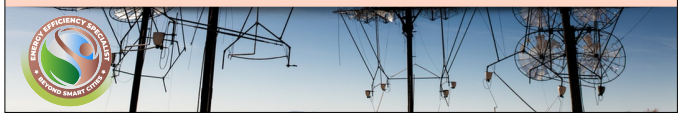
BEYOND SMART CITIES

ENERGY SAVINGS PERFORMANCE AND MEASUREMENT & VERIFICATION

ONLINE TRAINING COURSE

KRISHNAJI PAWAR, LEED AP BD+C,GSAS CGP,ISO 14001:2015,GCP
ENERGY SPECIALIST CURRICULUM



BEYOND SMART CITIES

BENCHMARKING FOR ENERGY PROFESSIONALS

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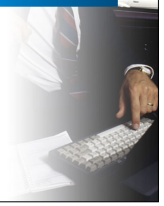
WHAT SHOULD YOU LEARN

- Energy Benchmarking for Buildings
- Benchmarking Audit
- Benchmarking Tools

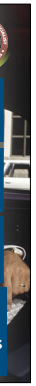


BENCHMARKING

- A benchmark is a value you compare something against.
- Building energy benchmarking is the comparison of whole-building energy use relative to a set of similar buildings.
- It provides a useful starting point for individual energy audits & for targeting buildings for energy-saving measures in multiple-site audits.
- Benchmarking is of interest and practical use to a number of groups.
  ➡ Energy service companies and performance contractors communicate energy savings potential with “typical” and “best-practice” benchmarks.

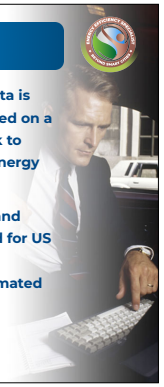
ENERGY BENCHMRKING +

- Control companies and utilities can provide direct tracking of energy use and combine data from multiple buildings for benchmarking.
- Benchmarking is also useful in the design stage of a new building or retrofit to determine if a design is relatively efficient.
- Energy managers & building owners have an ongoing interest in comparing energy performance to others.
- Large corporations, schools, & government agencies with numerous facilities also use benchmarking methods to compare their buildings to each other.



BENCHMARKING AUDIT

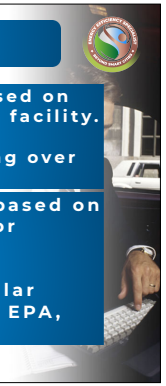
- Audits are associated with the idea that after the energy bill data is collected and processed, some facility information will be collected on a walk-through, and the data will be run through some benchmark to determine if there is a potential for significant improvement in energy efficiency and reduction in energy operating cost.
- Examples of existing benchmarking programs are: Gigajoule and Energy Intensity Calculator from Natural Resources Canada. And for US IP units - EPA’s Portfolio Manager, LEED-EB, California Energy Benchmarking, Chevron BM, ARCH, etc. SI data is easily approximated for these program inputs.



BENCHMARKING CRITERIA

- ☑ Energy Use Index - MJ/m2/year
  - ➡ Total, Electric, Gas, Oil
- ☑ Energy Cost Index - $/m2/year
  - ➡ Total, Electric, Gas, Oil
- ☑ Productivity Index
  - ➡ kJ/kg, kJ/person, kJ/student, kJ/tonne, kJ/item
  - ➡ kWh/kg, kWh/person/ kWh/tonne, kWh/item
  - ➡ L H2O/kg, or /student, or /item (also sewer)
- ☑ System performances
  - ➡ kWe/kW cooling, LPS/kW air, kWh/L pumping

TYPES OF BENCHMARKS



☑ **Internal - An internal benchmark is based on the performance of your own building or facility.**

For example, the EUI of your own building over the past year.

☑ **External - An external benchmark is based on some large group of similar buildings or facilities.**

For example, the EUI of a group of similar buildings or facilities from EIA/CBECS, EPA, BOMA, CA, etc

BENCHMARKING COMPARISON OF ENERGY EFFICIENCY AND WATER USE

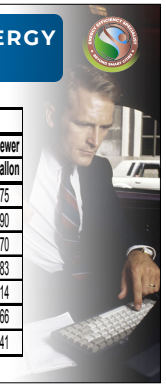


Figure 6 Benchmarking Comparison of Energy Efficiency and Water Usage

Building	Conditioned Sq. ft.	Electric BTU/Sq.Ft./YR	Nat Gas BTU/Sq..Ft./Yr	Total BTU/Sq.Ft./Yr	Wtr/Sewer Gall/sq.ft.Yr	Electric $/KWH	Nat Gas $/MCF	Wtr/Sewer $/K Gallon
1	4,411,494	83,866	13,389	97,255	10.7	$0.0446	$7.042	$4.75
2	602,181	91,948	4,404	96,353	4.1	$0.0486	$7.597	$5.90
3	214,156	83,060	649	83,709	40.6	$0.0492	$8.593	$3.70
4	291,092	70,044	13,952	83,996	91.8	$0.0876	$8.542	$0.83
5	427,000	75,409	25,638	101,047	17.2	$0.0547	$4.392	$2.14
6	523,558	66,647	8,433	75,080	24.0	$0.0835	$11.180	$4.66
7	366,183	95,875	14,799	110,674	41.2	$0.0505	$9.395	$6.41

BENCHMARKING TOOLS

Several benchmarking tools have emerged on the market in recent years. Some were developed as a service to utility and ESCO customers or as a component of an enterprise tools providing a broader range of functions.

There are also a number of online tools, many of which are free.

A list of online benchmarking tools and information relevant to benchmarking commercial building energy use (in Btu/square foot/year) can currently be found at:

BENCHMARKING TOOLS +

https://www.energystar.gov/buildings/benchmark

As a close approximation, conversion between IP and SI gives MJ/m2/year = (Btu/ft2/year)/100 Using 1 kJ is about 1 Btu and 1 m2 is about 10 ft2 The benchmarking programs easily found online can be categorized into four different types of benchmarking services: simple benchmarking, load shape libraries, utility services, and enterprise tools.

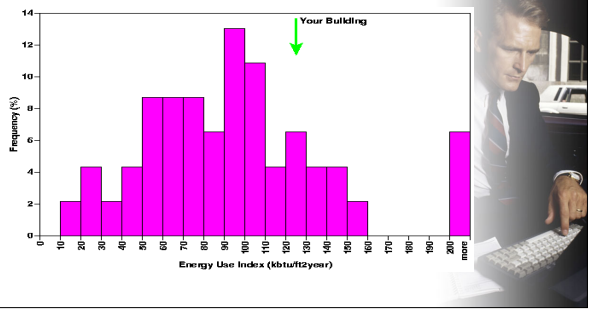
ARCH TEXT RESULTS FOR EXAMPLE BUILDING

- ☑ The green arrow indicates your building's energy use. This graph is of site energy.
- ☑ You entered a Floor Area of 100,000 square feet, so buildings with areas between 50,000 and 200,000 are used. The number of buildings on this graph is 45.
- ☑ Your building consumes 14,000,000 kBtu/year of energy, which is 140 kBtu/ft2year.

CONVERSIONS TO SI UNITS

- ☑ 100,000 square feet is approximately 10,000 square metres
- ☑ So, multiply square metres by 10 and enter as square feet
- ☑ The program output says the Energy Use Index for the building is 125,000 Btu/ft2/year
- ☑ One Btu is approximately 1 kJ One MJ is 1000 kJ
- ☑ So, divide this EUI by 100 to get 1250 MJ/m2/yr

EUI BENCHMARK FROM ARCH



GIGA JOULE AND ENERGY INTENSITY CALCULATOR – NATURAL RESOURCES CANADA

- ☑ Electricity * kWh × 0.0036 = 7200 GJ
- ☑ Oil #2 (light) litres × 0.038680 GJ
- ☑ Natural Gas m^3 × 0.03720 GJ
- ☑ Natural Gas GJ × 1 = 6800 GJ
- ☑ Steam kg × 0.002250 GJ
- ☑ Total = 14000 GJ
- ☑ Area in square metres m^2 = 10000 m^2
- ☑ Energy Intensity = 1.4 GJ/m^2

ENERGY MONITORING, TARGETING AND REPORTING

MT&R is a powerful management technique for

- ☑ Analyzing the historical energy performance of industrial, commercial, and institutional facilities
- ☑ Setting energy reduction targets
- ☑ Controlling current energy performance and,
- ☑ Projecting future energy budgets.

The working definitions that commonly apply are the following:
Energy Monitoring is the regular collection and analysis of information on energy use.