



**BERKELEY LAB**  
LAWRENCE BERKELEY NATIONAL LABORATORY



# Benchmarking: How does your building measure up?

Andrea Mercado

Senior Research Associate

Lawrence Berkeley National Laboratory

[ACMercado@lbl.gov](mailto:ACMercado@lbl.gov)



UNIVERSITY OF  
CALIFORNIA

# Benchmarking Policies

- **Municipal Public Disclosure Laws**
  - San Francisco, NYC, DC, Austin, Philadelphia, Seattle, etc.
- **California**
  - Prop 39: Local Education Agencies must benchmark to qualify for energy project funding.
  - AB1103: Benchmark all commercial buildings at time of sale
  - S-20-04: Benchmark all state buildings
  - SB1: Benchmark to qualify for solar incentives
- **Federal**
  - EISA 2007: Benchmark all federal buildings and track performance towards energy goals
- **Europe**
  - Energy Performance of Buildings Directive requires energy performance to be publicly displayed



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA

# Why benchmark energy use?

Energy benchmarking is one part of a broader energy management process

## Benchmarking

Establish  
Baseline

Validate  
Design

Identify Best  
Practices

Set Goals

Estimate  
Savings  
Potential

Prioritize  
Efforts



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA

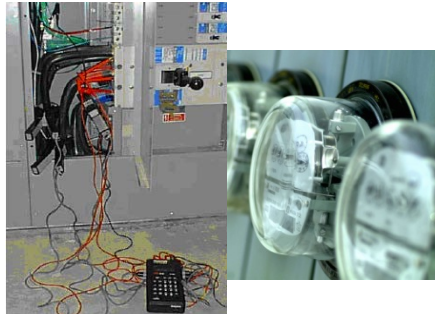
# Benchmarking Effort vs. Results

Accuracy of Benchmarking Results

*Investment-Grade  
Energy Audit*



*Action-Oriented  
Energy Benchmarking*



*Whole Building  
Energy Benchmarking*



*Data Collection Effort (time)*

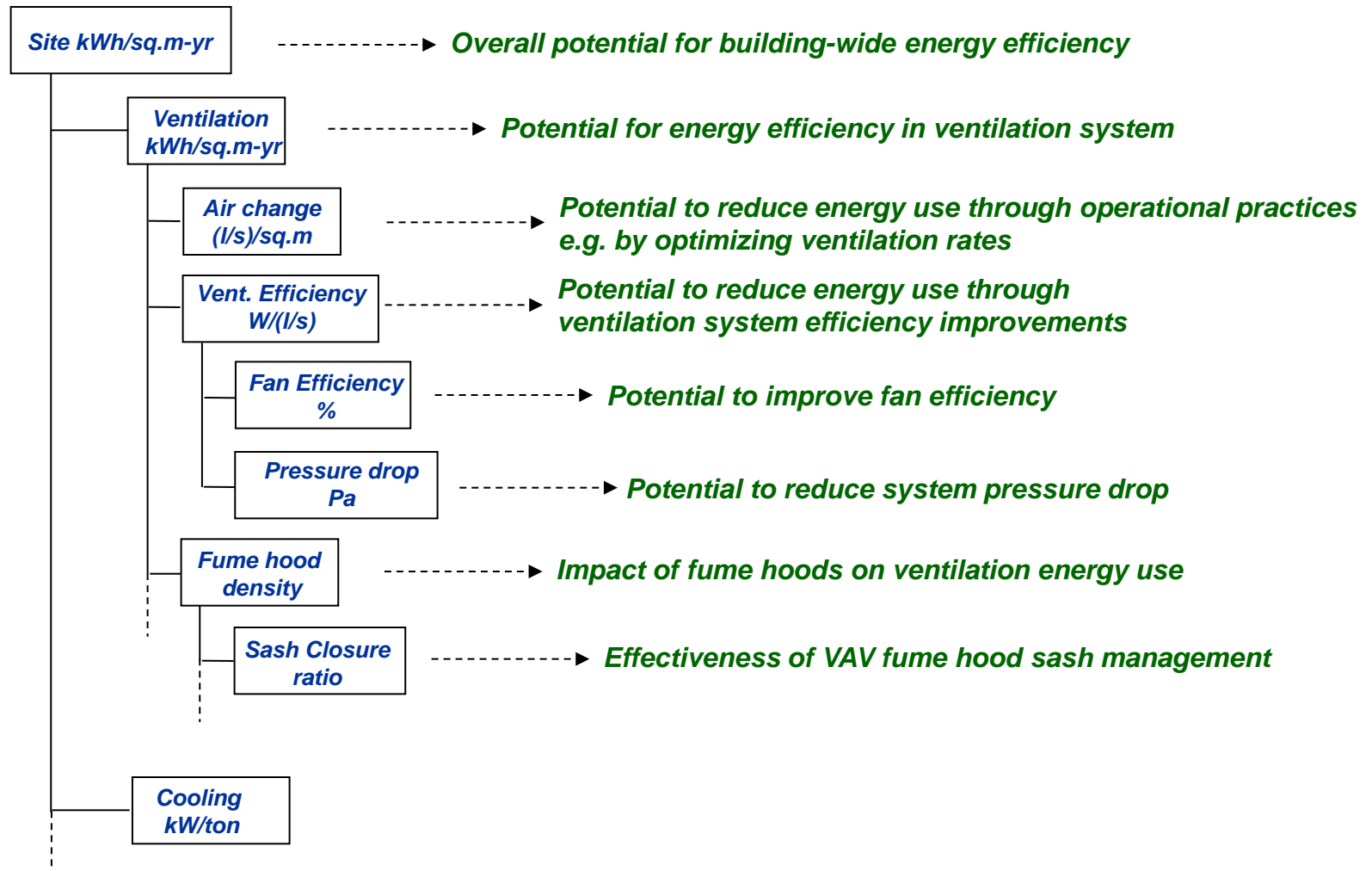


U.S. DEPARTMENT OF  
**ENERGY**



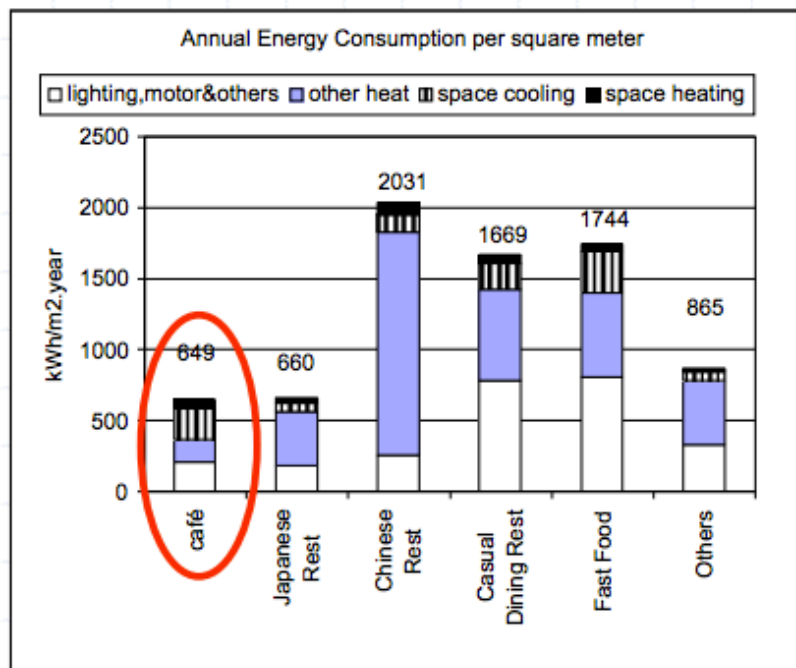
UNIVERSITY OF  
CALIFORNIA

# Benchmarking Metrics

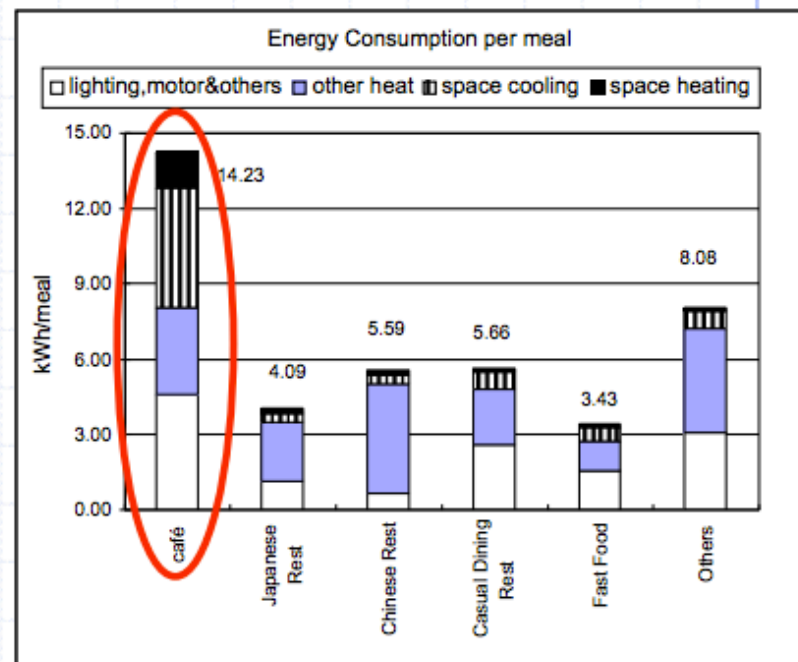


# Normalization is key

## Energy per unit floor area



## Energy per meal



Café ranks “best” by floor area and “worst” by meals

Source: The Energy Data and Modeling Center, 2001



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA

# Example: CEC Headquarters

A building that is average when looked at coarsely, but among the best-in-class when benchmarked using progressively appropriate peer groups

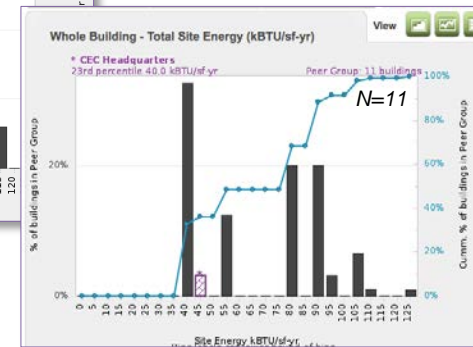
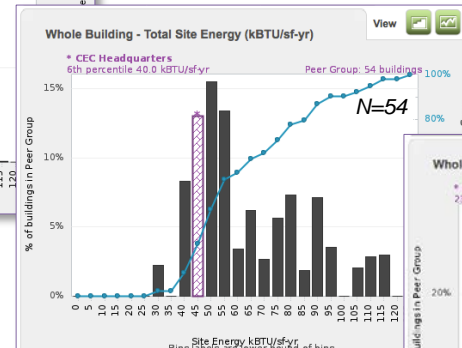
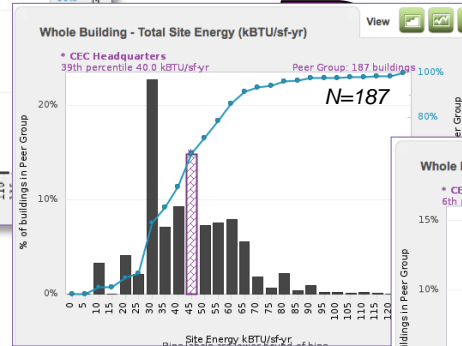
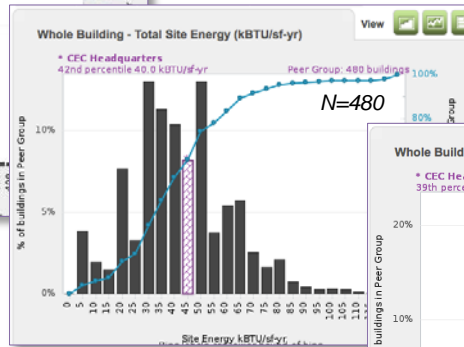
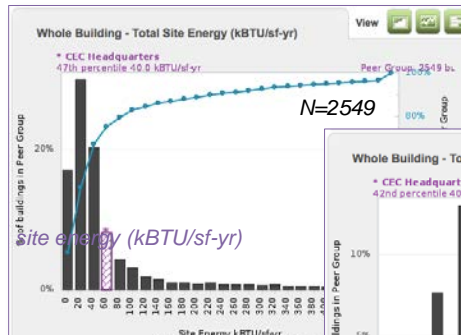
Compared to ...all California buildings

...+ only offices

... + 1979-1990 vintage

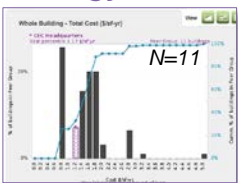
... + 25-150k sf size range

... + Central Valley

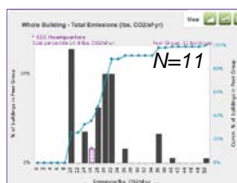


Other Metrics:

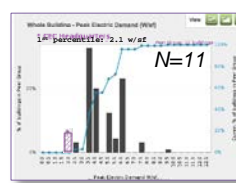
Energy Cost



Carbon



Peak Electricity



U.S. DEPARTMENT OF ENERGY



UNIVERSITY OF CALIFORNIA

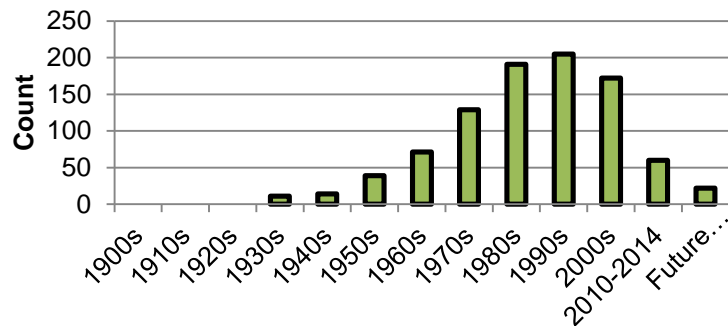
# EnergyIQ

energyiq.lbl.gov

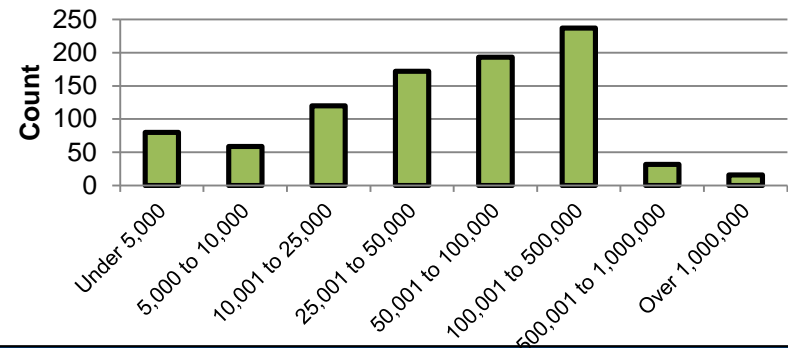


- Commercial benchmarking
  - California and national database
  - 88 million sq. ft. of floor area
- Over 15,000 unique visitors
  - 1,300 users with accounts
  - An additional 134 million sq. ft. of user floor area

Vintage Distribution



Area Distribution



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA



Export

Email

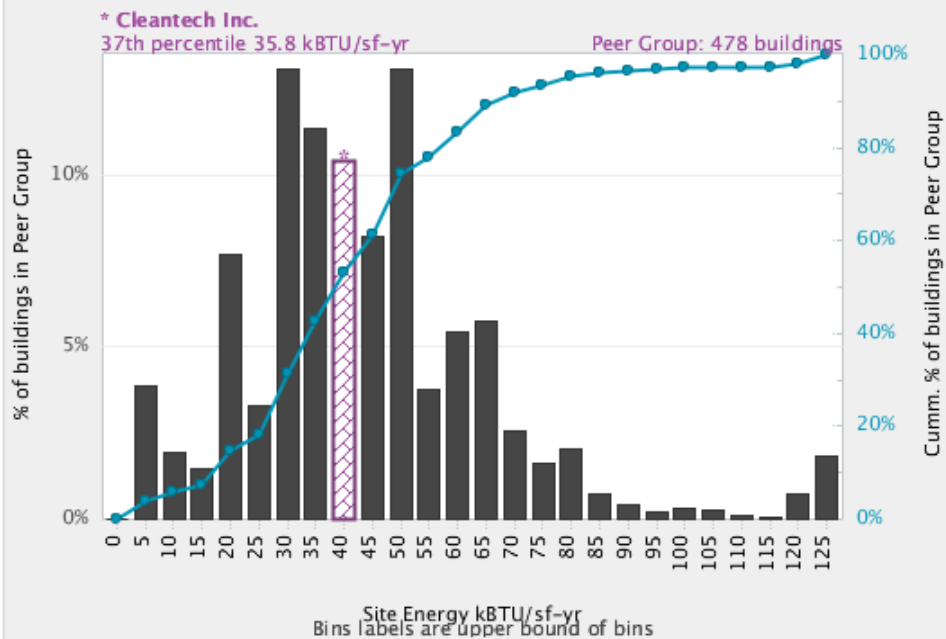
Add to Dashboard

Create New Chart

Add a Building

### Whole Building - Total Site Energy (kBTU/sf-yr)

View:



Axis Label | Units

## Peer Group Information

**SUMMARY** The **Site Energy** for typical buildings of the type(s) you've specified is 43.6 kBTU/sf-yr [median value], with a range of 13.7 to 82.3 kBTU/sf-yr [5th to 95th percentiles] for the population. Enter your own building information at the left to see how yours compares. Try other Views for graphical and tabular detail. This analysis includes **population weights** for each building.

**DATA SET** California only (CEUS)

**LOCATION** California= Central Coast, Central Valley, Desert, Mountains, North Coast, South Coast, South Inland

**SIZE** 0 - 25,000 sf, 25,001 - 150,000 sf, Over 150,000 sf

**VINTAGE** 1901 through 1940, 1941 through 1978, 1979 through 1990, 1991 through Present, Unknown

**TYPE** Administration and Management, Assorted/Multi-tenant, Financial/Legal, Government Services, Insurance/Real Estate, Medical/Dental Office, Other Office, Software Development

Export

Email

Add to Dashboard

Create New Chart

Add a Building

## Whole Building - Total Site Energy (kBTU/sf-yr)

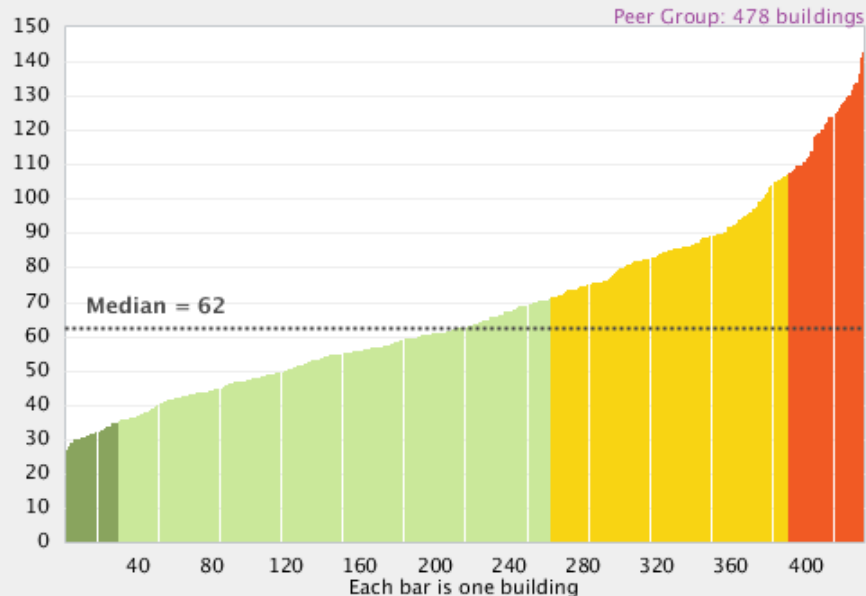
View:



Axis Label

Units

Site Energy kBTU/sf-yr



5-25%-ile
  25-50%-ile
  50-75%-ile
  75-95%-ile

SHOW OUTLIERS

## Peer Group Information

**SUMMARY** The **Site Energy** for typical buildings of the type(s) you've specified is 43.6 kBTU/sf-yr [median value], with a range of 13.7 to 82.3 kBTU/sf-yr [5th to 95th percentiles] for the population. Enter your own building information at the left to see how yours compares. Try other Views for graphical and tabular detail. This analysis includes **population weights** for each building.

The data in the plot is an **unweighted** representation of the values you selected.

**DATA SET** California only (CEUS)

**LOCATION** California= Central Coast, Central Valley, Desert, Mountains, North Coast, South Coast, South Inland

**SIZE** 0 - 25,000 sf, 25,001 - 150,000 sf, Over 150,000 sf

**VINTAGE** 1901 through 1940, 1941 through 1978, 1979 through 1990, 1991 through Present, Unknown

**TYPE** Administration and Management, Assorted/Multi-tenant, Financial/Legal, Government Services, Insurance/Real Estate, Medical/Dental Office, Other Office, Software Development

Export

Email

Add to Dashboard

Create New Chart

Add a Building

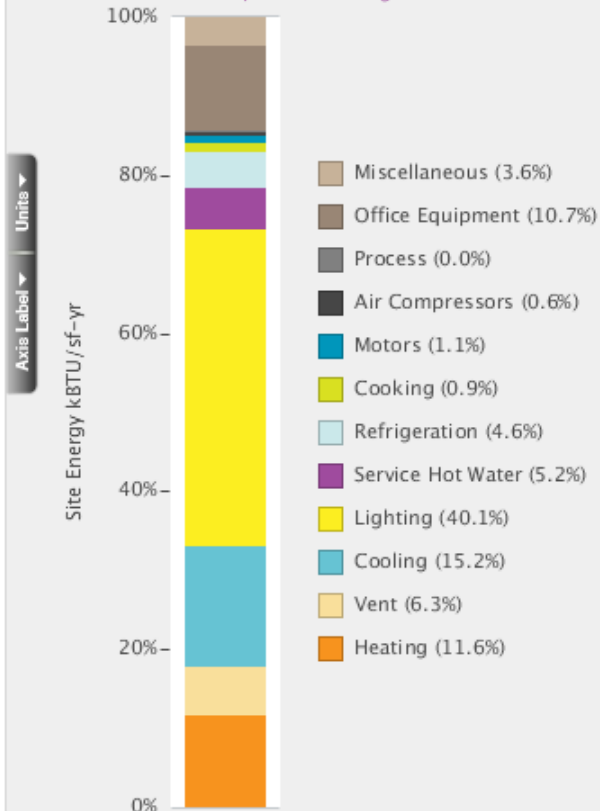
## End Use Breakout - Total Site Energy

Peer Group: 478 buildings

View:



Absolute Value | By Percentage



## Peer Group Information

**SUMMARY** The Site Energy for typical buildings of the type(s) you've specified is 43.6 kBTU/sf-yr [median value], with a range of 13.7 to 82.3 kBTU/sf-yr [5th to 95th percentiles] for the population. Enter your own building information at the left to see how yours compares. Try other Views for graphical and tabular detail. This analysis includes population weights for each building.

**DATA SET** California only (CEUS)

**LOCATION** California= Central Coast, Central Valley, Desert, Mountains, North Coast, South Coast, South Inland

**SIZE** 0 - 25,000 sf, 25,001 - 150,000 sf, Over 150,000 sf

**VINTAGE** 1901 through 1940, 1941 through 1978, 1979 through 1990, 1991 through Present, Unknown

**TYPE** Administration and Management, Assorted/Multi-tenant, Financial/Legal, Government Services, Insurance/Real Estate, Medical/Dental Office, Other Office, Software Development

paul's dash

Default

Top 5 Performers

ENERGY-Per sq. ft.

COST-Total

EMISSIONS-Per sq. ft.

EMISSIONS-Total

	Source kBTU/sf	\$ ('000)
Cleantech Inc.	120	\$70
Dilbert Park	192	\$213
Energy place	88	\$31
Holistic organica	72	\$12
Natural grocery co.	86	\$7

| = Target ; = Target not specified  
Shadings = peer group quartiles

	lbs CO <sub>2</sub> e/sf	lbs CO <sub>2</sub> e ('000)
15	15	737
24	24	2,423
11	11	325
8	8	165
10	10	99

Green band is target

Bottom 5 Performers

ENERGY-Per sq. ft.

COST-Total

COST-Per sq. ft.

EMISSIONS-Per sq. ft.

	Source MBTU	\$ ('000)	\$/sf	lbs CO <sub>2</sub> e/sf
Sunset Park	Peer group and Energy use required.	\$0	Energy use required.	0

| = Target ; = Target not specified  
Shadings = peer group quartiles

Green band is target



California Environmental Protection Agency  
**Air Resources Board**

## Actions

Print Send Export

Filter Site energy

END USE	ACTION	BUILDING	POTENTIAL WHOLE-BUILDING SAVINGS (25th/50th/75th %tile)	ROI	STATUS	NOTES
Lighting	Reduce Indoor Power Density by 10%	Cleantech Inc.	0.6 / 1.6 / 4.9		Pending	
Lighting	Reduce Indoor Power Density by 15%	Cleantech Inc.	0.9 / 2.1 / 4.9		Pending	
Lighting	Reduce Indoor Power Density by 25%	Cleantech Inc.	1.5 / 3.5 / 8.1		Pending	

\*Enter characteristics for your building (My Buildings Tab) to determine if this measure is applicable. 1-3 of 3



EnergyIQ™ and the EnergyIQ™ API were developed by the Lawrence Berkeley National Laboratory with funding from PIER and the California Environmental Protection Agency.  
 © Copyright 2013 Environmental Energy Technologies Division. | [Privacy Policy](#)



benchmarking

F A B S 21

[labs21benchmarking.lbl.gov](http://labs21benchmarking.lbl.gov)[fabs21.lbl.gov](http://fabs21.lbl.gov)

# Labs21 & Fabs21

- Building-type specific benchmarking
  - Laboratories
  - Fabrication Facilities
- Annual energy and water use tracking
- Dataset is made up of user-input data that is periodically reviewed, analyzed, and approved for peer group comparison



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA

# DOE BPD

bpd.lbl.gov



- Commercial and residential benchmarking
  - Empirical national database with over 750,000 buildings from public and private datasets

## Public Sector

U.S. Energy Information Administration  
U.S. General Services Administration  
U.S. Environmental Protection Agency  
New York City Dept. of Citywide Administrative Services  
Pennsylvania Keystone HELP Home Energy Loan Program  
San Francisco Department of the Environment  
State of California Public Utilities Commission  
State of California Energy Commission  
University of Arizona  
University of Dayton  
District Department of the Environment: Washington, DC  
Vermont Energy Investment Corporation  
Virginia Beach City Public Schools

## Private Sector

Brandywine Realty Trust  
Connexion Asset Group  
Kohl's  
EnergyIT.com  
Liberty Property Trust  
Lucid Design Group  
Prudential  
Related  
Tishman Speyer  
Transwestern  
USAA  
Vornado Realty Trust



U.S. DEPARTMENT OF  
**ENERGY**



UNIVERSITY OF  
CALIFORNIA

FILTERS



Search Location: State, Zip code or Climate Zone



### Welcome to the DOE Buildings Performance Database

- Information is Power. The BPD unlocks the power of building energy performance data.
- The BPD contains *actual* data on tens of thousands\* of existing buildings – not modeled data or anecdotal evidence.
- Get started now and discover trends in the energy performance of commercial and residential buildings across the country.

\* Data are continually being added to the BPD. Current data may be limited for some locations, building types and characteristics, but more analyses will become possible as the dataset grows.

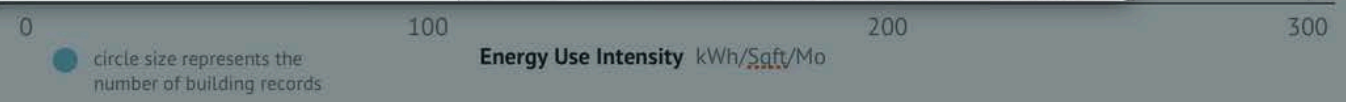


### Log in

LOG IN CANCEL

[Forgot password?](#)

- BUILDING CLASSIFICATION
  - Classification Type
- BUILDING
  - Facility Type
  - Gross Floor Area
  - Year Built
  - Hours Occupied
  - Number of People
- LOCATION
  - Climate Zone
  - State
  - Zip Code
- BUILDING SYSTEMS
  - Lighting
  - Heating
  - Cooling
  - Air Distribution
  - Window
  - Wall
  - Roof / Ceiling





### DEFINE PEER GROUP



#### BUILDING CLASSIFICATION

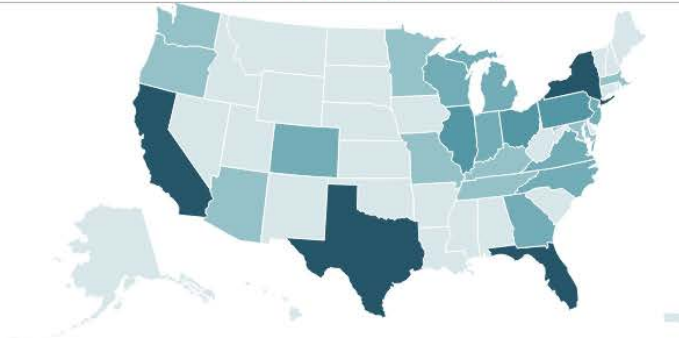
- Classification Type Commercial >
  - Facility Type >
- #### BUILDING INFO
- Floor Area >
  - Year Built >
  - Average Weekly Operating Hours >
  - Number of People >
  - Year Measured (Source) All >

#### LOCATION

- Climate Zone >
- City >
- State >
- Zip Code >

#### BUILDING SYSTEMS

- Lighting >
- Heating >
- Heating Fuel >
- Cooling >
- Window Glass >
- Window Glass Layers >
- Air Flow Control >
- Wall Insulation R-Value >
- Exterior Wall >
- Roof/Ceiling >



39,089 / 755,633 Buildings

Featured Examples

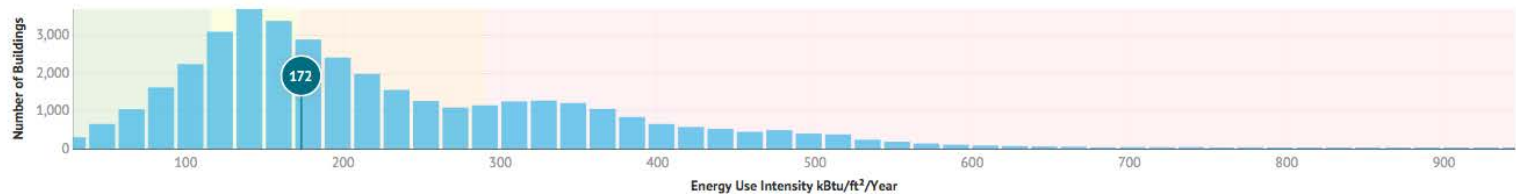
#### Peer Group

Bar Scatterplot Table

DISPLAY: Energy Use Intensity by Source Consumption



ADD YOUR BUILDING PEER GROUP MEDIAN



#### Retrofit Analysis

Building system... compare Select one... versus Select one...



DEFINE PEER GROUP

BUILDING CLASSIFICATION

Classification Type Commercial >

Facility Type >

BUILDING INFO

Floor Area >

Year Built >

Average Weekly Operating Hours >

Number of People >

Year Measured (Source) All >

LOCATION

Climate Zone >

City >

State >

Zip Code >

BUILDING SYSTEMS

Lighting >

Heating >

Heating Fuel >

Cooling >

Window Glass >

Window Glass Layers >

Air Flow Control >

Wall Insulation R-Value >

Exterior Wall >

Roof/Ceiling >

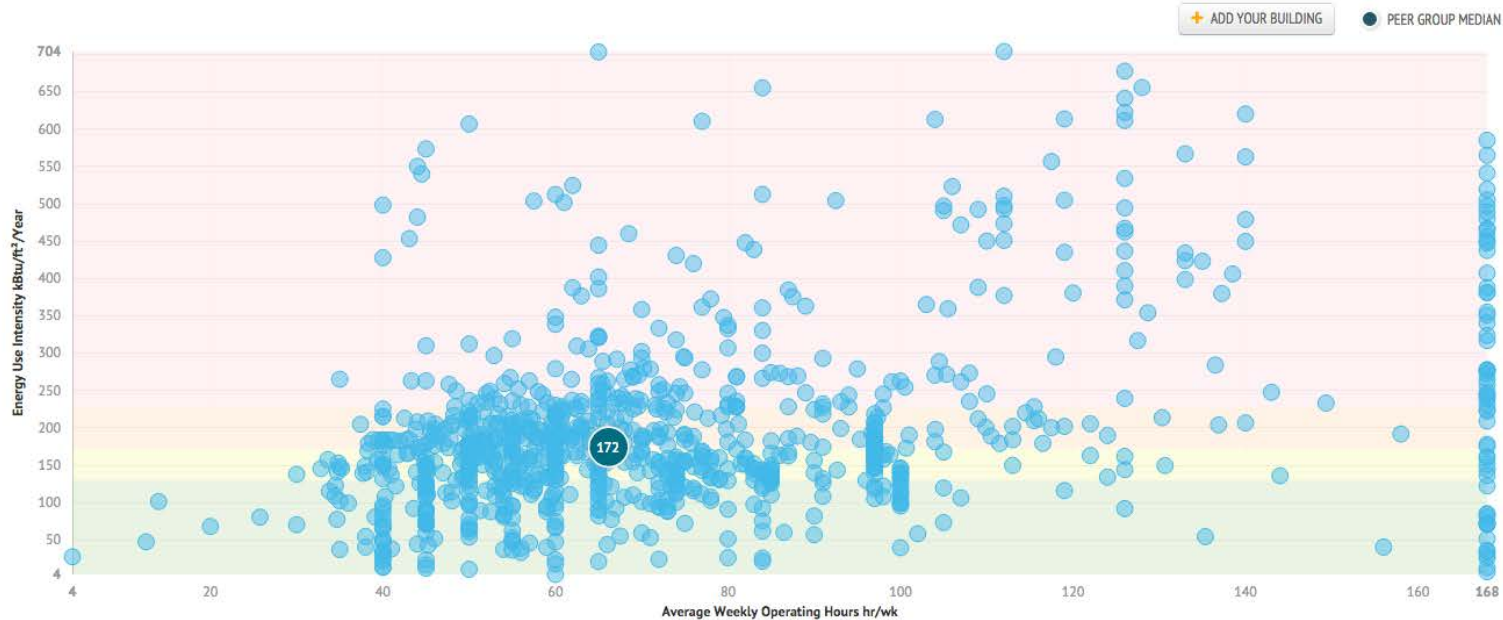
39,089 / 755,633 Buildings

Featured Examples

Peer Group

Bar Scatterplot Table

DISPLAY: Energy Use Intensity by Source Consumption and Average Weekly Op



Retrofit Analysis

Air flow control compare Constant Volume versus Other Or Combination



32% PROBABILITY THAT EUI WILL DECREASE 10% OR MORE



# Conventional Method for Retrofit Savings

My building:  
now

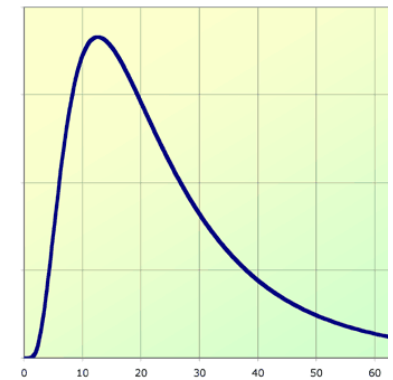


My building:  
after retrofit



Similar  
retrofitted  
buildings in  
Database

Number of  
Buildings



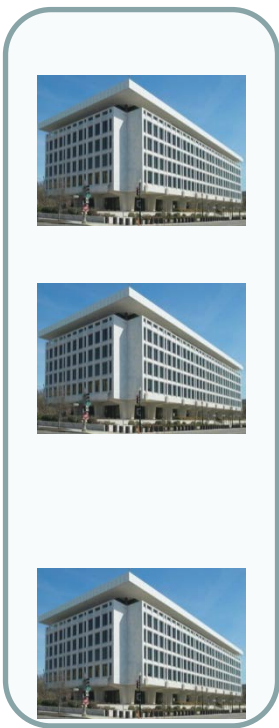
Savings

# Actuarial Method of Savings Analysis

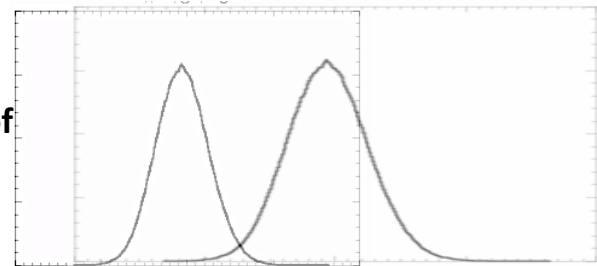
My building:  
now



My building:  
after retrofit



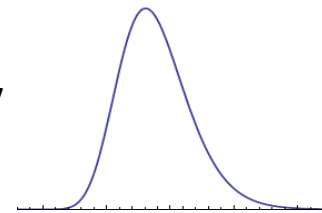
Number of  
Buildings



Energy/SqFt

“Subtract” the two  
histograms to get savings  
histogram

% Probability  
of savings



Savings/SqFt

### DEFINE PEER GROUP

#### BUILDING CLASSIFICATION

Classification Type: Commercial >

Facility Type >

#### BUILDING INFO

Floor Area >

Year Built >

Average Weekly Operating Hours >

Number of People >

Year Measured (Source): All >

#### LOCATION

Climate Zone >

City >

State >

Zip Code >

#### BUILDING SYSTEMS

Lighting >

Heating >

Heating Fuel >

Cooling >

Window Glass >

Window Glass Layers >

Air Flow Control >

Wall Insulation R-Value >

Exterior Wall >

Roof/Ceiling >

39,089 / 755,633 Buildings

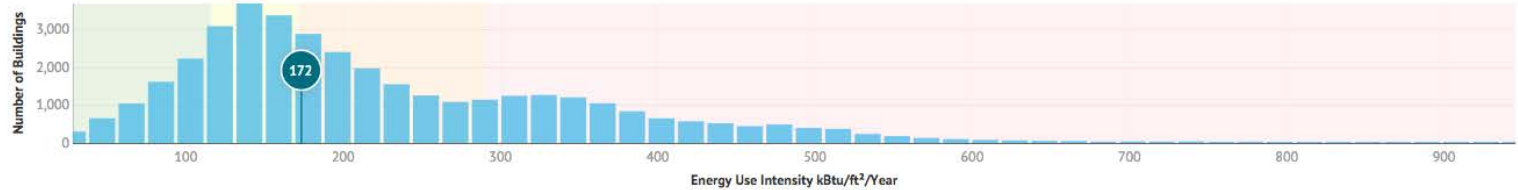
Featured Examples

### Peer Group

Bar | Scatterplot | Table

DISPLAY: Energy Use Intensity by Source Consumption

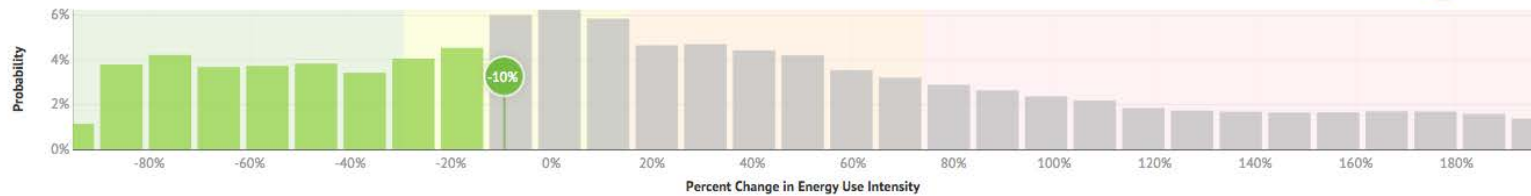
ADD YOUR BUILDING | PEER GROUP MEDIAN



### Retrofit Analysis

Air flow control | compare | Constant Volume | versus | Other Or Combination

32% PROBABILITY THAT EUI WILL DECREASE 10% OR MORE





**BERKELEY LAB**  
LAWRENCE BERKELEY NATIONAL LABORATORY



# Thank you!

**Andrea Mercado**

Senior Research Associate

Lawrence Berkeley National Laboratory

[ACMercado@lbl.gov](mailto:ACMercado@lbl.gov)

**510.486.4174**



UNIVERSITY OF  
CALIFORNIA