

LIGHT POLLUTION MANAGEMENT IN THE OUTDOORS

INTRODUCTION

Light pollution is the degradation of natural light levels in the outdoor environment from artificial light sources. Light pollution (sometimes known as photopollution) is often described as excessive, misdirected or obtrusive artificial light.

WHY IS LIGHT POLLUTION CONSIDERED HARMFUL?

The term light pollution sounds rather innocuous, but the cumulative impacts on the natural world are actually quite harmful. Exposure to light pollution impacts the biology of many species, including humans. The problem is that artificial light can interfere with the eco-dynamics of living organisms which have evolutionary adaptations to diurnal patterns of light and dark. For example, nocturnal animals exposed to excessive light at night may be unable to hunt or forage. Exposure to light pollution can disrupt the migratory timing schedules of birds and can cause some migratory species (which are naturally adapted to navigate by moonlight and starlight) to wander off course. Light pollution disrupts the seasonal cycle of many tree and plant species that rely on daylight length to trigger seasonal changes. Prolonged exposure to artificial light at night can even alter the human biological clock and melatonin production, impair night vision and cause sleep disorders. Sleep disorders, in turn, are associated with a number of human health problems.

HOW IS LIGHT POLLUTION WASTEFUL?

Light pollution from street and parking lot illumination in the U.S. alone results in an enormous waste of energy and money. In fact, an estimated 50% of the energy used for outdoor lighting is wasted due to inefficient outdoor lighting design. This wastes \$3.3 billion dollars annually and releases 21 million tons of carbon dioxide.

TYPES OF LIGHT POLLUTION

Light pollution is a nonspecific term that encompasses several potentially overlapping impacts which are caused by the undesirable or inappropriate application of artificial lighting. These impacts are briefly described below.

Light trespass means intrusion of an artificial light source (from inside a building or from exterior light sources) beyond a property boundary which causes a nuisance to others in a neighboring property. Light trespass can be mitigated by selecting shielded light fixtures that limit the amount of light emitted more than 80 degrees above the nadir.

Over-illumination refers to the excessive or inefficient use of artificial light both indoors and outdoors. This is a common problem because energy audit data show that 30-60% of energy consumed for artificial light is unnecessary. Over-illumination is caused by a number of factors, such as failure to use lighting controls, improper lighting design, and incorrect choice of fixtures and bulbs.

Light clutter and glare is the effect that describes the excessive grouping of lights causing confusion or distraction. For example, brightly lit advertising surrounding a busy roadway in some cases can distract a driver from seeing street lights or brake lights and can contribute to accidents.

There are several types of glare-related light pollution. For example, disability glare is best described as the effect of being blinded by oncoming car lights. The light scattering in fog for example can reduce sight capabilities. Discomfort glare is a less intense form of glare, but can cause eye fatigue over extended periods. Both forms of glare can also contribute to accidents.

Skyglow is the nighttime glow effect that can best be observed over densely populated areas from an aircraft or from adjacent mountains. For example, the skyglow of the Los Angeles basin is sometimes visible from an aircraft from 200 miles away. Skyglow is the combined effect of artificial light escaping to the sky and artificial light being reflected in the atmosphere back to the ground. Skyglow obscures the nighttime sky and is the reason that many big city dwellers have never seen the Milky Way galaxy.

WHAT ARE OUTDOOR LIGHTING ZONES?

Outdoor lighting zones reflect the acceptable ambient light levels desired by a community. The California Energy Code uses lighting zone designations to determine allowed outdoor lighting power for newly installed outdoor lighting. Each zone is adjusted for established background lighting conditions as described by the Illuminating Engineering Society of North America (IESNA). The explanation for the different outdoor power allowances between these zones is that our eyes adapt to surrounding conditions; the darker the surrounding conditions, the less artificial outdoor light is needed to see (and vice-versa). For example, LZ1 (e.g., zone) standards are intended to set appropriate outdoor lighting levels for a wildlife preserve with dark ambient illumination and LZ3 standards are appropriate for an urban area with medium ambient illumination.

BEST PRACTICES TO REDUCE LIGHT POLLUTION FOR SCHOOLS

- Comply with Cal-Green Code Section 5.106.8 requirements for backlight, uplight and glare (BUG). BUG standards are maximum allowable standards for outdoor lighting close to property boundaries. The purpose is to minimize light trespass and glare across property lines.
- All outdoor lighting should be automatically controlled to ensure that they turn off after hours.
- All general purpose outdoor lighting for general illumination should be fully shielded.

ZONE	AMBIENT ILLUMINATION	STATE WIDE DEFAULT LOCATION	MOVING UP TO HIGHER ZONES	MOVING DOWN TO LOWER ZONES
LZ1	Dark	Government designated parks, recreation areas, and wildlife preserves. Those that are wholly contained within a higher lighting zone may be considered by the local government as part of that lighting zone.	A government designated park, recreation area, wildlife preserve, or portions thereof, can be designated as LZ2 or LZ3 if they are contained within such a zone.	Not Applicable
LZ2	Low	Rural areas, as defined by the 2000 U.S. Census.	Special districts within a default LZ2 zone may be designated as LZ3 or LZ4 by a local jurisdiction. Examples include special commercial districts or areas with special security considerations located within a rural area.	Special districts and government designated parks within a default LZ2 zone may be designated as LZ1 by the local jurisdiction for lower illumination standards, without any size limits.
LZ3	Medium	Urban areas, as defined by the 2000 U.S. Census.	Special districts within a default LZ3 zone may be designated as LZ4 by a local jurisdiction for high intensity nighttime use, such as entertainment or commercial districts or areas with special security considerations requiring very high light levels.	Special districts and government designated parks within a default LZ3 zone may be designated as LZ1 or LZ2 by the local jurisdiction, without any size limits
LZ4	None	None	Not applicable	Not applicable

- Limit total light output per acre to 50,000 lumens, of which 5,000 lumens may be partially shielded or unshielded in LZ1 and LZ2 zones. (Except Sports Fields)
- Limit total light output per acre to 100,000 lumens, of which 10,000 lumens may be partially shielded or unshielded in LZ3 and LZ4 zones. (Except Sports Fields)
- Sports fields should be designed to achieve no more than minimum illumination levels for Sports Class IV by IESNA and use fully shielded fixtures that permit no light to be emitted above horizontal and be turned off 30 minutes of end of play.
- Minimize light sources from the blue end of the light spectrum (color temperature less than 3200 K.) (except sports fields).
- Use high mounting heights as much as possible and main beam angle of all lights directed towards any observer should be not more than 70 degrees to minimize glare.

WHAT ARE DARK CAMPUS PROGRAMS?

A dark campus program challenges the conventional belief that outdoor light reduces crime. For many schools, the main crime problem is vandalism. The theory behind the dark campus approach is that darkness works as a deterrent to vandalism because vandals lose the thrill of seeing the impact of the damage they cause. Also potential vandals and burglars are forced to use portable lights to perpetrate crimes within a dark campus, but this presents a high risk of arousing suspicion. The program involves turning off all emergency interior lights and outside security lighting between certain hours. The most successful dark campus schools are proactive in communicating with neighbors, local police, parents and students about the program to improve community participation and vigilance. Some schools even block access to all foot and vehicle traffic at night and install occupancy sensors and audible alarms in areas with valuable equipment.

Certain school districts in Oregon and Texas have virtually eliminated serious vandalism in problem schools by adopting a dark campus strategy, thus preventing hundreds of thousands of dollars in damages. In California, Livermore Joint Unified School District saved about 10 percent of energy costs with a slight decrease in vandalism. Cupertino Union School District reported a 29% drop in vandalism and \$8,190 in annual energy savings.

SUMMARY

Schools and community colleges that elect to minimize outdoor light pollution by implementing outdoor lighting best practices may derive several potential benefits. Reduced energy costs, conservation of energy resources, reduced carbon footprint, improved campus traffic safety, and improved campus aesthetics are among the potential outcomes.



REFERENCES & RESOURCES

Dark-Sky Association www.darksky.org

Dark Campus Programs Reduce Vandalism and Save Money”, *Education News* www.schoolde.com

California CHPS Criteria, 2014