





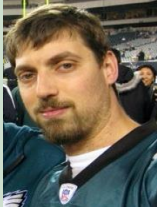
# Energy Models 101 for Building Owners, Managers, and Tenants

September 8, 2015  
3:00-4:00 PM EDT

# Overview and Agenda

- Welcome and Overview
- National Renewable Energy Lab
- District of Columbia
- Department of Energy
- Question & Answer Session

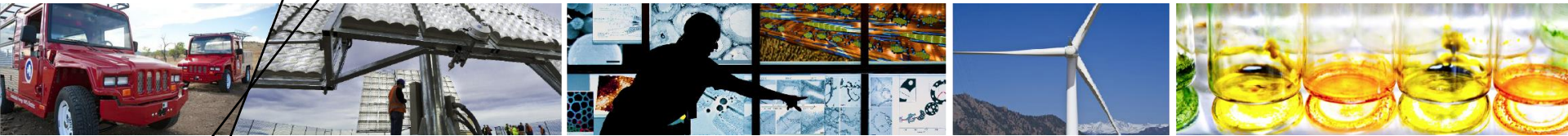
# Today's Presenters

Name		Organization
Kristin Field		National Renewable Energy Lab
Mark Chambers		District of Columbia
Amir Roth		Department of Energy

**Kristin Field**

**National Renewable Energy Lab**

# Owners' Guide to BEM

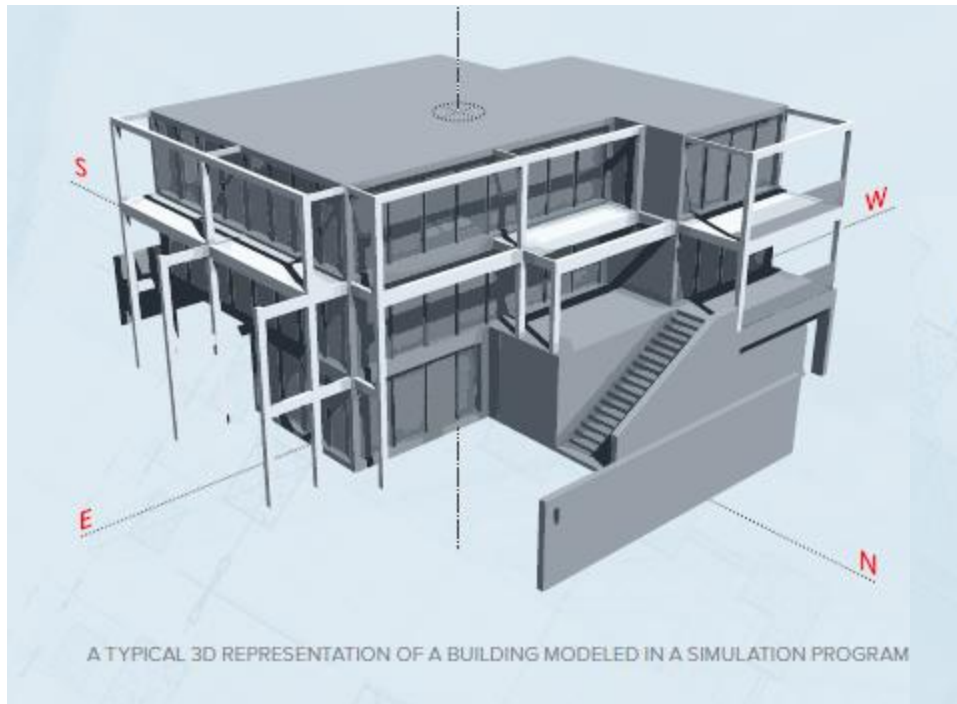


**Kristin Field, NREL**

**Sep. 8, 2015**

# What is BEM?

- **BEM = Building Energy Modeling: software calculation of building energy consumption from description of physical building, occupancy, operations, and weather**



## MOST WHOLE-BUILDING SIMULATION ANALYSIS INCLUDES:

- Typical weather data representing the site
- Building geometry, floor plan, construction materials, components, and systems
- Building divided into effective thermal zones
- Variations in occupancy, lighting, power loads, and set points and equipment operation by day, week, and season
- Instantaneous and delayed heat transfer
- Energy use of equipment and end uses
- Overall building energy use and costs

# Benefits of BEM

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- **Deeper understanding of building stock**
  - Energy and water consumption, peak demand
- **Greater ability to identify energy saving opportunities**
  - Customize measure packages to the building, location & occupancy
  - *Quantitatively* optimize operational savings, ROI, NPV, etc.
- **Demonstration of**
  - Compliance with code
  - Performance-level for green certification
  - Qualification for incentives and rebates
- **A more energy-efficient, cost-effective building**



# The Earlier The Better

- **Start with BEM early, before major decisions have been made**
  - BEM will help avoid mistakes that are difficult to overcome later
  - BEM will produce a better-performing, more cost-effective project



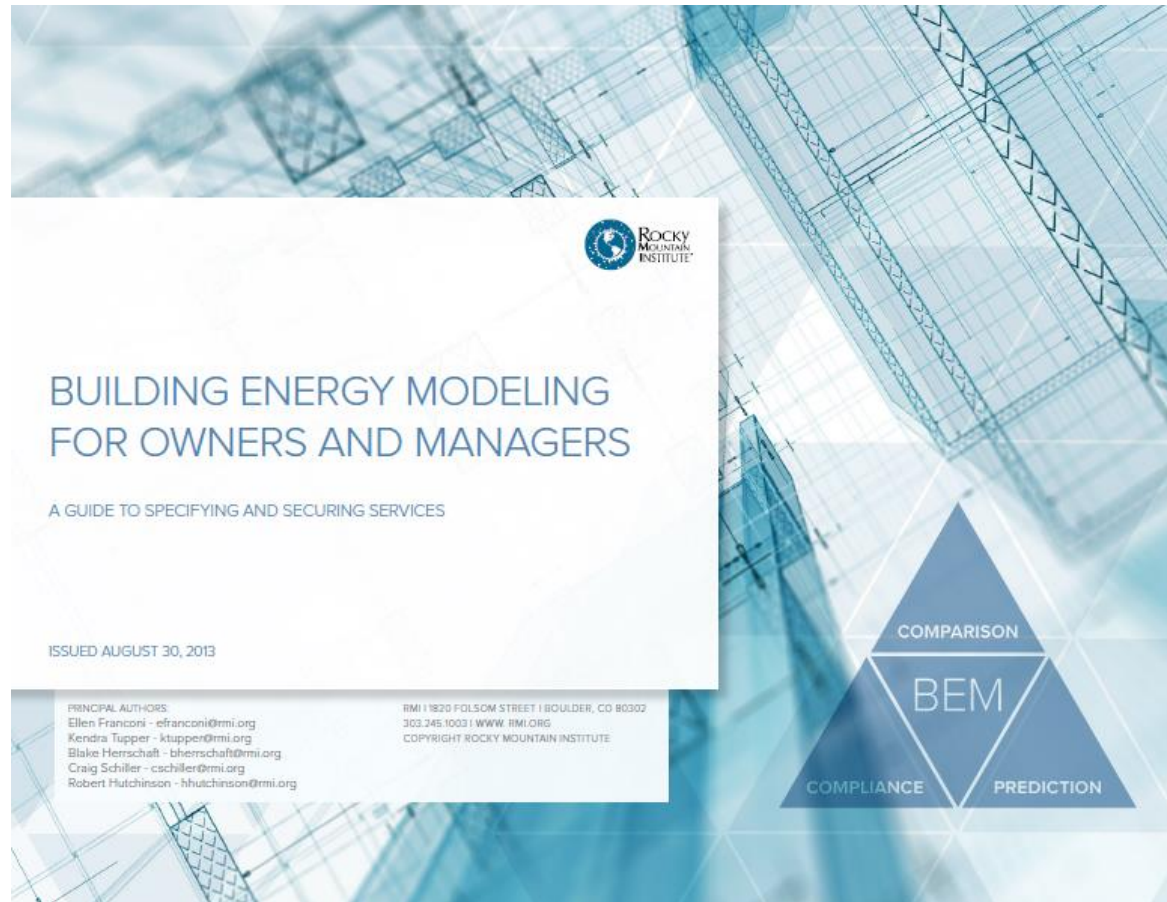


# So You Want To Get Started With BEM ...

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- **What modeling services exist? Which do I want?**
- **How do I tell if a modeler is good?**
- **Should I ask for a particular modeling software?**
- **What goes into a modeling contract?**

# ... Read This First



- **BEM Guide for Owners and Manager**
  - Developed in 2013 by RMI, NREL & DOE
  - Distributed to trade groups, owners, corporations, and investors

# What's Inside?

- **BEM overview**
- **Modeling services typically offered**
  - Roles and scopes
  - Timelines
  - Software
- **Contracting modeling services**
  - Types of contracts
  - Modeler credentials
  - Soliciting and contracting modeling services



# Choosing a Modeler

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- **Modeler affiliation is an important factor**
  - Specialized consulting firm
  - Project architect
  - Project mechanical engineer
  - Other
- **Look for modeler credentials**
  - ASHRAE BEMP and/or AEE BESA credential
  - Project experience
  - Firm dedication to quality assurance
- **Do you prefer particular software? Does modeler know it?**

# Soliciting BEM Services

- **Type of contract may impact team's motivation and ability to meet performance targets**
  - Design-build
  - Design-bid-build
  - Construction management at-risk
  - Integrated project delivery
- **BEM Guide Provides Templates**
  - Items to communicate to proposers
  - Items to look for in evaluating bids
  - Example RFP (Request for Proposals)



Credit: RMI/NREL/DOE, Owners' Guide to BEM

# Where Do I Get This?

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[http://www.rmi.org/Knowledge-Center/Library/2013-17\\_BEMFOANDM](http://www.rmi.org/Knowledge-Center/Library/2013-17_BEMFOANDM)

- **Questions?**
  - Kristin Field (kristin.field@nrel.gov)

**Mark Chambers**

**District of Columbia**



**More Data. Less Carbon. Zero Excuses.**

# **Energy Modeling in the District**

Mark Chambers

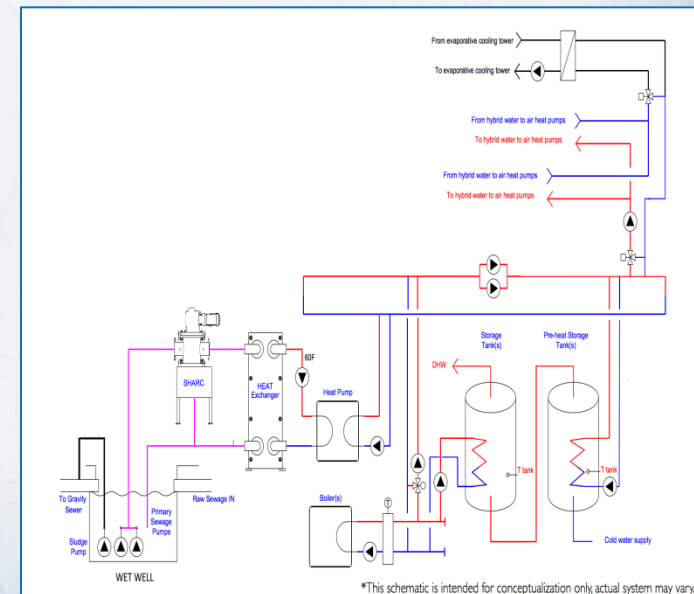
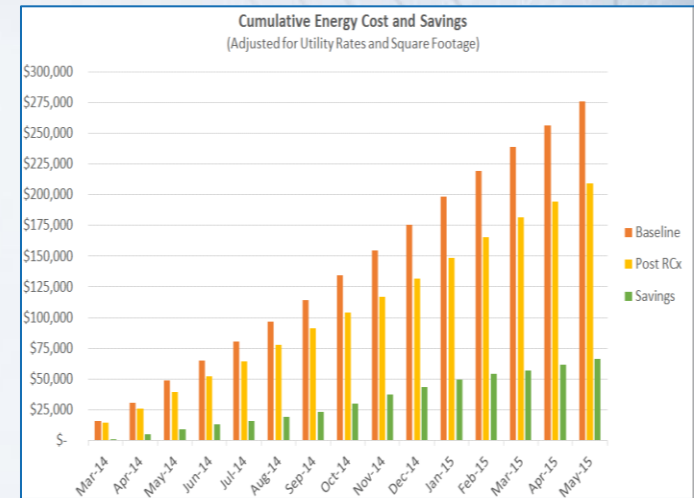
DC Department of General Services

Director of Sustainability & Energy



# Energy Modeling for Project Targeting

- Comparing modeled performance to actual performance; Stoddert example:
  - Site was not performing to design intent
  - DGS ran a retrocommissioning project
  - Now the site performs as modeled
  - Substantial cumulative savings from RCx
- Energy models support PPA financing
  - Pilot sewage-based heat exchange system
  - Economic pro forma hinges on model



# Predictive HVAC Optimization

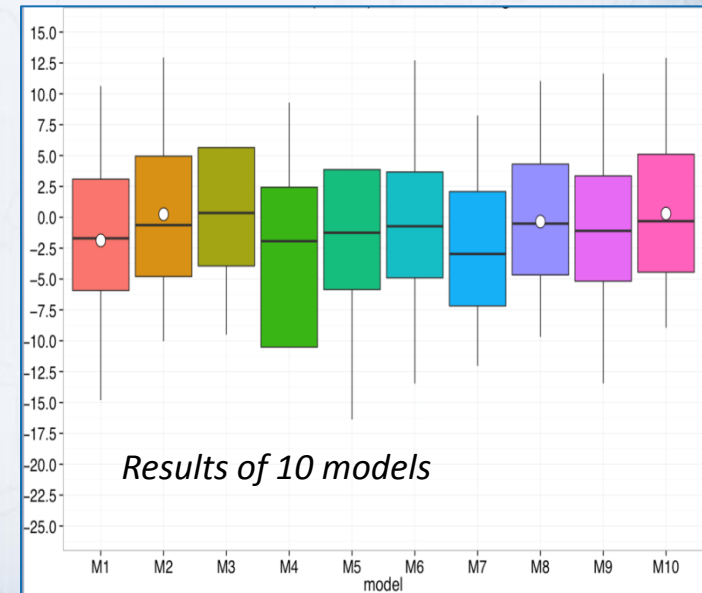
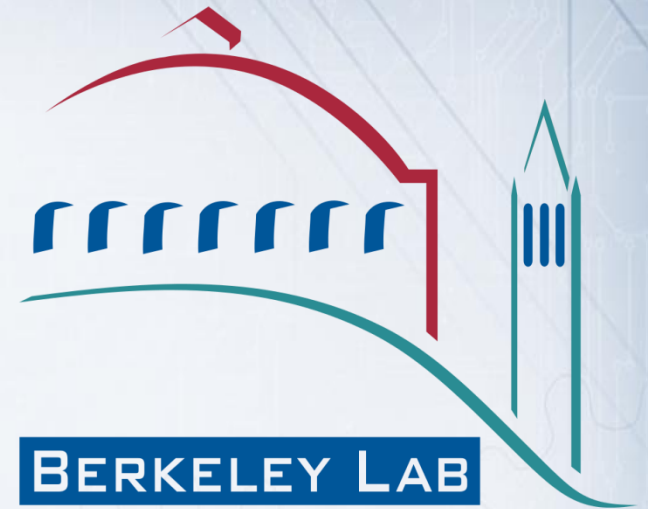
- DOE Building Technologies Office grant
- Deployment for 3M Ft<sup>2</sup>
- Building IQ system draws on open BAS data
- Builds thermal and energy performance model
- Fine tunes airside HVAC systems
- Responds to PJM pricing
- Delivers comfortable conditions with minimal cost





# Automated M&V Analysis

- LBNL study on whole building performance modeling based solely on interval data
- Ten models tested
- DGS provided 44% of data
- Conclusions
  - Differences between models are mostly small Average median percent error ~1.2%
  - No clear “winner” across models
  - All are good, especially with 12 months training



# Commitment to Leadership

**\$75,000,000**  
spent on energy, annually

**360,000 tons of CO<sup>2</sup>**  
emitted every year by buildings

**10% drop in kWh**  
since BuildSmart DC launched



# Thank You.

Feel free to follow up with me @GrowACity or Mark.Chambers@dc.gov



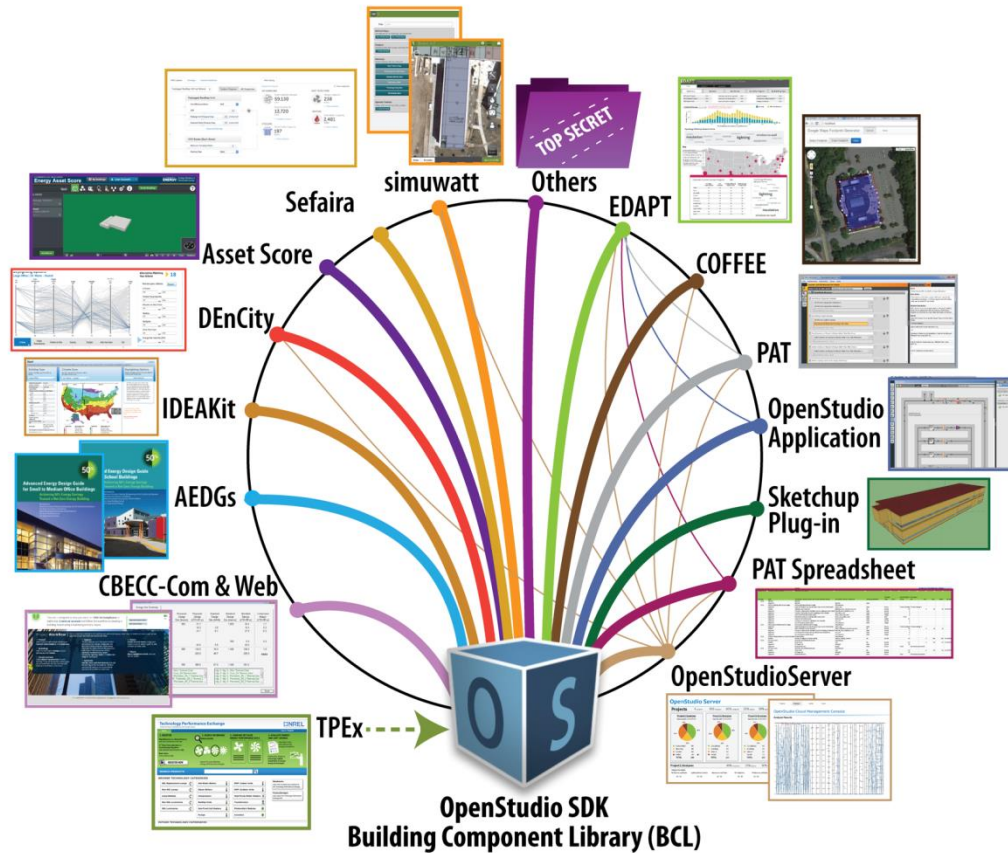
**Amir Roth**

**U.S. Department of Energy**



# Energy Modeling using DOE's Tools Ecosystem

<http://energy.gov/eere/buildings/building-energy-modeling/>



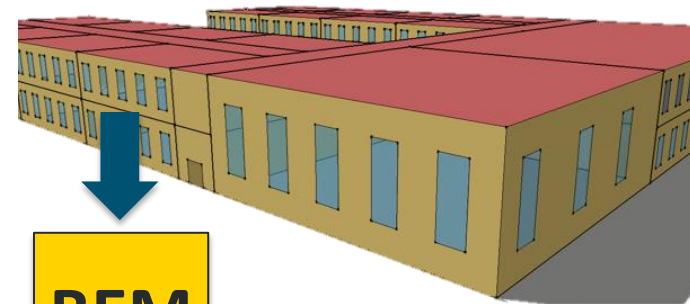
# Ins and Outs of Building Energy Modeling

## Ins: information about your building

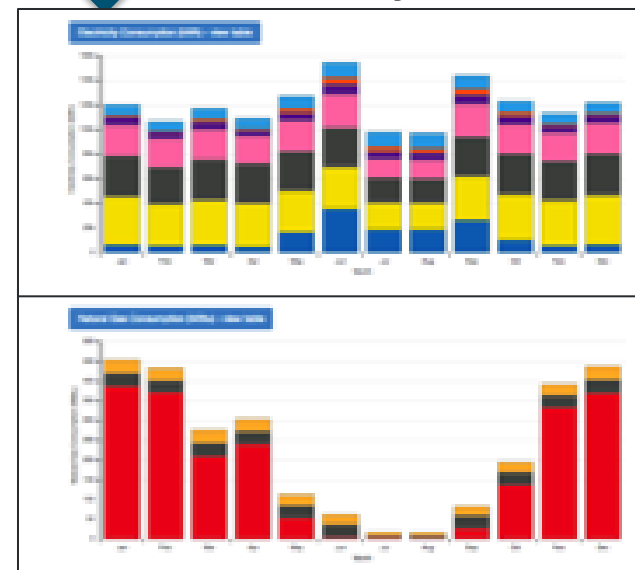
- Assets: geometry, constructions, systems
- Operations: occupancy, internal loads, setpoints
- Weather
- Consumption data (if you have it)
- Detail helps but isn't necessary

## Outs: analytical view of your building

- Where and when do kWh (& money) go?
- Where are savings opportunities?
- Can I improve occupant comfort?
- How far above or below is it from code?
- Does it qualify for certificates or incentives?
- Even if your building doesn't exist yet!



## Monthly end-uses



**Any BEM >> no BEM, but if you're going to BEM ...**

# ... Ask for an EnergyPlus™ Model (and Modeler)!

## Why? Advanced capabilities

- Low-energy designs & systems
- Thermal & visual comfort & IEQ
- Flexible HVAC configurations (*e.g.*, VRF) & controls
- DOE backing → continuous improvement

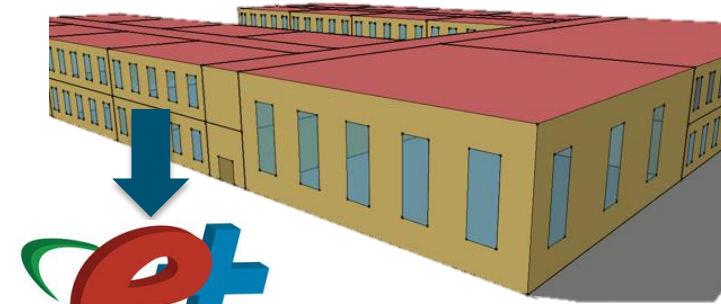
## Why? Open-source licensing

- Know what you're getting & avoid lock-in

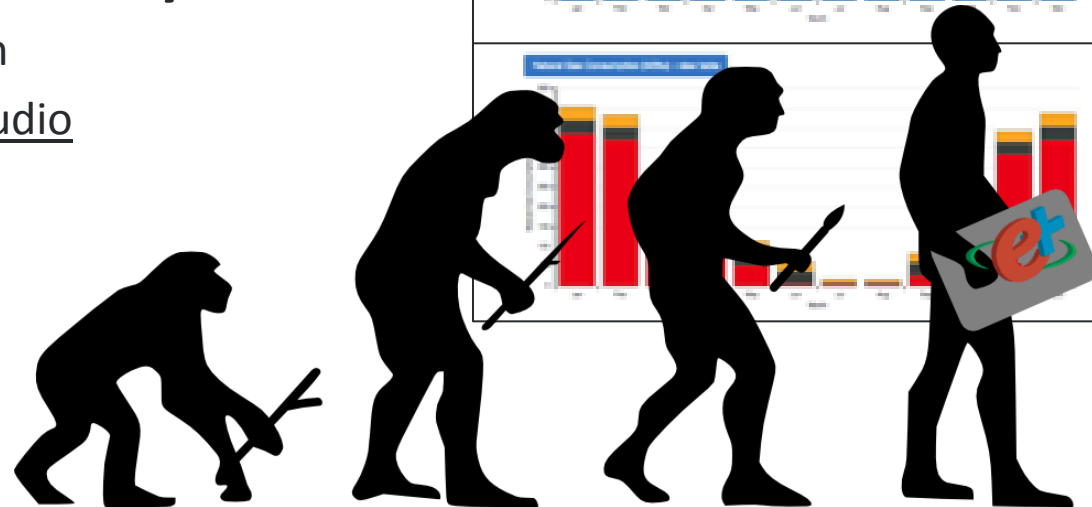
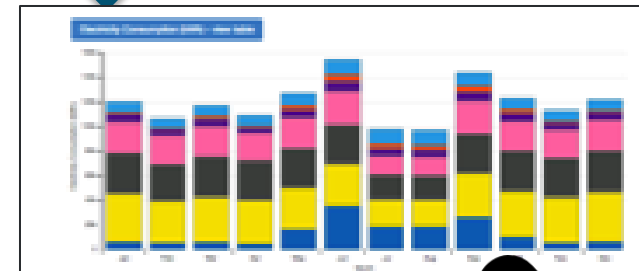
## Why? Growing user & tool ecosystem

- 27,000+ downloads per version
- DesignBuilder, Sefaira, OpenStudio

More at [energyplus.net](http://energyplus.net)



Monthly end-uses



# DOE's BEM Ecosystem = EnergyPlus engine ...

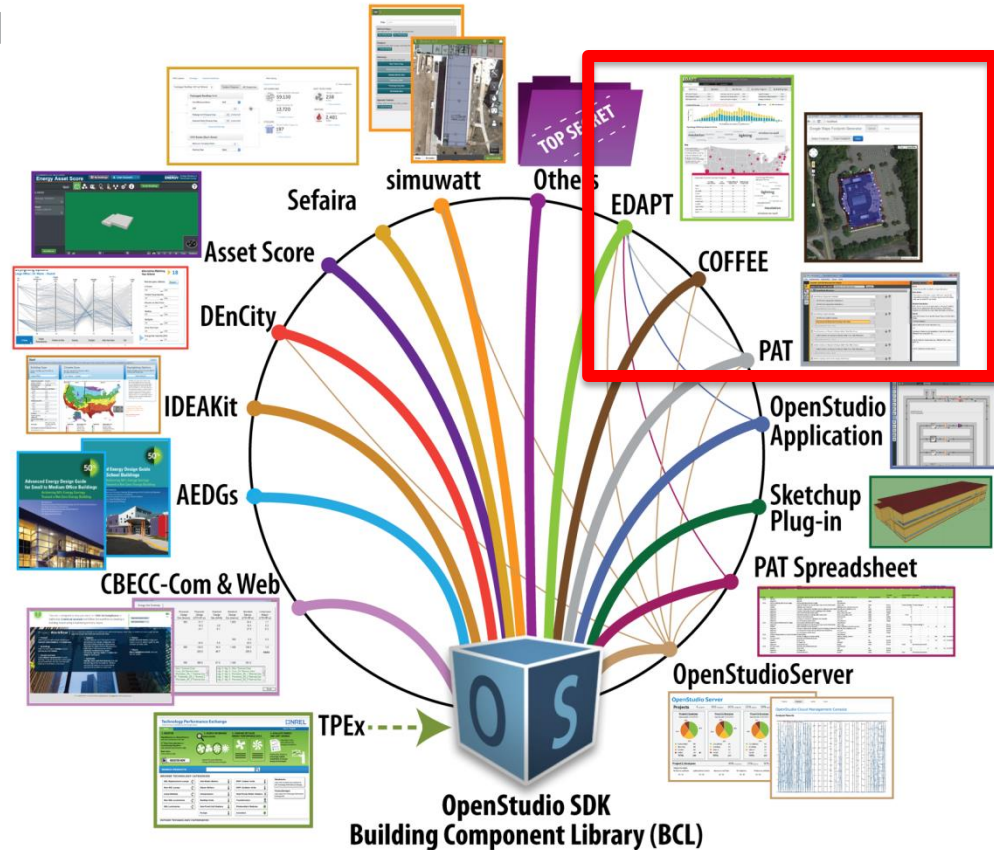
## OpenStudio middleware/SDK/platform

- Common core functions
- Large-scale analysis support via cloud

More at [openstudio.net](http://openstudio.net)

### → inter-operable apps

- Design & retrofit
- Auditing
- Code compliance
- Project management
- Portfolio management
- Inter-operable
- Commercial or open-source
- New app every couple of months ...
- ... many from utilities!!

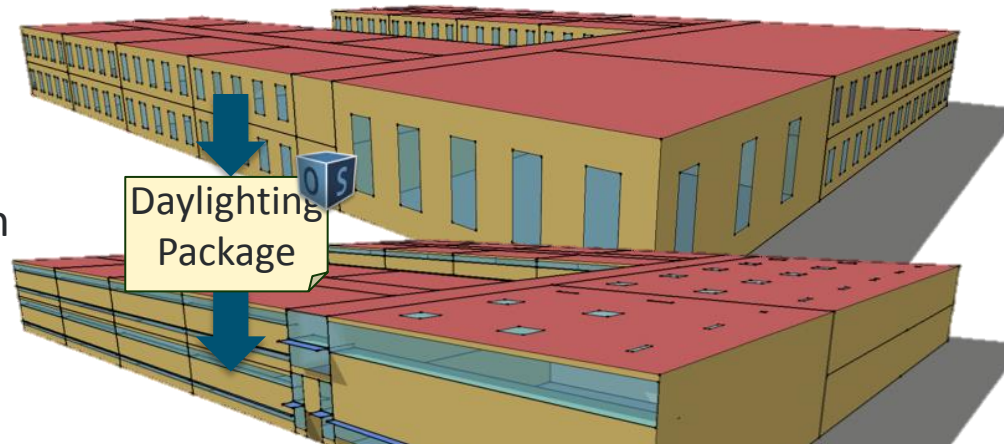




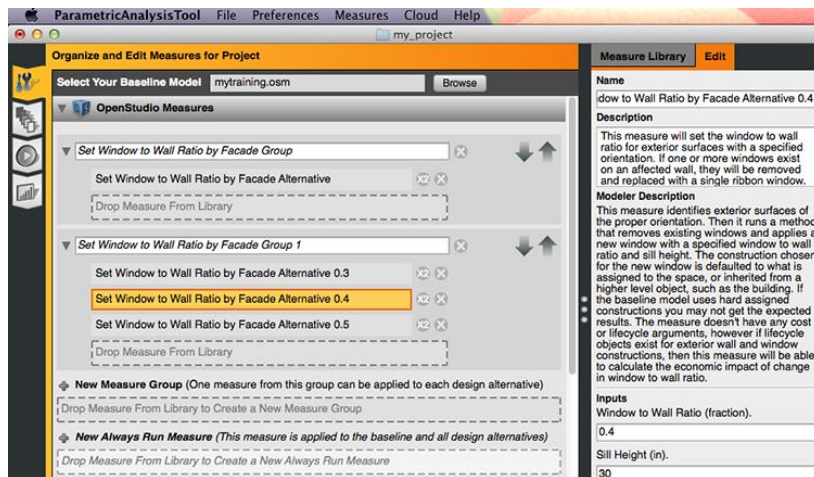
# Parametric Analysis Tool

## OpenStudio supports “measures” – scripts that operate on models

- Can be simple search & replace
- Or surgical & sophisticated
- ECMs or QA or reporting
- Automation, automation, automation
- [bcl.nrel.gov/nrel/types/measure/](http://bcl.nrel.gov/nrel/types/measure/)



## PAT: select measures



## Packages sorted by EUI, ROI, etc.

A screenshot of the PAT interface showing a table of design alternatives. The table is sorted by Energy Use Intensity (EUI). The table has columns for Design Alternative Name, Energy Use Intensity (kBtu/ft2-yr), Peak Electric Demand (kW), Electricity Consumption (kWh), Natural Gas Consumption (Million Btu), District Cooling Consumption (Million Btu), District Heating Consumption (Million Btu), and Fa Cap. The table shows several design alternatives, with the 'Baseline' alternative having the highest EUI and the 'Set R-value of Insulation for Exterior Walls to a Specific Value R-17.5 Only' alternative having the lowest EUI.

Design Alternative Name	Energy Use Intensity (kBtu/ft2-yr)	Peak Electric Demand (kW)	Electricity Consumption (kWh)	Natural Gas Consumption (Million Btu)	District Cooling Consumption (Million Btu)	District Heating Consumption (Million Btu)	Fa Cap
Baseline	161	215	807,169	1,269	0	0	2.9
Set R-value of Insulation for Exterior Walls to a Specific Value R-17.5 Only	...	...	...	...	...	...	...
Set R-value of Insulation for Exterior Walls to a Specific Value R-20 Only	2	5	4,583	44	0	0	27
Set R-value of Insulation for Roofs to a Specific Value R-30 Only	...	...	...	...	...	...	...
Set R-value of Insulation for Roofs to a Specific Value R-40 Only	0	2	2,886	1	0	0	21

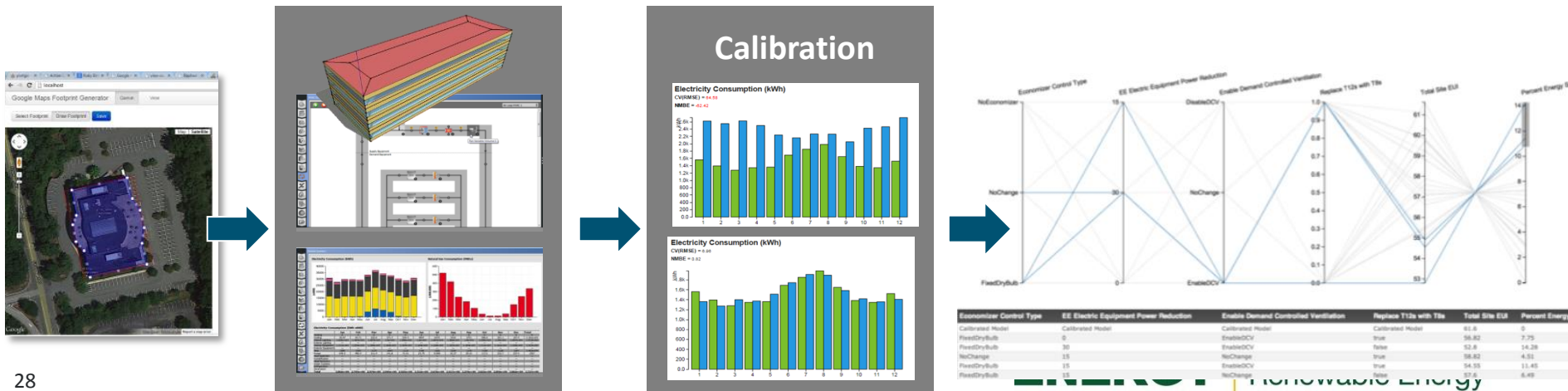
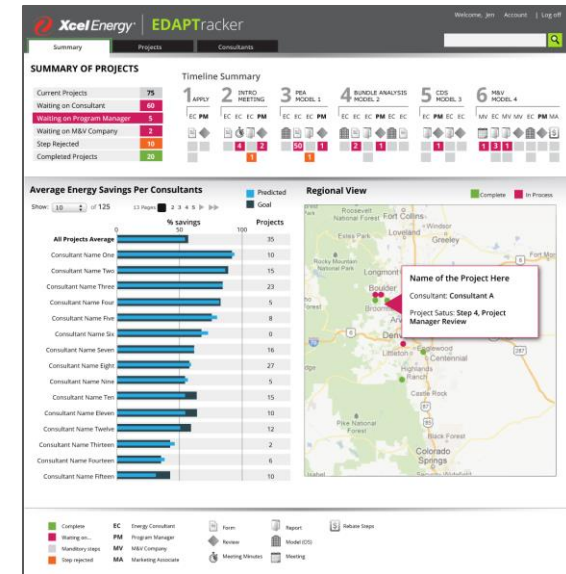
# Portfolio Management Tools – EDAPT and COFFEE

## Energy Design Assistance Project Tracker ([eda-pt.org](http://eda-pt.org))

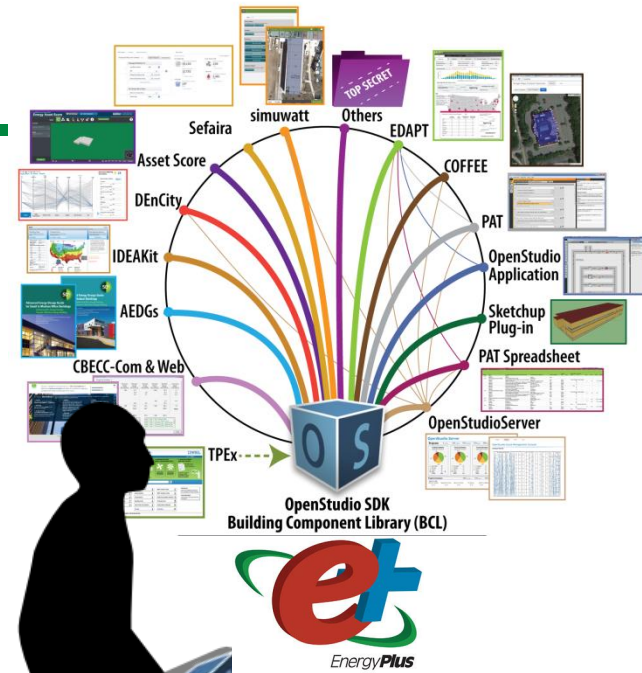
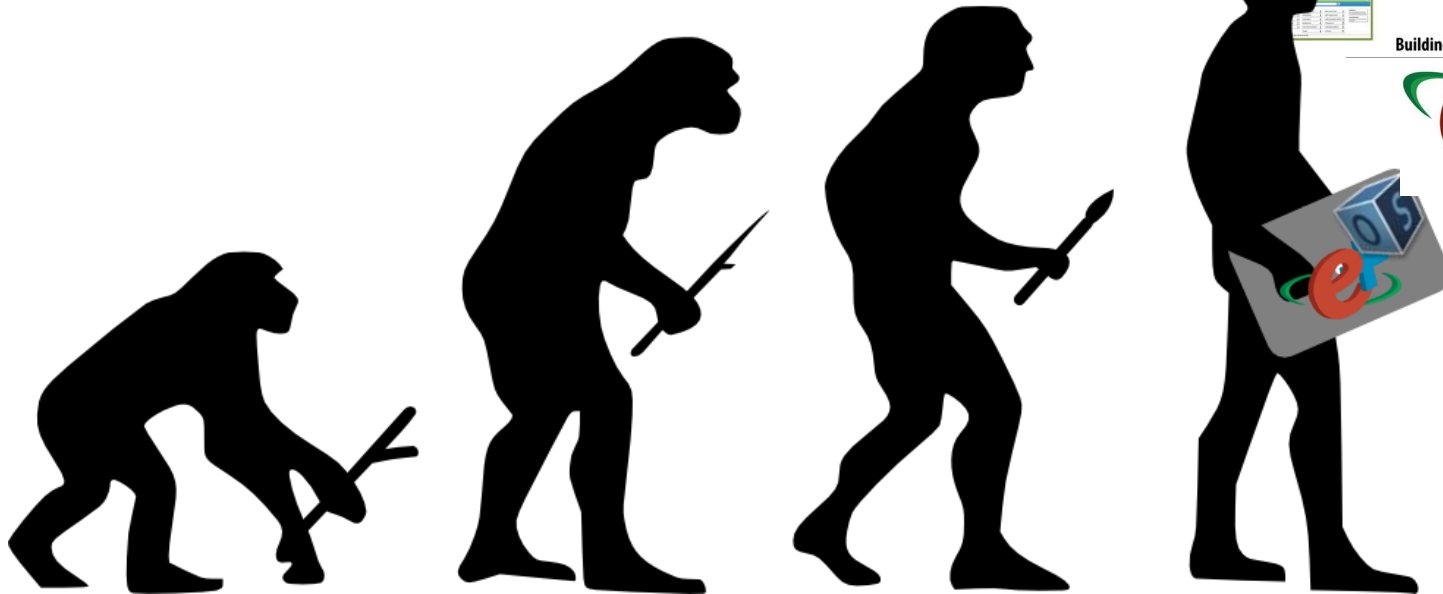
- Project QA/QC, reporting & rollups
- New construction & retrofit workflows
- “Bought back” and “opened up” by DOE

## COFFEE

- Calibrated models from rough asset data + utility bills
- Optimized ECM packages
- Not public yet



# More Info & Follow-up?



[amir.roth@ee.doe.gov](mailto:amir.roth@ee.doe.gov)

[energy.gov/eere/buildings/building-energy-modeling/](https://energy.gov/eere/buildings/building-energy-modeling/)



# Additional Resources

# For More Information

- NREL/Rocky Mountain Institute
  - [Building Energy Modeling for Owners and Managers: A guide to Specifying and Securing Services](#)
- District of Columbia
  - [Better Buildings Challenge Commitment](#)
  - [Showcase Project: Hotel Monaco DC](#)
  - [Implementation Model: Community Engagement](#)
  - [BuildSmartDC](#)
- Energy Plus
  - [Sign up for an account](#)
- Department of Energy
  - [Building Energy Modeling](#)

# Q & A

# Join us for the next Better Buildings Webinar

**Registration is now open!**

**October 6, 3:00 – 4:00 PM ET**

**Seize the Day – Using Building Milestones as Energy Efficiency Opportunities**

Attend this webinar to learn more about transforming building milestones such as purchase, sale, tenant transitions, etc. into energy efficiency opportunities. Presenters from Better Buildings participants University of Virginia, the City of Hillsboro, Oregon, and Arby's Restaurant Group share their strategies for taking advantage of these milestones to get more from their buildings.

Register [here](#)

Learn more at: <https://www4.eere.energy.gov/alliance/events>

# Additional Questions? Please Contact Us

[betterbuildingswebinars@ee.doe.gov](mailto:betterbuildingswebinars@ee.doe.gov)

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