# EmiratesGBC Technical Workshops

*by* Mieyar

## IS EUI Enough?

Exploring Comprehensive Building Benchmarking

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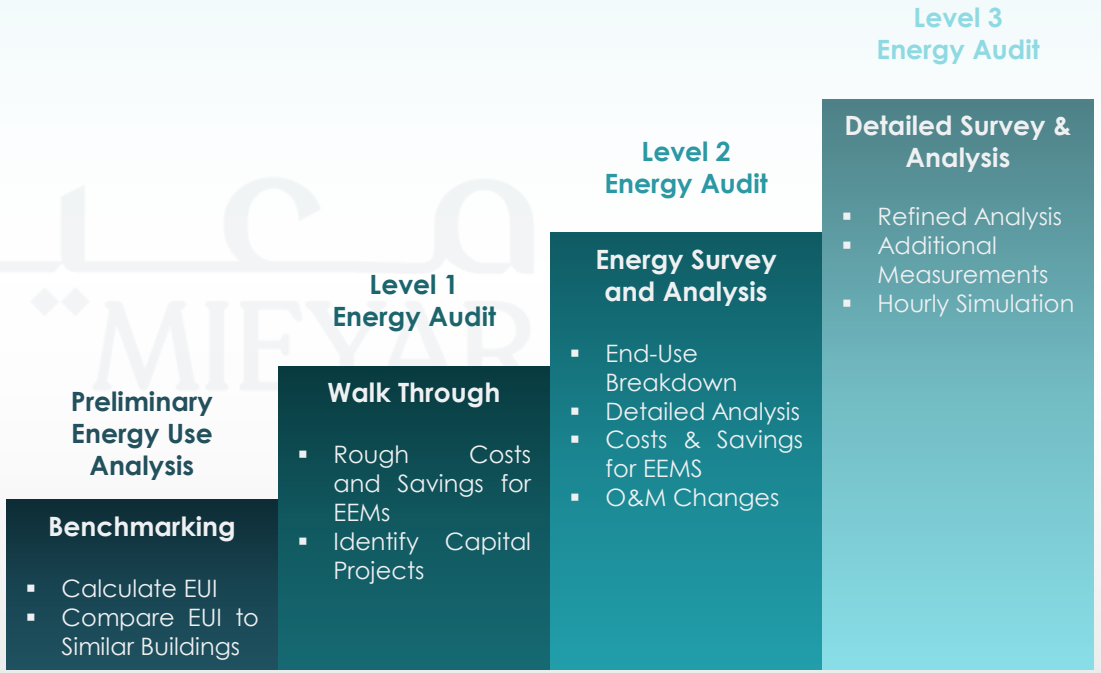
# What is Benchmarking?

**Benchmarking is evaluation by comparison**

Indicates the potential value of further levels of analysis.




**Energy Audit Levels**

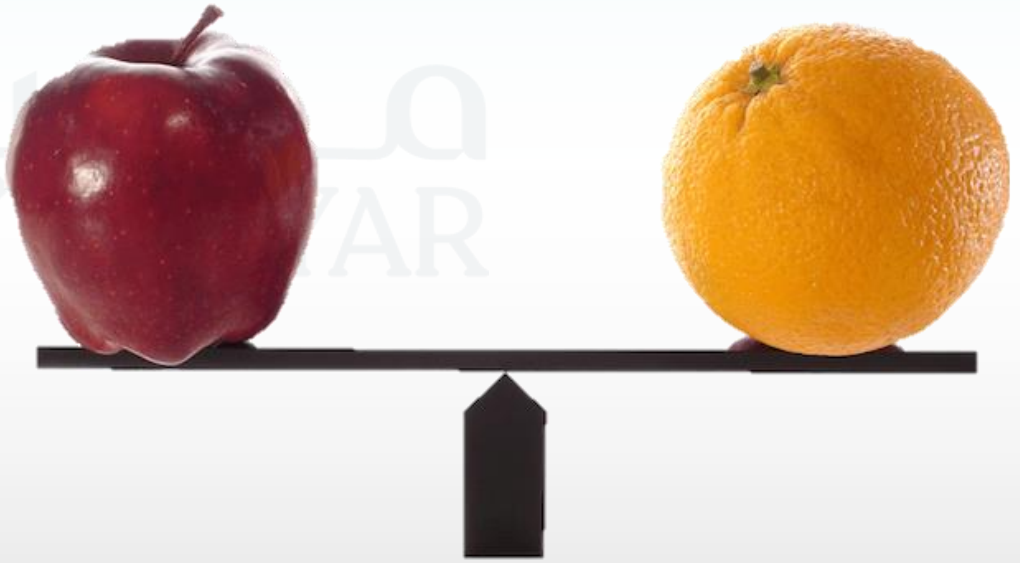
ASHRAE. 2011. Procedures for Commercial Building Energy Audits, 2nd Edition

# Apples to Oranges? Or Apples to Apples?

**Buildings are different in:**

1. Functions (e.g. school, mall, residential)
2. Physical Characteristics (e.g. areas, facilities)
3. Operational Characteristics (e.g. operating hours, occupancy)
4. Climate

**How can we ensure a fair comparison?**



# What is EUI?

## Energy Use Index

EUI is calculated by dividing the total energy consumption of a building by its total gross floor area

$$\mathbf{EUI} = \frac{\textbf{Total Energy Consumption}}{\textbf{Gross Floor Area}} \text{ (kWh/m}^2\text{)}$$

The ratio of Actual EUI to Average EUI serves as an energy efficiency metric, where a lower ratio indicates a more energy-efficient building.

EUI provides an initial step toward equitable comparisons by normalizing energy consumption relative to building size

**Is EUI truly enough for a fair comparison?**

| | School 1 | School 2 |
|---|---|---|
| |  |  |
| Total Energy Consumption | 1,716,320 kWh | 3,066,897 kWh |
| Gross Floor Area | 12,000 m$^2$ | 18,700 m$^2$ |
| **EUI** | **143 kWh/m$^2$** | **164 kWh/m$^2$** |
| Average EUI for Schools | 149 kWh/m$^2$ | 149 kWh/m$^2$ |
| $\frac{\textbf{Actual EUI}}{\textbf{Average EUI}}$ | **-4%** | **+10%** |

# Why EUI isn't Enough?

EUI is a good starting point, but it does not consider other important physical and operational characteristics, such as operating hours, occupancy, and activities.

These factors significantly influence energy consumption and ignoring them could lead to misleading benchmarks.

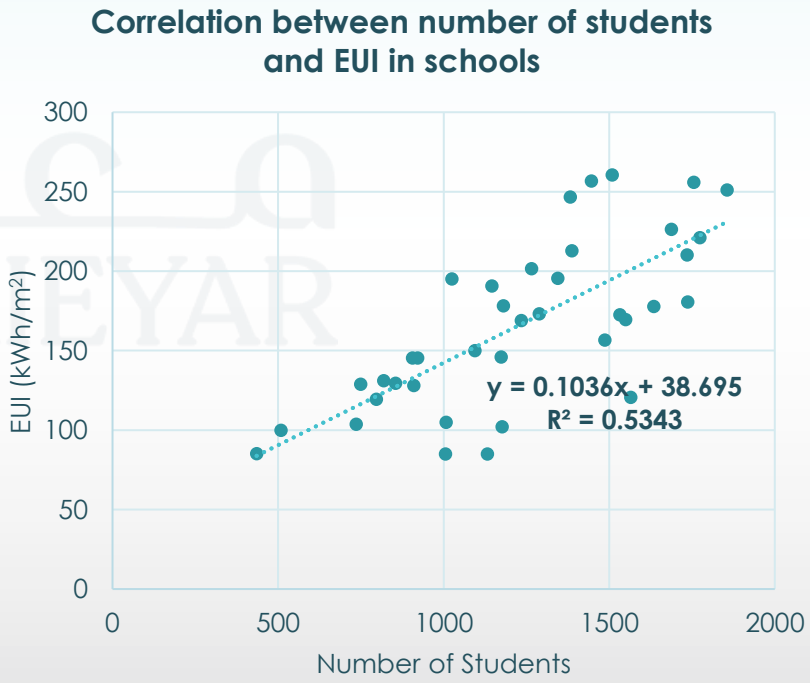
**How can we incorporate these additional factors to ensure a fair and comprehensive benchmark?**

| | School 1 | School 2 |
|---|---|---|
| |  |  |
| Total Energy Consumption | 1,716,320 kWh | 3,066,897 kWh |
| Gross Floor Area | 12,000 $m^2$ | 18,700 $m^2$ |
| **EUI** | **143 kWh/$m^2$** | **164 kWh/$m^2$** |
| Other Factors | 600 students – 8 Hours – Weekend Activities ….. | 850 Students – 10 Hours – No Weekend Activities ….. |

# Including Physical and Operational Characteristics

Statistical methods can quantify the impact of physical and operational characteristics on energy consumption

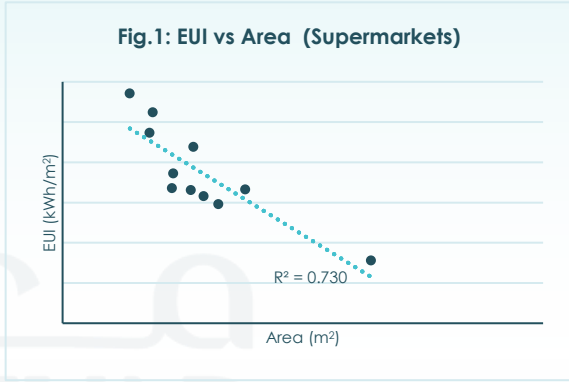
Individual characteristics may not always show a strong correlation, but considering multiple factors together can reveal significant relationships.

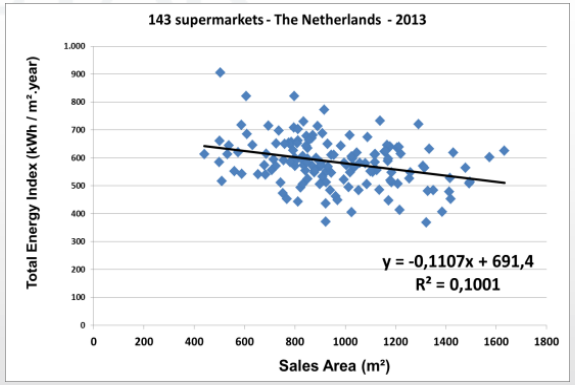


# Different Characteristics Have Different Impacts

Not all building characteristics impact energy consumption in a straightforward way. In some cases, they may have unexpected effects

Studies have shown that Energy Use Intensity (EUI) in supermarkets tends to correlate negatively with building area

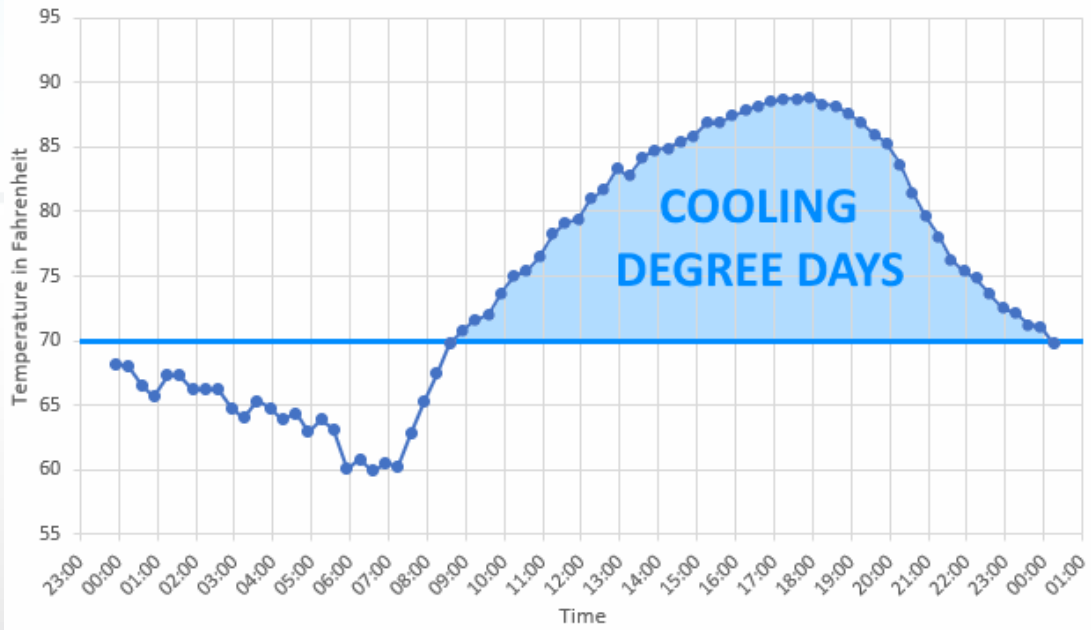


# Including Weather

"Cooling Degree Days (CDD): A measure used to estimate the energy needed for cooling. CDD represents the number of degrees by which the temperature exceeds a comfortable baseline (e.g., 24°C)

Including weather-related data helps normalize energy use by accounting for temperature variations. Higher CDD values indicate more energy is required for cooling, which directly impacts building energy performance."



# Predicting Energy Consumption

Using statistical analysis, we can predict Energy Use Intensity (EUI) by modeling it as a combination of multiple factors

This equation includes statistically significant characteristics such as building area, occupancy, operational hours, and climate conditions

The coefficients (a1, a2, a3, etc.) represent the weight or impact of each factor on energy use

$$Predicted\ EUI = a1 \times characteristic1 + a2\ \times characteristic\ 2 + a3\ \times characterstics3\ \cdots$$

# Comprehensive Benchmark

The predicted EUI is calculated based on each building's unique characteristics, including physical and operational factors.

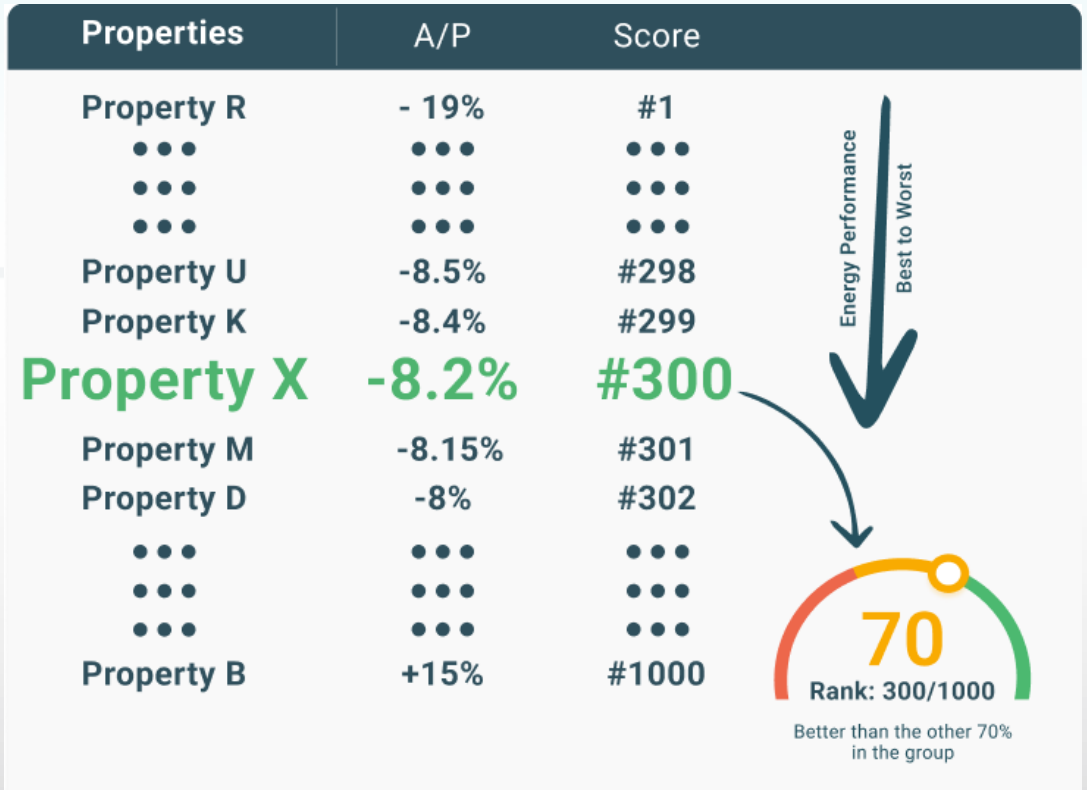
By comparing predicted EUI to actual EUI, we can evaluate whether a building is underperforming or overperforming relative to its potential

| | School 1 | School 2 |
|---|---|---|
| |  |  |
| Total Energy Consumption | 1,716,320 kWh | 3,066,897 kWh |
| Gross Floor Area | 12,000 $m^2$ | 18,700 $m^2$ |
| **EUI** | **143 kWh/$m^2$** | **164 kWh/$m^2$** |
| Other Factors | 400 students – 8 Hours – Weekend Activities ….. | 950 Students – 10 Hours – No Weekend Activities |
| **Predicted EUI** | **135 kWh/$m^2$** | **175 kWh/$m^2$** |
| $\frac{\text{Actual EUI}}{\text{Predicted EUI}}$ | +6% | -9% |

# The Big Picture – Percentile Score

Based on the Actual-to-Predicted (A/P) ratio, a percentile score is developed to rank buildings against their peers. This score helps to easily understand where a building stands in terms of energy performance compared to others in its group

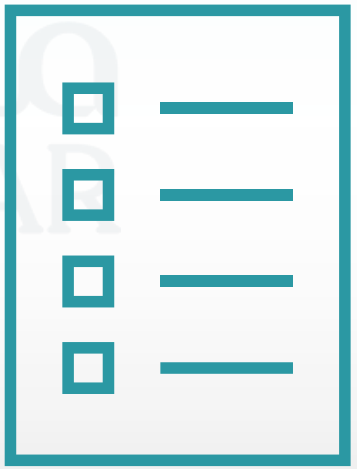
The A/P ratio (Actual EUI to Predicted EUI) serves as a key energy efficiency metric. A ratio below 1 (or a negative percentage) indicates that a building is performing better than expected, while a ratio above 1 (or a positive percentage) indicates underperformance



# Why not Use a Scorecard?

Efficient design doesn't guarantee efficient performance: A building may be designed with highly efficient systems but not commissioned or maintained properly, leading to higher-than-expected energy use

Advanced equipment doesn't ensure operational efficiency: Even if the best equipment is installed, improper operation or maintenance can negate potential energy savings



# Monthly vs Yearly EUI

Fig. 2: Consumption vs Benchmark (kWh)

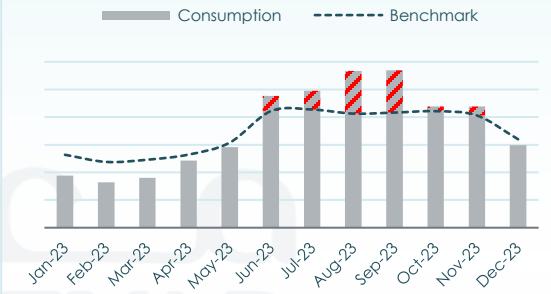
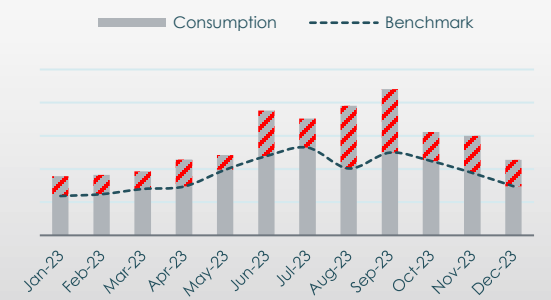



Fig. 3: Consumption vs Benchmark (kWh)



# Which Characteristics Should be Included in the Benchmark Analysis?

Discussion time!

# Thank You!

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