**Project Summary**

**Timeline:**
Start date: **Q1 FY10**
Planned end date: **Ongoing w/ Frequent Off-Ramping of Components**

**Key Milestones:**
1. Quarterly Major Releases
2. V2.0 (Extensive refactor with new patterns) – 9/30/2016

**Budget:**
Total DOE $ to date: **$10,106,000***
Total Cost Share to date: **$5,786,000**
Total future DOE $: **$3,500,000**

**Target Market/Audience:**
**Tool Developers, A&E Practitioners, Utilities, Researchers, and Students**

**Key Partners:**

<table>
<thead>
<tr>
<th>Key Partners</th>
<th>Coleman</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All BTO Labs</strong></td>
<td>NRCan/NRC</td>
</tr>
<tr>
<td>CEC</td>
<td>PSD Consulting</td>
</tr>
<tr>
<td>BPA</td>
<td>NYSERDA</td>
</tr>
<tr>
<td>Xcel Energy</td>
<td>Multiple Universities</td>
</tr>
<tr>
<td>National Grid</td>
<td>Several Private Sector Companies</td>
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</tbody>
</table>

**Project Outcome:**
Develop BTO’s building energy analysis ecosystem as a best-in-class capability that enables rapid, low-cost development of new market facing tools produced by the National Laboratories, Universities, Private Sector, and other agencies.

Facilitate successful deployment of the software development kit across BTO performers, utilities, and private sector developers to drive real energy savings in new construction and retrofit projects.

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* Includes funding from Asset Score and Prioritization Tool
Problem Statement

Q: What collection of software technologies will make energy modeling less costly, more accessible, increasingly reliable, and ubiquitous for the broad range of stakeholders who rely on analysis to make real business decisions for their new construction and retrofit portfolios?

A: DOE’s OpenStudio ecosystem.
Target Market and Audience

The market for OpenStudio is diverse and includes:

- Tool developers* that are able to quickly and cost-effectively bring new software innovations to market;
- A&E practitioners that use the example applications to reduce energy consumption for new construction and retrofit projects;
- Utilities that are trying to reduce the cost of incenting EE, realize greater EE savings, and assess technology potentials;
- Researchers who are trying to design and assess new technologies; and
- Students who are the next generation of building designers.

* This is OpenStudio's biggest growth area
Partial List of Partners
Approach to Development and Deployment

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.
OpenStudio’s Killer Feature: Measures

OpenStudio Measures: scripts that operate on models & results
- Transform model \( e.g. \), replace constructions, daylighting package, etc.
- Means for standardized modeling – fast, cheap, and consistent

• Measures can be ECMs or create entire models
Workflow Innovations Via OS Measures

Austin Energy EDA Reporting and QAQC

QAQC Check Summary

<table>
<thead>
<tr>
<th>Name</th>
<th>Category</th>
<th>Flags</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELU</td>
<td>General</td>
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<td>Description</td>
</tr>
<tr>
<td>Reasonableness</td>
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<td></td>
<td>Description</td>
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<tr>
<td>Weather Files</td>
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<tr>
<td>End Use by Category</td>
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<td>Description</td>
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<tr>
<td>Mechanical</td>
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<tr>
<td>System Part</td>
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</tr>
<tr>
<td>Load Efficiency</td>
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<tr>
<td>Internal Loads</td>
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<td>Schedules</td>
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<tr>
<td>Mechanical</td>
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<tr>
<td>System Efficiency</td>
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<td>Description</td>
</tr>
<tr>
<td>Envelope R-Value</td>
<td>Baseline</td>
<td>1</td>
<td>Description</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Baseline</td>
<td>1</td>
<td>Description</td>
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</table>

QAQC Flag Details

<table>
<thead>
<tr>
<th>Name</th>
<th>Flag Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Use by Category</td>
<td>Interior Lighting ELU of 7.1 (kBtu/ft²) is more than 10.0 % above the target Interior Lighting ELU of 5.8 (kBtu/ft²).</td>
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<tr>
<td>End Use by Category</td>
<td>Fans ELU of 1.5 (kBtu/ft²) is more than 10.0 % above the target Fans ELU of 1.4 (kBtu/ft²).</td>
</tr>
<tr>
<td>Envelope R-Value</td>
<td>U value of 0.62 (Btu/h²*°F) for U 0.60 SHGC 0.25 Dbl 2.5mm air in 90.1-2013 - Office - WholeBuilding - Md Office is more than 10.0 % below the target value of 0.83 (Btu/h²*°F).</td>
</tr>
<tr>
<td>Domestic Hot Water</td>
<td>Annual average of 201 gallons per day of hot water is more than 5.0 % below the target value of 258 gallons per day.</td>
</tr>
</tbody>
</table>
Prototype Model

Energy Efficiency Measures

Reporting & Quality Checking

Cloud-Based Scalability

Measures: Basis for Large-Scale Analysis
DOE’s Prioritization Tool “2.0”

Scout
Extensible, transparent, scalable technology potential assessment

Cloud-Based Scalability
Measures + OpenStudio Server

ECM package optimization

Do not apply ERV
If you want this site EUI

But also uncertainty analysis ➔ ranges instead of point estimates

Input parameter distributions

Output distributions

And calibration ➔ Better estimates for existing buildings

Calibrated Monthly kWh
Customer Optimization For Furthering Energy Efficiency (COFFEE)

High level data from public and utility records → Automated Model Generation → Automated Model Calibration → Cost/Performance Comparison of Available Measures

Cloud-Based Retrofit Recommendations For Each Customer

≈ 3,600 Buildings in MA $10-20 Per Building
EDAPT: Transforming Utility Incentive Programs

- Launched in FY14 for new construction incentive programs

- Automates:
  - Notifications
  - Quality checking
  - Reporting
  - Portfolio roll-ups

- Developed for Xcel Energy
  - Saved $500k in program admin costs in 1st year of operation
  - Grew from 2 consultants to 10
  - Significant increase in number of projects processed annually

- Now available to other utilities
  - Austin Energy
  - Energy Trust of Oregon
  - RFQ for Implementers in Process

- DOE dashboard quantifies real project impacts for OpenStudio
New Resources for a Growing Community

Welcome to OpenStudio® User Documentation

OpenStudio® is a cross-platform (Windows, Mac, and Linux) collection of software tools to support whole building energy modeling using EnergyPlus and advanced daylight analysis using Radiance. OpenStudio is an open source (GPLv3) project to facilitate community development, extension, and private sector adoption. OpenStudio includes graphical interfaces along with a Software Development Kit (SDK).

The graphical applications include the OpenStudio SketchUp Plug-in, OpenStudio Application, ResultsViewer, and the Parametric Analysis Tool. The OpenStudio SketchUp Plug-in is an extension to Trimble’s popular SketchUp 3D modeling tool that allows users to quickly create geometry needed for EnergyPlus. Additionally, OpenStudio supports import of gltXML and IPC for geometry creation. The OpenStudio Application is a fully featured graphical interface to OpenStudio models including envelope, loads, schedules, and HVAC.

ResultsViewer enables browsing, plotting, and comparing simulation output data, especially time series. The ResultsViewer application can also be used by software developers to C++, Ruby, and C# Users can be shared and applied to the results.

Getting Started

This section provides installation instructions, introductory tutorials, and information to get you up and running.

News

OpenStudio 1.10.0 Release

OpenStudio 1.10.0 has been released with an important bug fix.

Help & Additional Resources

Find professional training for OpenStudio.

OpenStudio on Unmet Hours

Check out this advanced application of OpenStudio for fault detection.

Use Third Party Tools

Set materials and constructions so they can be properly imported into CIESCC.com.

CRIBIC-Com Tutorial

Import an IPC file into OpenStudio using SimWeb.

Using Third Party Tools

Create OpenStudio models using the main-based VirtualPulse SE tool.
TPEx: Making Product Evaluation Drag-and-Drop Easy

Raw performance data automatically converted into BCL objects

Apply product to model using any OpenStudio app
Near-Term Focus Areas

- Extensive code refactor ➔ OS 2.0
  - Dependency & SDK code reduction
  - Command Line Interface (CLI)
  - Alignment of PAT and OS Server code/functionality

- App integrates “OS Spreadsheet” functions into PAT
- New development pattern leverages web tech to facilitate developer and SAAS adoption
Near-Term Focus Areas

• Extensive code refactor ➔ OS 2.0
  – Dependency & SDK code reduction
  – Command Line Interface (CLI)
  – Alignment of PAT and OS Server code/functionality

• OS Measure work
  – Additional content (ECMs, QAQC, etc.)
  – Release of building prototype measure
  – Automated baseline generation measure
  – Code cleanup and automated testing framework

• Adoption support
  – Tool vendors (e.g. Carrier)
  – CPUC, BPA, etc.

• Community-Scale Modeling – Internal Research
• Demand-Response Analysis – Internal Research
• OS support for EMS (Controls) Objects - NYSERDA
REFERENCE SLIDES
Additional Funding Sources:
# Project Plan and Schedule

**Project Initiation Date:**
Q1/FY10

**Planned Completion Date:**
Ongoing with Frequent Off-Ramping of Components (e.g. training transitioned to private sector in Q1 FY14)

**Release Schedule:**
Bi-weekly (Agile) Minor Releases
Quarterly Major Releases with DOE-Prescribed Focus Areas

<table>
<thead>
<tr>
<th>Project Name: OpenStudio Core</th>
</tr>
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<tbody>
<tr>
<td>Q1 Milestone: OpenStudio 0.6 Released (Initial BCL Integration with OpenStudio)</td>
</tr>
<tr>
<td>Q2 Milestone: OpenStudio 0.7 Released (First Version of OpenStudio App with BCL Integration)</td>
</tr>
<tr>
<td>Q3 Milestone: OpenStudio 0.8 Released (App Suite Workflow Improvements and DInCity)</td>
</tr>
<tr>
<td>Q4 Milestone: OpenStudio 0.9 Released (BIM Interop and Initial Support for BCL Measures)</td>
</tr>
<tr>
<td>Q1 Milestone: OpenStudio 0.10 Released (Sim Settings Tab and Backend Work for PAT)</td>
</tr>
<tr>
<td>Q2 Milestone: OpenStudio 0.11 Released (Initial Version of PAT and BCL UGC)</td>
</tr>
<tr>
<td>Q3 Milestone: OpenStudio 1.0 Released (PAT Economics and Measures)</td>
</tr>
<tr>
<td>Q4 Milestone: OpenStudio 1.1 Released (Cloud Support and additional Measures)</td>
</tr>
<tr>
<td>Q1 Milestone: OpenStudio 1.2 Released (Commercial Refrigeration Systems)</td>
</tr>
<tr>
<td>Q2 Milestone: OpenStudio 1.3 Released (HVAC, Refrigeration, and OS Server Improvements)</td>
</tr>
<tr>
<td>Q3 Milestone: OpenStudio 1.4 Released (OS Server Workflow and HVAC Improvements)</td>
</tr>
<tr>
<td>Q4 Milestone: OpenStudio 1.5 Released (HVAC and Performance Improvements, DENCity Development)</td>
</tr>
<tr>
<td>Q1 Milestone: OpenStudio 1.6 Released (E+ 8.2 and Title 24 Support)</td>
</tr>
<tr>
<td>Q2 Milestone: OpenStudio 1.7 Released (Radiance 3-Phase Support and Usability Improvements)</td>
</tr>
<tr>
<td>Q3 Milestone: OpenStudio 1.8 Released (E+ 8.3 and BIM-Server Support)</td>
</tr>
<tr>
<td>Q4 Milestone: OpenStudio 1.9 Released (Substantial Completion of HVAC Coverage)</td>
</tr>
<tr>
<td>Q1 Milestone: OpenStudio 1.10 Released (E+ 8.4 Support and Performance Improvements)</td>
</tr>
<tr>
<td>Q2 Milestone: OpenStudio 1.11 Released (E+ 8.5 and Dual Duct Support)</td>
</tr>
<tr>
<td>Q3 Milestone: OpenStudio 1.12 Released (Code refactor and PAT 2.0 Preview)</td>
</tr>
<tr>
<td>Q4 Milestone: OpenStudio 2.0 Released (Significant Code Refactor and PAT 2.0)</td>
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