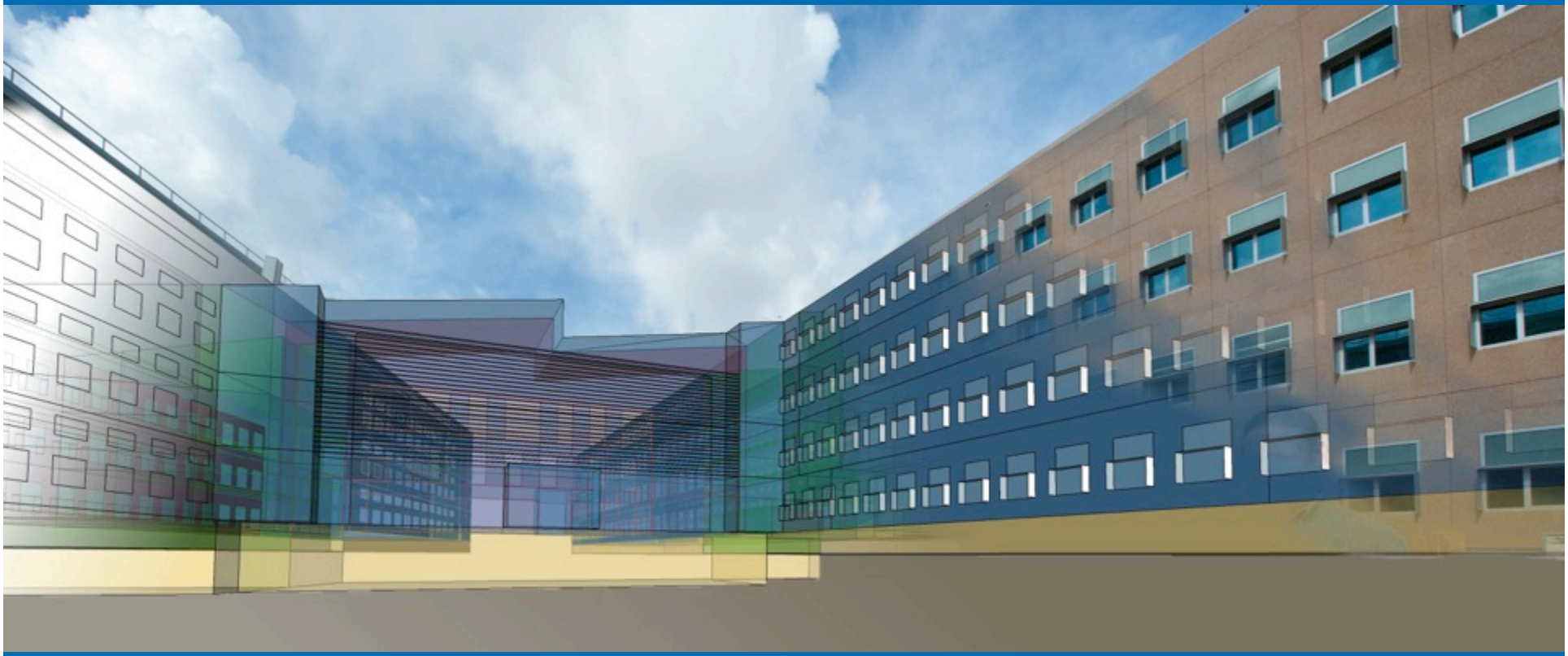
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

OpenStudio Overview

12th Annual Radiance International Workshop



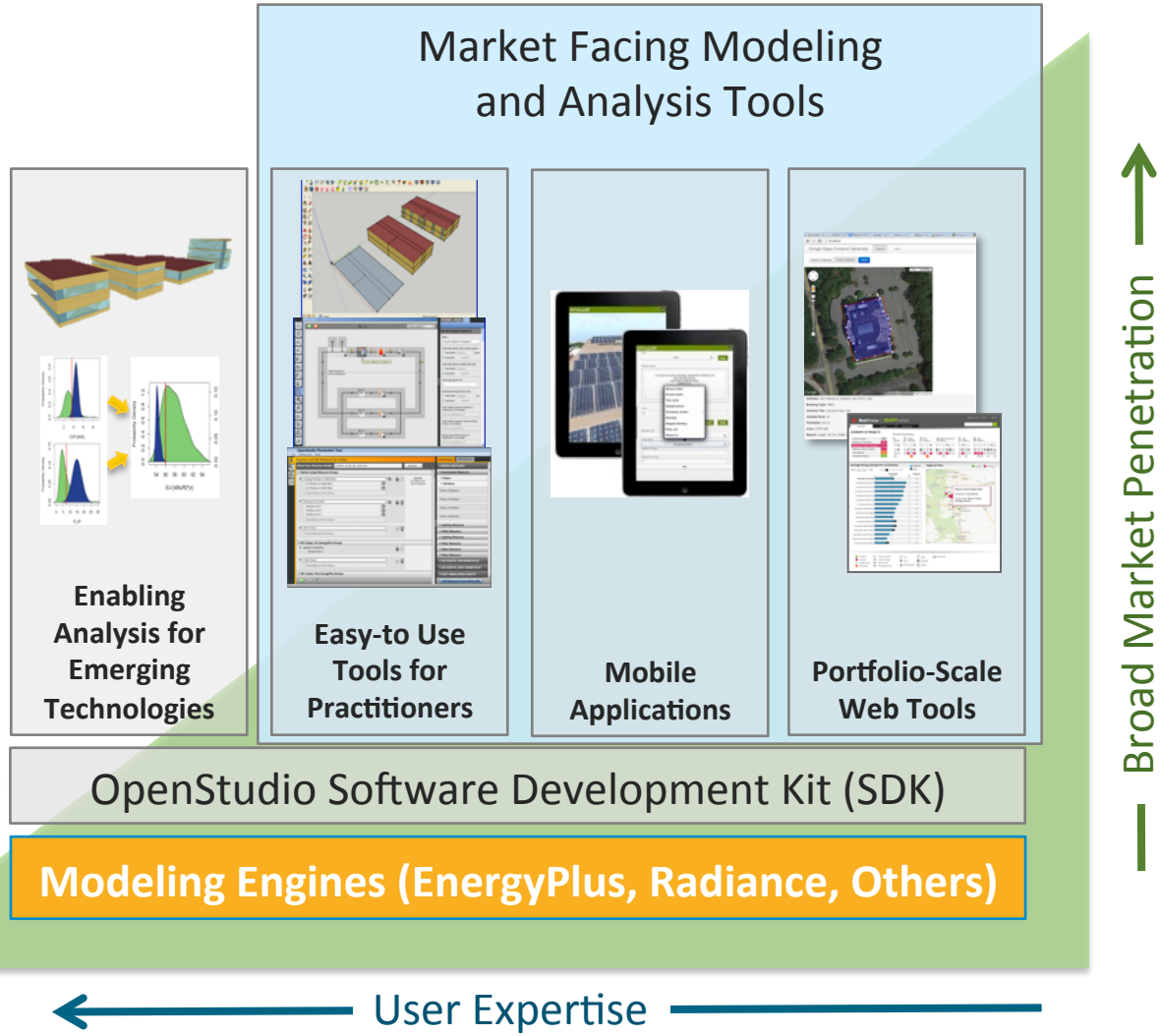
Commercial Buildings Controls and Analysis Tools Team
August 2013

DOE'S Energy Modeling Platform

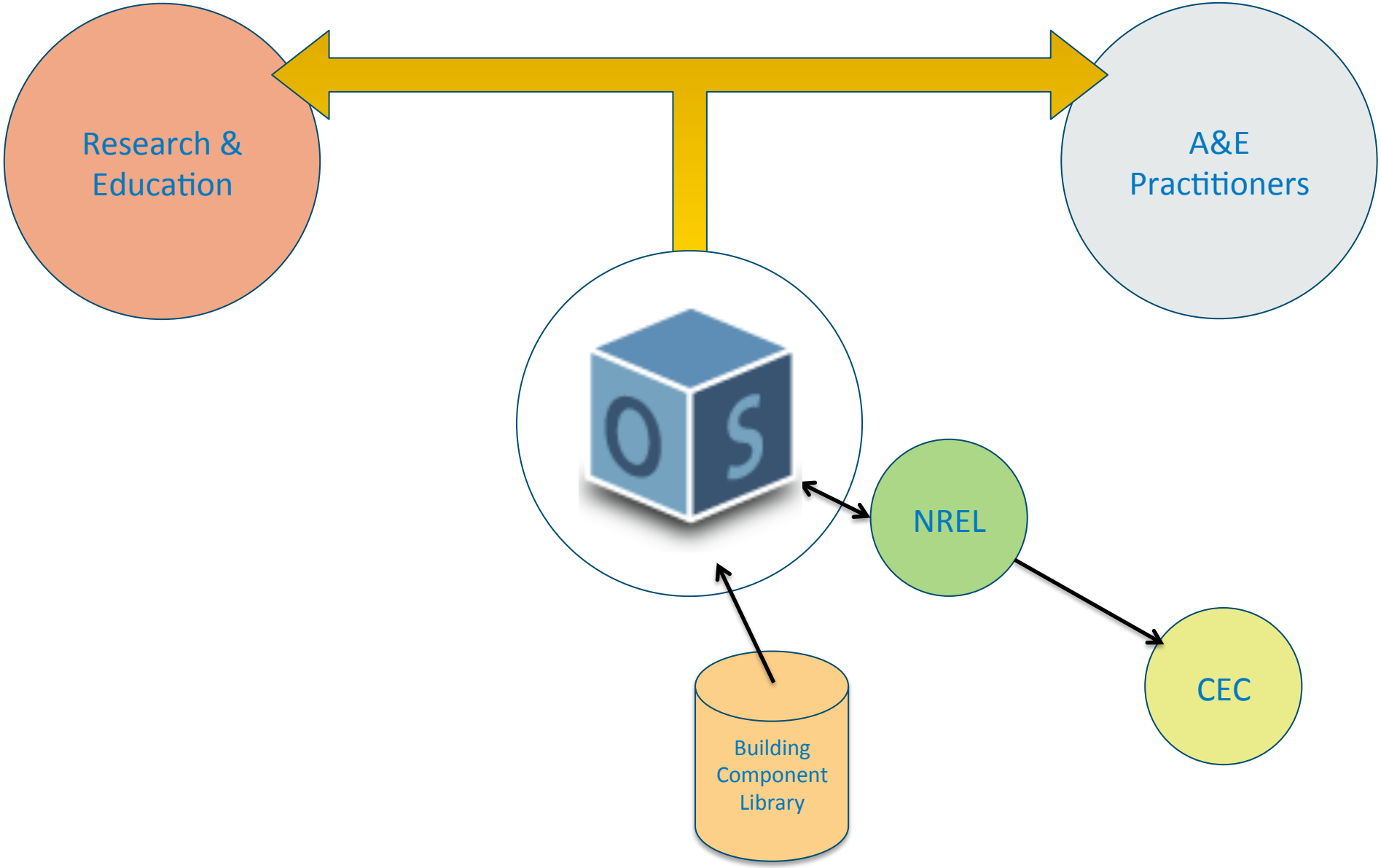
OpenStudio bridges the gap between capable but complex engines and the easy-to-use applications that drive change.

Sample Applications →

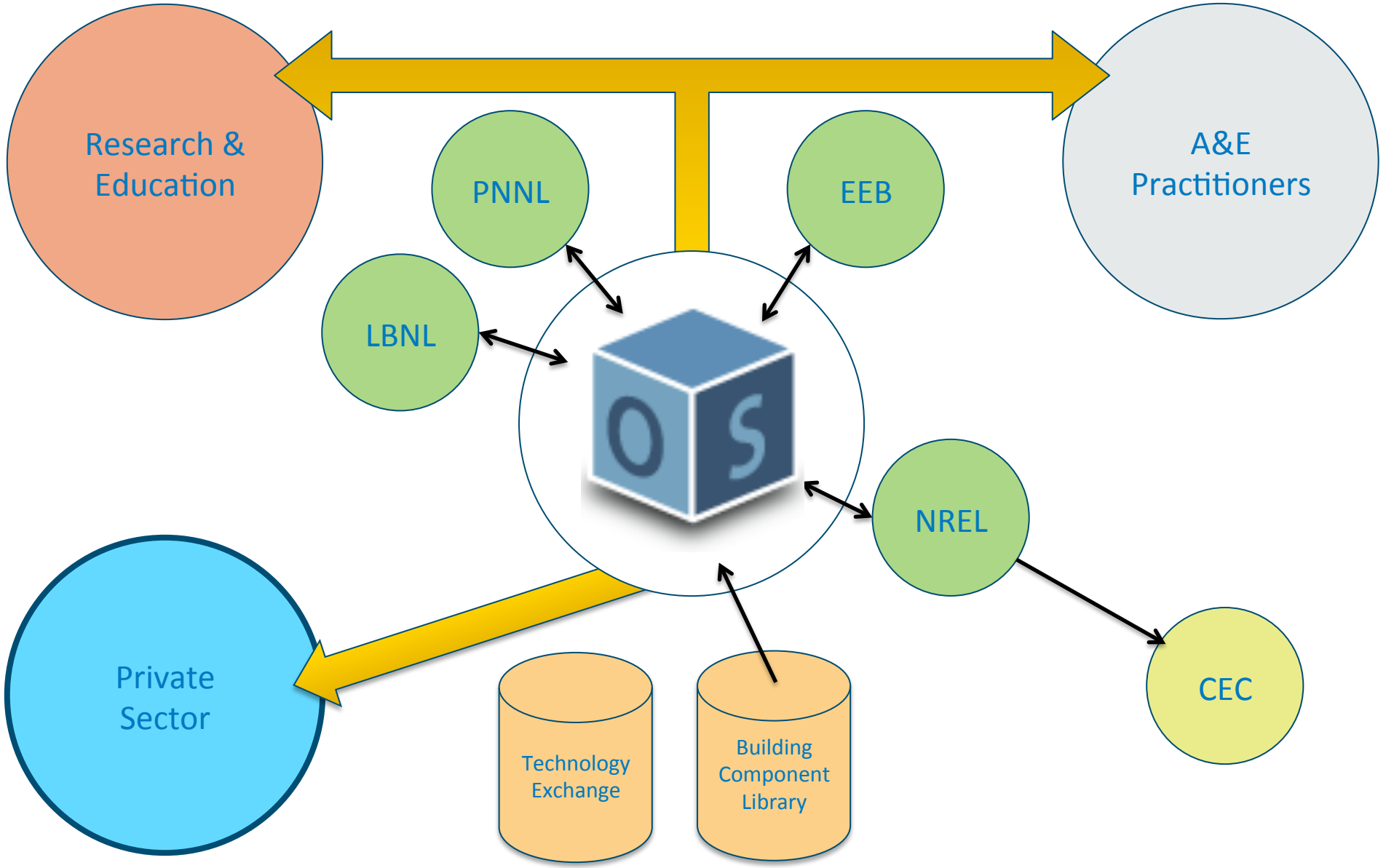
"Operating System" →



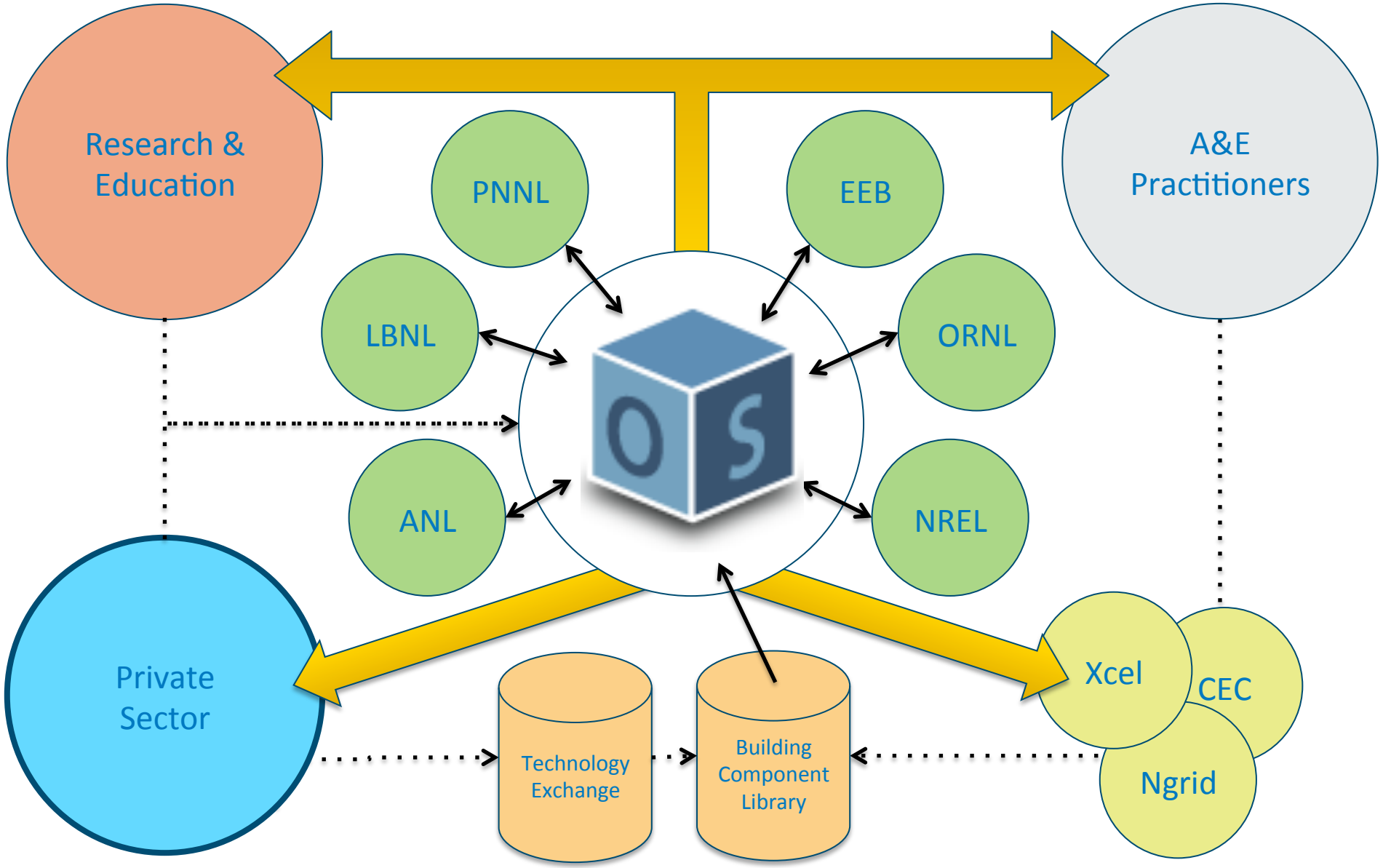
The Emerging OpenStudio Eco System – FY11



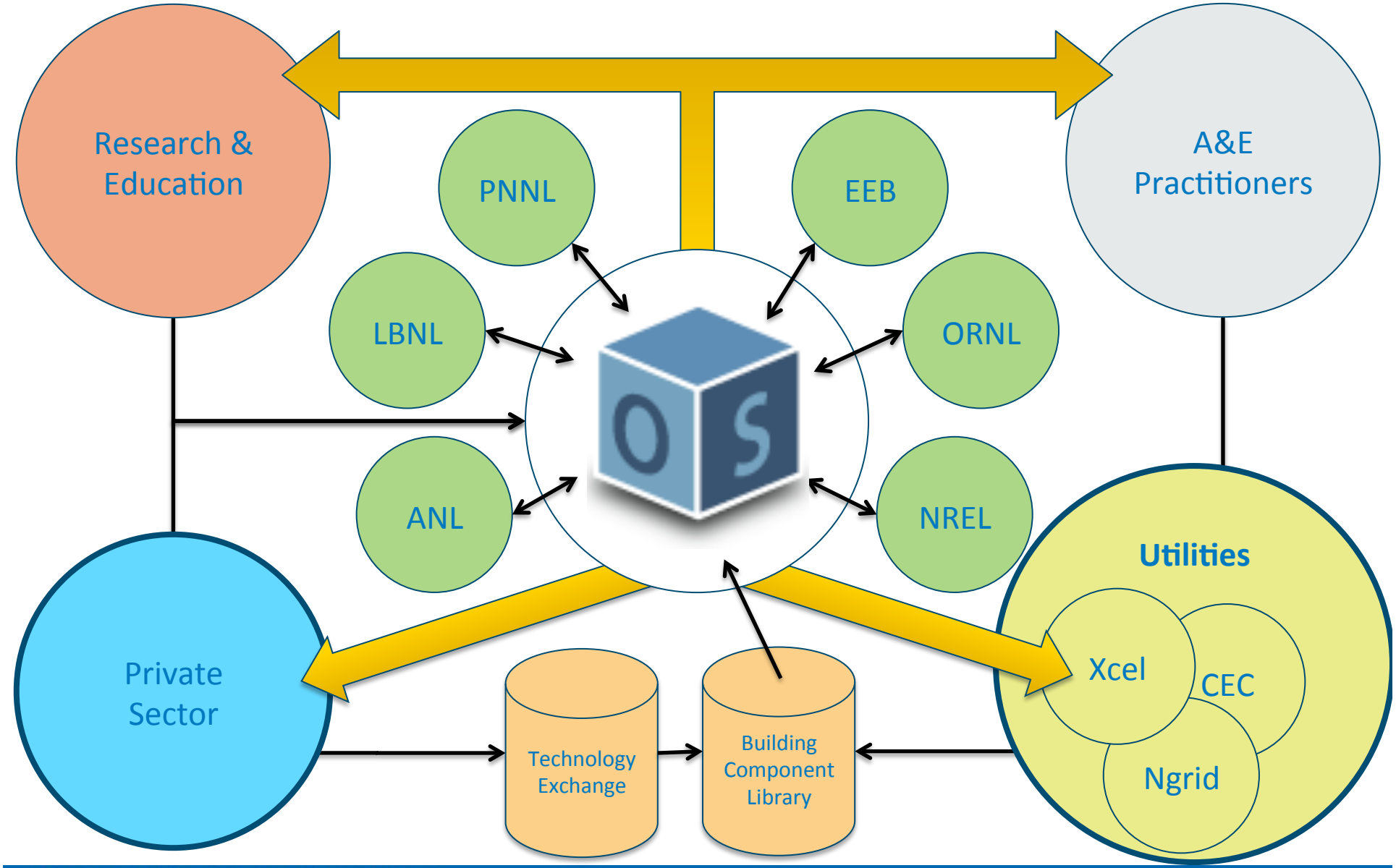
The Emerging OpenStudio Eco System – FY12



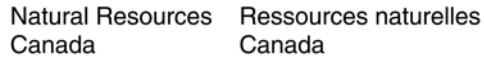
The Emerging OpenStudio Eco System – FY13



The Emerging OpenStudio Ecosystem



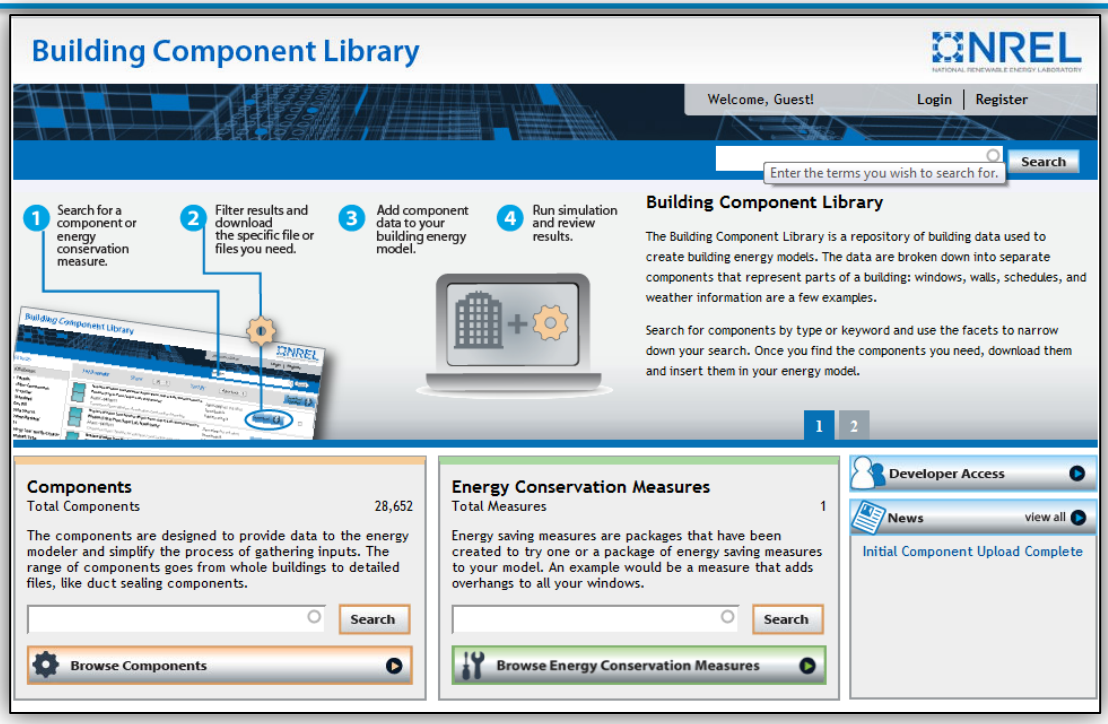
OpenStudio Partners (Partial List)



Who Uses OpenStudio Tools?

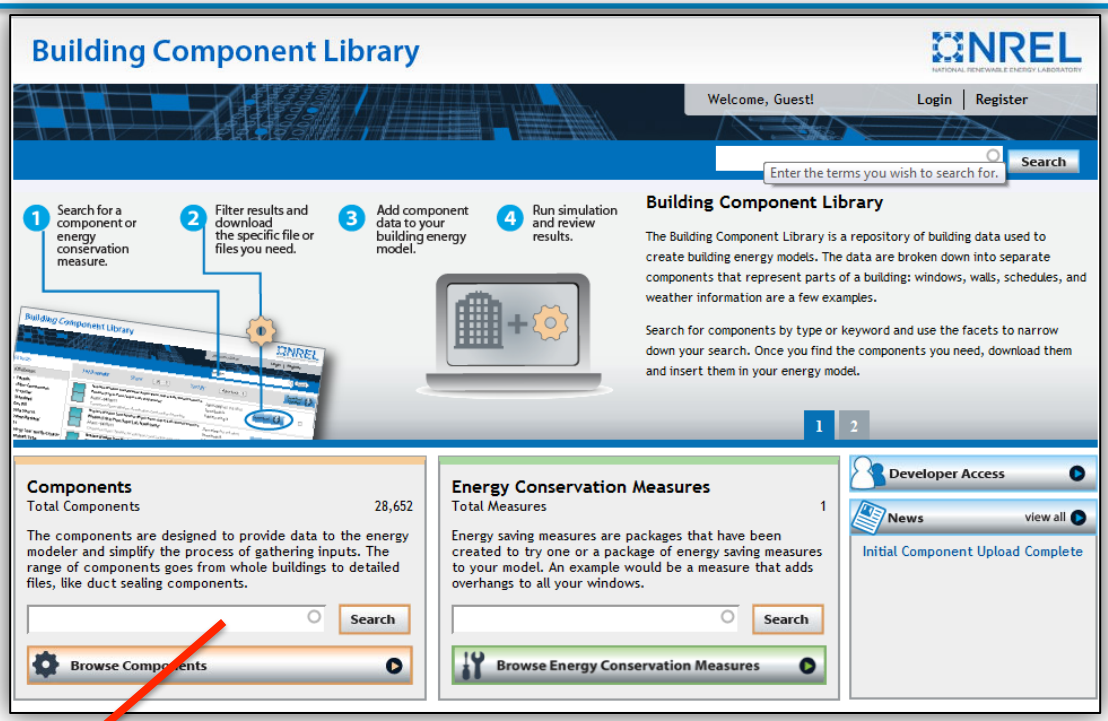
Note: gmail.com, hotmail.com, yahoo.com, and NREL.gov are filtered out of these results

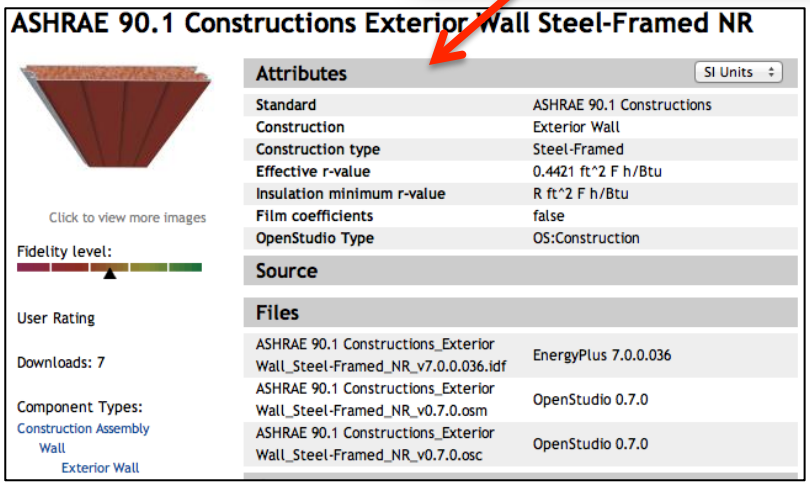
The Building Component Library



- 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

The BCL: A Source for Reusable Input Data

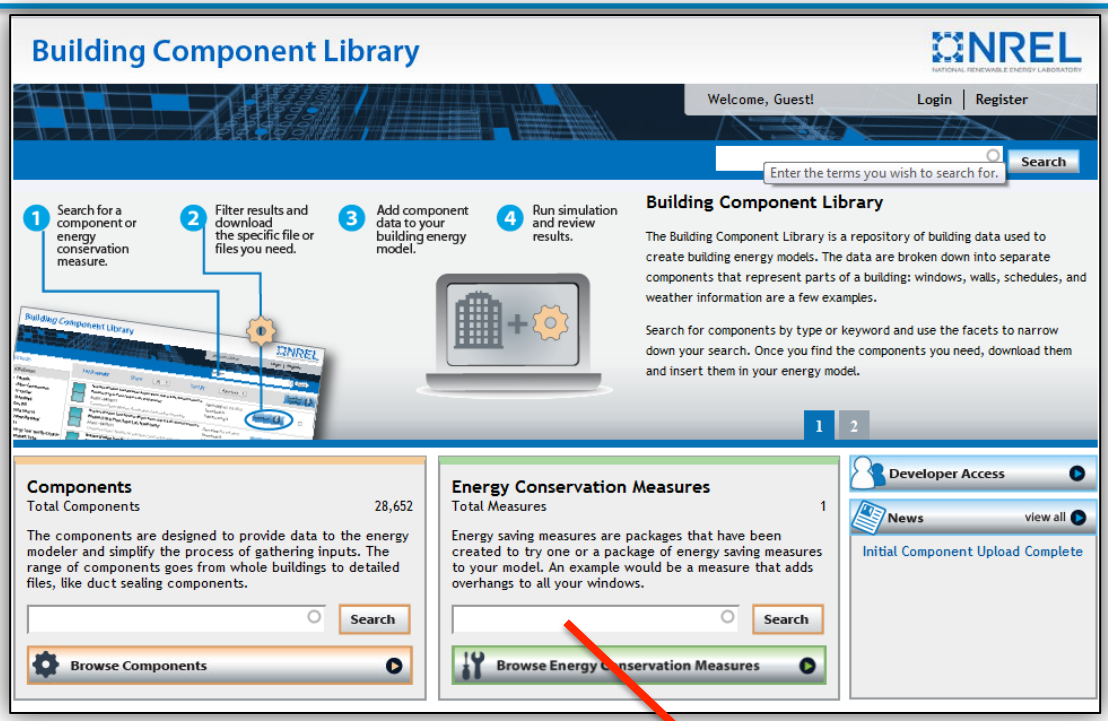




Components:

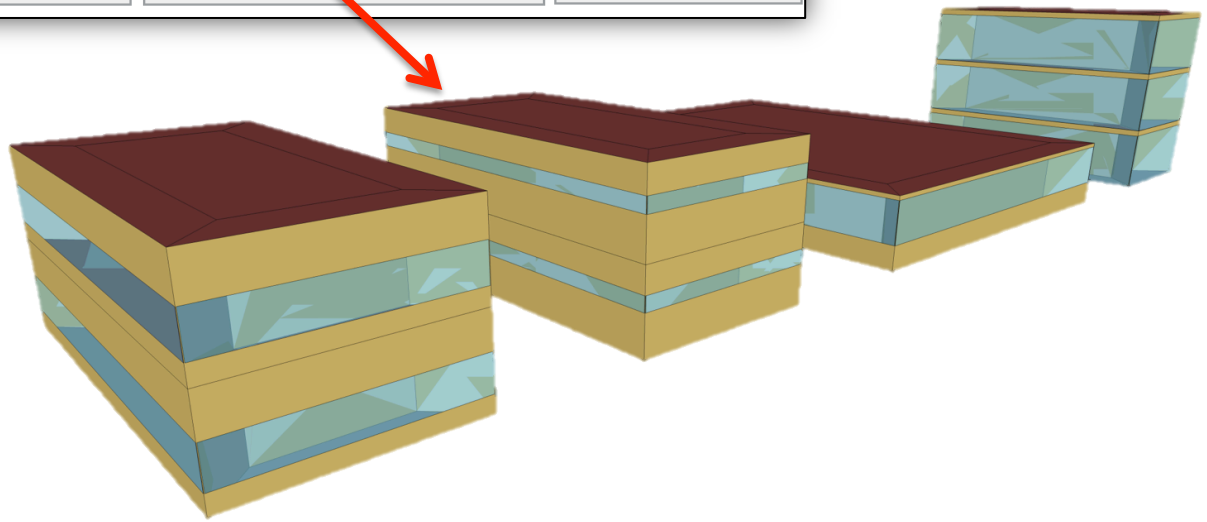
- Assembled to form complete energy models
- Include constructions, lights, schedules, weather data, PV components, and more

The BCL: Fast and Reliable Measure Application



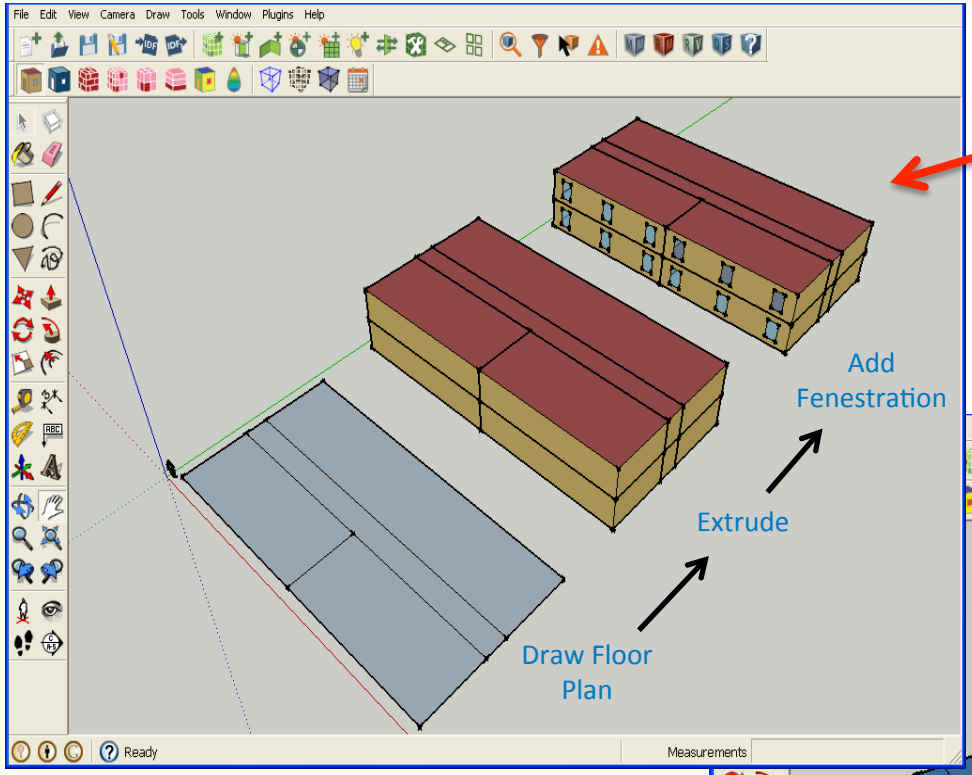
Measures:

- Contain logic needed to transform an energy model easily and consistently
- Can be applied singly or as part of a parametric analysis

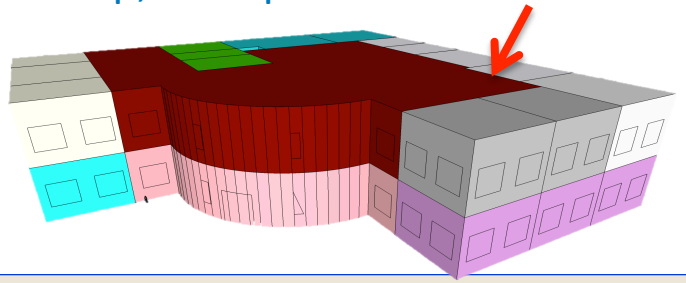


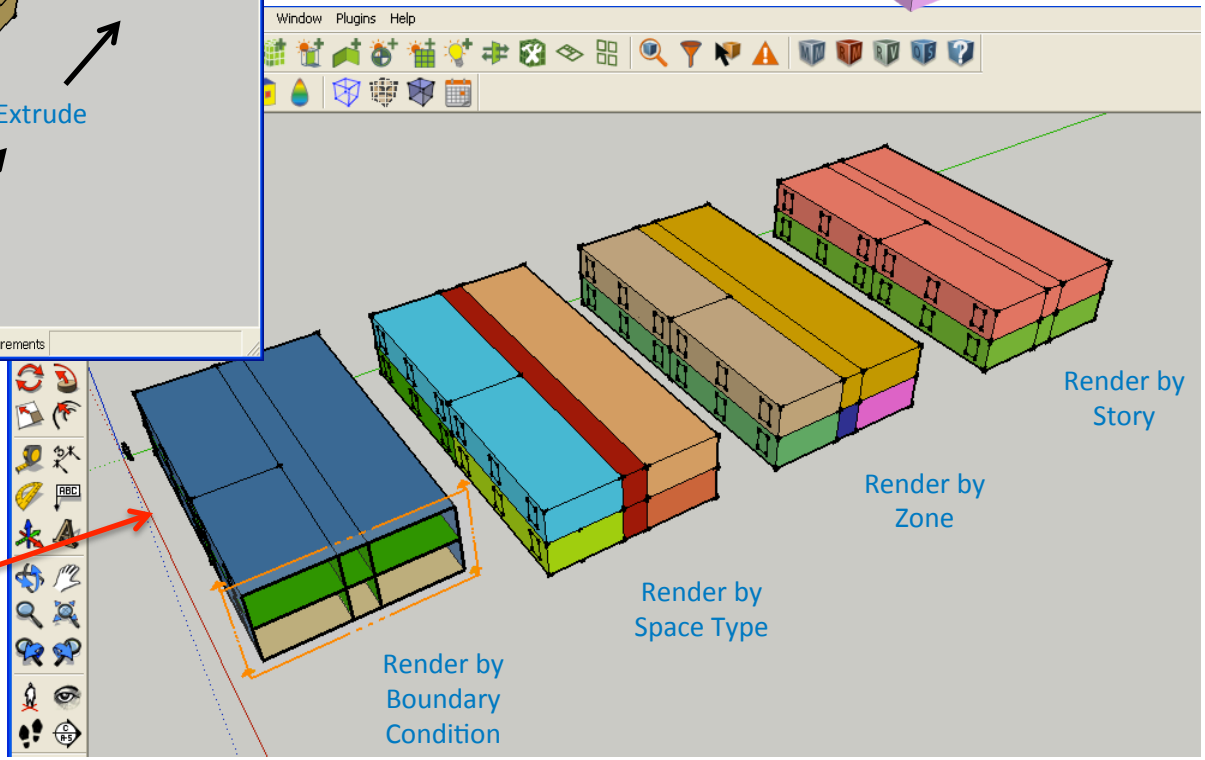
An A&E Practitioner's View

Rapid Geometry and Space Assignment with SketchUp



Draw envelope in minutes using SketchUp, or import from BIM





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

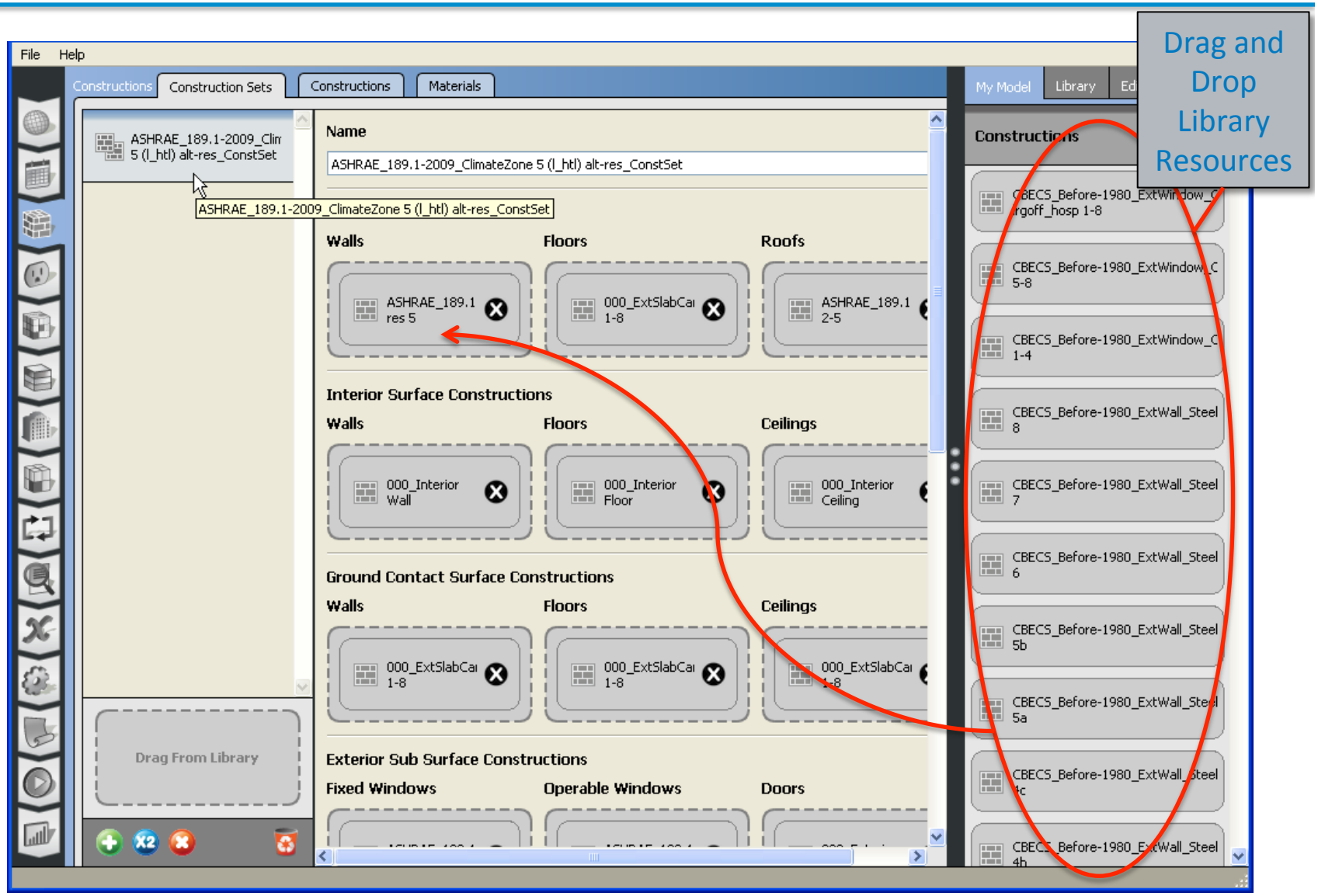
Credit: David Goldwasser / NREL

The OpenStudio Application

Define Resources

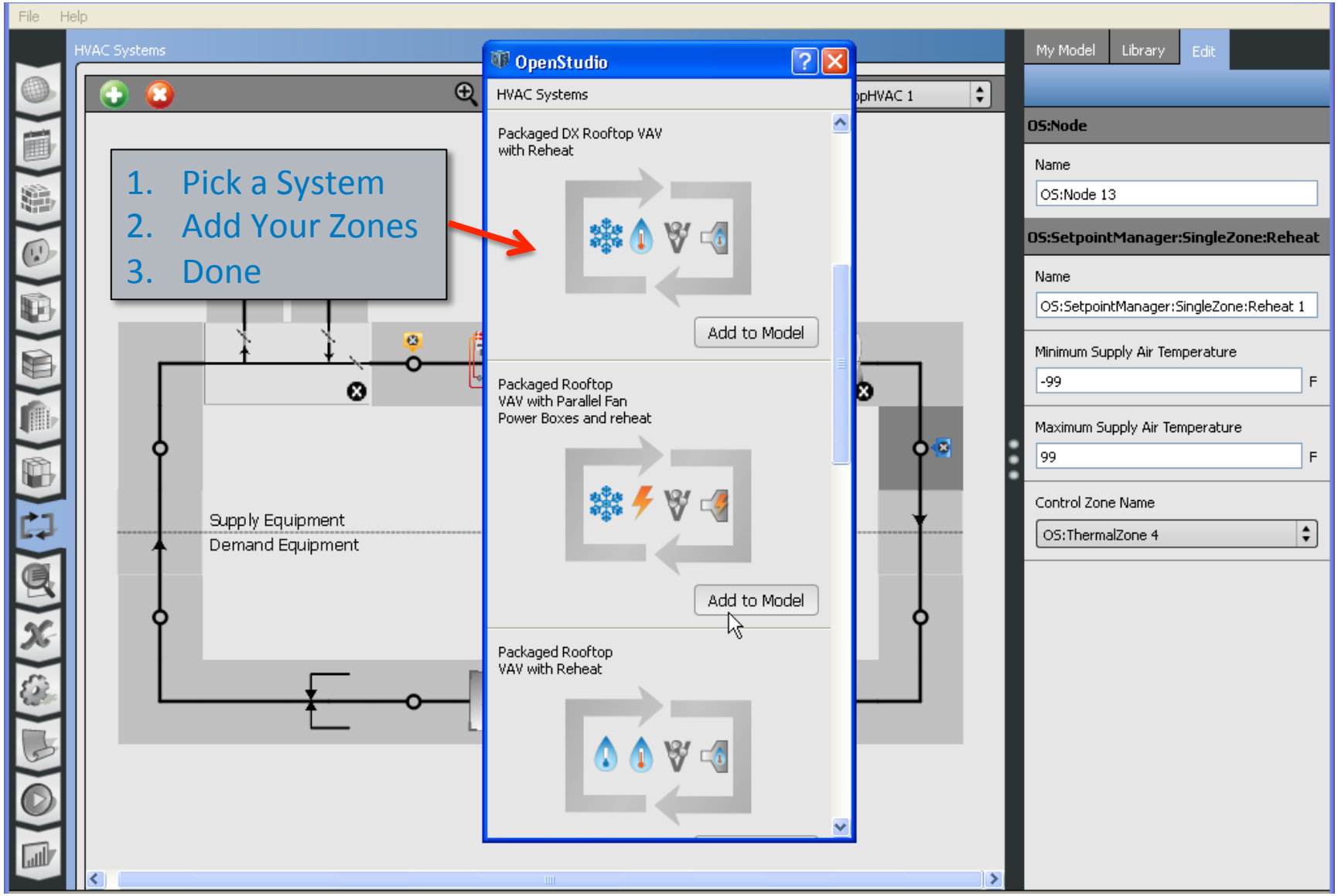
Workflow

Review Results



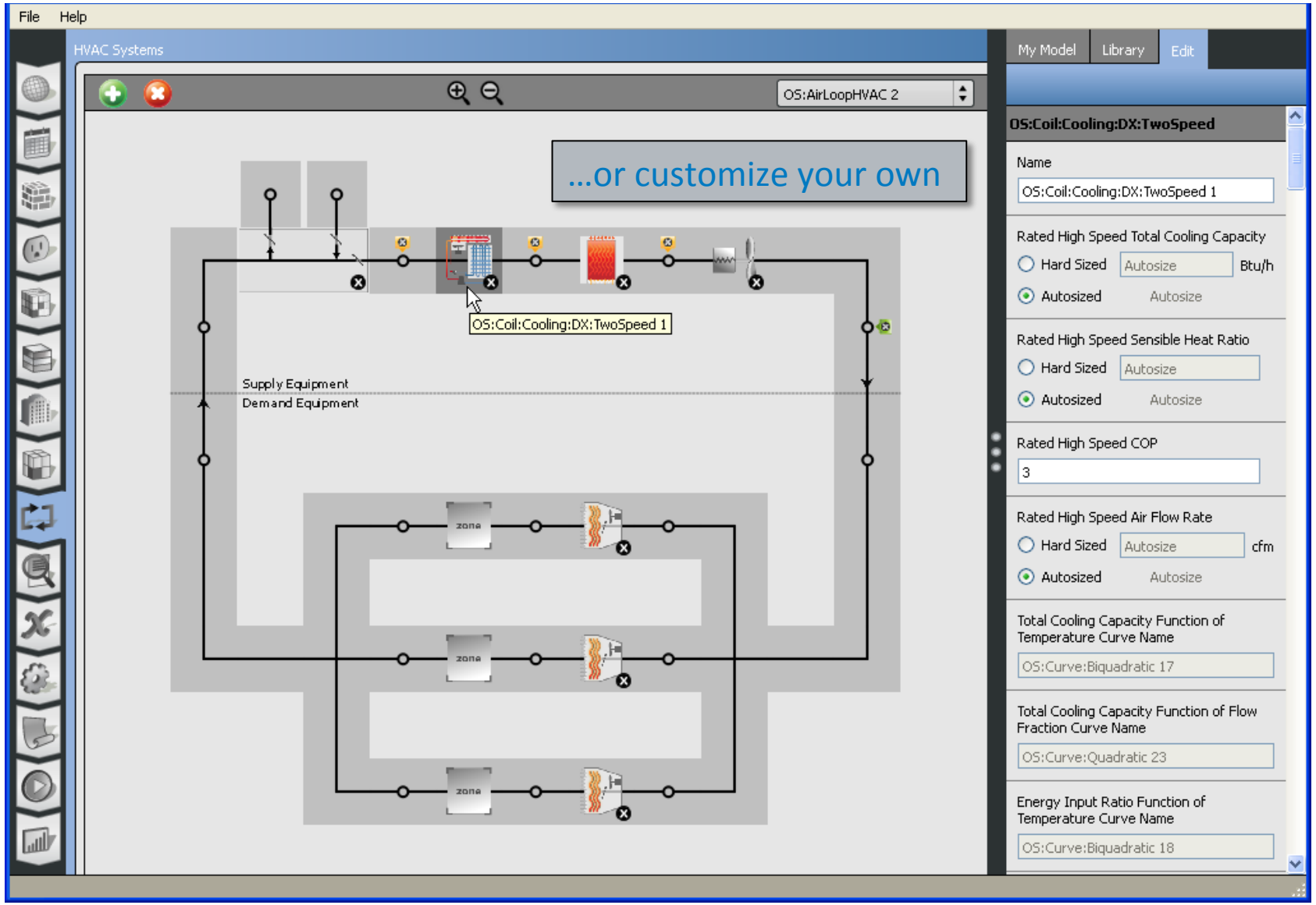
Credit: David Goldwasser / NREL

Templated HVAC Systems for Rapid Modeling



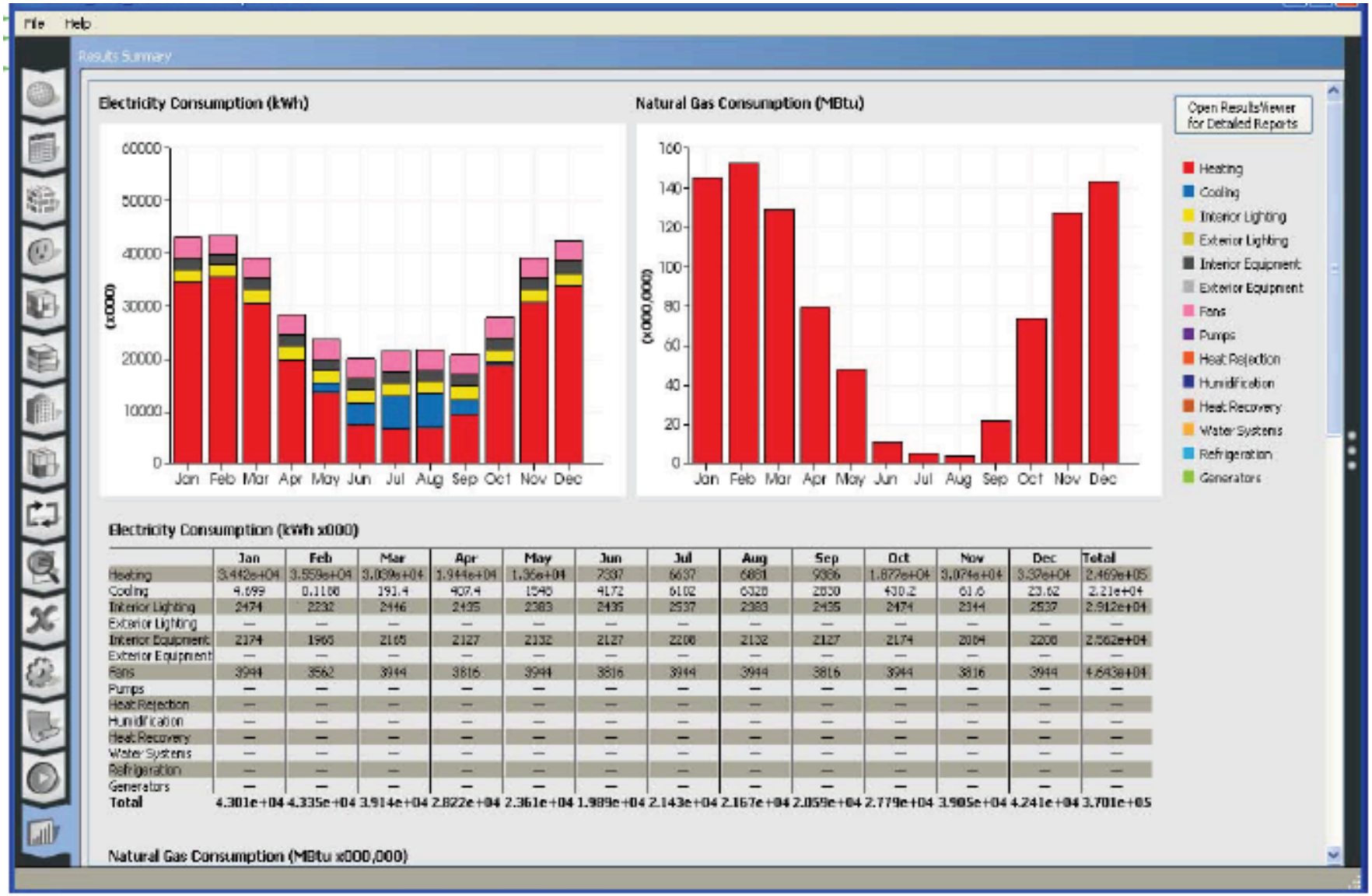
Credit: David Goldwasser / NREL

Drag and Drop HVAC System Models



Credit: David Goldwasser / NREL

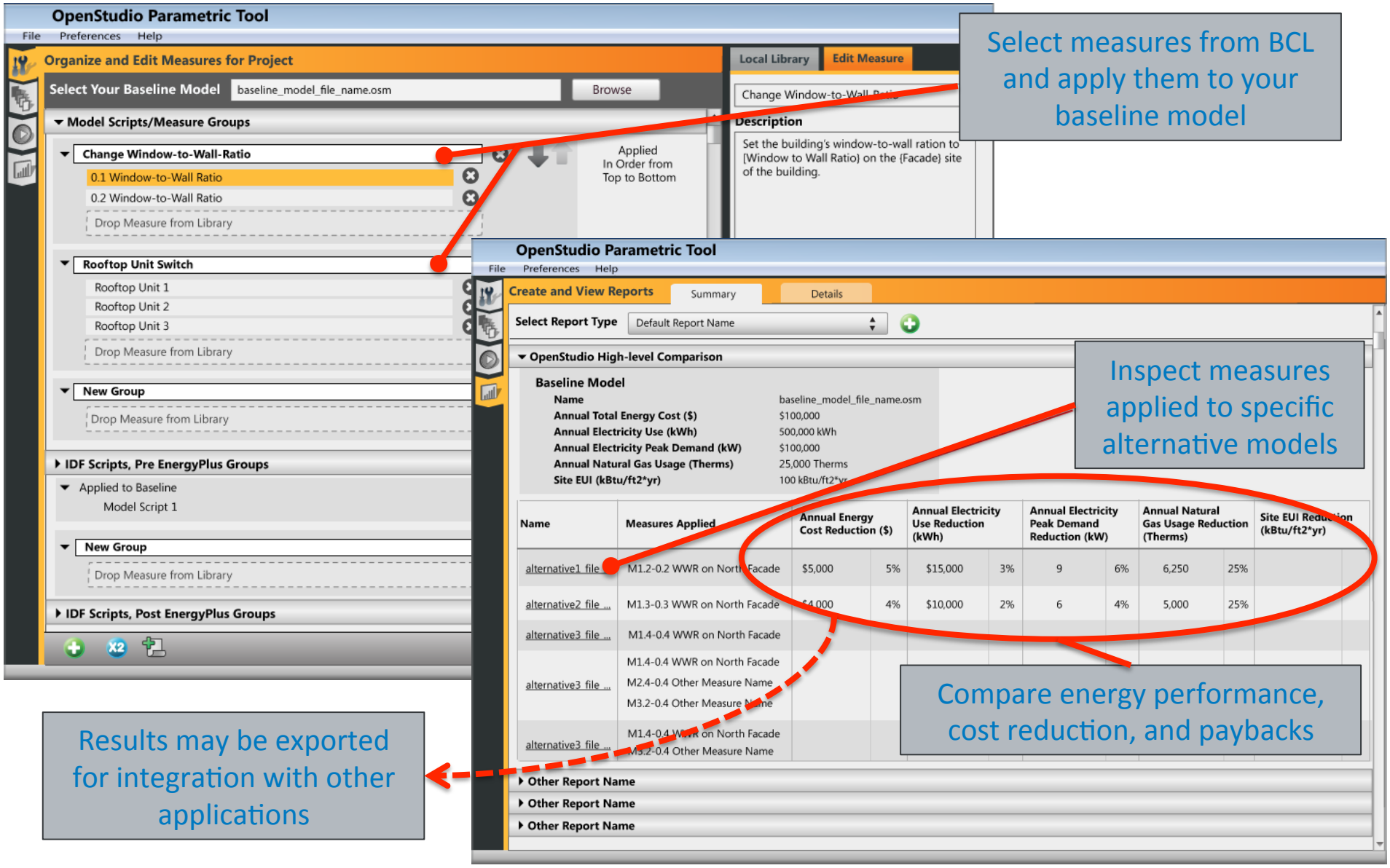
High Level Simulation Summary



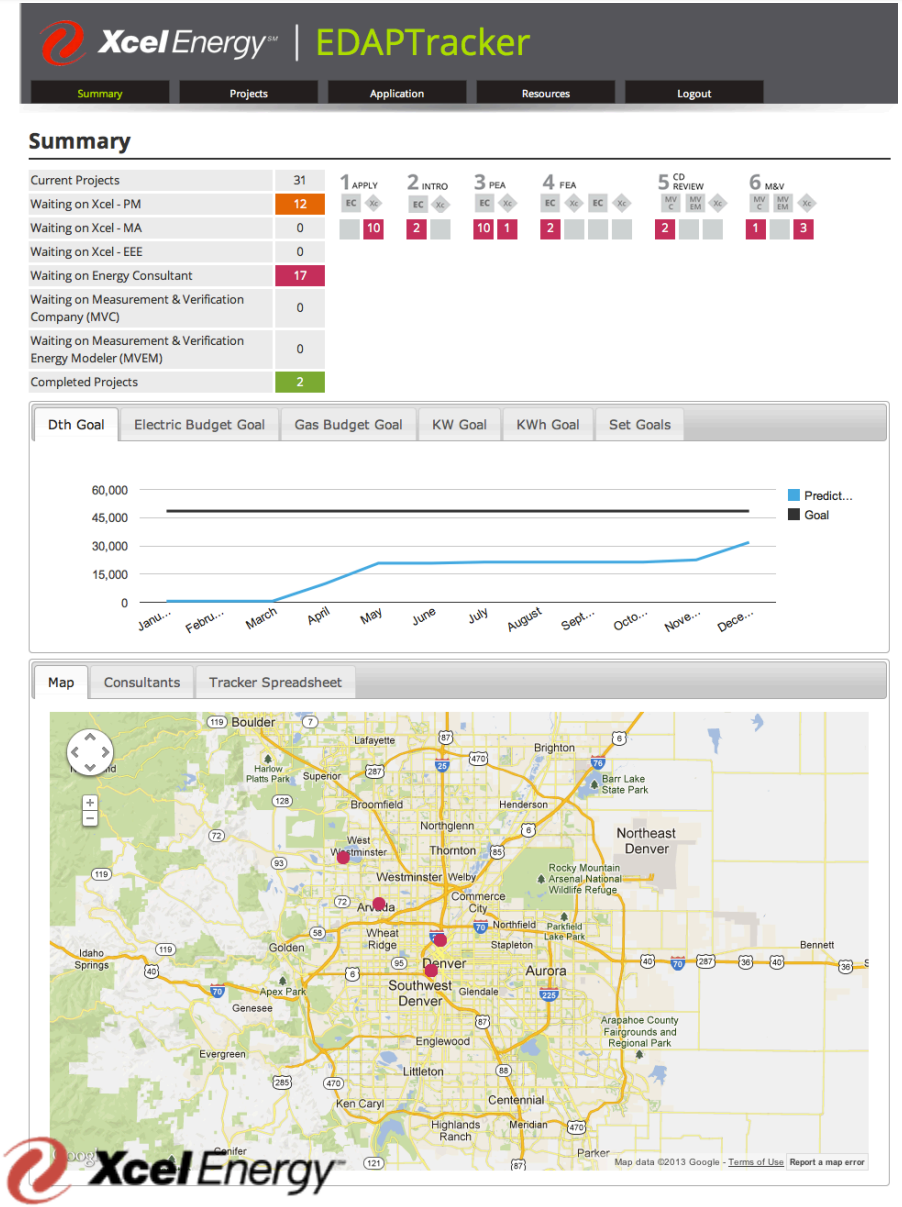
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Heating	3.442e+04	3.559e+04	3.039e+04	1.944e+04	1.36e+04	7337	6637	6881	9366	1.877e+04	3.074e+04	3.32e+04	2.469e+05
Cooling	4.699	0.1188	191.4	407.4	1540	4172	6102	6328	2830	430.2	61.6	23.62	2.21e+04
Interior Lighting	2474	2232	2446	2435	2383	2435	2537	2383	2435	2474	2344	2537	2.912e+04
Exterior Lighting	—	—	—	—	—	—	—	—	—	—	—	—	—
Interior Equipment	2174	1965	2165	2127	2132	2127	2208	2132	2127	2174	2084	2208	2.562e+04
Exterior Equipment	—	—	—	—	—	—	—	—	—	—	—	—	—
Fans	3944	3562	3944	3816	3944	3816	3944	3944	3816	3944	3816	3944	4.643e+04
Pumps	—	—	—	—	—	—	—	—	—	—	—	—	—
Heat Rejection	—	—	—	—	—	—	—	—	—	—	—	—	—
Humidification	—	—	—	—	—	—	—	—	—	—	—	—	—
Heat Recovery	—	—	—	—	—	—	—	—	—	—	—	—	—
Water Systems	—	—	—	—	—	—	—	—	—	—	—	—	—
Refrigeration	—	—	—	—	—	—	—	—	—	—	—	—	—
Generators	—	—	—	—	—	—	—	—	—	—	—	—	—
Total	4.301e+04	4.335e+04	3.914e+04	2.822e+04	2.361e+04	1.989e+04	2.143e+04	2.167e+04	2.059e+04	2.779e+04	3.905e+04	4.241e+04	3.701e+05

Credit: David Goldwasser / NREL

The OpenStudio Parametric Analysis Tool

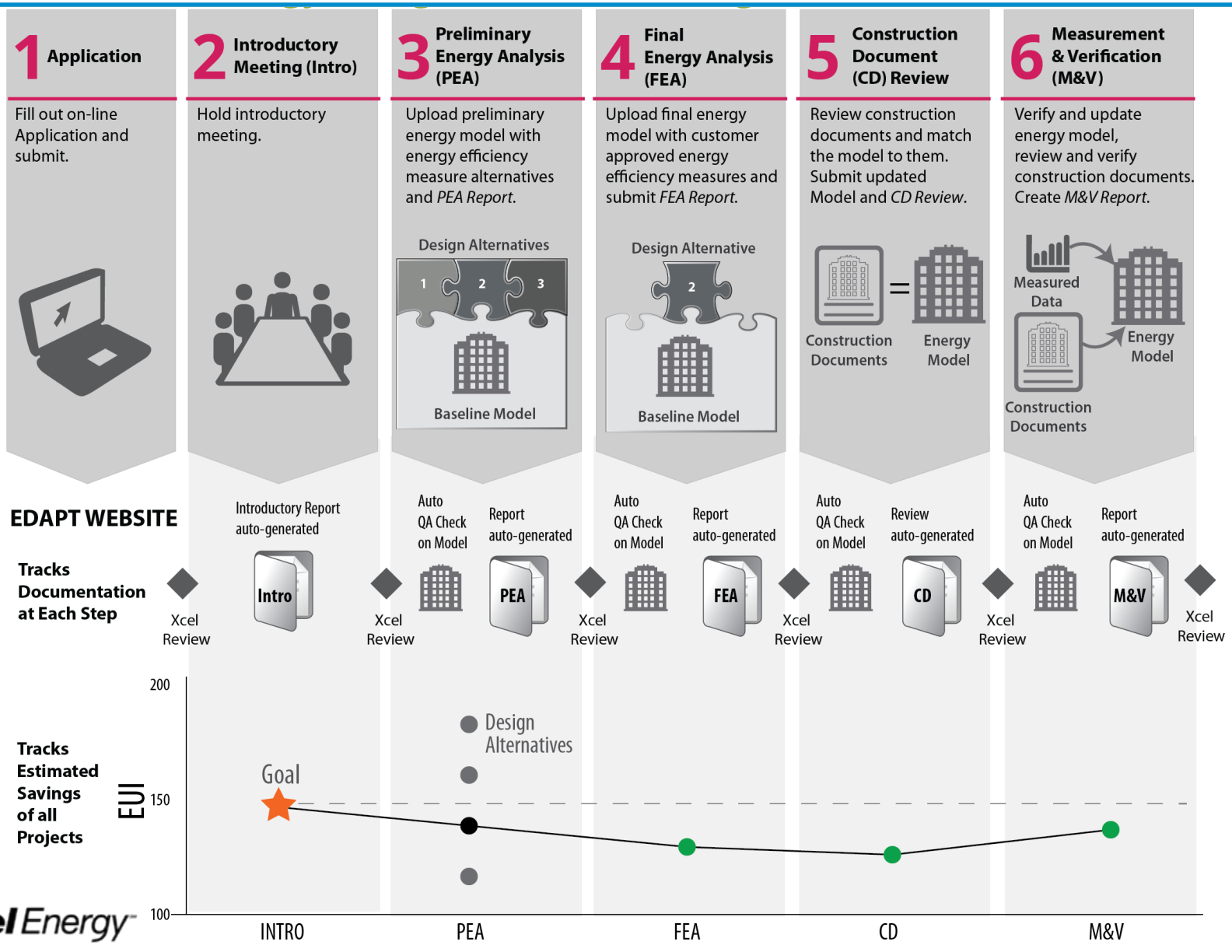


Incenting New Construction Efficiency

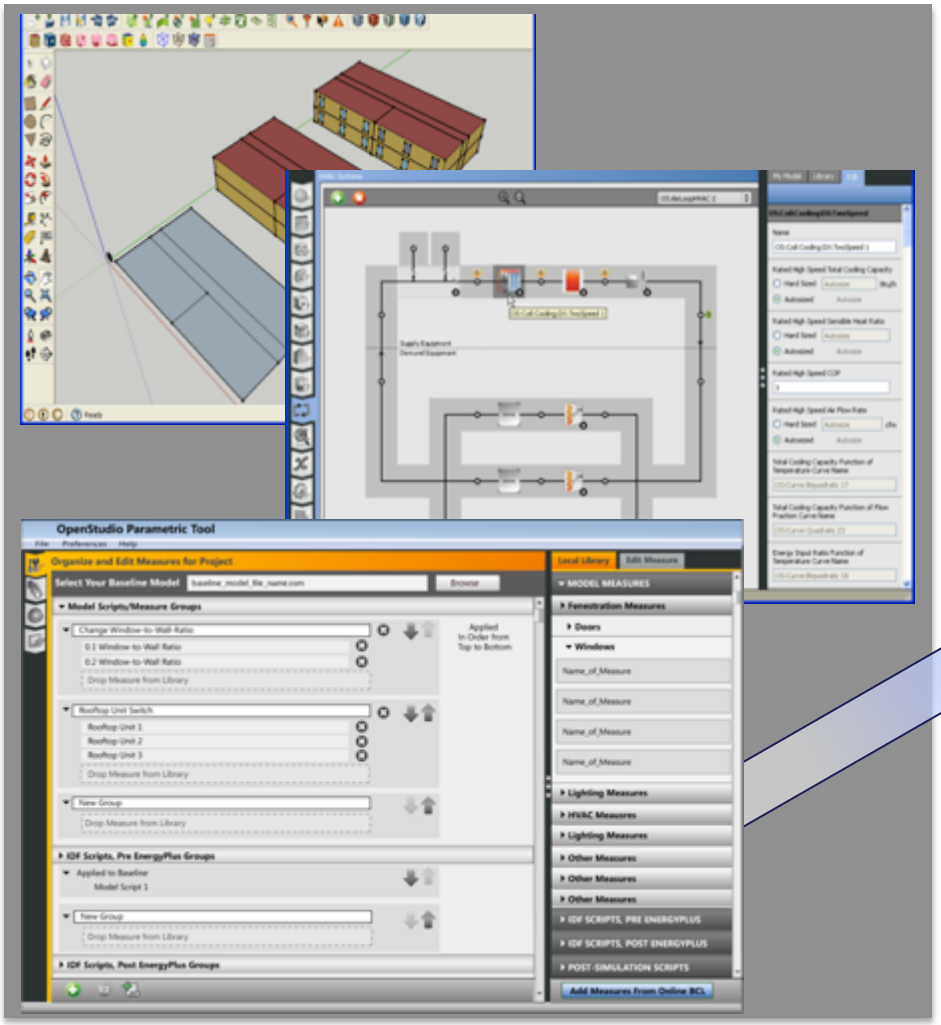


- **Energy Design Assistance (EDA)**
  - These programs are a primary tool to influence efficiency beyond code for new construction
- **Problems:**
  - EDA viability jeopardized as codes become more stringent
  - Must reduce admin costs to remain viable
  - Must maintain quality
- **Solution:**
  - Web service tracks projects, manages data and communications, and reports program-wide outcomes
  - OpenStudio provides automated quality and EDA protocol checking
  - EDAPT connects project data with model outcomes to streamline reporting

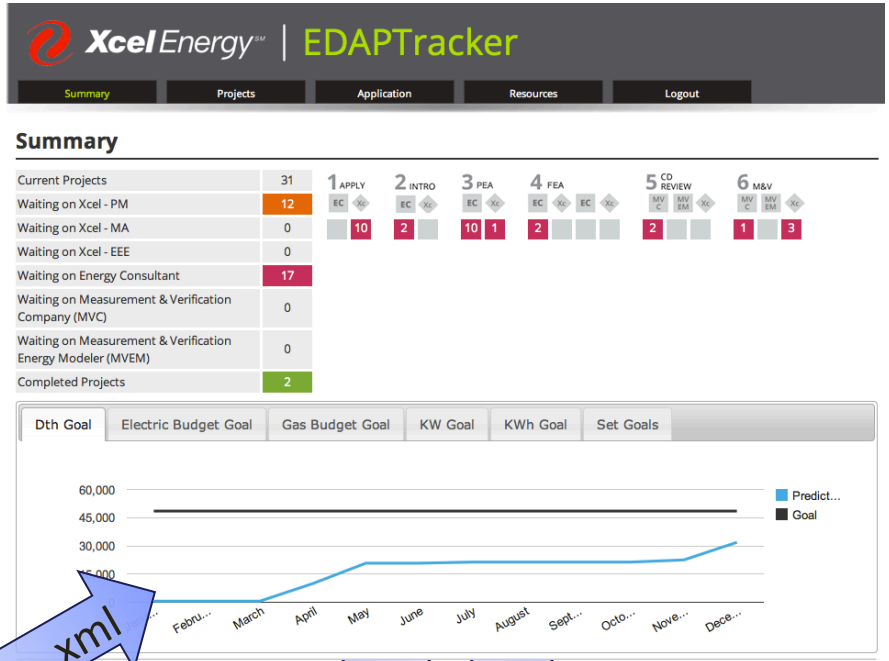
Incenting New Construction Efficiency



OpenStudio-EDAPT Integration



OpenStudio baseline and design alternate models along with simulation results



.xml

.doc

.xls

Template Reports

EDAPT automatically documents project data and OpenStudio output

Detailed Portfolio Tracking

Xcel Energy

Advanced Applications

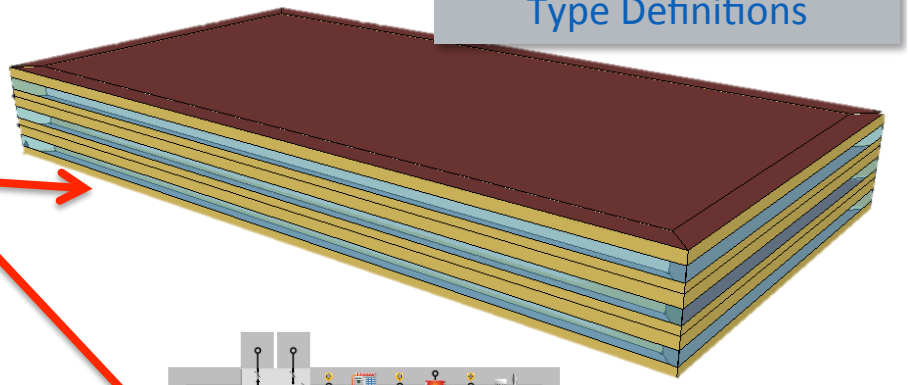
OpenStudio Enables Automated Model Generation

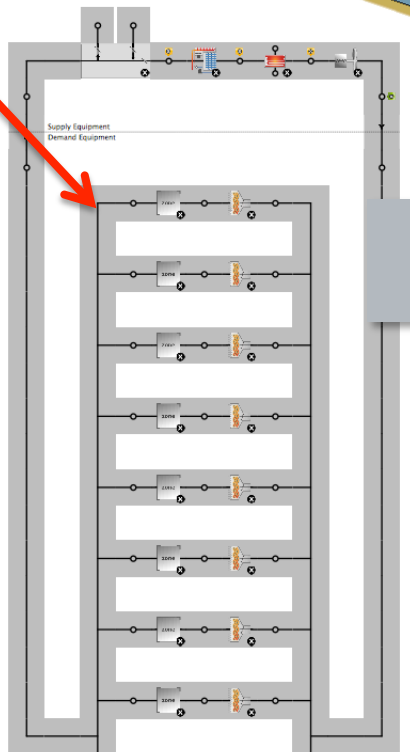
VirtualPULSE_run.rb

```ruby
require 'openstudio'
require 'VirtualPULSEModel'

#create a new model
model = VirtualPULSEModel.new

#add geometry (in this case a simple multi-story core/perimeter building)
model.add_geometry({"length" => 100,
#add windows at a given window-to-wall ratio
model.add_windows({"wwr" => 0.4,
#add HVAC - Packaged VAV w/ Reheat - DX Cooling, Hot Water heat and reheat
model.add_hvac({"fan_eff" => 0.5,
#add thermostats
model.add_thermostats({"heating_setpoint" => 24,
#assign constructions from a local library to the exterior walls/windows/etc. in the model
model.add_constructions({"construction_library_path" => "#{Dir.pwd}/VirtualPULSE_default_constructions.osm"})

#add space type from a remote library (BCL) to the model
model.add_space_type({"NREL_reference_building_vintage" => "ASHRAE_90.1-2004",
#add design days to the model
model.add_design_days()

#save the OpenStudio model (.osm)
model.save_openstudio_osm({"osm_save_directory" => Dir.pwd,
#translate the OpenStudio model (.osm) to an EnergyPlus model (.idf)
model.translate_to_energyplus_and_save_idf({"idf_save_directory" => Dir.pwd,
#run the EnergyPlus model (.idf)
VirtualPULSEModel::run_energyplus_simulation({"idf_directory" => Dir.pwd,
```

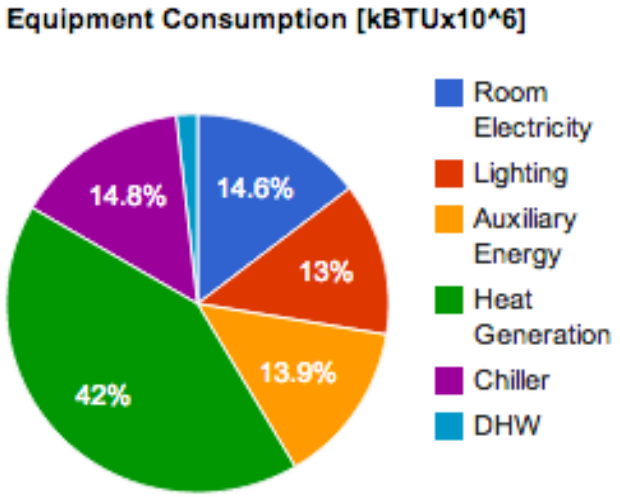
~ 2 Lines of Ruby Code + Comments

Geometry and Space Type Definitions





Detailed HVAC and Zoning

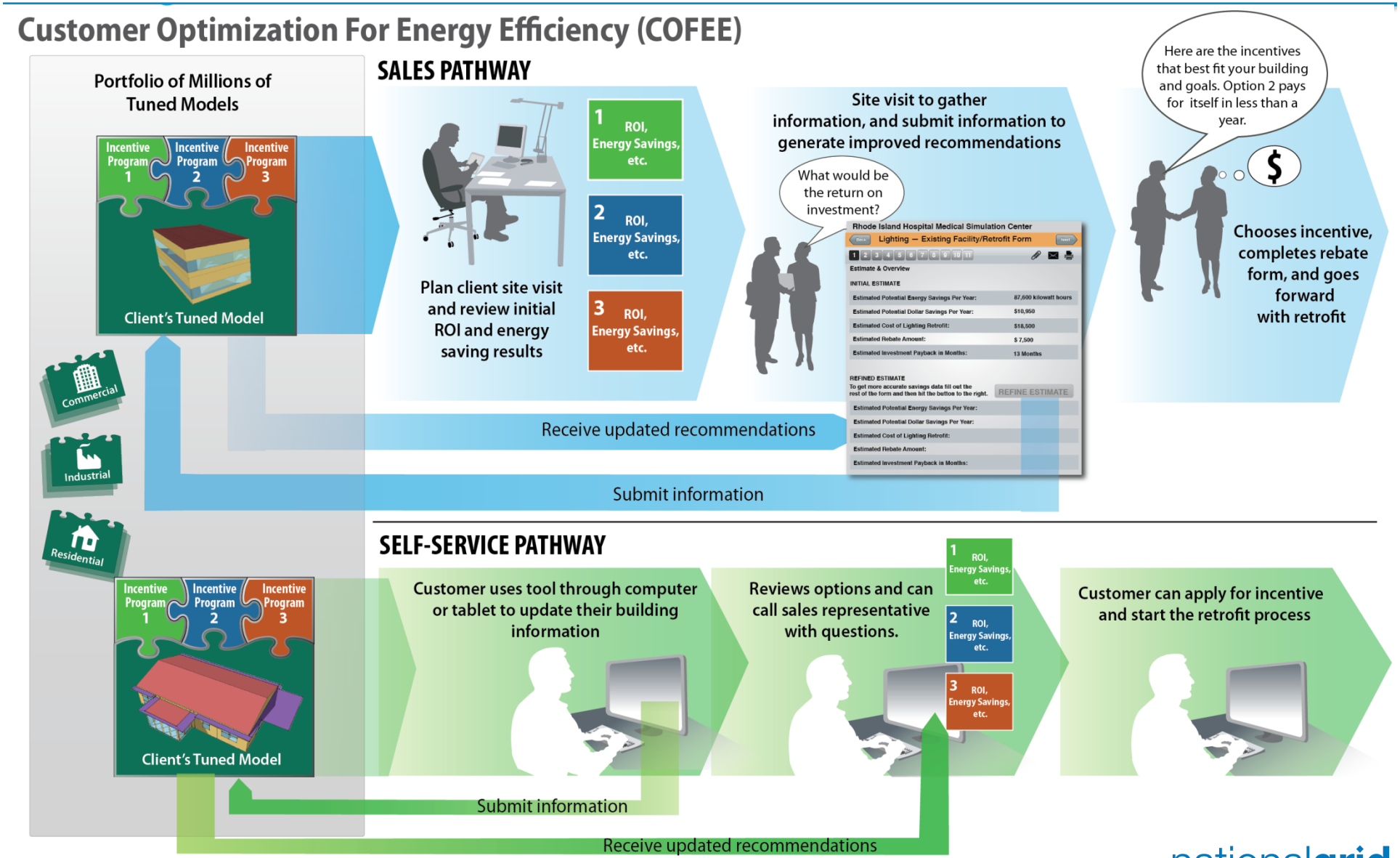


Simulated End Uses

Pacific Northwest NATIONAL LABORATORY

eebHUB Energy Efficient Buildings Hub

Portfolio-Scale Automated Modeling



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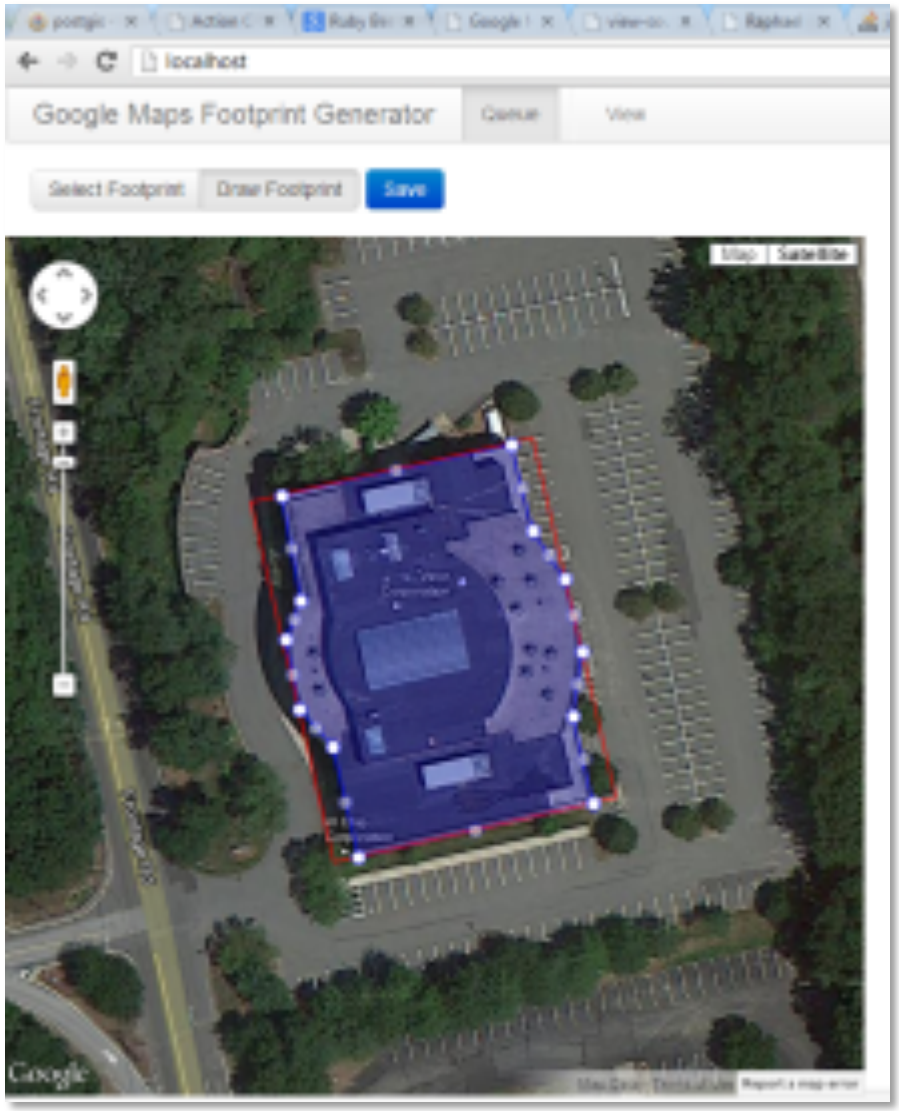
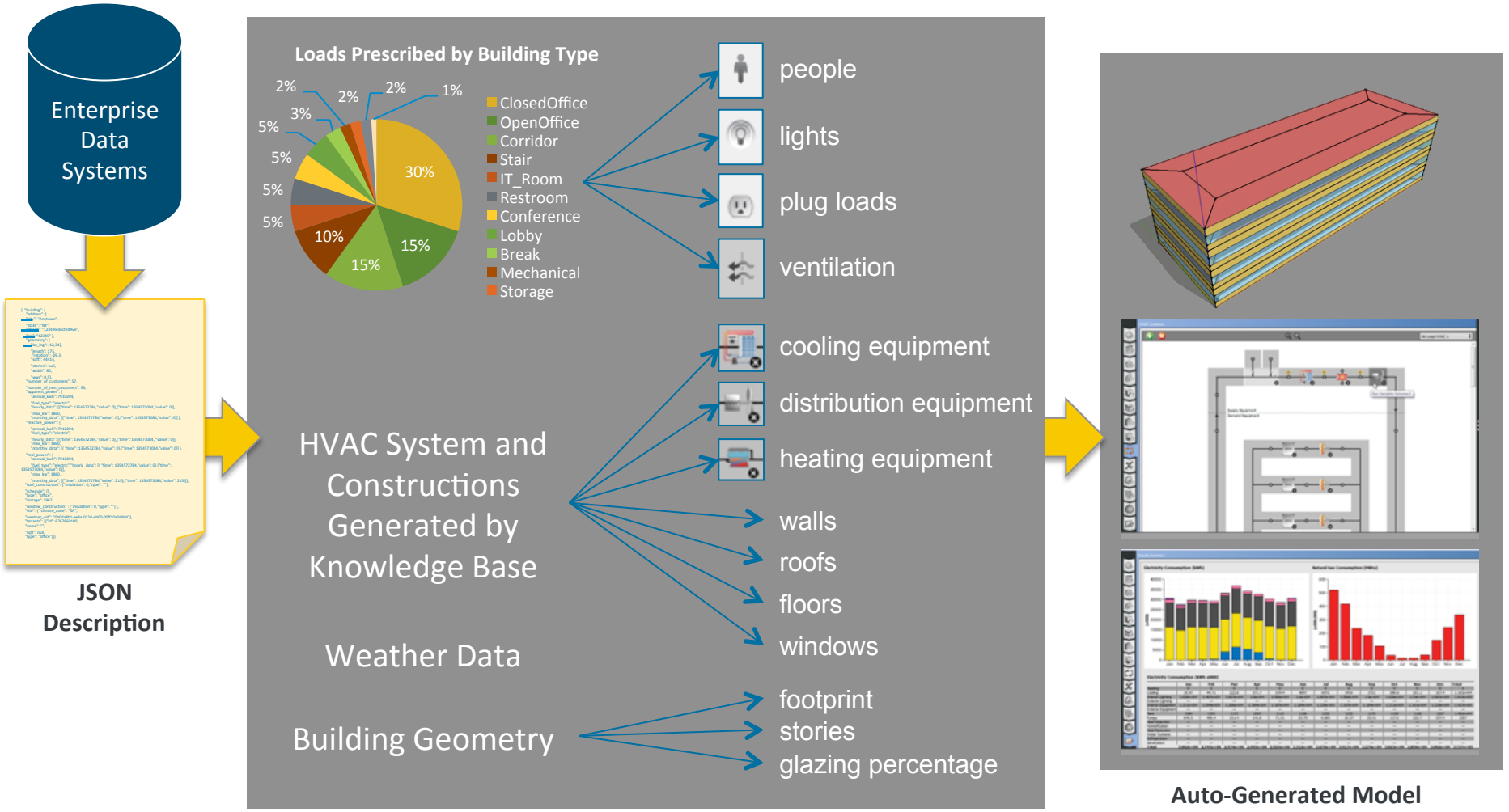
What High Level Data Are Used to Create Baseline Models?



- **Address:** *PII*
- **Size:** 10,000 ft^2
- **Number of Floors:** 3
- **Vintage:** 1982
- **Building Type:** Office
- **Web app assists with geometry extraction**

nationalgrid

An Expert System to Create Baseline Models



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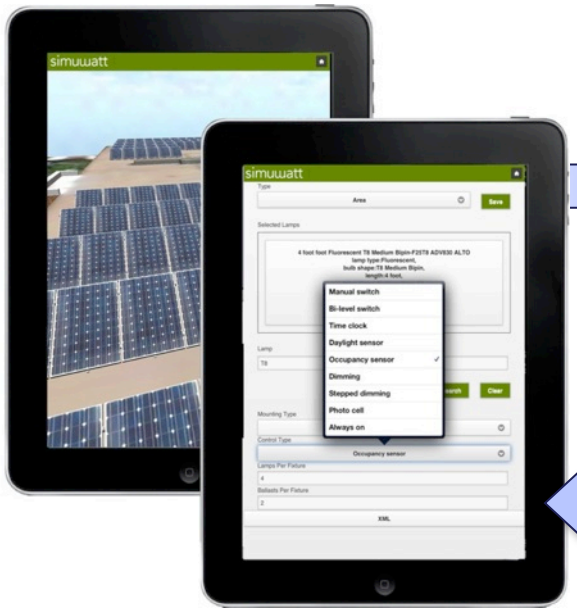
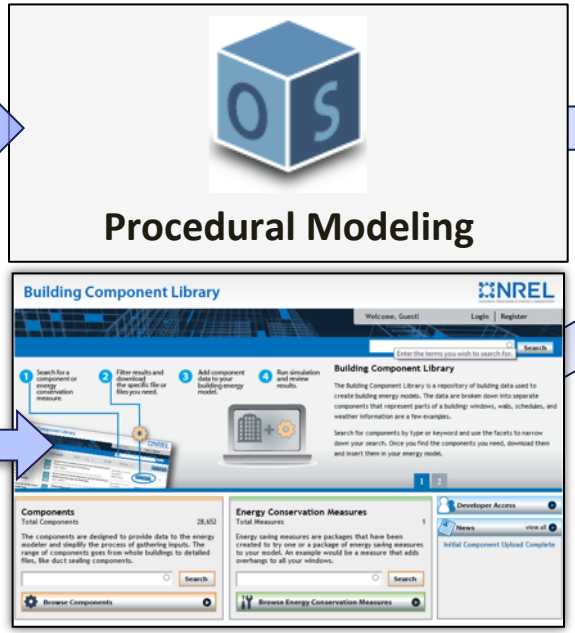
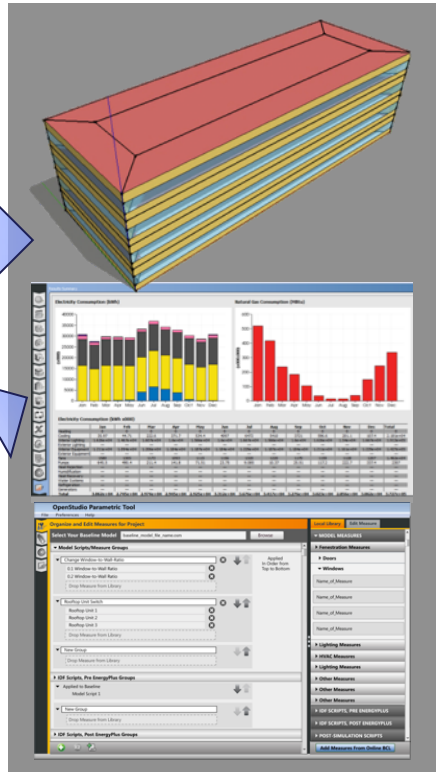
An OpenStudio-Enabled Product for Auditing and PV System Design



simuwatt™ Software Guided Audit Workflow on Tablet



OpenStudio and Building Component Library (BCL)



Analysis of Baseline and Energy Conservation Measures

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

simuwatt Software Guided Workflow

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

Geometry Capture

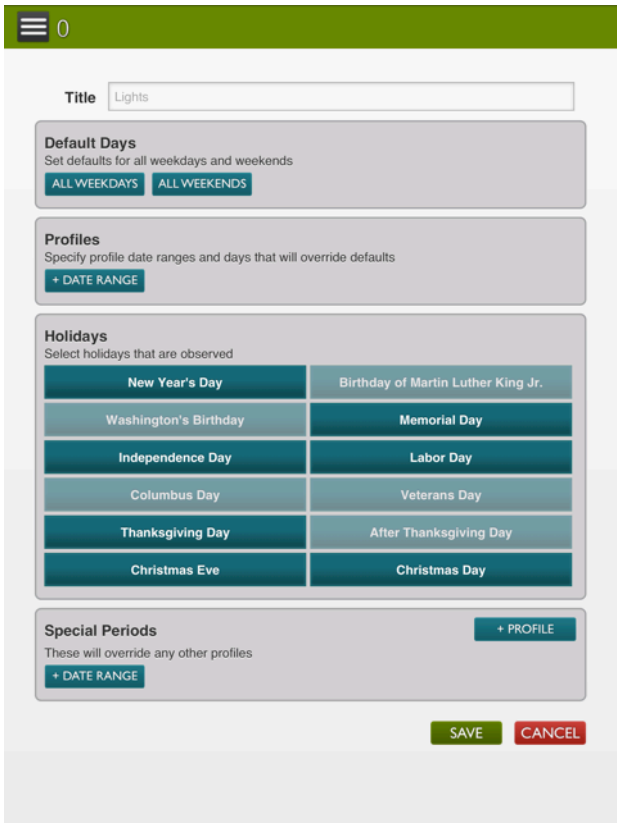
Level Navigation

simuwatt

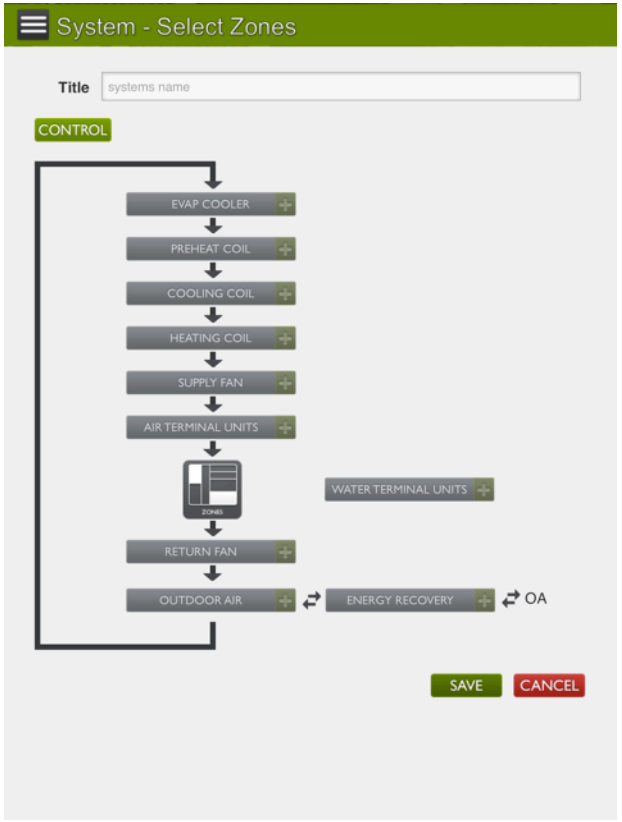
simuwatt Software Guided Workflow

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

Load Allocation to Spaces



Schedule Specification



HVAC System Specification

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simuwatt EE™: Using OpenStudio & BCL to Redefine Audits

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