



Design Guide for **Sustainable Lighting:** **An Introduction to the** **Environmental Impacts** **of Lighting**



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**Design Guide for Sustainable Lighting:
An Introduction to the
Environmental Impacts of Lighting**

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should be directed to IES.

**Prepared by:
The Lighting Sustainable Lighting Committee of the
Illuminating Engineering Society of North America**

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Prepared by the IES Sustainable Lighting Committee**Jeffrey Boynton – Chair**

K. Abernathy*	B. Hostetter	T. McGowan
J. An*	C. Jones*	N. Miller*
M. Andersen	K. Kane*	S. Mooney*
J. Ashmore	H. Kaplan	D. Nelson
E. Bartholomew	A. Keller*	L. North
P. Dee*	S. LaFleur*	S. Olson*
P. Duane	M. Lane	D. Rogers*
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C. English	M. Latchford*	M. Smith
N. Ferzacca	L. Leetzow	L. Sturm*
S. Haran*	M. Lien*	P. Walitsky*
G. Heinmiller*	A. Lindstrom*	
M. Hertel*	M. Loeffler*	*Advisory
P. Horner	D. Maniccia	

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FOREWORD

The IES and the International Association of Lighting Designers (IALD) define sustainable lighting design as “meeting the qualitative needs of the visual environment with the least impact on the natural environment.” Visually effective and appealing, high quality lighting provides the greatest environmental and economic value. The intent of this Design Guide is to introduce the topic of sustainability, present its elements, and explain how it affects the design of lighting in process and product.

Sustainable lighting consists of the following elements:

- Optimizing the use of daylighting
- Minimizing the use of energy through integrated design and effective controls
- Reducing light pollution and light trespass
- Minimizing embodied environmental effects
- Specifying environmentally-preferable materials and equipment
- Ensuring system quality, flexibility, adaptability, maintainability, and durability
- Providing for optimum commissioning

Sustainable lighting needs must be addressed during each phase of the project:

- **Programming and Schematic Design**
The building site, massing, and orientation, determined in the earliest design phases, is critical to designing quality daylighting, integrating efficient electric lighting, analyzing accurate energy modeling which anticipates effective controls strategies, and establishing early commissioning performance goals.
- **Design Development and Construction Documentation**
To achieve the desired programmatic results, an integrated lighting scheme must be fully designed and specified. Specifications can address environmentally-preferable manufacturing attributes such as less toxic material content, proximity to the project site, and recycled/recyclable packaging. Energy and computer modeling can verify performance goals.
- **Construction and Commissioning**
The person responsible for the lighting design can best respond to lighting information requests and substitution proposals. The commissioning process should include a full evaluation of the lighting and control

installation to ensure that optimal performance will be realized to meet goals for energy efficiency and system integration.

Post-occupancy commissioning and measurement can evaluate occupant satisfaction and verify or enforce achievement of performance goals and occupant satisfaction.

Design and application guidelines have been included for the following topic areas:

- Lighting Quality
- Optimizing the use of Daylight
- Lighting and Health
- Light Pollution
- Maximizing Energy Efficiency
- Ensuring System Flexibility, Maintainability and Durability
- Providing Commissioning
- End of life phase, demolition, disposal and recycling/re-use considerations

0 INTRODUCTION

1.1 Background

Sustainability is an essential environmental, economic, and social issue representing the next natural progression into our evolving lighting standards and practice.

Applying sustainability to lighting design requires us to re-evaluate many of our systems choices in terms of their potential impact on the environment. Lighting systems impact the environment in a variety of ways. For example, lighting accounts for 26% of commercial building electricity demand. The percentage of source fuels varies significantly from state to state, however; overall in the US, 45% of this electricity is generated through the combustion of coal and another 23% by natural gas³. Both methods emit CO₂ and other greenhouse gases into the atmosphere, contributing to climate change and each are now scheduled to be regulated by the Environmental Protection Agency (EPA). CO₂ emissions from coal-fired electricity generation comprise nearly 80% of the total CO₂ emissions produced by the generation of electricity in the United States². The manufacturing process for lighting products consumes raw materials and energy. Products must be packaged, transported and installed. Ultimately lighting products must be disposed, recycled or re-used at the end of useful life. Additionally, it is known that portions of the lighting spectrum variously affect the growth, development, and well being of plants, animals, and humans. All of these considerations and more relate to sustainability

ABOUT THIS DOCUMENT

This Design Guide is structured into two major sections. Section 1.0 and 2.0 address lighting topics; the annexes address applications of sustainable lighting in a life cycle context.

Section 1.0 introduces sustainable design and lighting impacts. Section 2.0 is an overview of sustainable lighting design and describes nine elements that address the central issues facing the lighting practitioner today.

The next three sections are organized into three areas that address assessment and life cycle stages of lighting.

- Annex A introduces various assessment and rating systems that are used in North America and abroad to understand environmental impacts, ranging from extraction of raw materials to the benefits of high performance lighting.
- Annex B is relevant to the manufacturing process and all those who specify, sell, design, build, and install lighting equipment.
- Annex C looks at the final stage in the life cycle when lighting products have the opportunity to be diverted from the waste stream into new resources that can be returned to the “cradle” instead of the “grave” (see definition below).

IES DG-22-12 can either be read top to bottom as a basic text on sustainable lighting or consulted chapter by chapter and by individual appendix for specific insights into their contents. The Guide is not intended as an exhaustive treatment of the subject, but rather as a roadmap of the major destinations in an ever-evolving journey that will change as technology and innovation bring new possibilities that expand our ability to provide cost effective quality illuminated environments with high performance and minimal environmental and social impacts.

Sustainability is too broad and dynamic a topic to address completely in one document. Therefore, this document should be viewed as a general guide that paints a picture of the elements that need to be considered when implementing sustainable lighting practices, not a “how to” guide for specific measures.

Sustainability is, in part, about design and technology, but it is also about the process of fundamentally shifting the way we think about our role and responsibilities in the world. This guide is organized around that shift, and to those who are part of the specifications, construction, and operations team. The shift is one of moving away from the perspective that we are only responsible for what happens on site to an understanding that our responsibilities span the entire spectrum of the project life cycle.

and can profoundly influence our lighting equipment and design choices and, ultimately, how those choices impact the environment.

For those elements that already have extensive documentation, this guide refers the reader to primary sources for detailed information, such as *IES DG-18-08 Light + Design: A Guide to Designing Quality Lighting for People and Buildings, the Advanced Lighting Guidelines Online (www.algonline.org) and the IES Lighting Handbook, 10th Edition*, which provide excellent guidance on lighting quality, energy efficiency, and daylighting. Other topics such as environmental impacts of manufacturing practices are new considerations. For these topics, this Design Guide will introduce the concept, provide guidance where possible and provide a basis for further dialogue and advancement.

1.2 Sustainable Design Overview

Sustainable or “green” design is a collaborative approach to the development of architecture and

construction and is intended to minimize the overall environmental impact of buildings while meeting the needs of building occupants and managers. Truly sustainable design improves processes that span a building’s life cycle from concept to demolition and re-use. It goes beyond daily conservation. It is closely related to the concept of Sustainable Development, defined by the United Nations World Commission on Environment and Development (The Brundtland Commission) in 1987 as “meeting the needs of the present without compromising the ability of future generations to meet their own needs.” From this concept evolved the “triple bottom line” definition of sustainability, which simultaneously addresses economic, societal, and environmental impacts. William McDonough, in his book “Cradle to Cradle”, describes these three impacts as Economy, Equity, and Ecology (See **Figure 1**).

The modern era of sustainable architectural design in much of North America can be traced to the 1973 energy crisis which sparked interest in energy conserving buildings and mechanical systems. The