Chapter 6

Data Collection for Establishment of Energy Efficiency Indicators

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Chapter 6

Data Collection to Establishment of Energy Efficiency Indicators

Leong Siew Meng

1. Introduction

After the General Department of Energy (GDE), Ministry of Mines and Energy (MME) has implemented the many action plans, the GDE has to assess how each energy efficiency and conservation (EEC) action plan contributes to saving energy consumption in Cambodia. For this assessment, generally the GDE also must produce a benchmark showing the current energy efficiency level of each industry sub-sector, each commercial building sub-sector, and each household per area or district. Thus, the collection of data and production of energy efficiency indicators (EEIs) are particularly important.

Establishing EEIs refers to the report of the International Energy Agency (IEA, 2014a), entitled *Energy Efficiency Indicators: Fundamentals on Statistics 2014*. This report is complemented by a companion document, *Energy Efficiency Indicators: Essentials for Policy Making,* (IEA, 2014b). The former focuses on what data to use and how to collect them. The latter is aimed at providing tools and methodology to determine the priority areas for the development of indicators and how to select and develop the data and indicators that will best support energy efficiency policy.

Referring to IEA's manuals, this chapter presents the requirements for data collection and establishment of EEIs for the commercial, residential, and industry sectors. Collection of quality energy consumption data is important for planning the country's policies and priorities to support economic development. It is equally important to develop indicators to compare energy efficiency trends at the macro and micro levels, i.e. energy performance at the national level and energy performance at each sector and sub-sector levels.

The EEIs are basically indicators. They may be disaggregated indicators to indicate and compare the extent of energy efficiency with benchmark values or with one another within the same category or sub-sector. In general, the EEIs will help demonstrate if one thing is more energy efficient than another. They may be aggregated, for example, to show total appliance energy consumption per type of appliance, or disaggregated, for example, to show the average cooling consumption per floor area of a building. In general, the EEIs are usually composed of an energy consumption as numerator and an activity data as denominator. The exact definition of the EEIs varies from sector to sector, and sub-sector to sub-sector. Therefore, the exact definitions of EEIs are given in the respective section for each of the commercial, residential, and industry sectors.

Collection of relevant and consistent data is the key factor in building meaningful EEIs. In other words, without relevant data, there are no indicators; and without indicators, the shortfall of information continues and will lead to difficulties in planning and optimising measures and policies, as well as tracking progress and monitoring the effectiveness of energy efficiency policies and measures. According to the IEA, three types of information are needed to understand the context and policy options for greater

effectiveness in energy planning, review, and policy updates based on measured performance through diligent data collection and analyses of the EEIs:

1) Why the end users use energy the way they do, i.e. the driving forces of energy demand;
2) What currently exists and how it performs, i.e. the state of energy consumption; and
3) Policy options and potential impact, i.e. the response that policies should enable.

2. Regulatory Requirements and Designated Premises

Establishment of the EEIs requires relevant data collection which includes production data for the industry sector and building operational data. However, such data are normally in the safekeeping of the private sector. In fact, many business entities consider energy consumption and activity data proprietary information not to be divulged to others, especially business competitors. Without a legislative framework and regulatory requirements, it is not possible to get the private sector to submit the required data voluntarily. If the programme of establishing the EEIs were voluntary, the challenges faced could be poor quality data, and inconsistency and insufficient collection of data. To address this gap, a legal framework should be established to set up regulatory or mandatory requirements of submitting energy consumption and activity data. In other words, a top–down approach is recommended to be adopted to collect quality data and establish the EEIs.

In setting up the legal framework, the mandatory requirements of submitting energy consumption and activity data should be confined to designated premises so that small business entities are exempted from submission. Designated premises are business entities in the commercial and industry sectors that consume energy above a threshold value of yearly energy consumption set by regulations. They will be required to engage a certified energy manager (CEM) (who may be in-house or outsourced) and submit energy management reports containing the required data. Table 6.1 shows the threshold value of yearly energy consumption in various countries that mandates a designated premise to submit its energy management report, which includes energy consumption and activity data.

Table 6.1: Comparison of Threshold Values in Some ASEAN Countries and Japan

Country	Threshold Value	Remarks
Thailand	20 mil MJ/y (energy)	Required to comply with the Energy Conservation Promotion Act 1992
Singapore	54 mil MJ/y (energy)	Threshold value applies, subject to yearly consumption in at least 2 out of 3 preceding calendar years, as required under the Energy Conservation Act.
Malaysia	6,000,000 kWh/y (electricity)	Required to appoint a certified energy manager and submit energy

	Under proposal in Energy Efficiency and Conservation Act (EECA): 20 mil MJ/y (energy)	management reports under the Efficient Management of Electrical Energy Regulations 2008. The draft Energy Efficiency and Conservation Act is pending to be tabled in Parliament for approval.
Indonesia	6,000 toe/y (energy) (or 251 mil MJ/y)	Government Regulation No. 70/2009 on Energy Conservation
Japan	Type 1: 3,000 kL/y (crude oil equiv.) or 115 mil MJ/y Type 2: 1,500 kL/y (crude oil equiv.) or 57 mil MJ/y	EC Act Crude oil conversion: 9,126 kCal/L[a]
Cambodia	Suggestion: 3,000,000 kWh/y (10 mil MJ/y)	To be established

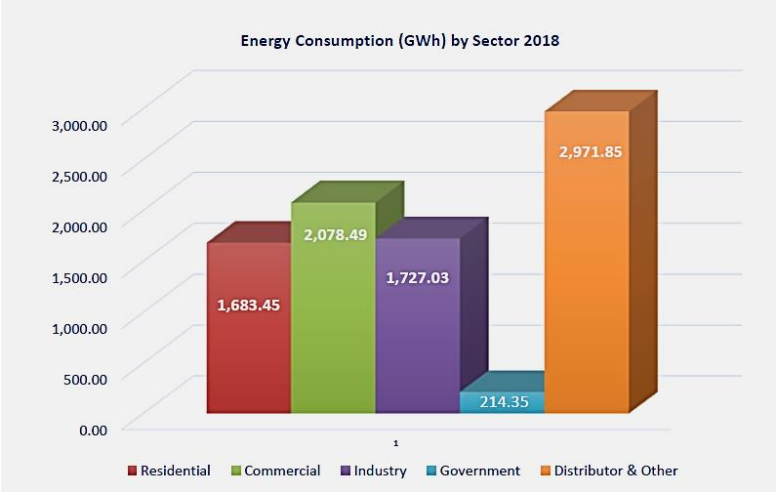
Note: [a] EECJ (2006).
Source: Compilation by author based on the acts and regulations of each country.

The significance of the threshold value is that if the value is set too low, more business entities in the commercial and industry sectors will be required to engage an energy manager and submit energy management reports. On the other hand, if the threshold value is set too high, very few premises will be subjected to the EEC mandatory requirements. As shown in Table 6.1, Cambodia can consider setting the threshold value at 3,000,000 kWh per year (or 10 mil MJ/y), which is half the threshold value set in Malaysia and Thailand. Without sufficient data, it is difficult to quantify and justify setting the threshold value at 3,000,000 kWh per year.

However, as a guide and approximate estimation based on Cambodia's energy statistics for 2018,[3] the number of premises that may be subjected to the mandatory requirements, if the threshold value is set at 3,000,000 kWh/y, is estimated in Figure 6.1.

[3] Information was obtained from the Cambodia's energy statistics for 2018 reported by Heang Theangseng at the first meeting of ERIA Research Project FY2019, Working Group on the Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia Region, 17–18 December 2019, Jakarta.

Figure 6.1: Energy Consumption of Cambodia in 2018



Source: Theangseng (2019).[4]

Energy consumption of the industry sector in 2018: 1,727,030 MWh

Number of manufacturing factories in 2018[5]: 1,528

Average energy consumption per factory: $\frac{1,727,030}{1,528} x\ 1,000 = 1,130,255\ kWh$

Half of these factories are assumed to be affected if the threshold value is set at 1,130,255 kWh. Therefore, the number of factories affected would be about 764. If this threshold value were raised to a higher value at 3,000,000 kWh/y, the number of premises is expected to be lower as the relationship is inversely proportional. Based on this relationship, the number of premises for threshold value set at 3,000,000 kWh/y is estimated as follows:

New number of premises = $764\ x\ \frac{1,130,255}{3,000,000}$ = 288

For estimation purposes, this number of premises is rounded up to 300.

Energy consumption of the commercial sector in 2018: 2,078,490 MWh

Based on the 2018 energy statistics,[6] the energy consumption of the commercial sector is fairly similar to that of the industry sector. Accordingly, the designated premises in the commercial sector are assumed to be about the same as those of the industry sector, i.e. 300 premises, making an estimated total of 600 premises for both the commercial and industry sectors.

[4] Heang Theangseng reported on Cambodia's energy statistics for 2018 at the first meeting of ERIA Research Project FY2019, Working Group on the Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia Region, 17–18 December 2019, Jakarta.
[5] Source of information: Open Development Cambodia (https://opendevelopmentcambodia.net/topics/industries/)
[6] See footnote no. 4.

However, the above is only a rough estimate and is suggested to be used as a guide in view of limited availability of data. Therefore, the estimated number of premises needs to be verified against the existing records of business entities, which consumed energy equal to or greater than the suggested threshold value of 3,000,000 kWh/y (or 10 mil MJ/y).

3. Role of the General Department of Energy

Data collection and establishment of the EEIs are major tasks that require budgets, time, and workforce resources. However, it is of utmost importance that a legal framework with regulatory requirements is established before any work on the collection of data and establishment of the EEIs can commence. Assuming that the regulatory requirements are set up, the roles of GDE are summarised as follows:

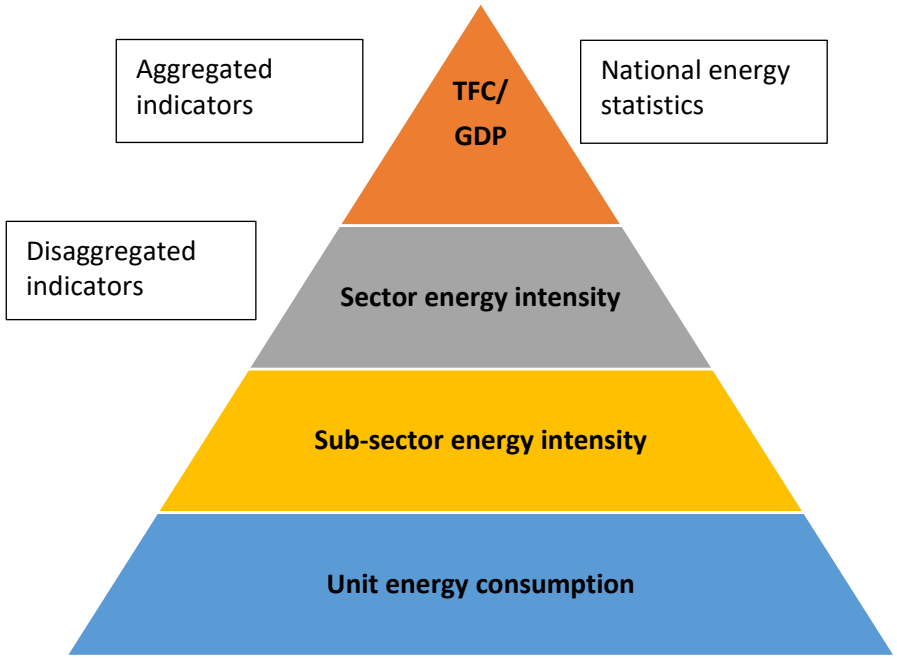
1) Establish a dedicated team to plan on data collection.
2) Collect, collate, analyse, and update data on a continuous and professional basis, adhering to the principles of non-disclosure practices.
3) Establish the EEIs by sector and sub-sector;
4) Liaise with and assist/guide the commercial and industry sectors.

It is recommended that the GDE engage stakeholders such as the trade associations, the professional bodies, and the academia in the planning phase. The objective is to make a practical plan such that once the plan and administrative process are rolled out, the plan will be widely accepted and implemented smoothly without much hiccups. The planning of labour resources required by the GDE should be based on the anticipated number of designated premises. GDE staff responsible for the safekeeping and analyses of data should not divulge information to safeguard the interests of business entities.

4. Validation and Analysis of Energy Consumption Data

Validation and analysis of energy consumption data are important steps before the EEIs are established. The accuracy and relevance of the EEIs depend heavily on the quality of data. Before looking into the details and methods of validation and analysis, it is necessary to understand the concept of EEI establishment. Figure 6.2 illustrates IEA's concept of the EEI pyramid. It explains the various levels of indicators and shows how indicators are organised into a hierarchy. Having understood the concept and data requirements, GDE's dedicated team will need to design and prepare a precise format for data collection. The objective of this data format is to ensure that the designated premises submit quality data according to the requirements. The GDE needs to reach out to business entities through technical forums to explain the data formats so that erroneous data can be minimised; hence, more accurate and meaningful EEIs can be derived.

Figure 6.2: Overview of Energy Indicators Pyramid



TFC = total final consumption.
Source: IEA (2014a).

Starting from the top of the pyramid in Figure 6.2, total final consumption (TFC) per gross domestic product (GDP) is an aggregated indicator. IEA's concept of EEIs is a 'pyramidal approach' starting from the most aggregated level at TFC/GDP to the most disaggregated level at unit energy consumption. The TFC/GDP indicator has been compiled in Cambodia's energy statistics. This report focuses on the establishment of EEIs for three sectors in Cambodia – commercial, residential, and industry. Therefore, this report primarily covers the development of the EEIs in terms of energy intensity for sub-sectors, such as hotels, retail malls, office buildings, and hospitals in the commercial sector; and textiles, food and beverages, breweries, cement, etc.in the industry sector. The objective of sub-sector energy intensity–type of EEIs is to compare energy efficiency within end-use sectors or sub-sectors. When sufficient EEI data are established, analyses can be made to develop benchmarking values for each respective sub-sector. Examples on this will be shown in the respective sections.

In general, the establishment of the EEIs require more disaggregated information. The EEIs are basically intensities, presented as a ratio between energy consumption (measured in energy units) and activity data (measured in physical units) shown as follows:

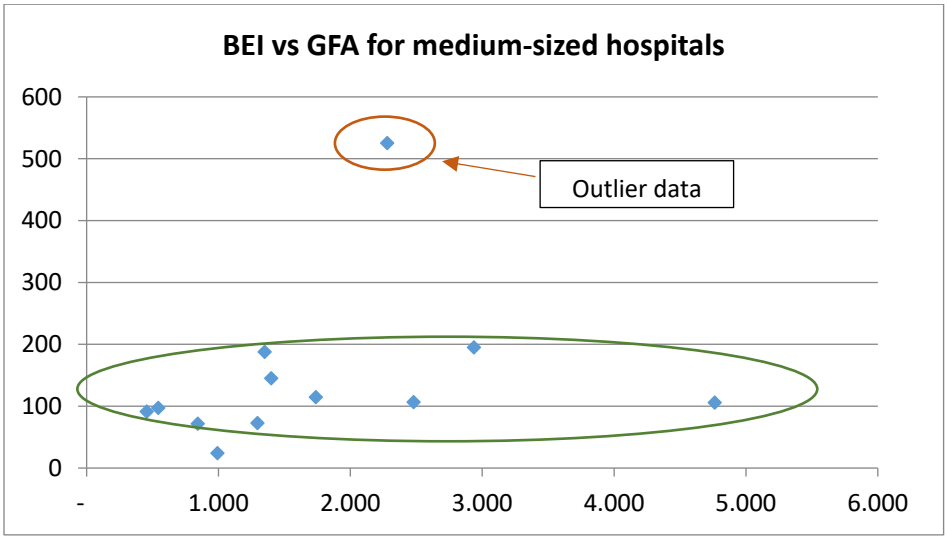
$$Energy\ efficiency\ indicator = \frac{Energy\ consumption}{Activity\ data}$$

The EEIs are computed at the end-use or sub-sector level, or at a more disaggregated level, which is the unit energy consumption level. For example, within the residential sector, space cooling energy consumption per floor area is an EEI at the end-use level, and energy consumption per unit of appliance is an EEI at the unit consumption level.

It is prudent to plan and design a good template or format to collect quality data so that validation and analysis of energy consumption data will be made easier. For better control and monitoring of data submission, the submission of energy management reports containing energy consumption data should be made every 6 months. Each report should contain the monthly energy consumption data.

Based on the details given in Section 6.5.1, by working out the building energy intensities (BEIs), validation of data can be made (Figures 6.3 and 6.4). The data lying outside the cluster of relevant data are outliers. These would not be included in the computation of BEI average values for the purpose of establishing BEI benchmark values for the respective sub-sectors after collecting data for at least 3 years. In addition, for the commercial sector, BEI values computed can be compared with the indicative BEI values for the respective sub-sectors (Table 6.2) to gauge the relevance of the computed BEI values. For example, if the computed BEI value is too low or too high compared with the values given in Table 6.2, the affected data should be checked and verified with the premises concerned.

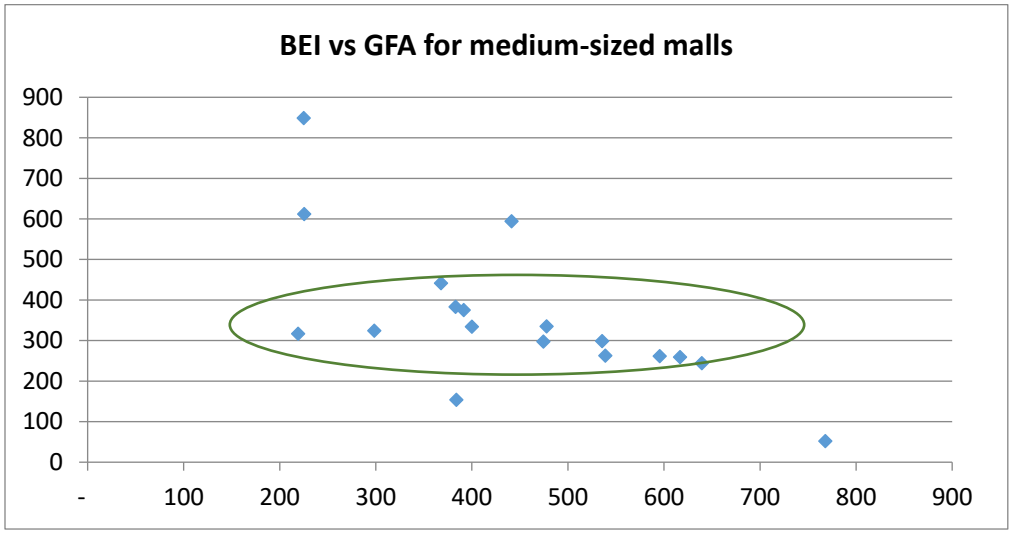
Figure 6.3: Example on Validation of Data based on Analysis of BEI Values for Hospitals



BEI = building energy intensity, GFA = gross floor area.

Source: Author's previous work with ERIA.

Figure 6.4: Example on Validation of Data based on Analysis of BEI Values for Retail Malls



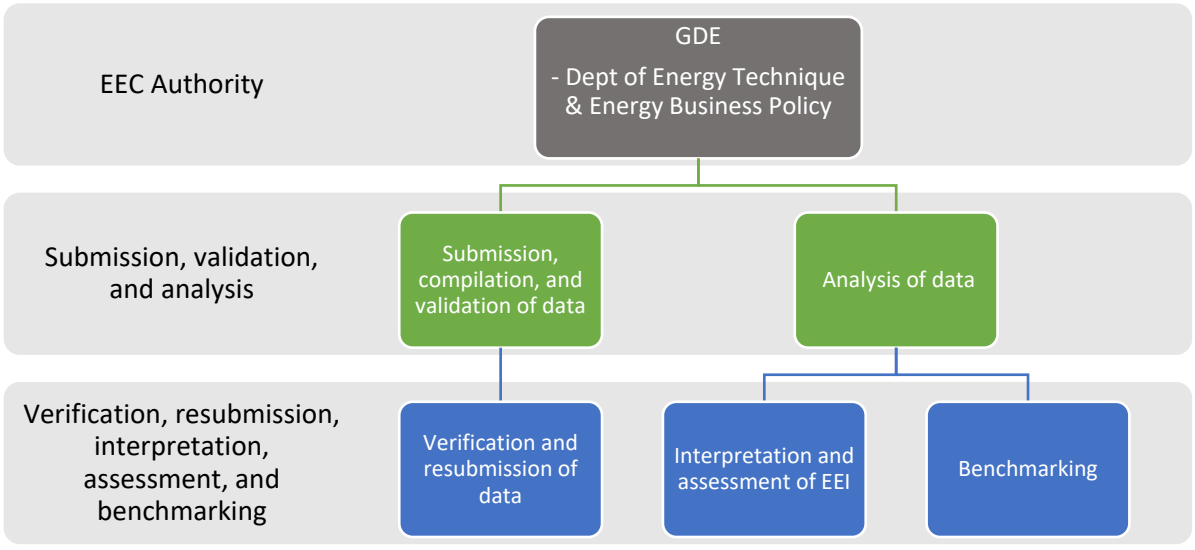
BEI = building energy intensity, GFA = gross floor area.

Source: Author's previous work with ERIA.

5. Establishment of EEIs

The establishment of EEIs for the three sectors is different as the definition of EEI varies. Therefore, the details on the establishment of EEIs are provided separately in the respective sectors. However, the general process that the GDE must carry out to establish EEIs is illustrated in Figure 6.5.

Figure 6.5: Process of Data Collection and Establishment of EEIs



EEC = energy efficiency and conservation, EEI = energy efficiency indicator, GDE = General Department of Energy.

Source: Author.

5.1. Commercial sector

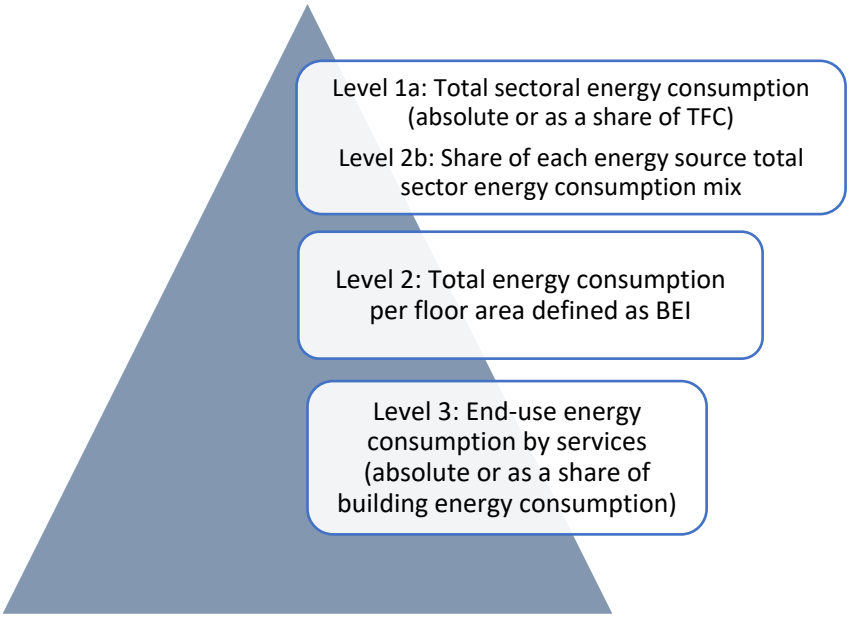
The EEIs in the commercial sector are intensities, which are defined as the ratio of yearly energy consumption (measured in energy unit, kWh) to gross floor area (measured in square metres). To differentiate this EEI from that of the industry sector, this ratio is referred to as building energy intensity (BEI) in this report and is referred to under level 2 in Figure 6.6. For meaningful comparison, the BEI values are to be compared amongst the same building sub-sector or building category. In other words, the BEIs of office buildings, retail malls, hotels, hospitals, etc. are compared within the same category or type of buildings. The reason for this is that different building categories have different operation functions. Therefore, the BEIs should be compared within the same building category for an 'apple-to-apple' comparison. The BEIs are computed at the sub-sector level and are computed as follows:

$$Building\ Energy\ Intensity = \frac{Yearly\ energy\ consumption}{Gross\ floor\ area}$$

Where: 1) Yearly energy consumption is the total energy usage in a building in 1 year

2) Gross floor area is the gross build-up area of a building including common areas such as reception area, corridors inside buildings, etc. but exclude any covered carpark area

Figure 6.6: Pyramid of Commercial Sector Indicators



BEI = building energy intensity, TFC = total final consumption.

Source: Produced by author based on IEA (2014a).

The establishment of commercial sector EEI focuses on level 2, which is to produce BEIs by building sub-sector, such as office buildings; hotels (one- to three-star rated, and four- to five-star rated); retail buildings or shopping malls (large, medium-sized, and small); and hospitals (large, medium-sized, and small).

Each of these building sub-sectors is expected to have different levels of energy intensities, which are mainly due to different building functions and operating hours; hence, they will have different BEI benchmark values. The level of energy intensities in hotels is expected to be different for four- to five-star rated hotels because the level of services and amenities available in such hotels is expected to be more energy intensive than one- to three-star rated hotels. Therefore, hotel category should be further classified under these two categories.

Similarly, retail buildings should be subdivided under low-end and high-end malls; and hospitals should be subdivided under large, medium-sized, and small so that data collection, analyses of data, and establishment of EEIs can be more accurately carried out. It is suggested that the GDE, in consultation with stakeholders, establish these subcategories after reviewing the statistical information on the sizes of these types of buildings.

Table 6.2: Suggested Minimum BEI Values for Building Sub-sectors

Category of Buildings	**Indicative BEI Benchmark Value**[a] ($kWh/m^2/y$)	**Remarks**
Office buildings	150	Suggested minimum entry level BEI value for office building
Hotels	200 (3-star and below) 290 (4-star and above)	The classification of hotel is based on the hotel industry's classification
Retail buildings	240 (low-end outlets) 350 (high-end outlets)	Classification of retail buildings under low end and high end to be established by the GDE in consultation with stakeholders
Hospitals	200 (small/medium) 290 (large)	Classification of retail buildings under small, medium-sized, and large to be established by the GDE in consultation with stakeholders

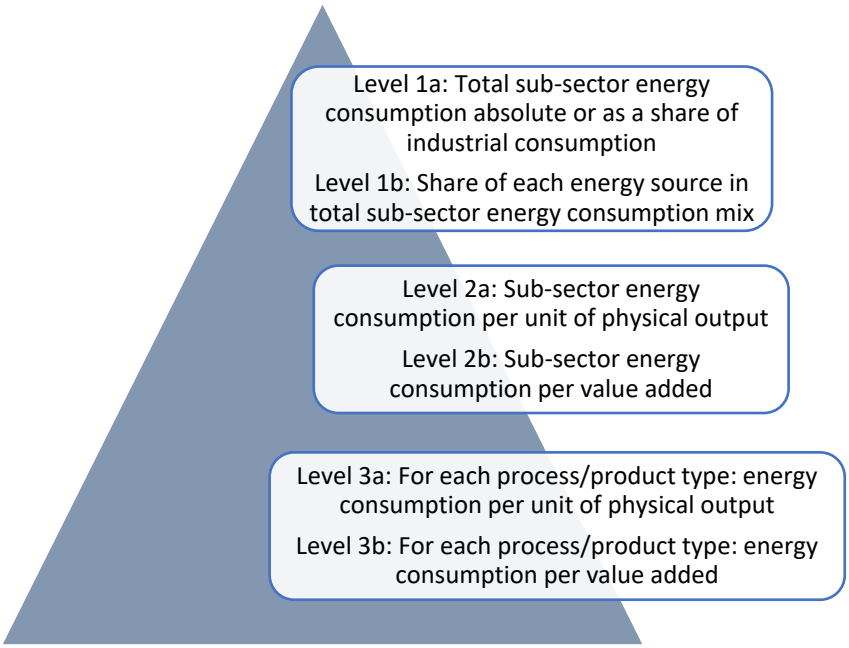
[a] Suggested minimum BEI values given in Table 6.2 are based on Malaysia's Green Building Index entry level BEI values and are subject to further analyses and verification upon the establishment of EEIs in Cambodia.
Source: Green Building Index, Malaysia, www.greenbuildingindex.org.

5.2. Industry sector

Like the commercial sector, the development of industry sector EEIs is pyramidal but focusing on level 2 of industry sector energy consumption per unit of sub-sector physical output. Figure 6.7 illustrates the pyramid of industry sector indicators. The most aggregated level refers to the overall energy consumption

of the industry sub-sector expressed either in absolute or as a share of industry sector consumption under level 1a, and the share of each energy source in the total sub-sector consumption mix. These two indicators, although not intensities, provide an overview of sub-sectoral energy consumption. However, the establishment of industrial EEIs focuses on level 2a. The establishment of level 2b on industrial sub-sector energy consumption per value added would require factories to submit data on the value of production output, which represents the measure of the contribution of the sub-sector to the GDP. The possibility of this aspect of data submission needs to be addressed. Hence, the establishment of level 2b EEIs is left to the GDE's planning, upon further deliberations, on whether level 2b EEIs can be developed.

Figure 6.7: Pyramid of Industry Sector Indicators for Sub-sectors



Source: Produced by author based on IEA (2014a).

Level 2a industry sector EEIs are energy intensities for industrial sub-sectors such as textiles, food and beverages, breweries, and cement, etc. The EEI is a ratio of sub-sector energy consumption to production output, which can be computed as follows:

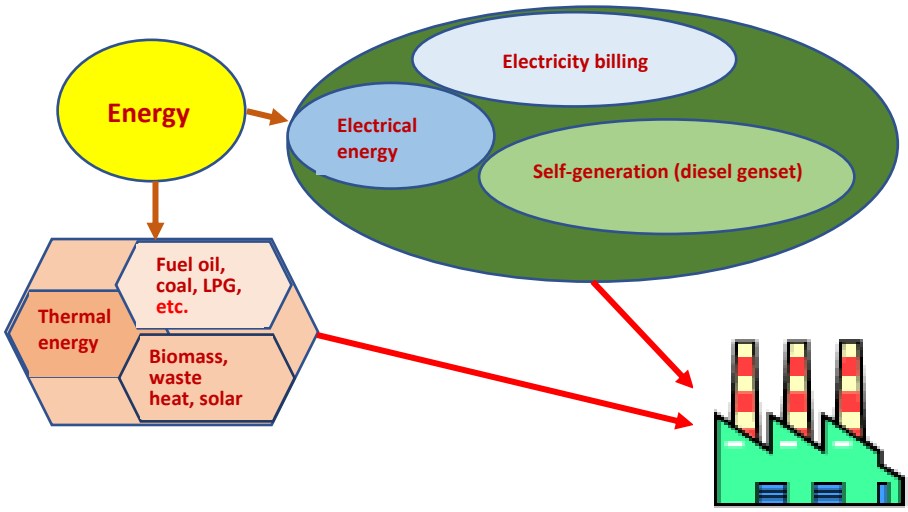
$$Industrial\ subsector\ EEI = \frac{Yearly\ subsector\ energy\ consumption}{Yearly\ production\ output}$$

Where:

1) Yearly sub-sector energy consumption is the total energy consumption including the use of all energy sources for production processes only (excluding fuel for transportation) as illustrated in Figure 6.8.

2) The denominator is the activity data, which is the yearly production output in terms of weight, volume, or other unit deemed most suitable by respective factories.

Figure 6.8: Typical Energy Flow and Utilisation in Industrial Production Process



Source: Author and Ir. Luk Chau Beng.

To establish industrial EEIs, the industry sector refers to the manufacture of finished goods and products, as listed under 'manufacturing industries' within the United Nations International Recommendations on Energy Statistics. Accordingly, this sector excludes upstream power generation; refineries; and distribution of electricity, gas, and water. In line with IEA's energy balance on the industry sector, the list excludes mining and quarrying of raw materials, as well as construction industry (IEA, 2014a).[7] Therefore, the industrial sub-sectors considered for EEI establishment would cover textiles and leather, food, beverages, and tobacco including breweries, non-metallic minerals including cement and ceramic products, wood and wood products, pulp and print, iron and steel, non-ferrous metals, chemical including fertilisers, rubber and plastic products, machinery, transport equipment, etc. The final list is subject to GDE's planning upon further deliberations. Nevertheless, the classification of the industrial sub-sectors should be based on the International Standard Industrial Classification adopted by Cambodia.

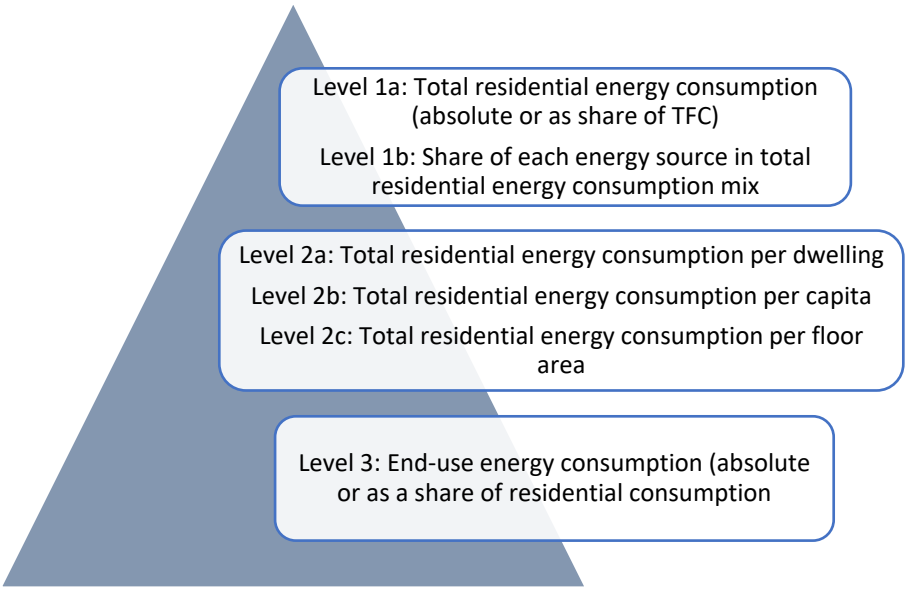
5.3. Residential sector

Unlike the commercial and industry sectors, the establishment of residential sector EEIs does not depend on the collection of data through the regulatory or mandatory requirements of submitting data by homeowners. However, like the commercial sector, the development of residential sector EEIs is 'pyramidal' but focusing on level 2a of residential sector energy consumption per dwelling. Figure 6.6 illustrates the pyramid of residential sector EEIs. Therefore, residential energy consumption per dwelling

[7] Refer to 'What does the industry sector mean and cover?', IEA (2014a).

is the recommended EEI for the overall residential sector. However, in addition to the overall EEIs, the development of EEIs should be classified under type of dwellings, i.e. houses, apartments, etc.

Figure 6.9: Pyramid of Residential Sector Indicators



TFC = total final consumption.
Source: Produced by author based on IEA (2014a).

Level 1a on total residential energy consumption, level 2a EEIs on per dwelling basis, and level 2b on per capita basis can be developed from the data of the Electricite du Cambodge (EDC). Level 2a EEIs can be used for the analysis and home energy reporting presented in Section 5.7 of this report. Level 1b on energy consumption mix, level 2c on residential energy per floor area, and level 3 on end-use energy consumption by appliance will require residential energy consumption survey.

6. Publication of Energy Consumption Data at the National Level

Having successfully collected and processed data and established EEIs, the task would not be complete if such useful information is not suitably disseminated nationwide. Energy consumption data and EEIs may be compiled and published in national energy statistics; websites; EEI promotion booklets; press releases; conferences and workshop; governmental and trade association publications; dialogue meetings with trade, professional, and academic bodies, etc. Feedback to the commercial and industry sectors, and, to some extent, the residential homeowners via home energy reporting (refer to Section 5.7) would be extremely useful for achieving national energy-saving targets.

To safeguard the interests of business entities and to publish reliable information, the following principles are recommended:

1) Ensure that the processed data are of good quality.
2) Published information should be precise and useful without ambiguity such that readers do not need to interpret the data. The publication should include trending graphs or charts, and any assumptions and basis used in the analyses. The graphs or charts should be simple and easy to understand.
3) The publication of EEIs should be aggregated to industrial or building sub-sector basis without publishing the names of business entities. In fact, only the trending of EEIs and/or average value should be published instead of the individual EEIs of each business entity. EEI benchmark values for the respective sub-sectors can be established and published after sufficient collection of data covering a few years. Such benchmark values should be deliberated on and accepted by stakeholders when the GDE is ready for such analyses and deliberation.
4) Ensure that the energy consumption information and indicators are reviewed and updated periodically before the next release of information.

7. Road Map (2020–2025)

Data collection to establish the EEIs is an important part of the EEC plan. According to the IEA, energy efficiency has the unique potential of simultaneously contributing to long-term energy security, economic growth, and even improved health and well-being as greenhouse gas (GHG) emissions can be reduced through the adoption of energy efficiency practices. To be effective in implementing EEC plans, it is important to develop and maintain reliable EEIs to achieve the following objectives:

1) To better inform the policy process and help decision makers develop policies that are best suited to meet domestic and/or international objectives;
2) To better inform and prompt business entities to explore energy-efficient measures that will save energy and improve energy productivity in their respective work premises, i.e. efficient use of energy resources.

The success of data collection for establishing the EEIs depends on the following factors:

1) the establishment of regulatory or mandatory requirements;
2) yearly budget and workforce resources of the implementation department or agency; and
3) effective planning.

Accordingly, recommended road-map activities for data collection and EEI establishment are given in Table 6.3. It is assumed that the establishment of regulatory or mandatory requirements is addressed separately from the planning of data collection and EEI establishment. Some of the proposed activities may be carried out in parallel whilst some activities may be carried forward to the following year. As highlighted in Section 6.4, EEIs, including BEI benchmark values, should only be established after continuous collection and analyses of data for at least 3 years.

Table 6.3: Recommended Road Map for 2020–2025 Activities

Phase	Description of Activity	Remarks
Phase 1a: 2020–2021	The GDE to head the formation of a task force to plan and design data collection and assessment formats	The task force may include key stakeholders from the commercial and industry sectors, and professional and academic bodies.
Phase 1b: 2020–2021	Establishment of an EEC resource centre with progressive increase of qualified and trained staff to spearhead collection, processing, and analyses of data	The GDE must estimate the number of designated premises required under the regulatory requirements and identify organisational structure and workforce required.
Phase 2a: 2021–2022	Conduct of technical workshops/forums to disseminate EEC measures, mandatory requirements, data collection to establish EEIs	Stakeholders from the business entities need to be informed and explained about energy management reports and data submission.
Phase 2b: 2021–2025	Collection, processing, validation, and analysis of data	Collecting, processing, and validating the data will be a continuous process.
Phase 3a: 2022–2025	Analysis and establishment of EEIs	Analysing and establishing EEIs will be a continuous process.
Phase 3b: 2023–2025	Further analysis and establishment of EEI benchmarking values, including engagement with stakeholders	After establishing sufficient EEIs, benchmarking values for the respective sub-sectors will be developed to drive the EEC agenda.

EEC = energy efficiency and conservation, EEI = energy efficiency indicator, GDE = General Department of Energy

Source: Author.

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