OpenStudio
TDM – Amir Roth (OpenStudio/BCL Core)
TDM – Joan Glickman (Asset Score Tool)

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**Problem:** Building energy analysis has historically been costly and produces uncertain results depending upon practitioner skill and available input data. New tools are expensive to produce and aren’t well integrated.

**Impacts:** OpenStudio is DOE’s platform for rapid, collaborative development of energy analysis applications. It is being used by the labs, EEB, the private sector, and others to create market facing tools.

**Project Focus:** The project cross cuts ET and CBI to spur adoption of new and existing EE technologies by making tools available to a wide range of decision makers.
Software Technology

Approach:

• **Rapid application development:**
  – Cross platform, multi-language support
  – Easy to write web apps for energy modeling
  – Maximum code reuse for low cost
  – Highly efficient, automated model construction

• **Open Source:**
  – Why reinvent the wheel?
  – Remove barriers for adoption
  – OpenStudio is creating a community

• **Interoperability:**
  – Multiple simulation engines
  – BIM (gbXML, IFC)
  – Title 24 compliance engine (SDD)
  – Sandia’s DAKOTA Library for analysis

Key Issues:

• Full coverage of all EnergyPlus objects still in progress – a moving target
• Need modularized build process for lighter apps that don’t require everything in OpenStudio
• Heavy adoption is putting additional pressure on team for user and developer support
Software Development

Approach:

• Development team uses an “agile” software development process
  – Formal task and bug tracking systems
  – Automated nightly software build, test, and dashboarding system
  – Formal processes for design document and code reviews
• Frequent vetting of UI concepts and workflows with external stakeholders

Distinctive Characteristics:

• Flexibility to quickly produce new desktop, mobile, and web tools that are easily integrated with one another
• Agile process allows focus to change as new requirements emerge
• Rigorous approach to creating software for the marketplace - not a research project
• Open, collaborative approach to software development that welcomes partners from other labs, institutions, and the private sector.
Accomplishments and Progress

Accomplishments:

• Substantial adoption of OpenStudio
  • Practitioners
  • Researchers
  • Software developers
  • Utilities

• Significant new capability for:
  • Rapid desktop, mobile or web application development
  • Efficient automated model generation (Short script ➔ 1000s of .idf lines)
  • Extensive tool, model, and data interoperability
  • Parametric analysis and extensible measures formalism

Progress on Goals:

• Continued to meet aggressive quarterly release schedule
• On-track to meet key deliverables related to
  • OpenStudio-based parametric analysis
  • User generated (crowd-sourced) content for Building Component Library (BCL)
  • Private sector stakeholders
OpenStudio Partners (Partial List)

- CRADAs
- Xcel Energy
- National Grid
- Concept3D
- Wrightsoft
- Group 14
- SketchUp
- Pacific Northwest National Laboratory
- Berkeley Lab
- Oak Ridge National Laboratory
- Argonne National Laboratory
- Natural Resources Canada
- Ressources naturelles Canada
- eebHUB
- SPARC
- GARD Analytics
The OpenStudio Tool Suite – An OpenStudio SDK Sample Application

Quickly assign constructions, loads, and schedules via templates and specify zones

Draw envelope in minutes using SketchUp, or import from BIM

Render by
Boundary Condition

Render by
Zone

Render by
Space Type

Render by
Story
Simple Workflows and Modern Software Paradigms with the OpenStudio Suite

Define Resources

Workflow

Review Results

Drag and Drop Library Resources
Selecting Templated HVAC Systems with the OpenStudio Suite

1. Pick a System
2. Add Your Zones
3. Done
Drag and Drop HVAC Systems for Advanced Users

...or customize your own
High Level Simulation Results Summaries with the OpenStudio Suite

Credit: David Goldwasser / NREL
How Do We Improve Input Data Quality for OpenStudio-Based Tools?

- Input data remains a serious issue for modelers
- Garbage In = Garbage Out $\Rightarrow$ Quality In = Quality Out
- **Solution:** Standardize input data and seamlessly link to OpenStudio-based tools

An Internet-connected source of building energy modeling data:
- Enables drag-and-drop modeling for **quick** technology evaluation
- Provides **consistent**, detailed inputs to drive decision-making
- **Searchable** readily available within applications
- **Crowd sourced** content leverages sector knowledge

**Templates**

**Usability**

**Consistent Inputs**

**Fast, Low-Cost, Reliable Energy Modeling Outcomes**
The Building Component Library (BCL)

**Components:**
- Assembled to form complete energy models
- Include constructions, lights, schedules, weather data, PV modules, and more
- Supports faceted searching from web site or API

**Measures:**
- Contain logic needed to transform an energy model easily and consistently
- Can be applied singly or as part of a parametric analysis
Select measures from BCL and apply them to your baseline model.

Inspect measures applied to specific alternative models.

Compare energy performance, cost reduction, and paybacks.

As we will discuss, results are exported for other purposes.
EEB and the DOE Asset Score Tool Use OpenStudio Scripted Models for Web Apps

Geometry and Space Type Definitions

Simulated End Uses

Detailed HVAC and Zoning
OpenStudio enables:
- modeling using multiple data sources,
- rigorous portfolio assessment, and
- detailed analysis of retrofit measures for each building.
What High Level Data Are Used to Create NGrid’s Baseline Models?

- Address: PII
- Size: 10,000 ft²
- Number of Floors: 3
- Vintage: 1982
- Building Type: Office
- Web app assists with geometry extraction
An OpenStudio-Enabled Expert System to Create Baseline Models for NGrid

Loads Prescribed by Building Type

- ClosedOffice: 30%
- OpenOffice: 15%
- Corridor: 15%
- Stair: 10%
- IT_Room: 5%
- Restroom: 5%
- Conference: 5%
- Lobby: 5%
- Break: 3%
- Mechanical: 2%
- Storage: 2%
- Print Room: 1%

HVAC System and Constructions Generated by Knowledge Base

- people
- lights
- plug loads
- ventilation
- cooling equipment
- distribution equipment
- heating equipment
- walls
- roofs
- floors
- windows
- footprint
- stories
- glazing percentage

Building Geometry

Weather Data

OpenStudio Measures Generate Model
NGrid’s Approach to Incentive Program Design – The Long Term Goal

Program measures are applied to tuned model of a customer building.

Energy savings, simple payback, and more are calculated from an energy simulation.

Calculate incentive required to overcome individual customer hurdle rate.

Ranked, customer-specific marketing strategy.

Repeat Across Portfolio.
**Problem:** Reduce cost of Xcel’s EDA program, while maintaining quality as additional energy consultants are engaged

**Solution:**
- EDAPT web service tracks projects, manages data and communications, and reports program-wide outcomes
- OpenStudio and BCL are expanded to include automated quality and EDA protocol checking
- EDAPT connects high level project data with model outcomes to streamline reporting

**Launching in June 2013**
OpenStudio-EDAPT Integration

OpenStudio baseline and design alternate models along with simulation results

EDAPT web portal automatically generates report templates from project data and OpenStudio output

xml
doc
Reports
Key Goals

- **Reduce cost** of investment-grade, level 3 audits below current cost of level 1 or 2
- **Produce higher quality, more consistent** audits with greater residual value
  - Not simply a report that prescribes actions and quantifies savings
  - Data and models aggregate and can be reused for further cost reduction in EISA 2007 compliance, portfolio assessment, etc.

http://simuwatt.com/rd100.html
simuwatt Software Guided Workflow

- Comprehensive workflow is modeled after NREL Deployment’s proven methodology
- UI design guided with input from industry professionals

Geometry Capture  
Level Navigation
simuwatt Software Guided Workflow

- Workflow includes space-by-space load assignment, scheduling, HVAC system specification, photo logging, note taking, and more
- Component definitions pulled from BCL
Data Seamlessly Converted to Baseline

Automatically Generated OpenStudio Model Geometry

Simulated End Uses in OpenStudio Application
Project Initiation Date: Q1/FY10
Planned Completion Date: Ongoing with Frequent Off-Ramping of Components
(e.g. BCL transitioned to private sector by Q4/FY13)
Release Schedule: Bi-weekly (Agile) Minor Releases
Quarterly Major Releases with DOE-Prescribed Focus Areas

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Legend:
- Work completed
- Active Task
- Milestones & Deliverables (Original)
- Milestones & Deliverables (Actual)
Additional Funding Sources:

- $0
- $500
- $1,000
- $1,500
- $2,000
- $2,500
- $3,000
- $3,500

FY13 Spend* ($k)

- March Deliverables

FY10-13 Budgets* ($k)

- FY10
- FY11
- FY12
- FY13

* FY13 Spend and Budget Includes both OpenStudio/BCL and Asset Score CBI Budgets
Project Integration, Collaboration & Market Impact

Partners, Subcontractors, and Collaborators:
- Many - spanning other national laboratories, EEB, universities, and the private sector
- RFP for training and user support partners released in February (Train the trainers)

Technology Transfer, Deployment, Market Impact:
- Adoption metrics encompass diverse user base from academia and private sector
- Some noteworthy private sector uptake examples were presented in earlier slides - many more in process
- CEC and utilities are using OpenStudio as a means of shifting the market to EnergyPlus

Communications:
- Multiple training workshops (NREL, AIA, IBPSA, BPA, International, and others)
- Online training at [http://openstudio.nrel.gov](http://openstudio.nrel.gov) and on YouTube (Over 100 videos)
- Online discussion and user support forums
- Publications through IBPSA, ACEEE, WREF, etc.
- Frequent webinars
- Multiple universities teaching with OpenStudio

Registered Users

- 10,496 Total Registered Users
- 1,153,650 Total Web Page Views
- 240,317 Total YouTube Video Views

![Graph showing registered users over time](image)
Next Steps and Future Plans

- **Continue making quarterly releases of SDK**
- **Near-term Capability**
  - Add more components and measures to BCL
  - Provide OpenStudio Cloud Support for Practitioners
  - Additional HVAC Systems, Commercial Refrigeration
  - Add additional Quality Checking (QC) automation
  - Extensible Results Visualizations
  - Build System Improvements
- **Utility App Replication**
  - Xcel and National Grid Technology Exchange
  - ComEd
  - Others?
- **Off-Ramping**
  - BCL – In Process
  - Training and User Support – In Process
  - Tool Suite – Seeking Partner
- **Greater interoperability**
  - Additional engines – CONTAM integration at EEB
  - Data sources – e.g. TPEx, OpenEI, DSIRE, etc.
- **Support SDK Adoption for New Products and Applications**
Thank you!

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Dan Macumber
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Marjorie Schott
Alex Swindler
Jason Turner
Evan Weaver

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