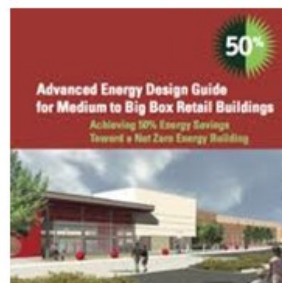
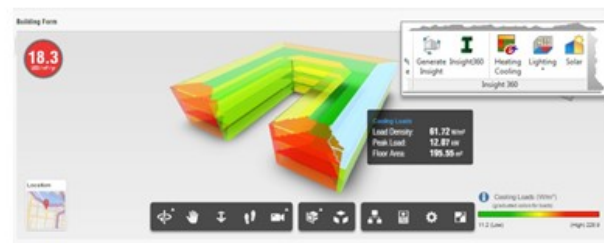
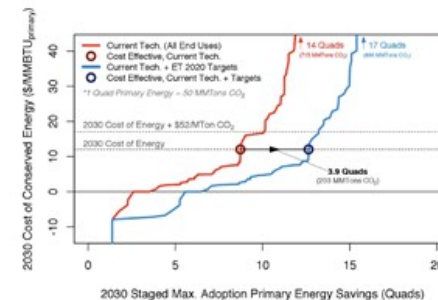
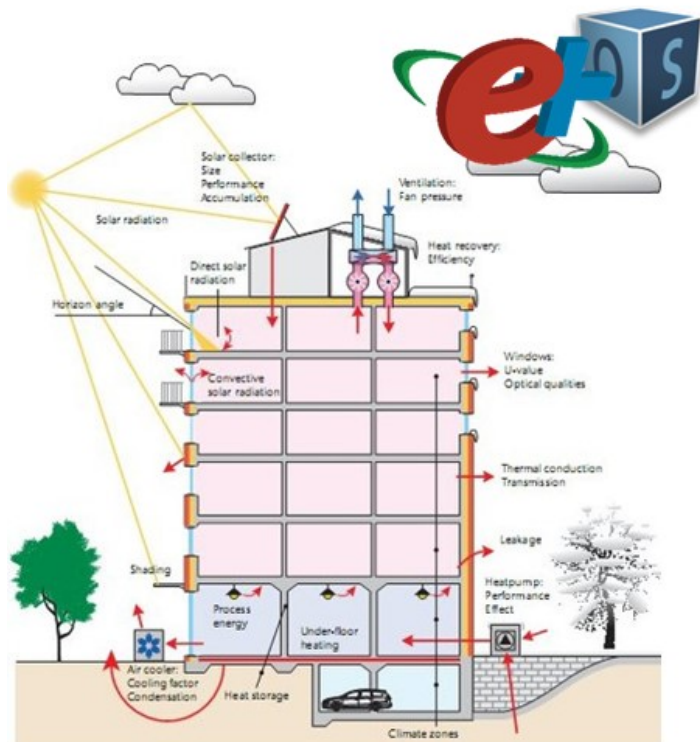


BTO's Building Energy Modeling Program

BTO Peer Review 2016

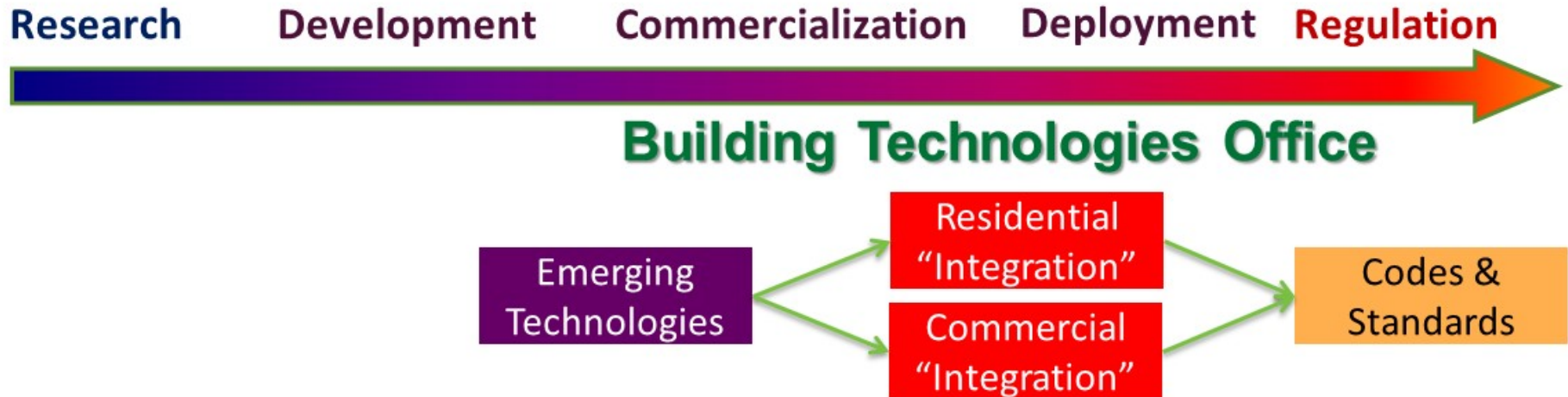


U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Amir Roth, Ph.D.
amir.roth@ee.doe.gov

BTO → ET/CBI → BEM



BEM program unique within BTO ← BEM is unique

Unlike windows & LEDs, BTO is a *direct* player in BEM sector → we make software

- We do this because: i) we can, ii) we always have, iii) transparency & impartiality matter
- But we can't act like a company because we're trying to enable & nurture, not compete

Our "constitution"

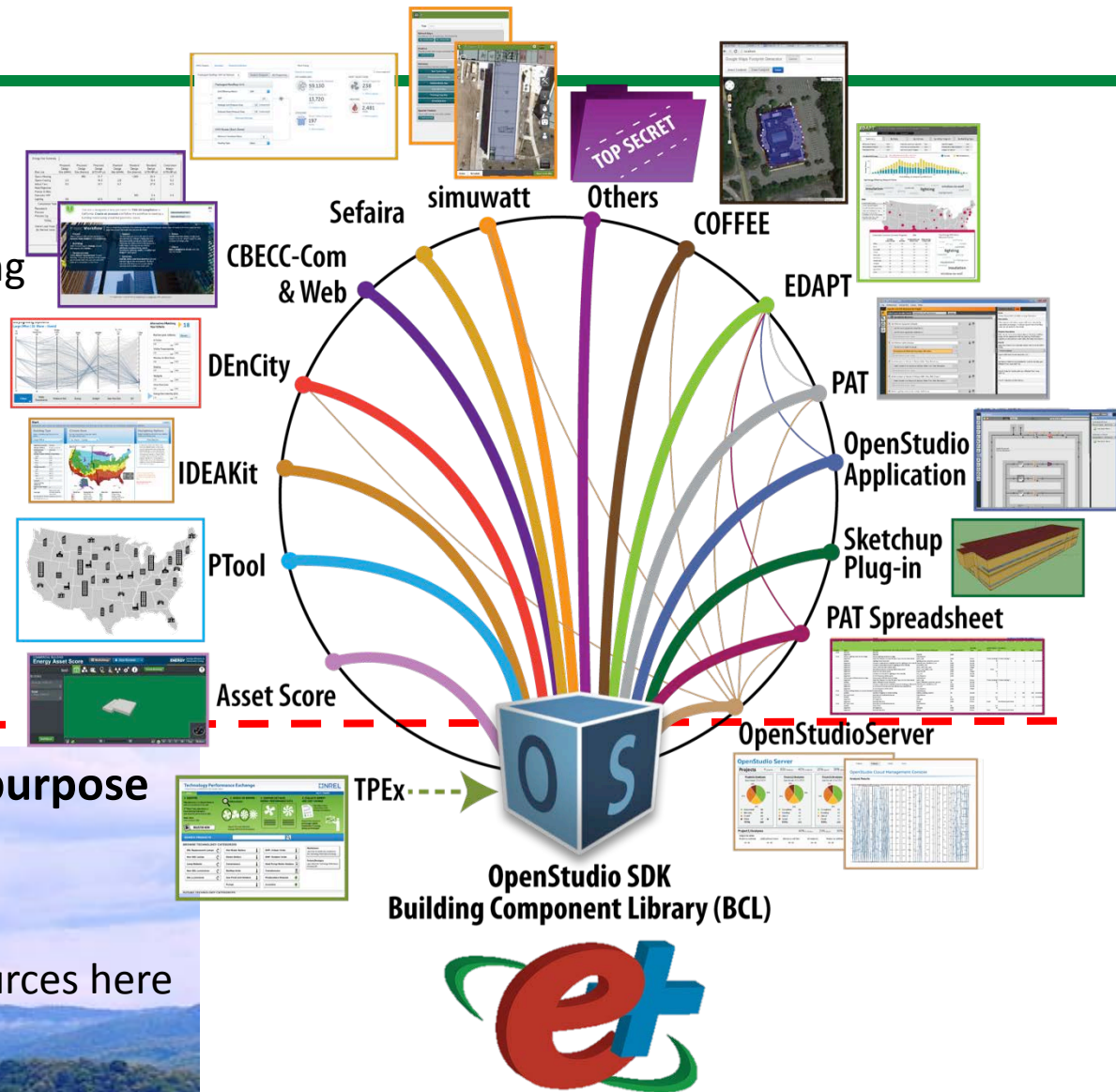
- No end-user applications or customer relationships → "50 vendors, not 50,000 users"
- Commercial-friendly open-source → software you *are allowed to* build a business on ...
- State-of-the-art capabilities → you *want to* ...
- Commercial-grade development & support → you *feel good* about it ...
- Long-term commitment → and *continue* feeling good about it

The Dream-catcher

Apps: use-case specific

- Open-source or proprietary
- Public, private, or mixed funding

**BEM industry adapting to
(and adopting) open-source
software!**

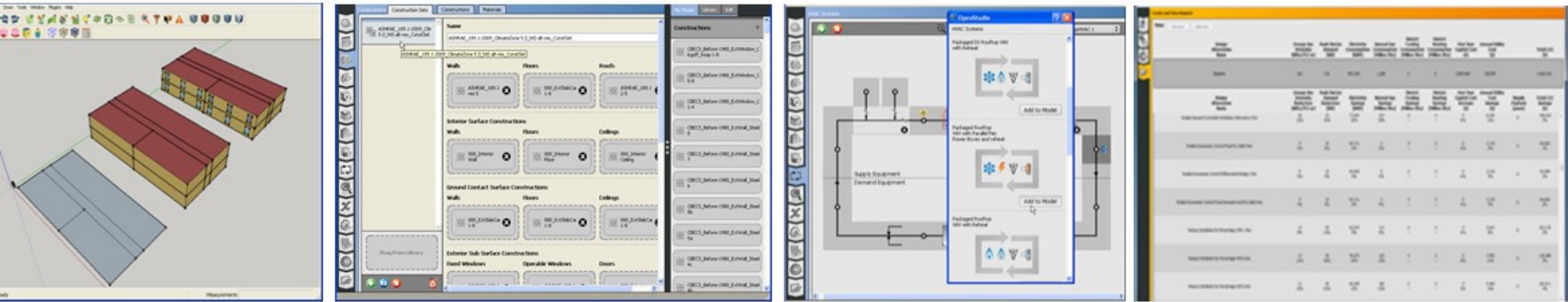
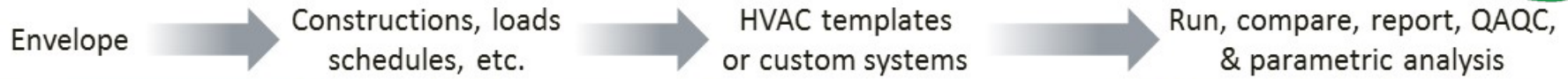


Platform: multi-purpose

- Open-source
- Publicly-funded
- Focus BTO resources here



The Platform: EnergyPlus & OpenStudio



EnergyPlus (energyplus.net)

- Industry leading simulation engine

OpenStudio (openstudio.net)

- Software development kit (SDK) & demo application
- Measures, Amazon EC2 image & more measures

High-value package

- Great offering to market partners (vendors, utilities, etc.)
- Helps streamline BTO's own BEM work
- Serves as template for other BTO BEM projects



API (C++, Ruby, Python, JS, C#)



Supporting & Related Activities

BEM Portfolio

- EnergyPlus (\$2,500k/yr): AOP, labs (NLO) & competitively solicited contractors
- OpenStudio (\$1,500k/yr): AOP, labs (NLOAP)
- Supporting activities: ~\$2,000k/yr, mixture of AOP & FOA

ET Projects

- ASHRAE Standard 140 & Empirical Validation
- Radiance lighting engine & Envelope tools

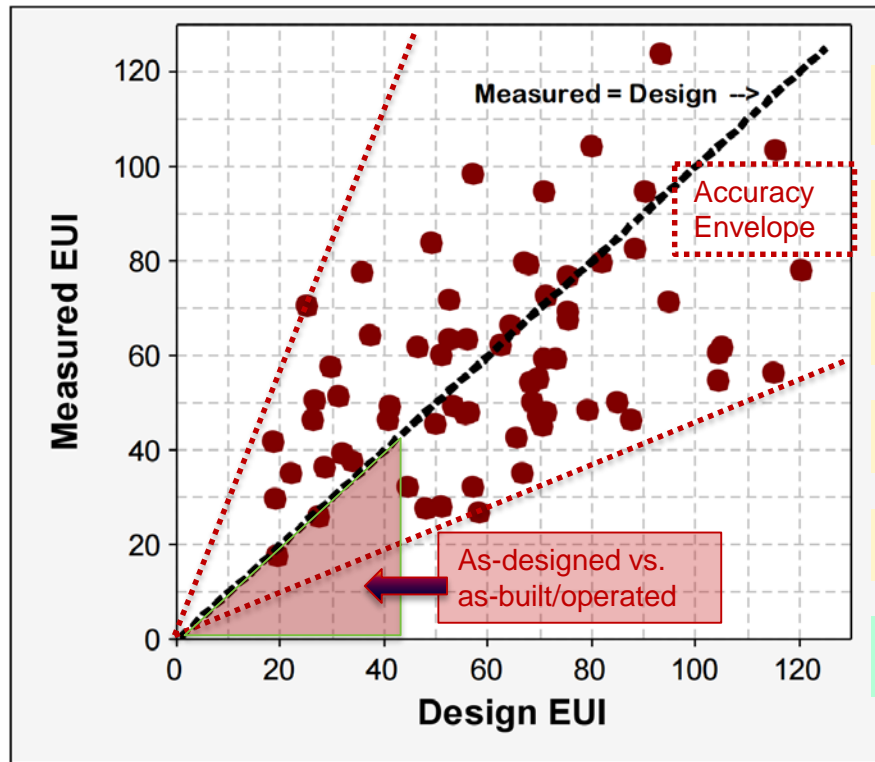
CBI Projects

- AIA 2030 Commitment Reporting
- IBPSA-USA (UnmetHours, BEST Directory, Low-down Show-down)

Cross-cutting projects

- Scout

Problem: BEM's Image & Credibility



"A $\pm 30\%$ proposition at best"

"Have to discount savings by 2X"

"Details are right, big picture is wrong"

"Not accurate enough to support investment"

"Can't predict energy use, what good is it?"

"All models are wrong, some are useful" –G. Box

Predictive BEM is hard ← many uncertain inputs (occupancy, infiltration, etc.)

- That's ok ← most BEM use-cases are comparative & control for uncertainty
- Actually, it's not ok ← few people understand this distinction
- That ASHRAE Standard 140 testing is analytical & comparative doesn't help matters
 - 140 accomplishes quite a bit given that it doesn't have empirical data sets!

ET: Validation & Uncertainty Characterization

Opportunity: new, flexible, highly instrumented test facilities at LBNL & ORNL

- LBNL FLEXLAB: 4 single-zone 1,200 ft² test cells with dedicated HVAC & control
 - Each cell can be split for side-by-side “differential” testing
 - One active façade per cell (south), one cell yaws 270°, one cell is two story
- ORNL FRP: 1 single-story 2,400ft² single-zone shell, 1 2-story 3,200ft² 10-zone shell
 - All façades active & multiple, switchable HVAC systems
- Several other facilities & HVAC test loops

3-year BENEFIT FOA project (FY16-18): develop critical data sets for BEM validation

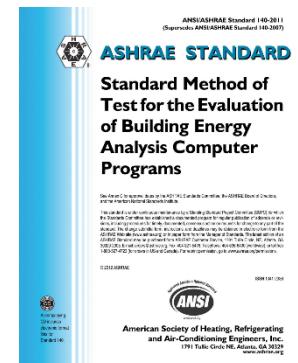
- Quantify accuracy of key aspects of EnergyPlus → definitive statements
- Codify in Standard 140 so that other engines can be characterized & improved
- Develop robust uncertainty framework



7 LBNL FLEXLAB



ORNL's FRP



Standard 140

ET: Radiance Lighting Engine + Envelope Tools

Complementary use cases: facade design, product design & product rating!

RADIANCE detailed lighting & rendering engine

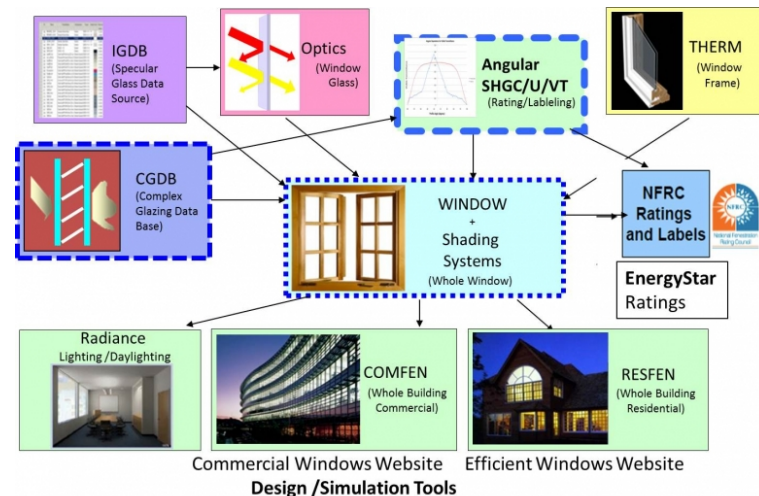
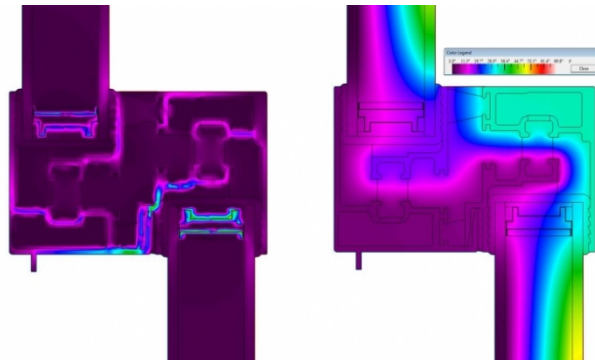
- Still most widely used, supported from OpenStudio for lighting metric calculations

Detailed fenestration & envelope heat & light transfer engines & databases

- THERM: 3D heat transfer through assemblies
- WINDOW & OPTICS: bulk heat & light transfer
- IGDB & CGDB: comprehensive characterization databases for simple & complex glazing

FY16: working on AERC support, open-source & alignment with BEM portfolio

- Much more to report at next peer review



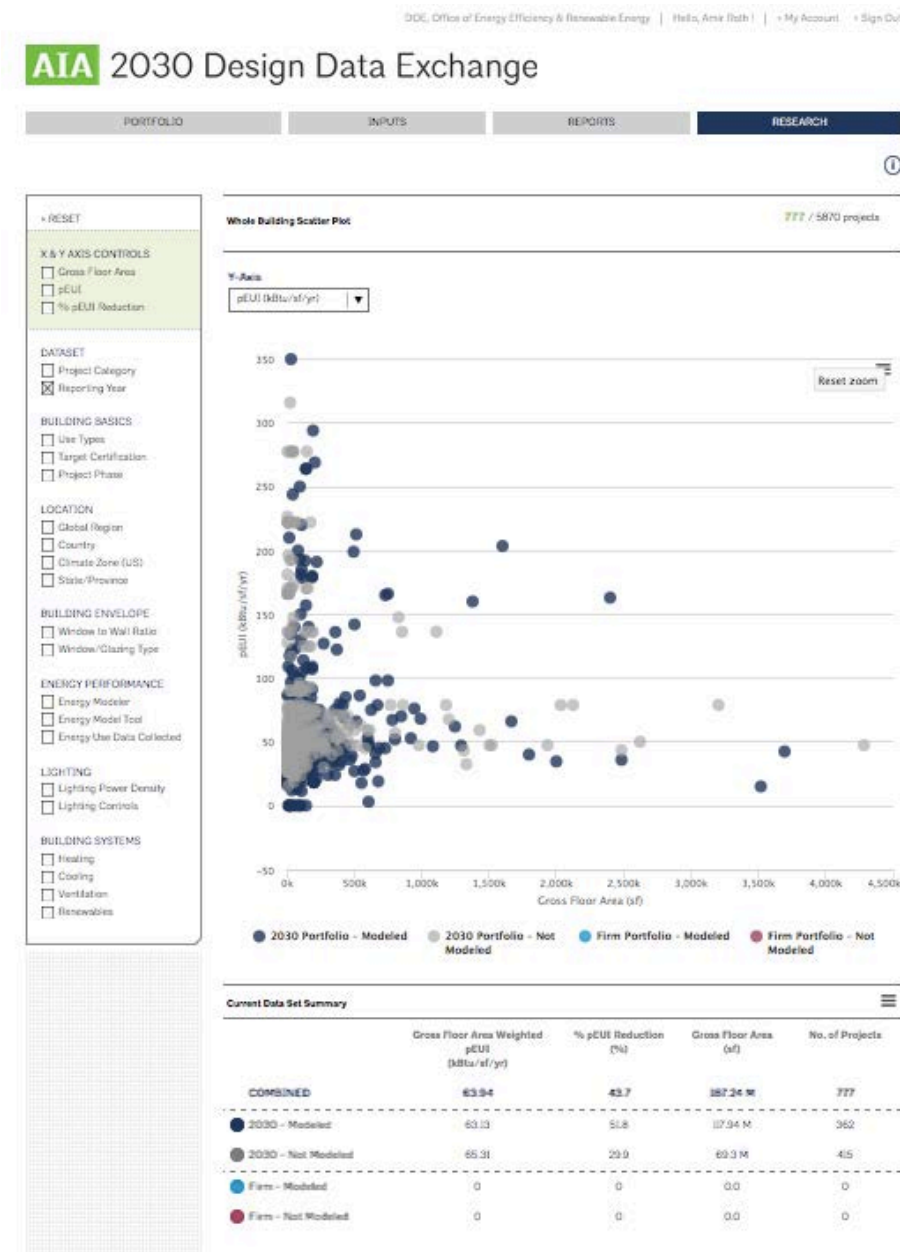
CBI: AIA 2030 Commitment DDx

AIA 2030 Commitment

- 50% less than CBECS by 2005 →
- 60% by 2010 → 70% by 2015 → ⑤ →
- ZNE by 2030!
- Signatory firms report on all projects!
 - CZ, GSF, building-type, LPD, EUI, *etc.*
- Encourages performance-driven design
 - Modeling & measurement “meta-data”

DDx portal (2030ddx.aia.org)

- Reporting (in), reporting (out) & research
- Firms see their own portfolio & ...
- Anonymized view of all portfolios (*a la* BPD)
- DOE has a “firm” account (but no projects)
 - Data helps us track progress



CBI: IBPSA-USA

International Building Performance Simulation Association


- A BEM-focused mini-ASHRAE → our partner for BEM-community initiatives


UnmetHours (unmethours.com): peer-to-peer BEM Q&A site


- Launched Sep. 2015: >1,000 users, >2,200 questions


UnmetHours BETA Question-and-Answer Resource for the Building Energy Modeling Community
[Get started with the Help page](#)

[AmirRoth](#) (Karma: 2945, Badges: 3 13) [Sign Out](#) [Tags](#) [Users](#) [Badges](#)

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Founding Sponsor

IBPSA-USA

Training Workshops

EnergyPlus
for Practitioners
[Boise, May 16-17](#)
[San Francisco, June 6-7](#)
[Salt Lake City, August 8-9](#)



CBI: IBPSA-USA

BEST (buildingenergysoftwaretools.com): more functional tools directory

- Soft-launched Jan. 2016 not much action yet

Low-Down Showdown: simulation-focused low-energy design competition

- First iteration (8 teams) focused on new buildings
- Second iteration (Aug. 2016) focuses on existing building upgrades

The screenshot shows the BEST Directory website. The header includes the BEST Directory logo, navigation links (Home, Software Listing, About), and the text "Building Energy Software Tools" and "Formerly hosted by US Dept. of Energy". The main content area is titled "Software Listing" and shows "Total Listed Programs: 34". A sidebar on the left contains a search bar and a "Capabilities" section with a list of software features. The main listing shows the "DesignBuilder" software entry, which includes a description, a list of capabilities, and a "Ratings" section.

BEST Directory
Building Energy Software Tools
Formerly hosted by US Dept. of Energy

Home Software Listing About

Search

Software Listing
Total Listed Programs: 34

DesignBuilder
DesignBuilder, a whole building energy use analysis simulation tool, is the oldest, e-graphical user interface to EnergyPlus available and includes ASHRAE 90.1 Appendix templates, materials, and construction libraries.

Whole-building Energy Simulation | Load Calculations | HVAC System Selection and Sizing
Last Software Update: 09 February 2015 | Last Entry Update: 14 August 2015
Ratings ★★★★★ | Reviews 0 | Add to compare

Sefaira Architecture
Sefaira offers the industry's only software for real-time Performance Based Design.

Whole-building Energy Simulation | Parametrics & Optimization | Lighting Simulation
Last Software Update: 21 January 2015 | Last Entry Update: 12 October 2015
Ratings ★★★★★ | Reviews 0 | Add to compare

TREAT
TREAT is winner of the prestigious R&D 100 award and still the only energy audit software for all residential housing types – including multifamily.

Whole-building Energy Simulation | Model Input Calibration | Energy Conservation Measures
Last Software Update: 01 October 2015 | Last Entry Update: 06 October 2015
Ratings ★★☆☆☆ | Reviews 0 | Add to compare



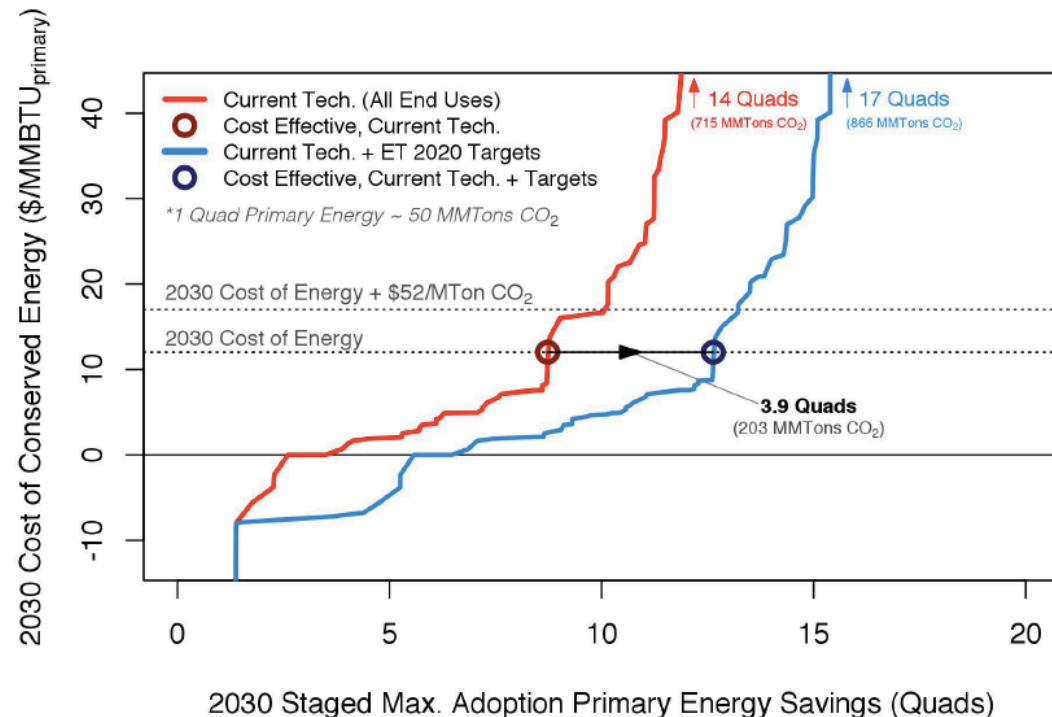
Cross-Cut: Scout

National scale EE technology impact assessment tool P-Tool 2.0

- Fine-grain characterization of building energy sector
- Comparable energy savings estimates using energy simulation on prototype buildings
- Energy savings by end use to support measure packages
- Market share approach to technology competition
- Support for uncertainty
- Flexible, extensible python implementation
- Web interface?

Learn more tomorrow

- 8:30AM!



Market Impact & More Information

A lot has happened since BTO Peer Review 2015

- Autodesk releases EnergyPlus-based Insight360 for Revit and FormIt
- Sefaira-cum-Trimble releases EnergyPlus-based Sefaira Architecture
- Trane releases beta of EnergyPlus-based TRACE (most frequently used BEM tool)
- RESNET votes to adopt single EnergyPlus-based implementation of HERS rating
- Canada and India basing new whole-building codes on EnergyPlus/OpenStudio
- Four utilities (OET, Austin, CPS, Duke) using EnergyPlus/OpenStudio for incentives

Anticipate similar progress in coming year

More information

- Website: <http://energy.gov/eere/buildings/building-energy-modeling/>
- Blog: [.../end-use-breakdown-building-energy-modeling-blog](http://energy.gov/eere/buildings/building-energy-modeling-blog)
- MYPP: <http://energy.gov/eere/buildings/downloads/multi-year-program-plan>
- Draft R&D Roadmap: [.../bto-seeks-comments-draft-building-energy-modeling-roadmap](http://energy.gov/eere/buildings/downloads/draft-building-energy-modeling-roadmap)
- Email: amir.roth@ee.doe.gov