Chapter 2

Brunei Darussalam Commercial and Public Buildings Energy Consumption Survey

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Chapter 2

Brunei Darussalam Commercial and Public Buildings Energy Consumption Survey

1. Introduction

Commercial and public buildings accounted for 53% of total electricity consumption in 2015 – higher than in the residential and industrial sectors. Following the completion of the BDHECS, a similar survey was conducted for commercial and public buildings. The survey's primary objective was to understand the energy consumption patterns through building energy intensity (BEI), which is basically energy consumed per square metre of a building in 1 year.

The survey was carried out under an international cooperation framework similar to the BDHECS'. Experts from ERIA provided technical guidelines to develop the survey questionnaire and to validate and analyse data. BNERI and ME primarily managed the survey, including coordination with survey target respondents and data collation and analyses.

2. Survey Methodology

2.1. Sampling and Sampling Size

A total of 116 samples were collected throughout the 1-month field survey in Brunei-Muara, Tutong, and Belait, but not in Temburong because of logistical and budget constraints. Offices made up most of the samples at about 54%, followed by mosques at 23%, retail stores at 13%, hotels at 6%, and hospitals at 3%. Table 2.1 shows the distribution of samples by building type.

The evaluation of the energy performance of commercial and public buildings uses BEI, which is typically determined by the following formula (based on Malaysia's Green Building Index BEI computation):

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

where

BEI is the Building Energy Intensity (kWh/m^2/year),

TBEC is the annual total building energy consumption (kWh/year),

CPEC is the annual car park energy consumption (kWh/year),

DCEC is the data centre energy consumption (kWh/year), GFA is the gross floor area (m^2),

CPA is the car park area (m^2),

DCA is the data centre area (m^2),

GLA is the gross lettable area (m^2),

FVR is the floor vacancy rate (%),

AWH is the average weekly operating hours (hours/week), and

WOH is the weighted weekly operating hours (hours/week).

Table 2.1: Number of Samples by Building Type

Type of Equipment	Number of Samples	Share of Samples
Office	63	54.3%
Retail	15	12.9%
Hospital	4	3.4%
Hotel	10	6.0%
Mosque	27	23.3%
Total	**119**	**100%**

BEI has been widely used in many countries. Most ASEAN members have already developed their own green building rating systems to promote green and energy-efficient buildings. Indonesia has GREENSHIP, Malaysia has the Green Building Index, Singapore has Green Mark, whilst the Philippines has Building for Ecological Responsive Design Excellence. Different building categories have different BEI values depending on the function of the buildings and, therefore, their energy requirements. Each green building rating tool sets a minimum BEI value requirement for green building entry level.

Table 2.2 illustrates typical benchmark values used in Malaysia and Singapore for various building types, which can be used to compare BEI values for Brunei Darussalam in this study.

Table 2.2: Comparison of Building Energy Intensity Values in Malaysia and Singapore

Building Type	EUI for Green Mark, Singapore (kWh/m^2/y)		BEI for Green Building Index, Malaysia (kWh/m^2/y)	
	Conventional (Based on average 2008 EUI)	***Green Building Entry Level***	***Conventional***	***Green Building Entry Level***
Office Buildings	274	160	250	150
Hotels	274	260	330 (1–3-star) 480 (4–5-star)	200 (3-star and below) 290 (4-star and above)
Retail Buildings	389	360	400 (low-end outlets) 580 (high-end outlets)	240 (low-end outlets) 350 (high-end outlets)
Hospitals	354 (private) 341 (public)	N/A	330 (small/medium sized) 480 (large)	200 (small/medium sized) 290 (large)

BEI = Building Energy Intensity, EUI = energy use intensity.
Source: BCA (2018)

2.2. Questionnaire Preparation

A questionnaire was developed in consultation with study team members comprising staff from the Sustainable Energy Division (SED) of ME and BNERI, as well as experts from ERIA. For all sample types except for mosques, the questionnaire consisted of sections shown in Table 2.3.

Table 2.3: Questionnaire Sections and Details

Section	Details
A1	Name of Building
A2	Address
A3	Building Information • Building Age • Total Floor Area • Total Air-Conditioned Area • Total Non-Air-Conditioned Area • Maximum Number of People • Building Footprint Sketch
A4	Building Utilisation • Building Operating Hours per Day • Air-Conditioning System Operating Hours per Day • Building Operating Days per Week
A5	Data Centre or Server Room • Area • Total Electricity Consumption per Year (for the last 3 years)
A6	Electricity Consumption • Total Electricity Consumption per Year (for the last 3 years)

2.3. Distribution and Collection of Questionnaires

The questionnaires were distributed by the survey enumerators according to their assigned locations. Target respondents, through their focal persons, who were available during the survey, were interviewed face-to-face, and then given the questionnaires together with an official letter of information and request from ME. Focal persons who were unavailable for interviews were requested to respond to the questionnaire at their convenience. In such instances, the documents (questionnaires and official letters) were emailed or left with administration officers. After a period agreed on by enumerators and focal persons, completed questionnaires were collected and checked thoroughly by the enumerators.

For quality assurance, the following steps were undertaken: (i) training of enumerators to understand and interpret survey questionnaires, including simulated survey sessions; (ii) checking by individual enumerators; (iii) second checking by supervisors; and (iv) call back or revisit (random and spot checks) by the team leader or supervisor.

3. Data Validation

Out of 119 samples (Table 2.4), only 78 were deemed valid and complete, corresponding to about 65% of the total survey samples; 35% of the samples were not considered as most of the key data (electricity consumption or floor areas) were missing.

Table 2.4: Validated Samples with Respect to Total Samples

Type of Equipment	Number of Samples	Share of Samples	Number of Validated Samples
Office	63	52.9%	37
Retail	15	12.6%	4
Hospital	4	3.3%	3
Hotel	10	8.4%	9
Mosque	27	22.6%	25
Total	119	100%	78

Source: Author (2019).

3.1. Office Buildings

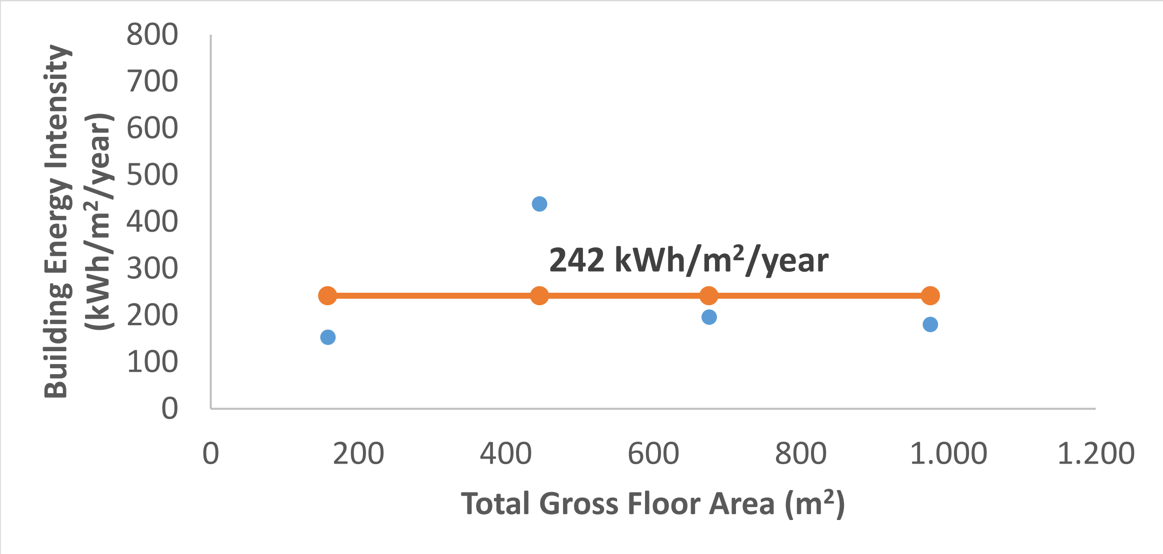
Electricity was the main source of energy in offices. Offices had varying operating hours and the average operational hours amongst the buildings surveyed worked out to be 2,028 hours per year, corresponding to an average of 39 operating hours per week. The surveyed data included working hours beyond the average official operational hours where the air-conditioning systems were still in operation. Nonetheless, total energy consumption was adjusted to reflect the same operational hours of 2,028 hours per year to rationalise energy consumption for comparison purposes.

Offices were grouped according to their size:

(i) small offices with gross floor area of less than 1,000 m^2,
(ii) medium-sized offices with gross floor area of 1,000 m^2 to 2,000 m^2, and
(iii) large offices with gross floor area exceeding 2,000 m^2.

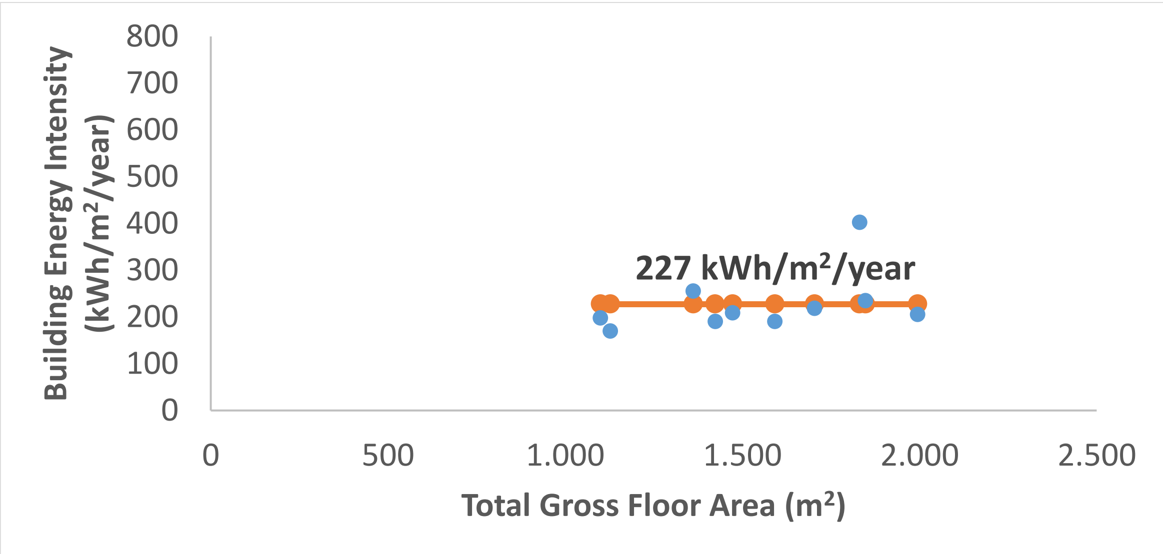
In general, the average BEI values were distinct from each other in accordance with office size. However, the average BEI value for medium-sized offices at 227 kWh/m^2/year (Figure 2.2) was slightly less than that for small offices at 242 kWh/m^2/year (Figure 2.1). This is comparable to offices in Singapore, where small and large offices have conventional BEI values of 268 and 212 kWh/m^2/year, respectively. For large offices in Brunei Darussalam, the average BEI value was about 275 kWh/m^2/year (Figure 2.3). Taking into account offices of all sizes, the average BEI was calculated as 258 kWh/m^2/year (Figure 2.4), which is higher than Singapore's and Malaysia's BEI values for conventional office buildings but in similar order of values (i.e. comparable values).

Figure 2.1: Building Energy Intensity Against Total Gross Floor Area for Small Offices



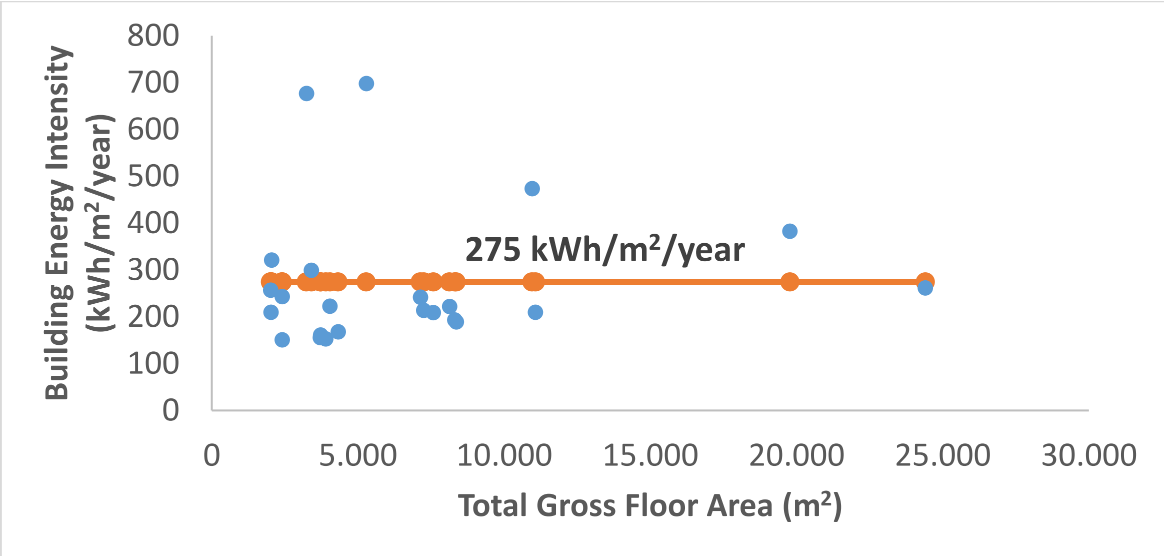
Source: Author (2019).

Figure 2.2: Building Energy Intensity Against Total Gross Floor Area for Medium-sized Offices



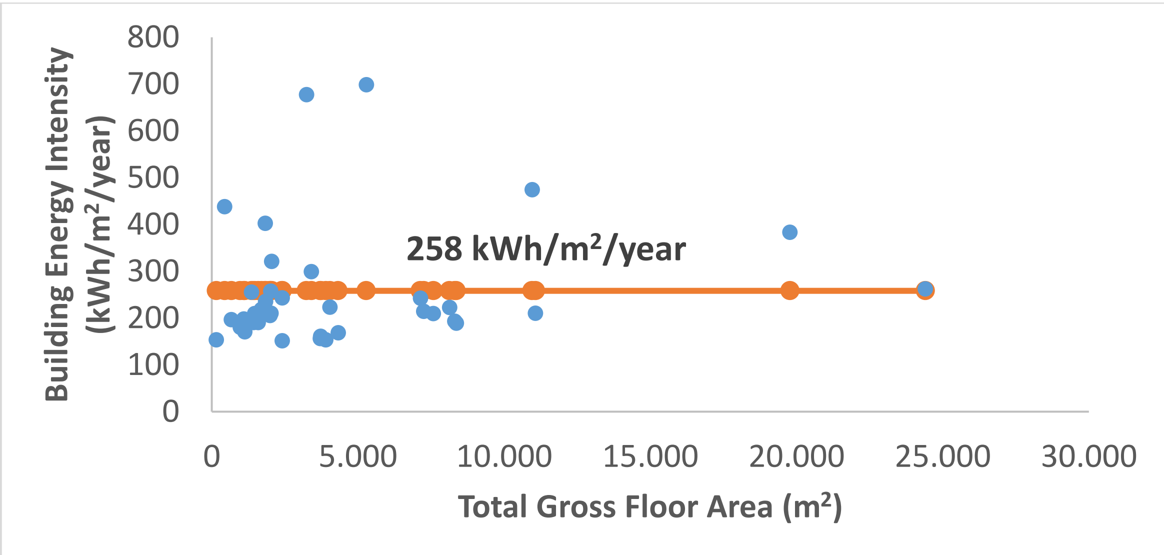
Source: Author (2019).

Figure 2.3: Building Energy Intensity Against Total Gross Floor Area for Large Offices



Source: Author (2019).

Figure 2.4: Building Energy Intensity Against Total Gross Floor Area for All Offices



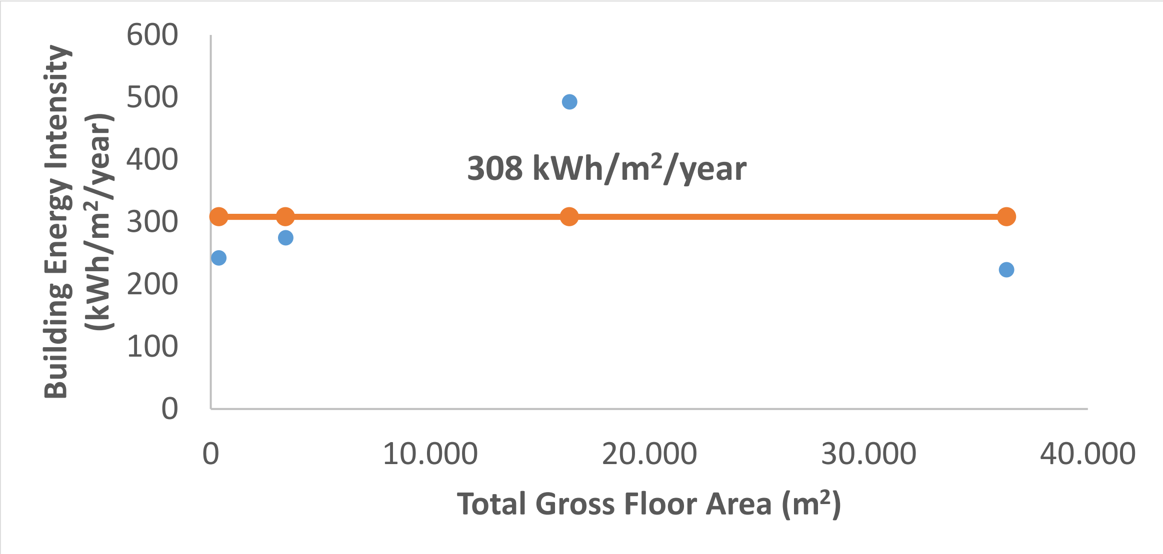
Source: Author (2019).

3.2. Retail Buildings

Retail buildings surveyed consumed mainly electricity, although a few large shopping malls also utilised LPG, primarily in their food and beverage section, and diesel, as fuel for back-up generators. Like offices, these buildings had different operating hours but averaged 81 hours weekly, which corresponded to 4,212 hours annually. Therefore, total energy consumption was adjusted to reflect the same operational hours of 4,212 hours per year to rationalise energy consumption for comparison purposes.

Figure 2.5 illustrates that the average BEI value was about 308 kWh/m²/year, based on a very small sampling size. The rest of the samples were found to have exceptionally low BEI values (less than 100 kWh/m²/year) and deemed outliers and therefore omitted from data analysis.

Figure 2.5: Building Energy Intensity Against Total Gross Floor Area for Retail Buildings

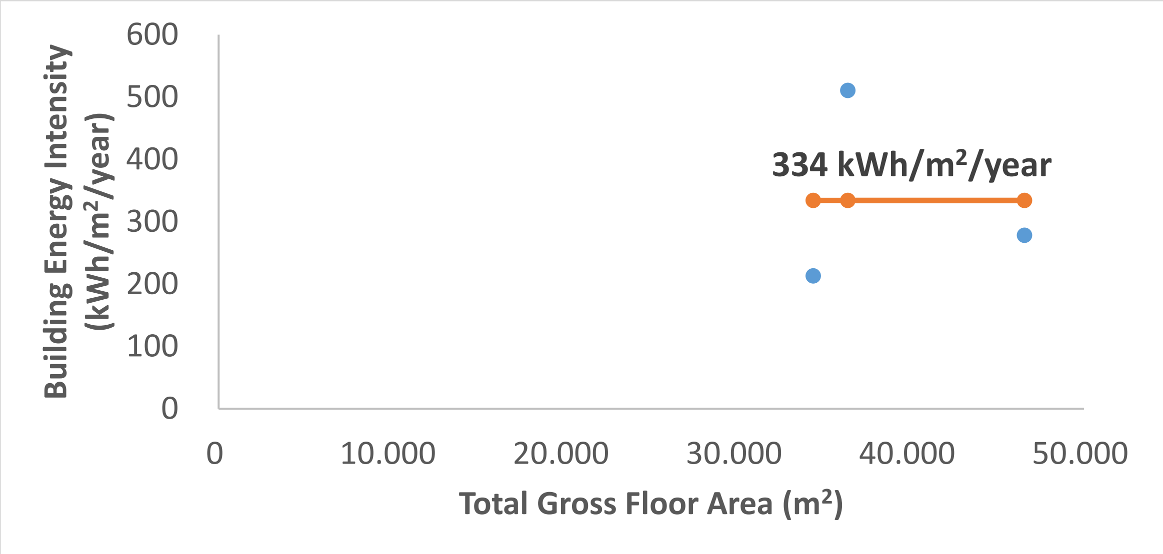


Source: Author (2019).

3.3. Hospital Buildings

Because of the limited number of samples, all the hospitals surveyed were large, with floor areas from 30,000 m² to 80,000 m². Most hospitals recorded BEI values from 213 to 511 kWh/m²/year, except for one with an exceptionally low value of 80 kWh/m²/year. Therefore, the computation of average BEI value for hospitals did not include this hospital as the value was considered an outlier. The average value worked out to be 334 kWh/m²/year (Figure 2.6). Electricity was the main source of energy for hospitals, with diesel as a secondary fuel for standby generators.

Figure 2.6: Building Energy Intensity Against Total Gross Floor Area for Hospital Buildings



Source: Author (2019).

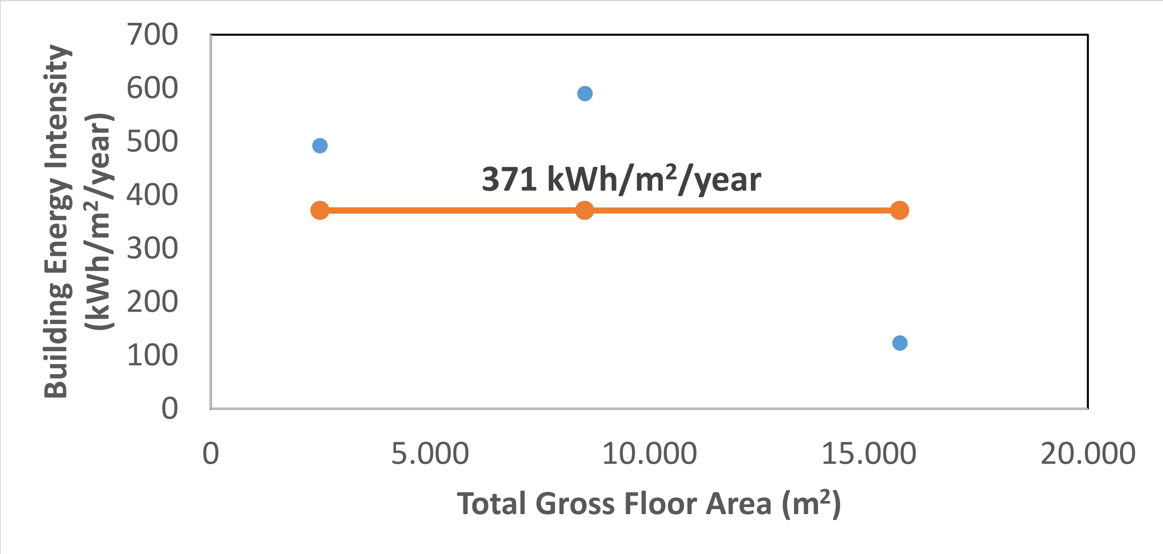
3.4. Hotels

Half of the 10 hotels surveyed were 3-star rated, whilst one was 4-star rated, two 4.5-star rated, and the rest 5-star rated. Electricity was the main source of electricity, followed by diesel for standby diesel generators and LPG for cooking.

Figure 2.7 and Figure 2.8 illustrate the vast difference in BEI values of 1–3-star and 4–5-star hotels. The average BEI value of 1–3-star hotels at 177 kWh/m^2/year was much lower than that of 4–5-star hotels at 371 kWh/m^2/year. The BEI value of 371 kWh/m^2/year for the 4–5-star hotels was much higher than for corresponding hotels in Singapore and Malaysia. This could mean that hotels in Brunei Darussalam have the potential to save energy if this BEI value could be accepted as the benchmark for conventional 4–5-star hotels.

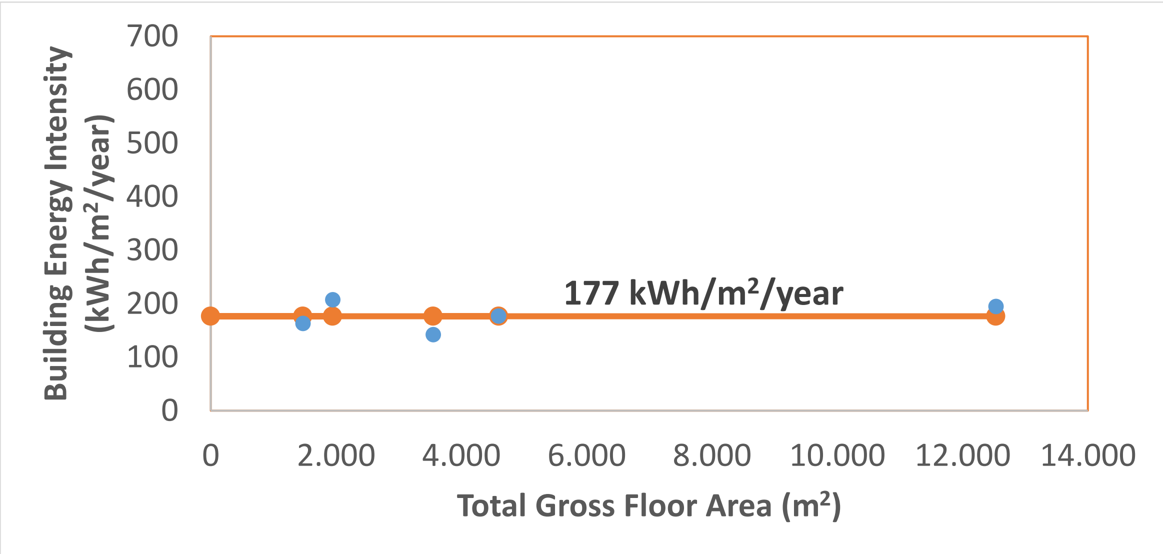
The 1–3-star BEI value of 177 kWh/m^2/year, however, seems low compared with Singapore's 274 kWh/m^2/year and Malaysia's 330 kWh/m^2/year for conventional hotels of the same class. The survey did not ascertain whether the difference might be due to low occupancy rates, fewer hotel facilities, or inadequate record keeping by 1–3-star hotels in Brunei Darussalam. Therefore, the average BEI value of 177 kWh/m^2/year for 1–3-star hotels needs to be further verified before it is adopted as the baseline BEI value for 1–3-star hotels in Brunei Darussalam.

Figure 2.7: Building Energy Intensity Against Total Gross Floor Area for 4–5-Star Hotels



Source: Author (2019).

Figure 2.8: Building Energy Intensity Against Total Gross Floor Area for 1–3-Star Hotels



Source: Author (2019).

3.5. Mosques

Like offices and retail buildings, mosques surveyed were grouped by size:

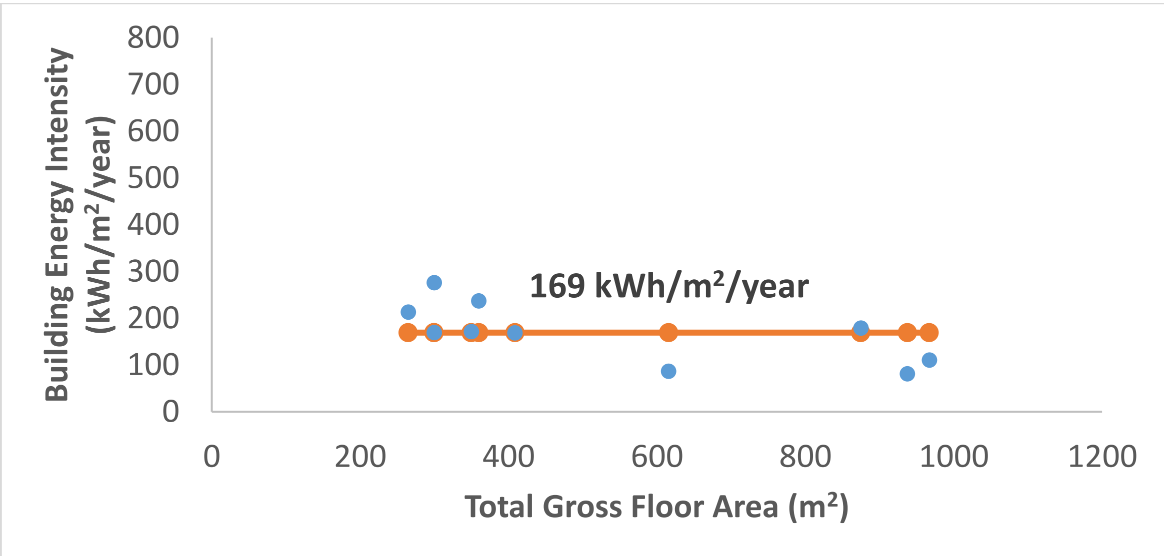
(i) small mosques or prayer halls with gross floor area of less than 1,000 m^2,

(ii) medium-sized mosques with gross floor area from 1,000 m^2 to 2,000 m^2, and

(iii) large mosques with gross floor area exceeding 2,000 m^2.

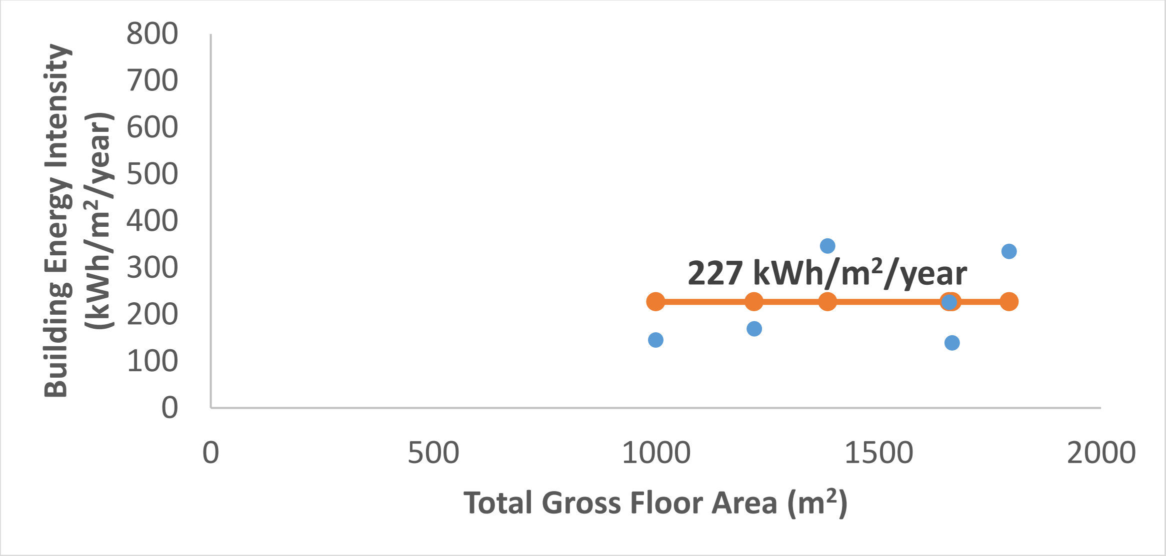
Electricity was the main source of energy for mosques. It was primarily used for air conditioning and lighting. As expected, the BEI value was influenced by the size of mosques (Figure 2.9, Figure 2.10, and Figure 2.11). Small mosques or prayer halls had an average BEI value of 169 kWh/m^2/year, followed by medium-sized mosques with 227 kWh/m^2/year, and large mosques with 323 kWh/m^2/year. The difference in BEI values was likely due to the extent of air-conditioning installations and usage. Small mosques were likely to have fewer air-conditioning installations and less usage, and smaller-capacity air-conditioning systems, whilst larger mosques were likely to have more air-conditioning installations and usage and larger-capacity air-conditioning systems. This is why large mosques had higher BEI baseline values.

Figure 2.9: Building Energy Intensity Against Total Gross Floor Area for Small Mosques or Prayer Halls



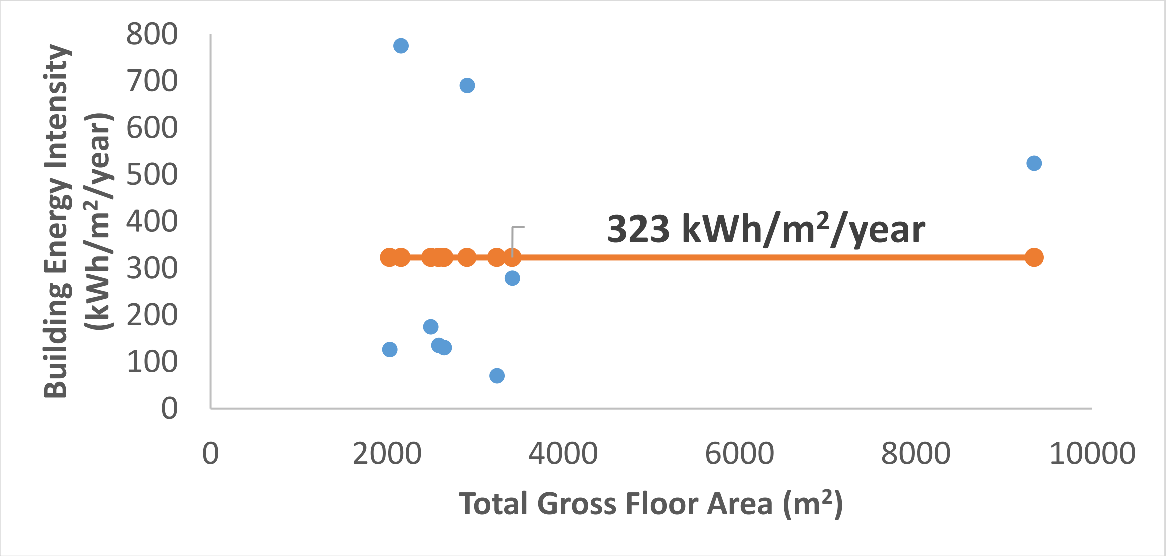
Source: Author (2019).

Figure 2.10: Building Energy Intensity Against Total Gross Floor Area for Medium-sized Mosques



Source: Author (2019).

Figure 2.11: Building Energy Intensity Against Total Gross Floor Area for Large Mosques



Source: Author (2019).

4. Summary of Key Findings

The key findings from the commercial energy consumption survey can be summarised as follows:

(i) The average BEI values derived from the survey are summarised in Table 10. Because of the limited number of survey samples, these BEI values were indicative baseline average values only for conventional buildings without energy efficiency measures. However, it appears that the BEI values for office buildings and mosques were more acceptable because of their more substantial number of samples. The BEI values for conventional retail buildings, hospitals, and hotels were not conclusive and should be analysed further using more samples.

Table 2.5: Summary of Average Building Energy Intensity Values for Conventional Buildings Derived from the Survey

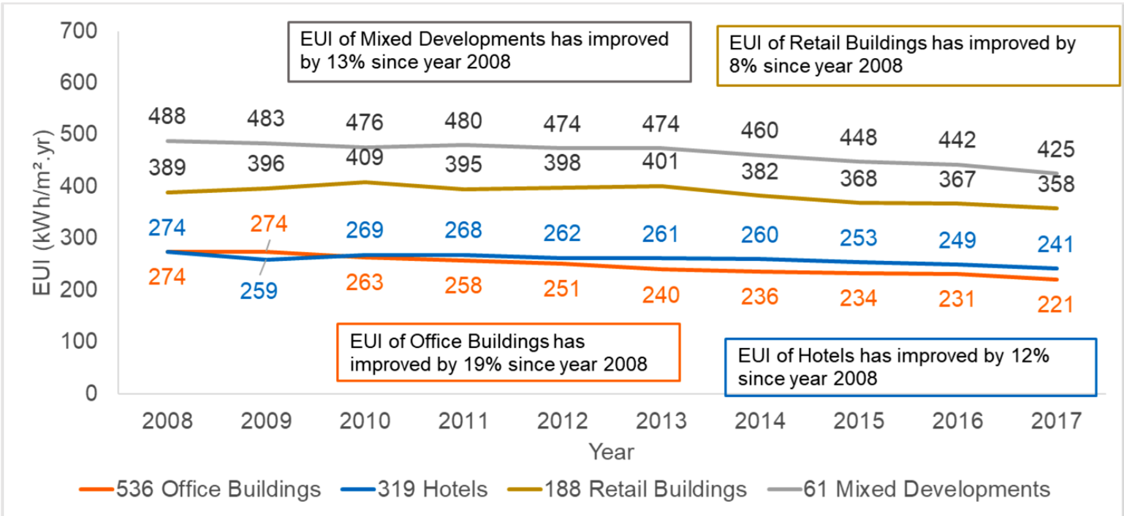
Building Type	Average BEI Derived from the Survey (kWh/m^2/year)	Remarks
Offices	Small: 242 Medium sized: 227 Large: 275 Overall: 258	The overall BEI value is similar to that Singapore (274 kWh/m^2/year) and Malaysia (250 kWh/m^2/year).
Retail Buildings	Overall: 308	This BEI value appears to be better than that of Singapore and Malaysia. However, the comparison may not be accurate as the sample was small and the extent of facilities maybe different.
Hospitals	Overall: 334	This BEI value is comparable with Malaysia's small and medium-sized hospitals' BEI.
Hotels	4–5 star: 371 1–3 star: 177	Because the sample is small, comparisons with Singapore and Malaysia's BEI values may not be meaningful.
Mosques	Small: 169 Medium sized: 227 Large: 323	Data to make a comparison is lacking. However, the trend of these BEI values shows that less usage of air conditioning (in the small mosques) indicates lower BEI value.

BEI = Building Energy Intensity.
Source: Author (2019).

(ii) Average BEI values by building type can help in monitoring national trends in building energy efficiency. Figure 33 shows average EUI (or BEI) against years, illustrating the trend of energy performance of Singapore office buildings, hotels, retail buildings, and mixed developments that have attained Green Mark certification since 2008. The EUI of office buildings has improved by 19% since 2008, hotels by 12%, retail buildings by 8%, and mixed developments by 13%.

If BEI labelling were adopted in Brunei Darussalam, however, energy savings would be greater because they would be compared with Brunei's BEI baseline values, which are higher than Singapore's EUI values in 2008 (Figure 2.12).

Figure 2.12: Average Energy Use Intensity Trend by Commercial Building Type in Singapore



EUI = energy use intensity.
Source: BCA (2018).

(iii) BEI labelling and benchmarking could be useful in driving the energy efficiency agenda in the commercial sector. Once the baseline BEI values are established for conventional buildings and minimum 'entry level' BEI values for energy-efficient buildings for the various building categories, energy savings can be easily quantified. Commercial viability can then be analysed and justified.

(iv) Despite the limited number of survey samples and the physical and financial constraints in conducting the survey, indicative BEI values for existing building stocks showed that energy savings could be made if BEI were used to drive the energy efficiency agenda and make the operation of buildings more energy efficient. In other words, if there were BEI labelling and BEI targets for energy-efficient buildings, which adopt energy efficiency measures, energy consumption in the commercial sector and, therefore, carbon dioxide emission intensity could be reduced.

5. Issues and Challenges

The survey faced challenges and limitations:

(i) **Sampling size.** Because of field survey time and budget constraints, the number of samples across some building types was low, especially hotels (nine validated samples), hospitals (three), and retail buildings (four). The number of samples was higher for offices and mosques, so the results for these buildings should be better.

(ii) **Data collection.** The answered questionnaires had missing items such as gross floor area and energy (electricity) consumption of buildings. The issue of missing data on electricity consumption in some buildings was resolved through DES, which checked the yearly and monthly electricity consumption through buildings' account numbers. The issue of missing gross floor area was far more complex as most of the buildings, especially the old ones, did not have accurate plans and drawings. Google Maps was used to measure area and results were not accurate, which resulted in questionable BEI values.

(iii) **Resources.** Most of the significant number of discrepancies discovered during data collection were difficult to rectify because of limited resources and time.

(iv) **Survey questionnaire.** It was designed with assistance from ERIA. Before the survey, the questionnaire was pilot tested to gauge field enumerators' understanding of it. Whilst no major changes were needed, enumerators took some time to understand the questionnaire, especially the sections on building information and building utilisation.

(v) **BEI.** BEI is relatively new and not well understood amongst building owners and management personnel in Brunei Darussalam. No regulatory frameworks are dedicated to BEI and energy management in general, so building managers are not obliged to record, monitor, or report regularly on BEI.

(vi) **Results.** The survey results were indicative as this was the first survey of its kind to be conducted in Brunei Darussalam and was not comprehensive. It is recommended that similar surveys be conducted separately, i.e. one survey per building type.

6. Green Buildings Action Plan

6.1. Background

The study's objective was to carry out a baseline survey to establish the current energy performance of commercial and public sector buildings in Brunei Darussalam. The study results provide first-hand information about current energy consumption of buildings in the country. While the information is useful, however, it is not sufficient to set national green building targets because the number of survey samples was limited. This section provides an outline of the next steps to increase the sustainability of the building sector and to promote the development of green buildings.

6.2. National Benchmarking Study

The study established baseline information on the energy performance of public sector and commercial buildings. The results are useful inputs to develop a national policy that promotes the development of green buildings. Following international standards, the study used BEI to measure energy performance and estimated the average BEI for each building category.

Because the number of samples was limited, the study results were insufficient to establish BEI target values for policy making. More samples are needed to establish a reliable database to develop policies on green buildings. The next step is to establish more accurate BEI values through a comprehensive building benchmarking study that will collect and analyse information and energy consumption data of all buildings.

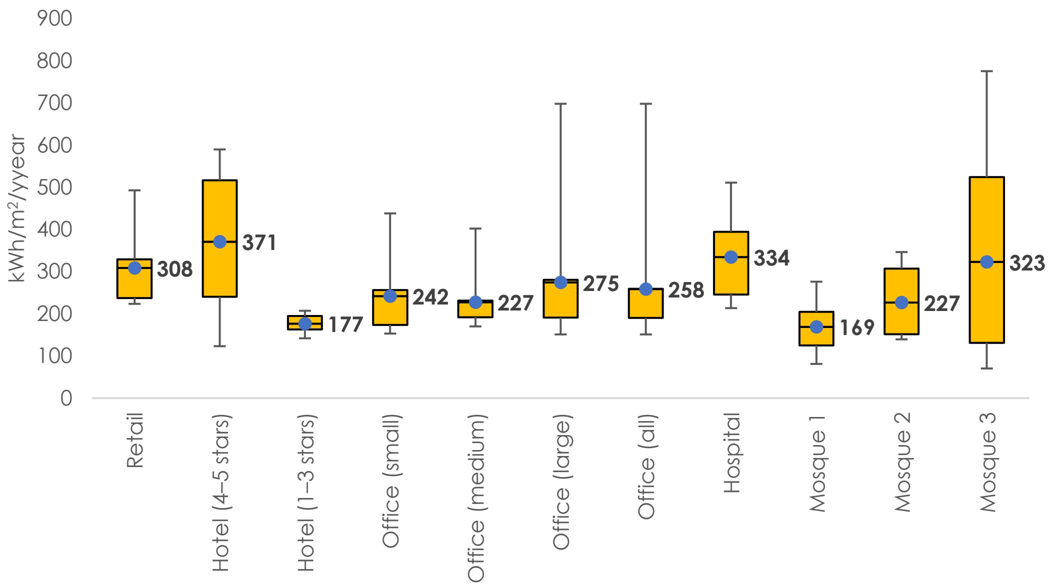
A detailed benchmarking study will enable (i) the government to more accurately assess buildings' energy consumption and efficiency and provide a more concrete basis to formulate policy measures to reduce the impact of buildings on the environment; (ii) building owners, facilities managers, and tenants to know the energy performance of their buildings and improve their energy efficiency; (iii) consultants and designers to have more effective guidelines and adopt best practices in designing or retrofitting energy-efficient buildings; and (iv) research and education communities to carry out research and studies using shared data to further advance green building technologies and solutions (BCA, 2014b).

6.3. Green Building Certification Scheme

The survey results are summarised in Figure 2.13. The box plot diagram shows the average values of the samples as well as maximum and minimum values of BEI by building category. Amongst the buildings covered in the survey, 4–5-star hotel buildings had the highest BEI, followed by hospitals, large mosques, and retail buildings. The results are an important input to the development of energy efficiency indicators under a national green building certification system.

The Ministry of Development (MOD) has introduced a rating scheme for government buildings called Brunei Accredited Green Unified Seal (BAGUS) (Kimura, Pacudan, Leong, and Phoumin, 2017). Three government buildings were awarded the BAGUS and required to reduce electricity consumption by more than 15% per year and to meet the government-mandated energy efficiency indicator of 175 kWh/m^2 per year.

Figure 2.13: Survey Results



Source: Author (2019).

The existing scheme could be further expanded to cover the private sector and other building types in addition to government office buildings. This expanded scheme should be hosted by a dedicated agency to be identified by MOD since a green building certification scheme covers much broader criteria. In Singapore, for example, the criteria include climatic responsive design (passive measures), energy efficiency, water efficiency, smart and healthy buildings, and other advanced green efforts. Malaysia's Green Building Index criteria include energy efficiency, indoor environmental quality, sustainable site planning and management, materials and resources, water efficiency, and innovation. A new set of criteria and procedures that are suitable for the country needs to be developed when introducing a more comprehensive green building certification system to cover both the public and private building sectors in Brunei Darussalam.

Under the energy efficiency criterion, BEI for different building types will be established for existing and new buildings. The target BEI values must be set based on specific studies and in consultation with various experts, industry practitioners, and other stakeholders. However, the full implementation of a green building certification scheme will take time as it will involve greater efforts and more stakeholders. As an interim measure, ME can look into establishing BEI labelling under the MEPS, which will be an easier and effective route to achieve energy-efficient buildings.

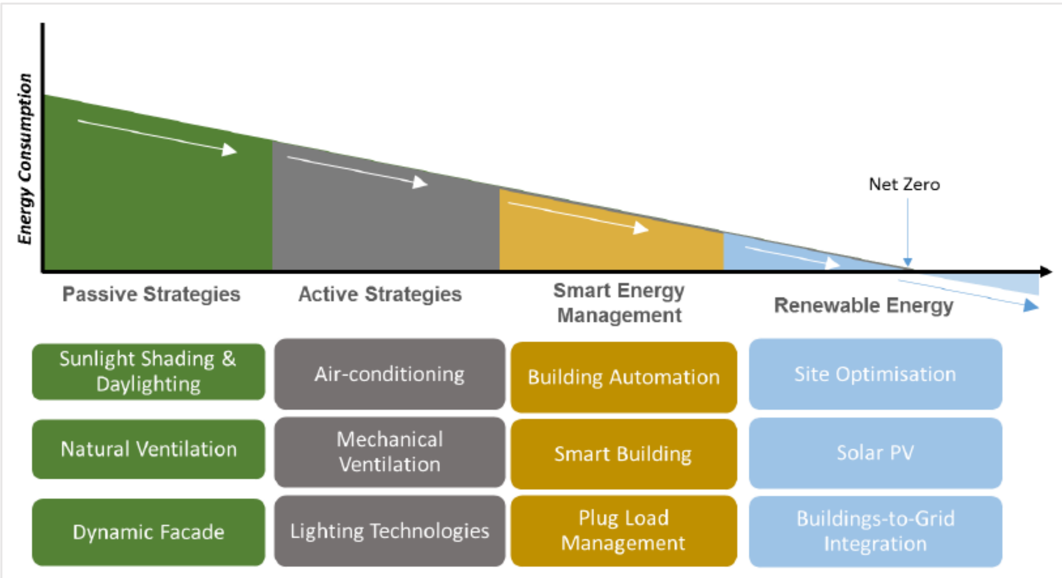
6.4. Technology Road Mapping

Kimura, Pacudan, Leong, and Phoumin (2017) identify technologies and strategies that could be applied in Brunei Darussalam, including passive design strategies, active design strategies, and the use of smart and green technologies. Singapore's BCA (2018) emphasises renewable energy technologies as the fourth area for energy efficiency in buildings (Figure 2.14). For a holistic approach to energy efficiency in buildings, passive design must be adopted before an active design strategy is considered (BCA, 2018; BCA, 2014a; Kimura et al., 2017).

Building energy efficiency studies have focused mostly on active strategies because the analysis has been centred on electricity demand and direct measures to reduce demand. The Mitsubishi Research Institute (MRI) (2012) found that about 80% of electricity demand in private buildings was mainly used for air conditioning, about 75% in government buildings, and about 70% in hotels and other buildings. Lighting constituted the second-largest end-use demand in the building sector with demand share of 10%–15%. Water heating is important in hotels and hospitals.

In technology road mapping, strategies and technical measures are identified and feasibility studies (technical and economic) carried out. The measures are ranked based on their cost-effectiveness. Cost-effective measures are then considered for policy interventions.

Figure 2.14: Energy Reduction Strategies Towards Low-energy Buildings



Source: BCA (2018).

Based on studies carried out in Singapore, strategic and technical options that could be adopted in Brunei Darussalam are outlined in Table 2.6. The list focuses mainly on existing technologies that could be readily adopted. The impacts of these measures were estimated for Singapore, but the results could provide a good reference for Brunei Darussalam. Most of the measures under passive strategies and plug load reduction technologies and strategies have medium impacts on BEI (5–10 kWh/m^2/year) whilst most measures under active strategies and smart energy management systems have high impacts on BEI (higher than 10 kWh/m^2/year).

Further studies need to be carried out and experts and industry stakeholders consulted when adopting these measures for technology road mapping. Some measures may be relevant only to some building categories and some may not be relevant at all. The measures' cost-effectiveness needs to be further assessed.

Technology road mapping could project the potential reduction of a green BEI in the medium (5 years) and long (10 years) terms. Aggressive but realistic green BEI targets could then be established.

Table 2.6: Existing Technologies and Strategies

Strategies	Technologies	Impacts
PASSIVE STRATEGIES		
Temperature control through insulation	Thermal insulation	L-M
	Insulated glazing	L-M
Temperature control through shading	Double skin façade	M
	Façade greenery	M
	Cool paints	M
Temperature control through natural ventilation	Wind-driven natural ventilation	M-H
Daylight redirecting technologies	Light shelves	L-M
	Tubular daylight	L-M
Building envelope	Insulation materials	M
	Solar heat shielding film	M
ACTIVE STRATEGIES		
Air conditioning and mechanical ventilation	Demand-controlled ventilation	H
	Dedicated outdoor air system	H
	Radiant cooling panels	H
	Active chilled beam	H
	Displacement ventilation	H
	Hybrid system: elevated temperature + increased air movement	H
	Advanced direct expansion type AC system	H
	VAV fan speed's optimisation system	M
	Energy efficient, oil less chiller	H
	Evaporative cooler	M-H
	Energy valve	M
	Solar air conditioner	M

	High-volume low-speed fan	M
Lighting technologies	Direct DC LED lighting with smart control	H
	Ambient + task lighting	L-M
	DALI smart lighting control system	H
SMART ENERGY MANAGEMENT SYSTEM		
Smart energy management system	ACMV optimisation	H
	Continuous commissioning	M
	Retro-commissioning	M
	Building energy management system	H
	Fault detection and diagnosis system	H
	Demand ventilation controls	M
	Weather sensing and adaptive controls	L-M
Solar PV	Integrate PV into architectural	H
	Co-location of solar PV and greenery	H
	Innovative lightweight structures	M
	Anti-degradation system	H
PLUG LOAD REDUCTION TECHNOLOGIES AND STRATEGIES		
Technologies impacting user behaviour	Individual technological control	M
	Centralised control systems	M
Reduce energy waste	Smart power strips	L-M
	Timers	L-M
	Computing and printing equipment	M
	Eliminate redundant equipment	M
Plug load reduction – change user behaviour	Smart WiFi timer plug with remote control	M
	Personal electricity consumption monitoring and benchmarking	L-M

Note: Impact on building energy efficiency indicators: low (L): < 5 kWh/m^2/year; medium (M): 5–10 kWh/m^2/year; high (H): >10 kWh/m^2/year.
Source: BCA (2018).

6.5. Building Energy Policies and Regulatory Frameworks

One challenge in improving the energy performance of the building sector and in deploying green buildings is the lack of or limited policy and regulatory frameworks. Most initiatives have been directed to public sector buildings.

Building Regulation

The legal frameworks for buildings are the Building Control Order (2014) and Building Control Regulations (APERC, 2015). MOD recently released the fourth edition of the mandatory Building Guidelines and Requirements (PBD 12: 2017). PBD 12 stipulates regulations related to space, light, and ventilation; structural, construction, and fire requirements; electrical installations; earthworks, roads, and water; and drainage and sewerage.

MOD issued the Energy Efficiency and Conservation Guidelines for Non-Residential Buildings in 2015, which is mandatory for public buildings. MOD and ME could, however, collaborate to make this guideline mandatory for the private sector as well to achieve greater energy savings.

Standards and Labelling Regulation

ME has conducted several preparatory studies and created implementation plans to introduce MEPS and labelling programmes. The plan is to focus initially on air conditioners and later cover refrigerators, lighting equipment, and others.

Various regulatory hurdles face the introduction of a mandatory standard and labelling programme. Perhaps ME could introduce a voluntary programme as a transitory phase and make it mandatory (with supporting legal frameworks) later.

6.6. Capacity Building and Awareness Raising

The lack of technical capacity is a limiting factor in the development of green buildings. ME is gradually building the capacity of energy managers in government buildings through training and a certification scheme for energy auditing and management. This programme could be expanded to the private sector.

Initiatives to increase awareness of energy efficiency have focused on the public sector. Since energy efficiency activities are limited, efforts related to energy efficiency information campaigns and awareness raising have also been minimal.

Aggressive capacity building and awareness raising are associated with implementing energy efficiency regulatory frameworks and programmes such as standards and labelling, building energy certification, benchmarking policy, amongst others. These activities must, therefore, be packaged together, with new initiatives related to building energy efficiency.

7. Conclusion

The commercial sector survey shows that more samples would produce more credible results. The results for office and mosque buildings are considered acceptable but show that energy savings could be made in the commercial and public building sector if BEI labelling and benchmarking were established. Baseline or benchmark indicators are needed so that building owners and management are well informed and able to monitor and assess the building energy performance of their buildings. Therefore, establishing BEI labelling and benchmarking within the MEPS framework should be explored and considered to attain energy efficiency in a shorter time.