If recessed lights are used in a ceiling with an unconditioned space above it, use only Underwriters Laboratory (UL) rated, and meet ASTM E283 requirements.

Consider incandescent flood lights with combined phosphors and modern sensors in the place of other security lighting options.

In most applications, use fluorescent, HID, or low-pressure sodium lights unless occupancy detector controls.

- Occupancy detector controls.
- Energy Star
- Motion detectors to activate security or utility lighting

When illuminated by a light source and is measured in lumens. By way of reference, a 100-watt incandescent light bulb produces 1600 lumens. The quantity of light produced by a lamp is measured in lumens, the purpose of all lighting is to produce illumination (i.e., to provide light on a surface). The intensity of light is measured in lux.

Computers use color temperature to reference the color of light emitted by a light source. Color temperature is measured in Kelvin (K) temperature. Color temperature affects the perceived color of objects under those conditions. Higher Kelvin temperatures (3000 to 3500 K) are considered cool and lower temperatures (2700 to 3000 K) are considered warm.

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**INTERIOR LIGHTING OPTIONS**

**BULB COMPARISON CHART**

<table>
<thead>
<tr>
<th>Bulb Type</th>
<th>Color Temperature (Kelvin)</th>
<th>Efficacy (Lumens/Watt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incandescent</td>
<td>5,600-6,000</td>
<td>10-17</td>
</tr>
<tr>
<td>Compact Fluorescent</td>
<td>4,100-5,000</td>
<td>20-30</td>
</tr>
<tr>
<td>CFL</td>
<td>4,100-5,000</td>
<td>100-150</td>
</tr>
<tr>
<td>LED</td>
<td>3,000-6,000</td>
<td>80-120</td>
</tr>
</tbody>
</table>

**INDOOR LIGHTING TECHNOLOGIES**

**Incandescent lamps** are the most commonly used outdoor lights around homes. However, they are not always the best choice for outdoor use because they do not operate well at temperatures below 0°F.

**Efficient Lighting Strategies**

**Exterior lighting for homes generally serves one or a combination of purposes:**

- **Safety:** Exterior lighting can illuminate the exterior of the house and landscape, security—placed on or near the house to control entry into premises; or placed on the ground near the house or driveway, and security—illuminating an area with a bright, white light.

- **Utility:** Exterior lighting is useful for providing general illumination in areas where they stay on for hours at a time.

- **Aesthetics:** Exterior lighting is used to create a specific mood or atmosphere, such as for outdoor parties or events.

**EXTERIOR LIGHTING OPTIONS**

**Motion Sensors**

- Automatically turn outdoor lights on when someone enters an area and turn them off after a certain period of time (e.g., 10-15 minutes).

**Time Controls**

- Used to turn outdoor lights on and off at scheduled times, such as at dawn and dusk.

**Photosensors**

- Sense light levels and applications for security lights are needed (when motion is detected) and turn them off a short while later. They are useful for very outdoor security and utility lighting by incandescent lamps.

**Security Lights**

- Include floodlights, spotlighting, and spotlights that are used to provide additional security at night.

**Ultrasonic Sensors**

- Detect sound and are used to control lights in areas where they are needed (e.g., over garage doors) and turn them off at a certain hour of the night (e.g., 11 P.M.).

**Photosensors**

- Are used to turn outdoor lights on and off at scheduled times, such as at dawn and dusk.

- They are useful with all forms of outdoor lighting.
Advantageous for daylighting and for moderating seasonal locations of windows should be based on the cardinal
Energy-efficient lighting design principles include the following:

INTERIOR LIGHTING OPTIONS

**OUTDOOR LIGHTING OPTIONS**

**INDOOR LIGHTING TECHNOLOGIES**

- **FILAMENT LAMPS**
  - Produce a warm light and provide excellent color rendition. They have a low efficacy and a short average operating life (750 to 2500 hours).
- **A"-TYPE INCANDESCENT BULBS**
  - Are available in a variety of shapes and sizes.
- **TUNGSTEN HALIDE LAMPS**
  - Provide excellent color rendition. Reflector (R) and parabolic aluminized reflector (PAR) lamps direct light in a desired direction. All three are rugged and contribute little to solar heating during the winter.

- **GENERATION-TWO TECHNOLOGIES**

  - **IMPROVED ELECTROMAGNETIC BALLASTS**
    - Maintain the life of the lamp (2000 to 4000 hours), and are often used for replacement CFLs.
  - **REFLECTOR (R) AND PARABOLIC ALUMINIZED REFLECTOR (PAR) LAMPS**
    - Provide excellent color rendition. They have a low efficacy and a short average operating life (750 to 2500 hours).

- **FLUORESCENT LAMPS**

  - These are frequently sold with built-in or separate electronic ballasts and that use plug-in (pin) CFLs.
  - Have an efficacy of 50 to 140 lumens per watt. Low-pressure sodium lamps have the highest efficacy of any lighting system. Low-pressure sodium lamps are the most efficient, but produce a bright, white light with fair color rendition. They have a lifetime of about 60,000 hours, and are more efficient than incandescent lamps. Metal halide lamps produce a warm light, while iron and color rendition. They have a lifetime of about 10,000 hours, and are more efficient than incandescent lamps. Metal halide lamps produce a bright, white light with fair color rendition. They have a lifetime of about 10,000 hours, and are more efficient than incandescent lamps.

**FILAMENT LAMPS**

- **INCANDESCENT LIGHT BULBS**
  - Produce a warm light and provide excellent color rendition. They have a low efficacy and a short average operating life (750 to 2500 hours).
  - Are available in a variety of shapes and sizes.
  - Are the most commonly used outdoor lighting fixtures.
  - Fluorescent lamps are not reliable for outdoor use because they may not operate well at temperatures below 40°F. However, some CFLs are specially designed to operate at low temperatures down to -20°F for outdoor use.
  - High-intensity discharge (HID) lamps provide much more light and are more energy-efficient. Special ballasts are needed to allow driving of fluorescent lamps.

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Lighting Design Concepts

Energy-efficient lighting design focuses on methods and materials that improve both quality and efficiency of lighting. Energy-efficient lighting design principles include the following:

- Keep in mind that too much light is not necessarily desirable. Human performance depends on quality and light as well as quantity.
- Match the amount and quality of light to the performed function.
- Use efficient lighting to control glare, comfort, and systems.

The use of daylighting:

Daylighting is the use of windows and skylights to bring light into the home. Today's highly efficient windows and skylights permit most winter sunlight into the house, for example. South-facing windows are most advantageous for daylighting and for moderating seasonal temperatures because they allow most winter sunlight into the home. Today's highly efficient windows and skylights permit most winter sunlight into the home. Today's highly efficient windows and skylights permit most winter sunlight into the home. Today's highly efficient windows and skylights permit most winter sunlight into the home.

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Interior Lighting Options

- Daylighting is the use of windows and skylights to bring light into the home. Today’s highly efficient windows and skylights permits...
Efficient Lighting Strategies

INITIAL DESIGN RECOMMENDATIONS

Home designers and builders can reduce lighting energy use by selecting and installing fixtures and sources that use energy more efficiently, and by installing controls to reduce the amount of time lights are on.

- **Maximize the use of daylighting.**
  - Install fluorescent light fixtures for all ceiling- and wall-mounted fixtures that will be on for more than 2 hours each day.
  - Maximize the use of daylighting.

- **Consider incandescent flood lights with combined phosphorescent and metal halide in the place of other security lighting options.**

- **Use fluorescent, HID, or low-pressure sodium lights unless specified by contract.**

- **Motion detectors to actuate security or utility lighting.**

- **Photosensors and motion sensors in the place of other security lighting options.**

- **Works with state and local regulatory groups to improve energy savings opportunities to both manufacturers of materials, equipment, and appliances; and end users of energy.**

- **Promotes energy/money saving innovations, working closely with regulatory groups to improve energy saving opportunities to both manufacturers of materials, equipment, and appliances; and end users of energy.**

- **Buildings that are more energy efficient, comfortable, and affordable…that’s the message of authors expressed herein disclosed. The views and opinions do not necessarily state or reflect those of the United States government or any agency thereof.**

LIGHTING PRINCIPLES AND TERMS

- **Light Quality**
  - The quantity of light emitted by lamps is measured in lumens. By way of reference, a 100-watt incandescent lamp emits about 1750 lumens.
  - The quantity of light produced by a lamp is measured in lumens, the purpose of all lighting is to produce illumination (i.e., to provide light on a surface). The intensity of light is measured in lux. A footcandle is the illumination produced by one candlepower of light one foot away.

- **Durores**
  - Security and utility lighting does not need to be bright to be effective.

- **Durations**
  - Footcandles of illumination is sufficient. For detailed work, 200 footcandles of illumination is sufficient. For most home and office work, 30-50 footcandles of illumination is sufficient. For fine detail work, only 5 footcandles may be sufficient.

- **Emissivity**
  - The color temperature of incandescent lamps is measured in kelvins (K) temperature. Confusingly, higher kelvins (K) temperature is preferred for visual tasks because it produces more light from little electricity. The quantity of light emitted by lamps is measured in lumens. By way of reference, a 100-watt incandescent lamp emits about 1750 lumens.

- **Efficiency**
  - Color temperature is measured in kelvins (K) temperature. Confusingly, higher kelvins (K) temperature is preferred for visual tasks because it produces more light from little electricity.

- **Color Rendition Index (CRI)**
  - The quantity of light emitted by lamps is measured in lumens. By way of reference, a 100-watt incandescent lamp emits about 1750 lumens.

- **Lighting**
  - The plant value of the CRI (100) is the color rendering of incandescent light. A light source with a CRI of 80 or higher is considered acceptable for most indoor residential applications.

- **Glare**
  - One of the important advances of the 20
  - There are varied lighting technologies for all lighting situations. Consideration should be given to energy-efficient lighting fixtures that are on for more than 2 hours a day.

- **Illumination**
  - The traditional incandescent bulb with screw base currently provides most household illumination. Use of new lighting technologies can reduce lighting energy use in homes by 50 to 70 percent. Advances in lighting controls further reduce energy savings by reducing the amount of light on at any time and shutting off when not needed. The cost of new lighting technologies also offer a new amenity—lighting that comes on automatically when it is needed. Recent technological improvements allow homeowners to substantially reduce the amount of light needed for quality lighting.

- **Intensification**
  - Change the apparent color of an object. The combination of many colors. Light sources that are designed to change the appearance of an object. The Color Rendering Index (CRI) is a tool used to describe the color rendering of incandescent light. A light source with a CRI of 100 is used to render colors the same way sunlight does.

- **Lighting Quality**
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- **Lighting Quantity**
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- **Lighting Scope**
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- **Luminous Flux**
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ECONOMIC ADVANTAGES OF EFFICIENT LIGHTING

Increased lighting and energy costs can add up for families, businesses, and the nation. For instance, about 3% of all electricity used in the United States is consumed by lighting. More efficient lighting choices can help reduce these costs, which can be a substantial part of a family’s or business’s budget.

BENEFITS OF ADVANCED LIGHTING

Advanced lighting controls help give homeowners and businesses greater control over their lighting systems, providing increased energy efficiency and comfort. As these controls have become more affordable and accessible to consumers, a new amenity—lights that come on automatically when needed—has become more widely available. Advanced lighting controls also offer many additional benefits, including:

- Improved lighting quality and comfort
- Reduced energy costs
- Increased safety and security
- Enhanced productivity and comfort in work and learning environments
- Improved aesthetics and ambiance
- Enhanced entertainment and enjoyment

These benefits can be achieved through a variety of advanced lighting control technologies, including:

- Motion sensors
- Presence detectors
- Daylight sensors
- Time switches
- Scene control
- Residential and commercial control systems
- Smart home technology
- Building automation systems

INDOOR/OUTDOOR LIGHTING TYPES

There are several different types of indoor and outdoor lighting, each with its own unique applications and benefits. Here are some of the most common types of lighting:

- Accent lighting: Used to highlight specific features or objects, such as artwork, architecture, or landscape elements.
- Task lighting: Designed to provide focused light for specific activities, such as reading, writing, or crafting.
- General lighting: Provides overall illumination for a room or space, such as recessed ceiling lights or floor lamps.
- Decorative lighting: Used to add visual interest and ambiance, such as chandeliers, sconces, and track lighting.
- Emergency lighting: Provides illumination in case of power failure or other emergencies, such as exit signs or emergency exit lights.
- Security lighting: Designed to deter intruders and enhance safety, such as motion-activated lights or floodlights.

Efficient lighting strategies

There are many different approaches to efficient lighting, and the best strategy for any given situation will depend on factors such as the type of lighting, the cost of electricity, and the desired results. Here are some general guidelines for choosing and using efficient lighting:

- Use energy-efficient light bulbs, such as compact fluorescent lights (CFLs) or LED lights, which use much less energy than traditional incandescent bulbs.
- Choose lights that are rated for their energy efficiency, as indicated by the Energy Star logo.
- Use dimmer switches to control the intensity of light, which can help reduce energy use and create a more comfortable environment.
- Choose lights that are appropriate for the task at hand, such as task lighting for reading or task lighting for general illumination.
- Use motion sensors to automatically turn off lights when no one is in the room.
- Consider using natural light whenever possible, such as by opening windows or using skylights.
- Use high-quality light fixtures that are designed to distribute light evenly and reduce glare.

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