. These loggers were located to measure on-time of either one-half (using two loggers in a single luminaire), one, or three fixtures. The 48 loggers thus monitored a total of 99 luminaires in the two stairwells. No efforts were made to monitor all luminaries within a given stairwell.

The loggers were installed inside the lens of each fixture, mounted to the fixture body. We placed the logger at the fixture end opposite the CFL night light. Loggers were calibrated such that they only detected the light emitted from the controlled T-8 lamp. Calibration was tested by removing the T-8 lamp and confirming that the LED in the logger remained off (indicating that no light was being detected). After mounting the logger inside the fixture, we noted the time listed on the digital display, and then replaced the lens. Overall, the installation took less than a day.

Loggers were left in place for two weeks. Prior to the removal of each logger, we removed the luminaire lens. We then recorded the time listed on the logger's digital display and removed the logger.

Five loggers failed or exhibited unrealistic data, and we did not include them in the data analysis:

- Three loggers had blank displays on removal, indicating dead batteries or other failures.
- One logger was removed by person(s) unknown. It was discovered later in the maintenance building.
- One logger's readout showed 100% on time for the luminaire in which it was installed. Since this fell several standard deviations outside this dataset, we didn't include it in the analysis. We believe that either the logger was defective, or the occupancy sensor controlling that luminaire had failed.

Data Analysis

This study compares the retrofit stairwell fixture – equipped with an occupancy sensor to control a single F32T8 lamp and an always-on CFL lamp – with a base case scenario of a standard one-lamp stairwell fixture operating 24 hours a day, seven days a week. We tested the hypothesis that the retrofit fixture is a cost-effective means of reducing stairwell lighting energy and operating costs.

We used MS Excel spreadsheets to analyze the light logger data from the Fillmore Center stairwells. For each logger, we recorded the starting and ending values. Simple subtraction yielded the total time that the light was on during the two-week sample period. We then extrapolated the data from the two-week sample to predict the total annual energy use and operating costs using this equipment. By comparing the data with the base case of one-lamp F32T8 stairwell fixtures that burn continuously, we were able to estimate annual energy and operating cost savings.

In this analysis, coincident peak demands savings were estimated as

Coincident Peak Savings = (kW of existing equipment – kW of replacement equipment) * Coincident Diversity Factor.

A coincident diversity factor of 0.76 for lighting in a typical commercial building was used. The demand of replacement equipment was weighted between the 9W fluorescent lamp and the percentage on-time of the 30W lamp for each fixture measured. No demand diversity factor was included as the stairwells are unconditioned space.

Results

The results of the data analysis strongly support the hypothesis that occupancy sensor controlled stairwell lighting is a cost-effective means of reducing lighting energy use and operating costs. The data analysis shows that this technology makes good sense for both retrofit and new construction applications. Table 2 summarizes the savings for the two applications. Note that the simple payback period for the new construction scenario is much less than the retrofit situation, due to the smaller incremental cost of implementing this strategy. The maximum input power (39W) of the retrofit fixture when fully on is higher than that of the base case (30W) due to the addition of the compact fluorescent lamp. However, there are coincident peak demand reductions because the retrofit fixture uses less energy on the average than the base case fixture. Overall, energy and cost savings of 66% make this an extremely attractive alternative.

Table 2: Fillmore Center Stairwell Lighting with Occupancy Sensors
Savings in Retrofit and New Construction Applications
(Results are for the total project)

Lighting Fixture	Est. Annual Energy Use	Annual Energy Cost	Demand	Upgrade Cost	Simple Payback
Standard 4ft fluorescent F32T8 lamp	26,017 kWh	$4,332	2.97 kW		
Retrofit Dimmable w/F32T8 & 5W standby CFL lamps	8,901 kWh	$1,482	1.48 kW		
Savings (Retrofit)	**17,116 kWh (66%)**	**$2,850**	1.5 kW (Coin. Peak, 50%)	**$18,315**	**6.4 yrs.**
Savings (New Construction)	**17,116 kWh (66%)**	**$2,850**		**$6,633**	**2.3 yrs.**

Notes
1. The project monitored 99 light fixtures in two stairwells.
2. Costs are based on an average electricity price of $0.167/kWh.
3. Upgrade cost includes removal of existing fixtures and replacement with new luminaires, including parts and labor.
3. The incremental cost in new construction is $67 over a standard stairwell luminaire.

Assumptions

This section lists the assumptions that were made during the lighting study to determine lighting demand, energy use and economics. To formulate predictions about the performance of the base case and design conditions, certain economic assumptions were made:

- Average cost of electricity is assumed to be $0.167/kWh. Higher rates will result in greater savings and shorter payback.
- Input wattage for a standard 1-lamp fluorescent stairwell fixture with an electronically-ballasted F32T8 lamp is assumed to be 30 watts. We used the same value in estimating the input wattage for the installed F32T8 lamp in the fixtures. Actual input wattage for different light fixtures varies, depending on ballast and lamp type, as well as luminaire mounting configuration.

- We assumed an additional 9 watts per fixture for the installed luminaires to account for the magnetically-ballasted 5W compact fluorescent lamp[2] that stays on all the time.
- Base case lighting hours of operation are assumed to be 24 hours per day, 7 days per week, or 8,760 hours per year. We also used this value to estimate the energy use of the CFL lamp for each of the installed luminaires.
- Cost data for the installed luminaires was provided by the vendor of the equipment, Bob Miller of Blinky, Inc. The per luminaire cost of $185 includes the equipment cost of the new luminaires, as well as labor for removal of the old equipment and installation of the new fixtures.
- Economic analyses do not include the additional benefits of the reduced cooling load resulting from the improvements in lighting efficiency, as the stairwells are unconditioned spaces.
- Attachment 1, which follows this report, summarizes the performance data for the base case and retrofit luminaires.
- Switching intervals vary for the luminaires. The loggers don't record switching time; however, we found that most of the occupant sensors had been commissioned with a time-to-off period of about 20 minutes. According to the supplier, they are capable of a minimal time-to-off delay of 2 minutes.
- Maintenance and management personnel at the Fillmore Center were invaluable in providing us with some of the more subjective data about the performance of this system. Much of their experience is related below in the section entitled "Additional Considerations."

Disclaimer: The use or naming of any specific manufacturer in this report or its attachments does not imply endorsement of any product by TMT Associates or PG&E. Manufacturers are mentioned only to provide current and relevant information used to formulate economic comparisons.

Conclusions

Occupancy sensor controlled stairwell luminaires offer a unique and cost-effective means of eliminating unnecessary lighting energy use in seldom-occupied building spaces. Energy use and operating costs can be reduced by as much as 66% with this approach. This technology may also offer significant energy-saving opportunities in building corridors, garages, and other spaces where building and safety codes require some lights to be on at all times.

Optimum performance of stairwell lighting fixtures requires a careful review of available products. Luminaires that increase maintenance costs by contributing to premature lamp failures are likely to be objectionable to building maintenance and management personnel. Every effort should be made to specify equipment that will minimize or eliminate the negative impact on lamp life that can result by using standard instant start electronic ballasts.

[2] Electronic ballasts are not available for 5W compact fluorescent lamps of this type.

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Log. Start Val.	Log. End Val.	Total Time On	Percentage Time On	Extrapolated Annual Total Time On	Fix. Watts (F32T8)	Fix. Watts (5W CFL)
001-A	S1 T1	3	FOYER	0.0	100.6	100.6 hrs	29.94%	2,622.8 hrs	30	9
001-B	S1 T1	3	FOYER	0.1	100.6	100.5 hrs	29.91%	2,620.2 hrs	30	9
002-A	S1 T1	NOTE>	MID	0.0	107.9	107.9 hrs	32.11%	2,813.1 hrs	30	9
002-B	S1 T1	NOTE>	MID	480.3	587.7	107.4 hrs	31.96%	2,800.1 hrs	30	9
003-A	S1 T1	3	MID	0.0	116.6	116.6 hrs	34.70%	3,039.9 hrs	30	9
003-B	S1 T1	3	MID	333.5	450.2	116.7 hrs	34.73%	3,042.5 hrs	30	9
004-A	S1 T1	4	MAIN	0.0	83.1	83.1 hrs	24.73%	2,166.5 hrs	30	9
005-A	S1 T1	5	MAIN	0.0	52.8	52.8 hrs	15.71%	1,376.6 hrs	30	9
006-A	S1 T1	6	MAIN	0.0	49.0	49.0 hrs	14.58%	1,277.5 hrs	30	9
007-A	S1 T1	7	MAIN	0.0	34.8	34.8 hrs	10.36%	907.3 hrs	30	9
008-A	S1 T1	8	MAIN	0.0	0.0	0.0 hrs	0.00%	0.0 hrs		
009-A	S1 T1	9	MAIN	0.0	18.9	18.9 hrs	5.63%	492.8 hrs	30	9
010-A	S1 T1	10	MAIN	0.0	22.7	22.7 hrs	6.76%	591.8 hrs	30	9
011-A	S1 T1	11	FOYER	0.0	5.1	5.1 hrs	1.52%	133.0 hrs	30	9
012-A	S1 T1	11	MAIN	0.0	18.0	18.0 hrs	5.36%	469.3 hrs	30	9
013-A	S1 T1	11	MID	0.0	15.6	15.6 hrs	4.64%	406.7 hrs	30	9
014-A	S1 T1	12	MAIN	0.0	16.7	16.7 hrs	4.97%	435.4 hrs	30	9
015-A	S1 T1	13	MAIN	0.0	25.1	25.1 hrs	7.47%	654.4 hrs	30	9
016-A	S1 T1	14	MAIN	0.0	1.0	1.0 hrs	0.30%	26.1 hrs	30	9
017-A	S1 T1	15	MAIN	0.0	6.0	6.0 hrs	1.79%	156.4 hrs	30	9
018-A	S1 T1	16	MAIN	0.0	5.1	5.1 hrs	1.52%	133.0 hrs	30	9
019-A	S1 T1	17	MAIN	0.0	0.1	0.1 hrs	0.03%	2.6 hrs	30	9
020-A	S1 T1	18	MAIN	0.0	1.4	1.4 hrs	0.42%	36.5 hrs	30	9
021-A	S1 T1	19	MAIN	0.0	3.5	3.5 hrs	1.04%	91.3 hrs	30	9
022-A	S1 T1	20	FOYER	0.0	0.0	0.0 hrs	0.00%	0.0 hrs	30	9
023-A	S1 T1	20	MAIN	0.0	1.3	1.3 hrs	0.39%	33.9 hrs	30	9
024-A	S1 T1	20	MID	0.0	4.3	4.3 hrs	1.28%	112.1 hrs	30	9

See text for assumptions

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Fix. Qty.	Annual Energy Used	Base Case Energy Use	Annual Energy Saved	Percentage Energy Saved	Coin. Demand Saved	Annual Cost Savings
001-A	S1 T1	3	FOYER	0.5	79 kWh	131 kWh	53 kWh	40.06%	4.57 W	$ 8.76
001-B	S1 T1	3	FOYER	0.5	79 kWh	131 kWh	53 kWh	40.09%	4.57 W	$ 8.77
002-A	S1 T1	NOTE>	MID	0.5	82 kWh	131 kWh	50 kWh	37.89%	4.32 W	$ 8.29
002-B	S1 T1	NOTE>	MID	0.5	81 kWh	131 kWh	50 kWh	38.04%	4.34 W	$ 8.32
003-A	S1 T1	3	MID	0.5	85 kWh	131 kWh	46 kWh	35.30%	4.02 W	$ 7.72
003-B	S1 T1	3	MID	0.5	85 kWh	131 kWh	46 kWh	35.27%	4.02 W	$ 7.72
004-A	S1 T1	4	MAIN	3.0	432 kWh	788 kWh	357 kWh	45.27%	30.96 W	$ 59.42
005-A	S1 T1	5	MAIN	3.0	360 kWh	788 kWh	428 kWh	54.29%	37.13 W	$ 71.26
006-A	S1 T1	6	MAIN	3.0	351 kWh	788 kWh	437 kWh	55.42%	37.91 W	$ 72.74
007-A	S1 T1	7	MAIN	3.0	318 kWh	788 kWh	470 kWh	59.64%	40.80 W	$ 78.29
008-A	S1 T1	8	MAIN		0 kWh	0 kWh	0 kWh			$ -
009-A	S1 T1	9	MAIN	3.0	281 kWh	788 kWh	508 kWh	64.38%	44.03 W	$ 84.50
010-A	S1 T1	10	MAIN	3.0	290 kWh	788 kWh	499 kWh	63.24%	43.26 W	$ 83.02
011-A	S1 T1	11	FOYER	1.0	83 kWh	263 kWh	180 kWh	68.48%	15.61 W	$ 29.97
012-A	S1 T1	11	MAIN	1.0	93 kWh	263 kWh	170 kWh	64.64%	14.74 W	$ 28.29
013-A	S1 T1	11	MID	1.0	91 kWh	263 kWh	172 kWh	65.36%	14.90 W	$ 28.60
014-A	S1 T1	12	MAIN	3.0	276 kWh	788 kWh	513 kWh	65.03%	44.48 W	$ 85.36
015-A	S1 T1	13	MAIN	3.0	295 kWh	788 kWh	493 kWh	62.53%	42.77 W	$ 82.08
016-A	S1 T1	14	MAIN	3.0	239 kWh	788 kWh	550 kWh	69.70%	47.68 W	$ 91.50
017-A	S1 T1	15	MAIN	3.0	251 kWh	788 kWh	538 kWh	68.21%	46.66 W	$ 89.54
018-A	S1 T1	16	MAIN	3.0	248 kWh	788 kWh	540 kWh	68.48%	46.84 W	$ 89.90
019-A	S1 T1	17	MAIN	3.0	237 kWh	788 kWh	552 kWh	69.97%	47.86 W	$ 91.85
020-A	S1 T1	18	MAIN	3.0	240 kWh	788 kWh	549 kWh	69.58%	47.60 W	$ 91.34
021-A	S1 T1	19	MAIN	3.0	245 kWh	788 kWh	544 kWh	68.96%	47.17 W	$ 90.52
022-A	S1 T1	20	FOYER	1.0	79 kWh	263 kWh	184 kWh	70.00%	15.96 W	$ 30.63
023-A	S1 T1	20	MAIN	1.0	80 kWh	263 kWh	183 kWh	69.61%	15.87 W	$ 30.46
024-A	S1 T1	20	MID	1.0	82 kWh	263 kWh	181 kWh	68.72%	15.67 W	$ 30.07

See text for assumptions

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Retrofit Installed Cost	Simple Payback	New Constr. Installed Cost	Simple Payback
001-A	S1 T1	3	FOYER	$ 92.50	10.6 yrs	$ 33.50	3.8 yrs
001-B	S1 T1	3	FOYER	$ 92.50	10.5 yrs	$ 33.50	3.8 yrs
002-A	S1 T1	NOTE>	MID	$ 92.50	11.2 yrs	$ 33.50	4.0 yrs
002-B	S1 T1	NOTE>	MID	$ 92.50	11.1 yrs	$ 33.50	4.0 yrs
003-A	S1 T1	3	MID	$ 92.50	12.0 yrs	$ 33.50	4.3 yrs
003-B	S1 T1	3	MID	$ 92.50	12.0 yrs	$ 33.50	4.3 yrs
004-A	S1 T1	4	MAIN	$ 555.00	9.3 yrs	$ 201.00	3.4 yrs
005-A	S1 T1	5	MAIN	$ 555.00	7.8 yrs	$ 201.00	2.8 yrs
006-A	S1 T1	6	MAIN	$ 555.00	7.6 yrs	$ 201.00	2.8 yrs
007-A	S1 T1	7	MAIN	$ 555.00	7.1 yrs	$ 201.00	2.6 yrs
008-A	S1 T1	8	MAIN	$ -	-		
009-A	S1 T1	9	MAIN	$ 555.00	6.6 yrs	$ 201.00	2.4 yrs
010-A	S1 T1	10	MAIN	$ 555.00	6.7 yrs	$ 201.00	2.4 yrs
011-A	S1 T1	11	FOYER	$ 185.00	6.2 yrs	$ 67.00	2.2 yrs
012-A	S1 T1	11	MAIN	$ 185.00	6.5 yrs	$ 67.00	2.4 yrs
013-A	S1 T1	11	MID	$ 185.00	6.5 yrs	$ 67.00	2.3 yrs
014-A	S1 T1	12	MAIN	$ 555.00	6.5 yrs	$ 201.00	2.4 yrs
015-A	S1 T1	13	MAIN	$ 555.00	6.8 yrs	$ 201.00	2.4 yrs
016-A	S1 T1	14	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
017-A	S1 T1	15	MAIN	$ 555.00	6.2 yrs	$ 201.00	2.2 yrs
018-A	S1 T1	16	MAIN	$ 555.00	6.2 yrs	$ 201.00	2.2 yrs
019-A	S1 T1	17	MAIN	$ 555.00	6.0 yrs	$ 201.00	2.2 yrs
020-A	S1 T1	18	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
021-A	S1 T1	19	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
022-A	S1 T1	20	FOYER	$ 185.00	6.0 yrs	$ 67.00	2.2 yrs
023-A	S1 T1	20	MAIN	$ 185.00	6.1 yrs	$ 67.00	2.2 yrs
024-A	S1 T1	20	MID	$ 185.00	6.2 yrs	$ 67.00	2.2 yrs

See text for assumptions

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Log. Start Val.	Log. End Val.	Total Time On	Percentage Time On	Extrapolated Annual Total Time On	Fix. Watts (F32T8)	Fix. Watts (5W CFL)
025-A	S2 T2	NOTE>	FOYER	0.0	12.3	12.3 hrs	3.66%	320.7 hrs	30	9
025-B	S2 T2	NOTE>	FOYER	0.0	12.3	12.3 hrs	3.66%	320.7 hrs	30	9
026-A	S2 T2	3	MAIN	0.0	6.5	6.5 hrs	1.93%	169.5 hrs	30	9
026-B	S2 T2	3	MAIN	0.0	6.4	6.4 hrs	1.90%	166.9 hrs	30	9
027-A	S2 T2	3	MID	0.0	5.0	5.0 hrs	1.49%	130.4 hrs	30	9
027-B	S2 T2	3	MID	115.3	116.5	1.2 hrs	0.36%	31.3 hrs	30	9
028-A	S2 T2	4	MAIN	0.0	0.0	0.0 hrs	0.00%	0.0 hrs		
029-A	S2 T2	5	MAIN	0.0	1.7	1.7 hrs	0.51%	44.3 hrs	30	9
030-A	S2 T2	6	MAIN	0.0	1.8	1.8 hrs	0.54%	46.9 hrs	30	9
031-A	S2 T2	7	MAIN	0.0	0.8	0.8 hrs	0.24%	20.9 hrs	30	9
032-A	S2 T2	8	MAIN	0.0	1.3	1.3 hrs	0.39%	33.9 hrs	30	9
033-A	S2 T2	9	MAIN	0.0	0.4	0.4 hrs	0.12%	10.4 hrs	30	9
034-A	S2 T2	10	MAIN	0.0	0.4	0.4 hrs	0.12%	10.4 hrs	30	9
035-A	S2 T2	11	FOYER	0.0	0.0	0.0 hrs	0.00%	0.0 hrs		
036-A	S2 T2	11	MAIN	0.0	0.0	0.0 hrs	0.00%	0.0 hrs		
037-A	S2 T2	11	MID	0.0	1.0	1.0 hrs	0.30%	26.1 hrs	30	9
046-A	S2 T2	12	MAIN	0.0	0.8	0.8 hrs	0.24%	20.9 hrs	30	9
039-B	S2 T2	13	MAIN	1.9	3.8	1.9 hrs	0.57%	49.5 hrs	30	9
040-B	S2 T2	14	MAIN	133.1	134.4	1.3 hrs	0.39%	33.9 hrs	30	9
041-B	S2 T2	15	MAIN	1592.5	1593.8	1.3 hrs	0.39%	33.9 hrs	30	9
042-B	S2 T2	16	MAIN	0.1	0.5	0.4 hrs	0.12%	10.4 hrs	30	9
043-B	S2 T2	17	MAIN	695.8	696.6	0.8 hrs	0.24%	20.9 hrs	30	9
044-B	S2 T2	18	MAIN	273.7	274.5	0.8 hrs	0.24%	20.9 hrs	30	9
045-B	S2 T2	19	MAIN	6.3	7.0	0.7 hrs	0.21%	18.3 hrs	30	9
~~046-~~	S2 T2	NA	NA	na	na	0.0 hrs	0.00%	0.0 hrs		
047-A	S2 T2	20	MAIN	0.0	4.0	4.0 hrs	1.19%	104.3 hrs	30	9
048-A	S2 T2	20	MID	0.0	1.5	1.5 hrs	0.45%	39.1 hrs	30	9
PROJECT TOTALS						1,079 hrs			2.97 kW	0.89 kW
PER FIXTURE AVERAGES						10.9 hrs	3.24%	284.1 hrs		

See text for assumptions

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Fix. Qty.	Annual Energy Used	Base Case Energy Use	Annual Energy Saved	Percentage Energy Saved	Coin. Demand Saved	Annual Cost Savings
025-A	S2 T2	NOTE>	FOYER	0.5	44 kWh	131 kWh	87 kWh	66.34%	7.56 W	$ 14.51
025-B	S2 T2	NOTE>	FOYER	0.5	44 kWh	131 kWh	87 kWh	66.34%	7.56 W	$ 14.51
026-A	S2 T2	3	MAIN	0.5	42 kWh	131 kWh	89 kWh	68.07%	7.76 W	$ 14.89
026-B	S2 T2	3	MAIN	0.5	42 kWh	131 kWh	89 kWh	68.10%	7.76 W	$ 14.90
027-A	S2 T2	3	MID	0.5	41 kWh	131 kWh	90 kWh	68.51%	7.81 W	$ 14.99
027-B	S2 T2	3	MID	0.5	40 kWh	131 kWh	92 kWh	69.64%	7.94 W	$ 15.24
028-A	S2 T2	4	MAIN		0 kWh	0 kWh	0 kWh			$ -
029-A	S2 T2	5	MAIN	3.0	241 kWh	788 kWh	548 kWh	69.49%	47.53 W	$ 91.22
030-A	S2 T2	6	MAIN	3.0	241 kWh	788 kWh	548 kWh	69.46%	47.51 W	$ 91.18
031-A	S2 T2	7	MAIN	3.0	238 kWh	788 kWh	550 kWh	69.76%	47.72 W	$ 91.58
032-A	S2 T2	8	MAIN	3.0	240 kWh	788 kWh	549 kWh	69.61%	47.62 W	$ 91.38
033-A	S2 T2	9	MAIN	3.0	237 kWh	788 kWh	551 kWh	69.88%	47.80 W	$ 91.73
034-A	S2 T2	10	MAIN	3.0	237 kWh	788 kWh	551 kWh	69.88%	47.80 W	$ 91.73
035-A	S2 T2	11	FOYER		0 kWh	0 kWh	0 kWh			$ -
036-A	S2 T2	11	MAIN		0 kWh	0 kWh	0 kWh			$ -
037-A	S2 T2	11	MID	1.0	80 kWh	263 kWh	183 kWh	69.70%	15.89 W	$ 30.50
046-A	S2 T2	12	MAIN	3.0	238 kWh	788 kWh	550 kWh	69.76%	47.72 W	$ 91.58
039-B	S2 T2	13	MAIN	3.0	241 kWh	788 kWh	547 kWh	69.43%	47.49 W	$ 91.15
040-B	S2 T2	14	MAIN	3.0	240 kWh	788 kWh	549 kWh	69.61%	47.62 W	$ 91.38
041-B	S2 T2	15	MAIN	3.0	240 kWh	788 kWh	549 kWh	69.61%	47.62 W	$ 91.38
042-B	S2 T2	16	MAIN	3.0	237 kWh	788 kWh	551 kWh	69.88%	47.80 W	$ 91.73
043-B	S2 T2	17	MAIN	3.0	238 kWh	788 kWh	550 kWh	69.76%	47.72 W	$ 91.58
044-B	S2 T2	18	MAIN	3.0	238 kWh	788 kWh	550 kWh	69.76%	47.72 W	$ 91.58
045-B	S2 T2	19	MAIN	3.0	238 kWh	788 kWh	550 kWh	69.79%	47.74 W	$ 91.61
~~046-~~	S2 T2	NA	NA		0 kWh	0 kWh	0 kWh			$ -
047-A	S2 T2	20	MAIN	1.0	82 kWh	263 kWh	181 kWh	68.81%	15.69 W	$ 30.11
048-A	S2 T2	20	MID	1.0	80 kWh	263 kWh	183 kWh	69.55%	15.86 W	$ 30.43
PROJECT TOTALS				99.0	8,901 kWh	26,017 kWh	17,116 kWh	65.79%	1485 W	$ 2,850
PER FIXTURE AVERAGES					90 kWh	263 kWh	173 kWh	65.8%	15.00 W	$ 28.79

See text for assumptions

Fillmore Center Stairwell Lighting Study Data

Logger #	Bldg./Stair	Floor	Fixture	Retrofit Installed Cost	Simple Payback	New Constr. Installed Cost	Simple Payback
025-A	S2 T2	NOTE>	FOYER	$ 92.50	6.4 yrs	$ 33.50	2.3 yrs
025-B	S2 T2	NOTE>	FOYER	$ 92.50	6.4 yrs	$ 33.50	2.3 yrs
026-A	S2 T2	3	MAIN	$ 92.50	6.2 yrs	$ 33.50	2.2 yrs
026-B	S2 T2	3	MAIN	$ 92.50	6.2 yrs	$ 33.50	2.2 yrs
027-A	S2 T2	3	MID	$ 92.50	6.2 yrs	$ 33.50	2.2 yrs
027-B	S2 T2	3	MID	$ 92.50	6.1 yrs	$ 33.50	2.2 yrs
028-A	S2 T2	4	MAIN	$ -	-		
029-A	S2 T2	5	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
030-A	S2 T2	6	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
031-A	S2 T2	7	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
032-A	S2 T2	8	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
033-A	S2 T2	9	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
034-A	S2 T2	10	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
035-A	S2 T2	11	FOYER	$ -	-		
036-A	S2 T2	11	MAIN	$ -	-		
037-A	S2 T2	11	MID	$ 185.00	6.1 yrs	$ 67.00	2.2 yrs
046-A	S2 T2	12	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
039-B	S2 T2	13	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
040-B	S2 T2	14	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
041-B	S2 T2	15	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
042-B	S2 T2	16	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
043-B	S2 T2	17	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
044-B	S2 T2	18	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
045-B	S2 T2	19	MAIN	$ 555.00	6.1 yrs	$ 201.00	2.2 yrs
~~046-~~	S2 T2	NA	NA	$ -	-		
047-A	S2 T2	20	MAIN	$ 185.00	6.1 yrs	$ 67.00	2.2 yrs
048-A	S2 T2	20	MID	$ 185.00	6.1 yrs	$ 67.00	2.2 yrs
PROJECT TOTALS				$ 18,315	6.4 yrs	$ 6,633	2.3 yrs
PER FIXTURE AVERAGES				$ 185.00	6.4 yrs	$ 67.00	2.3 yrs

See text for assumptions