Chapter 1

Introduction

November 2023

This chapter should be cited as

ERIA study team (2023), 'Introduction', in Kimura, S., L.S. Meng, C.E.N. Setyawati (eds.), *Conducting Energy Consumption Survey and Establishing Energy Efficiency Indicators for the Industrial and Commercial Sectors of the Philippines.* ERIA Research Project Report FY2023 No. 15, Jakarta: ERIA, pp.1-12.

Chapter 1

Introduction

1. Background

The Philippines has achieved high economic growth in the past 10 years, and its energy demand also increased according to its gross domestic product (GDP) growth (5.7% p.a. in 2021). The growth rate with biomass in 2010–2017 was 3.6% in terms of the total final energy consumption (TFEC), but the growth rate without biomass registered 4.5% from 2010 to 2017. If there were no plan to control the increase in energy demand, the TFEC without biomass in 2050 would be 3.2 times that of 2017, according to the country's energy outlook reported in the *East Asia Summit Energy Outlook* published by the Economic Research Institute for ASEAN and East Asia (ERIA). Thus, the Philippines' Department of Energy (PDOE) implements EEC programs and activities according to the Energy Efficiency and Conservation Act enacted by the legislature in April 2019. Consequently, the PDOE requested ERIA to promote EEC in the Philippines.

As part of the plans for PDOE to promote EEC per the Energy Efficiency and Conservation Act, signed on 12 April 2019 to institutionalise EEC as a way of life for Filipinos, the PDOE should prepare energy efficiency indicators (EEIs) to determine the current level of energy consumption. Thus, this project will support the Energy Utilization and Management Bureau (EUMB) of the PDOE to prepare EEs) to focus on commercial buildings and industrial factories, providing the EUMB staff with capacity building on the methodology in EEI preparation.

In addition to the aggregate data, such as total energy consumption per GDP per capita contained in national energy balances, the establishment of EEIs will support policy development, implementation, and monitoring for each final energy-use sector, such as the industrial and commercial sectors. EEIs can show policy-makers where energy savings can be made. In addition to providing useful information on trends in the energy performance of sectors and sub-sectors, EEIs can also help model and forecast future energy demand. Another significant outcome is establishing benchmarking EEI values once enough years of data are compiled. Benchmarking EEI values can drive the energy efficiency agenda for each sector and sub-sector.

2. Preparation of Energy Consumption Survey

Before the preparation and commencement of the energy consumption survey, ERIA and the EUMB had two online meetings—the first on 17 December 2021 and the second on 4 February 2022.

The 17 December 2022 meeting discussed the following agenda:

1) The scope of work – by Shigeru Kimura of ERIA
2) The Terms of Reference (TOR) of the local consultants – by Shigeru Kimura of ERIA
3) Briefing on the survey sample questionnaires – by Leong Siew Meng, Malaysian energy efficiency expert

4) Discussion on the selection of local consultants
5) Way forward by Shigeru Kimura of ERIA

This project aimed to conduct an energy consumption survey and prepare the EEIs for the industry and commercial sectors. Although this project was planned to collect energy consumption data for 2 years, the methodology, analyses, and development of EEIs would benefit the PDOE in future data collection, establishment of EEIs, and benchmarking values when sufficient data and in-depth indicators could be obtained. According to the International Energy Agency (IEA) (2014a), it is important to develop and maintain well-founded energy efficiency indicators to understand better the drivers and potential for energy efficiency, inform the policy process, and help decision-makers develop policies best suited to meet domestic and/or international policy objectives.

At the meeting on 17 December 2021, Leong Siew Meng conducted a briefing on the survey sample questionnaire. Subsequently, the EUMB raised some queries regarding Mr Leong's briefing. Mr Kimura replied to these queries on 30 December 2021, and Mr. Leong on 2 January 2022.

Requests for proposals were sent out to local consultants upon PDOE's recommendations after the approach, methodology, and the TOR for the energy consumption survey in the industry and commercial sectors were finalised. Two consultants—the Philippine Institute of Energy Management Professionals Inc. (PIEMPI) and Meralco Power Academy (MPA)—were shortlisted and asked to attend meetings on 4 February 2022 with ERIA and the EUMB to discuss the following agenda separately (10:00 a.m. session with PIEMPI, and 2:00 p.m. session with the MPA):

1) Briefing on the Philippines' EEC ACT and the need for EEIs – by the EUMB and PDOE
2) Briefing on overall ERIA support to the PDOE on the EEIs and the contents of the TOR to PIEMPI and the MPA
3) Presentation of the proposal by PIEMPI (10:00 a.m. session)/MPA (2:00 p.m. session).
4) Comments on the proposal by Mr Leong, Malaysian EE expert
5) Overall discussion (including questions and answers)

After the discussions and clarifications during the 4 February 2022 meetings, the MPA and PIEMPI submitted revised proposals to ERIA. As a result, the TOR and contracts to engage the MPA and PIEMPI to conduct energy consumption surveys in the commercial and industry sectors were finalised and awarded in March 2022.

PIEMPI would conduct the energy consumption survey with a total of 100 samples in the following sectors of the industry sector:

- Cement factories
- Sugar factories
- Food factories
- Beverage factories

The MPA would conduct the energy consumption survey with a total of 100 samples in the following building categories of the commercial sector:

- Office buildings
- Retail buildings

However, the MPA collected data for some hotels and condominiums, which was insufficient as the survey questionnaire did not cover sufficient parameters to allow the analysis and preparation of EEIs to be carried out. It was decided that the MPA would focus on analysing the data collected for office and retail buildings, and preparing their respective EEIs.

3. Training of Enumerators to Conduct the Energy Consumption Survey

ERIA conducted two training sessions, one on the industry sector with PIEMPI on 6 April 2022, and another on the commercial sector with the MPA on 7 April 2022.

3.1. Industry Sector

The training covered the following topics:

- Objectives of the energy consumption survey
- Understanding of EEIs
- Significance of EEIs
- Energy consumption and production output
- The outcome of survey and potential sources of errors
- Survey questionnaire and analysis format

1) Objectives

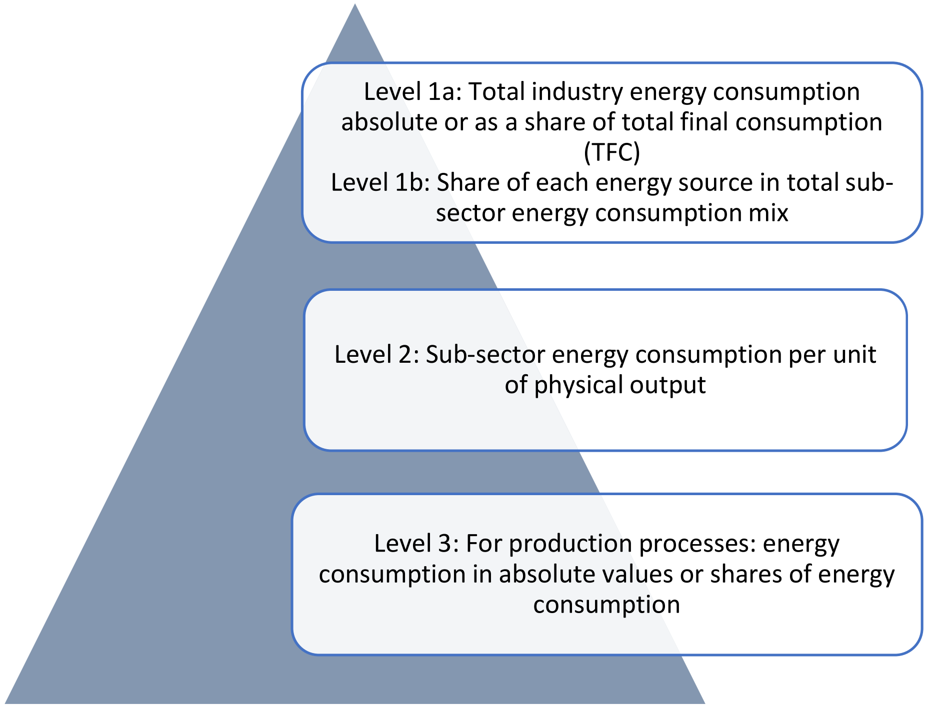
a) To conduct an energy consumption survey of the industry sector covering:
   (1) Cement factories
   (2) Sugar factories
   (3) Food factories
   (4) Beverage factories

b) The data to be collected shall be sufficient to prepare EEIs, which are representative of the respective sectors and shares of energy consumption by industrial processes.

2) Understanding energy efficiency indicators (EEIs)

The explanation of EEIs was based on the *Energy Efficiency Indicators: Fundamentals on Statistics* published by the IEA (2014a). The IEA indicators approach is based on a conceptual structure of an indicator pyramid, which portrays a hierarchy of energy indicators from the most detailed at the bottom of the pyramid to the least detailed at the top. The generic pyramid of manufacturing sector indicators (as illustrated in Figure 1.1) was explained to the enumerators. For this survey for the industry sector, the enumerators were asked to focus on getting sufficient data to compute EEIs under Level 2 in Figure 1.1, a measurement of energy use intensity (EUI), which is the same as the EEIs referred to by the IEA.

Figure 1.1. Generic Pyramid of Manufacturing Sector Indicators



Source: IEA (2014a).

Energy use intensity (EUI) would be an appropriate term to refer to the EEIs for the industry sector. EUI is the energy intensity that measures how much energy is needed to produce one unit of physical output from a sector factory. EUI is defined as follows:

$$EUI = \frac{(Total\ yearly\ energy\ consumption)}{(Total\ yearly\ production\ output)}$$

EUI is a ratio of total energy consumption within a year to total production output for the corresponding period. The total energy consumption covers all energy-consuming activities required in a factory's production processes, including the energy needed to operate facilities within the factory or plant. However, the energy needed to transport goods and services, which are not part of the production processes, is excluded. The collection of energy and production data for computing EUIs should be confined to the same industry sectors following the general International Standard Industrial Classification of all Economic Activities within the same year. The EUI computation corresponds with the Level 2 activity in IEA's generic pyramid manufacturing sector indicators.

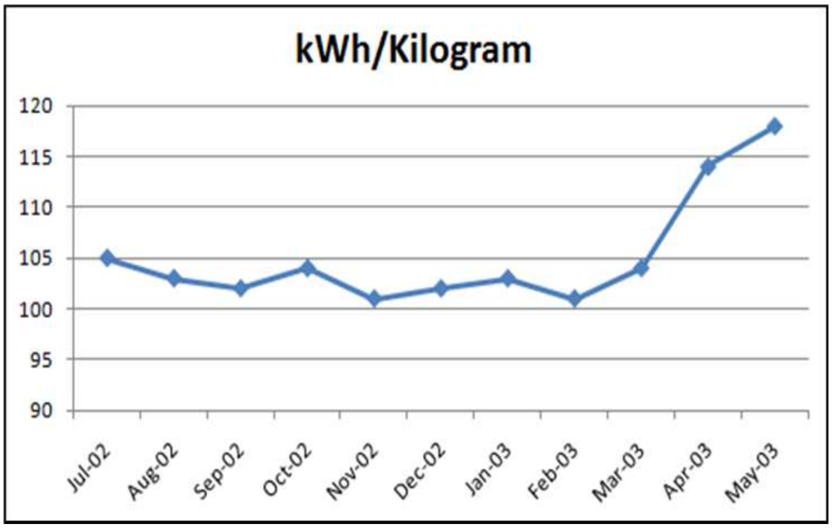
3) Significance of EEIs

Energy efficiency is "using less energy to provide the same service" (IEA, 2014a). An indicator is often taken as something that provides an indication; however, an indicator could be any statistical values that, once gathered and analysed, give a clue . With sufficient data, EEI trending can be charted to provide valid comparisons within a factory and other factories, providing they are of the same classification of industry sectors, as illustrated in Figure 1.2.

Establishing EEI benchmarking value for each industry sector is useful. However, this energy consumption survey does not intend to establish EEI benchmarking values because this exercise has its limitation. Only 2 years of data were collected during the survey period.

Figure 1.2 shows the energy required to dry a unit weight of a product. The energy requirement varies depending on the extent of drying, which in turn depends on the extent of moisture content present in the raw materials. Figure 1.2 shows that the unusually high energy consumption rate could be due to scenarios, namely, lack of maintenance in the production equipment and/or increased moisture content in a particular batch of raw materials. Figure 1.2 illustrates the significance and usefulness of EEI charting and tracking.

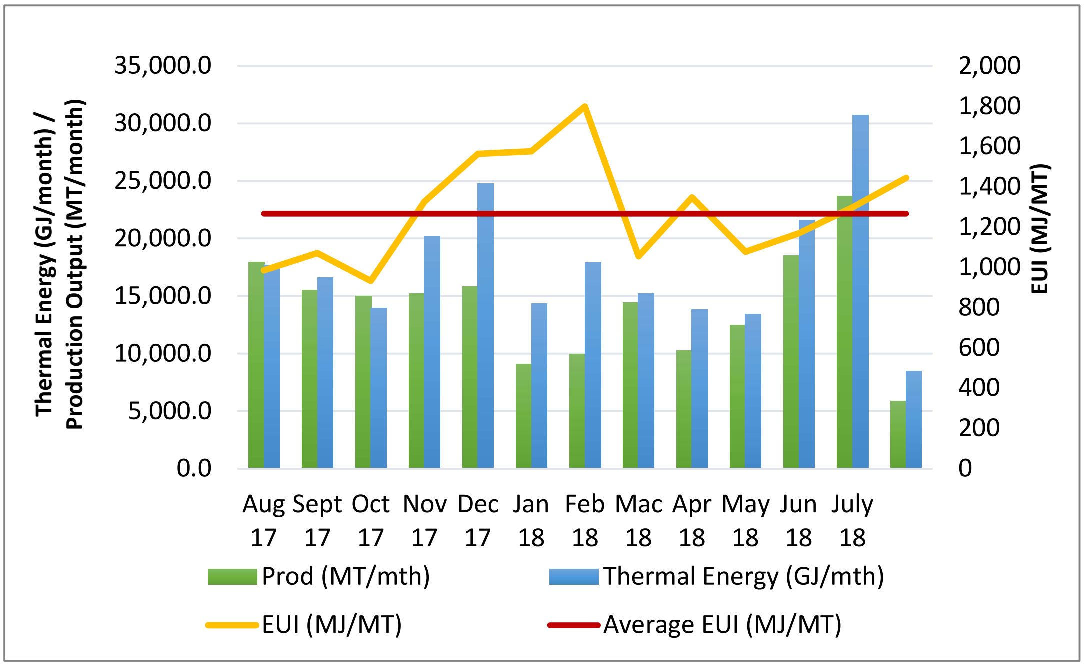
Figure 1.2. Illustration of EEI Tracking of a Drying Process



Source: UNIDO (2012).

The training conducted on 6 April 2022 also shows another application of EUI analysis and tracking method deployed in an oleochemical plant (Figure 1.3). Monthly energy consumption and production data were collected and computed as monthly EUIs. In addition, the monthly EUI and average yearly EUI were computed. The graphs of monthly data and EUIs were plotted in Figure 1.3. Figure 1.3 shows that the values of EUI fluctuate, and the EUIs in certain months are not as good and are above the average yearly EUI value. Such indication may prompt further data collection and investigation into the reasons for poorer energy performance. Nevertheless, Figure 1.3 shows that tracking of EUI can be a valuable tool for indicating energy performance and overall energy management of a factory.

Figure 1.3. Example of EUI Tracking in an Oleochemical Plant



Source: Authors.

4) Energy consumption and production output

The training highlighted that energy sources include electricity and fuel energy consumption. Table 1.1 was used in the training to explain the various forms of energy usage with respective calorific values. However, the exact values of fuel used would depend on the data from fuel suppliers in the Philippines. The training also highlighted the importance of applying consistent energy units in computing energy consumption from energy data (e.g., in kg or litre) that would be obtained in the survey. It was suggested that a common energy unit for different energy sources should be megajoules (MJ). Table 1.1 shows the typical calorific values obtained from APERC 2020 (APEC Energy Statistics 2018).

The training also explained the importance of applying consistent measurement units for production outputs, for example, tonne, cubic metre, litre, etc. as illustrated in Table 1.2. This will allow the computation of EUIs in consistent units to compare the EUIs of various plants in the same sub-sector.

Table 1.1. Example of Energy Consumption Data and Computation of Energy Consumption

Diesel for standby genset power	• Data in kg or litre (density: 860 kg/m³) • x CV = thermal energy in MJ
Fuel oil	• Data in kg • x CV = thermal energy in MJ
Natural gas	• Data in kg or m³ • x CV = thermal energy in MJ
Fuelwood	• Data in kg • x CV = thermal energy in MJ
Electricity	• Data in kWh • x 3.6 MJ/kWh = thermal energy in MJ

Fuel	Calorific Value (CV)
Bituminous coal	24,618 kJ/kg
Diesel	42,600 kJ/kg
Fuel oil	42,600 kJ/kg
LPG	47,700 kJ/kg
Natural gas	36,031 kJ/kg
Fuel wood & wood waste	15,500 kJ/kg

Note: Actual CV values to be obtained from fuel supply companies.
Source: APEC (2019).

Table 1.2. Example of Measurement Units for Production Outputs

	Products with Different Measurement Units	Energy Consumption in MJ	Production Output (should be in consistent units & corresponding period w.r.t. energy consumption data)	EUI per Product Type Basis
1	Product #1 (tonne)			
2	Product #2 (m3)			
3	Product #3 (litre)			
4	Product #4 (carton)			

Source: Authors.

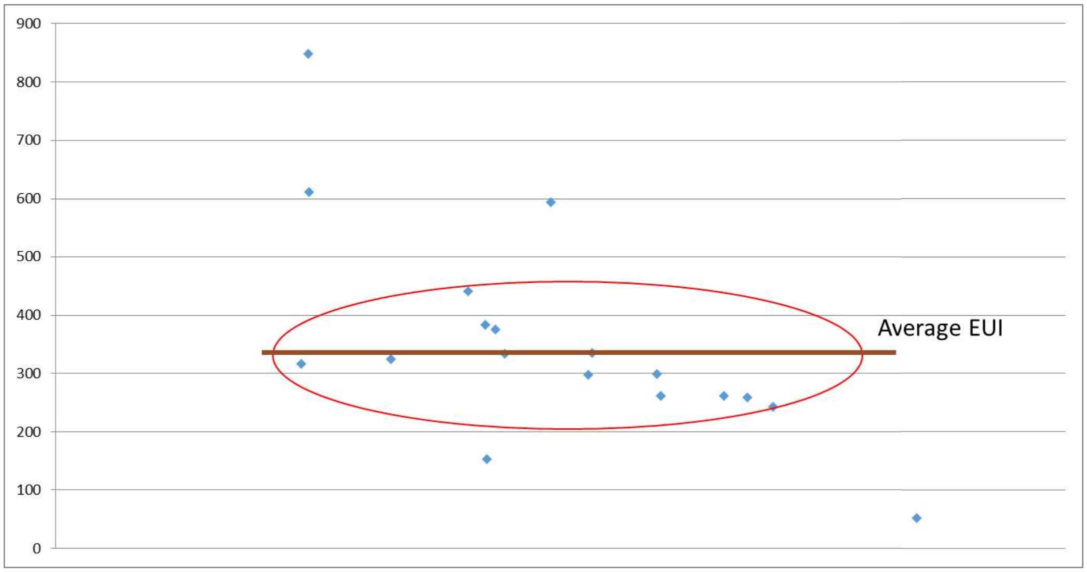
5) Outcome of the survey and potential sources of errors

The training discussed the outcome of the survey, which should provide the following:

1) Average yearly EUIs for cement, sugar, and food and beverage factories
2) Percentage shares of energy consumption for various production processes, such as heating, drying, production cooling, and production automation.

The training explained that the survey data would likely contain invalid and outlier data (Figure 1.4). Therefore, it is necessary to conduct data validation exercises after data collection. Various potential sources of errors, as illustrated in Table 1.3, were also explained during the training.

Figure 1.4. Illustration of Scattered EUI Data



Source: Authors.

Table 1.3. Example of Potential Sources of Errors

Energy Consumption Data	Production Output Data
Under-disclosure of data	Under-disclose
Over-disclose	Over-disclose
Inaccurate & inconsistent calorific values	Errors in measurement units
Inconsistency in energy units	Inaccuracy in production records
Errors in energy conversion	Mix-up between production input & output
Incomplete records, missing data, etc.	Incomplete records, missing data, not corresponding with the same period as the energy data.

Source: Authors.

3.2. Commercial Sector

The training covered the following topics:

- Objectives of the energy consumption survey
- Understanding of EEIs
- Significance of EEIs
- Energy consumption and gross floor area (GFA)

- Outcome of the survey and potential sources of errors
- Survey questionnaire and analysis format

1) Objective

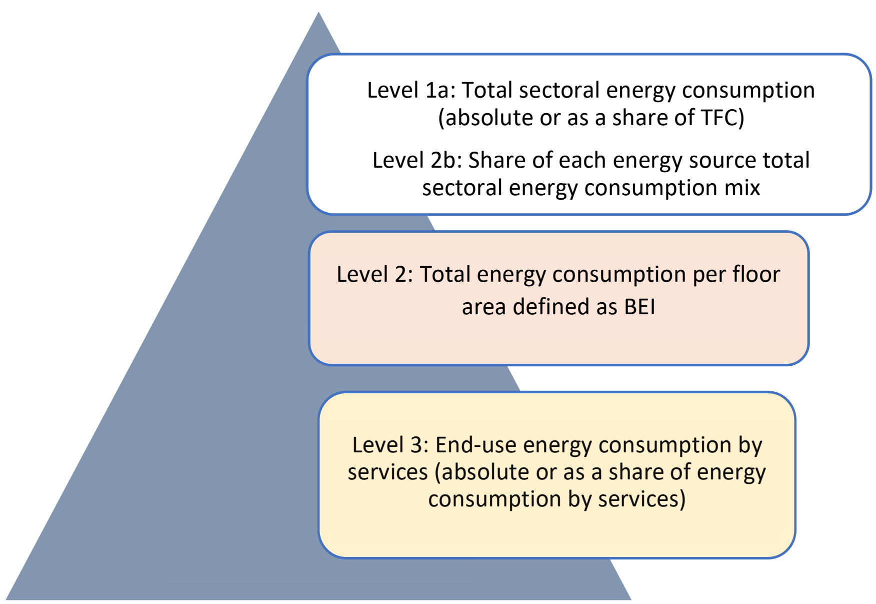
a) To conduct am energy consumption survey of the commercial sector covering office and retail buildings

b) The data to be collected shall be sufficient for establishing EEIs and shares of energy consumption by services.

2) Understanding of EEIs

The explanation of EEI was based on IEA's Energy Efficiency Indicators: Fundamental Statistics (IEA, 2014a). The generic pyramid of commercial sector indicators, as illustrated in Figure 1.5, was explained to the enumerators. For this survey, the enumerators were asked to focus on getting sufficient data to compute the EEIs under Level 2 in Figure 1.5, a measurement of building energy intensity (BEI) expressed as the ratio of total yearly energy consumption to the GFA of a building.

Figure 1.5. Generic Pyramid of Commercial Sector Indicators



BEI = building energy intensity, TFC = total final consumption.
Source: IEA (2014a).

Usually, commercial buildings are air-conditioned. For air-conditioned buildings, it was suggested to refer to BEI as the EEI for the commercial sector. Alternatively, the EUI may be used to describe building EEI in lieu of BEI. BEI is the energy intensity that measures how much distributed energy is needed per occupied floor area for buildings of the same category. The definition of BEI is given as follows:

$$BEI = \frac{(TBEC - CPEC)}{(GFA - CPA) - (GLA\ x\ FVR)}\ x \frac{AWH}{WOH}$$

Where: TBEC = total yearly building energy consumption (kWh/y)

CPEC = yearly car park energy consumption (kWh/y)

GFA = gross floor area (m^2)

CPA = car park area (m^2)

GLA = gross lettable area (m^2)

FVR = floor vacancy rate (%)

AWH = average weekly operating hours (hours/week)

WHO = weighted operating hours of building under BEI computation

The following factors should be considered in comparing BEIs between buildings:

a) BEIs of different buildings should be compared for buildings of the same categories, e.g., office buildings, retail buildings, hospitals, hotels, etc.

b) The average operating hours should reflect the actual average operating hours amongst the surveyed buildings of the same category.

c) Indoor car park areas are usually large and are not air-conditioned. Therefore, car park areas are excluded in the BEI computation to avoid distortion of BEI.

d) Similarly, the GFA should not include unoccupied floor areas, as some buildings may be partially occupied. Otherwise, BEI values will be distorted.

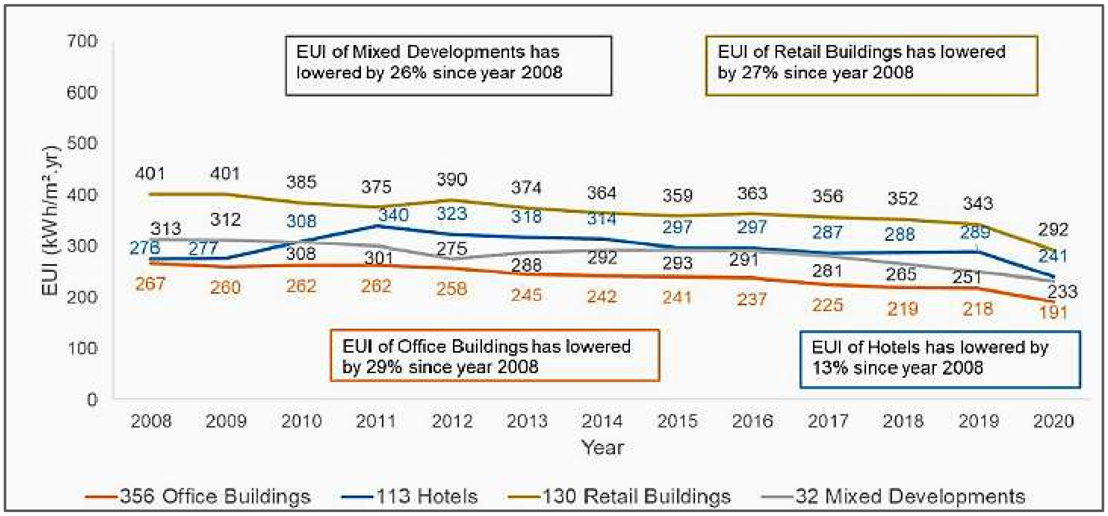
3) Significance of EEI

Space cooling is a major driver of building energy demand for hot and humid climates. Therefore, BEI reflects the distributed energy demand within the GFA of a commercial building, and will indicate total energy demand that includes air-conditioning. lighting, and other equipment loads.

With sufficient BEI data, building management can use BEI charting to monitor and evaluate the energy performance of a building. The tracking of BEIs can be used as a basis for diagnosing any issues on energy use in a building over a period.

BEI data and charting can provide valuable tools for policy-making to assess the effectiveness of energy efficiency strategies and policies. The information gained from establishing and tracking EEIs will help policy-makers set energy efficiency targets and track progress towards these targets, as well as quantify energy savings (Figure 1.6). Singapore commenced its green building programs in 2005. Figure 1.6 shows Singapore's average yearly EUI (or BEI as referred to by the author) trend by commercial building types. To compare the EUI/BEI on similar situation (initial stage of energy efficiency drive), reference should be made to the 2008 average EUI values in Singapore, i.e., 276 kWh/m^2/y for office buildings and 401 kWh/m^2/y for retail buildings.

Figure 1.6. Singapore's Average EUI Trend by Commercial Building Types



Source: Building and Construction Authority (BCA) (2021).

4) Energy Consumption and GFA

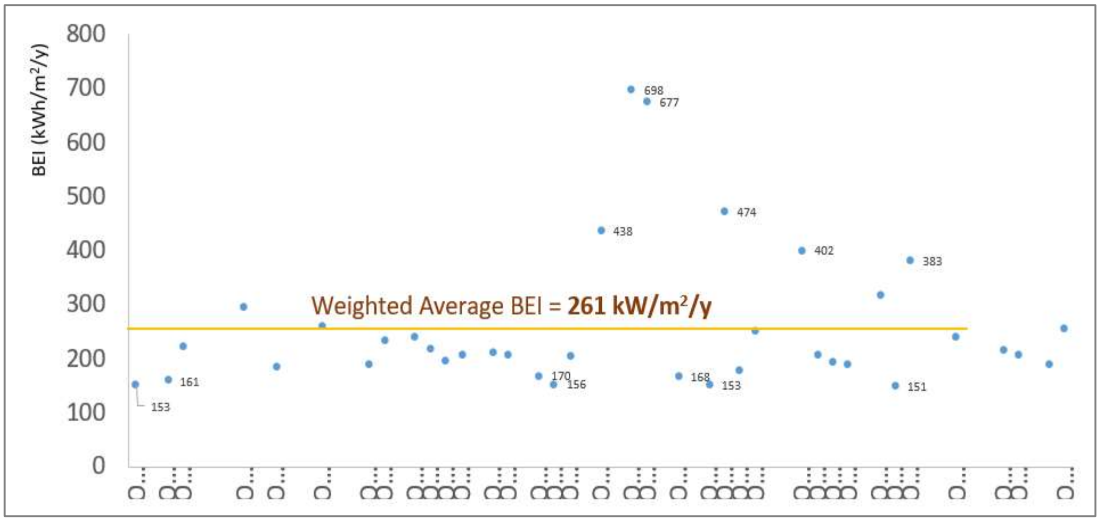
Like the industry sector, energy consumption and GFA should be consistent units. Energy consumption data include electricity and other fuels consumed in buildings. Other fuels will likely come from standby power generation, water heating, and food preparation.

As explained above, the GFA will exclude the indoor car park area. Therefore, the survey should determine the extent of floor vacancy rate by percentage for the computation of actual occupied area for a more accurate determination of BEI. In addition, information on the building footprint should be obtained to gauge the accuracy of any given GFA.

5) Outcome of the Survey and Potential Sources of Errors

The survey will produce indicators for office and retail building buildings. However, it was highlighted that data collection must undergo a data validation process to identify invalid and outlier data. Otherwise, unrealistic BEI values will be derived. Figure 1.7 shows examples of outlier data.

Figure 1.7. Example of Outlier BEI Data



Source: Authors.

Table 1.4. Example of Potential Sources of Errors

Energy Consumption Data	GFA and Other Factors
Under-disclosed data	Under-disclosed GFA
Over-disclosed data	Over-disclosed GFA
Inaccurate and inconsistent calorific values	Carpark area is included
Inconsistent energy units	Inaccuracy in operating hours
Errors in energy conversion	Floor vacancy rate not available
Incomplete records, missing data, etc.	Lack of as-built drawings/ building records

GFA = gross floor area.
Source: Authors.