



Refining Energy Use Benchmarks for commercial properties in Singapore

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

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Summary

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 energy use management. In September 2024, the Building and Construction Authority (BCA) announced the introduction of the Mandatory Energy Improvement (MEI) programme in 2025 to further improve energy use in existing commercial buildings. This programme will require building owners to undergo energy audits and implement energy efficiency improvement measures if their energy use is more intensive than that of other buildings or benchmarks using a standardised energy use measure called energy use intensity (EUI).

Since 2013, most commercial building owners in Singapore have been required to submit their building and energy consumption data to the BCA annually under the Annual Mandatory Submission of Building Information and Energy Scheme (AMS). This information is public and provides a basis for creating EUI benchmarks and targets. Until 2022, the BCA published benchmarks in their annual building energy benchmarking reports. The 2023 EUI data were 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 report describes the development of 'pure' commercial building benchmarks using the 2023 AMS data, which can help measure energy performance between buildings more precisely. The pure EUI benchmarks only include buildings that consist of one type of commercial use. This was done because there can be large differences in EUIs among different commercial uses, and many buildings in Singapore contain a mix of office, retail, hotel or other activities, even if they are described as an office, retail or hotel building. Buildings that were not fully operational or occupied at levels typical for Singapore were excluded.

From the three pure building categories of office, retail and hotel, subcategories were created 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. Pure benchmarks for building categories or subcategories can be combined to more robustly assess the energy performance of properties containing a mix of uses.

Overall results

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

Table I IREUS EUIs for “pure” commercial property types 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.

² Including office buildings containing laboratory space.

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

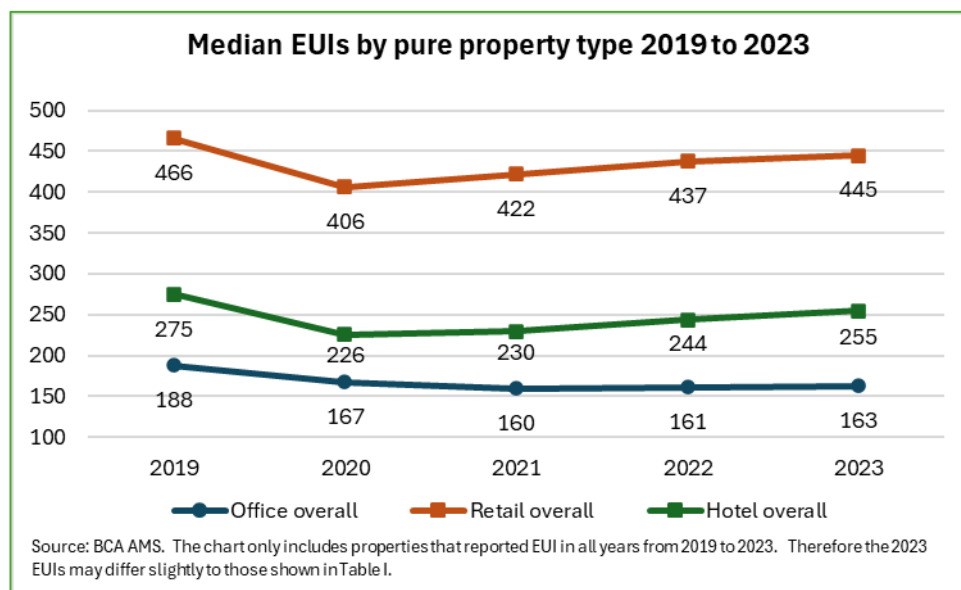


Figure I

Figure I shows the changes in EUIs since 2019 across the property sectors. For pure offices overall, the median EUIs fell by 13% between 2019 (just before the Covid-19 pandemic) 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 among office-based workforces, and some shopping centres and hotels might not have recovered to their pre-Covid utilisation levels by the end of 2023.

Subcategory results

Pure benchmarks for office, retail and hotel properties were further classified into subcategories. The medians for some of these subcategories are summarised in Table II.

Table II Selected subcategory EUIs 2023

Subcategory	Simple average	Weighted average ^a	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
Office								
All Pure Office with Laboratories	191	192	109	135	164	205	294	177
Laboratories	413	430	210	235	309	470	712	15
All Pure Office without Laboratories	171	167	108	133	160	196	235	162
Central Area^b	165	162	121	136	160	181	219	103
Outer Areas^b	174	167	106	132	167	204	220	29
Business Parks^b	185	183	99	114	145	205	299	30
Strata Office	155	148	105	146	160	164	177	12
District-cooled Buildings^b	183	162	83	110	148	183	319	20
Retail								
All Pure Retail	436	429	223	322	447	525	634	73
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
Hotels								
All Pure Hotel	266	247	188	215	255	311	360	69
5-star	267	249	199	231	256	292	360	24
4-star	258	240	174	207	238	323	352	39

^a. Weighted by building size.

^b. Laboratories are excluded.

Office

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

As expected, district-cooled buildings had lower median EUIs than those without, although the EUIs understated total electricity use because energy used for district cooling was not included. Pure offices in business parks (excluding laboratories) had the lowest median EUIs (at 145), partly because of district cooling being much more common in business parks (~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.

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 termed the former category ‘shopping centres’ and the latter ‘strata shopping centres’. Centres that were adjacent 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.

Most properties in the pure shopping centres subcategory were built after 1990 and represent the best performing retail properties in Singapore in terms of revenue and patronage. These centres typically have long opening hours and often contain uses with relatively high energy consumption, such as supermarkets, restaurants and cinemas. Thus, their median EUI was 483. Shopping centres linked to MRT stations had a higher median EUI of 511.

The median EUI for pure strata shopping centres was much lower (i.e. 284). While this can be attributed to their age (average year built was 1983) and being less competitive overall than shopping centres, some strata shopping centres were well patronised yet had EUIs lower than those of more modern shopping centres. Another reason could be that they accommodate smaller offices and service businesses that have lower energy footprints or shorter trading hours than seen in the shopping centre subcategory.

Hotels

The lodging industry contains various short-term accommodation forms. In Singapore, hotels are the most common, though there are also serviced apartments and hostel-style accommodations, sometimes called ‘capsule’ hotels. These are frequently in small buildings that are not currently in AMS.

Hotels were grouped by the 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. The median for 5-star hotels was the highest (256), followed by that of 4-star hotels (238).

Applications for pure benchmarks

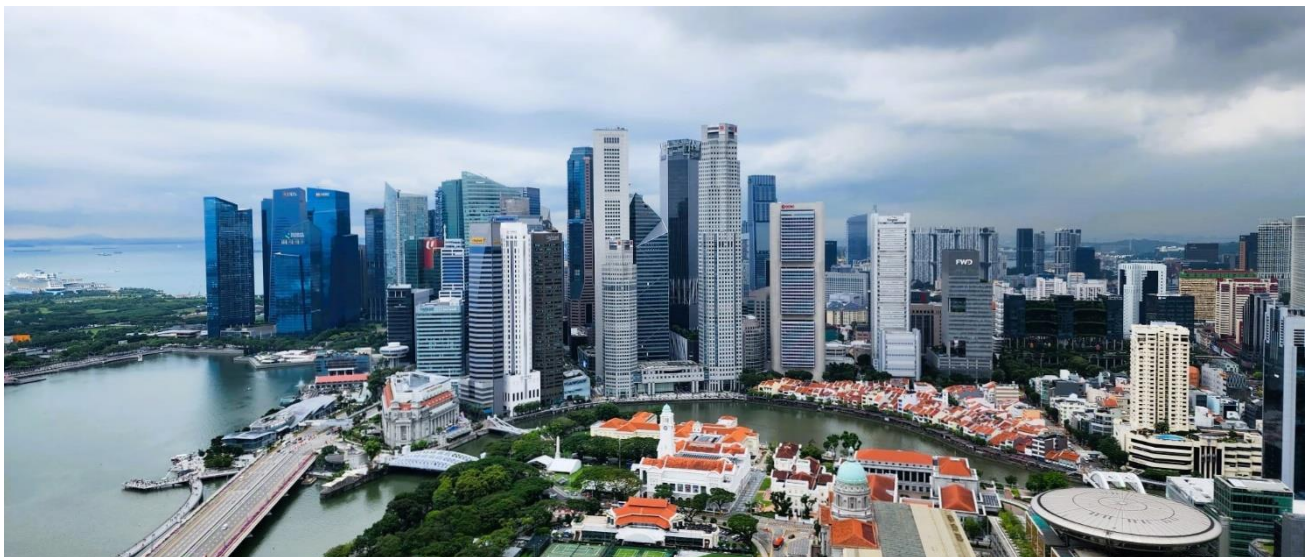
Broader benchmarks, such as those published by the BCA in their annual building energy benchmarking reports until 2022, defined a property as an office, retail or hotel building if one of these uses constituted 60% or more of the gross floor area (GFA). Buildings with no one use, constituting 60% of the GFA, were described as mixed developments. Thus, the performance of a property against its broad benchmark could be better or worse depending on its mix of uses versus the overall mix in the benchmark.

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

It 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 the floor space allocated to the different uses. Building owners report the amount of floor space allocated to different uses in the AMS, and the BCA published this data in 2023 together with the EUI data. Hence, owners can compare the performance of their buildings or that of peer buildings against a similarly weighted benchmark using the relevant pure benchmarks published by IREUS for the different building categories or subcategories.

The benchmarks can also be used to provide EUI reduction targets against ‘best-in-class’ properties with similar characteristics using, for example, the 10th or 25th percentile EUI level as reference points. They can also be used to identify ‘worst-in-class’ properties. This is important as the recently introduced MEI programme will require commercial buildings to undergo energy audits and implement energy efficiency improvement measures if energy use is high compared to other buildings.

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



1 Introduction



1 Introduction

Building operations, such as lighting, heating and cooling, form a major source of energy consumption, accounting for approximately 30% of final energy consumption globally in 2022. Consequently, CO₂ emissions from buildings represent approximately 27% of the total global energy demand and have been rising by about 1% a year over the last decade¹.

Given the significance of buildings as consumers of energy, many countries, including Singapore, are striving to reduce energy use by encouraging the construction of more energy-efficient buildings, retrofitting, managing energy use and, in some cases, introducing carbon-related taxes.

In Singapore, the Building and Construction Authority (BCA) first introduced green building standards through the launch of the Green Mark (GM) certification scheme in 2005. Subsequently, the BCA mandated the minimum environmental sustainability standards for new building construction in 2008. These standards have been progressively tightened, with the focus shifting towards energy use alongside energy-efficient physical building specifications. On 10 September 2024, the BCA announced the introduction of the Mandatory Energy Improvement (MEI) programme² from 2025 to improve energy use in existing buildings. This programme requires commercial buildings, healthcare facilities, sports and recreation centres and institutional buildings with floor areas of 5,000 m² or more to undergo energy audits and implement energy efficiency improvement measures if they are consistently energy intensive. Energy use intensity (EUI) is based on annual energy use per square metre of the gross building area.

Owners of properties covered by the MEI programme have been required to submit their energy consumption and associated building information³ to the BCA annually since 2013. This information has been published at the building level to help owners determine their energy performance relative to other buildings. It is summarised across property sectors by the BCA in their annual building energy benchmarking reports.

MEI, announced by BCA in September 2024, requires owners of energy intensive buildings to conduct an energy audit and implement measures to reduce energy consumption.

IREUS Pure EUI Benchmarks only include buildings that consist of one type of commercial use to avoid the variability in EUI caused by mixed-use buildings.

As part of a research collaboration between the BCA and the Institute of Real Estate and Urban Studies (IREUS), this report describes the development of finer-grained commercial building benchmarks to complement the broader benchmarks published by the BCA in their annual benchmarking reports. We call them ‘pure’ EUI benchmarks because they only include buildings that

contain one type of commercial use. This was done because there can be large differences in EUIs among different commercial uses, and many buildings in Singapore contain a mix of office, retail, hotel or other

¹ United Nations Environment Programme, & Global Alliance for Buildings and Construction (2024). *Global Status Report for Buildings and Construction - Beyond foundations: Mainstreaming sustainable solutions to cut emissions from the buildings sector*. <https://doi.org/10.59117/20.500.11822/45095>.

² https://www1.bca.gov.sg/docs/default-source/docs-corp-news-and-publications/media-releases/media-release_changes-to-the-building-control-act-to-enhance-energy-efficiency-measures-in-existing-buildings-for-a-sustainable-future_.pdf?sfvrsn=7f25a8ab_2

³ Currently, the Annual Mandatory Submission of Building Information and Energy Consumption Data (AMS) collects data on energy use and building characteristics such as size, uses, physical building services and utilisation. It was previously implemented and collected via the building energy submission system (BESS).

activities, even if they are described as an office, retail or hotel building⁴. From the pure building categories, we created subcategories to account for differences in the stock and applied filters to exclude buildings that were not fully operational or occupied at levels typical for Singapore.

This report first provides an overview of the approaches employed to measure building energy use on a standardised basis and then summarises examples of EUI measurement. We then document the creation of pure benchmarks and present preliminary results for 2023.

⁴ The AMS identifies buildings as ‘mixed development’ if no activity type constitutes 60% or more of the gross floor area.



2 Approaches to Measuring Commercial Property EIUs

- 2.1 Standardised Measure of Energy Use
- 2.2 Different Approaches Taken to Assemble EUI Benchmarks
- 2.3 Singapore's Annual Mandatory Submission of Building Information and Energy Consumption Data
- 2.4 Comparison of Approaches to Measuring EUI

2 Approaches to Measuring Commercial Property EUIs

2.1 Standardised Measure of Energy Use

The most common standardised measure of energy use in buildings is EUI per square metre of the building floor area, although it is not always calculated on the same basis.

Energy use is frequently based on the total amount of energy used within a property from all energy sources. In many developed countries, the main sources are electricity, gas and, to a lesser extent, fuel oils. Energy can be created on-site or sourced from off-site energy suppliers, such as the electricity grid.

For carbon reporting purposes, energy use is separated into ‘scopes’ that are associated with an organisation’s responsibilities for emissions. Scope 1 is emissions from ‘on-site’ sources of energy production. An example in real estate is fuels burnt on-site to heat a building. Scope 2 is associated with purchased electricity, heat, steam or cooling from an off-site provider that is needed by the owner to operate a building. If a building is owner-occupied, then all energy used in the building is usually attributable to the building owner. If the property is held for investment and leased to tenants, then the building owner often excludes energy use under a third category called Scope 3, which covers energy use in parts of a building that are not controlled by the property owner, such as in areas that are leased and under the control of tenants.

These distinctions are important when looking at energy-use data because EUI is not always reported on the same basis and depends on the purpose of the benchmarks. For example, the energy use shown for property portfolios in sustainability reporting is usually less than the total because some or all Scope 3 energy use may be excluded⁵.

EUI is mostly calculated using the gross building floor area (GFA) as the denominator. However, segments of GFA are sometimes used, such as lettable or common floor areas. Other denominators, such as guest room numbers, are sometimes used for hotels.

2.2 Different Approaches Taken to Assemble EUI Benchmarks

Many initiatives have been undertaken to assemble EUI data. This section provides a few examples to illustrate these initiatives.

Macro- and Hybrid Approaches

Sometimes, aggregated estimates of energy use and EUIs are made using data from energy grids and centrally held property data, although few provide the granularity of the Singapore collection system described in section 2.3.

In the UK, the Department for Energy Security & Net Zero⁶ publishes energy efficiency indices under the Non-domestic National Energy Efficiency Data (ND-NEED) framework for electricity and gas consumption by broad property types for England and Wales from government records on energy use,

⁵ Singapore public REITs have been required to make climate-related disclosures in sustainability reports since the start of 2023. Currently, most REITs report energy use associated with Scope 1 and 2 carbon emissions. From 2026, all public companies will need to report Scope 3 emissions.

⁶ ND-NEED. Department for Energy Security and Net Zero and Department for Business, Energy & Industrial Strategy. <https://www.gov.uk/government/collections/non-domestic-national-energy-efficiency-data-framework-nd-need>

building stocks and occupier types. It is reported on a highly aggregated basis⁷ for office, shop and hospitality properties. Property data associated with buildings and floor areas are sourced from the UK Valuations Office Agency records, though some estimation is usually required because of gaps in the building data. A mixture of net and gross internal areas is used to estimate EUIs depending on the type of property⁸. The European Union (EU) and individual EU governments have also published some EUI information, such as the EU Building Stock Observatory⁹ launched in 2016, though the commercial property data are highly aggregated under a single category of ‘service property’.

In the absence of extensive energy and/or property data, some studies have combined aggregate energy use data with sample-based property data. For example, in Australia, the Commercial Building Baseline (CBB) study was undertaken by the Department of Industry, Science, Energy & Resources in 2012 to estimate EUIs across major non-residential property types¹⁰. The study used a combination of methods because there were limitations on the use of disaggregated energy use data and building information was not always accurate or complete for all regions. The authors developed a set of ‘reference energy intensities’ for building types, which were then used to estimate energy use and EUIs by region and climate zone. Within each building type, subgroups were created to reflect variations in energy intensity¹¹.

Surveys and Voluntary Data Contributions

Surveys are a common approach and are based on either representative samples of building stocks or voluntary contributions of data. The surveys using representative samples can provide estimates of total energy consumption and intensities across building types and geographies.

A widely known survey of this type is the Commercial Buildings Energy Consumption Survey¹² (CBECS), which is periodically undertaken in the US by the U.S. Energy Information Administration. The latest survey was conducted in 2018, which collected data on energy consumption and building characteristics across approximately 6,500 commercial properties in the US. The respondents provided detailed building and energy use data, with utility billing records being sourced where available.

The CBECS grouped properties into major primary uses and then subcategories based on specific activities or physical property forms that were known to affect EUIs. For example, retail was captured under three broad groups. The first two groups were free-standing stores associated with food sales and food services. These included subcategories for convenience stores, grocery stores, fast-food outlets and restaurants. The third category, called mercantile, covered various forms of shopping centres, including malls and strip centres, and freestanding stores not associated with food. EUIs were based on gross building floor areas.

Some organisations also provide data and benchmarks on commercial property energy use for real estate investment communities, as energy efficiency and wider ESG issues have become important.

⁷ More granular information is available in the Building Energy Efficiency Survey from the UK Department for Energy Security & Net Zero, but the most recent was in 2014/15.

⁸ See Valuation Office Agency, Non-domestic rating: Stock of properties including business floorspace – Background Information. https://assets.publishing.service.gov.uk/media/5f17e9353a6f40727c229cb4/Background_Information.pdf

⁹ https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/eu-building-stock-observatory_en#background

¹⁰ The study was updated in 2022. Department of Climate Change, Energy, the Environment & Water, Commercial Building Baseline Study 2022 Final Report, August 2022.

¹¹ For example, offices were split into lower-energy-intensity smaller buildings without permanent air conditioning, medium-intensity newer full service office buildings, and high-energy-intensity data centres.

¹² See the following website. <https://www.eia.gov/consumption/commercial/>

These organisations usually collect data directly from building owners on a voluntary basis and use the information to construct benchmarks and energy efficiency ratings. As a result, their EUIs may reflect the characteristics of buildings held by participating organisations and not the total population of buildings.

In the UK, the Better Buildings Partnership¹³ (BBP) collects and publishes commercial building EUI data from its property-owning members in their Real Estate Environmental Benchmark reports that have been produced since 2010. Their reporting classifies properties according to typical types held by members, creating benchmarks that are most relevant to them. Medians are presented together with a 25th percentile to represent good practice. BBP estimates of EUIs for offices are for the total building and based on the gross internal floor area, though they exclude mixed-use elements such as retail spaces, gyms and data servers and only include office buildings that are substantially leased¹⁴. For shopping centres, EUI is only for the common floor areas and, therefore, excludes all retail unit energy use. The common floor area used in the calculation includes the landlord areas and circulation spaces, not the entire building area.

In Australia, the National Australian Built Environment Rating System (NABERS) was established in 1999 by the government to provide a performance-based rating system for buildings. It includes approximately 2,000 office, retail and hotel properties across Australia, and like Singapore, it publishes data on energy use at the building level. While voluntary, NABERS enjoys high coverage in the Australian office sector because office owners are required to provide a Building Energy Efficiency Certificate when selling or leasing a property, which requires a NABERS energy rating. EUIs are reported in different ways depending on the property type. Net lettable areas are used for estimating office EUIs, while gross lettable areas¹⁵ are used for shopping centres. Most office building owners report 'base building'¹⁶ energy use in common property areas. Similarly, shopping centre owners report only base building energy use. In contrast, for hotels, EUI calculations are per room, though they cover total energy use. Property types are not divided into use subcategories in reports. In developments that contain more than one use, such as offices and retail, the EUIs (and ratings) cover each use¹⁷.

The Energy Star¹⁸ building rating system is a voluntary¹⁹ U.S. Environmental Protection Agency programme in which building owners receive ratings for their buildings through a comparison between actual energy use and modelled energy use that is based on the CBECS and data contributed by participating owners. According to Energy Star, approximately 25% of all commercial and multifamily building space is covered and EUIs are published for the US states and metropolitan areas across property types and subcategories that are similar to those used in the CBECS.

The Global Real Estate Sustainability Benchmark (GRESB) was originally founded by a group of European pension funds that now provides ESG benchmarking to participating real estate organisations in many countries. GRESB publishes some EUI data collected from participants for the office and retail property sectors by region. Only high-level EUI data are published, but for participants and benchmarking, more granular data are available. Properties are categorised with similar energy intensity profiles and physical

¹³ The BBP is an industry group of UK property owners focused on sustainability issues.

¹⁴ The cut off is 75% in any year.

¹⁵ The gross lettable area concept is similar to gross floor area.

¹⁶ The NABERS term 'Base Building' energy use covers central services such as heating and cooling systems and lifts and lobby lighting associated with the owner's operation of a tenanted building. A few office owners report total building energy use.

¹⁷ In mixed-use developments, the EUI is reported only for the section of the building that matches the use for the NABERS rating. This is done by submetering or proportional allocations.

¹⁸ Energy Star is also used in Canada.

¹⁹ The data are entered by individual account holders voluntarily or as required by local or state laws.

characteristics using a hierarchy similar to that used by CBECs and Energy Star. As GRESB is global, subclassifications try to cover typical property types in different countries. Some specific mixed-use categories are used, based on the two major uses within a building. Contributors must provide building energy use associated with Scope 1 and 2 emissions, and the provision of Scope 3 energy use is encouraged. Approximately 50 property investment organisations based in Singapore participate in GRESB.

The Carbon Risk Real Estate Monitor (CRREM)²⁰ uses EUI data from GRESB and other sources to set baseline emission benchmarks and carbon reduction pathways over time for different types of commercial buildings across countries. While the CREEM categories are not highly granular, they do divide retail into three subcategories of high street (usually terraced style) shops, shopping centres (malls) and retail warehouses to capture unenclosed retail space where buildings are either stand-alone or attached with their entrances facing a street or carpark. A mixed-use classification is also used.

2.3 Singapore's Annual Mandatory Submission of Building Information and Energy Consumption Data

Since July 2013, most owners of non-residential buildings²¹ in Singapore have been required to submit building information and energy consumption data to the BCA annually under the Building Control Act. This is called the Annual Mandatory Submission of Building Information and Energy Consumption Data (AMS) and is intended to be used to monitor the energy use of buildings and establish annual national energy benchmarks. Data for each building have been published online since 2016 and include EUI together with GM ratings and a range of building attributes. EUIs are presently based on total building-level electricity consumption from the grid, though owners are required to report other energy sources used within a building, such as solar panels. They are estimated for the total amount of electricity used over a year based on the GFA. Total energy use for each commercial building is provided by the Singapore Energy Market Authority (EMA).

The BCA collects data across commercial office, hotel and retail buildings; mixed commercial developments; and healthcare, education and various institutional, sporting and recreational buildings. The EUI results are summarised in their annual Building Energy Benchmarking Report.

Building functions are designated as office, retail or hotel if one of these functions exceeds 60% of the total floor area²². If no function exceeds 60%, then a building is designated as a mixed development. The number of buildings in each classification reported in the benchmarks is less than the total submissions due to some having insufficient information, errors or being under redevelopment or refurbishment.

²⁰ CRREM was established as an EU-funded research project to foster investment in building energy efficiency. It uses EUI data from other sources, including GRESB.

²¹ Reporting for small buildings of under 5,000 m² GFA is not mandatory, though there are some.

²² In practice, this is sometimes approximate, as floor space use is often based on lettable areas and not GFA.

2.4 Comparison of Approaches to Measuring EUI

Table 1 summarises elements of each of the approaches described in this section.

Table 1 Summary of approaches to estimating commercial property EUI benchmarks

	Subcategories of Office, Retail & Hotel	Energy use measured	Floorspace measured	Coverage	Estimation of EUIs	Frequency
National energy use and EUI benchmarks						
UK ND-NEED	None published	Total electricity & gas via grid	Mix of gross & net internal area	All England, Wales & subregions	Grid energy use & building records. Some estimation ³	Annual
Australia CBB	Subgroups	Total electricity & gas via grids.	Gross floor area	Australia & sub regions	Grid energy use, geodata & estimation ³	Periodic, 2012, 2022 update
US CBECS	Subgroups	Total energy, all types & sources	Gross floor area	US stratified sample survey of properties	From survey results data	Periodic, latest 2018
Singapore AMS	None published	Total electricity via grid	Gross floor area	Singapore buildings down to 5,000m ² GFA	Owner reporting & energy providers	Annual
EUI benchmarks associated with owner groups						
UK BBP	Subgroups based on member properties	Varies by property type ²	Varies by property type	UK member properties	From data provided by UK members	Annual
Aust. NABERS¹	None published	Varies by property type ²	Varies by property type	Aust. owner-contributed data	From data provided by contributors	Annual
US Energy Star¹	Subgroups	Total energy, all types & sources	Gross floor area	US owner-contributed data	From data provided by owners & CBECS	Annual
GRESB¹	Subgroups exist but are not published	All energy types & sources. Scope 3 optional ⁴ .	Gross floor area	Owner-contributed data, globally	From data provided by owners	Annual

¹ Owners contribute to attain energy use or ESG ratings.

² While energy is reported from all sources, only energy use associated with Scope 1 and 2 emissions is reported for some types of property.

³ Estimation is used when there are gaps in the data.

⁴ Scopes 1 and 2 are mandatory.

Most of the initiatives taken for measuring energy use across building types and stocks have either relied on highly aggregated data sources or used sample surveys and/or voluntary submissions. While useful, surveys tend to be relatively infrequent, and voluntary reporting can introduce bias. The use of mandatory reporting of energy use in commercial buildings, such as that in Singapore, is not widespread but is becoming more common²³. The Singapore AMS provides almost national coverage, together with granular information usually only found in surveys.

²³ For example, in the US, six states and 49 city governments had introduced compulsory reporting of energy use at the building level by mid-2024. See Institute for Market Transformation, Comparison of US Commercial Building Energy Benchmarking & Transparency Policies, June 2024.

The national energy use surveys, such as the UK ND-NEED and Australia CBB, have suffered from data gaps and the need to make estimates to fill them. While suitable for highly aggregated measures, they are less useful for fine-grained analysis. The US CBECS is a good compromise, though the costs of large national surveys mean that they are difficult to undertake frequently.

Industry-based EUI benchmarks do, of course, reflect buildings held by their contributing owners and can be of considerable use to each group or jurisdiction, though the approaches to measuring energy use and floor space vary. This makes international comparisons difficult.

Regarding the treatment of properties with more than one use, the most common approach is to classify buildings according to their predominant use. Some have percentage cut-offs based on floor areas, while others include mixed-use categorisations. Some exclude all energy use and floor areas associated with secondary uses in order to provide purer EUI measures. This was the case with NABERS and the UK BBP.

Most approaches divide the three categories of office, retail and hotel into more granular subgroups, with retail being the most subdivided. This is attributed to the variety of retail and service activities undertaken, as well as the variability in building forms.

3 IREUS Pure Commercial Property Benchmarks for Singapore

- 3.1 Defining Pure Building Functions
- 3.2 Additional Filters
- 3.3 Pure EUI Benchmarks for Singapore
- 3.4 Subcategories of Pure Office, Retail and Hotel Properties



3 IREUS Pure Commercial Property Benchmarks for Singapore

3.1 Defining Pure Building Functions

In Singapore, commercial properties containing a mix of office, retail, hotel or other activities²⁴ are common, and there can be large differences in EUIs between uses. As previously described, the BCA's AMS classifies buildings under a main building function, such as office, if it constitutes 60% or more of the floor space. For example, Asia Square Tower 2 is a large building in the CBD that is defined as an office. However, it also contains a 5-star hotel with over 300 rooms. The reported EUI reflects both uses.

Approximately 26% of buildings that were classified as office in the AMS in 2022 had less than 90% of their floor areas devoted to office uses. For retail and hotel buildings, the respective percentages were approximately 25% and 15%.

To help reduce the possible averaging effects of different uses on EUIs, buildings were reclassified as 'pure' if one function was at least 90% of the GFA. The following criteria were used for each building function:

Office. Buildings were classified as pure offices when office use met the 90% threshold. The most common additional use was retail, and in a few cases, buildings containing slightly more than 10% retail were included if the retail was ancillary to the office function. For example, some office buildings fronting Raffles Place in the CBD were included as pure office, even though the retail space slightly exceeded 10%. Similarly, there can be customer service centres or banking chambers on the ground floors of office buildings, and these were also taken as ancillary. A simple test was whether retail or service uses were usually open only during office business hours.



Dedicated data centres were not considered as office and, therefore, not included in the benchmarks, even if they were defined as an office building. However, some office buildings contain areas used for data-related operations. These buildings were included if the percentage of floorspace allocated to such operations was not more than 10%²⁵ of the floor area, including other non-office uses.



Retail. Retail buildings also used a 90% cut-off, though the precise definition of retail and office uses can be somewhat blurred, as similar service activities and small businesses are found in both types of spaces. In addition, retail centres can contain some community facilities, such as public libraries²⁶. In a few cases, buildings containing slightly more than 10% of their floor areas for other uses, including libraries, were included as pure retail²⁷.

²⁴ Any integrated residential uses are excluded from the AMS. However, government-designated serviced apartment complexes are included.

²⁵ In the AMS, the amount of space devoted to data operations is not captured under function classifications but is asked separately.

²⁶ According to the National Library Board, shopping mall libraries vary in size from 1,200 to 2,300 m² and are smaller than the stand-alone public libraries. <https://www.nlb.gov.sg/main/article-detail?cmsuid=8c1b7b3d-eb09-4e56-a952-728149778bb0#>.

²⁷ Junction 8 shopping centre was excluded as approximately 17% of its GFA is dedicated to community and civic uses.

Hotel. Hotels were included as pure on the same basis as offices and retail. There are sometimes other functions ancillary to a hotel, such as facilities for functions, conferences and guest services. These were assumed to be part of the hotel function and are commonly found in higher-grade hotels. In some cases, hotel complexes contained retailing. If it had limited floor area and mostly targeted hotel guests, the hotel was included as pure. Hotels containing more substantial retail components, such as Concorde Hotel on Orchard Road, were excluded as their non-hotel uses were usually well above 10% of the floor area.



Photo: Goodwood Park Hotel

Buildings were regrouped as pure offices, retail and hotels using AMS information together with our knowledge of properties, building information published on websites and in annual reports of public company owners and some larger private real estate groups, advertising of floorspace for lease, URA development approvals and ‘virtual²⁸ inspections’ using online maps and street views.

3.2 Additional filters

Additional filters were applied to ensure that the resulting EUIs were based as much as possible on fully operational commercial buildings. The following filters were used.

Filters for building occupancy, unconventional building types, non-operational properties and reporting errors were also used.

Building Occupancy. Minimum occupancy rates were used to ensure that the EUIs were not biased downward by low building utilisation. The minimums were based on the 20th percentile occupancy level estimated from data in AMS in 2022. These were 75% for offices, 80% for retail and 56% for hotels. The lower hotel cut-off occupancy reflects lower medians and averages, as it is rare for hotels to ever maintain a 100% room occupancy rate for any length of time. In addition, the tourism sector in Singapore was still recovering from the effects of Covid-19 in 2022.

Table 2 Minimum occupancy rates by property type

	Office	Retail	Hotel
Minimum occupancy adopted	75%	80%	56%
AMS occupancy rates in 2022*			
20th Percentile	75%	80%	56%
Median	90%	92%	75%
Average	84%	87%	72%

* 2022 AMS occupancy data were provided by the BCA.

The occupancy rates for hotels are based on physical room occupancy, whereas those for offices and retail can be based on either contractual occupancy (where a current lease is in place) or physical occupancy, with the latter being most important for energy consumption. If owners reported contractual occupancy, this may have overstated physical occupancy and is a potential limitation of the occupancy data for office and retail.

²⁸ We did not have sufficient resources for physical inspections, though it would be the most accurate way to assess uses.

Unconventional building forms. Some properties were excluded from the benchmarks if they were not considered typical in terms of energy use or building forms. For example, among retail, the Singapore Flyer was excluded. Buildings that were not purpose-built for commercial activities such as old school buildings or industrial premises were excluded unless there was substantial rebuilding for the new use. Generally, historic buildings previously used for administrative, retail or hotel uses were included if they met all other inclusion criteria.



Registry of Marriages, unconventional office.
Photo: TNP File Photo

Some public sector buildings were described as office but were not strictly office buildings containing significant office-based activities. These were excluded. Examples are indoor sporting and community centres; depots; training centres; fire, police and civil defence facilities; museums; courts; and freestanding public libraries. Public sector office buildings, such as the MND Building and the URA Centre, were considered as office.

Non-operational property. Buildings that were known to be under redevelopment or extensive upgrading in the year of reporting were excluded in that year. Newly completed buildings were excluded in the first year of operation or longer if it was apparent that they were still in the leasing-up phase.

Minimum building size. Properties were included down to the minimum size for mandatory reporting of 5,000 m² of GFA. However, several hotels below 5,000 m² were added to ensure that as many hotels as possible were included overall.

Buildings excluded due to probable reporting errors. Likely errors associated with EUI estimation, namely total energy use and floor areas, were identified in several ways. Buildings were removed when the GFA varied by more than 10% from one year to the next or when the total commercial GFA was materially different from that approved for construction by the Singapore Urban Redevelopment Authority (URA)²⁹.

Substantial changes in energy use from year to year that could not be explained by a building moving between operational and non-operational phases, occupancy or reductions that might be associated with energy-saving initiatives³⁰ were excluded. In addition, buildings with EUIs that were consistently less than 50 kWh/m² per annum over multiple years that could not be explained by other reasons were excluded, as such low EUIs are unlikely for fully operational commercial properties in Singapore. These buildings were suspected of having data errors that could not be otherwise verified, such as incorrect occupancy rates, floor areas in older buildings where URA records are not publicly available or understated energy use³¹.

Table 3 provides a summary of the numbers of properties that were included and excluded from the final samples of pure office, retail and hotel buildings. The removed buildings did not meet the pure criteria or the other filters. Six properties were assessed as pure but had incorrect main building functions and were added under the correct function³².

²⁹ Based on searching public information on the URA website. <https://www.ura.gov.sg/maps/#>.

³⁰ The BCA provided information on projects associated with GM rating changes involving capital expenditures on energy-saving initiatives.

³¹ Understated energy use should be rare as the data are sourced from the EMA by postcode. There might be cases of postcode mismatches.

³² For example, Voco Hotel (previously Hilton) in Orchard was identified as mixed development but included as a pure hotel.

Table 3 Properties included and excluded from pure benchmarks

	Number with main function as		
	Office	Retail	Hotel
Total number of properties > 5,000 m²	409	162	117
Removed	236	90	49
Added from other building function categories	4	1	1
Used for pure benchmarks	177	73	69

3.3 Pure EUI Benchmarks for Singapore

Table 4 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. Tables 4 to 7 show averages together with medians and 10th, 25th, 75th and 90th percentiles. The discussion of the results focuses on medians and percentiles, as these provide equal weighting to each property. Weighted averages also allow comparisons with the weighted averages used in the BCA’s annual benchmarking reports.

Table 4 EUIs for pure commercial property types in 2023

Category	Simple average	Weighted average ¹	Percentiles					Number of properties
			10%	25%	Median	75%	90%	
Office²	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.

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.

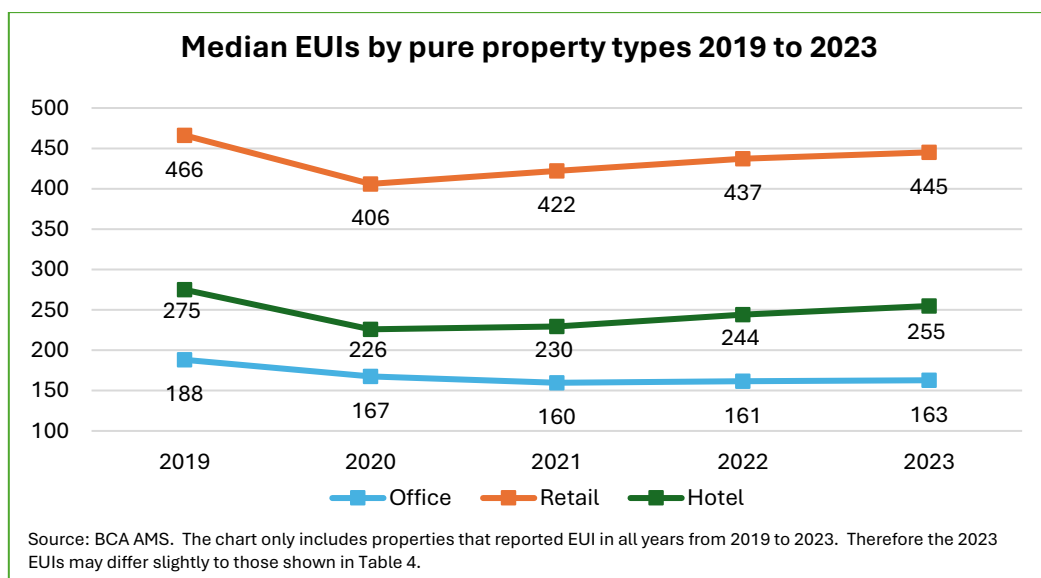


Figure 1

For the changes in EUIs since 2019, the sample was adjusted to include only buildings that reported EUIs every year to ensure like-for-like building samples. Therefore, the 2023 median EUIs in Figure 1 may differ slightly from those shown in Table 4.

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

3.4 Subcategories of Pure Office, Retail and Hotel Properties

While the overall pure benchmarks remove much of the distortion created by mixed uses, they might not capture other fundamental factors that could affect EUIs. In this section, we develop a series of subcategories for each pure property function based on building forms, age and locations to explore whether they have any bearing on building energy use.

3.4.1 Pure Office Subcategories

Office EUI benchmarks used in other countries sometimes subcategorise buildings by their types of occupants or activities where energy use is known to vary substantially from averages. For example, the CBECS in the US has subgroups for laboratories, finance and medical offices, as each consumes more energy than administrative or professional activities. Apart from the identification of buildings used for laboratory purposes³³, it was not possible to identify other types of uses from the AMS data. The subcategories used are described below.

Location. We proxied the possible differences in uses within office buildings by categorising them by location and zoning. Buildings were placed into three groups: commercial zones in the Central Area of Singapore, which includes the CBD and nearby office areas³⁴; commercial zones in other areas that we termed ‘outer areas’, which include suburban business centres such as Tampines; and office buildings in business park zones that are mostly in decentralised locations.



Photo: CapitaLand

The main uses in office buildings in commercial areas are for general business, administrative functions and professional services. In Business Parks office uses are often related to research and development, high-tech or knowledge-based sectors such as information technology, biotech and pharmaceuticals. These distinctions are broad and there is overlap. For example, there can be information technology operations office buildings outside business parks.

Laboratories. As laboratory uses within buildings were identified in the AMS, buildings were classified as laboratories if 30% or more of their GFA was used for this purpose. These buildings were excluded from the three location categories, although all were located in business parks.

³³ Areas devoted to data centre or processing operations are also collected in the AMS, and we note elsewhere that buildings with more than 10% area devoted to these activities are excluded from the pure office benchmarks. As many office buildings can have small areas utilised for data operations, a separate category was not created.

³⁴ Based on the URA’s definition of the Central Area, which is within their Central Planning Region and contains the CBD (called the Downtown Core) and other inner area commercial precincts including Orchard Road.

Building Size. Office buildings were divided into three size categories: medium (from 5,000 to under 15,000 m²), large (from 15,000 to under 30,000 m²) and very large (for buildings of 30,000 m² or greater in size).

Completion Year. Office buildings were divided into two groups: those completed before 2000 and those completed more recently³⁵.

Strata Office Buildings with Multiple Owners. These are strata-titled buildings consisting of multiple, mostly small, units that are held by many different individuals or companies³⁶. This category was identified as a common form of commercial property in Singapore, and their multiple ownership characteristics might have implications for energy use and building energy-related building upgrading.

District-cooled Buildings. As energy use in the AMS covers that used at the building address, buildings that use district cooling from off-site sources should have lower EUIs than comparable buildings that do not. Hence, buildings using district cooling are separately identified, though the energy used by the district cooling facility is not captured in the EUIs.

Table 5 EUIs for pure office subcategories in 2023

Office Subcategory	Simple average	Weighted average ^a	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
All Pure Offices with Laboratories	191	192	109	135	164	205	294	177
All Pure Offices 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 2000	164	162	111	131	155	181	218	79
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.

^b. Laboratories are not included.

^c. Gross floor area in metres.

³⁵ The years before and after 2000 were selected to ensure a similar number of buildings in each group. Completions before and after the introduction of the Green Mark scheme in 2005 were examined, and there was no material difference in the resulting median pure EUIs or their distributions.

³⁶ These developments were primarily identified from public URA transaction records showing multiple transactions of small units over time.

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

Pure offices in business parks (excluding laboratories) had the lowest median EUI (145), partly due to district cooling being much more common in business parks (~45% of building owners reported its use). The range of EUIs was also wider in business parks than in offices in other areas, ranging from 99 to 299 at the 10th and 90th percentiles, respectively, possibly reflecting a wider diversity of occupier activities, even with laboratories excluded. If laboratories had been included in the business parks, the median EUI would have been much higher³⁷.

Offices in outer areas had slightly higher median EUI, 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. Very larger buildings had lower median EUI than medium buildings, though the differences were not great. While the number of strata office buildings was small, their median EUI of 160 was not much different from the overall medians for offices in commercial areas.

As expected, district-cooled buildings had lower median EUIs than those without, though as mentioned above, the EUIs understate total electricity use because energy used for district cooling is not included.

Trends in Pure Office EUIs since 2019

Figures 2 and 3 summarise the trends in the median EUIs across some of the office subcategories since 2019.

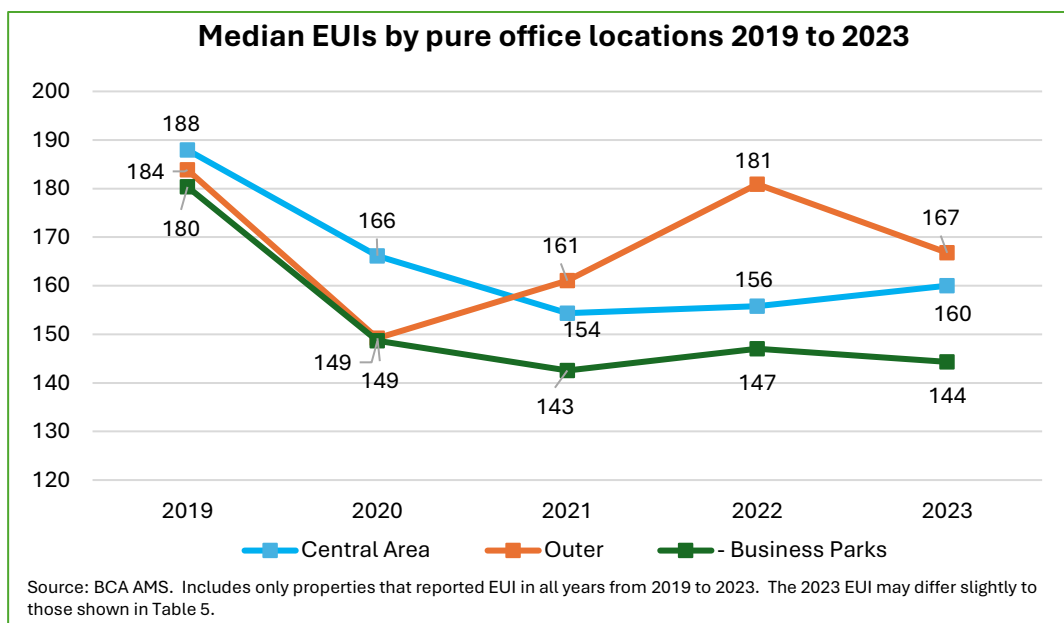


Figure 2

³⁷ The median EUI for business parks when laboratories were included was 205. The 10th and 90th percentiles were 106 and 494, respectively.

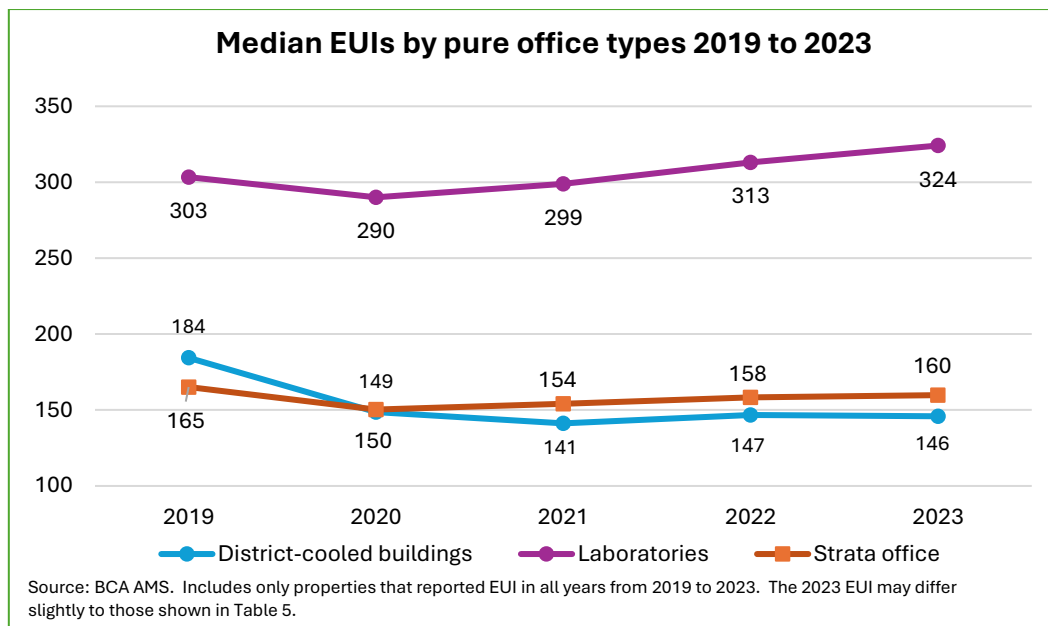


Figure 3

While the median EUIs for the locations shown in Figure 2 were similar in the central, outer and business park areas in 2019 (between 180 and 188), their trajectories were different over the five years to 2023. The median EUIs fell by approximately 21% for business park area, 15% for central area and 9% outer area. As shown in Figure 3, the median EUIs in laboratories increased by almost 7%, while those in strata buildings fell by 3%. In line with business park properties, EUIs in district-cooled buildings also fell by almost 21%.

3.4.2 Pure Retail Subcategories

Retail subcategories are often used for EUI benchmarking in other countries to account for different types of retail activities and building forms. In Singapore, the most common form of retail is enclosed multi-tenanted shopping centres, most of which contain air-conditioned public areas. Free-standing single stores and retail warehousing formats are much less common, though there are some strip shopping areas comprising street-front shops in terrace-type buildings in older districts. Such retailing is under-represented in the AMS given the 5,000 m² minimum property size required for compulsory reporting. Consequently, there were insufficient numbers of properties in smaller building formats on which to base subcategories.

Three subcategories of retail centre were created:

Shopping Centres. These are multi-tenanted pure shopping centres that have mostly been built since 1990 and provide regional, suburban or neighbourhood retail depending on their size. Most are owned by one or two organisations, and several are HDB shopping complexes³⁸.

Shopping Centres Linked or Adjacent to Mass Rapid Transit (MRT) Stations. These are a subgroup of the first category of shopping centres.



³⁸ These are Bras Basah Complex, Vista Point, Taman Jurong Shopping Centre, and Canberra Plaza. They may have multiple small owners under the broader management of the HDB.

Strata Shopping Centres with Multiple Owners. The same strata-owner criteria as for offices were applied to retail centres. These represent the majority of shopping centres built before 1990. There were only a few pure Strata shopping centres with the majority being a mix of retail and office uses.

Like offices, retail buildings were also subcategorised by completion year and size. Centres were not grouped geographically due to there being very few pure shopping centres in major precincts such as Orchard Road. The majority are mixed use.

Table 6 EUIs for pure retail subcategories in 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 ≥ 30,000m²	436	424	274	359	461	516	562	24
Large 15,000 - 29,999m²	448	437	303	382	462	529	594	18
Medium 5,000 - 14,999m²	430	439	214	292	380	533	671	31
Completion year								
Before 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.

^b. Gross floor area in metres.

The overall pure retail results were influenced by the sample of pure retail centres. Of a total of 73 properties included as pure, shopping centres made up the bulk with 50, followed by 15 strata shopping centres and additional 8 centres that were a mix of free-standing stores (e.g. Decathlon Stadium), cinema complexes (e.g. Jubilee Square), entertainment complexes (e.g. CQ @ Clark Quay) and retail warehousing (IMM).

The 2023 median EUI for pure shopping centres was 483. For centres that were linked or adjacent to MRT stations, their median EUI was slightly higher, at 511. Most properties in the shopping centre category were built after 1990 and are representative of the best performing retail properties in Singapore in terms of rental revenues and patronage. In addition, these centres typically have long opening hours and frequently contain uses with relatively high energy consumption, such as supermarkets, restaurants³⁹ and cinemas.

³⁹ Energy use associated with gas is not included and could be material in shopping centres and hotels if there is extensive food preparation. For shopping centres in Singapore owned by REITs, more than 30% of their rental revenues now come from food and beverage outlets.

The median EUI for strata shopping centres was much lower, at 284. While this can be attributed to their age (average year built was 1983) and being less competitive overall than their more modern peers, some strata centres were well patronised yet had EUIs lower than those of more modern shopping centres. Examples include Lucky Plaza in Orchard and Fu Lu Shou Complex near Bugis. One reason might be that the strata shopping centres could include smaller office and service businesses⁴⁰ that could have lower energy footprints and/or shorter trading hours than seen in the shopping centre subcategory. Furthermore, with many owners, it may be more difficult to position and manage strata properties to maximise income and patronage. There are examples of older strata properties across Singapore that are becoming run down, as owners are not willing or able to contribute to property upgrading or remixing to improve competitiveness.

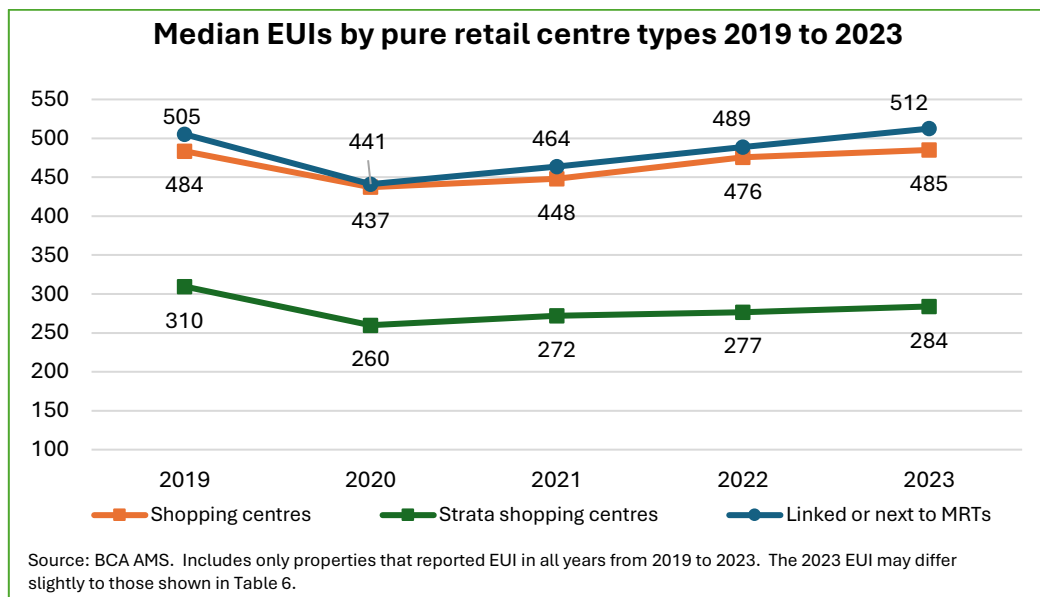


Figure 4

Across the pure retail subcategories, the changes in median EUIs have not been consistent since 2019. Median shopping centre EUIs had returned to their 2019 pre-Covid levels by 2023, and the centres adjacent to MRTs were marginally higher overall. These patterns are surprising given that some shopping centres had not yet seen their patronage⁴¹ return to the pre-Covid levels. In contrast, strata retail centre median EUIs in 2023 were 8% lower than their 2019 levels, though the sample was relatively small with 15 properties.

⁴⁰ This is often evident in higher floors or areas with low levels of pedestrian traffic or visibility.

⁴¹ In 2023, annual shopper numbers in malls held by CICT and FCT in Singapore were approximately 13% below the levels seen in 2019 for malls held over the period. Based on data extracted from annual reports of the REITs. It is possible that increased operating hours and F&B activities could have contributed to the rise in EUIs.

3.4.3 Pure Hotel Subcategories

The lodging industry can contain various short-term accommodation forms, such as hotels, inns, motels, serviced apartments and dormitory or hostel accommodation. In Singapore, hotels are most common, though there are also serviced apartments and hostel-style accommodation, sometimes called ‘capsule’ hotels. These are frequently found in small buildings that are not currently in AMS. There were too few pure serviced apartment complexes in AMS to create a subcategory.

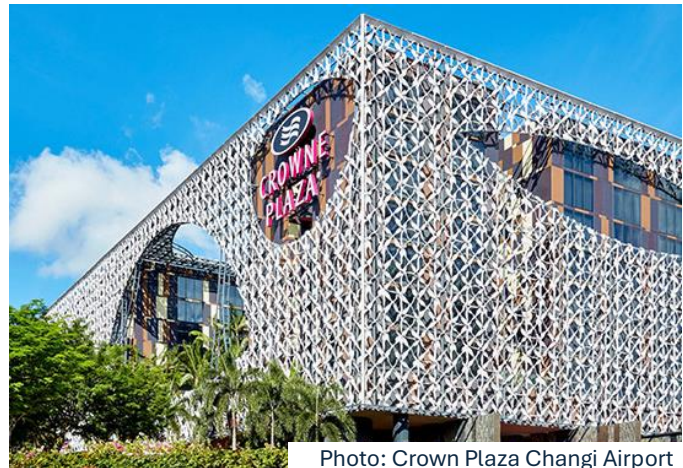


Photo: Crown Plaza Changi Airport

Quality Grades. Hotels were grouped by the quality grades⁴² commonly used for describing their facilities and pricing. There were too few 1- to 3-star hotels in the 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 7 EUIs for Pure hotel subcategories in 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 ≥ 15,000m²	243	244	179	209	233	259	316	36
Medium 5,000 - 14,999m²	290	287	197	238	283	344	379	33
Completion year								
Before 2000	221	227	177	195	226	255	257	27
2000 or Later	295	285	205	241	285	348	383	42

^a. Weighted by building size (GFA).

^b. Gross floor area in metres.

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

When EUIs are estimated on a per room basis (Table 8), the variation is much greater between 5- and 4-star hotels compared to EUIs based on the GFA (Table 7). Apart from larger guest room sizes, there are

⁴² These were sourced from Booking.com, a major online hotel booking site.

more facilities in 5-star hotels for both guests and visitors, including restaurants, conference halls and event facilities.

Table 8 Pure hotel energy intensity per room by grade in 2023

	GFA per Room ¹	Average 2023 kWh per Room	Median 2023 kWh per Room
All Hotels	66	17,324	12,333
5-star	105	30,130	23,804
4-star	43	10,867	10,705

¹ This is based on the total GFA of hotels divided by the number of rooms. Therefore, it overstates the actual room sizes.

Changes in median EUIs by hotel grade are shown in Figure 5. The falls in EUIs between 2019 and 2023 were similar, at 10% to 12%, respectively, for the period.

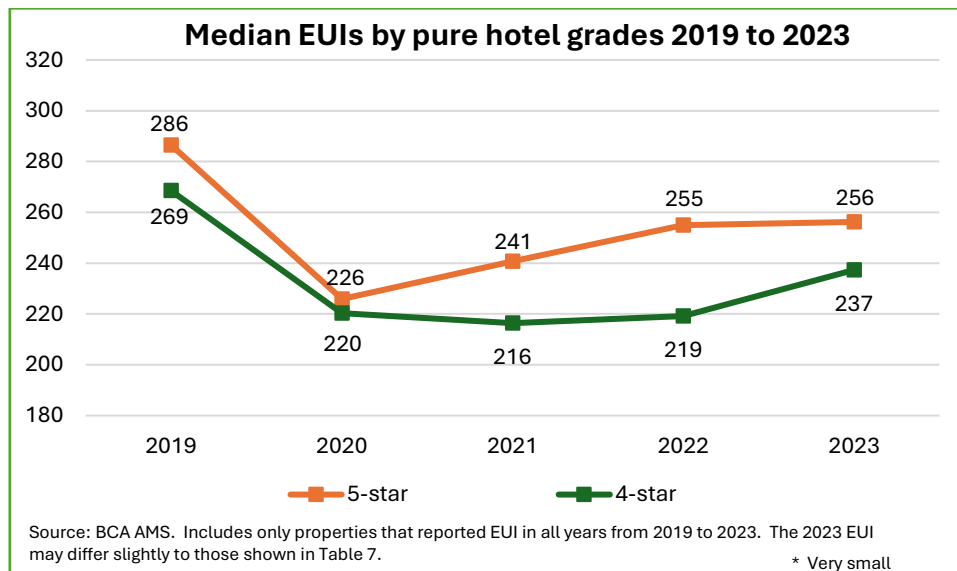


Figure 5

4 Applications and Limitations

- 4.1 Comparison to the BCA Building Energy Benchmarks
- 4.2 Comparison to BCA EUI Targets Associated with GM Accreditation
- 4.3 IREUS Pure Benchmarks Weighted by Building Uses
- 4.4 Establishing Green Targets Using the Benchmarks
- 4.5 Limitations



4 Applications and Limitations

The IREUS pure EUI benchmarks were developed to help remove some of the inherent variability in building characteristics that are known to influence energy use. They provide additional information on energy use across building subcategories that can assist benchmarking and the refinement of energy-use targets. In this section, the pure benchmarks are first compared to BCA published benchmarks and then to the EUI targets associated with the GM accreditation. This is followed by a description of how pure benchmarks can be applied to buildings with a mix of uses.

4.1 Comparison to the BCA Building Energy Benchmarks

Table 9 compares the pure EUI benchmark medians to the most recent benchmarks published by the BCA for 2022. The pure median EUI benchmarks for 2022 are used in the table.

Table 9 IREUS Pure Benchmarks compared to BCA National Benchmarks in 2022

Building Type	IREUS Pure Median 2022	BCA Benchmark Median 2022	Difference between IREUS and BCA
Office Large $\geq 15,000 \text{ m}^2$	156	160	-3%
Office Medium 5,000 – 14,999 m^2	169	155	9%
Retail Large $\geq 15,000 \text{ m}^2$	445	367	21%
Retail Medium 5,000 – 14,999 m^2	374	331	13%
Hotel $\geq 5,000 \text{ m}^2$	244	232	5%

Source: BCA Building Energy Benchmarking Report 2022.

The median EUIs for pure large offices were slightly below the BCA medians in 2022, though they were approximately 9% higher among medium offices from 5,000 to 15,000 m^2 in size. This could be due to the exclusion of buildings with lower occupancy as well as some government buildings described as offices in the AMS but containing public functions such as courts, fire and civil defence, indoor sports and recreation and free-standing libraries. Many of these buildings had low EUIs. In addition, laboratories were excluded from the pure office samples in Table 9 but included in the BCA benchmarks. For offices overall, the sample size in the BCA benchmarks was 308 versus 162 for the pure office benchmarks excluding laboratories.

The largest differences between the two sets of benchmarks were in retail. Large pure retail shopping centres had median EUIs approximately 21% higher than the BCA benchmark, while medium-sized pure retail was 13% higher. This was mainly because of the exclusion of properties that had larger amounts of non-retail uses with lower energy intensities⁴³, together with buildings with lower occupancy rates. For retail overall, 73 shopping centres were used in the pure benchmarks, compared to 117 in the BCA benchmarks.

For pure hotels, their 2022 EUIs were 5% higher than the BCA's national hotel benchmark. The pure benchmark did include hotels under 5,000 m^2 in size if they met other inclusion criteria, and this might have had a marginal impact on the resulting EUIs. The sample of hotels used for the pure benchmarks was 69, compared to 92 for the BCA's national benchmark.

⁴³ Examples of shopping centres with office components include Parkway Parade, Tiong Bahru Shopping Centre, Paragon, Wisma Atria and JEM.

4.2 Comparison to BCA EUI Targets Associated with GM Accreditation

This section compares the 2023 EUIs of pure buildings to the energy intensity targets associated with GM accreditation using Pathway 1⁴⁴. Owners of existing buildings have a second pathway to achieve a GM rating that uses fixed metrics associated with plant and equipment related to energy efficiency and a third pathway for new buildings that focuses on energy savings.

Table 10 Pathway 1 EUI for GM ratings

Building Type	Gold ^{Plus}	Platinum	SLE
Office Buildings (Large) (GFA ≥ 15,000m ²)	155	140	115
Office Buildings (Small) (GFA < 15,000m ²)	135	120	100
Hotels (Large) (GFA ≥ 15,000m ²)	230	220	190
Hotels (Small) (GFA < 15,000m ²)	180	160	140
Retail Malls	240	210	160

Source: Green Mark 2021 Energy Efficiency. BCA, Extract of Table 1B. The EUIs are for buildings that do not use district cooling systems, distributed district cooling or centralised cooling systems.

Table 10 shows the EUI targets for GM grades by building type. For both office and hotel buildings, the EUI target levels were higher (less stringent) for large buildings (15,000 m² and above in GFA) than for small buildings⁴⁵ under 15,000 m². For example, the target for the large office Gold^{Plus} EUI was 155, while that for small offices was 135.

Table 11 shows the proportions of pure buildings that had EUIs below or equal to the target EUIs shown in Table 10 for each of the building categories and GM ratings. For large offices, 47% of buildings had EUIs that met or exceeded the Gold^{Plus} target of 155, 30% met or exceeded the platinum target of 140 and 9% met the SLE target of 115. Similarly, for large hotels, 46% met or exceeded Gold^{Plus}, 33% met the platinum target and 16% met the SLE target of 190. Small office buildings did not perform as well, with 21% at or below the Gold^{Plus} target of 135 and only 3% of small hotels being as low as the Gold^{Plus} target of 180.

Table 11 IREUS pure property 2023 EUI against GM Pathway 1 EUI targets

Pure Building Type	% at or below EUI for Gold ^{Plus}	% at or below EUI for Platinum	% at or below EUI for SLE	Sample
Office Large GFA ≥ 15,000m ²	47%	30%	9%	85
Office Small GFA <15,000m ²	21%	15%	2%	56
Hotel Large GFA ≥ 15,000m ²	46%	33%	16%	35
Hotel Small GFA <15,000m ²	3%	1%	0%	33
Shopping Centres	2%	2%	1%	50
All Retail	12%	7%	1%	73

Note. The pure building sample excludes buildings that are district-cooled to be comparable to the GM rating targets in Table 10.

⁴⁴ Pathway 1 for commercial buildings also has mandatory total AC system efficiency targets and EUIs are based on occupancy minimums.

⁴⁵ The reasons why the EUI targets are lower (more stringent) for small hotels and offices than for larger properties in each category are not known.

Like small hotels, only 2% of the pure shopping centre subcategory were at or under the Gold^{Plus} target EUI of 240. When the total sample of retail properties was used, the proportion increased to 12%, mostly because of lower EUIs among the strata shopping centres.

4.3 IREUS Pure Benchmarks Weighted by Building Uses

While the pure benchmarks presented in section 3 are appropriate for properties that comprise a single use, they are less useful for properties with a mix of uses. Broader benchmarks, such as the BCA's national benchmarks shown in section 4.1 are more representative of the overall mix of properties within each property type, where other uses can take up to 40% of GFA. As a result, the performance of a property against its broad benchmark might be better or worse depending on its mix of uses versus the overall mix in the benchmark.

Given the extent of mixed-use properties in Singapore, IREUS pure benchmarks could be used to construct weighted benchmarks for individual properties based on the amount of floor area in different uses.

To illustrate the approach, we chose seven properties with various main functions based on those described in the AMS but containing two or three different uses. These properties, together with their main functions and GFAs, are shown in Table 12. Their 2022 EUIs are compared with the relevant 2022 median BCA National EUI Benchmark category.

Weighted Benchmark EUI is based on the percentage of GFA in each use.

Table 12 Sample buildings compared to the BCA median benchmarks in 2022

Property	JEM	Wisma Atria	The Atrium @Orchard	Fortune Centre	Guoco Tower	Robertson Walk	Orchard Gateway
Main Function in the AMS in 2022	Retail	Retail	Office	Office	Office	Hotel	Mixed Dev.
Gross floor area in sqm in AMS 2022	108,169	40,064	53,581	23,965	129,726	30,663	48,324
2022 EUI in AMS	349	340	215	194	235	245	324
BCA EUI benchmark median in 2022	367	367	160	160	160	232	226
BCA benchmark category	Retail Large	Retail Large	Office Large	Office Large	Office Large	Hotel	Mixed Devt.

Source: BCA Building Energy Benchmark Report 2022 & AMS. The main functions, GFA & EUI are as reported in 2022.

In Table 13, a weighted benchmark⁴⁶ was constructed for each building. This benchmark was based on the EUIs for the most relevant IREUS pure benchmark subcategories, with each being weighted by the percentage of the total floor area taken. Table 13 shows the percentage allocations to each use, together with the IREUS pure benchmark subcategories adopted. The weighted benchmark used the median of

⁴⁶ $Weighted\ EUI = \sum_{i=1}^n w_i \times EUI_i$
 where n is the number of different uses in a building,
 w_i is the proportion of the building's floor area used for use i , and
 EUI_i is the median EUI for use i .

2023 EUIs for each of the selected subcategories. The resulting weighted benchmarks and the 2023 EUI reported in the AMS are shown at the bottom of the table.

Table 13 Weighted benchmarks for the sample buildings in 2023

Property	JEM	Wisma Atria	The Atrium @Orchard	Fortune Centre	Guoco Tower	Robertson Walk	Orchard Gateway
Use 1 % of Floor Area	70% retail	67% retail	50% office	61% office	73% office	60% hotel	55% hotel
Use 2 % of Floor Area	30% office	33% office	50% retail	39% retail	16% hotel	40% retail	45% retail
Use 3 % of Floor Area	-	-	-	-	11% retail	-	-
IREUS pure benchmark subcategories adopted	Shopping centre linked to MRT & Outer office.	Shopping centre linked to MRT & Central office.	Central office & shopping centre linked to MRT	Strata office & strata retail	Central office, 5-star hotel & shopping centre linked to MRT	5-star hotel and All retail	4-star hotel & shopping centre linked to MRT
2023 EUI in AMS	345	351	218	206	231	242	331
Weighted benchmark using pure subcategory medians	408	395	336	208	214	332	348

The following discussion compares the EUIs for each building against the appropriate **BCA benchmark** published for 2022 (Table 12) and its estimated **weighted benchmark** for 2023 (Table 13).

JEM and Wisma Atria: Both are classified as retail and are large shopping centres with office towers and links to MRT stations.

BCA benchmark: Compared to the BCA’s large retail median benchmark of 367, both centres had EUIs slightly lower at 349 and 340, respectively, in 2022. Hence, shopping centres with office components are likely to perform better against the BCA retail benchmark than most of the pure shopping centres. Among the pure shopping centres, the 10th percentile EUI was 371 in 2022 and 372 in 2023 (see Table 6).

Weighted benchmark: Compared to their weighted benchmarks of 408 (JEM) and 395 (Wisma), their 2023 EUIs were lower at 345 and 351, respectively. Both performed relatively better against their weighted benchmarks than against the BCA benchmark.





Photo: CapitaLand

The Atrium: This is an office building adjacent to the Plaza Singapura shopping centre. Part of the building is used as a shopping centre that is linked to Plaza Singapura and to the Dhoby Ghaut MRT station below. It was classified as an office in the AMS in 2022.

BCA benchmark: Its performance against the 2022 BCA ‘large office’ benchmark of EUI 160 (Table 12) was not strong, and it was above the 75th percentile for the BCA benchmark.

Weighted benchmark: Compared to its 2023 weighted benchmark of 336, its actual 2023 EUI of 218 was substantially lower. On the face of it⁴⁷, this suggests a highly energy-efficient performance.

Fortune Centre: This is a strata commercial building in the central area that is classified as an office but contains a significant amount of retail space.

BCA benchmark: Fortune Centre underperformed the 2022 median BCA office benchmark for large offices with an EUI of 193 versus 160 for the benchmark.

Weighted benchmark: The weighted benchmark in Table 13 was constructed using the median pure strata office and pure strata shopping centre subcategories. The resulting weighted 2023 benchmark was 208 compared to its actual 2023 EUI of 206. Thus, it performed much better against its weighted benchmark.

The estimated weighted benchmark using the pure strata building subcategories was much lower than would have been the case for a similarly configured building not in strata ownership due to the much lower median EUIs for strata retail components.



Guoco Tower: This large downtown development contains office, hotel⁴⁸ and retail components and is described as an office building in the AMS.

BCA benchmark: Its 2022 EUI performance in Table 12 against the BCA’s ‘large office’ benchmark of 160 was relatively poor (235). In addition, it was above the 75th percentile for the BCA benchmark of 206 (not shown in the table). This suggests relatively intensive energy use for a building classified as an office.

Weighted benchmark: Against its estimated weighted benchmark of 214 in 2023, shown in Table 13, its EUI of 231 in the same year was above the weighted benchmark but not substantially so.

⁴⁷ There may be other building-specific factors that affect the EUI result. For example, there could be some sharing of energy-related infrastructure with the adjoining property or perhaps the MRT.

⁴⁸ Contains the 223 room Sofitel Singapore City Centre.

Robertson Walk: This is a hotel property⁴⁹ in the Roberson Quay area of Singapore that also contains a significant retail component (40%).

BCA benchmark: Against the BCA 2022 hotel benchmark of 232, Robertson Walk performed slightly worse, with an EUI of 245, in the same year.

Weighted benchmark: Its weighted benchmark of 332 in Table 13 was much higher than its actual EUI of 242 in the same year. While this result suggests a highly energy-efficient performance, the pure benchmarks used to construct its weighted benchmark might not reflect the property-use characteristics well.



Photo: robinsonwalk.com

First, the hotel comprises serviced apartments ranging from one to three bedrooms that could exhibit energy intensities different from those exhibited by hotel rooms. There were not enough pure serviced apartment properties in the AMS to create a serviced apartment benchmark subcategory. Second, the retail component of the development largely consists of restaurants with peak use in evenings and weekends and other forms of less intensive retailing. The weighted benchmark used the pure All Retail median, as this was lower than that for shopping centres. However, the All Retail median EUI was influenced by the many shopping centres within the total All Retail sample. A pure retail benchmark for buildings with a predominant restaurant and entertainment focus would probably be a more relevant comparison. Like serviced apartments, we did not have sufficient properties of this type to create a retail subcategory. This issue is discussed in the section under limitations.



Photo: dreamimmigrationsg.com

Orchard Gateway: This is a 4-star hotel⁵⁰ and retail property linked to Somerset MRT that is described as mixed development in the AMS because no single use equals or exceeds 60% of the floor area.

BCA benchmark: Against the BCA's mixed development median benchmark of 226, its 2022 EUI of 324 suggests that it is highly energy intensive. However, this result could be due to the composition of the mixed development benchmark. The combination of a hotel and substantial shopping centre could be atypical of mixed developments as many include offices that generally have lower EUIs than either hotel or retail.

Weighted benchmark: This is corrected by the weighted benchmark of 348, and the property's 2023 EUI of 331 is much closer to this benchmark.

The weighted benchmarks based on building subcategories can, therefore, help remove some of the inherent averaging of more aggregated property sector EUI benchmarks, although they are not without limitations. Some of these are discussed in Section 4.5.

⁴⁹ It contains a serviced apartment complex called Fraser Place Robertson Walk with a 5-star rating.

⁵⁰ Contains the 499 room JEN Singapore Orchard gateway.

4.4 Establishing Green Targets Using the Benchmarks

Table 13 presents weighted benchmarks based on the median EUI results for subcategories. They can also be constructed to provide EUI reduction targets against ‘best-in-class’ properties with similar characteristics using, for example, the 10th or 25th percentile EUI level as a reference point.

They can also be used to identify ‘worst-in-class’ properties, such as those above the 75th or 90th percentile EUI. This is important as the recently introduced MEI programme will require commercial buildings to undergo energy audits and implement energy efficiency improvement measures if their energy use is high in comparison to other buildings.

Building owners report the amount of floor space allocated to different uses in the AMS, and the BCA published this information in 2023 together with EUI data. Hence, owners can compare their building’s 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.

4.5 Limitations

Coverage and Subcategories. The creation of property subcategories relies on sufficient properties within the AMS. Some categories are not possible, such as smaller buildings less than 5,000 m² in size, as they are currently below the mandatory reporting size.

There may also be some other material differences in energy use within the subcategories. We were aware of some possible differences in the energy intensity of hotels and serviced apartment complexes. However, we could not investigate this, as there were too few pure serviced apartment buildings to create a separate subcategory. There may also be other factors causing differences in EUI outcomes within the subcategories that have not been identified.

Several of the subcategories, such as strata office and strata retail, used small samples of properties and might not provide reliable estimates for the total population of buildings in their subcategories. This warrants further examination.

Measurement of Floor Areas in Different Uses. In the AMS, owners are asked to identify different uses within a building based on the amount of GFA taken. This is relatively straightforward in multi-storey buildings where uses are the same on a level but can be more difficult where common areas on a level are shared and not easily divisible into separate uses. In some cases, net lettable areas allocated to different uses can be used to approximate the percentage allocations.

Building Utilisation Measures. The limitations of occupancy data as a measure of building utilisation were previously highlighted. While hotel occupancy is a physical measure of room use, retail and office occupancy might reflect either contractual occupancy or physical occupancy (physical occupancy is a better measure). The AMS does include other utilisation measures, such as hours of commercial building operations and typical numbers of people visiting a building daily. Hours of operation can impact energy use and be considered an additional utilisation factor. The number of visitors is also likely to be important, though the response rates are not high and could be subject to errors. Other ways to measure building utilisation, such as mobile phone connection data, can also be usefully explored. Such information is already available as relative patronage indices for some commercial properties in Google Maps. If these could be obtained as absolute measures averaged over relevant periods, they could be a more precise building utilisation measure than occupancy rates.

For hotels, occupancy data might be sourced directly from the Singapore Tourism Analytics Network (Singapore Tourist Board), as these data are collected for each hotel for statistical purposes and for

owners to benchmark their performance against peers. If this source is available, it could remove possible owner-reported errors and thus ensure accurate annual averages.

Strata Buildings. There could be some systematic bias associated with strata commercial properties, particularly those with multiple small owners. For example, reported occupancy levels might be more prone to error⁵¹.

In addition, strata developments that incorporate private housing may have electricity used for the operation of common areas of residential components attributed to commercial uses if there is no additional submetering. This was most likely the case in buildings predating 2008, when sub-management corporations were introduced for each use within strata developments. Sub-management corporations simplify the identification of energy use across different uses, although adjustments to total energy use might still need to be made by owners. The impact on overall energy should be relatively minor but will depend on the size of the residential component.

The extent of any possible biases associated with reporting for strata buildings can be explored further.

EUI Measured. A limitation of this research is that it does not include energy used from the burning of gas (or other fuels) and can result in an understatement of total energy use and thus carbon emissions. This is likely to be most important in shopping centres and hotels containing restaurants and food courts that involve cooking.

District-cooled building EUI levels are under-reported due to the exclusion of electricity consumption for the production of chilled water. If possible, this should be included in the EUI at the building level.

Further Building Verification. Buildings were mostly classified and filtered using the desk-based techniques described in section 3. When data anomalies were suspected, a building was excluded from the analysis. With further investigation, the sample sizes within subcategories could be increased. In addition, the classifications of buildings can be refined further, especially for those owned by the government. Many government facilities described as offices in the AMS were not used because their descriptions and imagery indicated otherwise. Thus, a more rigorous review of these buildings is warranted to ensure that the assessment was correct.

Energy Use Associated with Landlord and Tenant Operations. The AMS collects total energy use in buildings. Many large owners of commercial real estate report energy use associated with landlord consumption for common areas (typically related to Scope 1 and 2 carbon emissions) as part of their sustainability statements and for industry-related accreditations, such as GRESB and NABERS efficiency ratings. The inclusion of common area energy use would provide visibility on the split between building operations and tenants (users), and thus, provide more clarity on what determines the total EUIs. In addition, organisations such as NABERS use this information to provide ratings for office buildings that separately cover tenant spaces and common areas.

Hotel Grade Classifications. The hotel subcategory benchmarks adopted hotel grades used by Booking.com, a large online hotel booking company. It may be better to use locally developed classifications for hotel grade adopted by the Singapore Tourism Analytics Network, as these could be more relevant for comparative purposes in Singapore. Hotels are grouped into luxury, upscale, mid-tier and economy. Like the previously mentioned hotel occupancy data, this might be explored with the Singapore Tourist Board for integration into the AMS.

⁵¹ For strata buildings, the reporting of energy use, together with the updating of building and operational data in the AMS, is usually done by the strata property manager on behalf of multiple small owners. Managers may not have full visibility of some operational variables.

5 Conclusions



5 Conclusions

The AMS in Singapore is unique in that it provides annual data on energy use across most commercial buildings, healthcare facilities, sports and recreation centres and institutional buildings with granular information usually found only in periodic energy use surveys in other countries. Much of the data collected at the building level are publicly available.

As part of a research collaboration between the BCA and IREUS, this report describes the creation of pure EUI commercial building benchmarks, presents the results and makes comparisons with existing EUI benchmarks available in Singapore based on the AMS data.

The pure benchmarks were intended to provide a clearer picture of the energy use associated with office, retail and hotel uses by removing the averaging effects associated with mixed uses in many commercial buildings in Singapore. Buildings contained in the AMS were selected if they contained either office, retail or hotel uses that constituted 90% or more of floor area. Other filters were applied to ensure that buildings were fully operational.

The resulting pure median EUI benchmarks for the office and hotel sectors in 2023 were similar to those published by the BCA in their 2022 Building Energy Benchmarking Report, although the samples of buildings within each benchmark were different. However, the pure retail median EUI benchmark was substantially higher because other uses, such as offices and hotels, embedded in the existing broader BCA retail benchmarks were removed. These uses generally have lower EUIs. As a result, the pure shopping centre benchmark is more representative of energy use associated with shopping centres in Singapore.

Buildings within each pure property sector were divided into subcategories based on location, age, size and other characteristics believed to affect energy use. We took guidance from the classifications used in other countries, AMS data on activities within buildings, such as laboratory uses in office buildings, and the characteristics of commercial buildings in Singapore.

Across the office subcategory benchmarks, the median EUIs were similar except for laboratories, at 309, which is almost double that for all offices without laboratories (160). As expected, EUIs for buildings using district cooling were lower, as were those for offices in business parks. While the medians were similar to the broader BCA benchmarks for offices, from 5,000 to 15,000 m² in size, EUI distribution was very different, possibly reflecting buildings with lower occupancies and our narrower definition of an office building used for the pure benchmarks.

Among the pure retail subcategories, shopping centres located on or next to MRT stations had the highest median EUI (511). This was much higher than the 2022 BCA benchmarks for retail and EUI targets for shopping centres associated with GM Pathway 1 accreditation. Strata shopping centres were also identified as a retail subcategory but had a much lower EUI median of 284. Strata shopping centres tend to be much older than those in the shopping centre subcategory, and to some extent, the two represent a bifurcation of multi-tenanted shopping centres in Singapore. For hotels, the median EUIs were slightly higher across 5-star hotels than 4-star hotels.

The pure EUI benchmarks were also used to construct weighted benchmarks tailored to the mix of uses in a building. The resulting weighted benchmarks can help remove some of the averaging present in broader benchmarks. For example, buildings classified as office but containing retailing and/or hotels could be disadvantaged when compared to a broad office benchmark. The same can occur for buildings described as mixed developments if their combination of uses is very different from the average mix of uses within a mixed-development benchmark.

Overall, the IREUS pure EUI benchmarks and their subcategories should improve our understanding and measurement of energy use in commercial buildings in Singapore.

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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
Joseph.ooi@nus.edu.sg

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Refining Energy Use Benchmarks for Commercial Properties in Singapore – update with 2024 EUI data. (Draft)

Summary

This study provides a 2024 update for the “Refining Energy Use Benchmarks for Commercial Properties in Singapore” study that presented 2023 energy use intensity (EUI) for commercial property in Singapore. Like the earlier study it focuses on 'pure' property benchmarks that cover buildings that consist of one type of commercial use. It is based on building energy consumption data collected and published by the Building and Construction Authority (BCA) under their Annual Mandatory Submission of Building Information and Energy Scheme (AMS).

In September 2024, the Building and Construction Authority (BCA) announced the introduction of the Mandatory Energy Improvement (MEI) programme in 2025 to further improve energy use in existing commercial buildings. This programme will require building owners to undergo energy audits and implement energy efficiency improvement measures if their energy use is more intensive than that of other buildings or benchmarks using a standardised energy use measure called energy use intensity (EUI). This update provides information to assist owners to assess their energy use.

In addition to the EUI categories and subcategories used for 2023, energy use amongst buildings with and without a Green Mark (GM) rating is added this year. Buildings were included as having a GM rating only if there was a rating current at the end of 2024. Buildings were labelled as not rated if they had never received a GM rating or if any previous rating had expired.

The sample for this update is slightly larger than for 2023, as additional buildings meeting pure building criteria have been added to AMS. There were also some building-level revisions to energy use and gross floor areas in the 2024 data that also resulted in small adjustments to previous year EUIs.

I. Overall Results

Table I summarises the pure benchmarks for each property sector in 2024, and Figure I plots the trend from 2019 to 2024 for the medians. The table shows averages together with medians and 10th, 25th, 75th and 90th percentiles. The upper percentile EIUs presented in the report are particularly relevant for identifying properties that may fall within the scope of the MEI programme.

Table I IREUS EIUs for pure commercial property types in 2024

Category	Simple average	Weighted average ¹	Percentiles					Number of properties
			10%	25%	Median	75%	90%	
Office²	187	191	110	133	161	196	279	200
Retail	451	437	217	342	473	542	646	98
Hotel	267	257	186	215	251	312	375	82

¹ Weighted by building size

² Including office buildings containing laboratory space.

Based on the medians, pure offices had the lowest EIUs in 2024 (161), followed by hotels (251) and retail properties (473).

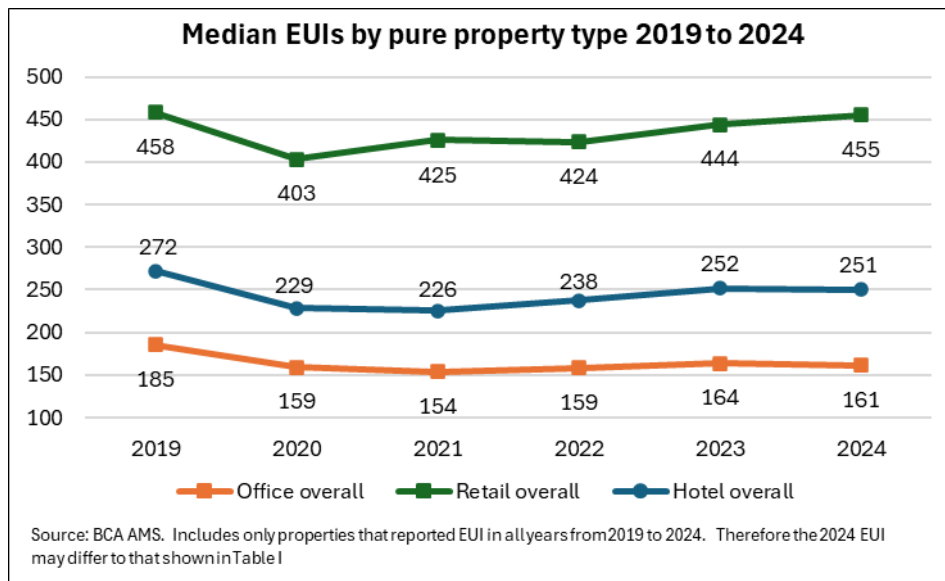


Figure I

Figure I shows the trend in EIUs since 2019 across the property sectors using buildings where EUI was reported in every year. Over 2023/2024, EIUs fell slightly for offices and hotels while increasing for retail. For the five years from 2019 to 2024, pure office median EIUs fell by 13%. Amongst all retail and hotels, the falls in EIUs over the same period were 1% and 8% respectively.

II. Subcategory results and trends

Pure benchmarks for office, retail and hotel properties were further divided into subcategories. The medians for some of these subcategories are summarised in Table II and are discussed in the report together with trends from 2019 to 2024.

Table II Selected subcategory EUIs 2024

Subcategory	Simple average	Weighted average ^a	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
Office								
All Pure Office with Laboratories	187	191	110	133	161	196	279	200
Laboratories	362	404	186	218	291	469	598	19
All Pure Office without Laboratories	169	143	109	131	159	182	224	181
Central area^b	162	158	121	135	159	180	206	111
Outer areas^b	172	173	105	128	161	190	256	36
Business Parks^b	190	169	82	111	141	204	297	34
Strata Office	144	144	102	122	150	164	181	19
District-cooled Buildings^b	154	147	74	109	138	159	188	22
Retail								
All Pure Retail	451	437	217	342	473	542	646	98
Shopping Centres	523	505	392	455	511	585	681	67
- Linked or next to MRTs	537	506	394	475	531	616	676	32
Strata Shopping Centres	263	262	172	216	234	299	364	20
Hotels								
All Pure Hotel	267	257	186	215	251	312	375	82
5-star	266	262	194	216	254	303	365	36
4-star	261	245	185	211	242	311	369	40

^a Weighted by building size

^b Laboratories are excluded

Office

The results for 2024 were similar to 2023 and small variations were mostly due to changes in the sample of buildings within subcategories. However, on a trend (like-for-like) building basis, median Central area EUIs were stable, Outer area offices increased by 2%, and Business parks were down by 2%. The largest fall was amongst Laboratories, down by 11% from 324 to 288 at

the medians. Over the longer term from 2019 to 2024 the median EUIs for all offices have fallen by 13% overall. The falls were largest in Business parks and amongst District Cooled buildings that were down 24% and 26% respectively.

Retail

The most common form of retail 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 termed the former type ‘shopping centres’ and the latter ‘strata shopping centres’. Shopping centres had a much higher median EUI (511) than Strata shopping centres (234) and Shopping centres that were linked or next to mass rapid transit (MRT) subway stations had the highest median EUI of 531.

On a trend basis, median Shopping centre EUIs increased by 5% in 2024 over 2023 while Strata centre EUIs decreased over the year by about 9%. Strata centre median EUIs were also about 21% below levels in 2019 while Shopping centre EUIs were 5% higher in 2024 than in 2019.

Hotels

The median EUIs for 5-star hotels (254) were slightly higher than 4-star hotels at 242 in 2024. On a trend basis 5-star hotels EUIs were down slightly by 1% in 2024 compared to 2023, while 4-star were up by about 2%. Over the 2019 to 2024 period, 5-star median EUIs were down by 7%, and 4-star, by 10%.

Energy use amongst buildings with a GM rating in 2024

This section summarises the results for EUIs between buildings with a current GM rating in 2024 and those that did not have a current rating. Table III shows the results at the aggregated level across each pure property type. The report shows and discusses the results across property subcategories.

Table III Median EUIs in 2024 for GM rated buildings

Subcategory	Had a current GM rating in 2024	No GM or no current rating in 2024	% Difference with GM rating	% of properties with a current GM rating
Office (Exc. Laboratories)	157	159	-1%	52%
Shopping centres (excluding Strata & other retail)	502	533	-6%	61%
Hotels	223	274	-19%	38%

Across all office categories (excluding Laboratories) buildings with a current GM rating had a 1% lower median EUI than did offices with no rating. However, this masks considerable differences between office subcategories. While some subcategories, such as offices over 30,000 sqm in GFA with GM ratings had 8% lower EUIs than offices without a rating in the same size category, others had higher energy use if they were GM rated. For example, Outer area offices with a GM rating had 9% higher EUIs than unrated Outer area offices.

Research in other countries has shown that while green-certified office buildings generally perform better on average, it is not uncommon for a meaningful share to use more energy than comparable uncertified offices. Certified office buildings may achieve higher occupancy rates and attract tenants with relatively intensive energy requirements, resulting in EUIs that are similar to those of uncertified buildings. A common finding is that the impact of certification on energy use is difficult to isolate unless differences in operational intensity (such as occupancy levels, operating hours and tenant plug loads) are controlled for. The analysis in this study does not adjust for these operational factors and therefore the results do not imply that GM certification of office buildings has only minimal impact on energy consumption.

The benefits of a current GM certification are clearer for pure retail and hotel properties. For Shopping centres (excluding strata and other forms of retail), median EUIs were 6% lower for GM-rated centres. Within the subcategories the benefits were greater for Shopping centres built before year 2000 (-10%).

The reduction in median EUI was by far the largest amongst hotels at 19% overall. Smaller hotels of under 15,000 sqm in GFA displayed an even larger reduction in median EUIs of 24%, whilst older hotels (opened before year 2000) appeared to benefit less, with a reduction of 7%.

Update of Pure Office, Retail, and Hotel Property energy use intensity for 2024

In late 2024 IREUS released a study called “Refining Energy Use Benchmarks for Commercial Properties in Singapore” that developed energy use intensity (EUI) measures called 'pure' property benchmarks. The pure EUI benchmarks included buildings that consisted of one type of commercial use. This was done because there can be large differences in EUIs among different commercial uses, and many buildings in Singapore contain a mix of office, retail, hotel or other activities, even if they are described as an office, retail or hotel buildings. The first report covered EUIs associated with electricity use in calendar year 2023 and examined trends from 2019 to 2023. It was based on building energy consumption data collected and published by the Building and Construction Authority (BCA) under their Annual Mandatory Submission of Building Information and Energy Scheme (AMS).

From the three pure building categories of office, retail and hotel, subcategories were created 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. Pure benchmarks for building categories or subcategories can be combined to more robustly assess the energy performance of properties containing a mix of uses. Filters were applied to remove buildings that that may not have been fully operational or known to contain uses that were not typical of each property type.

The pure office, retail and hotel subcategories and filters used in the first report have been retained for this update that covers electricity use in 2024. The sample for this update is largely the same as used for EUI use for 2023, though buildings have been added if they were completed in recent years and judged to be operational over the full 2024 calendar year period. Also, some properties used in last year's subcategories were not included in this update because their EUIs had not been reported for 2024 or if known to fall outside the filters adopted for inclusion. For example, if building occupancy rates were known to have fallen below minimum thresholds, such as being vacated for redevelopment. There were also some building-level revisions to energy use and gross floor areas in the 2024 data that resulted in adjustments to previous year EUIs (2023). As a result, there are some changes to the EUIs in earlier years. Care should be taken when comparing the results for 2023 in last year's study to the 2024 results, especially for subcategories containing small numbers of buildings. The trend EUI data is more reliable as it uses buildings where data was available¹ for all years.

¹ There are also some changes in the trend results because of backward adjustments to EUIs and some changes in the samples, for example if 2024 data was not available.

In addition to the EUI categories and subcategories used for 2023 a new category for buildings with and without a Green Mark (GM) rating was added. Buildings were included as having a GM rating only if there was a rating current at the end of 2024. Buildings were labelled as not rated if they had never received a GM rating or if any previous rating had expired.

Pure Office EUIs

The office subcategories used are described below.

Location. We proxied the possible differences in uses within office buildings by categorising them by location and zoning. Buildings were placed into three groups: commercial zones in the Central Area of Singapore, which includes the CBD and nearby office areas²; commercial zones in other areas that we termed 'outer areas', which include suburban business centres such as Tampines; and office buildings in business park zones that are mostly in decentralised locations.

The main uses in office buildings in commercial areas are for general business, administrative functions and professional services. In business parks, office uses are often related to research and development and high-tech or knowledge-based sectors, such as information technology, biotech and pharmaceuticals. These distinctions are broad and overlapping. For example, there can be information technology operations office buildings outside business parks.

Laboratories. As laboratory uses within buildings were identified in the AMS, buildings were classified as laboratories if more than 30% of their GFA was used for this purpose. These buildings were excluded from the three location categories, although many were in business parks.

Building Size. Office buildings were divided into three size categories: medium (from 5,000 m² to under 15,000 m²), large (from 15,000 to under 30,000 m²) and very large (for buildings of 30,000 m² or greater in size). In some large multi-building campuses in business parks EUI was reported on a multi-building basis³. These were included, though the statistics can mask individual building energy use. Where relevant this is noted in the discussion of the EUIs.

² Based on the URA's definition of the Central Area, which is within their Central Planning Region and contains the CBD (called the Downtown Core) and other inner area commercial precincts including the Orchard Road.

³ Reported EUI for some multi-building campuses was based on total electricity use for all buildings divided by total GFA for all buildings. There were two multi-building campuses in Business Parks reported on this basis containing 12 buildings, meaning that electricity use covered a total of 44 buildings in Business parks. For Laboratories, there were five multi-building campuses containing 18 buildings reported this way, meaning that electricity use covered 32 laboratory buildings in total.

Completion Year. Office buildings were divided into two groups: those completed before 2000 and those completed more recently⁴.

Strata Office Buildings with Multiple Owners. These are strata-titled buildings consisting of multiple, mostly small, units that are held by many different individuals or companies⁵. This category was identified as a common form of commercial property in Singapore, and their multiple ownership characteristics might have implications for energy use and building energy-related building upgrading.

District-cooled Buildings. The electricity used reported covers that used at the building address. Buildings that use district cooling from off-site sources should have lower EUIs than comparable buildings that do not. Hence, buildings using district cooling are separately identified, though the energy used by the district cooling facility is not captured in the EUIs.

Buildings with and without a GM rating. This subcategory was added this year. The source for the GM ratings was the BCA⁶ as of 11 September 2025 and included buildings that had a current rating for the full CY 2024.

⁴ The years before and after 2000 were selected to ensure a similar number of buildings in each group. The year of completion was based on the year owners were issued with a Temporary Occupation Permit (TOP).

⁵ These developments were primarily identified from public URA transaction records showing multiple transactions of small units over time.

⁶ Data.gov.sg. https://data.gov.sg/datasets/d_c4bd082b48fa7611713f39e23d250c27/view

Table 1 EUIs for pure office subcategories in 2024

Office Subcategory	Simple Average	Weighted Average ^a	Percentiles					Number of properties
			10%	25%	50%	75%	90%	
All Pure Offices with Laboratories	187	191	110	133	161	196	279	200
All Pure Offices without Laboratories	169	143	109	131	159	182	224	181
Location^b								
Central Area	162	158	121	135	159	180	206	111
Outer Areas	172	173	105	128	161	190	256	36
Business Parks	190	169	82	111	141	204	297	34
Size^{b,c}								
Very large ≥ 30,000 m²	158	159	110	131	155	175	208	62
Large 15,000 - 29,999 m²	164	164	100	126	148	174	227	55
Medium 5,000 - 14,999 m²	183	187	114	139	164	196	226	64
Completion year^b								
Before 2000	165	158	109	129	157	181	216	86
2000 or later	173	165	108	134	159	188	246	95
GM rating^b								
Current GM rating in 2024	167	158	109	130	157	179	218	94
No GM or not current GM	171	176	108	132	159	190	229	87
Other								
Laboratories	362	404	186	218	291	469	598	19
Strata Office	144	144	102	122	150	164	181	19
District-cooled Buildings^b	154	147	74	109	138	159	188	22

^a Weighted by building size.

^b Laboratories are not included.

^c Gross floor area in metres.

At the aggregate level all pure offices including laboratories had a median EUI of 161 in 2024. When laboratories were excluded from the pure office total, the median EUI fell to 159. Within the laboratory subcategory, the median EUI was 291, substantially higher than other types of offices.

Pure offices in business parks (excluding laboratories) had the lowest median EUI (141), partly due to district cooling being much more common in business parks (~44% of building owners reported its use). Also, the range of EUIs continued to be very wide across business park properties, ranging from 82 to 297 at the 10th and 90th percentiles, respectively, possibly reflecting a diversity of occupier activities, even with laboratories excluded.

For offices in the Central Area the median EUI was 159, marginally lower than in 2023, though the sample increased from 103 to 111. Offices in outer areas had a median EUI of 161, virtually

the same as in the Central area, though like in Business parks the distribution of EUIs was wide ranging from 105 to 256 at the 10th and 90th percentiles. The number of Outer Areas buildings also increased from 29 for 2023 to 36 for 2024.

Newer office buildings completed from 2000 had very similar median EUI as older buildings (157 vs 159), though newer buildings had higher 75th and 90th percentile EUIs, possibly due to buildings in Business parks and Outer Areas being more likely to have been constructed⁷ after year 2000.

Buildings that were 15,000 sqm or larger tended to have lower median EUIs than smaller buildings of under 15,000sqm, though the subcategory from 15,000sqm to 30,000sqm had the lowest median EUIs. The median EUI for strata office buildings was 150, slightly lower than the overall medians for offices excluding laboratories of 159, though the Strata building sample size was small.

As expected, district-cooled buildings had lower median EUIs than those without, though as mentioned above, the EUIs understate total electricity use because energy used for district cooling plant is not included.

For buildings with and without a current GM rating, the median EUI for rated buildings was only slightly lower than for unrated buildings at 157 and 159 respectively. However, there was considerable variation in energy use between different types of office properties. These are shown in Table 2, though in some subcategories the sample sizes are very small.

Table 2 Median EUIs in 2024 for GM rated offices by subcategory

Office Subcategory	Had a current GM rating in 2024	No GM or no current rating in 2024	% EUI difference with GM rating	% with a GM rating	Number of properties
All Office (ex labs)	157	159	-1%	52%	181
Completed before 2000 (ex lab)	162	147	10%	49%	86
Completed 2000 or later (ex lab)	154	159	-3%	55%	95
Central Area	159	159	0%	50%	111
Outer	161	148	9%	42%	36
Business Parks	138	146	-6%	71%	34
District cooled buildings (ex labs)	137	206	-33%	82%	22
Laboratories	302	274	11%	58%	19
Strata office	158	140	13%	11%	19
V.Large (30,000m ² & over) (ex Lab)	153	164	-7%	71%	62
Large (15,000 to 29,999) (ex Lab)	142	159	-11%	56%	55
Medium (5,000 to 14,999) (ex Lab)	182	148	23%	30%	64

⁷ The simple average completion year for buildings in Business Parks and Outer Area was 2007 and 2002, compared to 1997 in the Central Area.

There were five subcategories of office buildings with current GM ratings that had median EUIs lower than buildings without a current rating. These were newer office buildings (completed in 2000 or later: 154 vs 159), Business Parks (138 vs 146), and buildings of 15,000 square metres or more in GFA (Very Large: 153 vs 164; Large: 142 vs 159). These differences should be interpreted cautiously given the small sample sizes in some subcategories.

Overall, 52% of pure office buildings in the sample had a current GM rating in 2024. Across subcategories, 82% of district cooled buildings were rated, along with 71% of Very large buildings and buildings in Business parks. Strata office was the lowest at 11%.

Research from other countries⁸ shows that energy performance among certified office buildings varies widely. While certified buildings often perform better on average, a meaningful share use more energy than comparable non-certified offices. Certified buildings also tend to achieve higher occupancy rates and attract tenants with relatively intensive energy requirements. This can result in EUIs that are similar to — and sometimes higher than — those of non-certified buildings.

This may help explain why the difference between Green Mark-rated and non-rated offices in Singapore appears modest or mixed. A common finding in recent studies is that the impact of certification is difficult to isolate unless differences in operational intensity — such as occupancy levels, operating hours and tenant plug loads — are controlled for. The analysis in this study does not adjust for these operational factors⁹.

The results for office buildings do not imply that certification has no impact. Rather, they suggest that measured outcomes depend heavily on how intensively a building is used. If two office buildings were otherwise comparable in terms of building fabric, system calibration, occupancy levels and tenant energy intensity, a Green Mark-rated building should, in principle, consume less energy than one that is not rated.

⁸ See, for example: Leite Ribeiro, L.M.; Piccinini Scolaro, T.; Ghisi, E., “LEED Certification in Building Energy Efficiency: A Review of Its Performance Efficacy and Global Applicability”, *Sustainability* 2025, 17, 1876.

⁹ The filters used to include/exclude buildings and define subcategories did account of some operational factors such as a high percentage of laboratory uses in a building. Also, buildings known to have low occupancies and significant data centre-type operations were also excluded. However, we did not have accurate or up to date information for building occupancy rates for many buildings.

Changes in pure office EUIs since 2019

Figures 1, 2 and 3 summarise the trends in the median EUIs across the office subcategories since 2019 based on a sample of buildings that reported energy use each year.

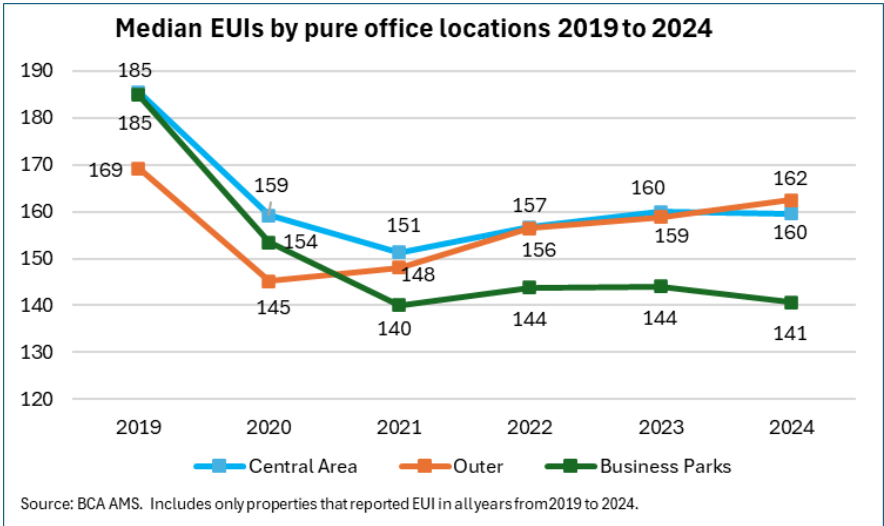


Figure 1

The change in pure office energy use shown in Figure 1 reveals that the reductions in EUIs between 2019 and 2024 were greatest amongst Business Park properties, (down almost 24%), followed by a fall of about 14% in the Central area. Amongst Outer area offices the decline in EUI was much less at about 4%. Median Central Area EUIs were unchanged in 2024 compared to 2023, while Business Parks fell by over 2%. A decline in average occupancy rates¹⁰ in Business Parks in recent years might have contributed slightly to the divergence. Also, the extensive use of district cooling amongst buildings in business parks might have also contributed to the fall.

¹⁰ Business Park occupancy rates fell from 82.5% in Dec. 2022 to 77.9% in Dec. 2024. In comparison, whole island office building occupancy rates increased from 88.7% to 89.4% over the same period. Sources, JTC and URA.

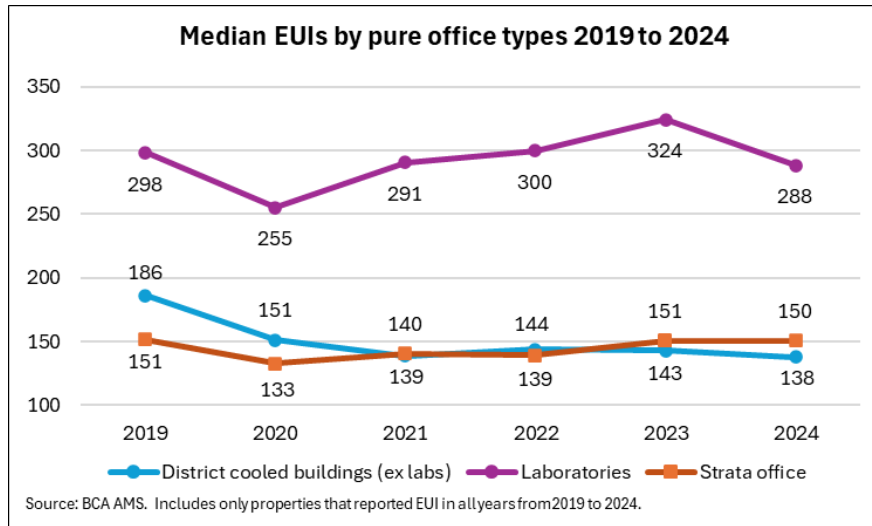


Figure 2

While median EUIs in Laboratories (Figure 2) had been increasing since 2020 they fell by 11% between 2023 and 2024. Strata office building median EUIs have remained more stable over the whole period and in 2024 were almost the same as in 2019. Like Business park properties, EUIs in District-cooled buildings fell by 26% since 2019.

In 2024 there were some revisions to the Business park, District cooled and Laboratory subcategories due to the inclusion of several multi-building campuses. As a result, some of the reported EUIs captured multiple buildings¹¹ and thus could mask trends at the building level in these categories to some extent.

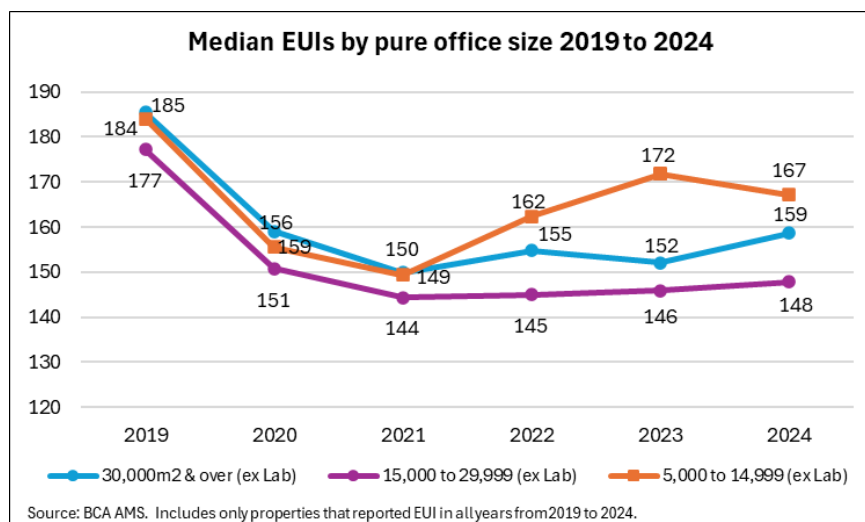


Figure 3

¹¹ There were 32 EUI entries for Business parks that contained data for 41 buildings. For Laboratories there were 18 EUI entries for 30 buildings, while for District cooled properties there were 21 entries for 33 buildings. Total building gross floor areas were used to estimate EUIs in the multi-building entries.

There are some notable differences in the trends between the largest and smallest buildings. Whilst all size categories had median EUIs between 177 and 185 in 2019, there has been some divergence in median energy use after 2021 with the smallest buildings (called Medium with 5,000m² to 15,000m² in GFA) rising more sharply, at least until 2023. The lower EUIs for buildings between 15,000 and 29,999 sqm may have been due to the higher representation of strata and Business Park office properties¹².

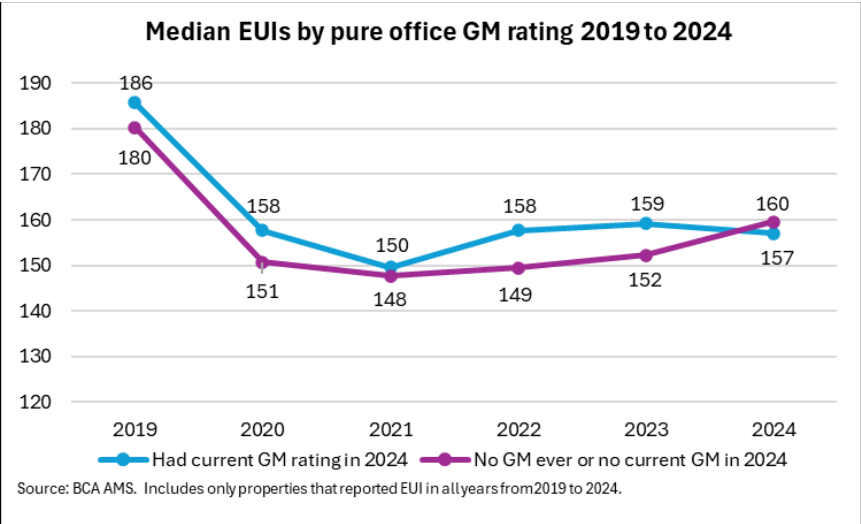


Figure 4

Up until 2023 all pure office buildings with GM ratings had higher median EUIs than those without a rating, though this reversed in 2024. Between 2023 and 2024 the EUIs of buildings without a GM rating increased by 5% in contrast to those with a rating that fell by almost 1.5%.

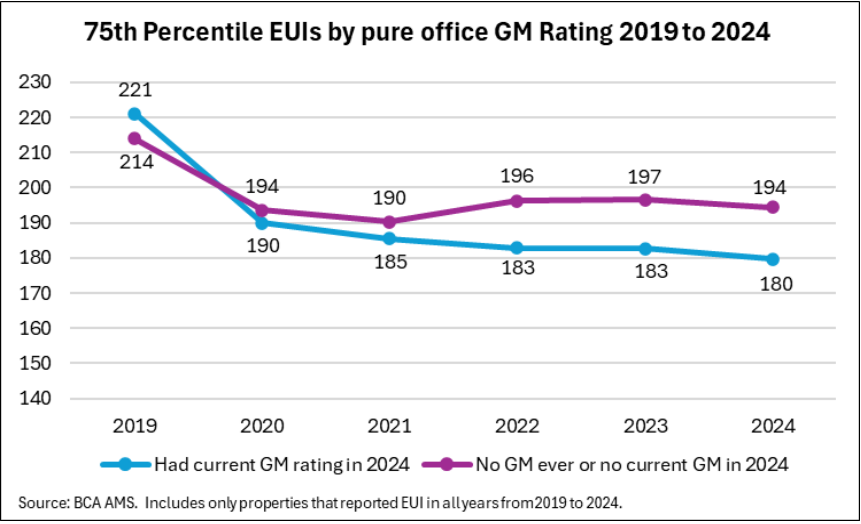


Figure 5

¹² Around 47% of buildings in this size group were in Business parks or were Strata, compared to 23% of buildings of 30,000sqm or larger, and 29% of buildings under 15,000 sqm.

While the trends for median EUIs are not very different between GM rated and non-rated office buildings, the implications for energy use reduction associated with a GM rating is clearer when the trend at the 75th percentile EUIs are examined (Figure 5). While the EUI amongst rated buildings was higher in 2019, it fell by almost 20% to 180 in 2024. This compares with a fall of 9% to 194 in 2024 amongst buildings that did not have a rating. This suggests that the GM impact more visible in upper tail EUI reduction.

Pure Retail Subcategories

In Singapore, the most common form of retail property are enclosed multi-tenanted shopping centres, many of which contain air-conditioned public areas. Free-standing single storey and retail warehousing formats are much less common, though there are some strip shopping areas comprising street-front shops in terrace-type buildings in older districts. Such retailing is under-represented in the AMS given the 5,000 m² minimum reporting threshold. Consequently, there were insufficient numbers of properties in smaller building formats on which to base subcategories.

The subcategories of retail centres used were:

Shopping Centres. These are multi-tenanted pure shopping centres that have mostly been built since 1990 and provide regional, suburban or neighbourhood retail depending on their size. Most are owned by one or two organisations, and several are HDB managed shopping complexes¹³.

Shopping Centres Linked or Adjacent to MRT Stations. These are a subgroup of the first category of shopping centres.

Strata Shopping Centres with Multiple Owners. The same strata owner criteria as for offices were applied to retail centres. These represent most of the shopping centres built before 1990. There were only a few pure strata shopping centres, with the majority being a mix of retail and office uses.

Like offices, retail buildings were also subcategorised by completion year, size and whether there was a current GM rating in 2024. Centres were not grouped geographically due to there being very few pure shopping centres in major precincts, such as Orchard Road. The majority were mixed-use.

¹³ The AMS reporting of 2024 EUIs included additional HDB managed shopping centres. These were added to the subcategory sample of Shopping centres and is the primary reason why the number of centres increased from 50 last year to 67 this year.

Table 3 EUIs for pure retail subcategories in 2024

Retail Subcategory	Simple Average	Weighted Average ^a	Percentiles					Number of Properties
			10%	25%	50%	75%	90%	
All Pure Retail	451	437	217	342	473	542	646	98
Category								
Shopping Centres	523	505	392	455	511	585	681	67
- Linked or Next to MRTs	537	506	394	475	531	616	676	32
- Not linked or next to MRTs	510	500	396	429	499	554	708	35
Strata Shopping Centres	263	262	172	216	234	299	364	20
Size^b								
Very Large ≥ 30,000 m²	438	417	260	350	481	528	556	27
Large 15,000–29,999 m²	483	484	241	382	475	578	656	23
Medium 5,000–14,999 m²	443	447	215	296	432	544	696	48
Completion year								
Before 1990	287	288	193	216	258	305	416	17
1990 to 1999	482	437	300	402	518	568	605	26
2000 or later	487	483	285	408	496	545	674	55
GM rating								
Current GM rating in 2024	484	446	350	416	497	546	623	46
No GM or no current GM	421	417	206	239	408	536	676	52

^a Weighted by building size

^b Gross floor area in metres

The overall pure retail results were influenced by the sample of pure retail centres. Of a total of 98 properties included as pure, Shopping Centres made up the bulk with 67, followed by 20 Strata Shopping Centres and an additional 11 centres that were a mix of free-standing stores (e.g. Decathlon Stadium), cinema complexes (e.g. Jubilee Square), entertainment complexes (e.g. CQ @ Clark Quay) and retail warehousing (IMM).

The 2024 the median EUI for all pure retail properties was 473. For Shopping Centres that were linked or adjacent to MRT stations, their median EUI was higher, at 531. Most properties in the Shopping Centre category were built after 1990 and are representative of the best performing retail properties in Singapore in terms of rental revenues and patronage. In addition, these

centres typically have long opening hours and frequently contain uses with relatively high energy consumption, such as supermarkets and restaurants¹⁴.

The median EUI for Strata Shopping Centres was much lower, at 234. While this can be attributed to their age (average year built was 1988) and being less competitive overall than their more modern peers, some strata centres were well patronised yet had EUIs lower than those of more modern shopping centres. Lower EUIs in strata centres may reflect lower trading intensity rather than superior energy efficiency. As noted last year, Strata shopping centres can include smaller office and service businesses that could have lower energy footprints and/or shorter trading hours than seen in the Shopping Centre subcategory. Furthermore, with numerous small owners, it may be more difficult to position and manage strata properties to maximise income and patronage.

Overall, retail properties with a GM rating in 2024 had a median EUI of 497 versus 408 for those without a rating (Table 3). This result is biased by differences in the mix of centre types of centres with and without ratings. A clearer picture is seen when EUI performance is examined within the retail subcategories. These are shown in Table 4.

Table 4 Median EUIs in 2024 for GM rated retail by subcategory

Retail Subcategory	Had a current GM rating in 2024	No GM or no current rating in 2024	% EUI difference with GM rating	% with a GM rating	Number of properties
Shopping centres (SC)	502	533	-6%	61%	67
- SC linked or next to MRTs	528	550	-4%	75%	32
- SC not linked or next to MRTs	496	518	-4%	49%	35
- SC 15,000sqm & over	502	544	-8%	78%	37
- SC under 15,000sqm	507	531	-5%	40%	30
- SC completed pre-2000	518	573	-10%	64%	22
- SC completed 2000 & later	499	529	-6%	60%	45
Strata & Other types of retail	281	257	9%	16%	31

While Shopping Centres had a median EUI of 511 overall in 2024 (Table 3), those with a current GM rating had a median EUI that was about 6% lower than shopping centres without a current rating (502 vs 533). When these centres were filtered by their proximity to an MRT, size and age, those with a current GM rating consistently had lower median EUIs than those that did not have a rating. Older Shopping centres built before year 2000 appeared to have benefited most, with the median EUI being almost 10% lower than centres in the same size category that

¹⁴ Energy use associated with gas is not included and could be material in shopping centres and hotels if there is extensive food preparation. For shopping centres in Singapore owned by REITs, more than 30% of their rental revenues now come from food and beverage outlets.

did not have a rating. About 61% of pure Shopping centres in the sample had a current GM rating, increasing to 78% for larger properties (over 15,000 sqm) and 75% amongst those linked or next to MRTs. Strata and other types of shopping centres are also shown in Table 4. Their much lower EUIs relative to Shopping centres help explain the overall retail results in Table 3. The percentage of these properties with a GM rating was also very low at 16%.

Changes in pure retail EUIs since 2019

Across the pure retail subcategories, the trends in median EUIs have not been consistent since 2019. Median Shopping Centre EUIs exceeded their 2019 pre-Covid levels by 2024, with centres linked or adjacent to MRTs at 529 in 2024. While shopping centres not linked or adjacent to MRTs had lower EUIs in 2024 (than those that were linked or adjacent to MRTs) the increase over 2023 levels was 7%. It is noted that amongst this latter group of shopping centres, 62% did not have a current GM rating in 2024.

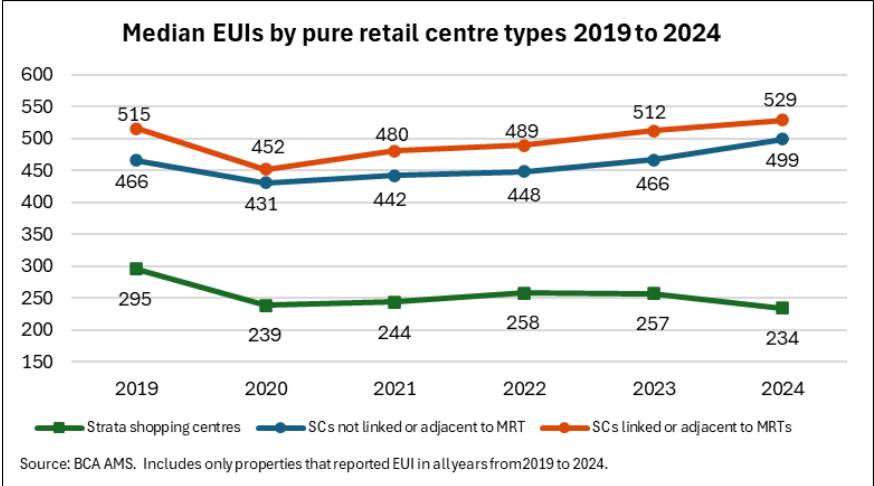


Figure 6

In contrast, the strata retail centre median EUI in 2024 was 21% lower than the 2019 levels and in 2024 were down by 9% compared to 2023. These falls in EUI might not only be due to energy savings initiatives but may reflect strata centres becoming a less competitive retail format due to competition, age and a changing retail landscape.

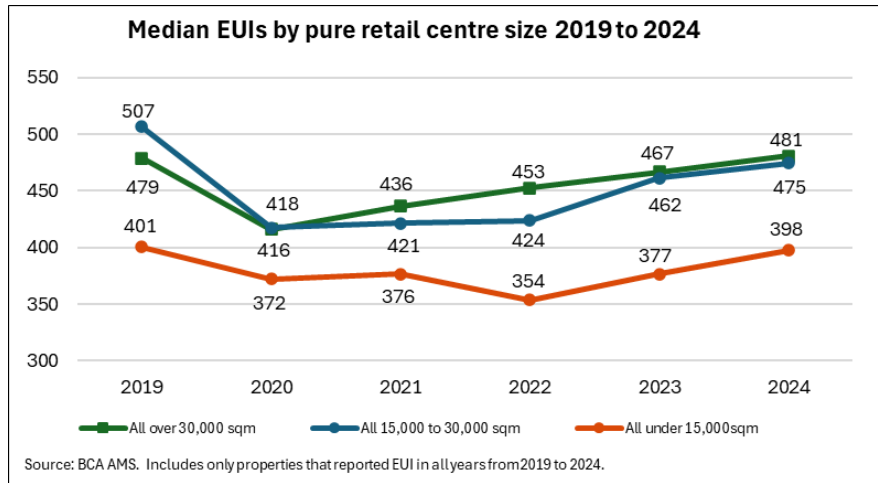


Figure 7

Trends in median EUIs amongst shopping centres with and without a GM rating are shown in Figure 8. To remove bias associated with different types of shopping centres, the figure excludes strata and other forms of retail that typically have lower EUIs. The trend results are based on Shopping Centres that reported continuously and were classified based on their GM status as at end-2024. Of a total of 62 pure shopping centres, 31 that had a rating in 2024 and 21 did not. Median EUIs amongst centres with a GM rating in 2024 were lower than those centres without a rating, though unrated centres had larger increases in their median EUIs from 2023 to 2024.

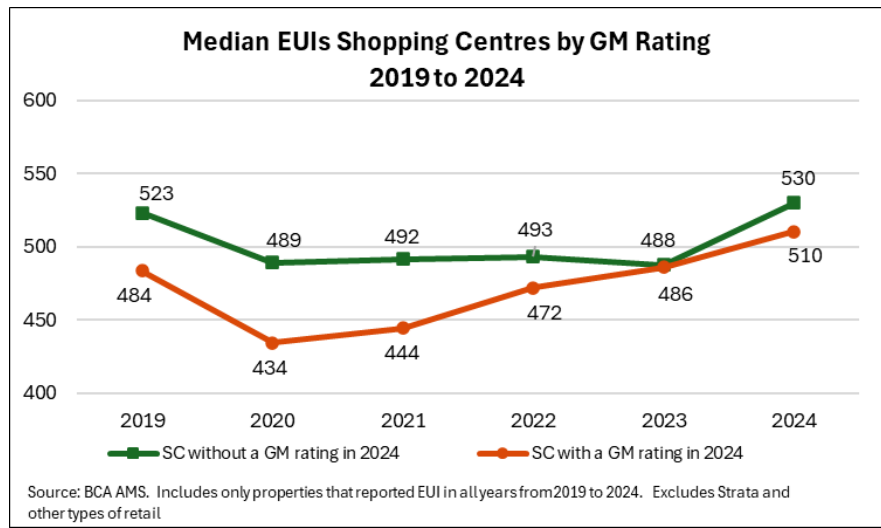


Figure 8

GM-rated shopping centres did consistently achieve lower EUIs than those without ratings, though in 2023 EUIs were close. These trends are based on GM ratings that were current in 2024 and thus may have been different for centres in earlier years.

Pure Hotel Subcategories

The lodging industry includes various forms of short-term accommodation, such as hotels, inns, motels, serviced apartments and dormitory or hostel accommodation. In Singapore, hotels are most common, though there are also serviced apartments and hostel-style accommodation, sometimes called ‘capsule’ hotels. These are frequently found in small buildings that are not currently in AMS.

Quality Grades. Hotels were grouped by the quality grades¹⁵ commonly used for describing their facilities and pricing. There were too few 1- to 3-star hotels in the 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, size and if they had a current GM rating.

Table 5 EUIs for Pure hotel subcategories in 2024

Hotel Subcategory	Simple Average	Weighted Average ^a	Percentiles					Number of Properties
			10%	25%	50%	75%	90%	
All Pure Hotel	267	257	186	215	251	312	375	82
Category								
5-star	266	262	194	216	254	303	365	36
4-star	261	245	185	211	242	311	369	40
Size^b								
Large ≥ 15,000 m²	246	248	182	208	234	278	341	46
Medium 5,000–14,999 m²	294	294	199	239	290	340	395	36
Completion year								
Before 2000	228	237	176	192	217	253	333	32
2000 or later	292	283	214	239	283	334	384	50
GM Rating								
Current GM rating in 2024	234	238	169	208	223	251	317	31
No GM or no current GM	287	276	195	236	274	336	381	51

^a Weighted by building size (GFA)

^b Gross floor area in metres

Compared to the overall hotel median EUI of 251, the EUI of 5-star hotels was marginally higher (254), while that of 4-star hotels was lower (242). Large hotels and those completed before 2000 had lower EUIs than smaller (medium-sized) hotels and newer hotels (completed in 2000 or more recently). One possible explanation is the higher prevalence of Green Mark

¹⁵ These were sourced from Booking.com, a major online hotel booking site.

certification among larger and older hotels (see Table 6), which is associated with lower median EUIs. Other differences in operating intensity and amenity provision may also play a role.

Median EUI amongst hotels with a current GM rating in 2024 was almost 19% lower than those hotels without a current rating (223 versus 274). Table 6 compares the differences associated with GM rating by hotel subcategory. Four-star hotels with GM ratings had lower EUIs than did 5-star hotels. The hotel subcategory showing the largest difference in median EUIs between GM rated and unrated, were hotels under 15,000sqm in GFA, being 24% lower. Unlike the office results, the differences associated with GM ratings in hotels are larger and more consistent across subcategories. Smaller and newer hotels within the sample were less likely to have a current GM rating (17% and 26% respectively compared to 38% overall).

Table 6 Median EUIs in 2024 for GM rated hotels by subcategory

Hotel Subcategory	Had a current GM rating in 2024	No GM or no current rating in 2024	% EUI difference with GM rating	% with a GM rating	Number of properties
All hotels	223	274	-19%	38%	82
5-star	240	270	-11%	47%	36
4-star	220	271	-19%	35%	40
Completed before 2000	215	231	-7%	56%	32
Completed 2000 & later	240	297	-19%	26%	50
15,000 sqm & over	223	257	-13%	54%	46
Under 15,000 sqm	231	303	-24%	17%	36

When EUIs are estimated on a per room basis (Table 7), the variation is much greater between 5- and 4-star hotels compared to EUIs based on the GFA (Table 5). Energy use per room reflects total hotel energy consumption divided by room count, and therefore captures all ancillary areas including restaurants, conference halls, event facilities and public areas rather than guest room consumption alone.

Table 7 Pure hotel Energy Intensity per room by grade in 2024

	GFA per Room ¹	Average 2024 kWh per Room	Median 2024 kWh per Room
All Hotels	66	17,008	12,745
5-star	96	25,519	22,719
4-star	44	10,753	10,961

¹This is based on the total GFA of hotels divided by the number of rooms. Therefore, it overstates the actual room sizes.

Changes in median EUIs by hotel grade, size and GM rating are shown in Figures 9, 10 and 11. The falls in EUIs between 2019 and 2024 were higher amongst 4-star hotels at 10%. From

2023 to 2024, the 5-star hotel median EUI fell by 1% while rising by 2% amongst 4-star hotels. Smaller hotels under 15,000sqm saw a slight fall in EUI over the year, though larger hotels rose slightly.

Hotels with a current GM rating in 2024 also displayed larger falls in EUIs over the 2019 to 2024 period (11%) in comparison to those hotels that did not have a current rating (4%). Over 2023/2024 both categories of hotel saw slight increases in median EUIs.

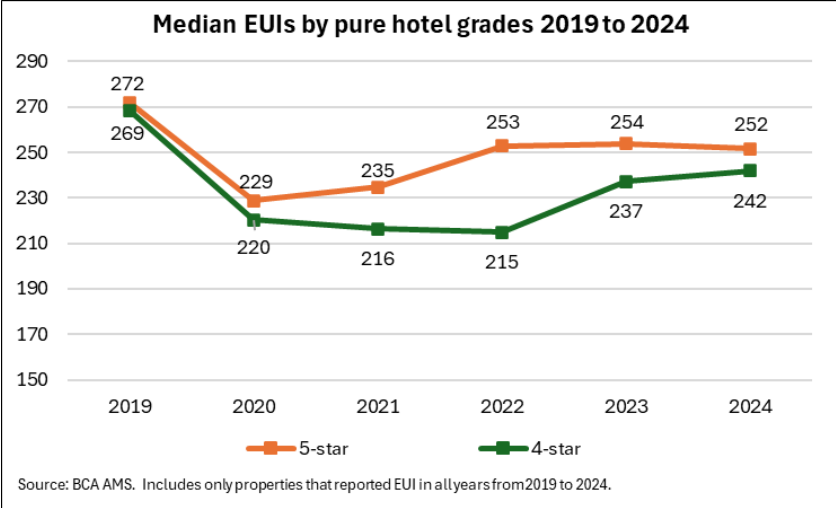


Figure 9

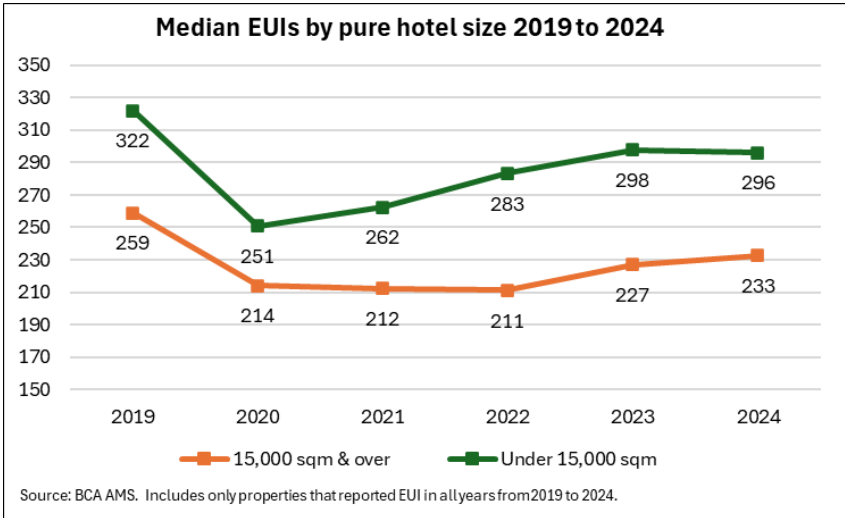


Figure 10

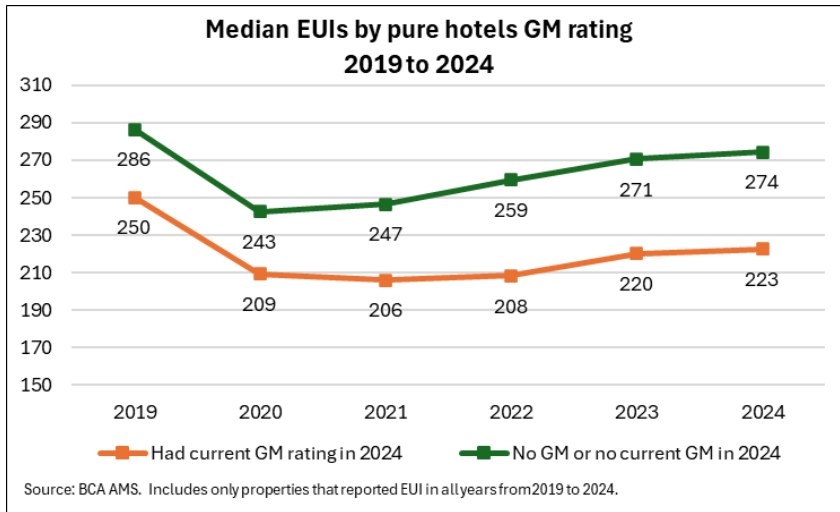


Figure 11