RESIDENTIAL LIGHTING

A guide to meeting, or exceeding, California’s 2013 Building Energy Efficiency Standards

DEVELOPED BY THE CALIFORNIA LIGHTING TECHNOLOGY CENTER, UC DAVIS
This guide is designed to help builders and lighting industry professionals become more familiar with the residential lighting portion of California’s 2013 Building Energy Efficiency Standards (Title 24, Part 6).

The guide provides information on current lighting technologies, lighting design terms and principles, and best-practice recommendations. It is designed to complement lighting courses developed through CLTC and sponsored by Pacific Gas and Electric Company through its Energy Education program.
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The California Energy Commission estimates these improvements will add $2,290 to the cost of constructing a new residential building, but they will reduce energy costs by an estimated $6,200 over 30 years. In other words, the new efficiency standards will add approximately $11 per month to a 30-year mortgage for the average home, but they will save $27 per month in heating, cooling, and lighting expenses. Energy efficiency improvements also increase home values.

Environmental Benefits
California is making strong efforts to address climate change. The state’s building and appliance standards, along with utility programs that promote efficiency, are vital means of reducing electricity use and lowering statewide carbon emissions.

California’s ambitious energy and climate goals include those legislated under the Lighting Efficiency and Toxics Reduction Act (AB1109). Passed in 2007, this bill calls for a 50 percent reduction in lighting energy use for interior residential lighting by 2018. California’s 2008 Long-Term Energy Efficiency Strategic Plan also set the goal that all new residential construction in the state be zero net energy (ZNE) by 2020.
This guide is designed to help builders, lighting designers, contractors, and other end users become more familiar with the lighting portion of California's 2013 Title 24, Part 6 residential lighting standards. It is designed to serve as a resource for lighting industry professionals involved in the construction, maintenance, or retrofit of California's residential buildings. The guide includes compliance requirements as well as recommendations for implementing the standards in new construction or renovation projects.

Compliance Process Overview
The guide begins with an overview of the compliance process including the responsibilities, requirements and documentation involved in each phase of a project, from design to final inspection.

Concepts & Principles
Chapter 2 is devoted to lighting concepts and principles such as color rendering, color temperature, light output, and lamp life. These concepts are vital for making informed decisions regarding lamps, luminaires and controls.

Compliance Requirements
Starting with an overview of new requirements and important updates to the 2008 standards, this portion of the guide examines the new Title 24, Part 6 requirements for luminaire efficacy classification and lighting controls. Recommendations for putting the standards into practice are also included.

Requirements & Recommendations
This section of the guide covers the lighting requirements set forth under Title 24, Part 6 for the most common residential space types. Floor plans with examples of compliant lighting designs are also provided, along with recommendations for implementing best practices.

NOTE: This guide is not intended to be used in lieu of California’s Title 24 Building Energy Efficiency Standards, and it is not a substitute for the code itself. Please visit www.energy.ca.gov/title24 to download the official 2013 Title 24 Building Energy Efficiency Standards, Errata, Reference Appendices, and the Residential Compliance Manual.
THE COMPLIANCE PROCESS

The following is an overview of the compliance process for residential lighting. Additional information and resources, including the 2013 Nonresidential Compliance Manual and forms may be found on the California Energy Commission website: energy.ca.gov/title24/2013standards

**Design**
Architects, energy consultants, designers, and other building professionals involved in the design phase of a project must ensure that their projects are compliant with Title 24 standards. They must also ensure that compliance measures are documented on the building plans and specifications, and on any certificates of compliance. These forms must be submitted to the local enforcement agency (i.e., the city or county government office).

**Permit Application**
After construction documents are ready and other approvals have been secured (from the planning department, water authority, etc.), the owner or contractor then completes a building permit application. Along with the building permit application, a set of compliance documents must be submitted to the enforcement agency, including certificates of compliance, building plans, and specifications. An energy consultant who understands the code and compliance methods often prepares this documentation. Ensuring all forms and documents are complete, clear and accurate helps to expedite the permit application process.

**Plan Check**
As part of their work, representatives from local enforcement agencies compare the requirements specified on residential Certificate of Compliance forms (Form CF1R) with building plans and specifications. If information is incomplete or unclear, the plans examiner may require a permit applicant to make corrections and resubmit the building permit application.
Building Permit Issuance
Upon approval by the plans examiner, the enforcement agency may issue a building permit, allowing the contractor to begin work. Building permits may be issued in phases. For example, a permit for site preparation will be issued before a permit for building construction.

Construction
During the construction process, the general contractor or specialty subcontractors are required to complete various Certificate(s) of Installation (Form CF2R) that list Title 24 requirements. These forms also document the energy features and technology components installed in the building.

HERS Registration
All new homes, additions over 1,000ft², and/or alterations to an existing home that has Home Energy Rating System (HERS) measures included in the compliance package will need to be registered with a HERS provider. This registration process includes the Residential Lighting Installation Certificate:

- CF2R-LTG-01-E for single-family dwellings OR
- CF2R-LTG-02-E for multi-family dwellings

HERS measures must be verified in the field by a HERS rater during construction. Visit the California Energy Commission’s website for a current list of approved HERS providers: energy.ca.gov/HERS/providers.html

Occupancy
In multifamily dwellings of three or more units, occupants may move in after the enforcement agency issues an occupancy permit. In the case of single-family dwellings or duplexes, a signed final inspection document often serves as approval for occupancy. The builder is required to provide the homeowner or building owner with operation and maintenance manuals. The owner is then responsible for maintaining the building’s energy-efficiency features.

Operation and maintenance manuals can provide owners and occupants with valuable information about the lighting features in their homes. This is especially important as new LED luminaires and advanced controls become more commonplace. Understanding basic terminology and what can be expected from new lighting systems, in terms of lifetime, functionality, quality, and energy savings, can increase acceptance of new technologies.
FINDING COMPLIANT PRODUCTS

Certain devices must be certified to the Energy Commission as meeting California’s Appliance Efficiency Standards (Title 20 of the California Code of Regulations). Others are regulated under the Building Energy Efficiency Standards (Title 24, Part 6).

Certification to the Energy Commission
The California Energy Commission maintains an appliance database that lists a variety of products that are certified as meeting Title 20 and Title 24 requirements. The following appliances must be certified under Title 20:

- Torchieres
- Metal-halide luminaires
- Portable luminaires
- Undercabinet luminaires
- Luminaires with GU-24 socket and base configurations and GU-24 adaptors
- Lighting controls and ballasts for residential recessed luminaires
- LED lighting systems classified as high efficacy for compliance purposes

The Energy Commission’s Appliance Efficiency Database also lists certified lamps, ballasts, and lighting controls.

Lighting specifiers who wish to work with a product not yet listed in the database can encourage the manufacturer or a pre-approved third-party certifier to submit appliance certification data to the Energy Commission.

IC / AT Recessed Luminaires, ASTM E283 Certified
Under Title 24, Part 6, all luminaires recessed in ceilings (not just those in insulated ceilings) must meet the following requirements:

- **Listed for zero-clearance insulation contact (IC):** Luminaires must be IC rated with a nationally recognized testing lab (such as UL)
- **Certified airtight per ASTM E283 - 04 (2012):** The product label must specify ASTM E283 certification, or documentation is required to indicate the luminaire has been tested and certified in accordance with ASTM E283
- **Sealed airtight with a gasket or caulking:** Any space between the luminaire housing and ceiling must be sealed during installation to prevent airflow between conditioned and unconditioned spaces

Recessed luminaires must also be certified to the Energy Commission for compliance with any applicable ballast requirements in Section 150.0(k)8, and building occupants must be able to readily access ballasts for maintenance or replacement without needing to cut holes in the ceilings. Fluorescent lamps rated 13 W or more must have electronic ballasts with an output frequency no less than 20 kHz.

For more information, see Section 150.0(k)8 and the Residential Compliance Manual, Chapter 6.1.2–3 and 6.3.12–13.
LAYERS OF LIGHT

Adding task and accent lighting to ambient lighting allows ambient lighting loads to be reduced without compromising safety or visual comfort. In fact, this layered approach to lighting improves visual comfort by reducing contrast. Lighting designs that include task and accent lighting are also more attractive, as they provide variety and visual interest.

**Ambient Lighting**

Ambient lighting should provide a comfortable level of brightness without causing glare. Most rooms benefit from having a central ambient light source in the form of a ceiling-mounted luminaire, recessed lights, wall-mounted luminaires, or a chandelier. In certain spaces, such as laundry rooms and closets, ambient lighting may also serve as the primary source of task lighting.

**Task Lighting**

Task light levels supplement ambient light levels and maximize efficiency by placing light directly where it is needed and allowing occupants to switch it on only when it is needed. A table lamp, for example, provides extra light for reading. Undercabinet lighting in the kitchen makes cooking and food preparation safer and easier.

Task lighting should be bright enough to prevent eye strain without causing glare. Multiple light sources can cast shadows that make tasks more difficult. High-quality task lighting makes visual tasks easier, and it allows for lower ambient light levels, reducing energy use.

**Accent Lighting**

Track lighting, cove lighting and wall-mounted luminaires are common choices for accent lighting. These luminaires can highlight architectural features, spotlight artwork, or illuminate interior design elements.

Color tunable LED products for the home are becoming more prevalent and more affordable, offering new options for accent lighting. For instance, with the press of a button, occupants can temporarily wash their walls with colored light.
Many consumers estimate the light output of lamps and luminaires based on the amount of power they draw, but it is lumens (lm), not watts (W), that indicate luminous output. More efficient sources can produce the same amount of light as legacy sources while consuming less energy.

**Luminous Output**
The amount of visible light emitted by a light source is measured in lumens (lm). The more lumens, the more light emitted, but other factors also affect visibility and perception of brightness, such as contrast ratios and color characteristics. In addition, the type of fixture or housing can greatly affect the amount of lighting reaching its intended target.

★★ Recommendations
- Compare the light output, not the energy consumption, of existing and replacement light sources or luminaires to ensure adequate lighting is maintained.
- Consider other factors, such as contrast, distribution and color quality; these also affect nighttime vision and perceived brightness.
- Install lighting controls, such as dimmers or motion sensors, to maximize energy savings while automatically tailoring light levels to occupants’ needs.
- To avoid energy waste and excessiveillumination, be sure to factor both task lighting and ambient lighting into the overall lighting design for a space.

**Comparing Lumens vs. Watts**

<table>
<thead>
<tr>
<th>LUMENS</th>
<th>450</th>
<th>800</th>
<th>1,100</th>
<th>1,600</th>
</tr>
</thead>
<tbody>
<tr>
<td>DIMMER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BRIGHTER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Standard Incandescent
  - 40W
  - 60W
  - 75W
  - 100W

- Halogen Incandescent
  - 29W
  - 43W
  - 53W
  - 72W

- CFLs
  - 10W
  - 13W
  - 16W
  - 20W

- LEDs
  - 5W
  - 10W
  - 15W
  - 19W

Luminous Efficacy
In lighting, the term efficacy refers to the ratio of luminous output produced by a light source to power consumed by that source (lm/W).

**Efficacy = Lumens / Rated Watts**

Different source technologies provide different efficacy levels. For example, a 75W A19 incandescent lamp, a 16W A19 CFL lamp, and a 15W A19 LED lamp use different amounts of power to produce the same amount of light (approximately 1,100 lumens). Each type of lamp has a different rated efficacy, with the LED example being the most efficacious (producing the most lumens per watt).

When assessing the overall value of lamps or luminaires, efficacy and initial product costs are two factors to consider. It is also important to compare longevity, lifetime performance and long-term energy and maintenance costs.

Life
Electric light sources have the potential to fail due to several factors, including faulty electrical components, corrosion inside the lamp, or lumen depreciation (the gradual decrease in lumen output that occurs over time).

Incandescent lamps typically last 1,000–2,000 hours and lose about 10–15% of their initial lumen output before burning out. A CFL lamp lasts about 12,000 hours and loses about 10–15% of its output before burning out. Linear fluorescent lamps typically last 25,000–40,000 hours, losing 5–10% of their original lumen output before they fail.

LEDs do not burn out suddenly in the same way as many legacy sources, their lumen output continues to decrease very gradually over time. Many LED A19 replacement lamps are rated to last 25,000 hours or more before they lose 30% of their initial light output, and recent testing indicates the diodes in these lamps may maintain useful light output longer than previously predicted. Capacitors or other components that provide power to the LED circuit are more likely to fail before the LEDs themselves reach their end of useful life. For these reasons, basing LED product life on lumen depreciation (L70, or 70% of initial lumen output, for example) may not be the best way to measure the useful life of LED lamps and luminaires.

LED life testing methodologies are still evolving as the technology improves. Meanwhile, a few best practices can help maximize the life of LED lighting:
- Always follow manufacturer installation instructions, including references to base position for replacement lamps (e.g. base-up, base-down or horizontal)
- Pair LED lamps and luminaires with manufacturer recommended dimmers and other controls
- Observe manufacturers’ recommendations on operating temperature to prevent heat-related performance degradation

Warranties
Manufacturers offer competitive warranties for lighting products. Energy Star requires that luminaires and LED lamps carry a warranty of at least three years. LED replacement lamps must come with a minimum five-year free replacement warranty in order to meet the Voluntary California Quality LED Lamp Specification and qualify for utility rebates.

**NOTE:** Life and lumen maintenance information presented here comes from The Lighting Handbook, Tenth Edition (sec. 7), published by the Illuminating Engineering Society (IES) in 2011.
COLOR CHARACTERISTICS

Color Temperature (CCT)
Correlated color temperature (CCT) indicates the warmth or coolness of the light emitted by a given source. CCT is measured on the Kelvin scale (K). Light sources with a low CCT (2,700–3,000 K) give off light that is warm in appearance. Sources with higher CCT values (4,000–6,500 K) provide light with a cooler color appearance.

Selecting light sources with consistent CCTs helps maintain some consistency in the appearance of various light sources. Check the Lighting Facts label for information on CCT (or “light color”), as well as lumen output, power consumption (watts) and efficacy.
Color Rendering (CRI)

The color rendering index (CRI) is the current industry standard for measuring how accurately a light source renders the colors of the objects it illuminates. The maximum CRI value is 100. Residential lighting should have a minimum CRI of 80; light sources with a CRI of 90 or higher provide even better color rendering.

Specifying lamps and luminaires with similar color rendering properties helps ensure wall color, carpeting and other materials have a consistent appearance, especially in adjoining spaces. The full-color Lighting Facts label issued by the Department of Energy includes CRI, but the black-and-white Federal Trade Commission label does not. Most manufacturers can supply information on CRI if it is not immediately available on product packaging or literature.

Comparing Color Quality

The LED MR16 lamps used for these photos both have a CCT of 3000 K and were produced by the same manufacturer. The difference is that the first-generation lamp on the left has a CRI of 80 while the lamp on the right has a CRI of 95.

Voluntary California Quality LED Lamp Specification

LED replacement lamps must now meet certain performance criteria in order to qualify for utility incentive programs and rebates in California. These include:

- Minimum color accuracy (CRI) of 90
- R9 greater than 50
- CCT of 2700 K or 3000 K
- Color consistency
NEW IN 2013: AN OVERVIEW OF UPDATES

Those familiar with the 2008 Title 24, Part 6 residential lighting standards will find few changes to the requirements in the 2013 iteration. Below is an overview of the most significant updates.

LED Quality Criteria

Quality requirements for residential LED lighting

Joint Appendix JA8 of the 2013 regulations sets new quality standards for LED luminaires installed in residences. To qualify as high efficacy under Title 24, Part 6, LED lighting must be designed and manufactured for residential use. Indoor lighting must also provide accurate color rendering (minimum CRI of 90) and a CCT of 2700K–4000 K. Outdoor LED lighting must have a CCT of 2700K–5000K. Decorative monochromatic LEDs are exempt.

Bathrooms

At least one high-efficacy luminaire

The 2008 standards grouped bathrooms with other room types and allowed all bathroom lighting to be low efficacy if controlled by a vacancy sensor. Lighting in bathrooms is now addressed separately, and at least one high-efficacy luminaire is required. The remaining installed luminaires may be low efficacy and controlled by a vacancy sensor or high efficacy (sensors optional).

Garages, Laundry Rooms & Utility Rooms

All high-efficacy luminaires and vacancy sensors

All luminaires in garages, laundry rooms, and utility spaces must now be high efficacy AND controlled by vacancy sensors. The 2008 standards allowed for all high-efficacy lighting without controls or low-efficacy lighting controlled by a vacancy sensor.

Common Areas of Multifamily Buildings

Size criteria for residential vs. non-residential standards

Common areas in multifamily buildings include interior hallways, lobbies, fitness facilities, and laundry rooms. In low-rise multifamily residential buildings (up to three habitable stories high) where the interior common areas constitute 20% or less of the building’s total floor area, interior lighting must be all high efficiency OR controlled by an occupancy sensor.

In each building where common areas exceed 20% of the total floor area, the permanently installed lighting must now comply with the nonresidential requirements of the 2013 Title 24, Part 6 standards. This includes occupancy sensor requirements in corridors and stairwells, with lighting power set to decrease at least 50% during vacant periods. Common areas in residential buildings with more than three habitable stories must also meet certain sections of the nonresidential standards.
Efficacy Classification

Two Strategies for Compliance
Title 24, Part 6 offers several methods of reducing lighting energy use in homes. Two main strategies require:

1. High-efficacy light sources, sometimes requiring controls
2. Low-efficacy light sources paired with mandatory controls

Some spaces, like garages, laundry rooms and utility rooms, require both high-efficacy luminaires and vacancy sensors. The full criteria for classifying luminaires as either high or low efficacy are listed in Section 150.0(k) (Tables 150.0-A and 150.0-B). Certification requirements for LEDs are detailed in Joint Appendix JA8.

The residential standards also set basic requirements for how these strategies must be applied in different residential spaces, e.g., kitchens, bathrooms, garages. These requirements are discussed later in the guide.

High-Efficacy Sources & Luminaires
The following types of light sources and luminaires satisfy Title 24 high-efficacy requirements (Table 150.0-A):

<table>
<thead>
<tr>
<th>Luminaire Type</th>
<th>Power Rating</th>
<th>Minimum Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0–5W</td>
<td>30 lm/W</td>
</tr>
<tr>
<td></td>
<td>Over 5W–15W</td>
<td>45 lm/W</td>
</tr>
<tr>
<td></td>
<td>Over 15W–40W</td>
<td>60 lm/W</td>
</tr>
<tr>
<td></td>
<td>Over 40W</td>
<td>90 lm/W</td>
</tr>
</tbody>
</table>

Luminaires rated for use with lamps that are not listed in Table 150.0-A must meet the minimum luminaire efficacy requirements listed in Table 150.0-B to qualify as high efficacy.
Low-Efficacy Sources & Luminaires

The following lamps and luminaires are classified as low efficacy for purposes of Title 24 compliance:

- Screw-base lamps or luminaires capable of operating any type of incandescent lamp
- Adaptors that allow the use of low-efficacy lamps in fixtures intended to use high-efficacy lamps
- Track lighting that allows relocation of luminaires without altering wiring

Section 130.0(c) 7–8

- Mercury vapor lamps

Appliance Efficiency Database
www.appliances.energy.ca.gov

LED luminaires not certified to the California Energy Commission

Luminaires compatible with low-efficacy sources, including any luminaire that allows for conversion between high- and low-efficacy sources without changing the luminaire’s housing or wiring

High-Efficacy LED Luminaires

The Appliance Efficiency Database allows users to search for “High Efficacy LEDs for Title 24” within its Lighting Products category. These compliant luminaires and light engines meet the requirements of Joint Appendix JA8, including:

- Minimum CRI of 80 for indoor LEDs
- CCT of 2700–4000 K (2700–5000 K for outdoor luminaires)
- Integral LED luminaire or LED light engine
- GU-24 base sources

High-Efficacy Residential Lighting Guide

cltre.ucdavis.edu/publication/high-efficacy-residential-lighting-guide

The High-Efficacy Residential Lighting guide provides information about lighting products and key lighting principles and best practice recommendations. The guide is designed to help builders and lighting industry professionals working on zero-net energy (ZNE) and sustainable residential projects.
CONTROLS
Section 150.0(k)2

Lighting controls allow increased flexibility and control over the lighting systems in a home. The controls requirements of Title 24, Part 6 aim to maximize energy savings while ensuring occupants are comfortable.

Many lighting controls must be certified to the Energy Commission before they can be installed in lighting projects. This certification verifies that a device has the minimum functionality required by the Title 20 Appliance Efficiency Regulations and meets all state and federal standards for energy efficiency.

Switches

Compliance Requirements
1. Separate switching: Permanently installed high-efficacy luminaires must be switched separately from low-efficacy luminaires.
2. Manual control: All installed luminaires must be switched with readily accessible manual ON/OFF controls.
3. No bypassing: No controls may bypass dimmer or vacancy sensor functions if the dimmer or sensor is used to comply with the standards.
4. Exhaust fans switched separately: Lighting systems must be switched separately from exhaust fans. Lights that are integral to fans must have independent manual controls, allowing them to be turned ON or OFF without affecting the fan.

What’s New in the 2013 Code?
cltc.ucdavis.edu/publication/whats-new-title24-2013-code

New requirements for lighting controls constitute one of the biggest changes to California’s Building Energy Efficiency Standards. This brief guide offers an overview of important requirements and major updates to the Title 24, Part 6 lighting code.

Permanently Installed Luminaires

Permanently installed luminaires are attached to the home or other structures on the property. These luminaires may have either plug-in or hard-wired connections. This includes all luminaires that are:

- Attached to walls, ceilings and columns
- Inside cabinets
- Mounted under cabinets
- Attached to ceiling fans
- Integral to exhaust fans
- Integral to garage door openers
- Part of track lighting and flexible lighting systems

Permanently installed luminaires do not include portable lighting or lighting installed in appliances by the manufacturer, like those in range hoods, refrigerators or microwave ovens.
Dimmers

Dimmers give occupants more control over their lighting, and they reduce energy use. Dimmers can be installed with both low-efficacy and high-efficacy lighting. Pairing low-efficacy lighting with dimmers is one option to comply with the efficacy requirements of Title 24 (see “Efficacy Classification” on page 18), except in garages, laundry rooms, and utility rooms. These spaces must use high-efficacy luminaires controlled by vacancy sensors. Homeowners may use dimmers in addition to vacancy sensors in these spaces.

Compliance Requirements

Compliant dimmers must meet the criteria in Section 1605.3 of Title 20 and be certified to the Commission. These requirements include:

1. **65% power reduction**: Dimmers must be capable of reducing power consumption by at least 65%.

2. **Full OFF**: Dimmers must include an OFF position with zero lumen output, consuming no more than 1 W of power per lighting dimmer switch leg.

3. **Reduced flicker**: Dimmers must provide electrical outputs to lamps for reduced flicker operation through the dimming range (amplitude modulation less than 30% for frequencies less than 200 Hz) without causing premature lamp failure.

4. **Three-way circuits**: Wall box dimmers and associated switches designed for use in three-way circuits must be able to turn the lighting ON and OFF. When turning lights ON, these devices must restore the light level set by the dimmer before the lighting was last turned OFF.

Recommendations

1. **Multi-way switches and dimmers**: Install multi-way toggle switches with multi-way dimmers, so lights can be switched or dimmed from all room entrances and exits.

2. **Lighting load**: Be sure to correctly match the dimmer with the electrical lighting load or early equipment failure may occur.

3. **Fluorescent lamps**: Dimmers may be used with fluorescent lamps, but many fluorescent lamps cannot be properly dimmed with typical wall box devices used with incandescent lamps. A special control and dimming ballast must be used. Some CFLs cannot be dimmed at all; check the packaging to see if they are dimmable.

Dimmer Compatibility

It is important to correctly match the dimmer with the type of lighting load being dimmed. This prevents equipment failure, and it is especially critical with LED lighting. Among other criteria, a dimmer should be chosen according to the total wattage of the lighting it will control.
Vacancy Sensors

Garages, laundry rooms, and utility rooms must use high-efficacy luminaires controlled by vacancy sensors. The standards allow for low-efficacy lighting paired with vacancy sensors to be used instead of high-efficacy lighting in other spaces, such as bedrooms, living rooms, dining rooms (where switched separately from the kitchen), closets greater than 70 ft², hallways, and attics.

**Compliance Requirements**

1. **Manual control**: Occupants must be able to turn lights ON and OFF manually.
2. **Auto-OFF**: Sensors must be capable of automatically turning lights OFF within 30 minutes of a room being vacated.
3. **Manual-ON**: Occupants must turn lights ON manually. No auto-ON function is allowed from the sensor.

**Recommendations**

1. **Safety first**: Avoid using vacancy sensors that use a ground wire for the operating current, as this method presents safety hazards.
2. **Partial-OFF vacancy sensors**: Some vacancy sensors allow lights to be partially shut OFF before switching OFF completely. This is especially useful in spaces where safety may be a concern.
3. **Full sensor coverage**: Be sure sensors are positioned for full coverage of the area where lighting will be controlled. Passive infrared (PIR) vacancy sensors, for example, require a clear line of sight to detect occupants. This is not necessary for ultrasonic sensors. When using a two-way switch for one luminaire, it is recommended to use a ceiling-mounted occupancy sensor rather than a wall-switch sensor. Another option is to use a three-way vacancy sensor at both switch locations.
Photosensors

Photosensors measure relative light levels and adjust electric lighting accordingly. Title 20 regulations prohibit photosensors from having a mechanical device that allows for their disabling.

Some common outdoor photocontrols simply turn lights ON or OFF at dusk or dawn, when light levels drop below or rise above a certain set point. More complex systems use advanced photosensors paired with dimming ballasts or drivers to automatically and dynamically adjust interior light levels in response to daylight availability.

Automatic Time-Switch Controls

Automatic time-switch control devices are capable of automatically controlling lighting based on time of day and astronomical events such as sunset and sunrise, accounting for date and geographic location. This type of control device can be used to comply with the outdoor lighting requirements of Title 24, Part 6. Astronomical time clocks may be used to comply with the residential outdoor lighting controls requirements, but are uncommon in the residential sector.

Compliance Requirements

Under the 2013 Title 20 Appliance Efficiency Regulations, these devices are required to:

1. Accurately predict sunrise and sunset +/− 15 minutes and have timekeeping accuracy +/− five minutes per year.
2. Be capable of displaying date, current time, sunrise time, sunset time, and switching times for each step during programming.
3. Automatically adjust for daylight savings time.
4. Be able to independently offset the ON/OFF times for each channel by at least 99 minutes before and after sunrise or sunset.

Energy Management Control Systems

An energy management control system (EMCS) is a computerized control system designed to regulate a building’s energy use by controlling the operation of energy-consuming systems such as lighting.

These systems must provide the same functionality as an astronomical time clock and may have an override switch that allows a luminaire to remain ON at all times. An EMCS may also be used to comply with vacancy sensor requirements if it meets the same functional requirements and all other applicable standards.
DESIGNING TO CODE

The standards allow designers and builders to choose from a variety of lighting strategies and technologies. Options are available across a broad range of price points and can suit a variety of aesthetics. The sample lighting designs presented here represent just some of the many possibilities on the market today.

Space Type Definitions
Section 100.1
Definitions for each residential space type within a home are provided in the Title 24 standards (under Residential Space Type). These definitions are also provided in the glossary of this guide. Some open plans blend space types. When working on a home that blends spaces, check the code for definitions to be sure plans are in compliance.

Lighting Plans
Each plan in the following section provides an example of a compliant lighting design. Each includes descriptions of the luminaires and lamps used in the plan, including lamp types, power consumption (watts), and lamp efficacy.

Calculating Efficacy
Use system power, the luminaire’s rated input power (watts), when making efficacy calculations.

Lighting Recommendations
Each plan includes recommendations for lighting each space. These tips are intended to optimize occupants’ comfort while meeting, or exceeding, the 2013 Title 24, Part 6 standards for energy efficiency.

The Honda Smart Home US is a model zero net energy (ZNE) home located in the UC Davis West Village. Honda collaborated with UC Davis, CLTC and WCEC to build this forward-thinking example of residential sustainability. The home includes daylighting, advanced lighting controls, and high-efficacy, circadian-friendly LED lighting.
KITCHENS
Section 150.0(k)

Kitchen lighting includes all permanently installed lighting in:

- Kitchens (note: interior cabinet lighting has a separate lighting power allotment)
- Adjacent spaces that are not separately switched, such as nooks and dining areas

 Compliance Requirements

1. **At least 50% high-efficacy (controls optional):** High-efficacy luminaires must constitute at least 50% of the total rated lighting power in kitchens. Because high-efficacy luminaires typically consume less power than other luminaires, about three-quarters of the luminaires in the kitchen are likely to be high efficacy. When switched separately from kitchen lighting, the lighting for dining areas, breakfast nooks or other adjacent spaces is not included in the 50% high-efficacy calculation.

   For both low-efficacy and high-efficacy luminaires, the installed lighting power is the maximum rated power (watts) of the luminaire, including power used by ballasts. This rating must be listed on the luminaire following UL standards.

   **Undercabinet or cabinet lighting** that projects light primarily outside the cabinetry is considered permanently installed lighting and counts toward the 50% high-efficacy requirement. This includes permanently installed, high-efficacy undercabinet luminaires that are not hard-wired but plug in to kitchen wall outlets.

2. **Blank electrical boxes for future installations:** Each electrical box with a blank cover or where no luminaire, surface-mounted ceiling fan or other electrical equipment has been installed, is counted as 180 watts of low-efficacy lighting power.

3. **Earn more low-efficacy lighting:** If all lighting, both high-efficacy and low-efficacy, is controlled by dimmers, vacancy sensors or a lighting control system, the standards allow additional controlled low-efficacy lighting to be installed in kitchens beyond the 50% maximum: up to 50 watts in units 2,500 ft² or smaller, and up to 100 watts in units larger than 2,500 ft². There is no limit to how much high-efficacy lighting may be installed.
3. **Manual control:** All lighting must have readily accessible manual controls, allowing occupants easy control of lighting in the space.

4. **Separate control of high-efficacy and low-efficacy lighting:** All high-efficacy luminaries must be controlled separately from all low-efficacy luminaires. Additionally, each lighting layer that serves a unique function should operate independently.

**Recommendations**

1. **Add controls:** Even though the standards do not require controls in the kitchen, add dimmers and vacancy sensors, or an energy management control system.

2. **Separate switching:** Switch nooks, dining areas and other adjacent spaces separately from the kitchen. This adds flexibility to the lighting design and reduces lighting energy use.

3. **Sink task lighting:** Install a luminaire over the sink on a separate switch to provide task lighting for this frequently used area of the kitchen.

4. **Low-glare countertops:** Select light-colored, matte-finish countertops if you want to increase light reflectance while minimizing glare. For dark or highly reflective countertops, be sure to choose downlights and undercabinet luminaires with optics that reduce glare.

5. **Clean ceiling lines:** Minimize the number of luminaires extending below the ceiling to reduce visual clutter.

6. **High-efficacy options:** Consider LED luminaires for recessed and undercabinet lighting to help satisfy the high-efficacy requirement in kitchens.
### Kitchen & Dining Room Lighting Schedule

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Luminaire Type</th>
<th>Lamp</th>
<th>Qty.</th>
<th>Watts</th>
<th>Total Watts</th>
<th>Efficacy (lm / W)</th>
<th>High Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linear suspended pendant</td>
<td>Dedicated LED</td>
<td>2</td>
<td>35</td>
<td>70</td>
<td>91</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Recessed downlight</td>
<td>GU-24 base LED</td>
<td>2</td>
<td>16</td>
<td>32</td>
<td>67</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Undercabinet</td>
<td>Dedicated LED</td>
<td>11</td>
<td>8.5</td>
<td>93.5</td>
<td>51</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>Ceiling fan with light kit</td>
<td>Dedicated LED</td>
<td>1</td>
<td>20</td>
<td>20</td>
<td>75</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Wall sconce</td>
<td>GU-24 base LED</td>
<td>5</td>
<td>9.7</td>
<td>48.5</td>
<td>93</td>
<td>—</td>
</tr>
</tbody>
</table>

**CONTROLS**

- $D$ Dimmer switch
- $D-VS$ Dimmer switch with vacancy sensor

---

**2013 TITLE 24, PART 6**
### Kitchen Lighting Schedule

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Luminaire Type</th>
<th>Lamp</th>
<th>Qty</th>
<th>Watts</th>
<th>Total Watts</th>
<th>Efficacy (lm / W)</th>
<th>High Efficacy</th>
</tr>
</thead>
<tbody>
<tr>
<td>🌟</td>
<td>Recessed downlight</td>
<td>GU-24 base LED</td>
<td>9</td>
<td>12</td>
<td>108</td>
<td>67</td>
<td>✓</td>
</tr>
<tr>
<td>○</td>
<td>Pendant</td>
<td>Dedicated LED</td>
<td>3</td>
<td>16</td>
<td>48</td>
<td>60</td>
<td>✓</td>
</tr>
<tr>
<td>──────</td>
<td>Undercabinet</td>
<td>Dedicated LED</td>
<td>11</td>
<td>8.5</td>
<td>93.5</td>
<td>51</td>
<td>✓</td>
</tr>
</tbody>
</table>

**CONTROLS**

- $\$\text{Switch} \quad $D-VS Dimmer switch with vacancy sensor

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![Kitchen Lighting Diagram](image-url)
Compliance Requirements

1. **One high-efficacy luminaire**: Each bathroom must have at least one high-efficacy luminaire.

2. **Vacancy sensors**: Low-efficacy lighting in bathrooms must be controlled by vacancy sensors.

3. **Switch separately**: Control lighting that is integral to ceiling fans separately from the ventilation.

Recommendations

1. **Choose UL rating — damp or wet**: Use luminaires that are rated appropriate for use in damp areas.

2. **Select high-CRI sources**: Choose luminaires and lamps that provide accurate color rendering to support hygiene and cosmetic tasks in the bathroom.

3. **Consider barriers**: Use a high-efficacy recessed downlight over the shower when a shower curtain or door limits ambient lighting.

4. **Prevent shadows**: Position bath bars or sconces vertically (parallel with the sides of mirrors as opposed to overhead) to distribute light more evenly.

5. **Add occupancy sensors and dimmers**: Installing dimmers and occupancy sensors adds amenity and convenience while maximizing energy savings potential.

6. **Make storage spaces more functional**: Use surface-mounted lights in deep cabinets and closets to spread light evenly on shelving and supplement lower ambient light levels.

7. **Design for safety**: If luminaires in bath or shower areas are controlled by vacancy sensors, consider installing a dual-technology device to make sure the sensor can detect occupants at all times.
## Bathroom Lighting Schedule

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Luminaire Type</th>
<th>Lamp</th>
<th>Qty</th>
<th>Watts</th>
<th>Total Watts</th>
<th>Efficacy (lm / W)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Flush mount ceiling light</strong></td>
<td>GU-24 base LED</td>
<td>1</td>
<td>15</td>
<td>15</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td><strong>Recessed downlight</strong></td>
<td>GU-24 base LED</td>
<td>1</td>
<td>12</td>
<td>12</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td><strong>Vertical bath bar</strong></td>
<td>Dedicated LED</td>
<td>2</td>
<td>15</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>

**CONTROLS**  
$ Switch
Compliance Requirements

1. **High efficacy and controls:** High-efficacy luminaires are required in garages, laundry rooms and utility rooms, and these must be controlled by a vacancy sensor.

2. **Garage door openers:** Lighting integral to garage door openers does not have to be high efficacy when there are no more than two screw-base sockets integrated by the manufacturer and the lights automatically turn ON and OFF.

Recommendations

1. **Ensure light levels are up to the task:** Ensure general light levels are sufficient for navigation from the garage to the house, but provide much more light in areas where auto repairs take place or power tools may be used, etc. IESNA recommends light levels up to 20 times higher for these types of task areas.

2. **Switch task lighting separately:** Task lighting, such as undercabinet lighting, helps make work areas safer, more comfortable and more energy efficient. Place task lighting on a separate switch from general lighting.

3. **Choose ultrasonic or dual-technology vacancy sensors:** Compared to standard passive infrared (PIR) vacancy sensors, ultrasonic and dual-technology sensors are less likely to turn OFF while occupants are behind cars or other objects.
## Garage Lighting Schedule

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Luminaire Type</th>
<th>Lamp</th>
<th>Qty.</th>
<th>Watts</th>
<th>Total Watts</th>
<th>Efficacy (lm / W)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linear surface mount</td>
<td>Dedicated LED</td>
<td>3</td>
<td>51</td>
<td>154</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Undercabinet (not permanently installed)</td>
<td>Dedicated LED</td>
<td>4</td>
<td>11</td>
<td>42</td>
<td>61</td>
</tr>
</tbody>
</table>

**CONTROLS**  
$ Switch  
$VS Switch with vacancy sensor
OTHER ROOMS
Section 150.0(k)7

This category covers any room or area that is not a kitchen, bathroom, laundry room, garage, or utility room, including:

- Bedrooms
- Living rooms
- Home offices
- Dining rooms (if switched separately from kitchens)
- Nooks, if switched separately from kitchen lighting
- Hallways
- Attic spaces
- Closets 70 ft² and larger

Compliance Requirements
Three compliance options are available for permanently installed lighting in this residential space category:

1. High-efficacy lighting
2. Low-efficacy lighting controlled by a vacancy sensor
3. Low-efficacy lighting controlled by a dimmer switch

These options may be used in combination with one another; for example, high-efficacy downlights and dimmable low-efficacy track lights — both on separate dimmer switches — may be installed in the same living room.

Choose high-efficacy luminaires AND dimmer switches to exceed code requirements, improve efficiency and make lighting adjustable in areas like bedrooms, living rooms and dining rooms, where different activities call for varying light levels.

Recommendations

1. In large living rooms and dining rooms, layer ambient, task and accent lighting to reduce shadows and create visual interest.
2. Provide separate switches for different layers of lighting to allow residents control and reduce energy use.
3. When using ceiling fans with light kits, be sure the fan and light can be switched separately. Select a dimmable fan light and be sure the dimmer switch is compatible.
Living Rooms

1. Track lighting is typically considered low-efficacy. Be sure to install low-efficacy track lights on a dimmer switch, or use a vacancy sensor, to comply with code requirements.

Hallways

1. Use high-efficacy luminaires with three-way switching.
2. Lighting should be controllable from all points of entrance.
3. Combine high-efficacy luminaires with vacancy sensors to maximize efficiency.

Living Room Lighting Schedule

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Luminaire Type</th>
<th>Lamp</th>
<th>Qty.</th>
<th>Watts</th>
<th>Total Watts</th>
<th>Efficacy (lm/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recessed downlight</td>
<td>GU-24 base LED</td>
<td>8</td>
<td>12</td>
<td>96</td>
<td>67</td>
</tr>
<tr>
<td></td>
<td>Track light</td>
<td>Dedicated LED</td>
<td>3</td>
<td>18</td>
<td>54</td>
<td>69</td>
</tr>
<tr>
<td></td>
<td>Spot downlight</td>
<td>Dedicated LED</td>
<td>3</td>
<td>10</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td></td>
<td>Inside cabinet</td>
<td>Dedicated LED</td>
<td>2</td>
<td>8.5</td>
<td>17</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Ceiling fan with light kit</td>
<td>Dedicated LED</td>
<td>1</td>
<td>20</td>
<td>20</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Wall sconce</td>
<td>GU-24 base LED</td>
<td>3</td>
<td>9.7</td>
<td>29.1</td>
<td>93</td>
</tr>
</tbody>
</table>

CONTROLS $D_\text{Dimmer switch}$
Compliance Requirements

1. **High efficacy or controls:** All lighting attached to the exterior of a residential building or to other buildings on the same lot must follow one of these two compliance strategies:
   - All high-efficacy lighting
   - Low-efficacy lighting controlled by a motion sensor AND a photocontrol, astronomical time clock or EMCS to automatically reduce lighting energy use when sufficient daylight is available

2. **Manual control:** Lighting must be controlled by a manual ON/OFF switch that is not capable of turning on any lighting that has been shut off by an automatic lighting control.

3. **Temporary motion sensor overrides:** Motion sensors may have a temporary override function that allows luminaires to stay switched ON regardless of motion detection, but the motion sensor must automatically reactivate within six hours.
★Recommendations

**Outdoor Lighting**

1. Sparse ground-level lighting placed strategically along pathways and area perimeters gives occupants a sense of their surroundings without over-lighting the space.
2. Where switches are less accessible, use a motion sensor.
3. Adjust motion sensor coverage to avoid unwanted triggers from street traffic or neighbors’ movements. Most sensors have controls that allow for such adjustments.
4. Control landscape lighting and other luminaires not permanently attached to building exteriors with a time clock or photocontrol. This is not required under Title 24, Part 6, but it will save energy and extend lamp life by automatically turning lights OFF during daylight hours.
5. Position adjustable heads to aim light on the objects they are meant to highlight, so as to avoid causing glare or light trespass.
6. When selecting LED luminaires, choose those with a CCT of no more than 3000 K to minimize discomfort glare and circadian disruption at night.

**Front Porch Lighting**

1. Choose LED sources for colder outdoor environments.
2. Install a motion sensor to automatically reduce energy use and light pollution when spaces are vacant. Position and adjust motion sensors so they provide light as occupants approach but are not triggered too easily.
3. Shield outdoor lighting near bedroom windows to minimize light trespass that might disrupt sleep.
4. Use a photocell or programmable timer to ensure that lights operate when desired for safety and security, but are not left on all day.
5. Consider installing LED hybrid luminaires with motion sensors. These use an LED source for continuous low-level security lighting and another source to provide brighter lighting when occupants are detected.

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**Address Signs**

Section 130.0(d)

Internally illuminated address signs must consume no more than 5 W of power. In areas where the nonresidential lighting standards apply, internally illuminated signs must not exceed 12 W/ft², and externally illuminated signs must not exceed 2.3 W/ft².

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**LED Hybrid Luminaires**

LED hybrid luminaires with motion sensors use an LED source to provide continuous low lighting for security purposes and another source, such as a CFL lamp, to provide brighter lighting when occupants are detected. Products with photosensors automatically turn on at dusk and off at dawn.
INDOOR COMMON AREAS OF MULTIFAMILY BUILDINGS

Section 150.0(k)12

Common areas in multi-family buildings include:

- Interior hallways
- Lobbies
- Entertainment rooms
- Pool houses
- Clubhouses
- Laundry facilities

Buildings up to three habitable stories high are classified as low-rise residential buildings.

 Emblem Compliance Requirements

In low-rise multifamily residential buildings where common areas constitute 20% or less of the building’s total floor area, permanently installed interior lighting must be either:

1. High efficacy OR
2. Controlled by an occupancy sensor

In low-rise multifamily residential buildings where common areas constitute more than 20% of the floor area, permanently installed interior lighting must:

1. Comply with non-residential standards (Sections 110.9 through 141) AND
2. Lighting in corridors and stairwells must be controlled by occupancy sensors that reduce lighting power by at least 50%

High-rise multifamily residential buildings (over three habitable stories) must meet the nonresidential standards for permanently installed indoor lighting in all common areas.

★ Recommendations

1. Use occupancy sensors to maximize energy savings. This will put most residential common areas in compliance with the standards. Options are available that turn lights OFF when an area is vacant or offer dual-level lighting.
2. Accommodate elderly or visually impaired residents with high-quality lighting that is bright without causing glare. Lighting should minimize shadows while offering enough contrast to aid in distinguishing objects and supporting depth perception.
3. Check that lighting for staircases and in stairwells provides good contrast between treads and risers.
OUTDOOR COMMON AREAS OF MULTIFAMILY BUILDINGS

Section 150.0(k)9

Low-rise multifamily buildings are subject to the same outdoor lighting requirements as single-family buildings (see page 36), but outdoor lighting in the following areas may comply with either the residential or nonresidential standards:

- Private patios
- Entrances
- Balconies
- Porches
- Residential parking lots and carports for seven or fewer vehicles
- High-rise multifamily buildings

All outdoor lighting must comply with the chosen set of standards—mixing requirements from the residential and nonresidential standards is not allowed. However, any outdoor lighting attached to the building that is controlled from inside the dwelling unit must meet the residential requirements. Outdoor lighting attached to the building that is not controlled from inside the dwelling unit must adhere to the nonresidential requirements.

Parking Lots, Carports, and Garages

Residential requirements for up to seven vehicles: Parking lots and carports for fewer than eight vehicles must adhere to the basic outdoor residential lighting requirements:

1. High-efficacy lighting OR
2. Low-efficacy lighting with controls

Nonresidential requirements for eight or more vehicles: Parking lots, carports and parking garages designed for eight or more vehicles are required to meet the nonresidential lighting requirements, including lighting power density limits (Sections 130.2 and 140.7).
A

**Accent lighting:** Directional or localized light used to focus attention on a specific architectural or design element of a building’s interior or exterior.

**Accessible:** Capable of being reached fairly easily for operation, repair or inspection. Accessible components may still require removal or opening of access panels, doors or similar obstructions.

**Ambient lighting:** Also known as **General lighting.** Lighting designed to provide a substantially uniform level of illumination throughout an area, exclusive of any provision for special visual tasks or decorative effect.

**Approval by the Commission:** Approval by the California Energy Commission under Section 25402.1 of the Public Resources Code.

**Astronomical time switch control:** An automatic lighting control device that switches lights on or off at dusk or dawn, or at specified times of the day, to prevent energy waste during periods when daylight is available.

B

**Bathroom:** A room or area containing a toilet, a sink used for personal hygiene, a shower or a tub.

C

**California Energy Commission:** The California State Energy Resources Conservation and Development Commission.

**Carport:** A covered, open-sided structure used solely for the purpose of parking vehicles, consisting of a roof over the parking area. Carports typically are free standing or projected from the side of the building and one or two car lengths deep.

**Chandelier:** A ceiling-mounted luminaire that uses glass, crystal, ornamental metals, or other decorative materials. A chandelier may be mounted close to the ceiling or suspended. Typically used as a significant element of interior architecture.
**Closet:** A non-habitable room used to store linens, household supplies, clothing, or non-perishable food items, which is not a hallway or passageway. Closets smaller than 70 ft² are exempt from many Title 24, Part 6 requirements.

**Color Rendering Index (CRI):** The current industry standard for measuring how accurately a light source renders the colors of the objects it illuminates when compared to an ideal light source. The maximum CRI value is 100.

**Common areas:** Common areas include interior hallways, pool houses, reading rooms, and laundry rooms.

**Correlated Color Temperature (CCT):** Expressed in Kelvin (K), CCT indicates the warmth or coolness of light emitted from a particular source. Light sources with a low CCT (2700–3000K) have a warmer, more reddish appearance than those with higher CCT values (4000–6500K, for example), which appear cooler, or more bluish, in color.

**D**

**Dimming, continuous:** Also known as full-range dimming. A lighting control method that is capable of varying the light output of lamps over a gradual range from full light output to OFF (zero lumen output).

**Dimming, stepped:** A lighting control method that varies the light output of lamps in one or more predetermined discrete levels between full light output and OFF.

**Dining area:** An area or room where meals are eaten. May be attached to the kitchen or in a separate space.

**Electrical box:** Also called a junction box or electrical junction box. A plastic or metal container for electrical circuits where the main electrical service from the grid is distributed throughout the building.

**Efficacy, lamp:** Lamp efficacy indicates how much light is produced by a lamp or lighting system for the amount of electrical power consumed. The quotient of rated initial lamp output (lumens) divided by the rated lamp power (watts), without including auxiliaries such as ballasts, transformers, and power supplies.

**Energy Management Control System (EMCS):** A computerized control system designed to regulate the energy consumption of a building by controlling the operation of an energy-consuming system. An EMCS is capable of monitoring environmental and system loads, adjusting operations to optimize energy usage, and responding to demand response signals.

**Exhaust fan:** A fan in a wall or ceiling that moves air from within a building to outside the building. Commonly located in bathrooms and kitchens.

**Electricity:** The generation, transmission, and distribution of electrical energy for the purpose of lighting, heating, cooling, and other electrical devices.

**Fluorescent:** A low-pressure mercury electric-discharge lamp in which a phosphor coating transforms some of the UV energy generated into visible light.

**F**

**Garage:** A non-habitable building or portion of a building, attached to or detached from a residential dwelling unit, in which motor vehicles are parked.

**Glare:** The uncomfortable or visually impairing effect of stray light, often resulting from a light source placed directly in an occupant’s field of view.

**GU-24:** A lamp holder and socket configuration, based on the International Energy Consortium coding system, where “G” stands for the broad type of two or more projecting contacts (pins or posts), “U” distinguishes between lamp and holder designs of similar but not interchangeable types, and “24” indicates 24 millimeters between the center points of the electrical contact posts.

**H**

**High intensity discharge (HID) lamp:** A point-source, electric-discharge lamp in which the arc producing light is contained within a secondary bulb. HID lamps are typically used in exterior lighting applications such as parking areas. Examples include metal halide and high-pressure sodium lamps.

**High-efficacy luminaires:** Luminaires classified as high efficacy under Title 24, Part 6 must satisfy the criteria. They may contain only high-efficacy lamps or high-efficacy LED light sources. They cannot contain a socket compatible with low-efficacy lighting systems.

**High-rise residential building:** A building, other than a hotel/motel, of Occupancy Group R-2 or R-4 with four or more habitable stories.
**Incandescent lamp**: An electric lamp in which a filament gives off light when heated by an electric current.

**Kitchen**: A room or area with cooking facilities and/or an area where food is prepared.

**Lamp**: The lighting industry term for a light source, such as a light bulb or fluorescent tube.

**Laundry room**: A non-habitable room or space that contains plumbing and electrical connections for a washing machine and/or clothes dryer.

**Light-emitting diode (LED)**: A solid-state diode that is constructed to emit colored or white light. The acronym LED is often used to refer to an LED component, device, or package.

**Hybrid LED luminaire**: A complete lighting unit consisting of both an LED light source and a non-LED light source.

**LED lamp**: An LED component, device or package, and other optical, thermal, mechanical, and electrical (control circuitry) components with an integrated LED driver (power source) and a standardized base that is designed to connect to the branch circuit via a standardized base, lamp holder or socket.

**LED luminaire**: A complete LED lighting unit, consisting of a light source and driver together with parts to distribute light, to position and protect the light source, and to connect the light source to a branch circuit. The light source itself may be an LED component, package, device, array, module, source system, or lamp. The LED luminaire is intended to be connected directly to a branch circuit.

**Light trespass**: A form of light pollution that occurs when light spills into areas where it is not useful or wanted, for example, when outdoor lighting spills into neighboring interior spaces.

**Line-voltage socket**: Line-voltage sockets pair with a variety of screw, pin and bayonet bases (also called holders). Line-voltage sockets do not include a transformer, ballast or power supply between the wires connected to the luminaire and the lamp. Only GU-24 line-voltage luminaires can qualify as high efficacy under Title 24, Part 6.

**Low-efficacy luminaire**: Per Table 150.0-A of Title 24, Part 6, a low-efficacy luminaire is one manufactured or rated for use with: a line-voltage or low-voltage lamp holder (socket) capable of accepting a low-efficacy lamp, such as an incandescent lamp; track lighting and similar flexible lighting systems; conversions between screw-base and pin-base sockets; electrical boxes used for a luminaire or ceiling fan; uncertified LED light sources; mercury vapor lamps.

**Low-rise residential building**: A building, other than a hotel/motel, that is of Occupancy Group R-2, multi-family with three or fewer habitable stories; or a single-family residence of Occupancy Group R-3; or a U-building located on a residential site.

**Lumen**: Unit of measurement for the amount of light emitted by a light source.

**Luminaire**: Also commonly referred to as a light fixture. A complete lighting unit consisting of a lamp and the parts designed to distribute the light (lens, reflector), to position and protect the lamp (housing), and to connect the lamp to the power supply (ballast, transformer).

**Luminance (L)**: The term used to describe the intensity of light (flux) reflected from a surface in a given direction. It is measured in candelas per square foot ($\text{cd/ft}^2$) or candelas per square meter ($\text{cd/m}^2$).

**Luminous flux**: The rate at which a light source emits visible light. This “flow rate” of light is measured as lumens over time.

**Motion sensor**: A device that automatically controls outdoor lighting systems based on occupancy. Devices used to control indoor lighting systems are called occupant sensors. Also often called occupancy sensors, occupant-sensing devices or vacancy sensors.

**Multi-level lighting control**: A lighting control device that reduces lighting power in multiple steps while maintaining a reasonably uniform level of illuminance throughout the area controlled.
**Multi-family building:** A building containing multiple dwelling units that share common walls and may also share common floors or ceilings. Examples include apartments and dormitories.

**Multi-scene programmable switch:** A lighting control device that is capable of setting light levels at pre-established settings throughout a continuous range.

**N**

**Nook:** A small, often recessed section of a room, such as a corner area adjacent to a kitchen (“breakfast nook”). Under Title 24, Part 6 lighting in kitchen nooks is counted as separate from kitchen lighting if it is switched separately.

**O**

**Occupancy sensor:** Also known as an occupancy-sensing device, occupant sensor, or vacancy sensor. A device that automatically turns indoor lighting off, and sometimes on, based on occupancy or vacancy. Vacancy sensors are a type of occupancy sensor that automatically turns lights off within 30 minutes of vacancy but requires lights be turned on manually. Motion sensors control outdoor lighting systems.

**Other rooms:** Any room or area that is not a kitchen, bathroom, garage, closet 70 ft² and larger, laundry room, or utility room, e.g., dining rooms, family rooms, home offices, bedrooms, attic spaces, hallways, and closets smaller than 70 ft².

**Outdoor lighting, residential:** Permanently installed luminaires that provide lighting for private patios, entrances, balconies, and porches.

**P**

**Parking area:** The area of a parking garage used for parking and maneuvering vehicles on a single floor, and which is not the roof of a parking structure.

**Parking garage:** A covered building or structure for the purpose of parking vehicles. Consists of at least a roof over the parking area enclosed with walls on all sides. May have fences, rails, partial walls, or other barriers in the place of walls. Parking garages have entrances and exits, and include space for vehicle maneuvering to reach the parking spaces. If the roof of a parking structure also is used for parking, the section without an overhead roof is considered a parking lot instead of a parking garage.

**Parking lot:** An uncovered area used for parking vehicles. Includes some parking structure roofs.

**Pendant:** A ceiling-mounted luminaire that is suspended, either close to the ceiling or closer to task surfaces. Pendant luminaires are generally a less formal choice than a chandelier.

**Permanently-installed lighting:** All luminaires attached to the inside or outside of a building site, including track and flexible lighting systems; lighting attached to walls, ceilings, columns, inside or outside of permanently installed cabinets, internally illuminated case work, mounted on poles, in trees, or in the ground; lighting attached to ceiling fans; and lighting integral to exhaust fans other than exhaust hoods in cooking equipment. Does not include portable lighting or lighting that is installed by the manufacturer in appliances.

**Photocontrol:** An electric device that detects changes in illumination levels then automatically controls lighting load accordingly, e.g., turning luminaires on at dusk or off at dawn.

**Pin-base luminaire:** A luminaire, or fixture, that accepts lamps with a pin base. The pin base performs the same function as the screw base, but with greater efficiency. GU-24 pin-base luminaires are meant to prevent the use of low-efficiency lamps in high-efficiency luminaires.

**Portable lighting:** Lighting that is not permanently installed or hard-wired but uses a plug-in connection for electric power, e.g., freestanding floor or table lamps, luminaires attached to modular furniture, workstation task lights, lights attached to workstation panels, movable displays, and other impermanent luminaires. Code requirements for portable lighting are covered by Title 20 Appliance Efficiency Regulations.

**R**

**Readily accessible:** Capable of being reached quickly for operation, repair, or inspection, without climbing or removing obstacles, or resorting to using portable access equipment.

**Residential compliance manual:** The Residential Compliance Manual was developed by the California Energy Commission,
under Section 25402.1 of the Public Resources Code, to aid designers, builders and contractors in meeting the California Building Energy Efficiency Standards (Title 24, Part 6).

**Residential occupancy types:**

**Group R-1:** Residential occupancies containing sleeping units where the occupants are primarily transient, including: boarding houses, hotels, motels, and efficiency dwelling units.

**Group R-2:** Residential occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent, including: apartments, boarding houses, convents, dormitories, fraternities and sororities, hotels, live/work units, monasteries, motels, and vacation timeshare properties.

**Group R-2.1:** Occupancy group including buildings, structures, or parts thereof that house clients who live in a supervised residential environment that provides personal care services. This includes: assisted living facilities, residential care facilities, retirement facilities, halfway houses, correctional centers, and recovery or treatment facilities.

**Group R-3:** Residential occupancies with primarily permanent occupants and not classified as Group R-1, R-2, R-2.1, R-3.1, R-4 or I. This includes: buildings containing fewer than two dwelling units; adult care facilities that provide accommodations for six or fewer clients of any age for less than 24 hours (adult day programs); child care facilities that provide accommodations for six or fewer clients of any age for less than 24 hours; congregate residences.

**Group R-4:** Residential occupancies including: buildings arranged for occupancy as residential care/assisted living facilities, including more than six ambulatory clients, excluding staff.

**Group U:** Buildings and structures not classified in any specific occupancy that must adhere to fire and safety regulations. Examples include: barns, carports, greenhouses, livestock shelters, private garages, sheds, and stables.

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**S**

**Sconce:** A wall-mounted ornamental luminaire.

**Screw-base luminaire:** A luminaire, or fixture, that accepts lamps with a screw base, e.g., incandescent, CFL or LED replacement lamps. Screw-base luminaires are classified as low efficacy under Title 24, Part 6 because they are compatible with low-efficacy lamps.

**Stairs:** A series of steps providing passage from one level of a building to another.

**Storage building:** A non-habitable detached building used to store tools, garden equipment, or miscellaneous items.

**Task lighting:** Lighting that is designed specifically to illuminate a task location, and that is generally confined to the task area.

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**V**

**Vacancy sensor:** An occupant sensor that requires occupants to turn lights on manually but automatically turns the lights off soon after an area is vacated. Also called a manual-on occupancy sensor or manual-on/automatic-off sensor.

**W**

**Watt:** The unit of measure for the electric power used by a lamp or luminaire.
COMPLIANCE RESOURCES

California Advanced Lighting Control Training Program (CALCTP)
calctp.org
CALCTP educates, trains, and certifies licensed electrical contractors and state-certified general electricians in the proper installation, programming, testing, commissioning, and maintenance of advanced lighting control systems.

California Energy Commission Appliance Efficiency Database
appliances.energy.ca.gov
The Appliance Efficiency Database contains all fixtures, systems, lamps, and devices currently certified to the California Energy Commission by their manufacturers as meeting applicable efficiency standards. The database allows users to search by category for each appliance type listed in the database.

California Lighting Technology Center
cltc.ucdavis.edu/title24
The California Lighting Technology Center at UC Davis conducts research, development and demonstrations of state-of-the-art outdoor lighting systems. CLTC was established with support from the California Energy Commission. The center offers training programs on energy-efficient lighting solutions that meet or exceed Title 24, Part 6.

Energy Code Ace
energycodeace.com
This new site developed by the California Statewide Codes & Standards Program provides free tools, trainings and resources to help users meet the latest Title 24, Part 6 requirements. Visitors can download fact sheets, trigger sheets, checklists, and information on classes (online or in person) and workshops.

Energy Standards Hotline
Toll-free in California: (800) 772-3300
Title24@energy.ca.gov
The Energy Standards Hotline is a resource for any questions regarding the 2013 Title 24, Part 6 standards. The hotline is available Monday through Friday, 8 a.m – 12 p.m. and 1 – 4:30 p.m.

Title 24 Building Energy Efficiency Standards
energy.ca.gov/title24/2013standards
The 2013 Building Energy Efficiency Standards (Title 24, Part 6) are available as a PDF on the Energy Commission website. This includes the standards for residential lighting, along with standards for all other residential applications. The standards should be the first resource for any contractor, builder, or designer seeking information on Title 24, Part 6 regulations.

CLASSES

California Center for Sustainable Energy (CCSE) Events and Workshops
energycenter.org/events

Building Operator Certification California Training Schedule
theboc.info/ca/ca-schedule.html

Building Owners and Managers Association Online Education Schedule
boma.org/education/Pages/default.aspx

California Association of Building Energy Consultants Title 24 Resources
cabec.org/title24info.php

MANUFACTURER TRAINING CENTERS

Acuity Brands
Center for Light & Space
Berkeley, CA
acuitybrands.com

Eaton’s Cooper Lighting Business
Online Design Center
cooperindustries.com

Lutron
California Experience and Training Center
Irvine, CA
lutron.com

UTILITY EDUCATION & DEMONSTRATION CENTERS

All or most of these California utility centers host Title 24 lighting classes. They also house lighting technology demonstration spaces and tool lending libraries that can provide visitors with energy and light meters, data loggers, lighting design software, lighting design manuals, and other resources.

Online calendars list training events and workshops, and some websites offer virtual video tours of the demonstration centers, as well as information on resources, services and more. Visitors and class participants can also learn about utilities’ rebate and incentive programs.

Pacific Gas and Electric Company (PG&E)
pge.com
  Pacific Energy Center (PEC), San Francisco
  Energy Training Center, Stockton

Sacramento Municipal Utility District
smud.org
  Energy & Technology Center, Sacramento

San Diego Gas & Electric
sdge.com
  Energy Innovation Center, San Diego

Southern California Edison (SCE)
sce.com
  Energy Education Centers
  Irwindale, Tulare and on-location in other cities
For more information and resources about Title 24, Part 6, visit the CLTC website at cltc.ucdavis.edu/title24.