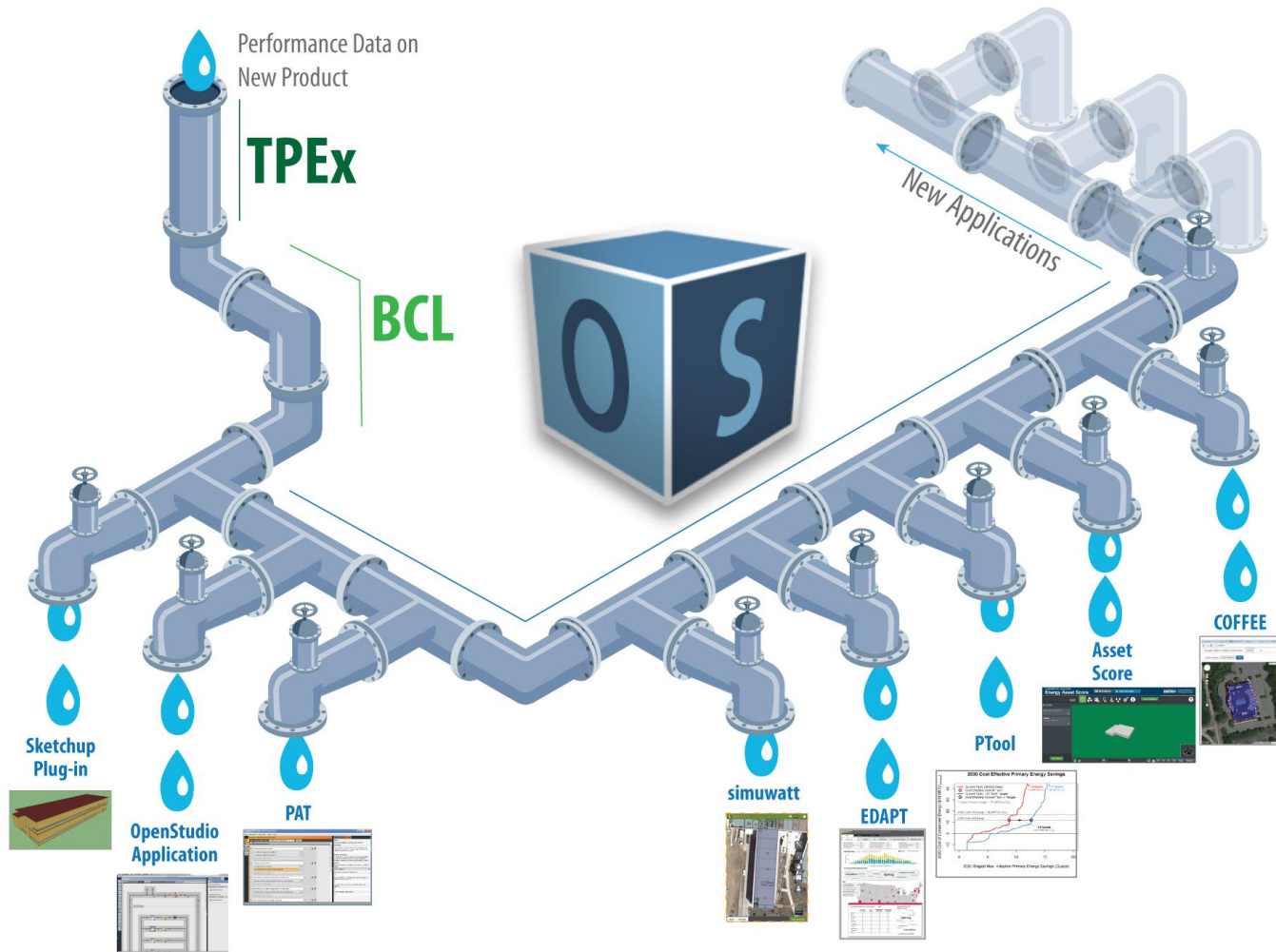


OpenStudio Core

2016 Building Technologies Office Peer Review



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:

All BTO Labs	NRCan/NRC
CEC	PSD Consulting
BPA	NYSERDA
Xcel Energy	Multiple Universities
National Grid	Several Private Sector Companies

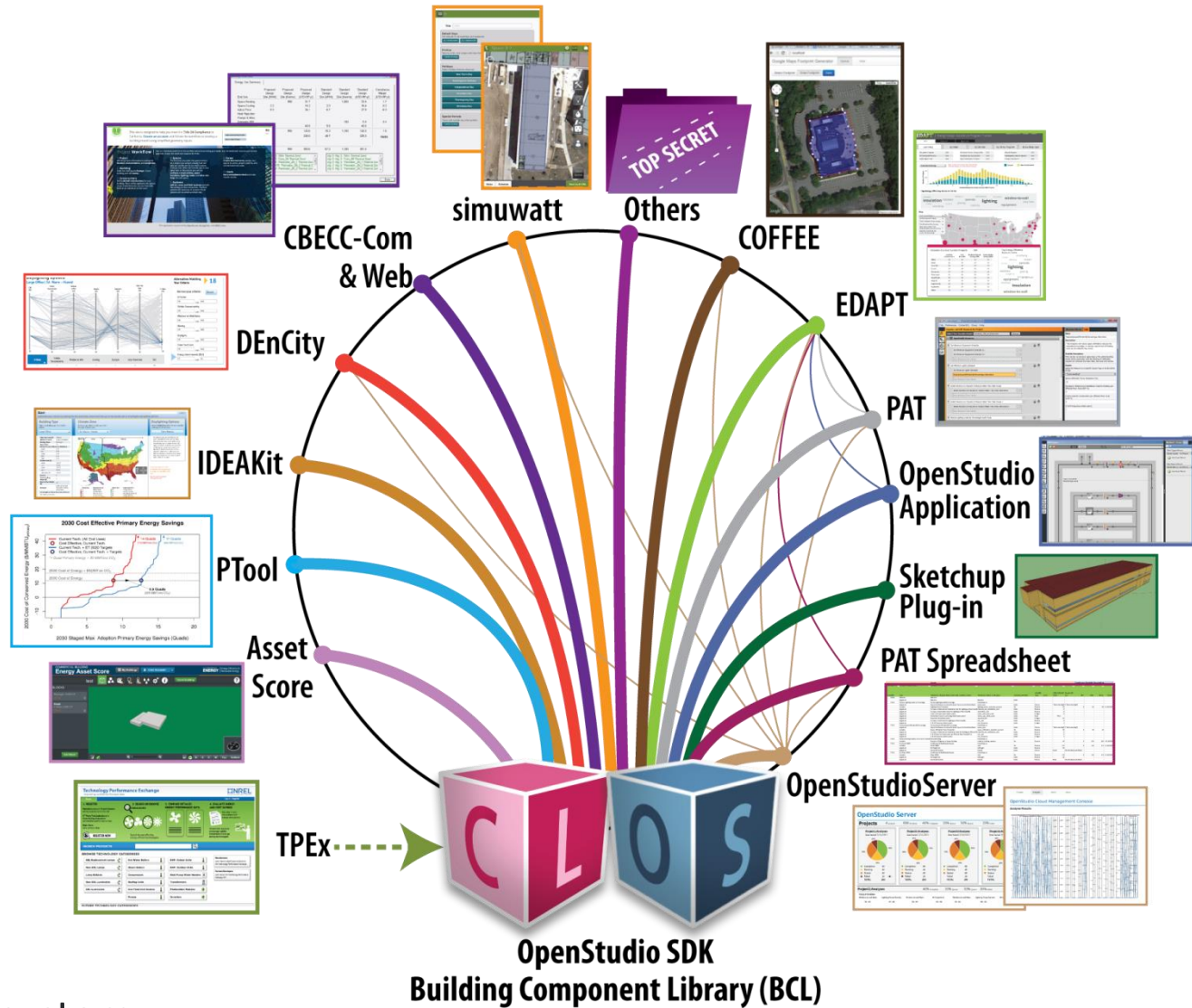
Project Outcome:

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.

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?



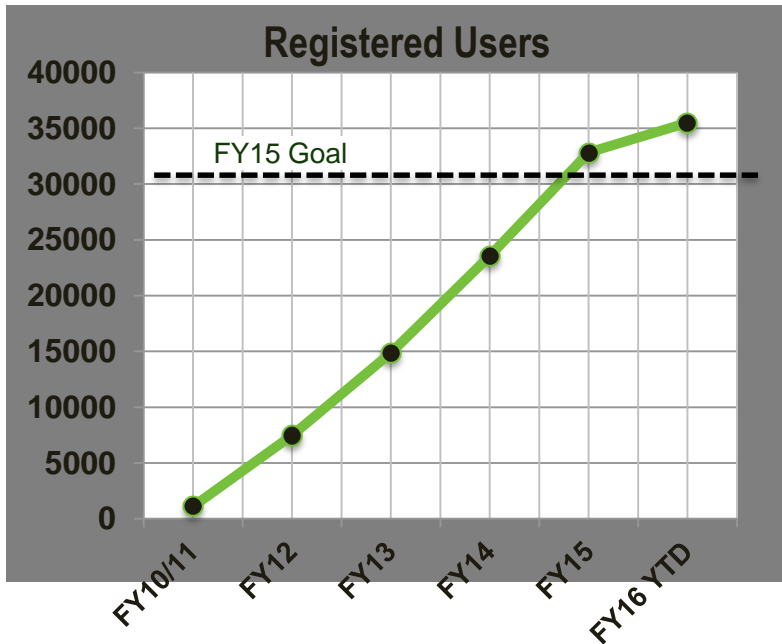
A: DOE's OpenStudio ecosystem.



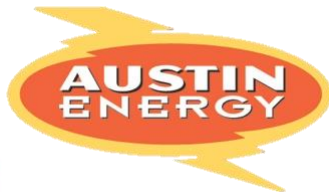
Target Market and Audience

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.



Partial List of Partners



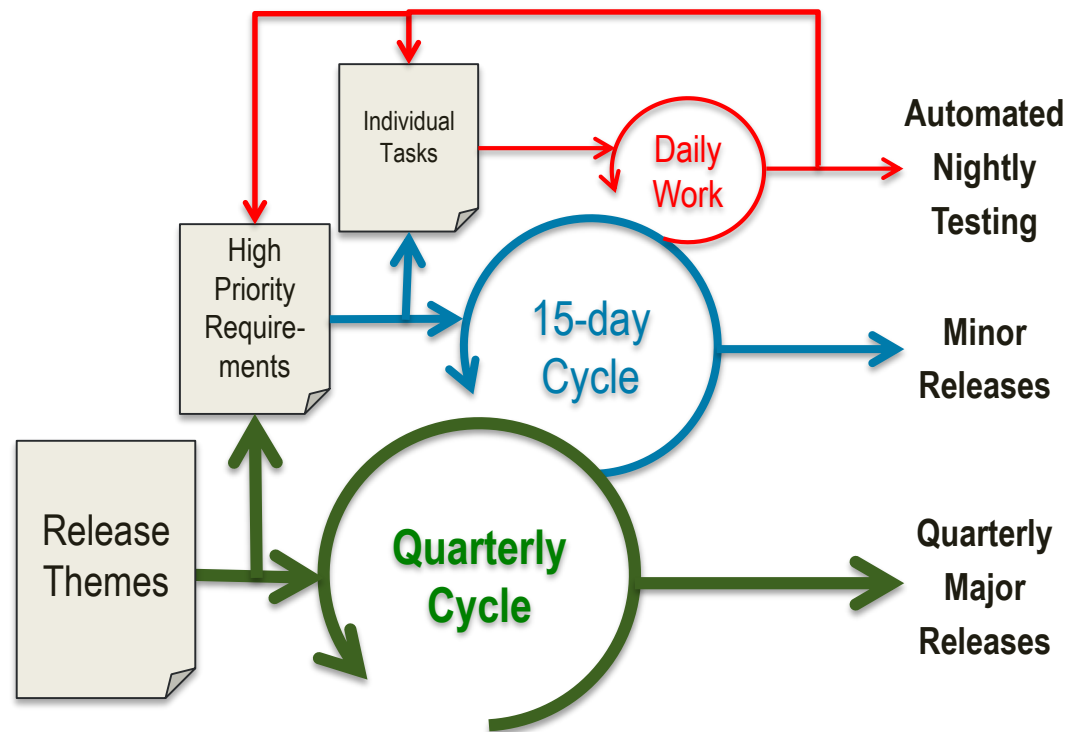
Approach to Development and Deployment

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:

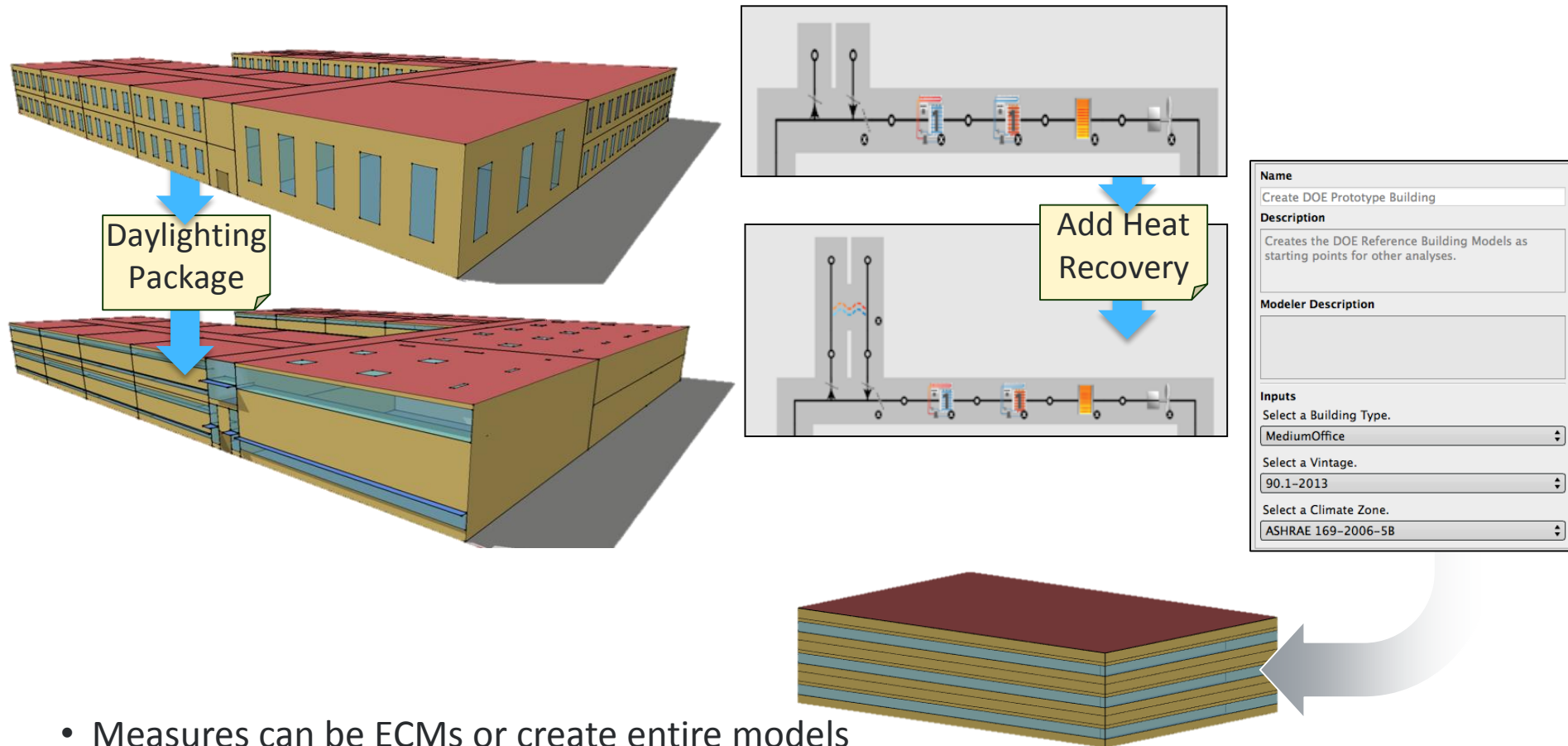
- Flexibility to **quickly** produce new desktop, mobile, and web tools that are easily **integrated** with one another
- **Agile process** allows focus to change as new requirements emerge
- Rigorous approach to creating software for the marketplace - **not a research project**
- **Open, collaborative**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



OpenStudio's Killer Feature: Measures

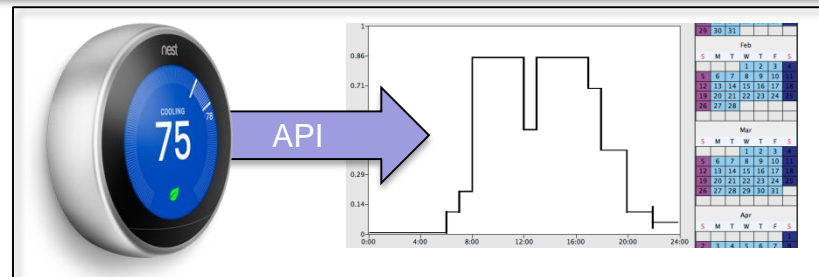
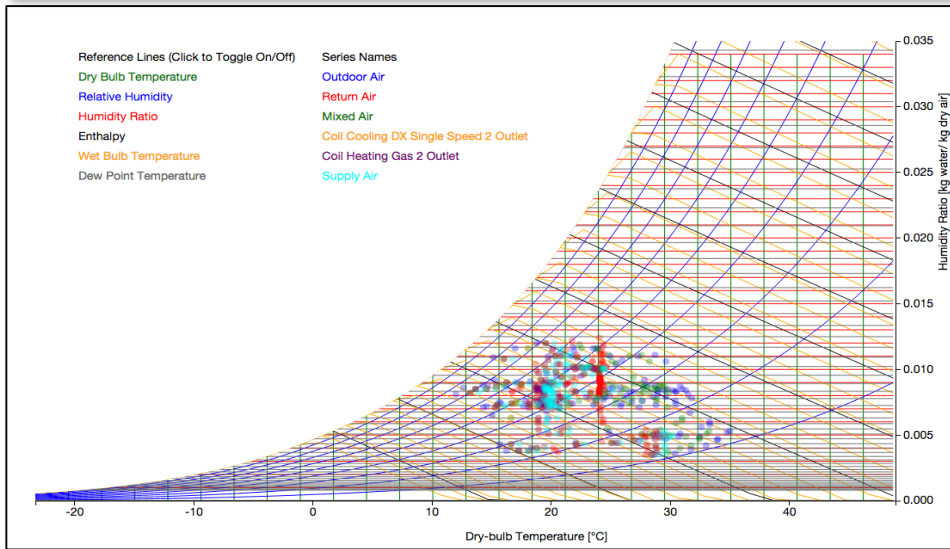
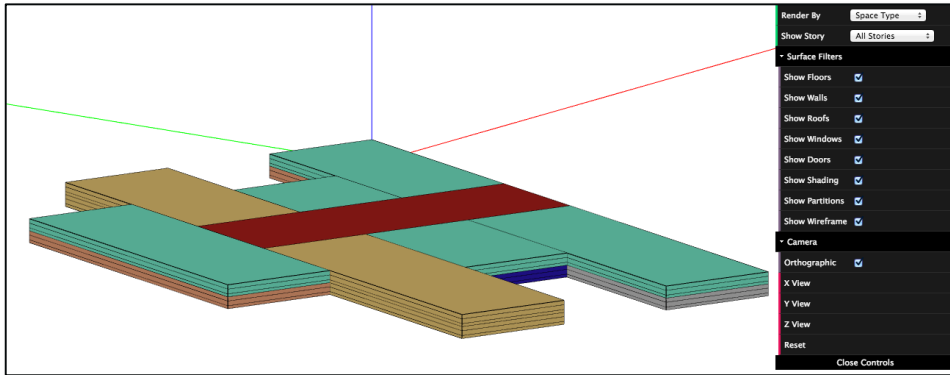
OpenStudio Measures: scripts that operate on models & results

- 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

List of Checks in Measure

Name	Category	Flags	Description
EUI Reasonableness	General	0	Check EUI for model specific building type against DOE prototype buildings with Austin Energy specific tolerance.
Weather Files	Austin Energy	0	Check weather file, design days, and climate zone against Austin Energy list of allowable options.
End Use by Category	General	2	Check end use by category against DOE prototype buildings with Austin Energy specific tolerance.
Mechanical System Part Load Efficiency	General	0	Check 40% and 80% part load efficiency for the following component types: ChillerElectricEIR, CoilCoolingDXSingleSpeed, CoilCoolingDXTWoSpeed, CoilHeatingDXSingleSpeed. Checking EIR Function of Part Load Ratio curve for chiller and EIR Function of Flow Fraction for DX coils.
Internal Loads	Baseline	0	Check Space-by-space load checks for LPD, ventilation rates, occupant density, plug loads, and equipment loads against ASHRAE standards and DOE Prototype buildings.
Schedules	Baseline	0	Check schedules for lighting, ventilation, occupant density, plug loads, and equipment based on DOE reference building schedules in terms of full load hours per year.
Mechanical System Efficiency	Baseline	0	Check per 90.1 Tables 6.8.1 A-K. The following component types are checked: ChillerElectricEIR, CoilCoolingDXSingleSpeed, CoilCoolingDXTWoSpeed, CoilHeatingDXSingleSpeed, BoilerHotWater, FanConstantVolume, FanVariableVolume, PumpConstantSpeed, PumpVariableSpeed
Envelope R-Value	Baseline	1	Check per ASHRAE 90.1 Table 5.5.2-2 per Table G2.1.5 b,c,d,e (with reflectance = 0.55), Section 5.5.3.1.1a.
Domestic Hot Water	Baseline	1	Rule-of-thumb check per ASHRAE standards.

QAQC Flag Details

List of Flags Triggered for All Checks in Measure.

Name	Flag Detail
End Use by Category	Interior Lighting EUI of 7.1 (kBtu/ft ²) is more than 10.0 (%) above the target Interior Lighting EUI of 5.8 (kBtu/ft ²).
End Use by Category	Fans EUI of 1.6 (kBtu/ft ²) is more than 10.0 (%) above the target Fans EUI of 1.4 (kBtu/ft ²).
Envelope R-Value	U value of 0.62 (Btu/ft ² h ² R) 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/ft ² h ² R).
Domestic Hot Water	Annual average of 201 gallons per day of hot water is more than 5.0 % below the target value of 268 gallons per day.

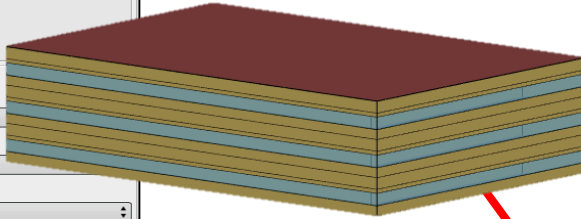
Measures: Basis for Large-Scale Analysis

Name
Create DOE Prototype Building

Description
Creates the DOE Reference Building Models as starting points for other analyses.

Modeler Description

Inputs
Select a Building Type.
MediumOffice
Select a Vintage.
90.1-2013
Select a Climate Zone.
ASHRAE 169-2006-58



Name
AedgOfficeHvacVavDx

Description
Measure replaces a high efficiency m (VAV) HVAC system multizone VAV sys

Modeler Description
Airloops are dedic cooling system and operation, hot wat DX cooling. The c

Inputs
This space type sh plenum.

Total Cost for HVAC
0

Apply recomm schedules for al

Name
Chilled Beam with DOAS

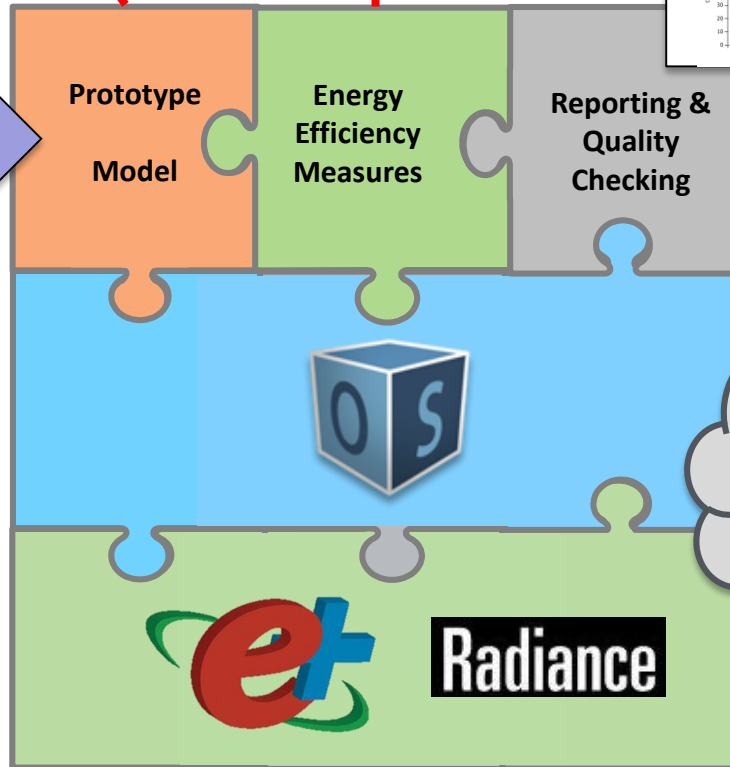
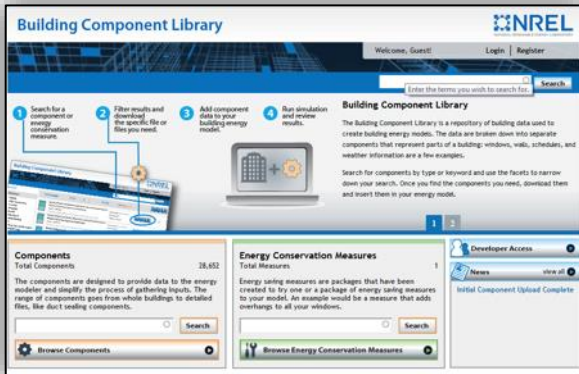
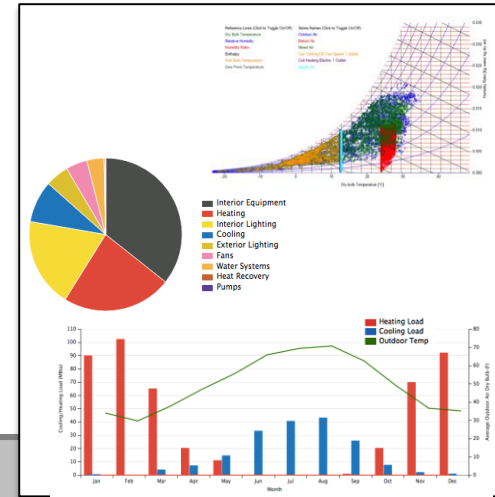
Description
Measure replaces existing HVAC system (if any) with a chilled beam system with DOAS HVAC system (one DOAS per floor). The chilled beam with DOAS system (centralized DOAS, with zone level)

Modeler Description
Airloops are dedicated to ventilation (DOAS) and have constant speed fan operation, gas furnace or hot water heating, single speed DX, two speed DX chilled water, or no cooling and optional energy

Inputs
This space type should be part of a ceiling return air plenum.

Add 90.1-2013 - Office - WholeBuilding - Md Office space type to Chilled Beam system?

Chilled Beam Type
Passive



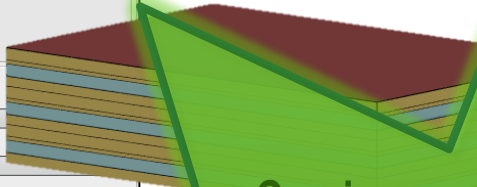
DOE's Prioritization Tool "2.0"

Name
Create DOE Prototype Building

Description
Creates the DOE Reference Building Models as starting points for other analyses.

Modeler Description

Inputs
Select a Building Type.
MediumOffice
Select a Vintage.
90.1-2013
Select a Climate Zone.
ASHRAE 169-2006-5B



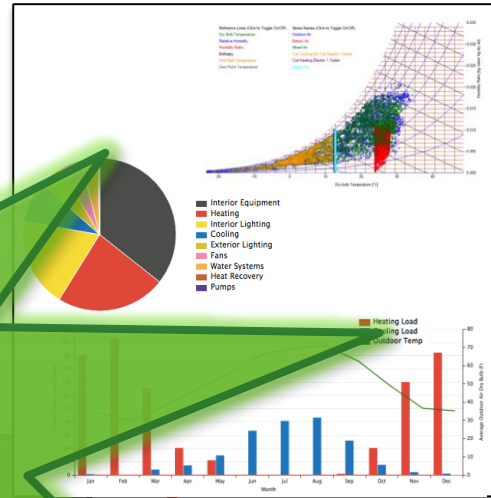
Name
AedgOfficeHvacVavDx

Description
Measure replaces a high efficiency m (VAV) HVAC system multizone VAV system

Modeler Description
Airloops are dedicated to ventilation (DOAS) and have constant speed fan of hot water heating, single speed chilled water, or no cooling.

Inputs
This space type should be of a ceiling return air plenum.

Total Cost for HVAC



Coming soon to a Department of Energy near you...

Building Component Library

- Search for a component or energy conservation measure.
- Filter results and download the specific file or files you need.
- Add component data to your building energy model.
- Run simulation and review results.

Components
Total Components: 28,852

The components are designed to provide data to the energy modeler and simplify the process of gathering inputs. The range of components goes from whole buildings to detailed files, like duct sealing components.

Search: []

Browse Components []

Scout

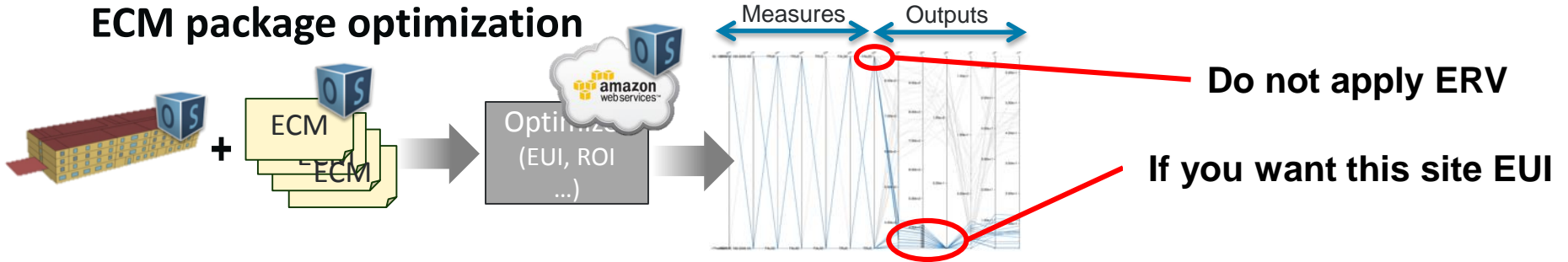
Extensible, transparent, scalable technology potential assessment

Cloud-Based Scalability

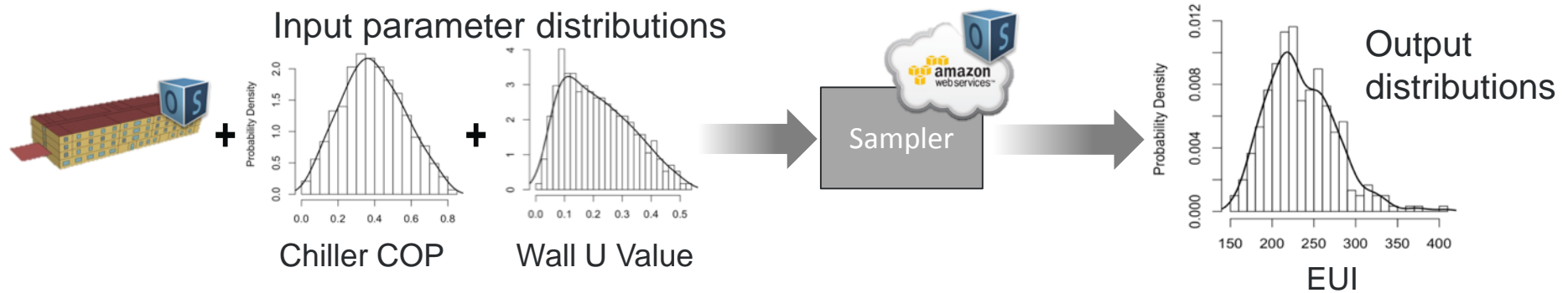


Measures + OpenStudio Server

ECM package optimization



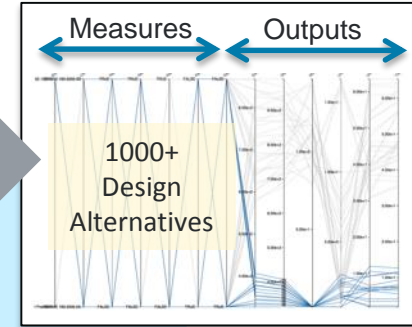
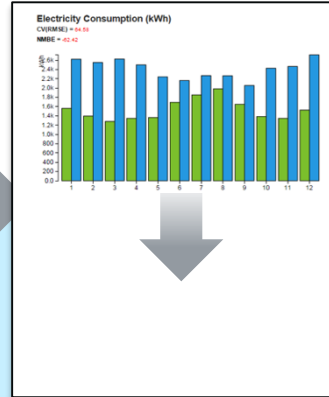
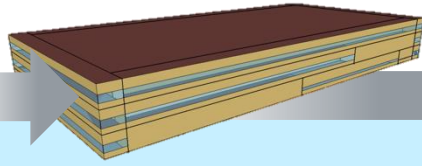
But also uncertainty analysis → ranges instead of point estimates



And calibration → Better estimates for existing buildings



Customer Optimization For Furthering Energy Efficiency (COFFEE)



**High level data
from public and
utility records**

**Automated
Model
Generation**

**Automated
Model
Calibration**

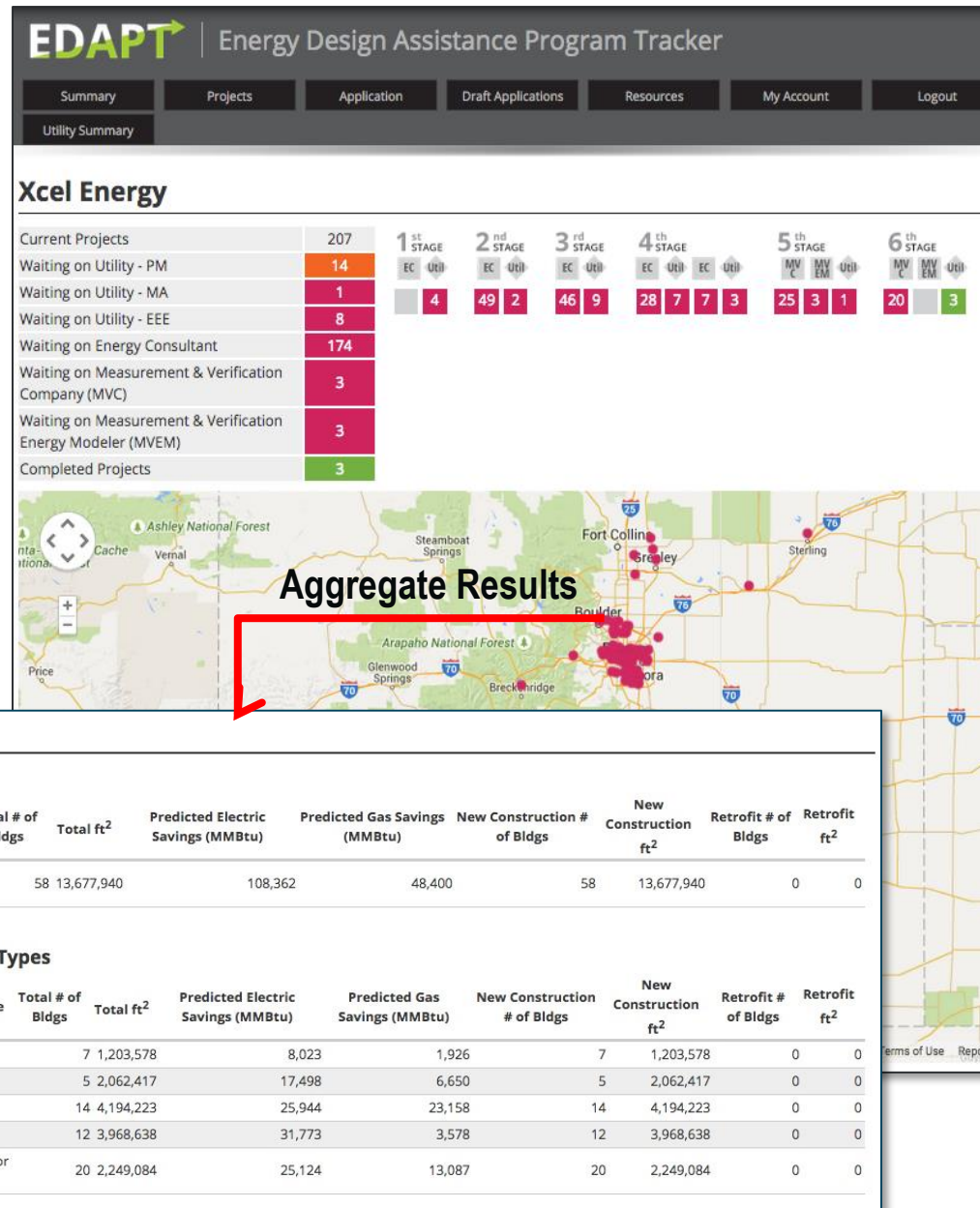
**Cost/Performance
Comparison of
Available Measures**

**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

The screenshot shows the OpenStudio website homepage. At the top, there's a navigation bar with links for Downloads, Documentation, Developers, Forum, Feedback, and Log in. Below the navigation bar, there's a search bar and a "Follow Us" section with social media icons for Facebook, Twitter, YouTube, and LinkedIn. The main content area features a "News" section with a heading "OpenStudio 1.10.0 Rerelease" and a sub-heading "OpenStudio 1.10.0 has been rereleased with an important bug fix." The text below the heading describes the software's capabilities and mentions that it supports various programming languages like C++, Ruby, and C#.

Welcome to OpenStudio® User Documentation

This is OpenStudio's user documentation. A brief summary of the content of the site is below. Use the buttons or the horizontal navigation above to learn more about the OpenStudio suite of applications.



Getting Started

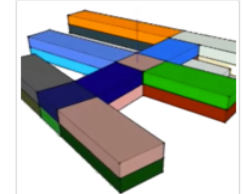
This section provides installation instructions, introductory tutorials, and information to get you up and running.

[Installation & Tutorial](#)

Review the list of features and building elements that can be modeled.

[Current Features](#)

[Planned Features](#)



References & Tutorials

Interface guides give detailed overviews of the OpenStudio applications.

[SketchUp Plug-in](#)

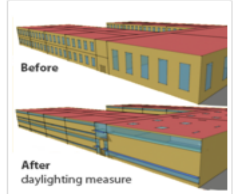
[OpenStudio Application](#)

Tutorials cover essential workflows as well as advanced topics.

[Creating Your Model](#)

[Running Your Simulation](#)

[Radiance & OpenStudio](#)



Speed Up Your Workflow With Measures

Learn what measures are, how to use them for various use cases, and where to find them.

[About Measures](#)

Can't find the measures you want, or need to customize an existing measure? The Measure Writing Guide will help you get started.

[Measure Writing Guide](#)

The screenshot shows the Unmet+Hours website, which is a question-and-answer resource for the building energy modeling community. The page features a search bar, a list of questions, and a "ASK YOUR QUESTION" button. The questions listed include topics like "Sizing error of Coil-Cooling:DX:SingleSpeed unit in DOAS system", "Where are OpenStudio fan schedules?", "How to list and measure area surfaces", "Error when Modelling a Low Temperature Radiant Floor", "How to model an underslab glycol loop in EnergyPlus?", "Modeling VAV Active Chilled Beams in EnergyPlus or OpenStudio", "Geometry diagnostic steps in OpenStudio Sketchup mode", "Building Cooling Peak load on Oct", "Can EnergyPlus model a wastewater treatment plant with digesters?", "Modelling a Low Temperature Radiant Floor", "rogue shading surface", and "Change building location measure in PAT".

Welcome! Please add your suggestion below or vote on other ideas for improving OpenStudio following the [posted guidelines](#).

This website is exclusively for **ideas and suggestions** for OpenStudio.

This site is NOT intended for:

- Support questions (use [Unmet Hours](#) instead)
- Bug reports (use [GitHub Issues](#) instead)

To link a suggestion to an existing [Unmet Hours question](#) or [GitHub Issue](#), simply copy and paste the URL into the suggestion.

How can we improve OpenStudio?

Enter your suggestion

[Hot Ideas](#) Top New Category Status My feedback

2 VOTES **Allow several runPeriods**

Problem: right now you can only use one model 'runPeriod'.

Solution: Add ability to have several runPeriods.

Context: It's extremely useful during iterative changes or troubleshooting. You might want to have for example a run for three days: one in winter (january), one in summer (july) and one in shoulder season (april). That would allow short runtime while still seeing different load conditions.

Also, I could also see a case where you'd run for a week in each month (reduce runtime but without sacrificing the accuracy too much). The good thing about using several runPeriods in EnergyPlus (rather than launching... [more](#))

1 comment OS App Flag idea as inappropriate...

Sign in

Powered by [bigladder](#)

Sign in to suggest ideas, vote, or participate in polls for your favorite feature request!

OpenStudio

- Post a new idea...
- All ideas
- My feedback
- Code 8
- Documentation 2
- gbXML 2
- OS App 32
- OS App 32
- PAT 5
- Radiance 1
- SketchUp 4

Search

[Give feedback](#)

[OpenStudio](#)

Using Third Party Tools

Set materials and constructions so they can be properly imported into CBECC-Com.

[CBECC-Com Tutorial](#)

Import an IFC file into OpenStudio using BIMserver.

[Import IFC Tutorial](#)

Size a vertical ground heat exchanger with OpenStudio and GLHEPro.

[GLHEPro Tutorial](#)

Create OpenStudio models using the web based VirtualPULSE tool.

[VirtualPULSE Tutorial](#)

Help & Additional Resources

Find professional training for OpenStudio.

[Training, Support, & Consulting](#)

Check out Unmet Hours, to post a question or search for answers to your energy modeling questions.

[OpenStudio on Unmet Hours](#)

Check out this advanced application of OpenStudio for fault detection:

[Fault Detection Measures](#)

Additional help topics.

[Finding Model Data](#)

[Best Practices](#)

[Troubleshooting](#)

[FAQ](#)

More training videos are available on our YouTube page.

[YouTube Videos](#)

The OpenStudio Repository on GitHub

[OpenStudio on GitHub](#)

TPEX: Making Product Evaluation Drag-and-Drop Easy

TPEX™ Technology Performance Exchange™
Confidence through data.

NREL
NATIONAL RENOVABLE ENERGY LABORATORY

Home Technology Categories Companies About Developers ARoth Logout | My Account

1. REGISTER
Manufacturers and Brand Owners add your products to the site
3rd Party Test Laboratory or Contributing Evaluators add detailed performance data
Basic Users view product data
REGISTER NOW

2. SEARCH OR BROWSE TECHNOLOGIES
Search for cost-effective, energy-efficient technologies

3. COMPARE DETAILED ENERGY PERFORMANCE DATA
Use data in your calculations and energy simulations

4. EVALUATE ENERGY AND COST SAVINGS
Present the results to encourage capital investment in energy saving technologies

SEARCH PRODUCTS

BROWSE TECHNOLOGY CATEGORIES

- SSL Replacement Lamps
- Non-SSL Lamps
- Lamp Ballasts
- Non-SSL Luminaires
- SSL Luminaires
- Refrigerated Cases
- Hot-Water Boilers
- Steam Boilers
- Compressors
- Rooftop Units
- Gas-Fired Unit Heaters
- Pumps
- DHP: Indoor Units
- DHP: Outdoor Units
- Mini-Split Systems
- Heat Pump Water Heaters
- Transformers
- Photovoltaic Modules

Manufacturers
Learn how to submit your products to the Technology Performance Exchange.

Partners/Developers
Learn about the Technology Performance Exchange API.

HVAC Systems

Layout Control Grid VRF

Drop VRF Terminal Drop Thermal Zone

Core_ZN Thermal Zone

Perimeter_ZN_1 Therma

Perimeter_ZN_2 Therma

Perimeter_ZN_3 Therma

My Model Library Edit

- VRF Terminal
- VRF System
- AirTerminal Single Duct VAV Changeover Bypass
- AirTerminal Single Duct VAV NoReheat
- AirTerminal Outdoor Air System
- AirTerminal Single Duct Uncontrolled
- AirTerminal Heat and Cool No Reheat
- AirTerminal Heat and Cool Reheat
- AirTerminal Inlet Side Mixer
- Four Pipe Fan Coil
- AirTerminal Single Duct Series PIU Reheat
- AirTerminal Single Duct Parallel PIU Reheat
- AirTerminal Single Duct VAV

Raw performance data automatically converted into BCL objects

Building Component Library

Welcome, Guest! Login Register

Any User
As an individual you can:
• download public components and measures to use in your energy models

Register and Join a Group
As a group member you can:
• download public and group specific components and measures to use in your energy models
• upload components and measures to share with your group and/or the public, after group administrator approval

Start a New Group
As a group administrator you can:
• download and upload components to share with the public or just your group
• review membership requests
• approve public uploads of other members

Components
Total Components: 47980
The components are designed to provide data to the energy modeler and simplify the process of gathering inputs. The range of components goes from whole buildings to detailed files, like duct sealing components.

Measures
Total Measures: 190
Energy saving measures are scripts that have been created to apply an energy conservation measure on an energy model. An example measure is adding overhangs to all south-facing windows in the model.

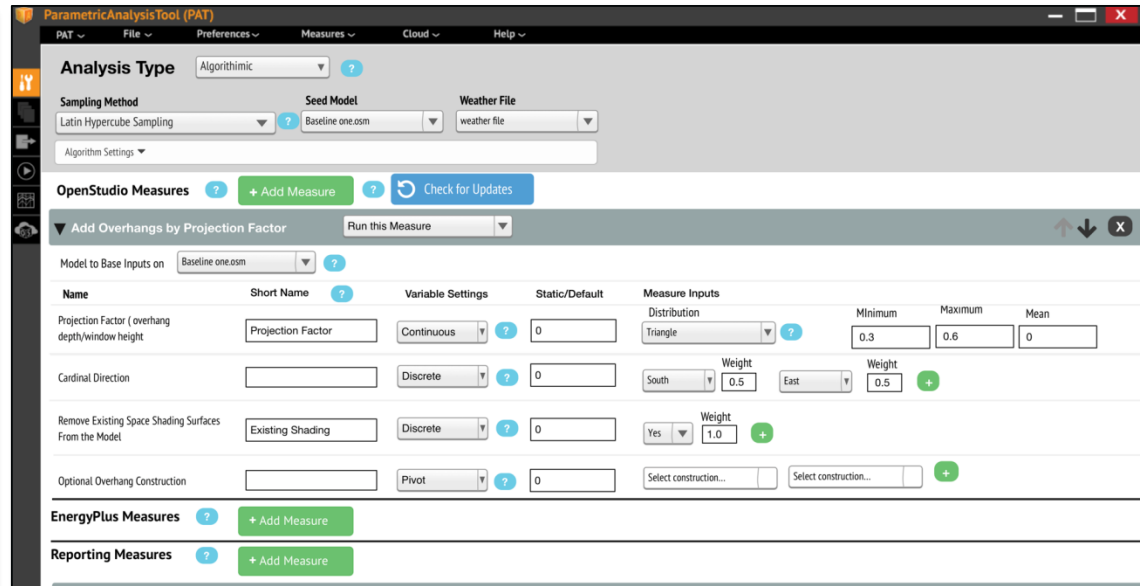
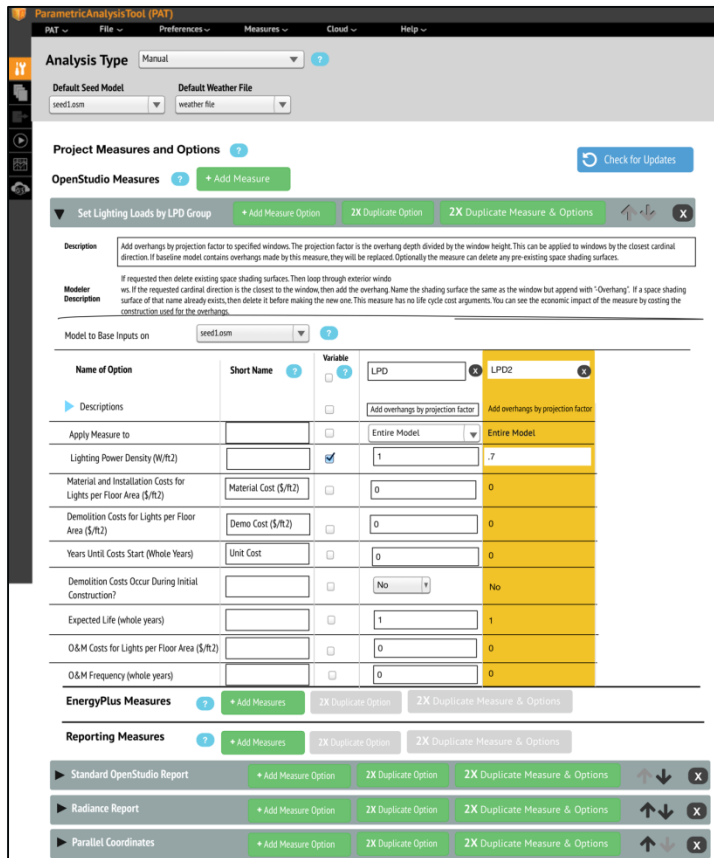
Groups
• About the BCL
• Developer Resources

Browse Components Browse Measures

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

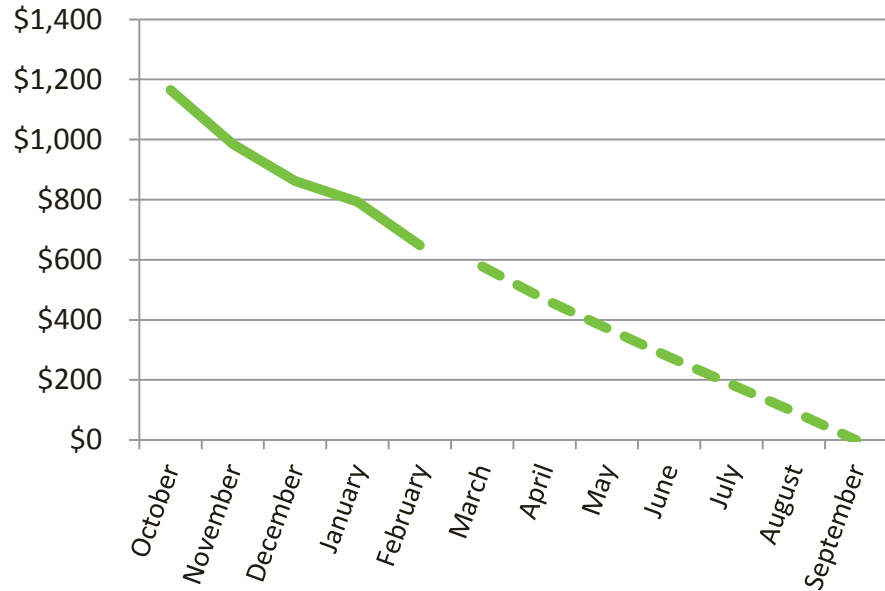
Near-Term Focus Areas

- 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*

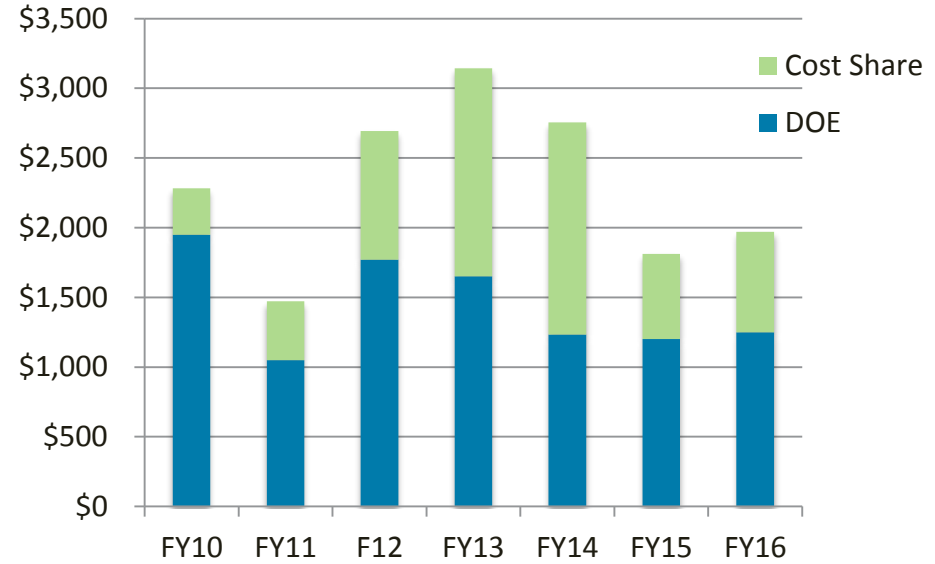
REFERENCE SLIDES

Project Budget

FY16 Spend* (\$k)



FY10-16 Budgets* (\$k)



Additional Funding Sources:

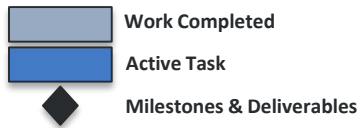


Project Plan and Schedule

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



	FY2012				FY2013				FY2014				FY2015				FY2016			
	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)	Q1 (Oct-Dec)	Q2 (Jan-Mar)	Q3 (Apr-Jun)	Q4 (Jul-Sep)
Project Name: OpenStudio Core																				
Q1 Milestone: OpenStudio 0.6 Released (Initial BCL Integration with OpenStudio)		◆																		
Q2 Milestone: OpenStudio 0.7 Released (First Version of OpenStudio App with BCL Integration)			◆																	
Q3 Milestone: OpenStudio 0.8 Released (App Suite Workflow Improvements and DEnCity)				◆																
Q4 Milestone: OpenStudio 0.9 Released (BIM Interop and Initial Support for BCL Measures)					◆															
Q1 Milestone: OpenStudio 0.10 Released (Sim Settings Tab and Backend Work for PAT)						◆														
Q2 Milestone: OpenStudio 0.11 Released (Initial Version of PAT and BCL UGC)							◆													
Q3 Milestone: OpenStudio 1.0 Released (PAT Economics and Measures)								◆												
Q4 Milestone: OpenStudio 1.1 Released (Cloud Support and additional Measures)									◆											
Q1 Milestone: OpenStudio 1.2 Released (Commercial Refrigeration Systems)										◆										
Q2 Milestone: OpenStudio 1.3 Released (HVAC, Refrigeration, and OS Server Improvements)											◆									
Q3 Milestone: OpenStudio 1.4 Released (OS Server Workflow and HVAC Improvements)												◆								
Q4 Milestone: OpenStudio 1.5 Released (HVAC and Performance Improvements, DEnCity Development)													◆							
Q1 Milestone: OpenStudio 1.6 Released (E+ 8.2 and Title 24 Support)														◆						
Q2 Milestone: OpenStudio 1.7 Released (Radiance 3-Phase Support and Usability Improvements)															◆					
Q3 Milestone: OpenStudio 1.8 Released (E+ 8.3 and BIM-Server Support)																◆				
Q4 Milestone: OpenStudio 1.9 Released (Substantial Completion of HVAC Coverage)																	◆			
Q1 Milestone: OpenStudio 1.10 Released (E+ 8.4 Support and Performance Improvements)																		◆		
Q2 Milestone: OpenStudio 1.11 Released (E+ 8.5 and Dual Duct Support)																			◆	
Q3 Milestone: OpenStudio 1.12 Released (Code refactor and PAT 2.0 Preview)																				◆
Q4 Milestone: OpenStudio 2.0 Released (Significant Code Refactor and PAT 2.0)																				◆