General Recommendations for New Construction Lighting

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Contents

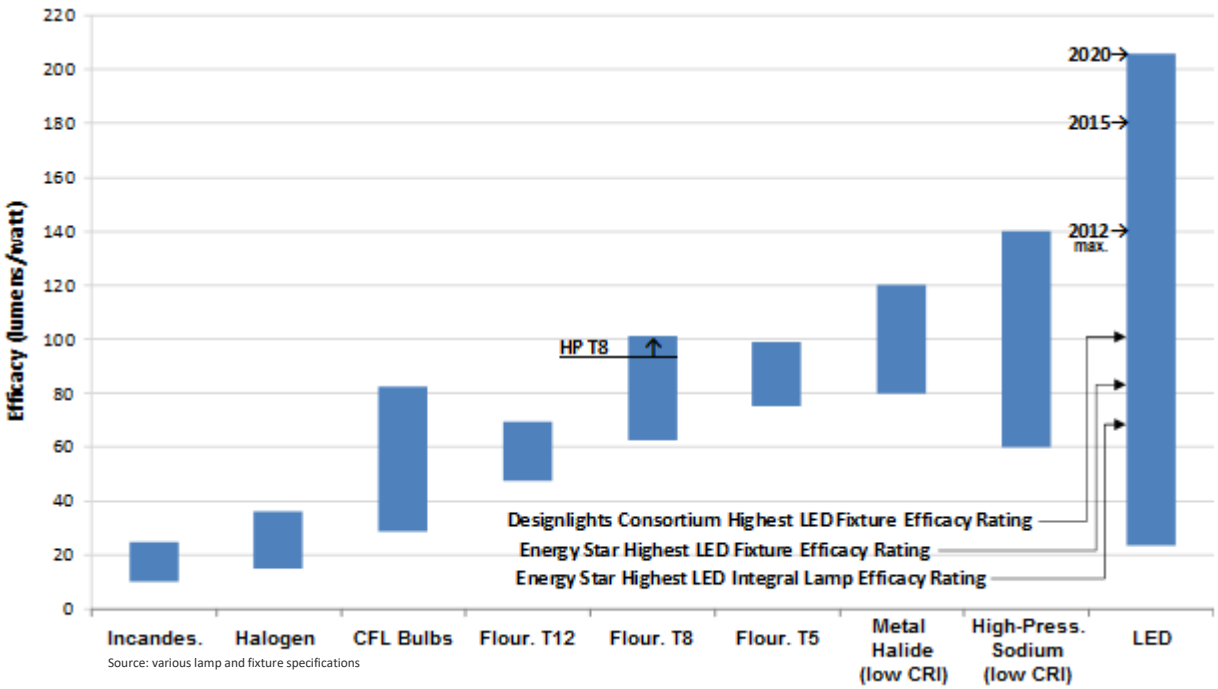
DESIGN GUIDELINES FOR ENERGY-EFFICIENT LIGHTING SYSTEMS

According to ENERGY STAR, 17 percent of the energy used in commercial buildings is consumed by lighting systems. This means there are significant savings to be had through energy-efficient lighting measures. The guidelines presented below are designed to support building designers and owners in selecting efficient lighting technologies and practices. This document provides both general technology recommendations and example specifications that can be copied and pasted into project specifications. These recommendations are based on those of the Illumination Engineering Society of North America (IESNA), the Consortium for Energy Efficiency (CEE), and other non-profit third-party industry groups that promote cost-effective energy efficiency in lighting. For more specific design recommendations, it is advisable to consult the most current IESNA Handbook.

Through your electric utility's energy efficiency programs, CLEAResult helps building owners, architects, and engineers realize the benefits of energy efficiency. Building owners are encouraged to assess and address their energy use through a variety of program-related services, including energy performance benchmarking, energy master planning, technical assistance, and even public relations support. These third-party recommendations, provided free of charge through your electric utility, are not intended to substitute for the services of paid professionals.

Lighting Technologies

Lighting technologies exhibit varying levels of efficacy, measured by light output per watt input. Incandescent lamps rank as the least efficacious lighting technology, whereas LED efficacies are consistently improving each year. The graph below, derived from IESNA reports, visually represents the diverse light efficiencies of different technologies. Specifically for indoor lighting, encompassing both high- and low-bay applications, our recommendation is to use ENERGY STAR® or DesignLights qualified LED fixtures.



ENERGY STAR and DesignLights LED Fixtures

LEDs stand out as the premier lighting technology, offering the potential for substantial energy and maintenance cost savings. We strongly recommend choosing LED fixtures that are qualified under ENERGY STAR or the DesignLights Consortium (DLC). These industry groups rate the best and most reliable LED products in the market. Opting for products endorsed by ENERGY STAR or DLC ensures that you select an LED fixture that maintains its brightness and color quality over time. Moreover, it's important to note that to qualify for incentives in many energy efficiency programs, your LED installation must use products endorsed by ENERGY STAR or DLC. For more detailed information, please refer to the following websites:

https://qpl.designlights.org/qpl/solid-state-lighting?search=

https://www.energystar.gov/productfinder/product/certified-light-fixtures/results

https://www.energystar.gov/productfinder/product/certified-light-bulbs/results

Outdoor Lighting

Due to the directional nature of LED lamps, which provide even spread, we recommend opting for outdoor illumination through ENERGY STAR or DesignLights qualified LED fixtures. The inherent directional quality of LEDs enables sufficient outdoor lighting with lower light output, translating to reduced energy consumption. Moreover, LED fixtures boast a lifespan of up to ten years and demand significantly less maintenance compared to traditional outdoor lighting. This is particularly advantageous in challenging maintenance areas, such as pole lights, where the decreased upkeep for LED fixtures helps offset the initial cost. It's crucial to ensure that the chosen LED product is rated for high temperatures when installing the fixture in a warm climate.

Lighting Power Density (LPD)

LPD, or Lighting Power Density, represents the power used by luminaires (including lamps, ballasts, transformers, and control devices) per unit area of a building, measured in watts per square foot. Local building codes specify the maximum allowed LPD for new construction buildings. Energy efficiency incentives for new construction lighting are determined by comparing the actual LPD of a project with the code requirements.

The following table presents the current maximum allowed LPD for various building types according to the International Energy Conservation Code 2021 (IECC 2021), alongside the recommended maximum LPD levels.

RECOMMENDED LIGHTING POWER DENSITIES		
Facility Type	**IECC 2021 Allowed LPD**	**Recommended LPD (30% Savings)**
Automotive Facility	0.75	0.53
Convention Center	0.64	0.45
Courthouse	0.79	0.55
Dining: Bar/Lounge/Leisure	0.80	0.56
Dining: Cafeteria	0.76	0.53
Dining: Family	0.71	0.50
Dormitory	0.53	0.37
Exercise Center	0.72	0.50
Fire Station	0.56	0.39
Gymnasium	0.76	0.53
Health Care - Clinic	0.81	0.57
Hospital	0.96	0.67
Hotel/Motel	0.56	0.39
Library	0.83	0.58
Manufacturing	0.82	0.57
Motion Picture	0.44	0.31
Multi-Family	0.45	0.32
Museum	0.55	0.39
Office	0.64	0.45
Parking Garage	0.18	0.13
Penitentiary	0.69	0.48
Performing Arts	0.84	0.59
Police Stations	0.66	0.46
Post Office	0.65	0.46
Religious Buildings	0.67	0.47
Retail	0.84	0.59
School/University	0.72	0.50
Sports Arena	0.76	0.53
Town Hall	0.69	0.48
Transportation	0.50	0.35
Warehouse	0.45	0.32
Workshop	0.91	0.64

The following table lists the current maximum allowed lighting energy for outdoor lighting areas according to the International Energy Conservation Code 2021 (IECC 2021).

ALLOWED OUTDOOR LIGHTING POWER DENSITIES				
Facility Type	Lighting Power Density (W/ft²)			
	Zone 1	Zone 2	Zone 3	Zone 4
Uncovered Parking: Parking Areas and Drives	0.03	0.04	0.06	0.08
Building Grounds: Walkways ≥ 10 ft. wide, Plaza Areas, and Special Feature Areas	0.1	0.1	0.11	0.14
Building Grounds: Dining Areas	0.65	0.65	0.75	0.95
Building Grounds: Stairways	0.6	0.7	0.7	0.7
Building Grounds: Pedestrian Tunnels	0.12	0.12	0.14	0.21
Building Grounds: Landscaping	0.03	0.04	0.04	0.04
Building Entrances and Exits: Entry Canopies	0.2	0.25	0.4	0.4
Building Entrances, Exits: Loading Docks	0.35	0.35	0.35	0.35
Sales Canopies: Free-standing and attached	0.4	0.4	0.6	0.7
Outdoor Sales: Open Areas	0.2	0.25	0.35	0.5
Building Facades	---	0.075	0.113	0.15
Entrances and Gatehouse inspection Stations at guarded facilities	0.5	0.5	0.5	0.5
Uncovered Loading areas for emergency vehicles	0.35	0.35	0.35	0.35
Source: International Energy Conservation Code 2021				

Zone	Description
1	Developed areas of national parks, state parks, forest land, and rural areas
2	Areas predominantly consisting of residential zoning, neighborhood business districts, light industrial with limited nighttime use and residential mixed-use areas
3	All other areas not classified as lighting zone 1,2 or 4
4	High-activity commercial districts in major metropolitan areas as designated by the local land use planning authority

Lighting Controls

Lighting controls play a crucial role in minimizing energy consumption by dimming or turning off luminaires in daylit or unoccupied spaces. These controls encompass dimming controls, daylight controls, and occupancy controls, and it's often suitable to employ multiple control strategies within a single building space. The most advanced buildings leverage a combination of control strategies to maximize lighting energy savings. We strongly recommend the installation of lighting controls wherever appropriate. Refer to the table below for a detailed description of each control type.

Lighting Controls - Control Definitions	
Control Type	**Description**
Occupancy	Adjusting light levels according to the presence of occupants • Wall- or ceiling-mounted occupancy sensors • Integrated fixture occupancy sensors • Time clocks • Energy management systems
Daylighting (Indoor)	Adjusting light levels automatically in response to the presence of natural light • Photosensors
Outdoor	Outdoor on/off photosensor/time clock controls; no savings attributed because already required by code
Personal Tuning	Adjusting individual light levels by occupants according to their personal preference; applies to private offices, workstation-specific lighting in open-plan offices, and classrooms • Dimmers • Wireless ON/OFF switches • Personal computer-based
Institutional Tuning	Adjustment of light levels through commissioning or provision of switches or controls for areas or groups of occupants • Dimmable ballasts • ON/OFF or dimmer switches for non-personal tuning • Field adjustable light output
Networked Lighting Control	Lighting systems with a combination of sensors, networked interfaces, software, and controllers that affect lighting changes in luminaires, retrofit kits, or lamps. NLC systems can be installed with or without luminaire level lighting control (LLLC), referring to the capability to have a networked occupancy sensor and ambient light sensor installed for each luminaire or kit.

Light Quality Concerns

Color Rendering Index (CRI)

CRI, or Color Rendering Index, quantitatively measures a light source's ability to reproduce colors in comparison to an ideal or natural light source. In simpler terms, it gauges how accurately colors appear. Lamps with higher CRI values excel in reproducing the visible light spectrum and may potentially reduce the required footcandle levels. For reference, natural light has a CRI of 100. We recommend using lamps with a CRI greater than 80 (the CRI is typically listed in the product specifications document of the lamp).

NOTE: Lamps with different color temperatures can still have a CRI greater than 80. Color temperature, measured in degrees Kelvin, indicates the color of a light source. Lower color temperatures (~3000K) appear more golden, while higher color temperatures (~6000K) have a bluer tint. The choice of color temperature depends on individual preferences, but we recommend maintaining consistent color temperatures across all light sources in a facility.

Illumination Levels

IESNA provides comprehensive recommendations for horizontal and vertical illumination levels for various space types in their Handbook. These light levels are typically measured in 'footcandles' (fc). For accurate guidelines on maximum and minimum footcandle levels in each applicable space type, lighting designers should refer to the IESNA Handbook. This ensures the maintenance of appropriate light levels while minimizing energy consumption.

Many existing facilities currently operate with footcandle levels that exceed the recommended standards, especially when compounded with the visual discomfort caused by 'glare'—often experienced during computer work. Glare from overhead lights can make it challenging to read computer screens or monitors, as these devices are already backlit. In situations where higher light levels are necessary or preferred for a specific task or usage, optimal illumination is achieved by either moving the light source closer to the task or incorporating supplementary task lighting. This approach is more effective than merely increasing the light output from an overhead fixture.

Recommended Light Levels		
Orientation and Simple Tasks: These tasks occur in public spaces where reading and visual inspection are only occasionally performed. Visual performance is largely unimportant.		
Public Spaces	Atriums	3 fc
Simple Orientation for Short Visits	Hallways	5 fc
Working Spaces for Simple Visual Tasks	Kiosks	10 fc
Common Visual Tasks: Visual performance is important for these. Higher light levels are recommended for visual tasks involving low contrast or small size.		
Tasks with High Contrast and Large Size	Classrooms & Offices	30 fc
Tasks with High Contrast and Small Size OR Low Contrast and Large Size	Assembly Line	50 fc
Tasks with Low Contrast and Small Size	Operating Room	100 fc

Source: IESNA Handbook

Example Lighting Specifications

New Construction and Retrofits

A. Average lighting levels and measurements must comply with the most current Illuminating Engineering Society of North America (IESNA) recommended practices.
B. Final light levels must meet the requirements of the end user and meet the satisfaction of all approving authorities having jurisdiction for specific applications.
C. The Engineer, Contractor or Supplier must confirm that the lighting levels will meet the illumination range stated in this document, or most current IESNA recommendations, for the applicable space type.
D. Retrofit designs should consider the recommended practice of:
    a. Reducing the number of lamps in the retrofit fixture.
    b. Reducing the number of fixtures in a room or space.
    c. Retrofitting with LED equipment.
    d. Uniform lamp and ballast types to facilitate a consistent and economical equipment stock.

LED Lighting Systems

A. LED Lighting Systems:
    a. All screw-in lamps will be LED
    b. LED lamps and fixtures must be certified and listed by at least one of the following organizations.
        i. DesignLights Consortium (DLC)
        ii. ENERGY STAR

High Bay and Outdoor Fixtures

LED fixtures should be installed in areas with high ceilings or in outdoor areas. All LED fixtures must be on the qualified products list of either ENERGY STAR or DesignLights Consortium (DLC).

Lighting Level Requirements

Lighting systems should be designed to maintain illumination levels within specified ranges based on the space type. Average lighting levels should not fall below the lower limit of the range nor exceed the upper limit, ensuring that all spaces are adequately lit without being over-lit. These ranges apply to all working areas within a space and should be sustained throughout the lamp's life. The footcandle (fc) ranges provided below are primarily derived from IESNA recommended levels and best practices for lighting gymnasiums as per NCAA standards.

Space Type	Lighting Level Range (fc)
Classroom	30 - 50
Science Lab	50 - 70
Library	30 - 50
Office	30 - 50
Computer Lab	3 - 30
Corridor / Common Space	10 - 20
Gym (recreational)**	30 - 50
Gym (competition)**	50 - 100
Gym (NCAA broadcasting)**	100 - 150
Cafeteria	10 - 20
Kitchen	30 - 50
Pool	5 - 50
Parking Garage	10 - 20
Restroom	5 - 15
Mechanical Room	20 - 50

**IESNA recommended lighting levels should be used for other space-types not listed above.*

*** "Gym" refers only to the lighting levels on the actual court, not the adjacent general circulation and seating.*

Lighting Controls

1. INTERIOR – All interior spaces must be controlled via occupancy sensors, infrared, ultrasonic, or dual technology, as applicable to the space.
2. INTERIOR – where possible, interior lighting fixtures should be equipped with photocells to dim or turn off fixtures when lighting levels reach desired brightness with ambient light alone.
3. EXTERIOR – Exterior light fixtures should be controlled via photocell or timeclock for energy conservation.