



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

Context

High-performance building design is evolving 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 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 and future code restrictions.

Integrated design is an important way to achieve deep energy savings in buildings at a reasonable cost. Through integrated design, the high cost of one feature such as high-performance glazing can be offset with cost-savings in another feature such as a downsized cooling system. Integrated design requires accurate energy models to ensure that such trade-offs are successful. The National Renewable Energy Laboratory's (NREL) OpenStudio Platform supports integrated design by providing a free, open source, user-friendly tool to create EnergyPlus building energy models (BEM) for new and retrofit buildings, early in the design process.

Daylight modeling plays an essential role in integrated design, because windows and skylights are essential components in most high-performance buildings. 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. Accurate daylight simulation tools such as Radiance are often relied upon for rigorous evaluation of daylighting measures on high performance building designs, however prior to this IDEAKit project, combining accurate daylight models with accurate energy models was a very slow, error-prone, and difficult process.

Description

The IDEAKit project builds on the OpenStudio Platform, 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. New functionality will increase the fidelity and speed of annual climate-based daylight simulation, along with characterizations of glazing and complex fenestration systems such as operable blinds, awnings and light shelves. This will allow for relatively rapid annual simulations of daylight performance as well as glare potential, and the impact of building occupants' responses to glare, e.g. deploying window treatments.

The software will be easy to use for the following conditions: Simple daylighting explorations that show energy benefits; compliance evaluation for codes, standards and building rating systems; as a research-level tool for the advanced user to perform multivariate optimization analysis and sector-wide evaluations of daylighting/energy use.

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 architects, engineers and lighting designers with a faster, more accurate way to achieve integrated design—combining daylight simulations with energy simulations for cost-effective energy savings.

In addition, the tool could potentially be applied to regional planning for energy efficiency, demand response and integrated transmission planning, to improve methods of time-dependent daylight resource prediction and the corresponding electric lighting load reduction potential.

Lastly, the IDEAKit simulation tool framework will be used in FY13 to create a large database of pre-computed energy simulation results, illustrating the energy savings potential of various daylighting measures applied to 16 standard commercial building types, in all US climate zones. This results database will be searchable by building type and geographic location, and will give a wide variety of stakeholders access to demonstrable, actionable daylighting-based energy efficiency strategies for new and retrofit construction projects.

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Goals and Objectives

Expand the OpenStudio Platform by adding the Radiance application for a more rigorous daylighting and lighting control simulation, combined with the existing EnergyPlus mechanical and building thermal simulation, creating a single model and outcome dataset.

Validate this functionality, and add parametric and optimization capability to the expanded OpenStudio platform.

Use this capability to generate a large database of pre-computed daylighting solutions for typical buildings in the Pacific Northwest, and in all U.S. climate zones.

Host this data behind a user-friendly web-based front end that stakeholders can use to explore simulation-backed, energy- and economically-based analyses of daylighting solutions.

Promote the use of this database (and of the underlying toolkit) through social media, websites, and in particular through Pacific Northwest energy awareness sources such as ConduitNW.

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 with Radiance integrated in OpenStudio
6. Vetted Pacific Northwest daylighting measures database and report
7. US daylighting measures database
8. Live Project Website with daylighting measures
9. Final Project Report

Project Start Date: October 1, 2011

Project End Date: September 30, 2013

Funding

Total Project Cost: \$543,372

BPA Share: \$254,030

External Share: \$289,342

BPA FY2013 Budget: \$144,672

Reports & References (Optional)

Links (Optional)

<http://openstudio.nrel.gov/>

Participating Organizations

National Renewable Energy Laboratory

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