DOE Smart Labs Symposium

Smart Benchmarking for Lab Buildings

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Outline

• Defining benchmarking
• Whole building energy benchmarking
  – The Labs21 Benchmarking Tool
  – Latest news and updates
• Future directions
  – The I^2SL Lab Benchmarking Tool and the Smart Labs Accelerator Program
    • Energy scores and the Boston data
    • Best practice benchmarking
Defining Benchmarking

• Comparing ourselves to others
  – Often energy usage (but not always)
• Doing so constructively
  – Contextualizing
  – Ranking
  – Certifying
  – Prioritizing
  – Motivating
  – Inspiring
Energy Benchmarking

- Whole building energy usage
- Comparing buildings’ energy consumption
  - Typically compare EUI (kBtu/sf/yr)
- Important for lab buildings
  - But difficult
  - Complex and varied functional requirements
Energy Benchmarking Demands

- LEED O&M
- AIA 2030 challenge
- ASHRAE energy audits
- Context for disclosed energy data
- Identify opportunities
- Prioritize portfolios
- Conversation starter
- Research and policy
LEED O&M Certification

Option 1. Benchmark against typical buildings
Path 1. National average data available
Demonstrate energy efficiency performance that is 25% better than the median energy performance of similar buildings by benchmarking against the national source energy data provided in the Portfolio Manager tool.

Path 2. National average data not available
If national average source energy data are unavailable for buildings of similar type, benchmark against the building site energy data of at least three similar buildings, normalized for climate, building use, and occupancy. Demonstrate a 25% improvement.

OR

Option 2. Benchmark against historical data
If national average source energy data are unavailable, compare the building's site energy data for the previous 12 months with the data from three contiguous years of the previous five, normalized for climate, building use, and occupancy. Demonstrate a 25% improvement.
Identifying Opportunities

What’s going on here?

This seems good

Facility A’s Peer Group

Facility B’s Peer Group

Source EUI (kBtu/sf/yr)

Facility A’s Peer Group

Facility B’s Peer Group

Your facilities

Other similar facilities
Starting Conversations

“What are the main energy drivers in your facility?”

vs.

“Why might your building be here relative to its peers?”

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![Graph showing Source EUI (kBtu/sf/yr) for Facility B's Peer Group.]
Providing Context

- Energy disclosure ordinances are on the rise
- All labs look like energy hogs
- No energy score to identify high-efficiency labs
- Consequences include audits, penalties, shame

from City of Boston BERDO report August 2015
Lab Benchmarking Datasets

- CBECS
- Portfolio Manager
- Energy disclosure datasets
- Data aggregators
- Private libraries
- The Labs21 Benchmarking Tool
The Labs21 Benchmarking Tool

• Online crowdsourced database:
  – Lab building energy usage
  – Lab-specific functional requirements
• Developed by LBNL for Labs21 program
• Public since August 2002

labs21benchmarking.lbl.gov
• Typically ~40 new buildings per year
• Big uptick recently

Most of the data is pretty recent
Labs21 Benchmarking Tool: Dataset

- Distribution of buildings across country
Labs21 Benchmarking Tool:Dataset

- 140 million sf of buildings
- 64 million sf of lab space

5-10% of total!
Labs21 Benchmarking Tool: Dataset

- Buildings from all eras
Most (75%) are from R&D and academic sectors.
Labs21 Benchmarking Tool: Dataset

- Large spread of energy intensity
- Average source EUI: 580 kBtu/sf/yr
- Average site EUI: 270 kBtu/sf/yr
- Median lab area: 41%
Contributing to the Labs21 Dataset

Welcome to the Labs21 Benchmarking Tool!

Use this tool to compare the energy use of your lab buildings with that of similar facilities in the US. The tool's database contains owner-submitted data from an ever-growing number of lab facilities.

Buildings in database: 760
Last database update: August 2017

Enter Data
Enter your data into the database. Your facilities appear in output reports. Username and password required.

View Data
View data already in the database. Output reports show database facilities only. No login required.
Viewing the Labs21 Dataset

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Benchmarking with the Labs21 Tool

Can be done via “Enter Data” and “View Data” pathways.

Benchmarking by data filtering:
1. Select **metric** for comparison
2. Select a **peer group of buildings** for comparison
3. Compare **energy use intensity** with peer group
1. Select Metric

**Tips:**

- **Total Building** has the most data
- **Source energy** is the best metric
- Read the instructions and tooltips
2. Select Peer Group

Tips:

- **Iterative** process
- Expand selection if selected peer group is too small
  - Climate zone
  - Lab type
- Use measured data
3. Compare Energy Usage

- Chart shows EUIs of peer group facilities
- Red line is average EUI
- Facilities sorted in order of increasing % lab area
- Your facilities will also appear (if applicable)

Tips:
- Create your own plots using outputs
Reformatting the Output

• Copy the output table into Excel
Labs21 Benchmarking Tool: Summary

• Rich dataset
• Unsurpassed in size and function
• Simple to use
• Enormously useful

• But not perfect…
The I²SL Lab Benchmarking Working Group

• Volunteers from I²SL community
• Formed in 2014
• Mostly focused on Labs21 Benchmarking Tool
  – Preservation
  – Understanding usage and needs
  – Maintenance
  – Upgrades
Working Group Achievements

• Identified areas for improvement:
  – Industry confusion about use and use cases
  – Infrequent database updates
  – Clunky interface
  – Data quality
Working Group Achievements

• Made improvements!
  – Industry confusion about use and use cases – 2014 survey; 2017 FAQs; 2015-17 conferences
  – Infrequent database updates – worked with LBNL staff; provided data reviews
  – Clunky interface – 2016 website facelift; “select all” buttons
  – Data quality – new 2016 regression analysis; live data checks

• Identified future opportunities
The purpose of this benchmarking database tool is to allow laboratory owners to compare the performance of their laboratory facilities to similar facilities and thereby help identify potential energy cost savings opportunities. The tool will allow benchmarking with energy use metrics (e.g. BTU/sf/yr) as well as system efficiency metrics (e.g. W/cfm).

To benchmark a facility, you will need to input facility characteristics (e.g. lab type, gross area) and energy use data (e.g. annual electricity use). Although measured data is preferred, estimated data may also be provided. The data you provide will remain anonymous to other users of the database.

Note: You will be prompted for a username and password in order to enter data and benchmark your lab. You may input data over multiple sessions. If you only wish to view the data, without inputting data for your lab, login is not required.

- Acquire a username and password, or edit your existing profile
- Bulk data input spreadsheet (to input 5 or more facilities)
- Guidance on how to use this tool for LEED-EB

Frequently Asked Questions
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Output Plot: Before
There is more work to be done…
What’s Next?

• New I$^2$SL lab benchmarking tool!

– Support from DOE Smart Labs Accelerator Program
– Continued collaboration with LBNL
The New I²SL Benchmarking Tool

- An **excellent opportunity** for improvement!
  - New modern, more usable website and graphing
    - Improved data quality checks
  - Expanded data fields
    - e.g. water usage
  - Modernized lab building classifications
    - Maintain back-compatibility
  - Special case study buildings
  - Automatic connection to Portfolio Manager
  - Energy scores for lab buildings
  - Data submission drives
    - e.g. submeter data; underrepresented regions
  - Benchmarking operational practices
Lab Energy Scores

• Comparison is inevitable: can we make it fair(er)?

• Regression analysis like Energy Star?
  – Historically too much scatter in Labs21 data
Regression Analysis: Approach

1. Identify functional requirements impacting energy use
2. Collect large dataset of buildings
3. Correlate energy use with requirements
4. Develop formula for energy use of “typical” building
5. Rank buildings against “typical”
A Simple (Fake) Example

1. Operating hours should affect EUI
2. Collect sample of office buildings
3. Correlate EUI with operating hours
4. Score other buildings against best fit line
5. Diamond gets low score; star gets high score

R² = 92%
Lab Energy Scores

• **Boston** has been leading the way!

• **Boston Green Ribbon Commission Higher Ed Working Group**: draft energy score for lab buildings
  – Uses multilinear regression (like Energy Star)
  – High-quality dataset with less scatter than Labs21
  – Functional reqs: lab type, % lab area, #FHs / lab area, occ hours/wk

• Include in new I²SL tool?
Benchmarking Operations

• Beyond energy benchmarking
• Compare **operational practices and policies**

• Useful for facilities:
  – Behind or ahead of the curve?
  – Demonstrate that projects have been achieved elsewhere
    • No need to reinvent from scratch
  – Best when combined with case studies

• Useful for community:
  – Take industry’s pulse
  – Identify trends
Summary

• Industry demands benchmarking for lab buildings

• The Labs21 tool is a unique, valuable, simple, and free lab benchmarking resource

• Successful collaboration between I²SL and LBNL has enhanced our resources
  – More improvements coming soon
  – Let us know what you need!

• **Working Group Meeting:** Wed 1pm