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LIGHTING SIMULATION SPECIALIST
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MODULE
2

Quality Lighting for High-Performance Buildings

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CERTIFIED LIGHTING EFFICIENCY PROFESSIONAL CLEP OVERVIEW

Quality lighting in high-performance buildings is a critical aspect of their performance, sustainability, and occupant satisfaction. It involves a holistic approach that integrates human physiology, architectural design, energy efficiency, and technological advancements.

Learning Objectives

INTRODUCTION

- Quality lighting in high-performance buildings is crucial for performance, sustainability, and occupant satisfaction.
- It integrates human physiology, architectural design, energy efficiency, and technological advancements.
- Human-centric lighting design emphasizes the biological effects of light, incorporating adjustable systems mimicking natural daylight patterns.
- Key principles of quality lighting design include efficacy, uniformity, color quality, and adaptability.
- Efficacy is the amount of light produced per unit of power consumed, measured in lumens per watt (lm/W).
- Uniform lighting minimizes contrast and shadows, enhancing visibility.
- Adaptable lighting systems allow for adjustments based on time of day, tasks, or individual preferences.
- Integration with architectural design is essential for creating spaces that leverage natural light while providing artificial illumination.
- Daylighting strategies involve strategic use of natural light to reduce reliance on artificial lighting.
- Energy efficiency and sustainability are paramount in high-performance buildings, with smart lighting controls optimizing energy use.

CLIMATE CHANGE AND DECARBONIZATION POLICIES

- Climate change is a global issue triggered by human activities like burning fossil fuels, deforestation, and industrial processes.
- Key consequences include rising sea levels, increased extreme weather events, biodiversity loss, agricultural disruptions, and health issues.
- Decarbonization policies aim to reduce carbon emissions and transition to a low-carbon economy. Key strategies include transitioning to renewable energy, improving energy efficiency, carbon pricing mechanisms, sustainable transportation, and enhancing carbon sinks.
- Countries like Denmark have made significant strides in wind energy, reducing reliance on fossil fuels.
- The 2030 Agenda for Sustainable Development (SDGs) aligns with decarbonization policies, demonstrating the interconnectedness of environmental sustainability and social development.
- Examples of integrated policies include the Paris Agreement, Green New Deal, and European Green Deal.
- Effective decarbonization policies are crucial for sustainable development and the interplay between environmental sustainability and social progress.
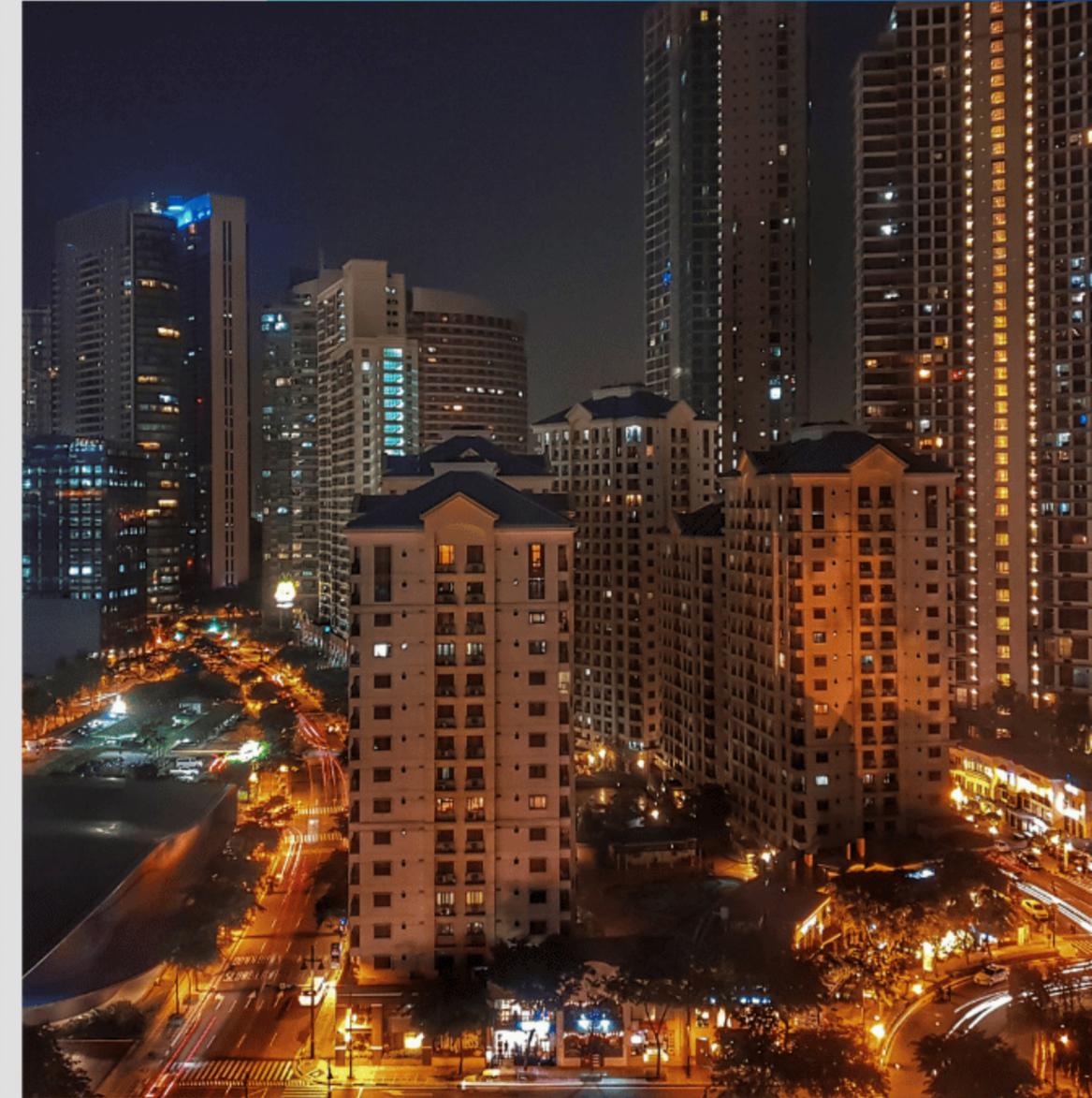
MODEL CODES, CODE-LANGUAGE STANDARDS & ENERGY CODES

- Model codes and code-language standards are technical documents that lay out the basis of a legal code, such as a building energy code.
- Standards organizations independently develop, maintain, and publish these codes, distinct from the governing bodies responsible for their enactment.
- The development of building codes can be expensive and complex, requiring more technical expertise.
- Non-profit and volunteer organizations contribute to the development process through a system of committees.
- Model codes and standards are consensus-based and developed in an open, public manner.
- Once published, states and municipalities can adopt them as is or with modifications, becoming the official code and can be enforced by compliance authorities.
- The work of the model code and standard writers is financed by the sale of copies of the published codes and standards to municipalities, design professionals, and contractors.

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MODEL CODES, CODE-LANGUAGE STANDARDS & ENERGY CODES +

- Every three to five years, model codes and standards undergo updates, releasing a new version at each update.
- The International Code Council (ICC) created the IECC (International Energy Conservation Code), a model building energy code that establishes minimum energy efficiency criteria for building design and construction.
- The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) developed and maintained the ANSI/ASHRAE/IESNA 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings.
- Both the IECC and ASHRAE 90.1 contain mandatory and prescriptive requirements that lay out the design parameters of various building systems.
- Both model codes offer a performance path to compliance, allowing for more flexibility in the building design.

LIGHTING DESIGN MODEL CODES, CODE-LANGUAGE STANDARDS, AND ENERGY CODES +

Model Codes

- Comprehensive documents developed by national or international organizations.
- Provide guidelines for building construction and safety.
- Emphasize safety in electrical installations.
- Ensure accessibility for individuals with disabilities.
- Define the integration of lighting with architectural elements.
- Include provisions for emergency lighting in commercial buildings.

Code-Language Standards

- Specific terminologies, metrics, and methodologies used within model codes and industry regulations.
- Provide guidelines on recommended illuminance levels for various spaces.
- Define the efficiency ratings of lighting fixtures.
- Guarantee consistent interpretation of the specifications within model codes across various jurisdictions and projects.

Energy Codes

- Focus on reducing energy consumption and improving the efficiency of building systems.
- Define limits on the maximum allowable power per square foot (LPD) for lighting systems.
- Mandate the use of lighting controls to optimize energy use.
- Encourage the integration of technology in lighting design to reduce waste.
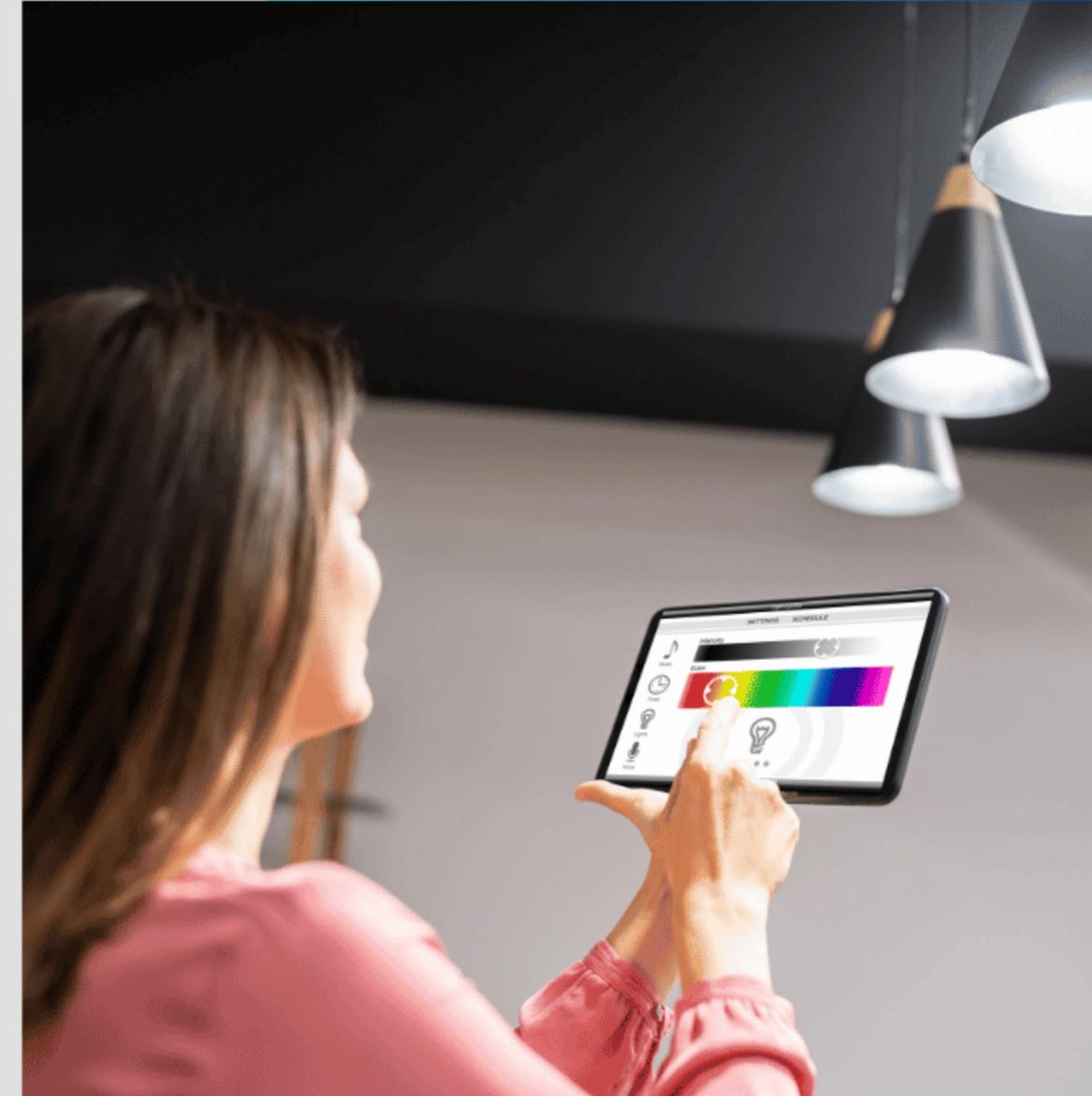
UNDERSTANDING BALLASTS AND DRIVERS IN FLUORESCENT LIGHTING

Fluorescent Ballasts

- Ballasts regulate current to fluorescent lamps and provide the starting voltage.
- They manage power consumption by controlling voltage and current supplied to the lamp.
- Magnetic and electronic ballasts are the two main types of fluorescent ballasts.
- Magnetic ballasts use electromagnetic induction to regulate current, are larger, heavier, and less energy-efficient than electronic ballasts.
- Electronic ballasts operate at a higher frequency, resulting in reduced flicker and improved energy efficiency.

Ballast Factor

- The ballast factor (BF) quantifies the efficiency of delivering light output from a fluorescent lamp.
- It can range from 0.0 to 1.0, with higher values indicating more efficient light delivery.
- Misuse of ballasts can lead to reduced lamp life, poor light output, and increased energy consumption.

UNDERSTANDING BALLASTS AND DRIVERS IN FLUORESCENT LIGHTING +

Fluorescent Sockets

- Fluorescent sockets, also known as lamp holders, secure the fluorescent tubes in place and provide electrical connectivity.
- Quality of sockets is paramount as poor connections can lead to increased resistance, causing overheating and potential failure.

Power Quality Issues (Power Factor)

- Low power factor signifies inefficient utilization of electrical power, leading to increased energy costs, overloading of electrical systems, and strain on the electrical infrastructure.
- Improving power factor in fluorescent lighting systems can be achieved by using high-efficiency electronic ballasts and implementing power factor correction capacitors.

LED/SSL Drivers

- LED drivers convert the input voltage into a suitable output for the LED, which could be constant current or constant voltage.
- High-quality drivers can achieve efficiency levels above 90% and offer dimming capabilities for dynamic control of light output.

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NET ZERO BUILDINGS (NZBS) AND REPORTING

- NZBs are structures that generate as much energy as they consume over a defined period, typically one year.
- Reporting on NZBs involves methodologies, metrics, and frameworks to quantify energy performance, assess sustainability, and communicate achievements.
- Key metrics for reporting include Energy Use Intensity (EUI), Renewable Energy Generation (REG), Carbon Emissions, and Performance Metrics Over Time.
- Data collection and monitoring involve smart metering infrastructure (AMI) and Building Management Systems (BMS).
- International frameworks like The Global Reporting Initiative (GRI) and LEED offer metrics for sustainability reporting.
- National standards in the United States, such as the Department of Energy (DOE) and ASHRAE, have established standards and guidelines for NZB performance reporting.
- Successful NZBs include the Bullitt Center in Seattle and The Edge in Amsterdam, which achieved NZE and NZC status through advanced technology and integrated monitoring systems.

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ASHRAE STANDARDS AND GUIDELINES OVERVIEW

ASHRAE/IESNA Standard 90.1-20XX: Energy Efficiency in Buildings

- Serves as a foundational guideline for energy efficiency in commercial buildings.
- Focuses on minimum energy performance requirements for building design and construction.
- Includes requirements for building envelope, mechanical systems, and lighting.

ASHRAE Standard 90.2-20XX: Energy Efficiency for Low-Rise Residential Buildings

- Provides guidelines for the design of single-family homes and low-rise multifamily buildings.
- Emphasizes energy-efficient construction practices and aims to minimize energy consumption.
- Includes recommendations for insulation and window performance, HVAC efficiency, and domestic hot water systems.

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ASHRAE STANDARDS AND GUIDELINES OVERVIEW +

ASHRAE Standard 62.1-20XX: Ventilation for Acceptable Indoor Air Quality
- Outlines minimum ventilation rates and indoor air quality (IAQ) requirements for acceptable indoor environments in commercial buildings.
- Includes a systematic approach for determining necessary ventilation rates and acceptable indoor air quality.

ASHRAE Standard 135-20XX: BACnet—a Data Communication Protocol for Building Automation and Control Networks
- BACnet facilitates interoperability among various building systems.
- Features include device communication and interoperability.

ASHRAE Standards and Guidelines for Green Buildings
- ASHRAE Standard 189.1-20XX: Guidelines for designing high-performance green buildings.
- Includes Site Sustainability, Water Use Efficiency, and Energy Efficiency.

ASHRAE STANDARDS AND GUIDELINES OVERVIEW +

ASHRAE Guideline 14-20XX: Measurement of Energy, Demand, and Water Savings

- Outlines methods for measuring energy and water savings from efficiency measures.
- Includes Measurement and Verification (M&V) protocols and Baseline Conditions.
- Analogy: Similar to a scoreboard in a sports game tracking points and progress.

ASHRAE Standard 211-20XX: Standard for Commercial Building Energy Audits

- Categorizes audits into three levels: Level 1 Audit, Level 2 Audit, and Level 3 Audit.

IEEE PQ Standard 519: Recommended Practices and Requirements for Harmonic Control in Electric Power Systems

- Focuses on power quality and guidelines for managing harmonic distortion in electrical systems.

ASHRAE STANDARDS AND GUIDELINES OVERVIEW +

International Energy Conservation Code (IECC)

- Sets minimum energy conservation requirements for residential and commercial buildings.
- Example: Adherence to the IECC to ensure energy-efficient designs.

ISO 50001: Energy Management Systems

- Provides a framework for organizations to manage and improve their energy performance systematically.
- Example: A manufacturing plant adopting ISO 50001 develops an energy management plan that identifies energy-intensive processes and sets specific reduction targets.

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INTERNATIONAL GREEN BUILDING RATING SYSTEMS: LEED CERTIFICATIONS & ACCREDITATION

- Developed by the U.S. Green Building Council (USGBC), a globally recognized framework for assessing building performance.
- Aims to minimize environmental impact while enhancing occupants' quality of life.
- Four levels of LEED certification: LEED Certified, LEED Silver, LEED Gold, and LEED Platinum.
- Rating systems tailored to different types of projects.
- Achieving LEED certification is systematic, divided into registration, application, review, certification decision, and post-certification.
- Professional accreditation offered to individuals with expertise in sustainable building practices.
- LEED certifications and professional accreditation represent significant milestones in sustainable building practices.

ENERGY STAR PROGRAM CYBERSECURITY CHALLENGES

- Established in 1992 by the U.S. EPA, ENERGY STAR is a voluntary labeling system for energy efficiency.
- The program's reliance on digital tools for data collection, reporting, and analysis has introduced cyber-security vulnerabilities.
- The program's structure involves product testing, energy consumption data, and comparative analysis against standard benchmarks.
- Cyber-security concerns include data breaches, integrity of data, phishing attacks, and insider threats.
- Strategies to address these issues include robust authentication protocols, regular security audits, and incident response planning.
- As the ENERGY STAR program expands, addressing cyber-security issues becomes increasingly crucial.
- Fostering a culture of security awareness can help safeguard the program against evolving cyber threats.

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