



Introduction to Building Energy Benchmarking

Oliver Baumann, September 2nd, 2020



Introduction to Building Energy Benchmarking

This webinar will provide an overview of the concept of energy benchmarking, the value of benchmarking, what you gain from benchmarking, and where benchmarking is required. Requirements for DC benchmarking will be presented and an introduction to EPA's Portfolio Manager will be provided. Examples of best practices, common benchmarking mistakes, and resources for further learning will be shared.

Agenda

- Introduction
- What is Benchmarking?
- Benchmarking Programs & Policies
- Energy Use Intensity (EUI)
- ENERGY STAR® Portfolio Manager®
- Benchmarking Disclosure and larger Purpose

Building Energy Benchmarking

Introduction & Agenda

In 2006, German-native Oliver Baumann relocated to the United States to establish Baumann Consulting, a specialty consulting firm for energy efficiency and sustainability. As the President and CEO, he successfully developed the business from a one-man operation to an international firm with a staff of 25 located in three offices across two continents.

Oliver has over two decades of experience in design, commissioning, and measurement & verification for high-performance buildings. After joining the EB-Group in Munich in 1996, he went on to establish the Building Simulation Group and later served as Project Manager for integrated building design and low-energy projects and Head of the International Projects Group. Oliver earned his Diploma (M.Sc.) in Mechanical Engineering from the Technical University of Munich in 1997.

Building on his experiences in Germany, Oliver's expertise covers the entire lifecycle of commercial, institutional and industrial buildings and facilities, from developing innovative energy concepts, peer review for design, quality assurance during construction, and measurement and verification of building performance and operation. As an advisory expert to building owners and project teams, Oliver advances cutting-edge best practices for high-performance buildings to maximize return on investment. Oliver also works to guide universities and communities to develop and implement campus wide and community wide integrated energy master plans.

One of the top engineering executives in the industry, Oliver earned the prestigious distinction of being named to Consulting-Specifying Engineer magazine's 40 Under 40 list in 2009. In 2014 Baumann Consulting was awarded the prestigious MERLIN Award for Outstanding Service Provider by the German American Chamber of Commerce. Oliver is the author of more than 25 publications and over 60 presentations on design, commissioning, and operation of energy efficient buildings. Since 2019, Oliver is teaching "Building Performance Verification" at the Catholic University of America in Washington DC.



Oliver Baumann, President & CEO
[linkedin.com/in/oliver-baumann](https://www.linkedin.com/in/oliver-baumann)

Building Energy Benchmarking

Introduction

What is Benchmarking?

The term **benchmark**, or **bench mark**, originates from the chiseled horizontal marks that surveyors made in stone structures, into which an angle-iron could be placed to form a "bench" for a leveling rod, thus ensuring that a leveling rod could be accurately repositioned in the same place in the future. These marks were usually indicated with a chiseled arrow below the horizontal line. The term is generally applied to any item used to mark a point as an elevation reference.

Benchmarking is the practice of comparing business processes and performance metrics to industry bests and best practices from other companies. Dimensions typically measured are quality, time and cost.

Benchmarking is used to measure performance using a specific indicator (cost per unit of measure, productivity per unit of measure, cycle time of x per unit of measure or defects per unit of measure) resulting in a metric of performance that is then compared to others.

Also referred to as "best practice benchmarking" or "process benchmarking", this process is used in management in which organizations evaluate various aspects of their processes in relation to best-practice companies' processes, usually **within a peer group defined for the purposes of comparison**. This then allows organizations to develop plans on how to make improvements or adapt specific best practices, usually with the aim of increasing some aspect of performance. Benchmarking may be a one-off event but is often treated as a continuous process in which organizations continually seek to improve their practices.

Building Energy Benchmarking

What is Benchmarking?



Benchmark
=
Reference Point

Source: [Wikipedia](https://en.wikipedia.org/wiki/Benchmark)

What is Energy Performance Benchmarking?

Benchmarking is the practice of **comparing the measured performance** of a device, process, facility, or organization to itself, its peers, or established norms, with the **goal of informing and motivating performance improvement**. When applied to building energy use, benchmarking serves as a mechanism to measure energy performance of a single building over time, relative to other similar buildings, or to modeled simulations of a reference building built to a specific standard (such as an energy code).

Benchmarking is useful for property owners, facility operators, managers, and designers. It **facilitates energy accounting**, comparing a facility's energy use to similar facilities to **assess opportunities for improvement**, and **quantifying/verifying energy savings**.

Commercial building energy performance benchmarking is a foundational element of an organization's **energy management strategy** because you can't manage what you don't measure. Across many commercial building markets, the practice has become standard operating procedure as energy costs and associated environmental and sustainability issues have raised awareness around the importance of energy management.

You can't manage what you don't measure.

- Peter Drucker -

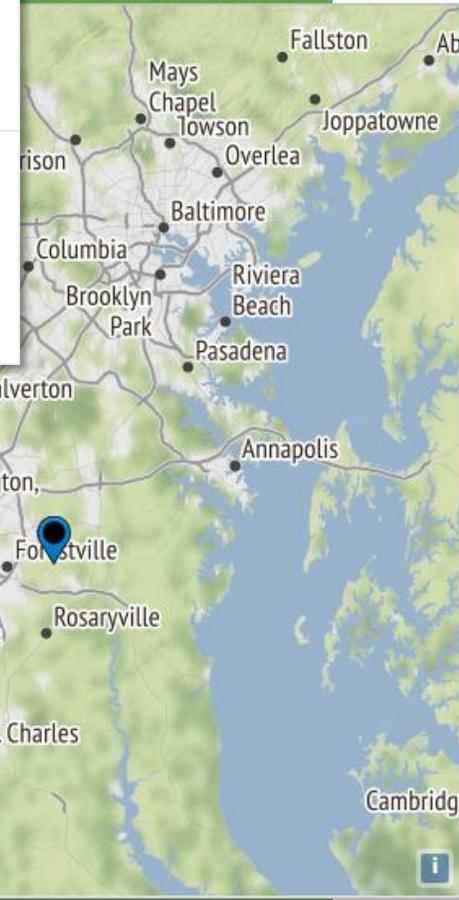
Building Energy Benchmarking

Source: www.energy.gov

What is Energy Performance Benchmarking?

Jurisdiction	Scope	Organization	Initiative	Requirements	Type	Status
Washington	New construction and major renovation buildings, 10,000 square feet or greater for district- owned and 50,000 square feet or greater for commercial.	Washington, District of Columbia	Green Building Act of 2006	<ol style="list-style-type: none"> 1. Applicable buildings must be designed to achieve an ENERGY STAR score of 75 as determined by the ENERGY STAR Target Finder tool. 2. Applicable buildings must track and report their annual energy use using the ENERGY STAR Portfolio Manager tool. 	Benchmarking Policy	Active
Washington	Privately owned commercial buildings more than 50,000 square feet.	Washington, District of Columbia	Clean and Affordable Energy Act	<ol style="list-style-type: none"> 1. Applicable buildings must track and report their annual energy use using the ENERGY STAR Portfolio Manager tool. 2. Benchmarking data will be publicly disclosed for applicable buildings via an online database. 3. Results are available on the BuildSmart DC database. 	Benchmarking Policy	Active
Washington	All existing buildings more than 10,000 square feet.	Washington, District of Columbia	Clean Energy DC Omnibus Act	<ol style="list-style-type: none"> 1. Applicable buildings must comply with Building Energy Performance Standards (BEPS) specific to each property type. 2. For buildings that are eligible for an ENERGY STAR score, the BEPS will be no lower than the District median ENERGY STAR score for buildings of each property type. 3. One compliance option is a performance pathway that can be met by achieving a 20% reduction in weather-normalized energy use intensity over a two-year period. 	Benchmarking Policy	Active

BUILDING ENERGY BENCHMARKING PROGRAMS AND POLICIES



FIND BENCHMARKING PROGRAMS AND POLICIES

Click on a pin or shaded area of the map to see details. Zoom in to view overlapping pins.

- States with voluntary programs
- States with benchmarking policies
- Cities with voluntary programs
- Cities with benchmarking policies
- Show only historical policies and programs

CLEAR THE MAP

[View all initiatives in a PDF](#)

KEY

- States with voluntary programs
- States with benchmarking policies
- States with voluntary programs and benchmarking policies
- Cities with voluntary programs
- Cities with benchmarking policies
- ★ Cities with voluntary programs and benchmarking policies

[Host this map](#)



Building Energy Benchmarking

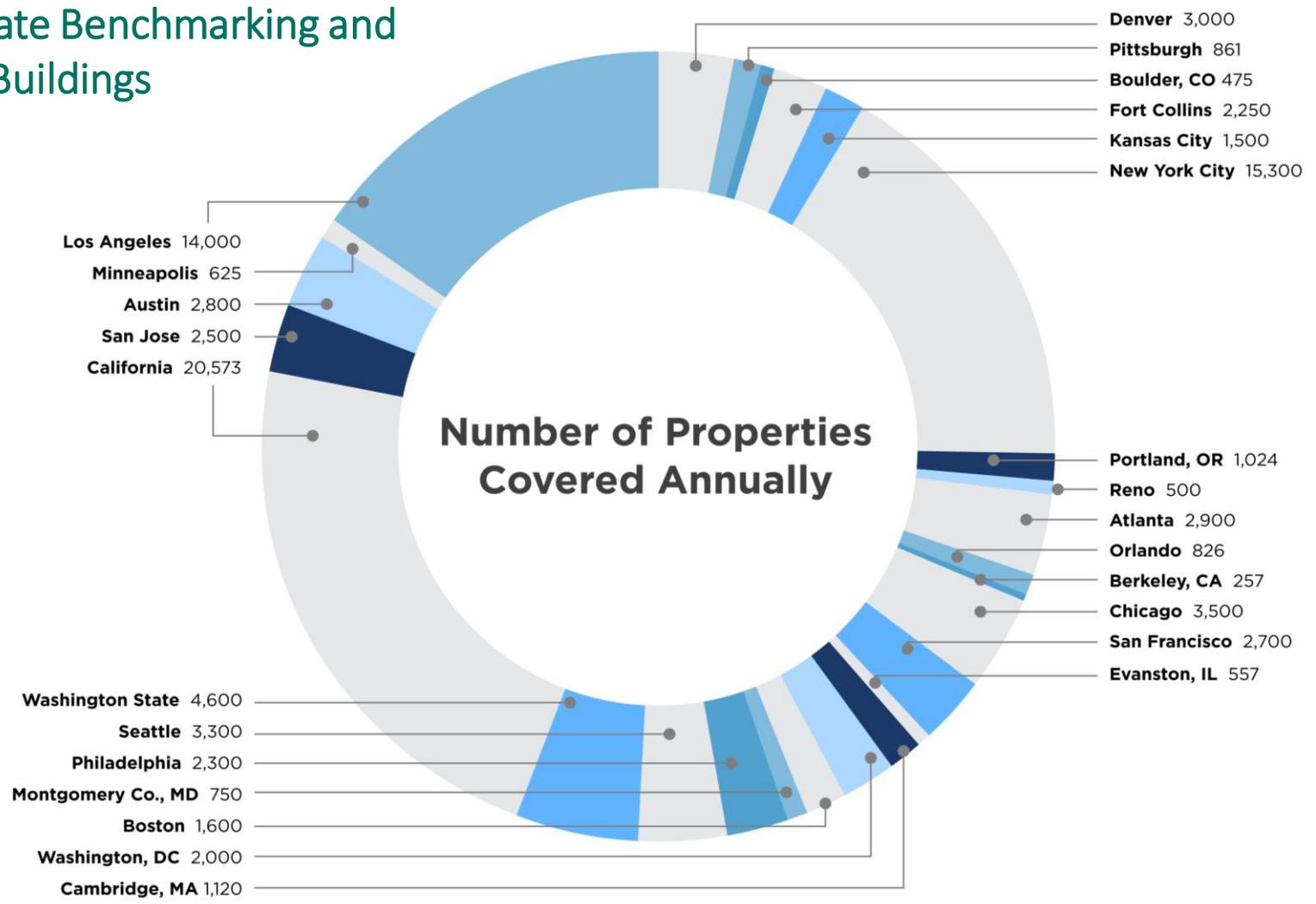
Benchmarking Programs & Policies

Source: [EPA ENERGY STAR® Website](#)



Impact of U.S. City, County, and State Benchmarking and Transparency Policies for Existing Buildings

Each year, existing policies will impact more than **91,800 properties** totaling approximately **11 billion SF** of floor space



Building Energy Benchmarking

Benchmarking Programs & Policies

Source: [BuildingRating](https://www.buildingrating.com/)/IMT





Benchmarking

Evaluate or check performance by comparison with a standard.

Energy Benchmarking

Energy benchmarking means tracking a building's energy and water use and using a standard metric to compare the building's performance against past performance and to its peers nationwide. These comparisons have been shown to drive energy efficiency upgrades and increase occupancy rates and property values.

In Washington DC, the Clean and Affordable Energy Act of 2008 (CAEA) requires that owners of all large private buildings (over 50,000 gross square feet) annually benchmark their energy and water efficiency and report the results to DOE for public disclosure. The District government also must annually benchmark and disclose the energy and water efficiency of District government buildings over 10,000 gross square feet. Benchmarking is done using the United States Environmental Protection Agency's (EPA) free, industry-standard online tool, ENERGY STAR® Portfolio Manager. Final regulations were published in January 2013.

The District of Columbia has enacted these requirements in order to increase the energy performance data available to owners and to the market, and drive efficiency improvements. Buildings are responsible for 75% of the District's greenhouse gas emissions, and energy benchmarking is critical to improving building performance and helping make the District the healthiest, greenest, and most livable city in the nation.

Building Energy Benchmarking

Benchmarking Programs & Policies

Who?

All private buildings over 50,000 gross square feet (and District government buildings over 10,000 gross square feet) within the District of Columbia, including multifamily residences, must measure and disclose their energy and water consumption to the Department of Energy & Environment (DOEE).

What?

The building's energy and water use.

When?

The annual reporting deadline is April 1st of each year.

How?

Either through the EPA ENERGY STAR® Portfolio Manager tool or a third-party tool that can report through Portfolio Manager.

What about Benchmarking Data Verification? → [DCSEU Webinar on September 29, 2020](#)

District properties will be required to obtain third-party verification every 3 years for benchmarking data submitted to DOEE. For this reporting year only, DOEE and the DCSEU are offering no-cost verification to covered buildings. With the upcoming Building Energy Performance Standards (BEPS), having accurate and verified benchmarking data is crucial. This Data will be used to set the performance standard that the property in question will be required to meet starting in 2021.

What's the Benefit for me?

Benchmarking results allow you to make targeted improvements to increase efficiency and to monitor how much was saved after installation. These operational improvements alone can lead to as much as 30% savings in energy costs.

Building Energy Benchmarking

Benchmarking in DC

Source: [DC Sustainable Energy Utility](#)

What is Energy Use Intensity – EUI and how is it calculated?

EUI is expressed as energy per square foot per year. It's calculated by dividing the total energy consumed by the building in one year (measured in kBtu or GJ) by the total gross floor area of the building.

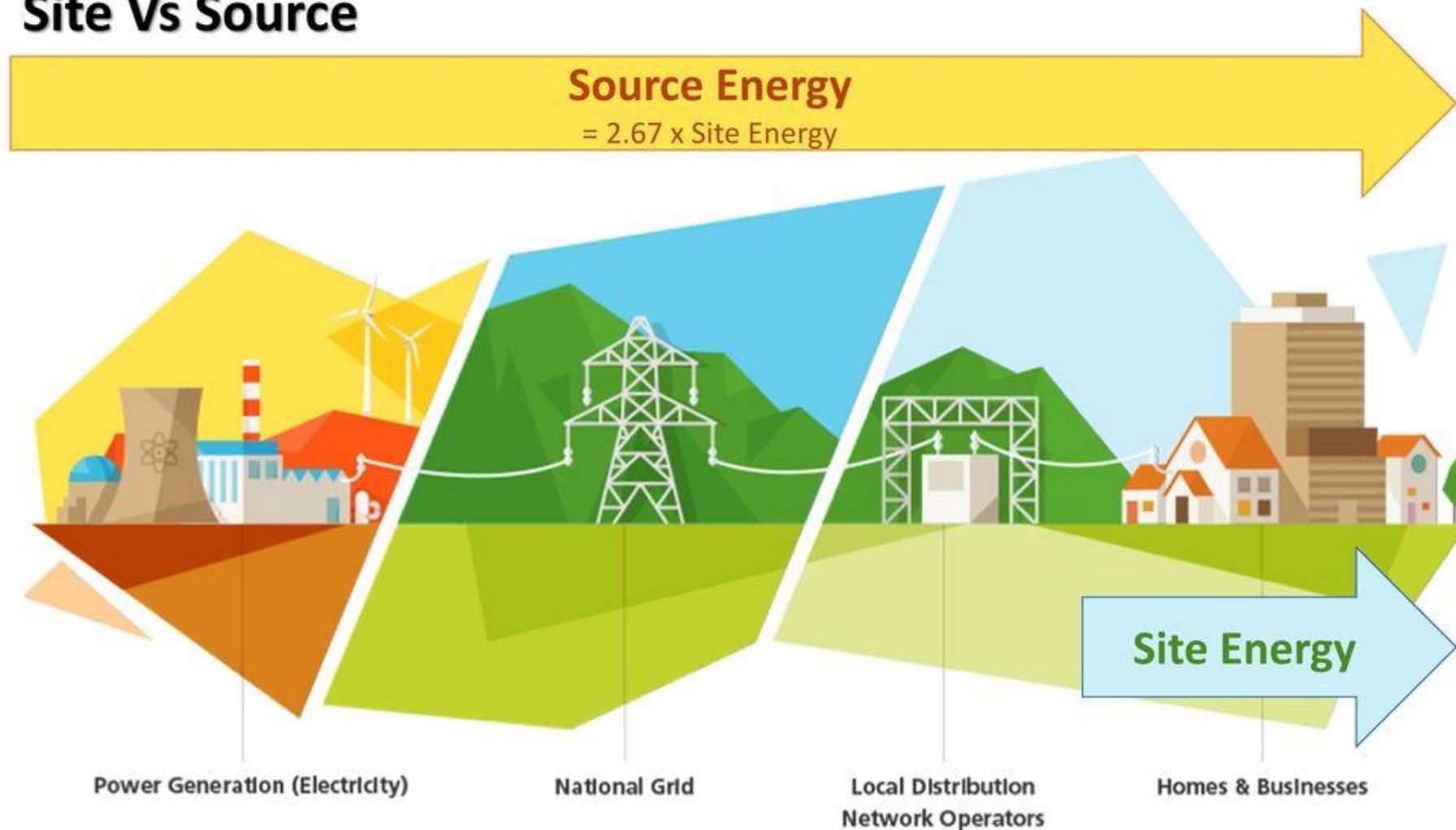
$$\text{EUI} = \frac{\text{energy consumed}}{\text{gross floor area}}$$

Building Energy Benchmarking

Energy Use Intensity

Source: ENERGY STAR®

Site Vs Source

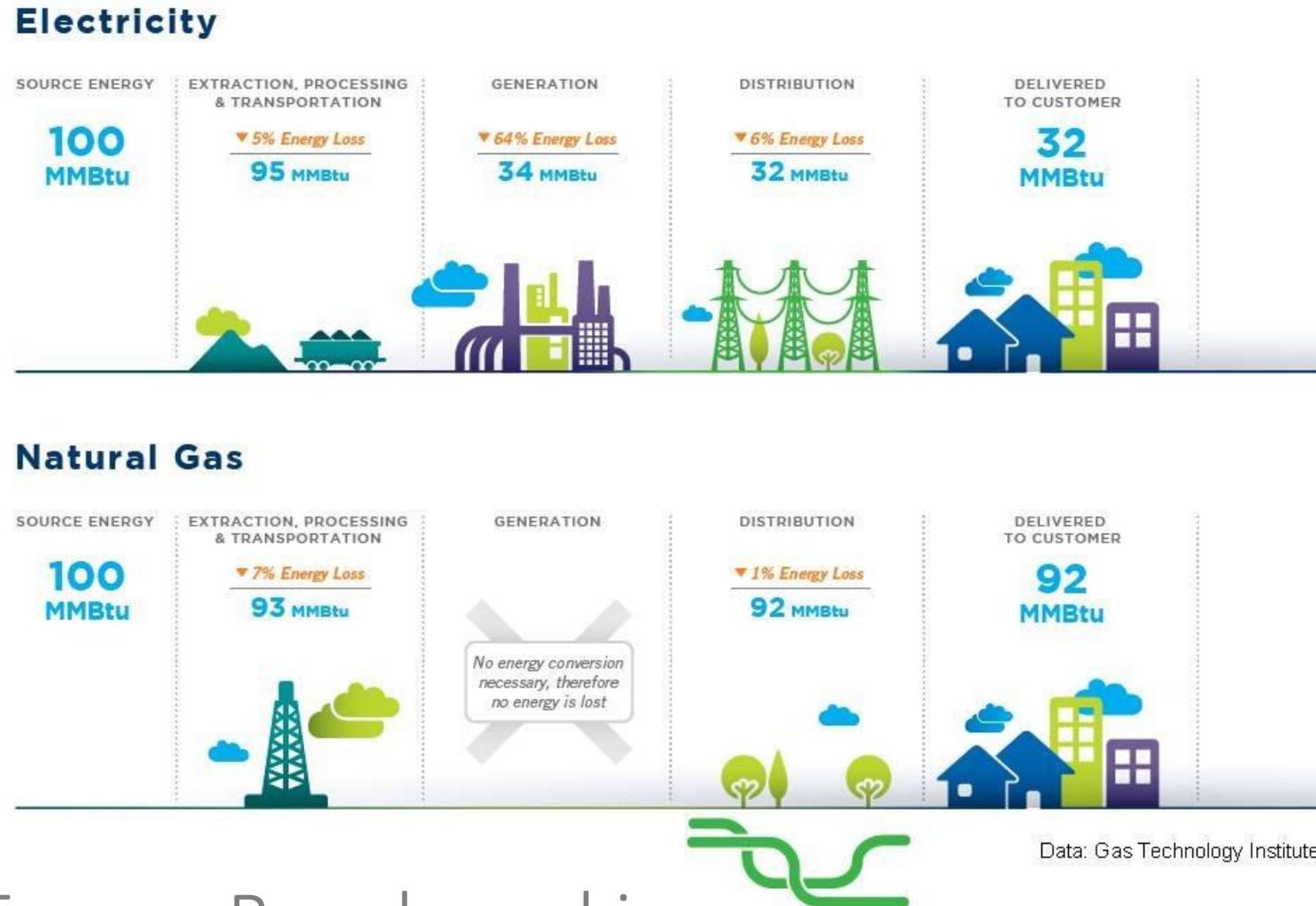


Building Energy Benchmarking

Energy Use Intensity

Source: University of Strathclyde

Site vs. Source Energy Use Intensity



Building Energy Benchmarking

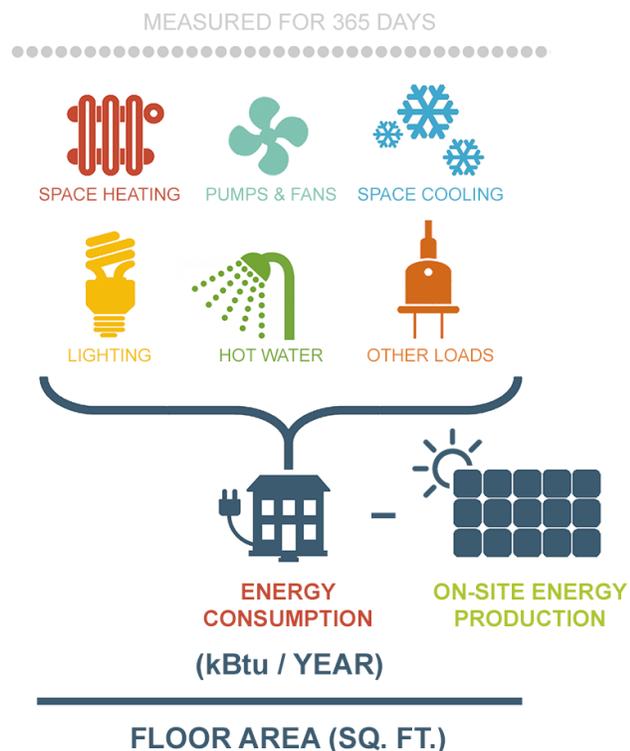
Energy Use Intensity

Source: [Electricity Blogger](#)

Site vs. Source Energy Use Intensity

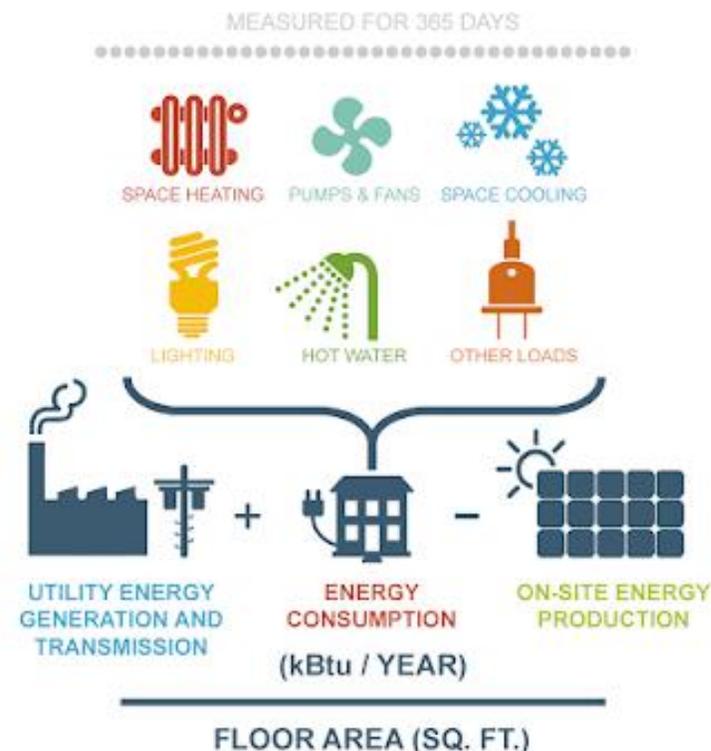
Site energy is most often referenced in the design community. In simple terms, site EUI is the energy consumed at the building site and is reflected in the utility bills paid by the owner.

Site Energy Use Intensity (EUI)



Source energy is a more accurate representation of a building's energy footprint as it considers the site energy as well as the energy lost during production, transmission and delivery to the site.

Source Energy Use Intensity (EUI)

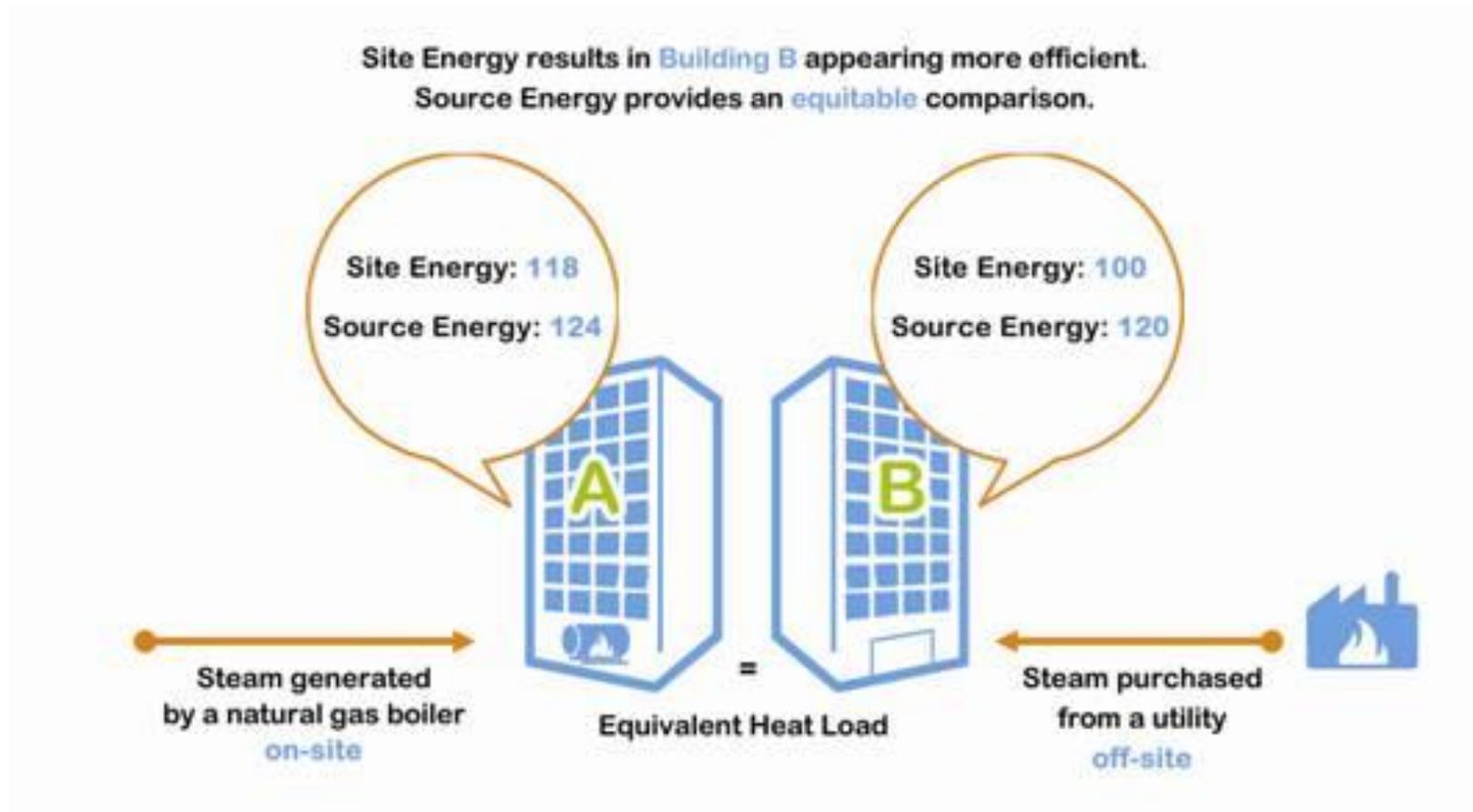


Building Energy Benchmarking

Energy Use Intensity

Source: [BuildingEnclosure](#)

Site vs. Source Energy Use Intensity



Building Energy Benchmarking

Energy Use Intensity

Source: [EPA ENERGY STAR® Website](https://www.epa.gov/energy-star)

FIND UTILITIES THAT PROVIDE ENERGY DATA FOR BENCHMARKING

Click on the map or search to quickly determine if your utility provides the energy data you need to benchmark in ENERGY STAR® Portfolio Manager®

Please enter your zip code below to show coverage in your area:

Zip Code:

Utility Name: Peppo
Fuel Type: Electric
Data Type: Web Services
Aggregate Whole-Building Data: Yes(5)
Multifamily Included: Yes
Contact Info:
 Email: kast-south@peppo.com
 Web Address: Click [here](#) for more information.

Utility Name: Washington Gas
Fuel Type: Gas
Data Type: Web Services
Aggregate Whole-Building Data: Yes(5)
Multifamily Included: Yes
Contact Info:
 Email: aggregateddata@washgas.com
 Web Address: Click [here](#) for more information.

Utilities Providing Energy Data for Benchmarking in ENERGY STAR® Portfolio Manager®

Leaflet | © OpenStreetMap © CartoDB

Building Energy Benchmarking

Energy Data Sourcing

Source: [EPA ENERGY STAR® Website](https://www.epa.gov/energy-star)

Building Areas

The BOMA Gross Areas of a Building: Standard Methods of Measurement, 2018 identifies BOMA Gross Area 4 as the sum of all areas within the boundary lines of Space Classifications A, B, C, D, E, and F. This includes the following:

- Space Classification A: Floor Area, Parking Area, and Connectors
- Space Classification B: Balconies, Exclusive Use Covered Galleries, and Finished Rooftop Terraces
- Space Classification C: Unenclosed Occupant Circulation and Roofless Structured Parking
- Space Classification D: Public Use Covered Galleries and Sheltered Area (Industrial)
- Space Classification E: Building Voids
- Space Classification F: Other Rooftop Areas, Unenclosed Connectors, Decks, and Plazas

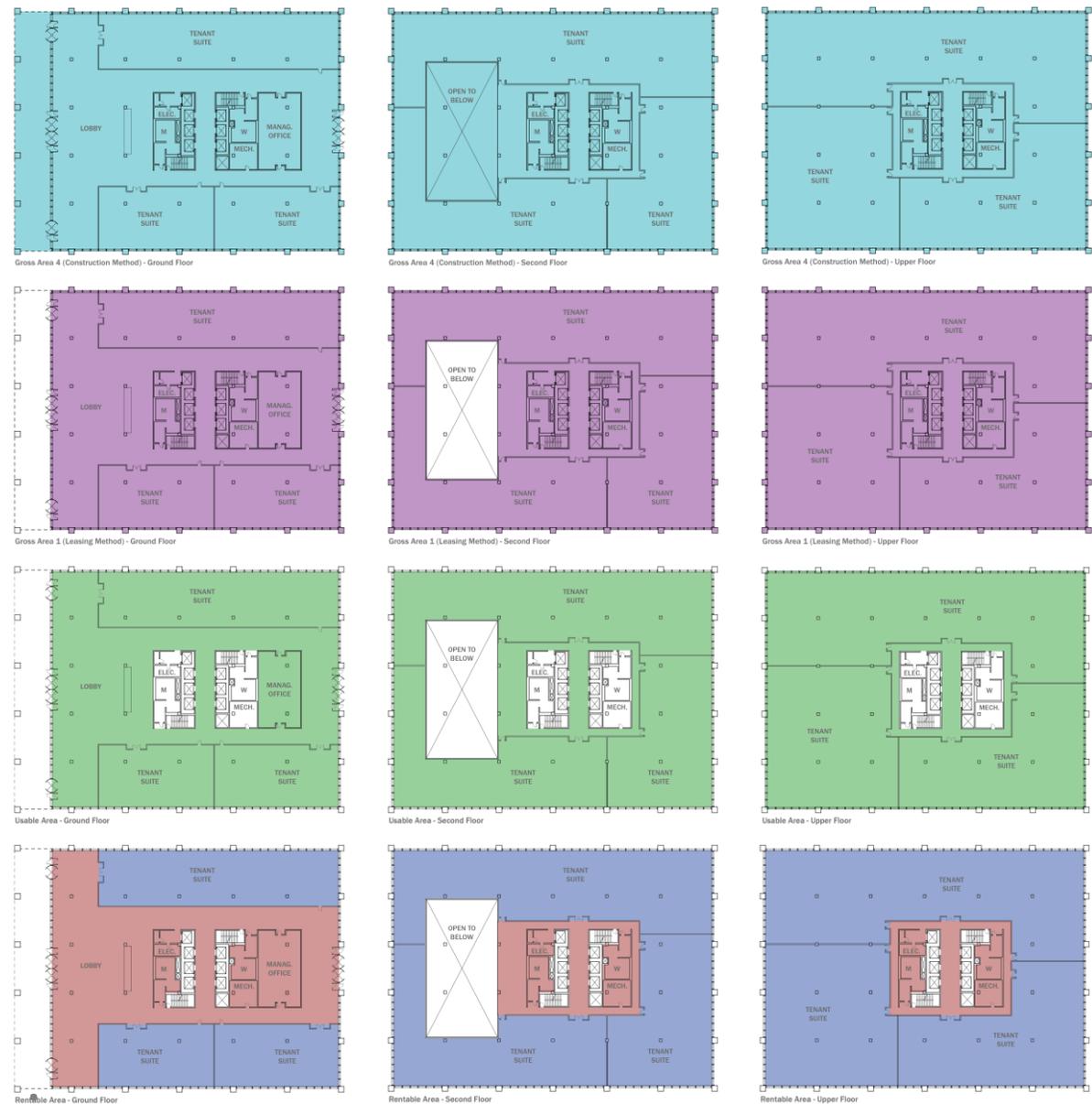
Building Energy Benchmarking

Energy Use Intensity

Source: [Archtoolbox](#)

Building Areas

- Gross Building Area
- Gross Floor Area
- Usable Area
- Rentable Area
- Net Assignable Area
- Zoning Floor Area / Floor Area Ratio (FAR)
- Site Area



Building Energy Benchmarking

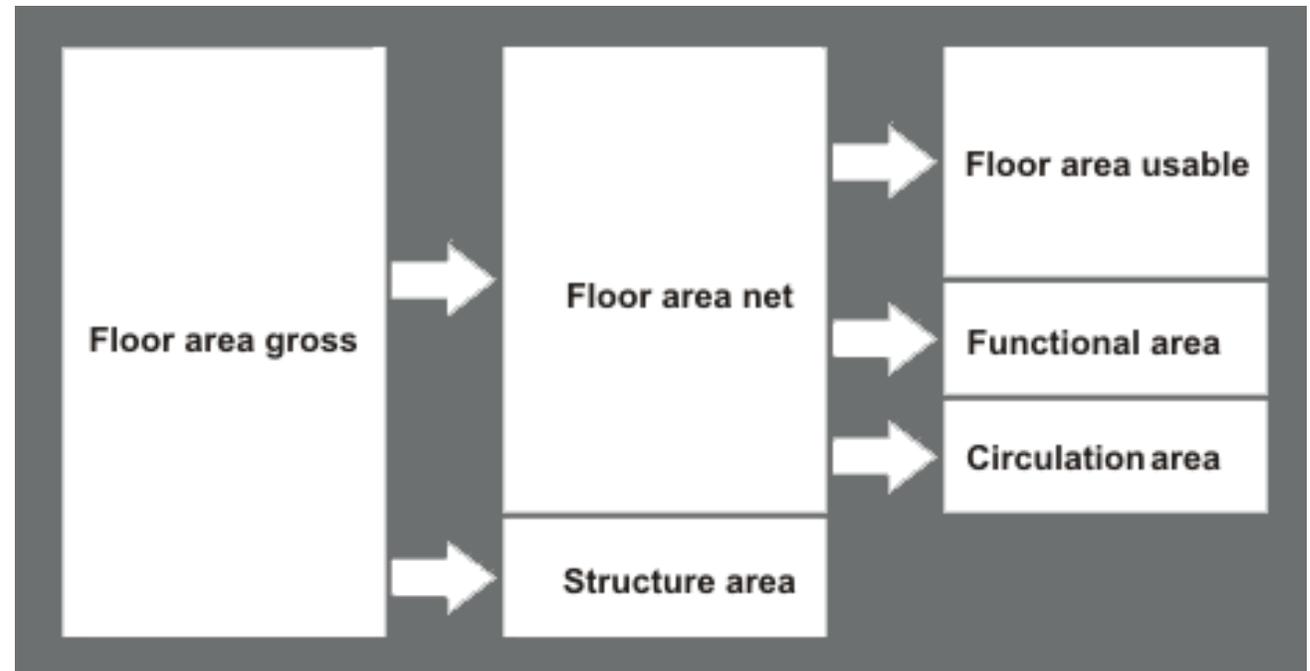
Energy Use Intensity

Source: [Archtoolbox](#)

Gross Floor Area – GFA

Gross floor area (GFA) in real estate is the total floor area inside the building envelope, including the external walls, and excluding the roof.

The area included within surrounding exterior walls, or exterior and fire walls, exclusive of vent shafts and courts. Areas of the building not provided with surrounding walls shall be included in the building area if such areas are included within the horizontal projection of the roof or floor above. 2018 International Building Code



Building Energy Benchmarking

Energy Use Intensity

Further References: ICC, NAIOP, BOMA

Objectives

EPA has identified the following objectives for a successful energy performance metric:

1. Evaluate energy performance for the whole building.
2. Reflect actual metered energy use.
3. Equitably account for different energy sources.
4. Normalize for building activity.
5. Provide a peer group comparison.

The Score Does	The Score Does Not
<ul style="list-style-type: none"> ✓ Evaluate actual metered energy use ✓ Normalize for business activity (hours, workers, climate) ✓ Compare buildings to the national population ✓ Indicate the level of energy performance 	<ul style="list-style-type: none"> x Sum the energy use of each piece of equipment x Credit specific technologies x Compare buildings with others in Portfolio Manager x Explain why a building performs well or poorly

Building Energy Benchmarking

ENERGY STAR Portfolio Manager®

Source: ENERGY STAR® Portfolio Manager® - Technical Reference

Computing Your Score

1. User enters building data into Portfolio Manager
 - 12 months of complete energy use information for all energy types
 - Specific physical building information (size, location, etc.)
 - Specific use details describing building activity (hours, etc.)
2. Portfolio Manager computes the actual source EUI
 - Total energy consumption for each fuel is converted from site energy into source energy
 - Source energy values are added across all fuel types
 - Source energy is divided by gross floor area to determine actual source EUI
3. Portfolio Manager computes the predicted source EUI
 - A regression equation for each property type is used to determine predicted source EUI
 - The equation begins with the average EUI for the property type and makes a series of adjustments based on the use details (hours, workers, etc.)
4. Portfolio Manager computes the energy efficiency ratio
 - The ratio equals the actual source EUI (Step 2) divided by predicted source EUI (Step 3)
 - Lower ratios indicate better performance
5. Portfolio Manager uses the efficiency ratio to assign a score via a lookup table
 - For each score on the 1 - 100 scale, the lookup table provides a range of ratio values
 - The ratio from Step 4 is used to identify the score
 - A score of 75 indicates that the building performs better than 75% of its peers

Building Energy Benchmarking

Source: ENERGY STAR® Portfolio Manager® - Technical Reference

To get started in Portfolio Manager you will need:

- Property Information
 - Primary function
 - Name, address, postal code
 - Year built
 - Gross floor area
- Property use details, e.g.
 - Operating hours
 - Number of computers
 - Number of workers, etc.
- At least 12 months of consumption data for resources you want to track
 - Property-specific utility bills for all purchased and on-site generated energy and water
 - Quantity of waste and materials recycled, disposed, donated, etc.

Portfolio Manager

How Portfolio Manager helps you save

- The benchmarking starter kit
- Identify your property type
- Enter data into Portfolio Manager
- The data quality checker
- How Portfolio Manager calculates metrics
- Interpret your results
- Verify and document your savings
- Share and request data
- Updates to ENERGY STAR® metrics with new market data
- Get help accessing your utility data
- Scorecard
- Track waste and materials

JOIN MAILING LIST

Sign up to receive updates from ENERGY STAR BUILDINGS & PLANTS on Portfolio Manager and program news.

SIGN UP

ENERGY STAR® Portfolio Manager®

The most-used energy measurement and tracking tool for commercial buildings.

COVID-19 Program Impacts: EPA has made several changes to the certification rules. See this FAQ for the latest updates.

Use Portfolio Manager

You've heard it before: you can't manage what you don't measure. That's why EPA created ENERGY STAR Portfolio Manager®, an online tool you can use to measure and track energy and water consumption, as well as greenhouse gas emissions. Use it to benchmark the performance of one building or a whole portfolio of buildings, all in a secure online environment.

Benchmark any type of building

You can use Portfolio Manager to manage the energy and water use of any building. All you need are your energy bills and some basic information about your building to get started.

Are you designing a new commercial building? You can also use Portfolio Manager to set your energy use target and see how your estimated design energy stacks up against similar existing buildings nationwide.

Join the rest of the industry

When you add your buildings, you'll be joining nearly 25% of U.S. commercial building space that's actively benchmarking in Portfolio Manager – making it the industry-leading benchmarking tool. You'll also be joining more than half of the Fortune 100®, half of the largest U.S. healthcare organizations, major league sports teams, colleges and universities, and entire cities.

Use the links on the left and start managing your energy and water consumption today.

2020 TOP CITIES

- LOS ANGELES
- WASHINGTON, DC
- SAN FRANCISCO

SEE THE FULL LIST!

Get help

Looking for Portfolio Manager technical support? Visit our help center.

ENERGY STAR® Portfolio Manager®

EPA's online energy management and tracking tool enables you to measure and track the energy and water performance of any building over time.

Register now

Log in

username

password

Forgot password?

Forgot username? **LOGIN**

What is the 1-100 ENERGY STAR score and certification for buildings?

PORTFOLIO MANAGER DATA COLLECTION WORKSHEET

Easily see what information

Building Energy Benchmarking

ENERGY STAR Portfolio Manager®

Source: [ENERGY STAR® Portfolio Manager®](#)



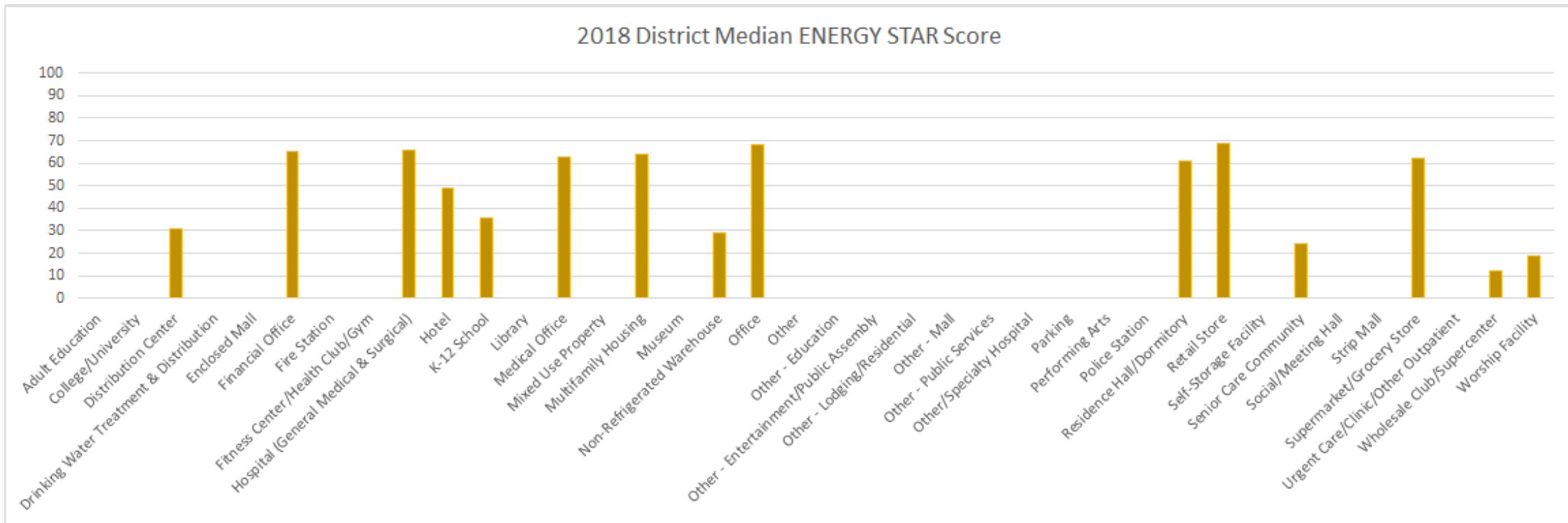
Additional ENERGY STAR Portfolio Manager® Training

- Live Online Training
- Recorded Training
- Slide Library
- Portfolio Manager Demonstration Videos
 - How to set up a property in Portfolio Manager
 - How to set up energy and water meters in Portfolio Manager
 - How to use spreadsheet upload templates
 - How to share properties in Portfolio Manager
 - How to connect with other Portfolio Manager users
 - How to request data from Portfolio Manager users
 - How to generate standard reports in Portfolio Manager
 - How to respond to a data request in Portfolio Manager
 - How to apply for ENERGY STAR Certification
 - How to track Onsite Renewable Energy in Portfolio Manager

Building Energy Benchmarking

ENERGY STAR Portfolio Manager®

Source: [ENERGY STAR® Portfolio Manager®](#)



Building Energy Benchmarking

Energy Benchmarking Disclosure

Source: [DC DOE](#)

ENERGY DC BETA
BENCHMARKING

DEPARTMENT OF ENERGY & ENVIRONMENT
GOVERNMENT OF THE DISTRICT OF COLUMBIA

Building address: [] Ward: [] Property Type: [] Report Status: []

METRIC FILTERS
Select: [] RESET ALL

- Property Information
- Energy Use
- Water Use
- Energy Performance Metrics
- Greenhouse Gas Emissions

Report Status: **In Compliance**
 Property Type: **Office**
 Property Size (ft²): **78,000**
 Year Built: **2006**
 ENERGY STAR Score: **31**
 Site Energy Use Intensity (kBtu/ft²): **75.5**
 Weather Normalized Source EUI (kBtu/ft²): **211.3**
 Water Use (kgal): **997.4**
 Total GHG Emissions (Metric Tons CO₂e): **563.4**
 Total GHG Emissions Intensity (kgCO₂e/ft²): **7.2**
 Electricity Grid Use (kWh): **1,725,229.2**
 Electricity Renewable Use (kWh): **0**
 Natural Gas Use (therms): **N/A**
 District Chilled Water Energy Use (kBtu): **N/A**
 District Hot Water Energy Use (kBtu): **N/A**
 District Steam Energy Use (kBtu): **N/A**
 Diesel and Fuel Oil Use (kBtu): **N/A**
 DC Real Property ID: **0218_3114**
 Ward: **2**

[less details...](#)

BUILDING COMPARISON

ENERGY STA...	SOURCE EN...	SITE ENERGY ...
AVERAGE 66	AVERAGE 138.6 kBtu/ft ²	AVERAGE 61.6 kBtu/ft ²

AVERAGES BASED ON RANGES SET IN FILTERS

Building Energy Benchmarking

Energy Benchmarking Disclosure

Source: [DC DOE](#)

The image displays four overlapping EnergyDC Benchmarking scorecard templates. Each template includes the following sections:

- Header:** ENERGYDC BENCHMARKING DC logo, [PROPERTY NAME], and [PROPERTY TYPE].
- Metadata:** Gross Square Feet: [PROPERTY GFA] and Portfolio Manager ID: [PM ID].
- Introduction:** Thank you for benchmarking your building's energy use in 2018. Share this scorecard with your property's decision-makers to understand more about your building's past performance and comparison to similar [PROPERTY TYPE] buildings in Washington, DC. Program offerings from the DC Sustainable Energy Utility (DCSEU) are detailed below to help you improve your building's performance and decrease operating costs.
- Performance Summary:**
 - When comparing your building's 2018 ENERGY STAR score with similar buildings in the District, your building is currently ranked [RNK] out of [TOT].
 - From 2017 to 2018, your building's Energy Use Intensity (energy usage per square foot) has [increased/decreased] by [EUI]%. Save \$[SA] building.
- Warning/Action:**
 - Warning!** Your property ranks in the lower half of [PROPERTY TYPE] buildings and your energy use intensity increased from 2017 to 2018. Starting in 2021, required to meet specific Building Energy Performance Standards (read more at [doee.dc.gov/service/beps](#)), and you may not be on track to meet those standards. Call DCSEU for assistance with getting your building on the right track.
 - Keep Working!** Your building saw some efficiency gains from 2017 to 2018, but is still in the lower half of [PROPERTY TYPE] buildings in the District. Call the DCSEU at 202.479.2222 or go to [doee.dc.gov/service/beps](#) for the upcoming Building Energy Performance Standards (read more at [doee.dc.gov/service/beps](#)).
 - Keep Working!** Although your property is ranked in the upper half of [PROPERTY TYPE] buildings in the District, your energy use intensity increased from 2017 to 2018. Call the DCSEU at 202.479.2222 or go to [doee.dc.gov/service/beps](#) for the upcoming Building Energy Performance Standards (read more at [doee.dc.gov/service/beps](#)).
- GET HELP! Improve Your Score & Save Money with These Services Available to DC Building Owners:**
 - Rebates when you upgrade to efficient lighting, HVAC, refrigeration, and more
 - Technical assistance to uncover savings opportunities throughout your building
 - Training for your operations and maintenance staff so they can make your building run more efficiently
- Call the DCSEU today at 202.479.2222 or go to [www.dcseu.com](#) for more information.**
- Footer:** DEPARTMENT OF ENERGY & ENVIRONMENT, CLEAN DC logo, GOVERNMENT OF THE DISTRICT OF COLUMBIA MURIEL BOWSER, MAYOR, and DOEE Benchmarking Help Center: 202.671.3300 | [info.benchmark@dc.gov](#)

Building Energy Benchmarking

What's Next?

Source: [DC DOEE](#)



**Verifying Energy Benchmarking
Data - Webinar**
Tuesday, September 29th, 2020
12:00 pm- 1:00 pm

Questions?

o.baumann@baumann-us.com

Introduction to Building Energy Benchmarking

Oliver Baumann, September 2nd, 2020

