TIP 252: Integrated Daylighting and Energy Analysis Toolkit (IDEAKit)

Context

High-performance building design must evolve in the face of continued evidence of climate change, increasing energy use in the buildings sector, and the desire to rely more heavily on renewable energy sources. Lighting accounts for 21% of energy use in U.S. commercial buildings, making it one of the largest energy-consuming building technologies, and a clear candidate for focus on energy efficiency (EE) improvements. In response, building codes are tightening and sustainable building rating systems are emerging that force designers to increase the efficiency of their designs and to prove their designs perform to these codes and goals. Unfortunately, codes are beginning to clash with fundamental lighting design precepts and illumination engineering best practices. Daylighting can help shed electric lighting loads, giving designers more flexibility in illumination design and saving energy while still conforming to current code restrictions.

Description

Daylighting is a viable energy efficiency strategy in new and retrofit buildings, but must be implemented as part of an integrated building design to be optimally effective. The IDEAKit project builds on the National Renewable Energy Laboratory's (NREL) existing OpenStudio Platform project, adding objects and methods to the OpenStudio building model to facilitate rigorous (Radiance-based) integrated daylighting and electric lighting control simulations within the broader whole building energy simulation context. The end goal is to create a tool that is easy to use for the following conditions: Simple daylighting explorations that show energy benefits; compliance evaluation against codes, standards and building rating systems; as a research-level tool for the advanced user to perform multivariate optimization analysis and sector-wide daylighting/energy evaluations.

Why It Matters

IDEAKit addresses many barriers to daylight simulation-- and by extension, to the adoption of daylighting -- in high-performance commercial building design. It will provide BPA with a valuable tool for evaluating daylighting performance in buildings, with applicability to other interesting research projects.

The goal is to build on this interest and momentum related to lighting simulation. New functionality represents a significant advance in the fidelity and speed of annual climate-based daylight simulation, along with characterizations of glazing and complex fenestration systems, allowing for relatively rapid annual simulations of daylight performance as well as occupant response to glare with window treatments. User friendliness fosters greater use of natural light over electrically powered systems; the proposed research project indirectly applies to transmission as a so-called "nonwires initiative," aimed at improving advanced modeling methods for time-dependent daylight resource prediction and in turn electric lighting load reduction potential. This could significantly influence demand/ response modeling efforts.

Goals and Objectives

NREL has begun development of an analysis platform called OpenStudio Platform that leverages EnergyPlus for user-friendly building energy modeling (BEM), early in the design process. Unfortunately, the daylighting algorithms in EnergyPlus are inadequate to accurately characterize daylight ingress into all but the most simplistic spaces, and do not accurately take into account the interaction of daylight with electric lighting and controls – a critical element to energy savings from daylighting. This proposal seeks to build on the OpenStudio Platform by adding the capability to perform integrated BEM using EnergyPlus for mechanical and building thermal simulation, and Radiance application for a more rigorous daylighting and lighting control simulation, all linked to a single model and outcome dataset.

Deliverables

1. Working demo of initial OpenStudio Radiance implementation
2. Report/paper describing the IDEAKit foundation, its elements, implementation, and functionality
3. Demo of fully-featured IDEAKit foundation
4. Report/paper documenting the results of the validation study
5. Live Project Website
6. Final Project (Phase 1) Report

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Project Start Date: December 2011

Project End Date: September 2012

Funding

Total Project Cost:	$580,687
BPA Share:	$291,344
External Share:	$289,343
BPA FY2012 Budget:	$146,672

Participating Organizations

National Renewable Energy Laboratory

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