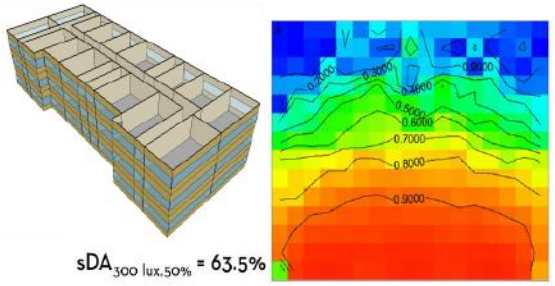
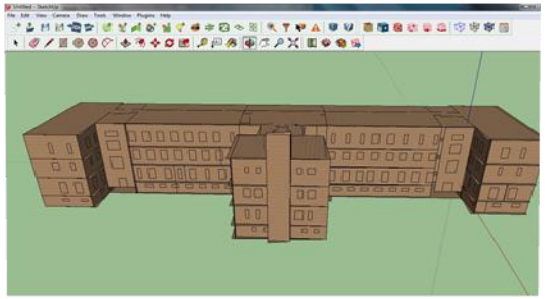
OpenStudio Enhancements for Whole-building Daylighting, Airflow, and Energy Modeling Leveraging Interoperable BIM Data for SMSCB

2014 Building Technologies Office Peer Review





BIM Apps

BIM Server

Open Studio

Enhance **Integrate** **Implement**

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

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The Pennsylvania State University

Project Summary

Timeline:

Start date: February 1, 2013

Planned end date: April 30, 2015

Key Milestones

1. Integrate airflow code into OpenStudio (Dec. 31, 2013)
2. Develop photocontrol module for Daysim with EnergyPlus input (Dec. 31, 2013)
3. Perform geometric data extraction from IFC models for use in OpenStudio (Mar. 31, 2014)
4. Develop specs for OpenStudio and BIM DataHub features (Jun. 30, 2014)
5. Integrate new features into OpenStudio and complete deployment (Apr. 30, 2015)

Budget:

Total DOE $ to date: $ 0.74 M

Total future DOE $: $ 0.57 M

Target Market/Audience:

Building design professions with a specific focus on teams performing energy retrofit projects for small and medium commercial buildings, along with tool developers who support these professions.

Key Partners:

Penn State
NREL
TNO (The Netherlands)
LBNL

Project Goal:

The goal is to enhance the functionality of OpenStudio to support retrofit projects, and enable project teams to easily integrate energy, daylight and airflow modeling into their design workflows.

The Challenge

Problem Statement:
Energy modeling is inconsistently applied in the SMSCB market, in part because existing models are either too complex relative to the project size or because models are not interoperable with other retrofit design tools.

Target Market and Audience:
Small and Medium Commercial Buildings design professionals performing retrofit projects, along with tool developers.

Impact of Project:
Enable more projects to adopt energy model of design alternatives through rapid, accurate energy analysis on retrofit projects.

SMSCB* Energy Efficiency Challenge

*SMSCB: Small and Medium Sized Commercial Buildings (less than 250k square feet)

Reducing building energy use is a national priority (EPAct 2005)

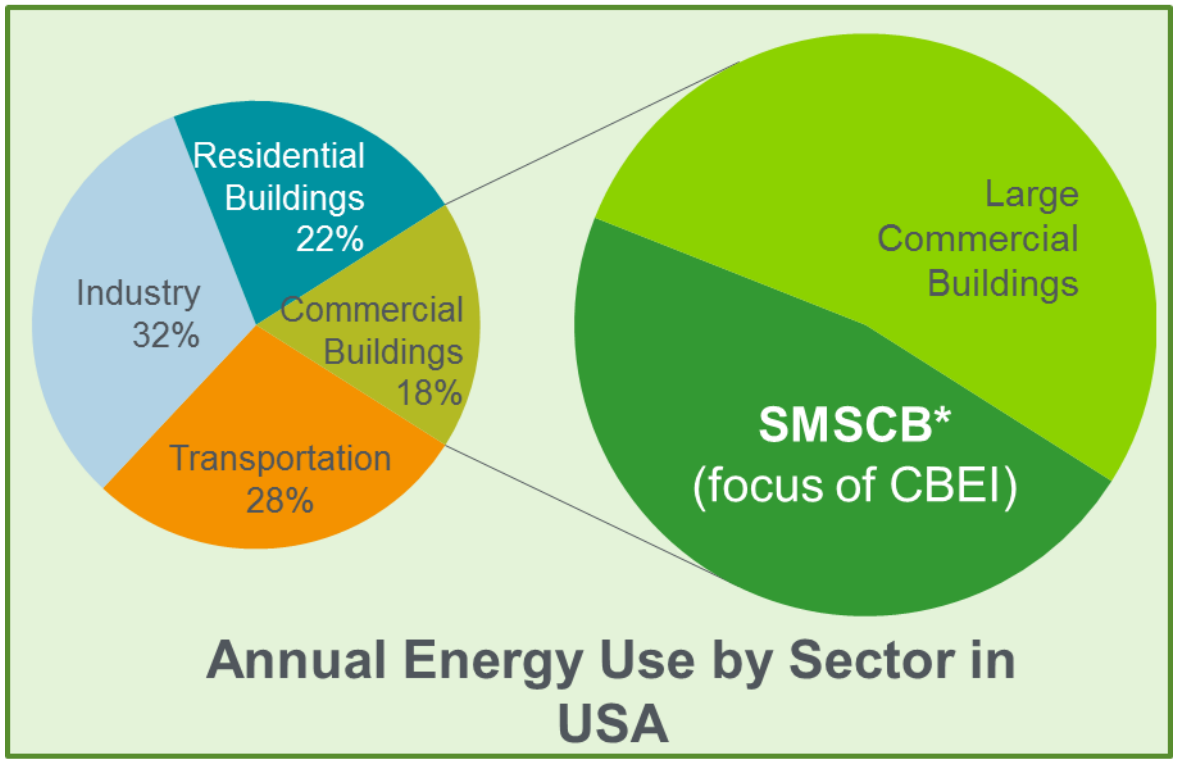
Despite ~50% improvement in equipment efficiency (since 1970s), building energy use has only declined by 15%

Challenge for SMSCBs:

>95% of all commercial buildings

SMSCB energy consumption is approximately 47% of commercial building

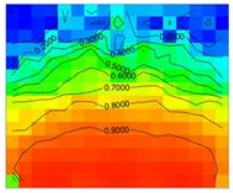
Have received little attention



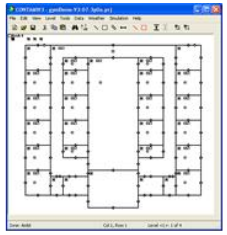
Based on data from NREL, DOE, and the National Trust for Historic Preservation

Our Approach

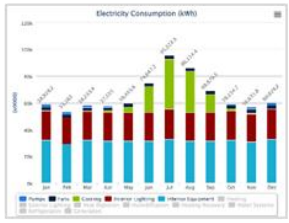
ENHANCE



Daylighting



Airflow Modeling



Energy Model

INTEGRATE

Design Tools

OpenStudio

EnergyPlus

IMPLEMENT

Training Videos

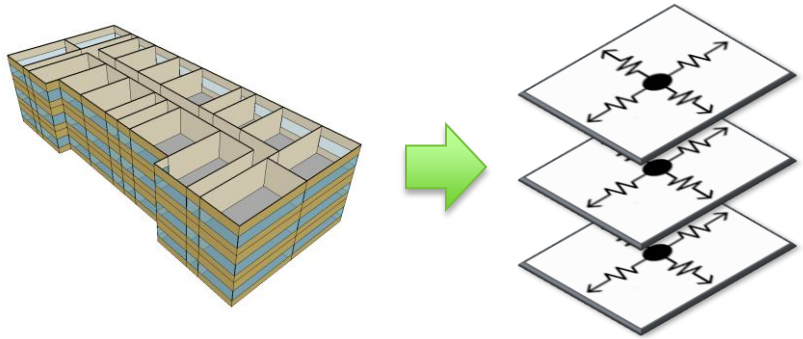
Training Documentation

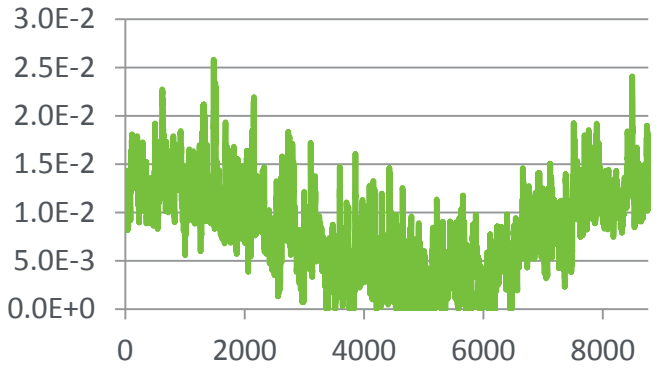
Code

Enhancements to OpenStudio - Progress

Airflow Modeling

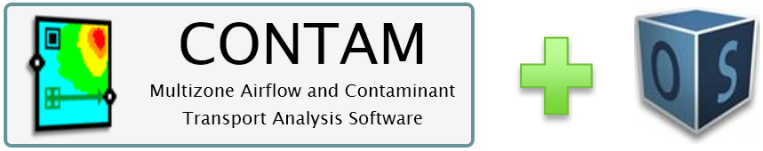
Developed objects in OpenStudio for airflow zones, paths, airflow elements, other essential elements, along with a translator object





Created programs / scripts for OSM to PRJ to OSM for infiltration and security modeling

Completed code to enable CONTAM integration in OpenStudio

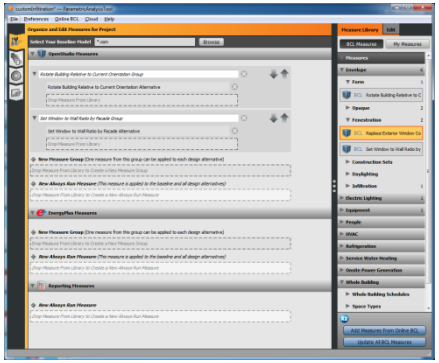


Enhancements to OpenStudio - Future

Airflow Modeling

Develop proof-of-concept translator for AirflowNetwork (AFN) by leveraging CONTAM effort for E+ internal solver

Fully integrate AFN into OpenStudio by developing element objects and extending the translator object

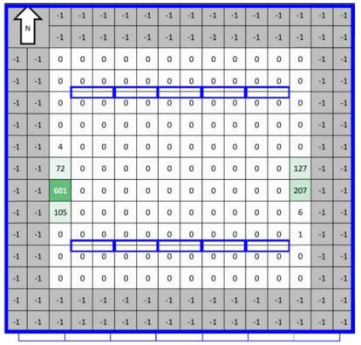


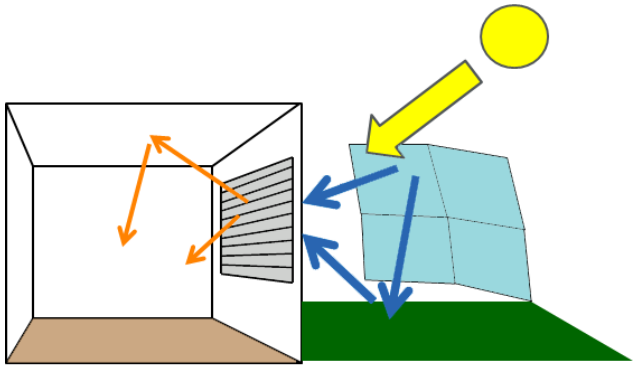
Develop PAT-based scripts for Indoor Air Quality and ventilation measures

Enhancements to OpenStudio - Progress

Daylighting – Added to Daysim

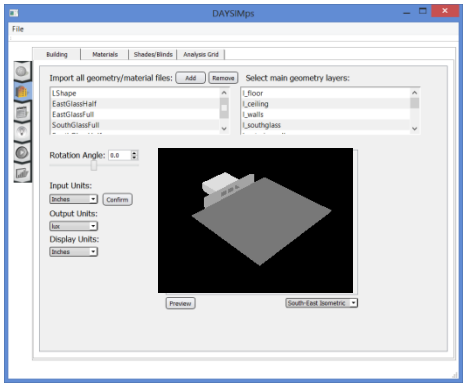
Developed an automated analysis approach for determining daylight sensor control zone power levels (with or without a known lighting system)





Added capability to model complex fenestration using bi-directional transmittance functions

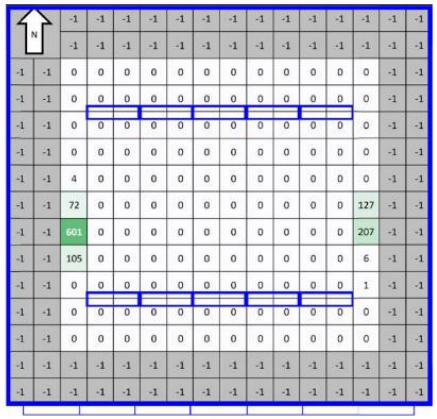
New user interface for Daysim to enable expanded Daysim capability with an OpenStudio menu system



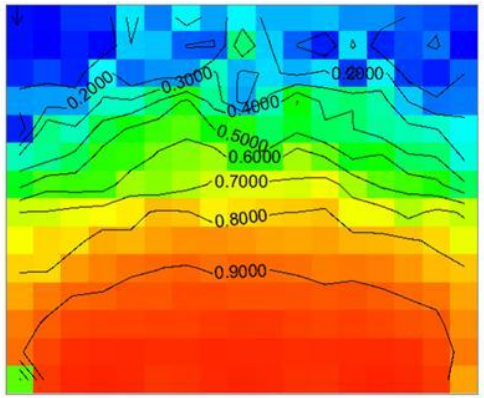
Enhancements to OpenStudio - Future

Daylighting

Implement complex fenestration modeling, automated reference point identification, and advanced hourly lighting power analysis for photosensor control zones into OpenStudio



Add modules for the analysis of Annual Sunlight Exposure and Spatial Daylight Autonomy (new IES annual metrics applied in LEED V4) across a full-building model

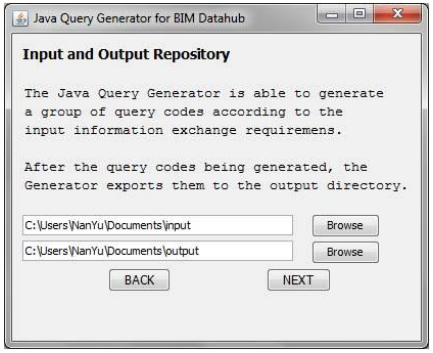


$sDA_{300\ lux,50\%}$ = 63.5%

Integration - Progress

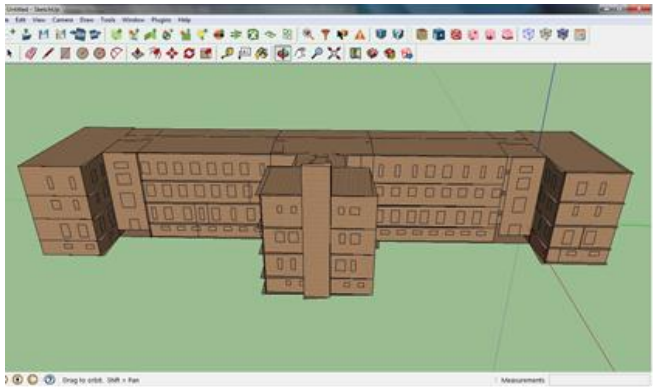
Building Information Model Server

Adopted a BIMserver approach toward the storage and retrieval of design information to support energy related analyses



Developed an open source query functionality for BIMserver to selectively extract model information for energy modeling

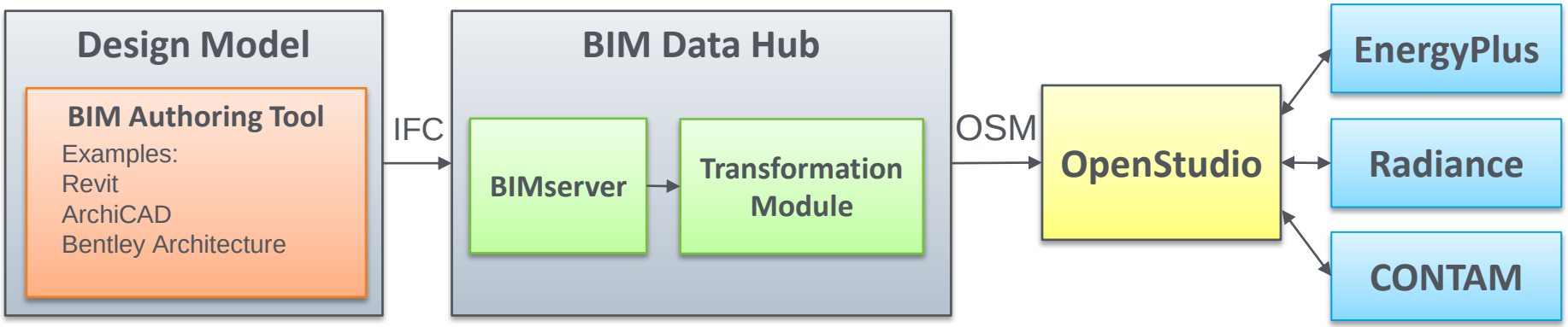
Created OpenStudio Model (OSF) file from query information for geometric objects including walls, floors, windows and doors



Integration - Future

Building Information Model Server

Automate the data transfer of design information via open standards to the BIM Server to enable rapid energy, daylighting and indoor air quality analysis.



IFC = Industry Foundation Classes
OSM = OpenStudio Model

Project Team Collaboration

Research & Development Team

NREL OpenStudio Team

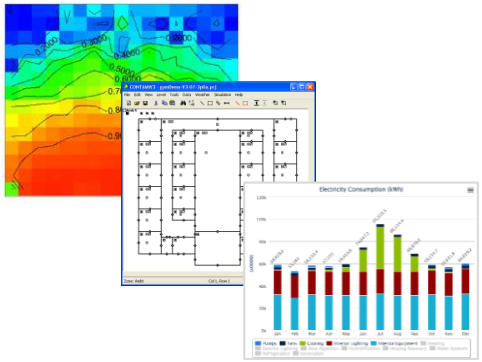
Design Community

Developer Community

Building Energy Informatics Summit 2013

The Vision

Project teams can quickly and accurately obtain energy analysis information regarding their designs to inform high quality, integrative design decisions.



Enhance

Integrate

Implement

REFERENCE SLIDES

Project Budget

Project Budget: The project is funded through The Penn State Consortium for Building Energy Innovation. This is a 5 year initiative. The current budget period is Budget Period 3 (BP3) which is from February 1, 2013 to April 30, 2014. BP4 is scheduled to start on May 1, 2014.
Variances: No variance to report.
Cost to Date: Approximately 98% of the current funds have been expended to date.

Budget History			
Feb. 1, 2013 to April 30, 2014 (current)		May 1, 2014 to April 30, 2015 (future)	
DOE	Cost-share	DOE	Cost-share
$ 0.75M	$ 0.06 M	$ 0.57 M	$ 0.15 M

Project Plan and Schedule