Refining Energy Use Benchmarks

for commercial properties in Singapore

Performance measurement using 'pure' property energy use intensity (EUI) benchmarks

Commercial buildings are a major consumer of energy and source of carbon emissions and Singapore is striving to reduce emissions by encouraging more energy efficient construction, retrofitting and improvements in the management of energy use. In September 2024 the Building and Construction Authority (BCA) announced the introduction of the Mandatory Energy Improvement (MEI) programme to further improve energy use in existing commercial buildings that will require buildings to undergo energy audits and implement energy efficiency improvement measures if use is high in comparison to other buildings or benchmarks using a standardised energy use measure called energy use intensity (EUI).

Most owners of commercial buildings in Singapore have been required to submit building and energy consumption data to the BCA annually since 2013 under the Annual Mandatory Submission of Building Information and Energy scheme (AMS). The information is public and provides a basis for the creation of EUI benchmarks and targets. Up until 2022 the BCA published benchmarks in their annual Building Energy Benchmarking reports. The 2023 EUI data was recently released, though no benchmarks have been published.

As part of a research collaboration between the BCA and the Institute of Real Estate and Urban Studies (IREUS) this paper describes the development of commercial building benchmarks using the 2023 AMS data that can help measure energy performance between buildings more precisely than benchmarks that have been used previously. We have called them "pure" EUI benchmarks because they only include buildings that consist of one type of commercial use. This was done because there can be large differences in EUIs between different commercial uses and many buildings in Singapore contain some mix of office, retail, hotel or other activities, even if they are described as an office, retail or hotel building. Filters were applied to exclude buildings that were not fully operational or occupied at levels typical for Singapore. These are described in detail in the main report.

From the three pure building categories of office, retail and hotel, subcategories were created that were based on different building forms and ownership typically found in Singapore, completion periods and locations to explore whether these have any bearing on energy use. The pure benchmarks for building categories or subcategories can be combined to help provide more robust assessments of the energy performance for properties containing a mix of uses.

Overall results

Table 1 summarises the pure benchmarks for each property sector as a whole for 2023 and Figure 1 plots the trend from 2019 to 2023 for the medians. The table shows averages together with medians, 10th,25th, 75th and 90th percentiles.

Table 1 IREUS EUIs for pure commercial property in 2023

Category	Simple average	Weighted average[1]	Percentiles					Number of properties
			10%	25%	Median	75%	90%	
Office[2]	191	192	109	135	**164**	205	294	177
Retail	436	429	223	322	**447**	525	634	73
Hotel	266	247	188	215	**255**	311	360	69

1. Weighted by building size (GFA).
2. Including office buildings containing laboratory space.

Based on the medians, pure offices had the lowest EUI in 2023 (164), followed hotels (255) and retail properties (447). The averages showed a similar pattern.
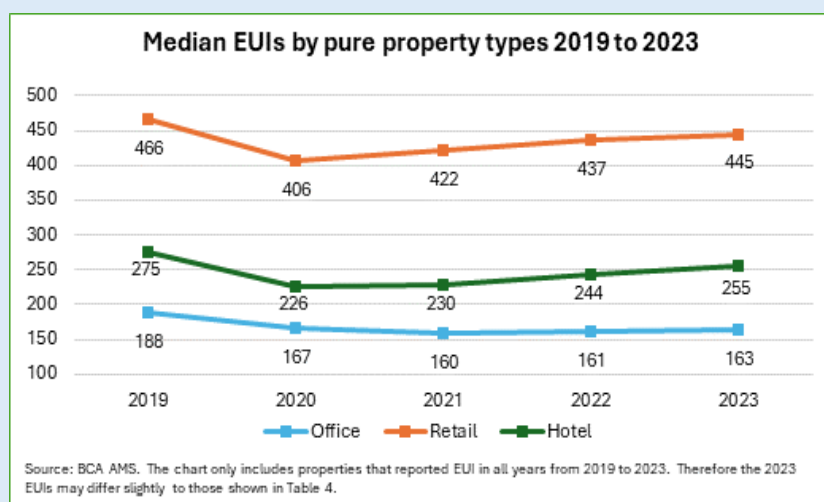
Figure 1

Figure 1 shows changes in EUIs since 2019 across the property sectors. For pure offices overall, the median EUIs fell by 13% between 2019 (just prior to COVID) and 2023. For retail and hotels, the falls in EUIs over the same period were 5% and 7% respectively. These reductions reflect a combination of energy efficiency initiatives undertaken by building owners and changes in building utilisation. For example, more employees working from home amongst office-based workforces and some shopping centres and hotels might not have recovered to their pre-COVID utilisation levels by end 2023.

Subcategory results

Office

Pure office subcategories were based on locations, building sizes, completion year, laboratory uses, strata ownership and use of district cooling. These are summarised in Table 2.

Table 2 IREUS pure office subcategory EUIs 2023

Office subcategory	Simple average	Weighted average[a]	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
All Pure Office with Laboratories	191	192	109	135	**164**	205	294	177
All Pure Office without Laboratories	171	167	108	133	**160**	196	235	162
Location[b]								
Central Area	165	162	121	136	**160**	181	219	103
Outer Areas	174	167	106	132	**167**	204	220	29
Business Parks	185	183	99	114	**145**	205	299	30
Size[b,c]								
Very large ≥ 30,000m²	163	165	111	132	**157**	183	207	56
Large 15,000 - 29,999m²	171	170	93	130	**154**	173	276	46
Medium 5,000 - 14,999m²	177	187	109	139	**174**	205	230	60
Completion year[b]								
Before year 2000	164	162	111	131	**155**	181	218	79
Year 2000 or later	177	172	108	138	**160**	200	245	83
Other								
Laboratories	413	430	210	235	**309**	470	712	15
Strata office	155	148	105	146	**160**	164	177	12
District cooled buildings[b]	183	162	83	110	**148**	183	319	20

a. Weighted by building size (GFA).
b. Laboratories are not included.
c. Gross floor area in metres.

When laboratories are excluded from the pure office totals, the median EUI falls from 164 to 160. Within the laboratories subcategory the median EUI was 309, almost twice that of offices overall.

As might be expected, district cooled buildings had lower median EUIs than those without, though the EUIs understate total electricity use because energy used for district cooling is not included. Pure offices in Business Parks (excluding Laboratories) had the lowest median EUIs at 145, partly due to district cooling being much more common in Business Parks (about 45% of buildings use it).

Offices in outer areas had slightly higher median EUIs, possibly due to more back-office data operations associated with banking and finance.

Newer office buildings completed from 2000 had a slightly higher median EUI than older buildings and medium sized buildings (5,000 to 15,000 sqm) had slightly higher EUIs than larger buildings. While the number of strata office buildings was small, their median EUI of 160 was not much different to overall medians for offices in commercial areas.

Retail

In Singapore the most common forms of retail buildings are enclosed multi-tenanted shopping centres owned by one or several investors and strata shopping centres that can have many owners of small units. We have termed the former category "Shopping Centres" and the latter, "Strata Shopping Centres". Centres that were adjacent to or linked to Mass Rapid Transit (MRT) subway stations were identified as a subcategory of Shopping Centres. There were too few buildings in other retail formats such as freestanding stores to create additional subcategories. Retail buildings were also subcategorised by completion year and size.

Table 3 IREUS pure retail subcategory EUIs 2023

Retail subcategory	Simple average	Weighted average[a]	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
All Pure Retail	436	429	223	322	**447**	525	634	73
Category								
Shopping Centres	504	486	377	445	**483**	562	668	50
Linked or Next to MRTs	513	496	395	457	**511**	565	646	29
Strata Shopping Centres	274	289	198	226	**284**	309	343	15
Size[b]								
Very large ≥ 30,000m^2	436	424	274	359	**461**	516	562	24
Large 15,000 - 29,999m^2	448	437	303	382	**462**	529	594	18
Medium 5,000 - 14,999m^2	430	439	214	292	**380**	533	671	31
Completion year								
Before year 1990	271	279	198	226	**284**	309	343	15
1990 to 1999	486	428	342	449	**510**	555	598	20
2000 or later	476	477	312	385	**464**	524	664	38

a. Weighted by building size (GFA).
b. Gross floor area in metres.

Most properties in the pure Shopping Centres subcategory were built after 1990 and would be representative of the best performing retail properties in Singapore in terms of revenues and patronage. These centres typically have long opening hours and frequently contain uses with relatively high energy consumption such as supermarkets, restaurants and cinemas. As a result, their median EUIs were 485. Shopping Centres linked to MRT stations had a higher median EUI of 511.

The median EUIs amongst pure Strata Shopping Centres were much lower at 284. While this might be explained by their age (average year built was 1983) and being less competitive overall than Shopping Centres, some Strata Shopping Centres are well patronised yet had EUIs lower than more modern Shopping Centres. Another reason could be that they accommodate more small office and service businesses that may have lower energy footprints and/or shorter trading hours than seen in the Shopping Centre subcategory.

Hotels

The lodging industry can contain various short-term accommodation forms. In Singapore hotels are most common though there are serviced apartments and hostel style accommodation sometimes called "capsule" hotels. These are frequently in small buildings that are not currently in AMS.

Hotels were grouped by quality grades commonly used for describing their facilities and pricing. There were too few 1- to 3-star hotels in AMS to create a subcategory for them, though they are captured in the total for pure hotels. Like offices and retail, hotels were also subcategorised by completion year and size.

Table 4 IREUS pure hotel subcategory EUIs 2023

Hotel subcategory	Simple average	Weighted average[a]	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
All Pure Hotel	266	247	188	215	**255**	311	360	69
Category								
5-star	267	249	199	231	**256**	292	360	24
4-star	258	240	174	207	**238**	323	352	39
Size[b]								
Large ≥ 15,000 m²	243	244	179	209	**233**	259	316	36
Medium 5,000 - 14,999m²	290	287	197	238	**283**	344	379	33
Completion year								
Before year 2000	221	227	177	195	**226**	255	257	27
Year 2000 or later	295	285	205	241	**285**	348	383	42

a. Weighted by building size (GFA).
b. Gross floor area in metres.

In comparison to the overall hotel median EUI of 255, the 5-star hotels EUI was marginally higher at 256 while 4-star hotels were lower at 238. Large hotels had a lower median EUI, possibly because of more ancillary uses such as conference or function facilities.

Applications for pure benchmarks

Broader benchmarks such as those published by the BCA in their annual Building Energy Benchmarking reports up until 2022 defined a property as an office, retail or hotel building if one of these uses made up 60% or more of the gross floor area (GFA). Buildings with no one use making up 60% of GFA were described as mixed developments. As a result, the performance of a property against its broad benchmark might have been better or worse depending on its mix of uses verses the overall mix in the benchmark.

For example, a modern pure Shopping Centre, especially one located on an MRT could have an EUI that is much higher than a broadly-based retail EUI benchmark. Conversely, a pure office building might have an EUI that is lower than a more broadly based office benchmark containing some retail or hotels components within the overall mix. A pure benchmark can help overcome this problem.

They can also provide a more precise measure for commercial properties with a mix of uses because weighted benchmarks can be constructed from relevant pure benchmark categories based on floor space allocated to different uses. Building owners report the amount of floor space allocated to different uses in AMS and the BCA published this data in 2023 together with EUI data. Hence owners can compare their performance or that of peer buildings to a similarly weighted benchmark using the relevant pure benchmarks published by IREUS for the different building categories or subcategories. The method of calculation is set out the full report.

The benchmarks can also be used to provide EUI reduction targets against "best in class" properties with similar characteristics using say the 10th or 25th percentile EUI levels as reference points. They also can be used to identify "worst in class" properties. This is important as the recently introduced Mandatory Energy Improvement (MEI) programme will require commercial buildings to undergo energy audits and implement energy efficiency improvement measures if energy use is high in comparison to other buildings.

Overall, the IREUS pure property EUI benchmarks should help improve the measurement of energy use in commercial buildings in Singapore.

To get the full report, please fill out a request form at:
https://forms.office.com/r/jWHx3dGAa0?origin=lprLink

For enquiries, please contact:

David Dickinson
Adjunct Senior Research Fellow
david_d@nus.edu.sg

Chen Huaying
Research Assistant
huaying@nus.edu.sg

Joseph Ooi
Co-Director of IREUS
Joseph.ooi@nus.edu.sg

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