International Energy Analysis Department
Energy Analysis and Environmental Impacts Division
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Analysis and Assessment of the Existing Landscape and Opportunities for Building Energy Efficiency in Selected Countries in Asia

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Table of Contents

List of Tables

List of Figures

Abbreviations

In addition to the below list, a number of single-use abbreviations and acronyms are also defined throughout the document text.

AC	Air conditioning
ACE	ASEAN Centre for Energy
ADB	Asian Development Bank
AEMAS	ASEAN Energy Manager Accreditation Scheme
AFD	Agence Française de Développement
AJEEP	ASEAN-Japan Energy Efficiency Programme
APAEC	ASEAN Plan of Action for Energy Cooperation
APEC	Asia-Pacific Economic Cooperation
APERC	Asia Pacific Energy Research Centre
ASEAN	Association of Southeast Asian Nations
BAU	Business as Usual
BCA	Building Construction Authority (Singapore)
BERDE	Building for Ecologically Responsive Design Excellence
CO_2e	Carbon Dioxide equivalent
DE	Distributed Energy
DKK	Danish Kroner
DOE	Department of Energy (Philippines)
EE	Energy Efficiency
EE&C	Energy Efficiency and Conservation
EDGE	Excellence in Design for Greater Efficiencies)
ERIA	Economic Research Institute for ASEAN and East Asia
ESCO	Energy Service Company
ESDM	Kementerian Energi dan Sumber Daya Mineral
EU	European Union
EUI	Energy Use Intensity
GBPN	Global Buildings Performance Network
GDP	Gross Domestic Product
GEF	Global Environment Facility
GIZ	Gesellschaft für Internationale Zusammenarbeit GmbH
Global ABC	Global Alliance for Buildings and Construction
HAPUA	Heads of ASEAN Power Utilities/Authorities
HCFC	Hydrochlorofluorocarbons
IDR	Indonesian Rupiah
IEA	International Energy Agency
IFC	International Finance Corporation
IRENA	International Renewable Energy Agency
JICA	Japanese International Cooperation Agency
KTOE	Kilotons of oil equivalent
LED	Light emitting diode
LGU	Local Government Unit

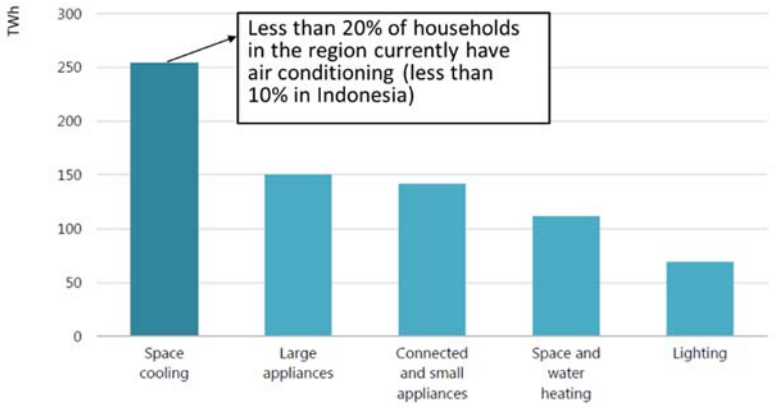
MASKEEI	Masyarakat Konservasi dan Efisiensi Energi Indonesia
NDC	Nationally Determined Contribution to the Paris Agreement on Climate Change
NZEB	Net Zero Energy Building
PLN	PT Perusahaan Listrik Negara (Persero)
PPP	Public-private partnership
PGBC	Philippine Green Building Code
SIDA	Swedish International Development Agency
TFEC	Total Final Energy Consumption
TOE	Tons of oil equivalent
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCAP	United National Economic and Social Commission for Asia and the Pacific
USAID	United States Agency for International Development

Executive Summary

This report examines ASEAN's building sector and the many opportunities that it offers for increased energy efficiency. The ten countries that make up ASEAN are diverse: the region contains some of the largest countries in the world by population, small highly developed city states, and a number of fast-growing economies with rapidly emerging middle classes. The report focuses mostly on the largest five of these markets: Indonesia, Malaysia, the Philippines, Thailand and Vietnam.

While their energy circumstances vary, the countries of ASEAN have one thing in common: increasing pressures on their energy systems, from ongoing economic and industrial growth, infrastructure and capacity constraints, a reliance on energy imports, and rising incomes leading to increasing demand for energy using appliances. Taken together, and with ASEAN countries expected to add building floor space of as much as 22 billion m^2 by 2060, optimizing energy use in buildings is therefore becoming an increasingly recognized policy priority in the region. Cooling is the most significant demand sector, accounting for a large percentage of energy usage and expected demand growth across the region, and penetration rates for air conditioning in many countries remain very low.

Sources of electricity demand growth to 2040 in Southeast Asia (IEA Southeast Asia Outlook, 2019)



ASEAN has set some relatively ambitious targets for energy efficiency, both as a region and at an individual country level. Member states aim to reduce energy intensity based on 2005 levels by 20 per cent in 2020, and 32 per cent in 2025. Recent progress towards these targets has been steady based on some countries moving towards more service-based, less energy intensive economies, and others moving away from inefficient traditional energy consumption at the household level.

There has also been a raft of supporting policy introduced to encourage energy efficiency in recent years. While many different initiatives have been supported, across building benchmarking, auditing schemes, building codes, green certification systems, financial incentives and support for the energy services company (ESCO) sector, many of the initiatives have been piecemeal, thinly resourced or poorly enforced, meaning that building energy efficiency's potential is largely untapped. The exception to this is Singapore, which is a world leader in both building efficiency policy and implementation,

and research and development into technologies and techniques that may be of broader interest to the region.

There are many positive developments in ASEAN related to more efficient buildings. For example, new law in the Philippines promises to catalyze actions by making it mandatory for building owners to report on opportunities. There has been a promising growth in green bonds issued specifically for green building projects. And there is an enormous range of support and financial resources provided by development agencies and investors, both in terms of technical assistance to governments, and facilitation support and financing for the nascent building energy efficiency industry.

The report analyzes each of the countries in the region and sets out their national circumstances, policy settings, particular opportunities and key active stakeholders. Based on this research, it concludes that the following topics are some of the most promising areas for further research and development to progress building energy efficiency in the region:

- Consistent approaches and common methodologies for classifying types, status and energy performance of the building stock.
- ESCO sector development assistance, to improve confidence in energy savings for retrofit projects.
- Financing for building energy efficiency through green bonds.
- A focus on innovative cooling and air conditioning technologies, which as a research theme, could focus on business models (e.g. 'cooling as a service'), technology (e.g. research into non-vapor compression types, automation and control systems, improving the use of natural ventilation and other passive cooling strategies, and advanced window coatings), policy and standards.
- Harmonization of building codes and ratings.
- A focus on Indonesia, Philippines and Vietnam as the locus of impact for policy and finance-related initiatives.
- Better information on the economic benefits of building energy efficiency, including the multiple resultant social and economic co-benefits that might accrue alongside energy savings.

Further scoping work in any of these recommended areas would need to be undertaken, to design interventions and identify partners and take actions forward.

1. Introduction to this study

Study terms of reference and scope

Asia Clean Energy Partners was engaged by Lawrence Berkeley National Laboratory (LBNL) in September 2020, to undertake a scoping study to assess opportunities in the area of building energy efficiency research and implementation in selected countries in Asia.

This report is targeted towards potential building sector policies and interventions related to energy efficiency, rather than broader activities related to energy sector reform and the transition to renewable power generation. This means that the focus of the reports data collection and analysis is on demand-side energy efficiency measures rather than on policy or regulatory measures targeting electric utilities or generators (e.g., utility obligations or pricing reforms). The report considers both commercial and residential buildings, for both new-build and retrofits, and the typical suite of policy and regulatory levers that may be applied to the sector.

This report is primarily a desktop review supplemented by inputs from expert country focal points, who have provided up-to-date country data where possible, and have reviewed the country sections to ensure that they are up to date and fairly reflect the current status of energy-efficiency efforts (data, technologies, programs) related to buildings in each country. The study team collected and analyzed available energy sector and building sector data to form as clear a picture as possible of the current status of building energy efficiency in each country, the context of energy use in the building sector; building energy efficiency regulations and policies that are active or under development; prevailing technology issues; and a summary of major stakeholders and actors in the sector.

Ultimately, the study aims to identify areas of opportunity-by technology, business model and/or country—for further engagement of local actors towards meaningful building sector initiatives either regionally or in particular countries.

Geographic Coverage

The report focuses on the five largest ASEAN markets (Indonesia, Malaysia, the Philippines, Thailand and Vietnam), which taken together comprise 89% of ASEAN's energy demand. The report presents brief summaries for the five less developed and/or smaller markets in ASEAN - namely Brunei, Cambodia, Laos, Myanmar, and Singapore. Singapore is a special case, in that its research and activities related to EE building research and policies are the most advanced in ASEAN and are well regarded globally. Its domestic market and energy efficiency circumstances are very well studied, and therefore this report does not place detailed emphasis on further study related to Singapore. Given that it has more available data and well established and tested building energy efficiency initiatives, Singapore can serve as a test-bed for new energy efficiency approaches, and its institutions can lend significant expertise to any expansion of scaled up energy efficiency building research and implementation in the region.

Data limitations and challenges

In any multi-country desk study such as this, it is challenging to collect complete, comprehensive, up to date and reliable data; therefore, the findings presented in this report are subject to interpretation and further investigation. Further, the comparability of data may be an issue, in that there are different categorizations applied by different countries, in terms of building class descriptions, and impact and applicability of different policies. Not all data points that would have been desired were available, especially related to building and construction data, data on the quality of existing building stock, and consistent evaluations of existing policies and their energy savings potential.

Examinations of the building sector tend to be either nationally based or too high-level to provide the resolution required by this study. However, the study team has been able to gather and present local insights and data on building energy efficiency, and the data presented on energy sector parameters is relatively solid and comparable. This means that the report findings can be used to assess the relative level of building energy efficiency efforts, make broad comparisons across countries, and inform the scope and nature of building sector energy efficiency programs and initiatives that might be of interest for the region. It is noted that the ASEAN Centre for Energy plans to release the 6th ASEAN Energy Outlook in coming months, and this will be an important further source of reliable information.

Report Structure

The report begins with a detailed regional overview, and the different countries of ASEAN are presented at a high level, in terms of their economic, energy and building sector characteristics. The initial section also covers some of the technology trends and emerging issues in the region, and discusses potential drivers of energy efficiency action that may be influential in different markets.

This overview is followed by five country-specific chapters that go into more detail on the major ASEAN economies, covering their building sectors, energy efficiency policies, and setting out the major stakeholders active in energy efficiency in each market. A summary chapter covering the remaining five ASEAN countries not covered above is also presented, for completeness.

Finally, the report lays out a set of conclusions regarding potential opportunities for future building energy efficiency measures in the region, with a view to priority technologies, business models, policy frameworks and potential for investment, which may be pursued as part of recommended further studies.

2. Regional Overview

The Energy Circumstances, Building Sectors and Drivers of Improved Energy Efficiency in ASEAN Countries

Energy and Economic Variations between ASEAN Member States

ASEAN comprises 10 countries of varying size, development levels and economic circumstances (refer Table 1, figures of interest highlighted in red). The five countries that form the focus of this report comprise approximately 87% of ASEAN population and 89% of total final energy consumption (TFEC). Indonesia alone dominates the region, accounting for 36% of regional TFEC and 41% of regional population, while Indonesia, Thailand and Vietnam taken together account for more than 70 per cent of ASEAN member states' TFEC, around ten times higher than that of Cambodia, Laos and Myanmar combined (GIZ, 2019).

Table 1. Key Economic and Energy parameters of ASEAN Member States

	Popul-ation ('000s), 2019	TFEC (million tons of oil equivalent /mtoe), 2019	Energy use per Capita (toe), 2019	Energy demand growth, 2007-17 (avg annual % growth)	% of primary energy used in buildings	% energy imports as a share of total primary energy production
Brunei Darussalam	433	1.3	3.0	2%	63%	3%
Cambodia	16,250	6.6	0.4	9.2%	37%	72.4%
Indonesia	270,626	174.0	0.6	2.8%	38%	12.9%
Lao PDR	7,169	3.1	0.4	5%	57%	24%
Malaysia	31,950	60.6	1.9	3.3%	14%	51.8%
Myanmar	54,045	19.8	0.4	4.3%	61%	23.3%
Philippines	108,117	33.4	0.3	5.2%	35%	126.5%
Singapore	5,804	24.7	4.3	5.8%	10%	29,800%
Thailand	69,428	98.9	1.4	3.1%	15%	110%
Vietnam	95,545	64.1	0.7	4.1%	22%	36.7%
ASEAN	**659,367**	**486.6**	**0.8**	**3.3%**	**-**	**-**

Sources: BP (2019), Enerdata (2019), UNESCAP (2020). Note that figures for Lao PDR energy demand growth are for 2000-2015.

Indonesia is by far the largest producer of energy in ASEAN, using 26% of the total primary energy in the region. In 2016, Indonesia also was the third largest oil importer and user of oil and the tenth largest electricity generator in the world (IEA, 2016). Indonesia's energy needs are expected to continue to increase in the future along with increased economic activity and the level of prosperity of its citizens.

Southeast Asia has some of the fastest growth in energy and electricity demand in the world. Between 2000 and 2015 the region's overall energy demand has nearly doubled,

with growth of 80% during the period. This trend is likely to continue until 2030, when universal access to electricity is expected to be reached with an estimated 45 million more people having access to electricity. Growth rates have generally been higher in less developed countries, reflecting rapid economic growth from low bases, energy access deficits, and the increasingly energy-intensive consumption preferences of large and growing middle classes.

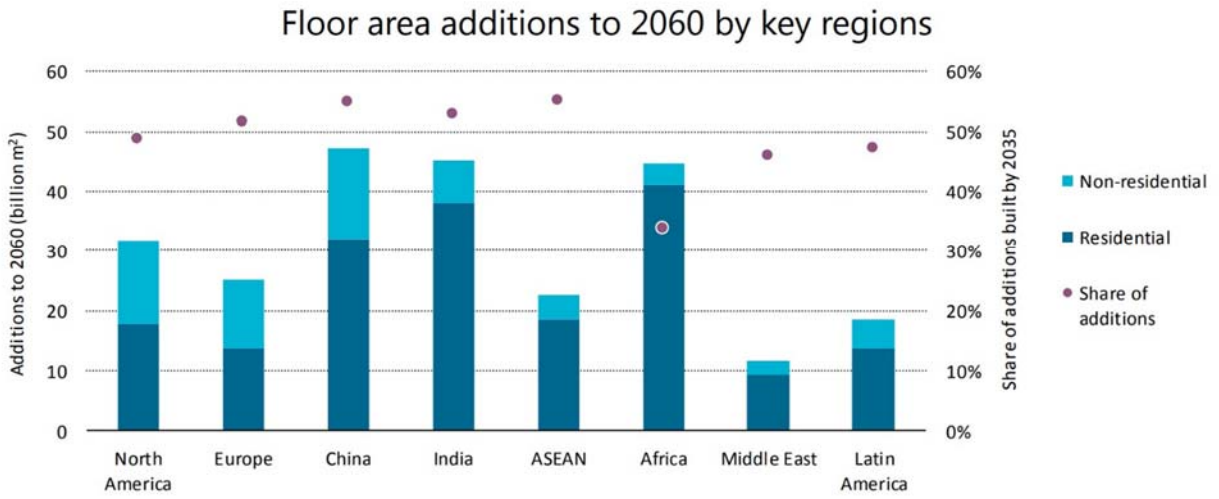
Another driver of building energy efficiency is energy security, and the reliance on imported energy supply, which can expose the country to economic and geopolitical fluctuation. Cambodia, Malaysia, Philippines, Vietnam are the countries in ASEAN most reliant on energy imports; therefore energy efficiency may be a more important lever in the eyes of policymakers in those countries.

ASEAN member states have generally achieved high (over 90%) rates of electrification and access to energy, with the exception of Myanmar (approximately 35%) and Cambodia (approximately 70%) (HAPUA Directory, 2016). Energy efficiency efforts in scarcity environments may be more difficult to implement than in countries with full energy access; however it also poses an opportunity to leapfrog inefficient practices as access grows (Efficiency for Access, 2020). Of further interest regarding energy sufficiency is the variation in per capita energy consumption figures; this suggests that rising incomes in less developed countries is likely to underpin further robust growth in energy demand, underscoring the importance of energy efficiency actions related to the building sector.

Size of the Buildings Sector in ASEAN countries

ASEAN countries are expected to add approximately 8.5 billion m^2 of floorspace to their collective building stock between 2015 and 2025, and as much as 22 billion m^2 by 2060, representing growth of about 55% over current levels. Residential buildings are expected to account for over 80% of floorspace additions (IEA, 2017). Although there are disparities in the pace of growth in construction output among the different ASEAN member states, in 2018 the region's construction industry as a whole was estimated to grow by 6.1% on an annual average basis in the period to 2024 (GlobalData, 2018). However, this growth is likely to be tempered by the impact of the COVID-19 pandemic, which will slow demand and investment activity in hard-hit countries such as Indonesia and the Philippines. Reforms have been underway to encourage Public Private Partnerships (PPPs) in Indonesia, the Philippines, Myanmar, Lao PDR and Vietnam to create more accessible markets for private sector investment in construction and increase incentives; land ownership is another area that has been reformed in Indonesia and Vietnam, to make the process of acquiring land fairer and more transparent.

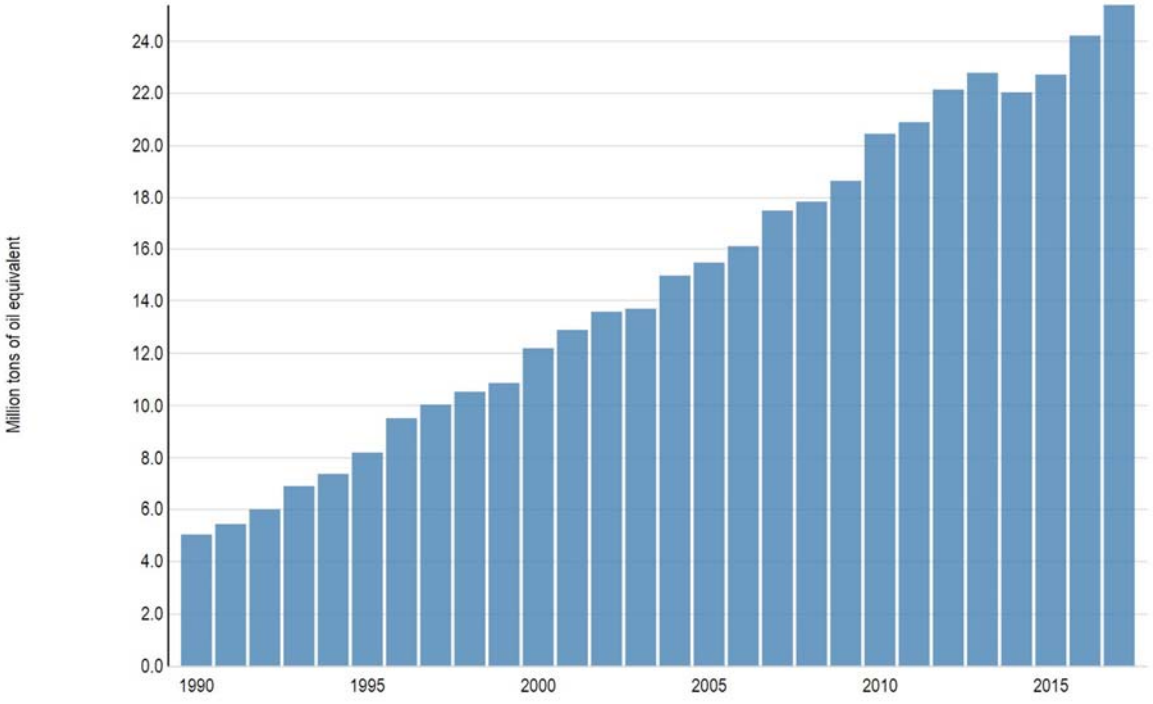
Figure 1. Global Building Stock Floor Area Additions by 2060



Source: UNFCC & IEA, 2017

Historically, building total final energy consumption has grown the slowest of all sectors at average rate of 2.3%/year from 1990-2007 (Figure 2); this is forecast to accelerate slightly since to expected growth of 2.6%/year through 2030 (UNESCAP, 2019). Building electricity use from lighting, appliances and equipment has grown more quickly, at around 6% per year on average since 2000. Residential space cooling demand is the largest factor, with air conditioner ownership nearly tripling and associated energy consumption quadrupling over the last two decades.

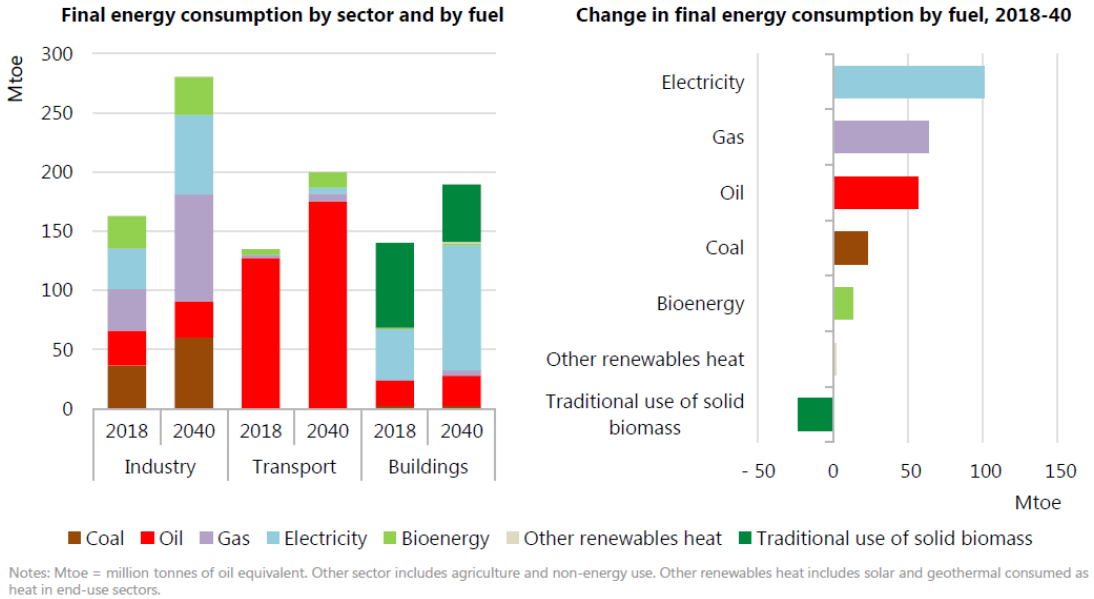
Figure 2. ASEAN Commercial and Public Services Buildings Final Energy Consumption, 1990-2017



Source: IEA, World Energy Statistics and Balances, 2020

Overall, by 2040 total final energy consumption in the building sector is expected to increase by 35% from the 2018 reference year (IEA, 2019). The building sector is expected to see a 250% increase in electricity use by 2040, with 70% of the increase in electricity demand originating from the residential sector (refer Figure 3). This increase in electricity demand somewhat offsets the expected reductions in the use of traditional biomass, mainly for heating and cooking.

Figure 3. Projected South East Asian energy consumption in the IEA's 'Stated Policies' Scenario



Notes: Mtoe = million tonnes of oil equivalent. Other sector includes agriculture and non-energy use. Other renewables heat includes solar and geothermal consumed as heat in end-use sectors.

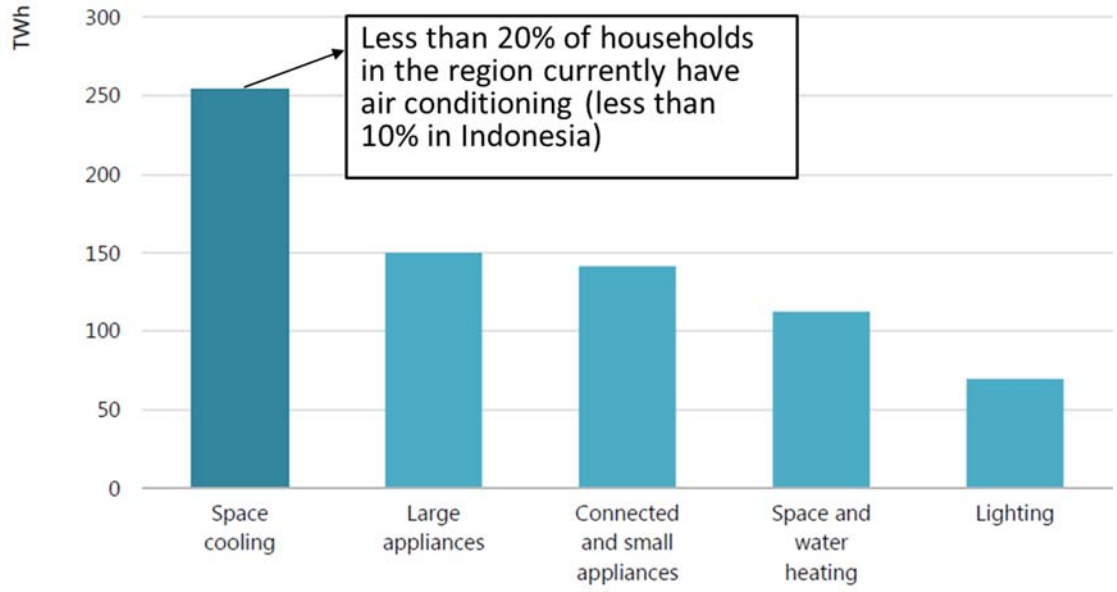
Source: IEA, 2019

Reliable data on energy consumption and efficiency benchmarks for ASEAN countries' buildings sectors has not been identified. This could be an area for future study, to inform future opportunities (refer Chapter 9).

Building Energy Use by Technology

Current and comparable ASEAN-wide data for energy demand by different technologies is not readily available; however, in terms of projected growth, the largest expected increase in electricity demand for buildings by 2040 is space cooling (250 TWh), followed in order by large appliances (150 TWh), connected and small appliances (140 TWh), space and water heating (110 TWh), and lighting (70 TWh) (Figure 4).

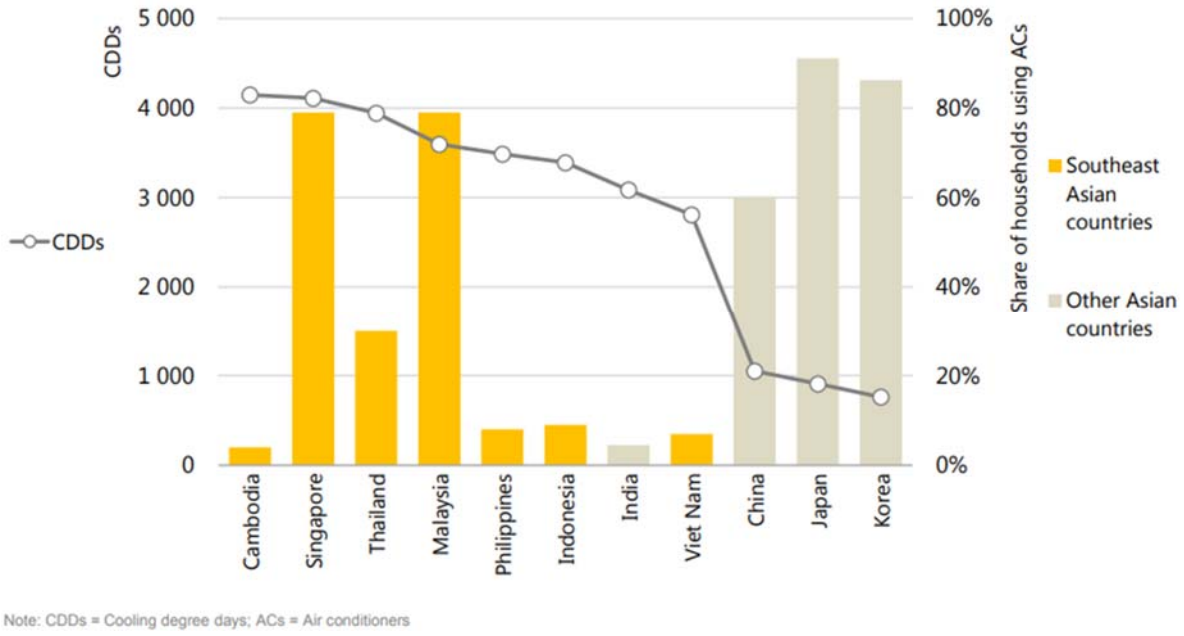
Figure 4. Sources of electricity demand growth to 2040 in Southeast Asia



Source: IEA Southeast Asia Outlook, 2019

Cooling electricity use in buildings in Southeast Asia has increased from 10 TWh in 1990 to around 80 TWh in 2018. There remain large disparities in air conditioner penetration across the region with ownership of almost 80% of households in Singapore and Malaysia, compared to less than 10% of households in Cambodia, Indonesia, Philippines, and Viet Nam. Combined with the region's climate that sees it record some of the highest cooling degree-days globally every year, this demonstrates the significant potential for increased adoption of efficient air conditioning technologies in the region, and underscores the importance of ensuring efficient equipment is available in key markets as they grow (Figure 5).

Figure 5. Cooling degree-days and share of households using air conditioning systems by country, 2017



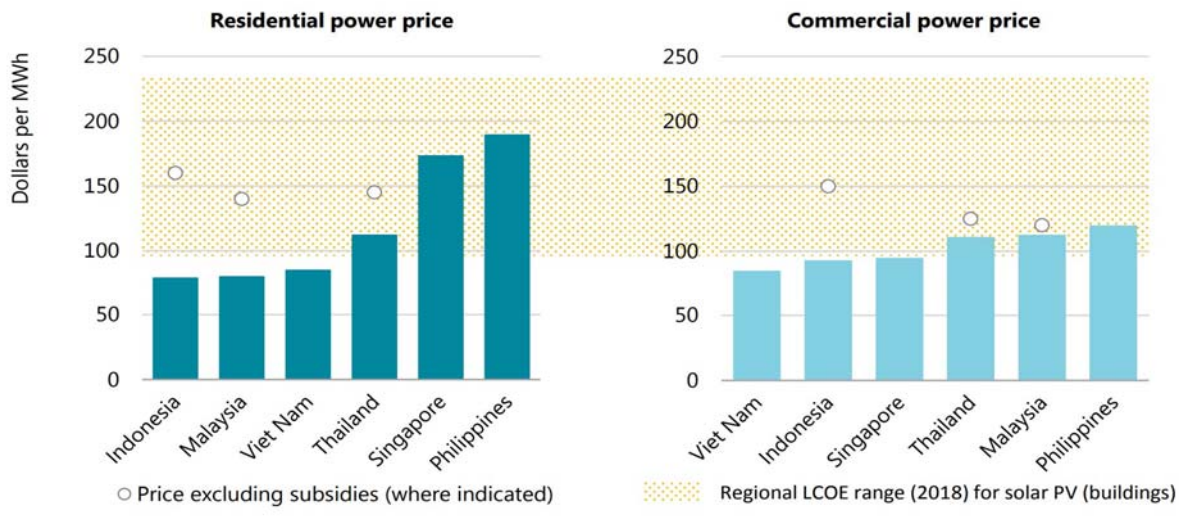
Source: IEA Southeast Asia Outlook, 2019

Moreover, energy use for cooling warrants being a substantial focus of further building energy efficiency efforts for the region. The IEA's Stated Policies Scenario estimates that the number of air conditioners in the region will increase from almost 40 million units in 2018 to nearly 350 million in 2040, largely for use in residential buildings. Indonesia is likely to see the biggest adoption, resulting in the country running around 50% of all installed air conditioners in Southeast Asia. This results in an increase in space cooling electricity consumption to around 330 TWh by 2040 as compared with the 80 TWh observed in 2018. Assuming that stronger policies to encourage the use of more efficient AC units are not adopted, an estimated 150 gigawatts of additional generation capacity would be required by 2040.

Energy tariffs

Energy costs and electricity tariffs can be a major driver of building energy efficiency. With the exception of high residential electricity tariffs in the Philippines and Singapore, and while aggregated comparisons do not always tell the full story of regional, volume-stepped and time-of-use variations, electricity tariffs among the major countries of the region have remained relatively consistent and relatively low, as per Figure 6. For comparison, average residential and commercial costs of electricity in the US in August 2020 were USD133/MWh and USD109/MWh respectively (EIA, 2020); China's average residential and commercial electricity tariffs, as of March 2020, were USD81/MWh and USD100/MWh respectively (Global Petrol Prices, 2020).

Figure 6. Average retail power tariffs in selected Southeast Asia markets and levelized cost of electricity (LCOE) for distributed solar PV



Notes: LCOE = levelised cost of electricity; MWh = megawatt-hour; solar PV = solar photovoltaics. LCOE range is expressed in real terms.

Source: IEA Southeast Asia Energy Outlook, 2019

Greenhouse reductions as an imperative for building energy efficiency

Despite the region's potential for renewables, only approximately 15% of energy demand is met by them. Energy intensity of the generation sector is also an indicator of both commitment to cleaner energy solutions, and the greenhouse imperative that energy efficiency can offer. Table 2 sets out ASEAN member states' progress towards decarbonization of the energy sector. Of note is the dominance of Indonesia in the region in terms of overall emissions, and also the energy intensive nature of Vietnam's economy, despite its efforts in renewable energy uptake.

Table 2. Renewable Energy and Greenhouse Gas Emissions in ASEAN

	Renewables as a % of total final energy consumption, 2017	Total emissions from fuel combustion, 2017 (million tonnes CO_2e)	Carbon Intensity (kg CO_2e/$GDP at 2010 PPP)
Brunei Darussalam	0.0%	7	0.50
Cambodia	18.8%	11	0.59
Indonesia	6.3%	496	0.46
Lao PDR	19.3%	5	0.29
Malaysia	5.2%	211	0.58
Myanmar	6.0%	30	0.46
Philippines	11.5%	126	0.42
Singapore	0.7%	47	0.15
Thailand	17.3%	244	0.58
Vietnam	25.7%	191	1.09
ASEAN	**15.0%**	**1,370**	**0.49**

Note: includes only 'modern' renewable energy sources (i.e. excludes biomass). Lao PDR figures are for 2016.

Source: UNESCAP (2020)

Expected future building sector trends – technologies and services

Increasing Urbanization, Population Growth and Industrialization

Even after accounting for the recent downturn caused by the COVID-19 pandemic, ASEAN continues to be one of the strongest-growing regions of the world in terms of both population and economic output. Increasing urbanization is also increasing energy demand in buildings; in every historical case, greater urbanization and the associated increase in the number of middle-class households with more discretionary income has helped fuel a big net increase in energy use, while greater population density and market concentration also facilitate the provision of an increasing variety of energy-intensive goods and services, which tends to raise total energy consumption (Kemp, 2019).

As the incomes of ASEAN's middle classes rise and access to electricity improves, a clear trend is towards the increasing penetration of air conditioning (IEA, 2019). IEA predictions of air-conditioner (AC) adoption have the number of AC units in the ASEAN region rising from 40 million in 2017 to 300 million in 2040; half are expected to be in Indonesia. The large adoption of AC units provides concerns about the energy efficiency of available AC and the increased building electricity load.

IEA (2019) estimates that increased building energy efficiency measures could reduce cooling-related electricity consumption by 35% relative to the Stated Policies Scenario in 2040. This results in a generation capacity of 100 gigawatts to meet cooling needs, instead of the 150 GW in the Stated Policies Scenario, offering significant cost savings. For residential buildings, greater emphasis on increasing building envelope performance and passive or hybrid strategies while raising the awareness of the impacts of consumer behavior are critical actions to reduce cooling loads. Key actions for the commercial building sector include incorporation of thermal storage technologies and hybrid cooling systems, tenant education and carbon footprinting, effective energy management and operations, and smart controls.

Common services for efficiency: localized generation and microgrids, building integrated PV, and centralized heating and cooling models

The adoption of decentralised energy (DE) systems has been rapid in several ASEAN countries, driven by lack of energy access and increasing energy demand. More rural areas with less energy access, such as in Cambodia and Myanmar, have seen DE adoption to supply schools and clinics with electricity. Regional plans for localised electricity generation and development of microgrids varies across countries. Countries like Thailand, Malaysia, and Vietnam are also looking to cost-effectively extend grids into rural areas using this technology (Paulos, 2019).

DE changes some parameters for the way that power is generated and transmitted to the grid. Smaller power sources such as building integrated solar photovoltaic (PV) panels can be used individually or aggregated to supply power to the grid. Data plays an important role, allowing the flow of information among multiple parties and facilitating dynamic adjustments to real-time market and operational conditions, in turn creating efficiencies for transmission and distribution networks. Benefits can also accrue in creating system resilience, where availability of power generation close to the consumer is less

susceptible to transmission and distribution outages; this can be a significant advantage in areas of poor grid reliability.

As building owners and energy managers turn their thoughts towards deeper energy savings, technologies that enable smart energy 'precincts' begin to offer possibilities. Linkage between energy production and consumption across a range of buildings in a single location can yield substantial benefits in allowing economies of scale for efficient equipment, and the balancing and smoothing of supply and demand to optimise equipment utilization and efficiency. Examples of this approach in ASEAN include:

- *District cooling in Cyberjaya, Malaysia:* Cyberjaya was conceived in the 1990s as a high-tech city akin to Silicon Valley near Kuala Lumpur in Malaysia. Since then the development has incorporated many leading efficient technologies, including a district cooling system (DCS). Running off two plants and a 15km underground network, the DCS supplies chilled water for the air-conditioning needs of 40 multi-storey buildings within Cyberjaya's flagship zone, including Wisma Shell, Multimedia Development Corporation (MDeC), and various government agencies. The system utilises off-peak electricity at night to chill water for the buildings' air-conditioning use during the day, thus reducing electricity usage by more than 65% compared to traditional air-conditioning systems.
- *T77 complex, Bangkok* – the T77 site is home to the world's largest blockchain-based peer-to-peer (P2P) solar power trading project. Four of the precinct's buildings are connected to a P2P energy network. Three of these buildings are equipped with different sized rooftop solar panels totaling 635 kilowatts capacity to meet their own electricity needs, or to trade excess with other buildings within the network. Different building types in the network ensure different electricity use patterns. At times, some buildings would have excess solar electricity to sell, while at other times they may need to buy it from neighboring buildings. A blockchain-based application, using a virtual token to represent each unit of energy traded, allows the buildings within the network to trade solar electricity in real time. This helps optimize the decentralized energy system, matching the different demand profiles to maximize system efficiency.
- The advent of electric vehicles and the subsequent potential for vehicle-to-grid applications is also an expected trend, allowing the substantial battery storage of EVs to become a significant contributor to load smoothing and demand management. Singapore is making advances in this regard; however, many of these new business models are subject to evolving market structures and regulations, so there is still uncertainty as to when they will become more mainstream (Deloitte, 2020).

Digitalization

Digitalization refers to the possibility for smart control of appliance use and building energy systems, through advanced metering and data availability, coupled with IoT technologies. Being able to extract and use digital information through such platforms allows optimisation of building set points and controls that can create superior performance by synethesising and using external data in building management, such as climate and weather data, occupancy information, smoothing of existing energy loads against on-site production, and prevailing spot electricity prices. IEA analysis (2017) on the role of digitalization in buildings finds that such smart controls and connected devices

could save 230 EJ in cumulative energy savings to 2040, lowering buildings energy consumption by as much as 10% globally, while improving thermal comfort and delivering greater amenity to building occupants. Those savings would also help reduce the carbon intensity of the power sector through better management of energy supply and demand across the grid.

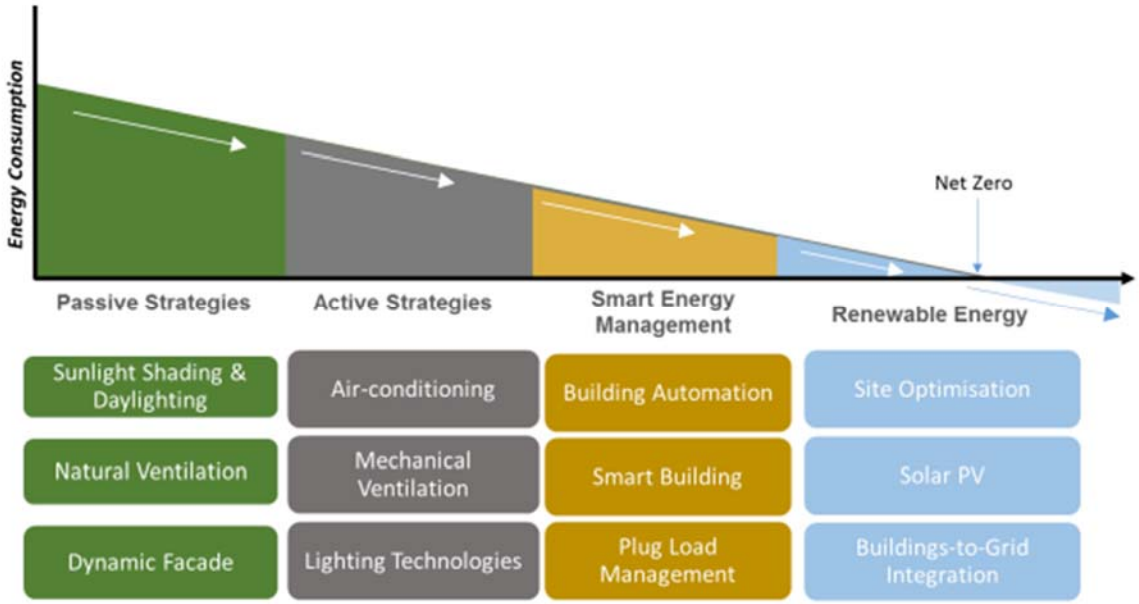
Net-positive buildings, Net zero energy buildings (NZEB), net zero carbon buildings, and 'nearly NZEB' design and construction

With the mass purchasing of air conditioners comes the adoption of stronger building codes. Not only have more building codes been introduced, but the introduction of net zero energy building plans and certifications are being seen across the region (Chen and Burros, 2020). The first EDGE Zero Carbon building in the Philippines was certified in October 2019, and at least two other buildings are expected to be certified (Remo, 2019). Also, in 2019, the National University of Singapore released the plans for the first NZEB to be built from scratch in Singapore (Wong, 2019). Singapore has some NZEB which were created by retrofitting existing buildings, such as the Building and Construction Authority Academy building.

Other movements towards Zero Energy Buildings can be seen through the launching of country specific facilitation programmes in the region. One such program is Malaysia's 'Zero Energy Building (ZEB) Facilitation Program' which seeks to promote the adoption of NZEBs in Malaysia (SEDA, 2019).

Singapore's Building and Construction Authority has set out a useful 'Super Low Energy Building Technology Roadmap', which charts a technological pathway towards NZEB and net-positive buildings, with an emphasis on the incremental adoption of different applicable technologies as building owners move from passive strategies to more active management (Figure 7):

Figure 7. Schematic of technology and management strategies towards Net Zero Energy and Net-Positive Buildings



Source: BCA, 2018

The BCA's Roadmap identifies more than 60 potential solutions from enhanced existing technologies and emerging R&D innovations under the above four categories. It estiamtes that achieving 60% energy efficiency improvement (over 2005 levels) is technically feasible with best-in-class technologies today.

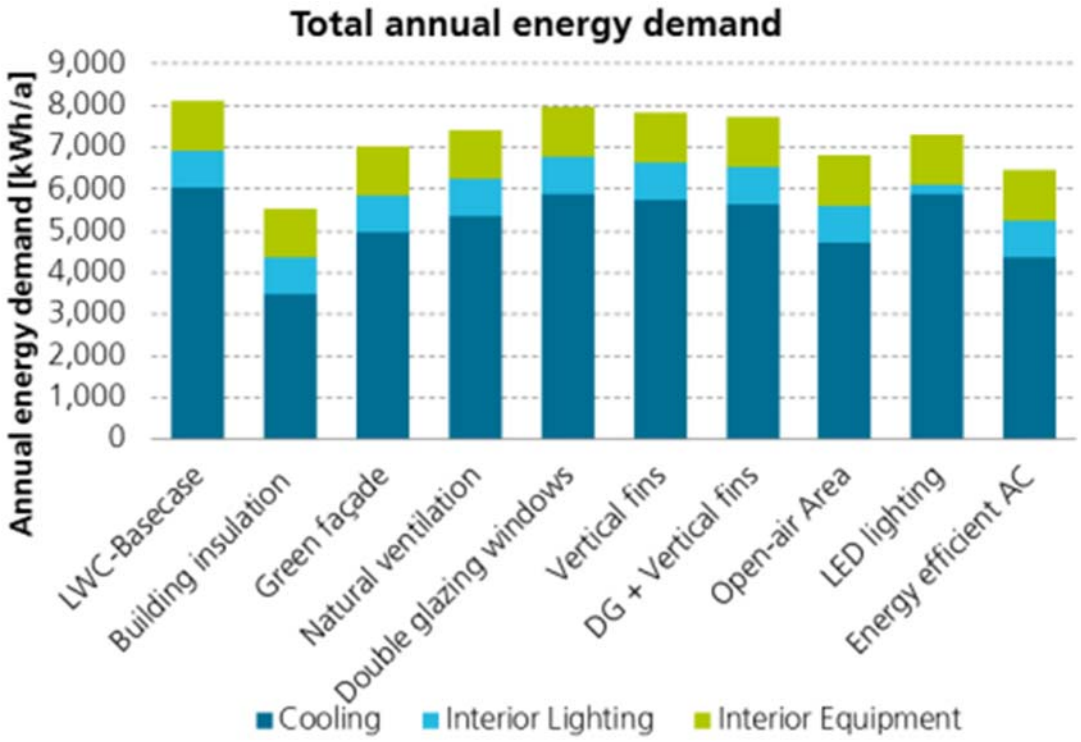
In brief, key developments and trends in the most important technologies to achieve the transition towards lower energy buildings include:

- Passive strategies across insulation, natural ventilation, low energy facades and daylighting; dynamic glazings and advanced coatings; high performance windows.
- Lighting, in particular LED lighting that has made enormous gains in cost and efficacy in recent years.
- Mechanical cooling: while vapor-compression air conditioning technology still dominates the landscape in ASEAN, there are at least 20 alternative cooling technologies in varying degrees of commercialization (Goetzler, 2014). Given the prevailing climate, of importance in Southeast Asia is the role of dehumidification in cooling energy requirements: reducing air moisture content through e.g. desiccant dehumidification before mechanical cooling could yield significant energy benefits, and also enable evaporative, radiant and ground cooling techniques (Katili et al, 2015).
- Sensors and controls: these technologies are in widespread use in developed countries as a means of overcoming inefficient user behavior and optimizing a range of energy systems. A recent study of R&D priorities in Singapore determined that further research into adaptive occupancy controls, self-adaptive systems and embedding intelligence in building management software were among the highest priority for further development (BCA, 2014).

In terms of the relative impact of different technologies, an interesting study was completed by the Fraunhofer Institute (2017) into relative benefits of different

technologies using a standard single-family row-house design from the National Housing Authority (NHA) of Thailand as a base case building. Figure 8 shows a summary of the study's findings on the analyzed building: overall, double glazed windows led to the lowest reduction in the energy demand, while the biggest effects are achieved by insulating the building envelope, and an energy efficient air conditioning system. Combing all described measures leads to a reduction of the energy demand of 62% compared to the base case; if the open-air area is considered as well, the reduction is 65%. Further study is required to estimate the impacts of more advanced technologies such as sensors and controls, which are typically not deployed in the residential context.

Figure 8. Reductions in residential energy demand in Thailand due to different technologies



Source: Fraunhofer Institute, 2017

While it is not an energy efficiency measure or technology *per se*, it is also worth noting that indoor environment quality and a building's 'usability' is often an important aspect of technologies that improve energy efficiency in buildings. Given that energy may be a small percentage of operating outlays for building owners, a more significant factor in building the business case for undertaking energy efficiency projects may be in payoffs in wellbeing or productivity of occupants. Energy efficiency technologies may save energy by, for instance, creating responsiveness to user behavior through localized controls; however the real benefits may be reflected in other areas, such as reduced staff absences, improved building image, and flow through effects on increased leasing rates and property values. It is common that some of these non-energy benefits and payoffs may help to financially justify measures and further acculturate energy efficiency practices (Malone, 2014).

Energy Service Companies, Energy Efficiency Financing and Green Bonds

Energy Service Companies (ESCOs) deploy a long-standing model under which the savings from an energy efficiency retrofit project can be used to pay for the upfront capital costs over the cooperation period. An energy performance contract is used to apportion the risk of the project's performance to the ESCO, and savings can be shared between the end user and the ESCO for the period of the contract, after which they accrue to the end user directly.

There are many studies about the success (or otherwise) of ESCO markets around the world, and it is out of scope for this paper to cover this topic in detail. In summary, the ESCO industry is relatively embryonic in many markets around the world, and the countries of ASEAN are by and large no exception: many ESCOs suffer from a lack of scale and balance sheet strength, and a lack of contractual confidence for their services, such that many financially viable energy efficiency projects do not get financed. There can also be a tendency for building owners to focus only on the most profitable opportunities, at the expense of a more systematic approach that captures greater savings; in many cases, very-cost effective measures can be used to balance out less cost-effective measures, still at an acceptable rate of financial performance and return. If this 'cream skimming' approach is taken to performance contracting, it can lock out future investments and savings that may have been realized with a more concerted and consolidated approach.

A lack of confidence in the achievement of project energy savings (on which repayment streams are based) can also result in financial institutions assessing risk for energy efficiency projects at unjustifiably higher levels, which leads to higher interest rates on loans and requirements for asset-backed security and/or energy saving guarantees for projects. The smaller size of some energy efficiency upgrade projects also deters investors from financing such projects, given the transaction costs incurred to become comfortable with the perceived risks (ACE 2019). For green buildings specifically, factors such as the perception of high upfront costs, a mismatch between the life of the asset and its holding period in a portfolio, and split incentives that incline market participants against investment in energy efficiency technology have precluded expansions in investment to optimize building energy efficiency's potential. Many finance schemes have targeted the proliferation of the ESCO sector, including for example by providing partial guarantees or concessional finance for ESCOs, in order to make their business model more viable and attractive to business owners.

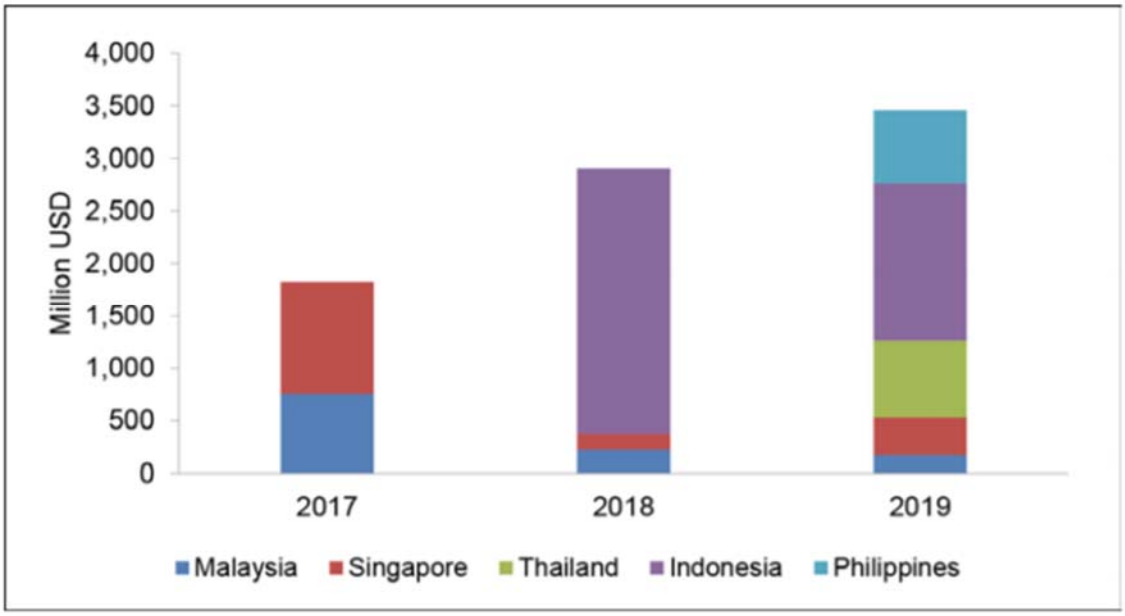
The green bond market is also emerging in ASEAN as an important source of financing for projects or assets with positive environmental or climate change mitigation benefits. Green bonds differ from conventional bonds because their proceeds are devoted to environmentally beneficial or climate positive investments with specific impact achieved for a given period of time (Asian Development Bank, 2018).

There is strong institutional support for green bonds as a means of financing from the governments of Indonesia, Singapore, Philippines and Malaysia. In Indonesia, green bonds are issued by the government, while in Singapore and Malaysia, issuance of green bonds is supported by green bond grants that cover the cost of labeling bonds "green" (Azhgaliyeva, Kapoor, and Liu 2020; Azhgaliyeva, Kapsalyamova, and Low 2019; Azhgaliyeva and Liddle 2020). Indonesia issued nearly half (49%) of the green bonds in ASEAN (Figure 7), coming in as the largest issuer of green bonds in ASEAN over the period

2017–2019, followed by Singapore (19%) and Malaysia (15%). Issuance of green bonds in ASEAN is growing fast, increasing by half in 2018, and nearly doubling in 2019 compared to 2017; nevertheless, ASEAN issued only around 1%–2% of the global green bonds issued annually (ADB, 2020).

Interestingly, in the ASEAN green bond market (Figure 9), green buildings are one of the main projects green bonds are issued to fund, accounting for 44% of green bond proceeds in 2019 compared to a global avereage of 18%, attributed in part to the climate of ASEAN countries and the higher imperative to reduce cooling loads as a response to climate change commitments (ADB, 2020).

Figure 9. Issuance of Green Bonds in ASEAN by year



Source: ADB, 2020

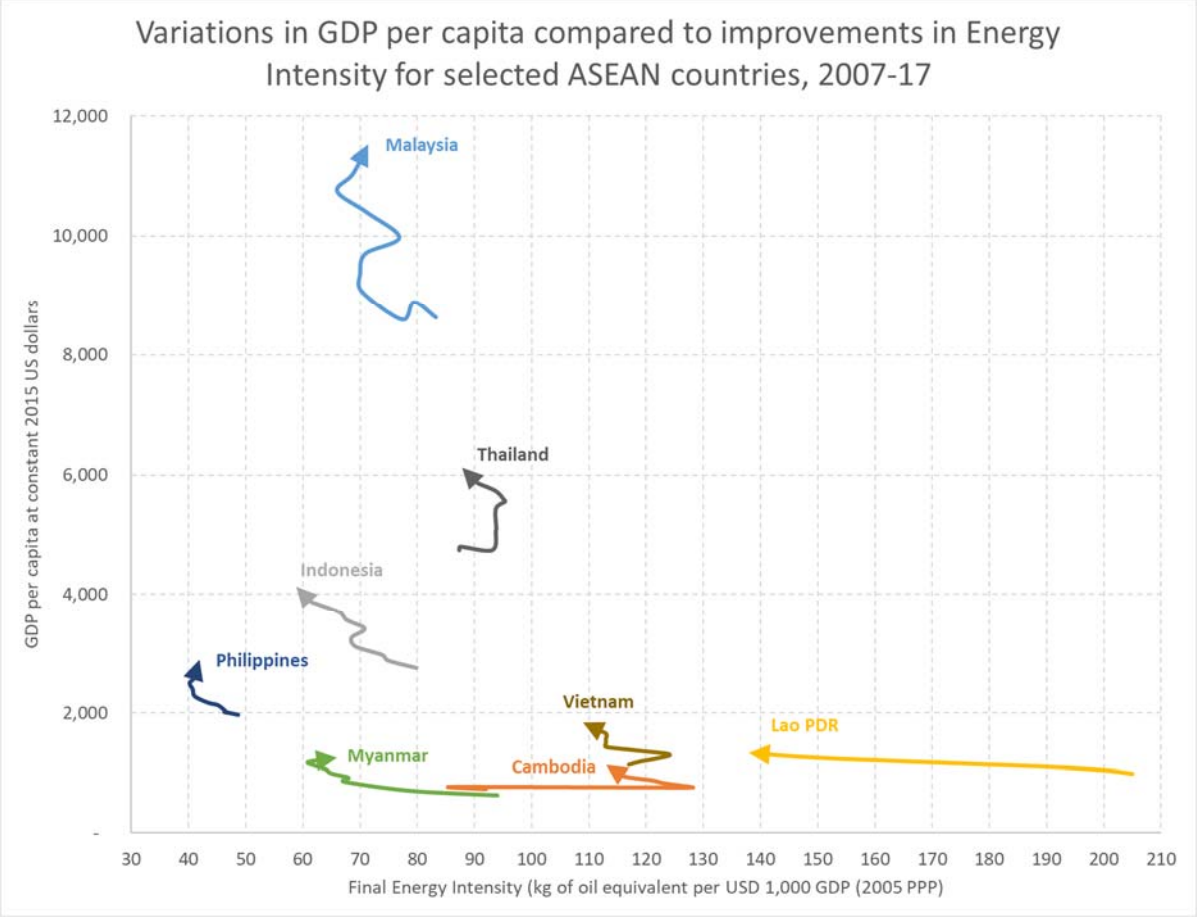
Regional Policy Settings

The ASEAN Plan of Action for Energy Cooperation (APAEC) 2016-2025 is the regional blueprint for the energy sector in the framework of the ASEAN Economic Community cooperation, and lists energy efficiency and conservation as one of its seven programme areas (ASEAN Centre of Energy, 2018). The APAEC commits ASEAN member states to achieve a 20 per cent reduction in energy intensity by 2020 and 32 per cent by 2025 based on 2005 levels. The Plan lists four "Outcome-based Strategies" for energy efficiency, all of which relate directly to the building sector: 1) harmonized energy efficiency standards and labelling on products, with a focus on air-conditioning and lighting; 2) Enhancing private sector participation including through creating enabling environments for Energy Service Company (ESCO) development; 3) developing 'green' building codes which reinforce energy efficiency efforts in new buildings; and 4) building capacity in energy efficiency finance.

This overarching plan (and its predecessors) has seeded many long-standing regional collaboration initiatives for building energy efficiency, including ASEAN Energy Management System (AEMAS), Promotion of EE&C (PROMEEC), ASEAN-Japan EE Programme (AJEEP), Energy Market Transformation with Information Provision Scheme (EMTIPS), and the ASEAN Standard Harmonization Initiative for Energy Efficiency (ASEAN-SHINE) on air-conditioners and lighting, which are described briefly at the end of this chapter.

In recent times, ASEAN countries have achieved relatively strong reductions in energy intensity. Overall building TFEC has increased more slowly than in other sectors: IRENA (2016) estimates that between 2014 and 2025, total primary energy will increase 49%, total final energy consumption will increase 43%, and building sector final energy consumption will increase only 21%. A more specific setting out of recent energy intensity performance of major ASEAN countries is shown in Figure 10 below. This chart maps GDP per capita against changes in energy intensity to give a trajectory for each country; this shows that progress against the target is very much underpinned by progress in the larger countries of Indonesia, Philippines and Vietnam, while Thailand and Malaysia have experienced economic growth with mixed experiences in intensity improvement.

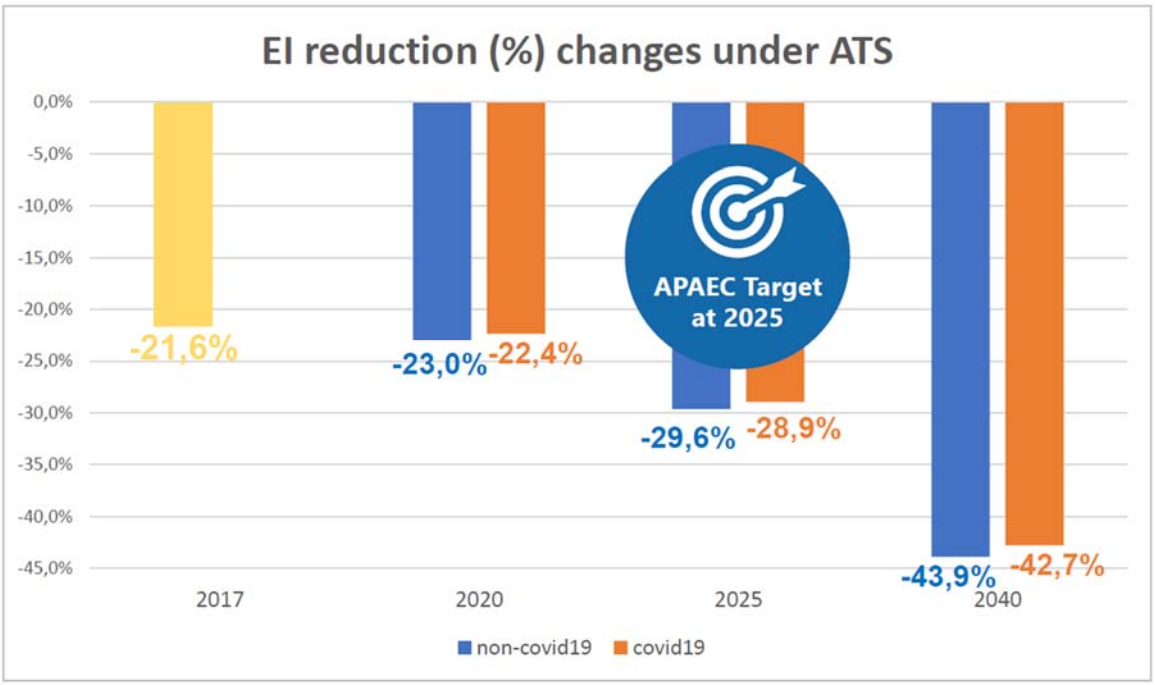
Figure 10. GDP Growth and Energy Intensity, 2007-17



Source: UNESCAP Asia Pacific Energy Portal, accessed 7 October 2020

Interestingly, the ASEAN Centre for Energy (2020) has estimated that the impact of the COVID-19 pandemic on the progress towards and achievement of energy intensity targets for ASEAN would be negligible, and far less than the impact on the renewables sector. The Centre's projected energy intensity reduction pre-COVID-19 was for savings over business as usual of 29.6% by 2025; adjusting for the impacts of the pandemic, the Centre has forecast that energy intensity reductions would be only marginally lower at 28.9% by 2025, and similarly would have hardly any impact on longer-term energy intensity reduction trends (Figure 11). This is attributed to the current slowdown in economic activity being matched by reductions in energy use, and an increased focus on cost cutting and productivity measures during the recovery phase.

Figure 11. COVID-19 impacts on achieving APAEC target projection



Source: ASEAN Centre for Energy, 2020

Other than these ASEAN-wide targets and objectives, individual countries have committed to national targets related to energy efficiency set out in Table 3, which is expanded upon in the country chapters that follow. Arguably the targets that are most ambitious are those of Singapore, Indonesia and the Philippines, the latter of which are also the national targets most recently set (in 2017).

Table 3. Summary of ASEAN Energy Efficiency Targets

ASEAN Member State	Reference Document	Official energy efficiency targets that apply to the building sector
Brunei Darussalam	Energy White Paper	Reduce energy intensity by 30% in 2035 (compared to 2011 level)
Cambodia	Cambodia EE Plan	Reduce total final energy consumption (TFEC) by 15% in 2030 and 20% in 2035, compared to Business-as-Usual (BAU).
Indonesia	National Energy Policy (Government Regulation No. 79/2014)	Reduce TFEC in 2025 by 17% in industry, 20% in transportation, 15% in households, 15% in the commercial building sector (compared to BAU). Achieve 1% energy intensity reduction per annum, up to 2025 and energy elasticity less than one in 2025.
Lao PDR	National EE Policy 2016	Reduce TFEC by 10% in 2030, and 20% by 2040 (compared to BAU).
Malaysia	National EE Action Plan	Reduce electricity consumption by 8% over a decade, from 2016 to 2025 as compared to BAU
Myanmar	National EE&C Policy	Reduce electricity consumption in TEFC by 12% by 2020, 16% by 2030 and 20% by 2030 (compared to BAU).
Philippines	EE Roadmap for the Philippines, 2017-2040	Reduce TFEC by 1% per year until 2040 (compared to BAU), equivalent with a reduction of 1/3 energy demand. Reduce energy intensity by 40% by 2040 (compared to 2005 level).
Singapore	Sustainable Singapore Blueprint 2015	Reduce energy intensity by 35% in 2030 (compared to 2005 level).
Thailand	Thai EE Policy 2015	Reduce energy intensity by 30% in 2036 (compared to 2010 level).
Viet Nam	National Target Program for EE&C	Reduce energy intensity by 5-7% by 2025 (compared to BAU). Reduced energy intensity of energy intensive industries by 10% (2020).

Source: ASEAN Centre for Energy, 2020

In terms of sectoral efforts emanating from these high-level settings a consolidated analysis performed by the ASEAN Centre for Energy, while not without a few inconsistencies, suggests that larger ASEAN countries have prioritized the building sector, with an emphasis on the commercial sector (Table 4).

Table 4. Key Energy Efficiency Priorities by Sector in ASEAN Member States

	SECTOR					
COUNTRY	Industry	Building	Commercial	Residential	Transport	Power Generation
Brunei Darussalam	L	M	L	M	L	L
Cambodia	L	M	M	M	L	L
Indonesia	H	H	H	L	L	L
Lao PDR	L	M	L	L	L	L
Malaysia	H	M	M	M	L	M
Myanmar	M	M	L	L	L	L
Philippines	M	M	M	L	M	L
Singapore	L	H	H	H	M	M
Thailand	H	H	H	M	M	L
Vietnam	M	M	M	M	M	M

L: Low | M: Medium | H: High

Source: ASEAN Centre for Energy, 5th ASEAN Energy Outlook (2015)

In terms of policy selection, many studies based on international experience have shown the efficacy of a range of interventions for the building sector to improve energy efficiency. In general terms, these sit across:

- *Market 'push' policies* – typically taking the form of regulations and mandated activities for which building owners must comply, examples of this include building codes and standards that include minimum energy performance requirements; minimum energy performance standards for specific appliance product classes; and requirements to periodically audit building energy use and disclose energy efficiency opportunities, coupled with implementation imperatives.
- *Market 'pull' policies* – typically taking the form of financial and other incentives for energy efficiency project implementation, including provision of concessional

finance, partial risk guarantees, and tax and/or fiscal concessions for efficient equipment.

- *Market 'lift' policies* – typically based in information, awareness raising, capacity and facilitation initiatives, such as undertaking publicity campaigns, training and capacity building for energy managers or the ESCO sector to implement projects, provision of subsidized audits and advice, energy awards and recognitions (e.g. the ASEAN Energy Awards), and promoting green building rating schemes.

Table 5 below presents a very summarized regional snapshot of developments in building energy efficiency policy against these principal policy levers in each of the ASEAN member countries, which are expanded upon with commentary and analysis in the country chapters that follow.

Table 5. Snapshot of building energy efficiency policy status in ASEAN member states

	Auditing/ benchmarking	Building certification, information disclosure and reporting regimes	Building codes and standards' coverage of energy efficiency	Financial incentive schemes for energy efficient new construction	Financial incentive schemes for energy efficient retrofitting	Green finance and ESCO market development
Brunei Darussalam						
Cambodia						
Indonesia						
Lao PDR						
Malaysia						
Myanmar						
Philippines						
Singapore						
Thailand						
Vietnam						

Legend:

 *Not currently mentioned/planned*

 *Mentioned/planned, but not underway*

 *In place - needs major strengthening*

 *In place - needs minor strengthening*

 *Fully established and operating effectively*

Key Regional Activities of agencies, institutions and organizations in building energy efficiency

The ASEAN Centre for Energy (ACE) was established in 1999 to act as a catalyst, knowledge hub and think-tank for ASEAN's clean energy transition. As an organization ASEAN has launched a range of activities related to building energy efficiency via this structure, including:

- ASEAN Energy Manager Accreditation Scheme (AEMAS) – AEMAS claims to be the world's first regional system for energy managers and energy end-users. Funded by the European Union under the Switch-Asia Program, it has been implemented by the ACE in all ASEAN Member States other than Brunei Darussalam and Singapore. To be certified under AEMAS, energy end-users (companies or organizations) are evaluated on their energy management performance based on their level of fulfilment against the following aspects: management, organization, process, information, financial, social responsibility and achievement.
- ASEAN-Japan Energy Efficiency Partnership (AJEEP) Scheme – implemented by the Energy Conservation Centre Japan, as official development assistance to ASEAN, the AJEEP program has focused on promotion and transference of Japanese knowledge, experience and processes of advanced energy efficiency technologies and measures. Focus of the program has been on energy manager training and certification.

Within ASEAN's regional energy efficiency policy rubric, many regional groupings and development actors have targeted efforts at building and appliance energy efficiency. Chief among these include:

- ASEAN-SHINE on Airconditioning and Lighting - a public-private partnership between the United Nations Environment Programme and the International Copper Association (ICA) in support of the United for Efficiency Initiative, ASEAN-SHINE works on standards harmonization across ASEAN for air conditioners and lighting products. It also aims to remove non-tariff barriers to trade through harmonization of product standards and adopts a holistic approach to market transformation including policy, regulations, capacity building along the supply chain, and awareness raising among end-users.

- APEC – while its membership extends well beyond ASEAN countries, APEC through its Expert Group on Energy Efficiency and Conservation (EGEEC) & Energy Working Group (EWG) has been active in developing resources for building energy efficiency, including data for benchmarking, and notably an APEC Nearly (Net) Zero Energy Building Roadmap (2018).
- USAID – USAID's Enhancing Development and Growth through Energy (EDGE) programme focuses specifically on the Indo-pacific region with four primary focus areas: Utility Modernization, Increased Deployment of Energy Technologies, Transparent and Best Value Procurement, and Regional Energy Trade and Integration. The program sits across regional and national USAID efforts to support the use of sustainable building technologies and promote energy efficiency standards.
- The ASEAN-German Energy Programme (AGEP) – a jointly implemented project by ASEAN Centre of Energy (ACE) and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ) – has been very active in building capacity in the ASEAN region on energy efficiency, including in supporting ACE to develop the ASEAN Energy Outlook, and also commissioning work to map energy efficiency financing in the region.
- Asian Development Bank (ADB) – The Asian Development Bank's regional work on building energy efficiency has been multi-pronged and in many cases targeted at individual countries; ADB frequently commissions reports on the energy efficiency performance of the region, such as *Same Energy, More Power* (2013). ADB has also undertaken regional projects in support of the ESCO sector and private sector energy efficiency finance, and its Energy Efficiency Accelerator program, that delivered ESCO market development, and support for an improved operating environment in Indonesia and the Philippines.
- UK Foreign and Commonwealth Office ASEAN Low Carbon Energy Programme - the UK's 4-year programme of policy support, capacity building and technical assistance aims for increased green finance flows for low carbon energy and energy efficiency. Focused on Indonesia, Malaysia, Vietnam, Thailand, Myanmar and the Philippines, it aims for strengthened policy and regulatory frameworks for green finance and energy efficiency, greater investment in low carbon technologies, energy efficiency savings, improved ease of doing business, and innovation and knowledge transfer.
- World Resources Institute – through its work on its Building Efficiency Initiative through the Ross Centre for Sustainable Cities, and the Sustainable Energy for All and GEF-supported Building Efficiency Accelerator, the WRI has a number of engagements with building efficiency capacity building in the region, including providing direct support to a number of city-level governments in the Philippines, Vietnam and Malaysia.
- Global Buildings Performance Network (GBPN) – The Global Buildings Performance Network (GBPN) is a globally organised and regionally focused organisation whose mission is to provide policy expertise and technical assistance to advance building energy performance and realise sustainable built environments. It has ongoing engagements with ASEAN governments, to build local capabilities to design and implement ambitious building energy codes, emphasising residential buildings, with a recent focus in Indonesia.

- United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) – UNESCAP's Energy Division has permanent workstreams related to sustainable cities and cooling, commissions buildings studies, convenes regional events and maintains detailed databases of energy efficiency information for the region.
- Global Alliance for Buildings and Construction – convened by the UN Environment Programme and the International Energy Agency, the Global ABC produces annual data and convenes regional groupings to provide status and updates on progress towards energy efficiency in buildings.

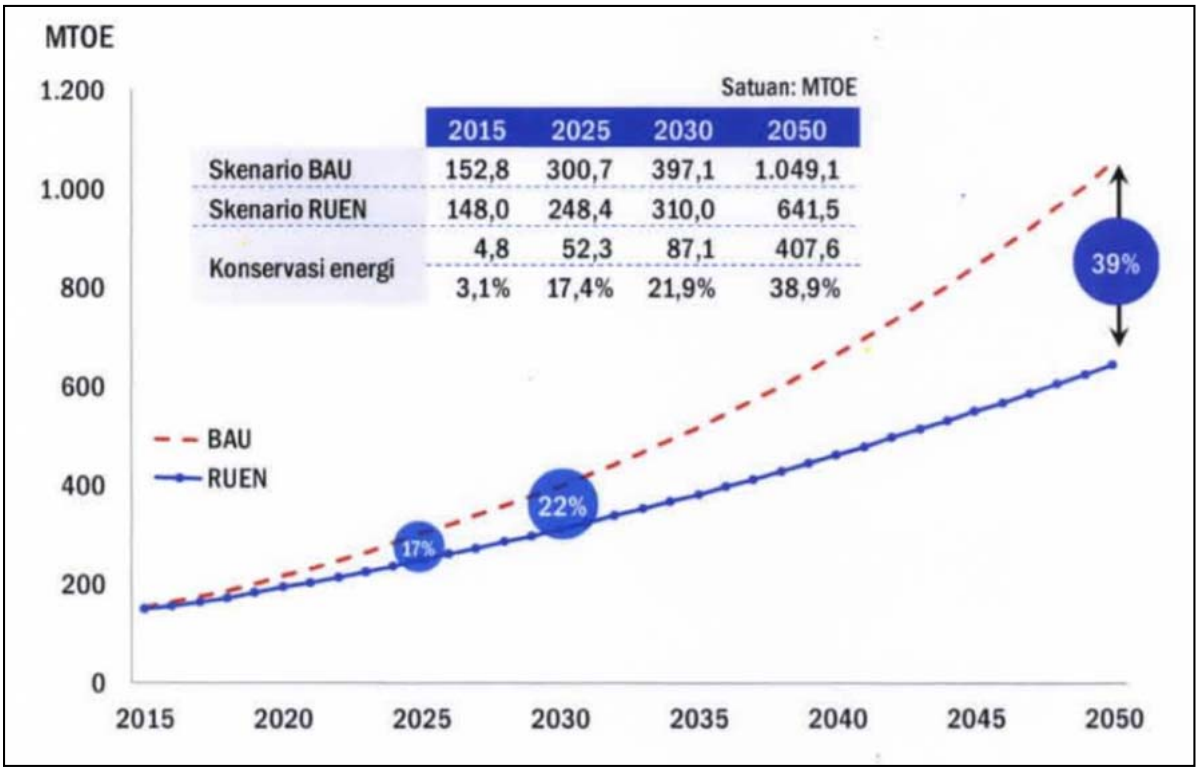
Note that further coverage of national engagements and actors is provided in each of the country chapters that follow.

3. Country focus – Indonesia

Building Energy Usage in the context of the National Energy Sector

Energy needs in Indonesia will continue to increase as a result of economic activity and population growth. Based on calculations in the National Energy General Plan (RUEN), with a business as usual (BAU) scenario, Indonesia's energy needs will increase nearly 8 times from 159 MTOE in 2015 to 1050 MTOE in 2050. With energy conservation efforts, energy demand could be as much as 39% lower, at 642 MTOE in 2050 (Figure 12).

Figure 12. Projection of Indonesia's energy needs up to 2050



Source: RUEN, 2017

Indonesia is the largest energy consumer in the region, and accounts for approximately 36% of ASEAN's energy demand (McNeil et. Al. 2018).

Table 6 shows the breakdown of end use energy by sector for Indonesia, historically from 2015, and projected to 2025. The largest sectoral share is for transportation (42%), followed by industry, which accounts for just over one-third of end-use energy demand. The combination of households, along with residential and commercial buildings, accounts for just under one-quarter (22%) of energy demand, and this is a growing share. *Demand from households and buildings are by far the fastest-growing area,* and is projected to grow by 56% over the decade from 2015-2025—twice the average of energy sector demand growth of 26% during this period.

Table 6. Breakdown of End Use Energy by Sector: Historical from 2015 and Projections to 2025

Sector	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	Share in 2025	Growth rate (2015-2025)
Transportation	314.5	322.1	335.8	348.5	360.3	371.2	381.3	390.9	399.9	408.1	415.8	42.0%	32.2%
Industry	278.9	259.4	268.5	277.9	287.6	297.8	311.3	325.5	340.5	355.4	358.7	36.2%	28.6%
Households	149.7	151.2	156.4	159.0	160.6	162.4	160.6	158.6	154.9	151.2	148.2	15.0%	-1.0%
Buildings (Residential & Commercial)	41.9	39.6	41.7	44.1	46.6	49.2	52.1	55.2	58.4	61.8	65.3	6.6%	55.8%
Street/Road Lamps	2.1	2.1	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	2.0	0.2%	-5.2%
Total	**787.1**	**774.4**	**804.5**	**831.6**	**857.2**	**882.7**	**907.3**	**932.2**	**955.7**	**978.5**	**990.0**	**100%**	**26%**
Units: MTOE													

Source: Statista, 2020

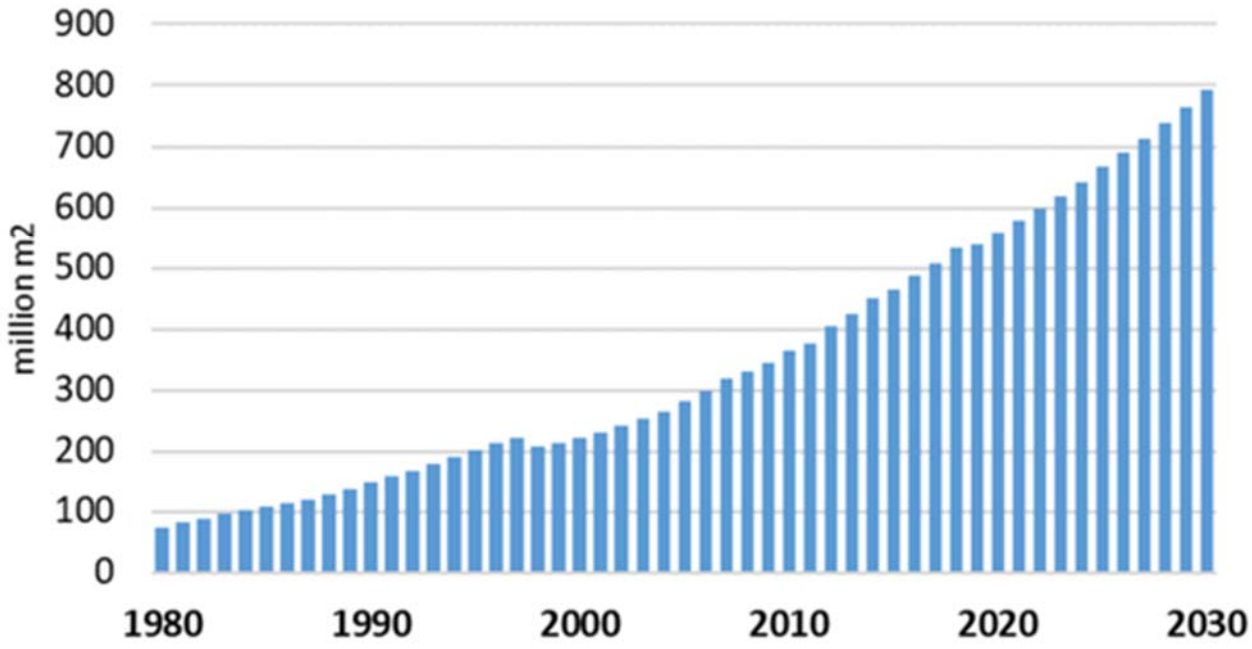
In terms of electricity demand, the largest consumer of electricity was the residential sector at 39.3% of TFEC, with the industrial sector following close behind with 36.6%. Electricity consumption in both sectors has more than doubled since 2008. While household sizes have declined roughly 0.8% each year, electrification rates are increasing around 1.8% per year (McNeil et. Al. 2018), with 100% electrification of households expected by 2025.

Commercial Buildings

Within commercial buildings electricity use across the country, public buildings make up a relatively large share; Indonesia's state-owned electric utility, Perusahaan Listrik Negara (PLN), reported that government-owned offices, hospitals and schools consumed ~5.4% of its total electricity supply in 2019. (PLN, 2019). A 25% reduction in electrical consumption with an 8-year payback could therefore result in potential annual savings of around IDR 3.2 trillion (USD 227 million), for a total investment of IDR 26.4 trillion (USD 1.8 billion (Dreessen, 2019).

As Figure 13 below shows, Indonesia's commercial building floor space is projected to continue steady growth through the next decade. The growth of commercial floor space is projected to be 4% per year, with 20-30 million square meters of new construction annually.

Figure 13. Historical and Projected Growth in Commercial Floor Space in Indonesia

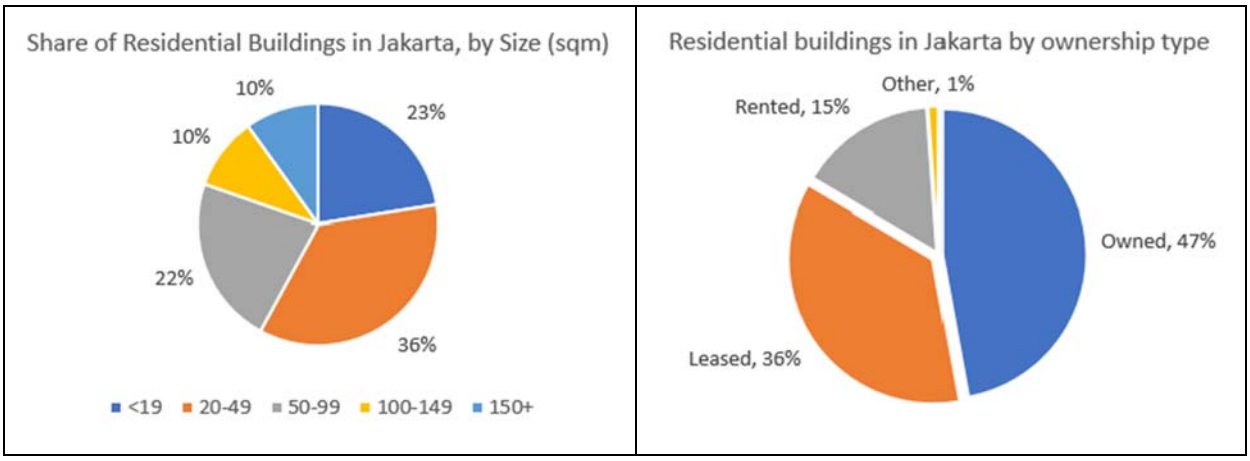


Source: LBNL estimate

Residential Buildings

Data on Indonesia's residential buildings are not widely available. Figure 14 below characterizes residential buildings in Jakarta. Well over half (59%) of residential buildings are < 50 square meters, and fully 80% are less than 100 square meters. Just under half of residential buildings are occupant-owned, and 51% are either rented or leased.

Figure 14. Characteristics of the Residential Building Stock in Jakarta



Source: MASKEEI, 2019

Impact of Growing Energy Demand in Buildings

With rapidly increasing residential electricity demand, the Indonesian Ministry of Energy and Mineral Resources (MEMR, or ESDM in Bahasa) produced a 2017-2026 Electricity Supply Business Plan (RUPTL). Indonesia requires an estimated additional 77.9GW in power

generation by 2026 to keep up with household demand and increasing electrification (McNeil et. al. 2018). With the current imbalance in capacity and demand, Indonesia experiences increasing blackouts, reliance on fossil fuels, and reliance on imported energy. Power plant capacity is increasing, but still falls short of energy security goals (Suharyati et. al. 2019). At the same time, there are substantive disconnects between energy supply asset availability (including transmission and distribution infrastructure) and demand centers, such that supply interruptibility and poor power quality remain common problems.

Continuing population growth and resultant construction growth will mean that the buildings sector remains important to Indonesia's energy needs. The construction sector has grown at between 5-6% per annum since 2014 (Hirschmann, 2020). Data available on energy intensity of commercial buildings shows modest but significant decreases in energy intensity from 2014-2018 (Table 7).

Table 7. Change in Building Energy Intensity (2014-2018)

	2014	2015	2016	2017	2018	Change for 2014-2018
Building Energy Consumption (TOE)	38,896,378	41,100,028	38,938,908	40,963,642	41,826,662	8%
GDP in Commecial Building Sector	3,325,974	3,503,315	3,695,379	3,893,717	4,115,940	24%
Energy intensity of commercial buildings (TOE/billion IDR)	11.69	11.73	10.54	10.52	10.16	-13%
Source: Building consumption data from HEESI; commercial sector GDP data from BPS-Statistics Indonesia						

Indonesia's national energy efficiency targets have specifications related to building energy efficiency. They aim to reduce total final electricity consumption by 20% for transportation, 17% for the industrial sector, 15% in households, and 15% in commercial buildings by 2025. These translate into annual reductions in energy intensity of 1% until the year 2025 (MEMR 2019). These reductions are made in comparison with the expected Business-As-Usual (BAU) Scenario as defined in the National Energy General Plan (Velautham and Poddy, 2018).

Summary of Policies aimed at improving Building Energy Efficiency

Indonesia's responsibility for building energy efficiency rests with MEMR/ESDM, which has responsibility for formulating, determining, and implementing policies and technical guidance in the field of training, controlling and supervising energy efficiency and conservation efforts, new energy, and renewable energy development. The Ministry of Public Works and Housing (MPWH) is also involved in supervising standards for construction and the regulation of Green Building guidelines. The concept of Net Zero Energy Building (NZEB) is beginning to get attention from building professionals and the government, and some implementation/piloting on the ground is expected in the near future.

Table 8 presents a summary of policy efforts that have been made to reduce building energy consumption and reduce the strain on the electricity grid.

Table 8. Relevant Policies to Building EE in Indonesia

Policy, Rule or Regulation	Description

Law No. 30/2007 on Energy. Article 25 on Energy Conservation	Establishes principles for management of energy resources. Sets governments basic targets for future development of energy mix.
Government Regulation No. 70/2009 on Energy Conservation	Energy users above 6,000 toe per annum must appoint an energy manager, conduct periodic energy audits, implement audit recommendations, and publish annual energy conservation reports. This threshold is being replaced by lower figures of 500 TOE (or equivalent to 15.000 m2) for commercial buildings, and 4000 TOE for industry and transportation users.
Ministerial Regulation No. O2/PRT/M/2015 on Green Buildings (from Ministry of Public Works and Housing)	Sets green building certification and implementation guidelines for Indonesia. Compliance to be met at (1) programme phase, (2) technical planning phase, (3) construction phase, (4) usage phase, and (5) demolition phase. Components include building envelope, ventilation and AC, lighting, transport within building premises, and electricity.
Governor Decree No. 38/2012 on Jakarta, Indonesia Green Building Code	This local government regulation for a green building code in Jakarta was established with assistance from IFC and issued before the national government issued similar code (see above). Other cities like Bandung and Semarang are considering replicating this regulation.

Most of the current policy activity in the sector is focused on revisions to PP70/2009 currently being contemplated, which include mandatory requirements for all sectors to engage in energy efficiency efforts through: implementation of energy management and regular energy audits; new roles of institutions (including assigning responsibility to regional administrations to initiate their own energy efficiency programs and supervise the efforts taking place in the region); reduced thresholds for energy use sizes of industries and buildings required to implement energy management; standardization of energy consumption equipment and application of energy efficient projects; and private sector incentives and disincentives. It also intends to remove the barriers for engagement of ESCOs and third-party financiers by government, synchronizing existing public-private partnership (PPP) processes to accommodate smaller energy efficiency project transactions.

In addition to regulations and policies, several government organizations and other stakeholders have implemented schemes and incentives for investment in efficient buildings. The Ministry of Finance has implemented Ministerial Regulations No. 21/PMK. 011/2010 and 24/PMK. 011/2010 that describes Indonesia's renewable energy incentives as well as a tax facility that includes mechanisms around income tax, import duty, tax holidays, and tax exemptions for qualifying imported energy efficiency equipment (Velautham and Poddy 2018). MEMR has also made plans to establish an Energy Efficiency Revolving Fund, but these were never realized (Velautham and Poddy 2018). Another ministry effort is from the Ministry of Public Works (MoPW) which has created National Guidelines on Green Buildings, with energy efficiency as one of the important requirements. The Guidelines act as an umbrella for local governments to regulate green building implementation in their respective authorities, and have flexibility to be gradually improved along the way.

Outside of government, the Green Building Council of Indonesia has partnered with the International Finance Corporation to promote use of its Excellence in Design and Greater Efficiencies (EDGE) rating tool as a competitive, voluntary tool in Indonesia (Taheri 2015). IFC and the Green Building Council Indonesia aim to certify at least 20 percent of new construction projects by 2021, which is estimated to help cut greenhouse emissions by 1.2 million metric tons per year (IFC, December 2018). Additionally, the work of MASKEEI (the Indonesian Energy Conservation and Efficiency Society, a CSO dedicating to addressing the energy efficiency and conservation issues) and some professional associations' members of MASKEEI have been instrumental in pushing forward training and capacity building initiatives for investment grade auditors, energy savings professionals and general awareness raising among building owners. MASKEEI has also been instrumental in helping the government (MEMR and other Sectoral ministries) formulate/establish relevant regulations on energy efficiency and conservation.

In summary, while there have been a series of ad-hoc policy initiatives developed in Indonesia, there is no concerted, overarching approach to the building sector that inspires confidence in government's resolve to realize energy efficiency's potential. Part of this springs from a disconnect in capacity and motivation of the national electricity utility PLN, whose incentives are not particularly pointed towards reduced energy consumption. This plays out in both the intent of senior MEMR/ESDM management as well as in the resultant capacity of PLN to effect reforms, though both have obvious interests in seeing more energy efficient buildings that can help align generation capacity with demand, and deliver on government's commitment in its NDC.

At the same time, numerous fundamental barriers persist. While energy efficiency in government buildings remains virtually untapped, government agencies are unable to implement much energy efficiency due to their inability under current policy and regulation to engage private sector companies like Energy Service Companies (ESCOs) and third-party financiers to develop, implement and/or finance projects from energy savings. Existing regulations preclude government agencies from being able to legally make multi-year savings payments; retain savings in budgets; and procure equipment and services on a 'life cycle benefit' versus 'lowest cost' basis, all of which is needed to access private sector resources and have energy efficiency implemented in government facilities on a scalable basis.

Key activities of agencies, institutions and organizations in building energy efficiency

There has been a plethora of international development efforts in Indonesia related to energy efficiency in recent years, including

- **DANIDA**. Danida (the Danish International Development Agency) had a large project, Energy Effiicency in the Industrial, Commercial, and Public Sectors during 2008-2013, which provide tools for building energy codes and established an information clearinghouse for energy efficiency. Since then, DANIDA has continued to support the design of voluntary Jakarta municipal building standards and mandatory building codes. DANIDA has also had a number of programs that support the Indonesian government in designing incentive programs for retrofits, designing the certification program for energy auditors and subsidizing initial energy audits, though this did not yield substantial implementation.

- **AFD.** AFD has financed investments and reforms in energy efficiency through development policy loans, direct loans to the public electricity company (PLN), and through dedicated credit lines to local banks supporting private or public investors. Most of these fforts have not been highly successful, with the requirement to use local intermediary banks proving restrictive in terms of overall cost of finance to the end user.
- **GIZ.** over the past five years, GIZ has assited MEMR in establishing appropriate incentive mechanisms for the implementation of efficient refrigeration and air conditioning technology in selected areas. To demonstrate the advantages of green cooling technology, pilot projects were implemented and technicians trained/certified.
- **IEA.** While not specific to the buildings sector, IEA has been working towards capacity building in energy efficiency implementation and improvements in energy data and statistics across demand and supply, leading to more timely submission and publication of Indonesian energy data.
- **APEC and APERC.** APEC has approved a Peer Review on Energy Efficiency (PREE) to be conducted in Indonesia in the second half of 2020. PREE deliverables include a Peer Review Report on Energy Efficiency for the host economy, which will include the identification of barriers to the effective implementation of the action plans and the recommendations for overcoming those barriers. The report covers a variety of issues such as institutional framework, goals and strategy, data collection and monitoring, policy measures and education. The process is conducted by the Asia-Pacific Energy Research Centre (APERC) in consultation with MEMR and includes experts from other APEC economies and international organisations. This PREE will differ from the previous effort in 2011, because it will focus explicitly on industry and commercial buildings.
- **IFC.** IFC assisted the City of Jakarta to develop a Green Building Code in 2011, with reference to the Green Building Council Indonesia. This regulation was enacted in 2012. The Jakarta building energy code apparenly inspired the central government to establish a national building code in 2017, and also inspired other major cities on Java, like Bandung, Semarang, and Surabaya to replicate it. While these efforts are in progress, we were not able to get information on the implementation status. Since 2017, IFC has been partnering with the Green Building Council Indonesia—providing providing resources for adoption of its EDGE online platform, green building standard and certification system. In 2019, IFC and the Swiss Government provided targeted assistance to Semarang in Central Java through its Green Buildings Market Transformation Program, to support the city's adoption of greener building codes. IFC has further developed a "National Green Building Toolkit" with the Ministry of Public Works and Social Housing, to assist local-level adoption of national policy, and worked to initiate green bonds for green buildings projects through the bank OCBC NSP.
- **ADB.** Following earlier support for energy efficiency finance capacity building for Indonesia's banking sector, in 2019, ADB approved a $500m loan for sustainable energy improvements, with a related assistance program to bolster energy efficiency policy and create an energy efficiency investment program, to enable municipalities and government contracting agencies to engage in energy efficiency savings programs with energy efficiency service companies (ESCOs) under Indonesia's revised 2018 legislation on PPPs and its Regulation on Government Procurement of Goods and Services Policy 29/2018, (Peraturan Lembaga Kebijakan Pengadaaan Barang / Jasa Pemerintah), which regulates solicited PPPs. The focus will be on

replacing municipal street lighting and retrofitting buildings. Status of this work is currently unclear. In the area of ESCOs, ADB has been assisting the Ministry of Energy and Mineral Resources since 2018 in development of a a pilot project in Commercial Buildings. The project applies the ESCO business model, and includes a capacity building program for ESCO professionals that covers certifications such as Certified Investment Grade Energy Audits (CIGAs) and Certified Energy Saving Verifier (CESVs). This work is being done in collaboration with EPS Corp, MASKEEI, TUV Nordt (CIGA) and EVO (CESV).

- **USAID.** In 2013-14, USAID explored a regional solution to reduce energy use and carbon emissions in the large and continuously expanding stock of commercial buildings in Asia, through the development and demonstration of a regional building energy performance benchmarking system and engagement of key regional partners. In partnership with ICF, a Benchmarking Tool was first developed for the Indonesian hotel sector, where existing energy consumption data created an opportunity to develop and showcase the potential impact for benchmarking across the region and where steady growth in visitors of 9-13% was being recorded annually. The Tool developed for Indonesia was designed to be simple to use while providing an accurate comparison of building energy performance. Benchmarking and EE improvements at 1,000 hotels in Indonesia were estimated to yield annual savings of 533 million kilowatt hours (kWh), 388 billion Indonesian Rupiah (US$ 38 million) and 381,000 $MtCO_2e$ avoided. MEMR became interested in using the tool to set minimum energy performance standards for the hospitality sector, however did not commit further resources into expanding and maintaining the existing benchmarking tool or housing it online. More recently, USAID worked with key Indonesian stakeholders, including MEMR/ESDM, the National Planning Agency (BAPPENAS) and the Financial Services Authority (OJK) to promote and accelerate renewable energy and energy efficiency as part of the Indonesia Clean Energy Development – Phase 2 (ICED II), soon to be renewed for a further five years, with a focus on sustainable finance.

Other noteworthy initiatives include:

- The Global Buildings Performance Network (GBPN) together with its local partners is establishing a policy advisory working group called HIDUP (meaning 'Live' in Bahasa Indonesia), which is a multi-lateral working group composed of building experts from both public and private entities. Its aims are the assessment, review and challenge of current regulatory frames (building codes), and their improvement and enforcement at national and regional level, along with their potential and limits in driving the building market shift toward net zero buildings.
- Indonesia has commenced the process of developing a National Cooling Action Plan, with support from UNESCAP and UN Environment. The Plan will help to quantify overall cooling needs in the country and galvanize efforts towards meeting cooling needs more efficiently across a range of sectors, including space cooling in building and residential and commercial refrigeration.
- The American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) has an active local chapter in Indonesia. ASHRAE administers educational seminars, training courses and exchange of best practices from the region for building practitioners.

ESCOs most active in the market include:

- Johnson Controls
- PT Signify Commercial Indonesia
- PT Sucofindo (Persero)
- PT Atmi Kreasi Energi
- PT Miura Indonesia
- EPS Capital Corporation
- Synergy Energy Solutions
- Smardt Indonesia

Commercial buildings, apartments and malls are mainly owned by big Indonesian property groups (e.g. Djarum; Summarecon, Lippo, Ciputra Group, Sinarmas Group, Murdaya (CCM), etc.). Some office buildings are also owned by state-owned enterprises such as Pertamina and Telkom. Typically, there is an unwillingness to use own credit lines on energy efficiency projects, being perceived as not related to their core business and without a large enough economic impact on operational costs. Electricity costs make only up of 15% of operational costs in a commercial building and, even though 10-35% of electricity reduction might be possible, it remains a small percentage of overall operational costs.

There is also a pervasive lack of trust in and experience with external service providers and ESCOs in provision of third-party finance. Recent increases in electricity prices, along with pressure to achieve clean energy development targets under national and international obligations, might change the economic dynamics of building energy efficiency projects in the future.

Technology developments

Lighting technology. The use of LED lamps has been growing steadily, thanks to the decreasing prices, which makes them more affordable. However, product quality varies widely, with imports dominated by Chinese products. There are a number of local assemblers supplying the lower segment of the market. Compact Fluorescent (CFL) lamps are still widely used, especially in rural households and shops. The government is in the process of setting up minimum energy performance standards (MEPS) for LEDs, while CFL already have MEPS in place.

Sensors and control applications. These products entered the building market a few years ago, but are still limited in their market penetration. They are currently primarily applied in the new office building market, and in other limited commercial and industrial contexts.

Cooling technology. Air conditioning in buildings is dominated by chillers that use various types of refrigerants. The government is promoting the use of “green refrigerants" to replace the older CFC and HCFC refrigerants that are banned internationally under the Montreal Protocol, with further impetus to link this effort to cooling efficiency in buildings through the 2016 Kigali Amendment to the Protocol.

The use of air conditioning with energy saving inverter technology in small offices and residential is increasing due to ongoing improving traction of MEPS and labeling, though non-inverter A/Cs are still favored primarily in the lower income sector because of their

relatively lower prices, and enforcement of standards on imported products remains weak.

Building Integrated PVs (BIPVs). BIPV systems are known to Indonesian building professionals, but the current cost of such systems is prohibitive even for large energy users such as commercial buildings. Another challenge to BIPV implementation is the reluctance of PLN to accept intermittent power sources. Rooftop solar applications are gaining in popularity, though still need clear support by government regulations to make their application easier and their wider use more impactful.

4. Country focus – Malaysia

Building Energy Usage in the context of the National Energy Sector

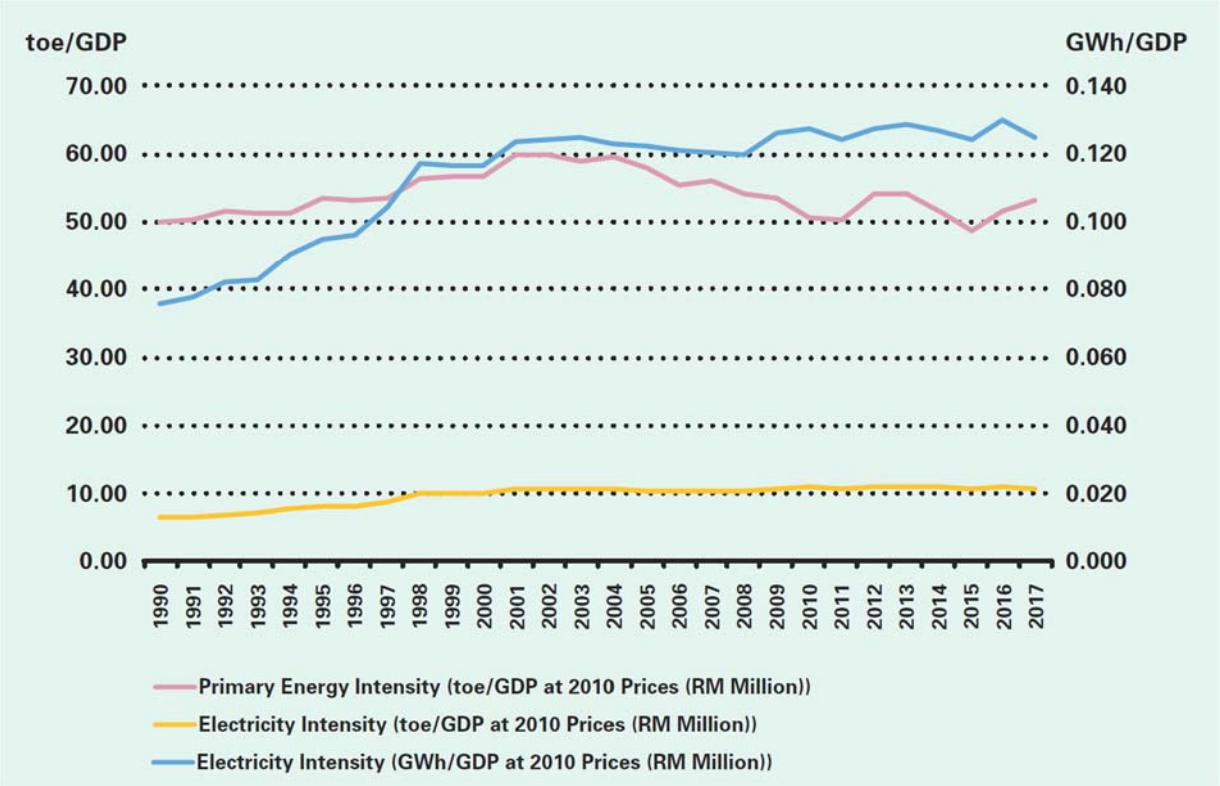
In Malaysia, total final energy consumption in 2017 was 62,489 KTOE, with the breakdown being 38.5% for the transport sector, 28% for industry; 20% for non-energy uses; 12.5% for the residential and commercial sectors; and 1% for agriculture (see Table 9).

Table 9: Breakdown of Total Final Energy Consumption by Sector

Sector	2014	2015	2016	2017	Share in 2017
Transportation	24,327	24,435	24,004	24,039	38.5%
Industry	13,162	13,989	16,019	17,463	27.9%
Non Energy Use	6,217	5,928	8,729	12,517	20.0%
Residential & Commercial	7,458	7,559	8,049	7,796	12.5%
Agriculture	1,045	895	415	674	1.1%
Total	**52,209**	**52,806**	**57,216**	**62,489**	**100%**

The total final energy consumption of electricity in 2016 was 144,024 GWh, and the breakdown was 47% for the industrial sector, 30.8% for the commercial sector, and 21.6% for the residential sector (National Energy Balance, 2016). Electricity in residential and commercial buildings therefore accounts for more than half (52.4%) of final electricity consumption, and this is expected to expand because of urbanization, industrialization, and continued population growth.

Figure 15. Energy Intensity of the Malaysian Economy



Source: ST 2019, p. 56

Figure 15 shows trends in energy intensity of the Malaysian economy. Electricity intensity rose rapidly during the 1990s, slowed down during the period after the 1998 economic crisis, and has gradually edged up. This is due to the absence of a dedicated regulatory instrument for energy efficiency and conservation, which has rendered Malaysia's numerous policy efforts sporadic and disjointed, with little cumulative impact in the face of ongoing demand growth in the country. At the same time, there has been an improving trend in primary energy intensity, which fell by about 15% from 2000 to 2015, but has since been edging upward. An Energy Efficiency and Conservation Act was put forward in Parliament in 2019, and was later put on hold and may be cancelled.[1]

There are no official public statistics of building sector demand in relation to total final energy demand. The energy intensity of a "conventional design" building is in the ranges of 200 kWh/m2/year; for a basic energy-efficient building is 150 kWh/m2/year; and down to 90 kWh/sqm/year for an energy-efficient building.

Summary of Policies aimed at improving Building Energy Efficiency

In terms of institutional framework, lead responsibility for developing and implementing building energy efficiency policy rests with the Ministry of Energy and Natural Resources (MENR), which until recently was the Ministry of Energy, Science, Technology, Environment, & Climate Change (MESTECC). Under MENR's purview is also the Malaysian Green Technology Corporation (GreenTech Malaysia), which catalyzes deployment of

[1] Kevin Hor, PFAN Malaysia Country Coordinator, personal communication. October 2020.

green technology in line with national environmental policies. In addition the Energy Commission of Malaysia regulates the Efficient Management of Electrical Energy Regulations (2008), and keeps track of the consumption of very high-consuming (>3,000,000 kWh per 6 months) facilities by mandating energy reporting and institutionalizing disclosure of action plans. While such a regulation exists, it lacks harsh penalties to encourage improving efficiency.

An Energy Efficiency and Conservation Bill was tabled in Parliament in June 2019, the draft of which was presented to and approved by the Malaysian Cabinet. Details of the draft bill have not been obtained. Plans for it to be tabled and enacted by the end of 2019 have been delayed, and the future of the Bill is uncertain in the light of the COVID-19 pandemic.

In the absence of the powers of the new Bill being enacted, in 2015 the Malaysia Government produced their 'National Energy Efficiency Plan 2016-2025' (MEGTW 2015). The plan was developed to respond to growing concerns over the rise in energy intensity and demand since 2000 with an emphasis on increasing energy security by improving energy efficiency at the demand-side of the energy sector. Five main barriers to energy efficiency efforts were identified as '(1) low energy prices, (2) lack of finance for energy efficiency, (3) lack of an overall national plan for Energy Efficiency, (4) lack of champion to drive energy efficiency, and (5) lack of consistency in embarking on energy efficiency' (MEGTW 2015).

The effective and efficient implementation of the 2016-2025 Plan, supported with sufficient resources, is estimated by Government to be able to save 52,233 GWh of electricity over the 10 years of its duration. The corresponding electricity demand growth reduction at the end of the Plan is projected to be at 8%, with a total of greenhouse gas emission reduction projected to be 34 million tonnes CO2 equivalent. Public and private expenditure under the Plan is expected to reach a total of RM6.3 billion over the 10 year period, with an estimated total direct monetary saving of RM18.5 billion (EECA, 2020).

It is important to note that the National Energy Efficiency Plan only covers electricity consumption, and no other energy sources. The plan is broken down into five separate initiatives: (1) promotion of 5-star rated appliances, (2) minimum energy performance standards, (3) energy audits and energy management in buildings and industries, (4) promotion of co-generation, and (5) energy efficient building design (MEGTW 2015).

While the National Energy Efficiency Plan is a driving source for building energy efficiency, there are several other long-standing policies that are still relevant to building energy efficiency in Malaysia. These policies can be seen in Table 10 below.

Table 10. Relevant Policies to Building EE in Malaysia

Policy, Rule or Regulation	Description
The Energy Commission Act 2001	Established the Energy Commission. The Commission regulates energy supply, enforces energy supply laws, and promotes energy efficiency, conservation and the use of renewable energy.

The Efficiency Management of Electrical Energy Regulations (EMEER) 2008	Developed under the Electricity Supply Act 1990. Large consumers of over 3 million kWh of electricity over a period of 6 months must (1) appoint a registered electrical energy manager, (2) establish an efficient electricity management policy and objectives, (3) monitor and record electricity use, and (4) produce periodical electricity use reports.
The Building Sector Energy Efficiency Project (BSEEP)	Developed guidelines for practising EE in buildings through building design, technical assistance, and financial savings estimates. Supported by United Nations Development Programme, funded by the Global Environment Facility, and executed by the Public Works Department.
Implementation of Energy Performance Contracting (EPC) within the government sector, 2014	Developed to overcome EE capital costs and financing barriers. Provides set of energy savings measures and guarantees of savings. Using EPC, government buildings engage with ESCO services.
Malaysia Standard and Code of Practice on EE and Use of RE for Non-Residential Buildings – MS 1525: 2001, revised 2007 and 2014	Voluntary standard for non-residential buildings. Includes building envelope, AC and mechanical ventilation, lighting, and energy management control system.
MS ISO 50001	Guides building management team in a significant amount of GHG emissions and energy cost through systemic management of energy.
Uniform Building By-Law	Clause 38A of the by-law mandates for minimum building envelope design

In addition to the rules, policies, and regulations, several stakeholders actively work on reducing the barriers to investing in building EE. Table 11 below provides descriptions on stakeholders work relevant to EE building investment (Suharyati et. al. 2019).

Table 11. Relevant Stakeholder Initiatives in Building EE in Malaysia

Stakeholder	**Work related to increasing EE investment and implementation**
Energy Commission (EC)	Responsible for advising MENR on electricity and tariffs related to energy efficiency. Administers the Energy Management Information System for large user energy reporting.
Sustainable Energy Development Authority (SEDA)	Administers and manages implementation of feed-in tariff mandated by Renewable Energy Act 2011. Implements energy demand management programs, including energy management training and administered energy audit grant programs
Malaysia Green Technology Corporation	Administers the Building Information Consumption System to track energy consumption of government facilities as well as administration of Low Carbon Cities Framework reporting. The

	focus is largely on infrastructure work, instead of building sector work. Previously developed an energy rating tool called MyCrest which was later transferred to the Ministry of Works.
Construction Industry Development Board (CIDB-MAMPAN)	Drives sustainable construction initiatives in Malaysia.
Green Building Index and GreenRE	Rating tools in the country which delivers energy efficient building design when mandated by local councils in developments
Real Estate & Housing Developers' Association (REHDA)	The leading representative body of private property developers. Committed to sustainable property development.
Malaysia Green Building Confederation (MGBC)	Internationally affiliated as established member of the World Green Buillding Council

The Green Building Index (GBI) rating tool is the most popular voluntary building rating tool, and is owned by the Malaysian Institute of Architects (PAM) and the Association of Consulting Engineers Malaysia (ACEM). It is in extensive use with many hundreds of certified buildings, and also detailed guidelines for certification of sustainable townships that are in increasing circulation (GBI,2016).

The government also has several fiscal incentives related to EE projects. Incentives include tax breaks, import duty and sales tax waivers in designated EE equipment, and an accelerated capital allowance on EE technologies and project investments (Suharyati et. al. 2019). A programme called 'The Sustainability Achieved via Energy Efficiency (SAVE) Programme focuses on increasing EE equipment in the market by providing a RM100-200 rebate on refrigerators, ACs, and chillers.

There are two current financial incentives schemes: The Green Technology Finance Scheme (GTFS), and the Green Investment Tax Incentive 2014 (Suharyati et. al. 2019). GTFS is a RM 3.5 billion scheme that provides specific financing for Energy Performance Contracting. It supports green technology projects with six criteria. There is one focusing on the building sector and another focusing on the energy sector (GreenTech Malaysia 2018). GTFS offers a rebate of 2% on interest/profit offered by participating financial institutions with credit guaranteed support for loan capital. GTFS 2.0 added ESCO's as a new category they offer financial support to. In GTFS they only provided financial support to producers and users of green technology (GreenTech Malaysia 2018). To leverage this incentive, project developers must seek approval from the relevant agencies before implementing the project, and this often delays project implementation by 3-6 months.

The Malaysian government has launched different initiatives to promote energy efficiency finance for buildings, in both the public and private sector. Aside from tax incentives and tax allowances for investments in green technology and services, the government has also introduced an "Energy Audit Conditional Grant" scheme, under which a budget of RM20.74 million (USD 5.0m) was approved and allocated under the

11th Malaysia Plan to spur the ESCO industry. This grant program is open to existing commercial and industrial buildings consuming more than 100,000kWh per month. Depending on the size of installations, applicants can receive as much as RM100,000 (USD 24,000) for conducting an Energy Audit by an ESCO. Last year, the Malaysian government also launched a USD 50 million energy performance contracting (EPC) fund to encourage the growth of energy-efficient projects in the country through concessional financing, through Malaysia Debt Ventures Bhd, a subsidiary of the Malaysian Government under the Ministry of Finance Incorporated (MOF Inc.). The EPC fund which will be supported by a credit guarantee fund of RM12 million (USD 2.9 million)contributed by the Ministry of Energy, Green Technology and Water (NEGTW) and the long-standing BSEEP, underpinned by the United Nations Development Program (UNDP) and the Global Environment Facility (GEF). So far the government has not realised its commitment to award a large number of government lead energy efficiency retrofit programmes through EPC under this mechanism but has extended the Green Investment Tax Allowance scheme up to 2023.

Additionally, in line with its international climate commitments, Malaysia's Low Carbon Cities Framework (LCCF) remains influential; the LCCF was initiated to provide a framework for achieving more efficient buildings that will subsequently reduce carbon emissions. The document can be used by all stakeholders, in human settlements of any size, be they cities, townships or neighbourhoods either new or existing, to measure the impact of their development decisions in terms of carbon emissions and abatement. LCCF is a national framework and assessment system to guide and assess the development of cities and to support holistic sustainable building development in Malaysia.

Key activities of agencies, institutions and organizations in building energy efficiency

As a substantially more developed economy than some of its less developed ASEAN neighbors, Malaysia does not have the same degree of support and input from development sector partners related to building energy efficiency outside of regional sector development efforts that apply across the ASEAN region. Some exceptions to this include the following initiatives focused on building energy efficiency in Malaysia:

National Energy Awards. The Malaysian government, through Greentech Malaysia, has held a National Energy Award[2] context each year since 2018. The award "acknowledges outstanding achievements and best practices in driving the country's sustainable energy sector." The categories covered include energy management, energy-efficient buildings, and renewable energy initiatives. More than 30 Malaysian companies have won and have gone on to represent Malaysia at the ASEAN Energy Awards (AEA). On 2030, Greentech Malaysia widened the scope to include entries in the area of Energy Performance Contracting (EPC) projects, as well as from local private and public universities and financial institutions.

[2] See https://www.thestar.com.my/metro/metro-news/2020/02/04/scope-widened-for-national-energy-awards-this-year.

UNDP. UNDP has maintained a concerted focus on building energy efficiency in its projects over recent years, including through the GEF-funded Building Sector Energy Efficiency Project (BSEEP)[3], which ran from 2010-2017. BSEEP supported monitoring and improving the energy performance of the building sector; policy development with the aim to support implementation and compliance with policies that encourage the application of EE technologies in the country's buildings sector; capacity development for institutions that finance EE building technology applications; increased awareness of the government, public and the buildings sector on EE building technology applications; and EE demonstration projects that build confidence in the feasibility, performance, energy, environmental and economic benefits of EE building technology applications leading to the replication of the EE technology application demonstrations. In addition to the BSEEP program mentioned above, UNIDO also conducts programs related to government green procurement, studies on demand side management, green technology application for low carbon cities, low emission capacity building and various small grant programs.

DANIDA/IFU. The Danish Government has provided substantial support to the sector through a public building contract implemented by Danish Energy Management, who retrofitted 9 buildings in Melaka at a cost of DKK 40 million (USD 6.5m). DEM and the Danish Climate Investment Fund designed, financed, and implemented the project under an Energy Performance Contract, with the Melaka State Government repaying the investment through energy cost savings.

Energy Conservation Center, Japan (ECCJ). Under the instruction and financial support of Japan's Ministry of Economy, Trade and Industry (METI), ECCJ continues to provide guidance for energy conservation audits and training programs in Malaysia under the AJEEP (ASEAN-Japan Energy Efficiency Partnership) Scheme.

World Resources Institute (WRI). The GEF-funded Building Efficiency Accelerator supports the City of Iskandar to achieve greater building efficiency at the local level. The Building Efficiency Accelerator is a is a multi-stakeholder network made up of over 30 businesses and organizations that work with local and sub-national governments in order to increase the uptake of energy efficiency policies and programs in the building sector.

UN Environment Programme. Through its District Energy in Cities Initiative, the UN Environment Programme has facilitated the installation of district cooling into numerous precincts in Malaysia, including in Sedenak and Medini. The initiative is assisting to develop planning guidelines to make it clear to master planners and developers when district cooling should be considered, and recommend best practices for its development, adapting successful international planning guidelines to the Malaysian context.

Funding and ascension to international agreements. The Global Environment Facility is the largest multilateral funder for energy efficiency related projects in Malaysia, followed

[3] See http://bseep.gov.my.

by the Multilateral Fund under the Montreal Protocol where funds have been used to support the twin goals of HCFC phase-out and improved energy efficiency of air-cooled split system air conditioning units. Malaysia however has yet to ratify the Kigali amendment, to enable larger funding in support energy efficient air conditioning technologies.

There is a relatively strong degree of ESCO sector activity in Malaysia. The Energy Commission deals with ESCO and energy efficiency professional accreditation. It reports that the country has 205 registered ESCOs, and 1,371 Registered Energy Managers. In attempting to raise capital, ESCOs have attempted a range of relatively sophisticated methods such as blended finance and crowd-sourced equity (Leet, 2020).

Other issues and trends

Impact of COVID-19. The commercial and residential property markets suffered a sharp contraction in Mar, April, and May 2020 due to the COVID-19 pandemic, dropping from about USD 2.6 billion per month in February, to about USD 200 million in April. But by June the monthly value of property market transactions had increased back up to USD 2.4 billion (JPPH 2020).

Lighting. Malaysia is a hub for high-end LED lighting, and OSRAM has a major manufacturing plant in Penang. LED lighting penetration is very high, and the efficacy of LED lighting is regulated by Energy Commission.

Cooling. Chilled water systems are used for most commercial and industrial buildings with some demonstration projects of solar thermal absorption. Malaysia is one of the largest split-system air conditioner producers in the world, and the industry has made great strides towards reducing damaging F-gases under the requirements of the Montreal Protocol.

Building design and envelopes. The Building Energy Code in Malaysia sets minimum criteria for the building envelope in terms of overall and roof thermal transfer values (OTTV and RTTV). Compliance is mandatory in all states in Malaysia. In some of the new, high-end commercial buildings, there is movement toward building integrated PV design, enhanced building insulation, low-energy facades and daylighting, dynamic glazings and advanced coatings, and high performance windows, although these are not mainstreamed and used mainly in demonstration sites.

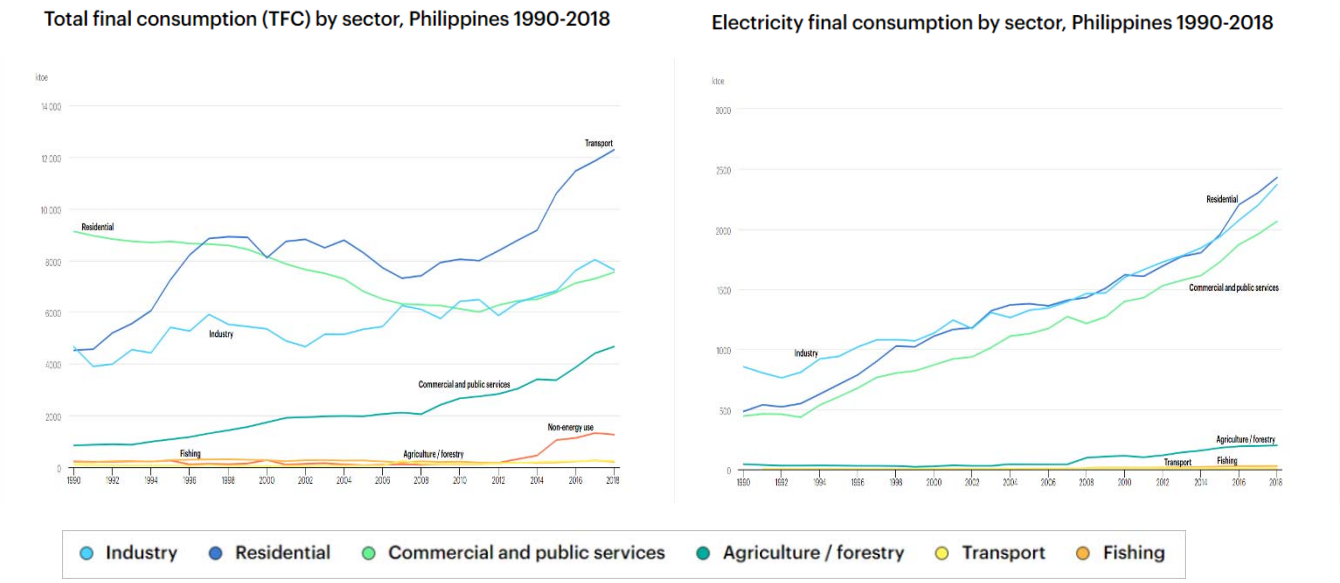
Professional associations. A Building Automation System Association of Malaysia (BASAM) was formed to increase competency of building professionals to commission and design functional systems which can be used to improve monitoring and energy monitoring and controls of buildings. Building commissioning courses were also increased where the industry had intended to replicate the building commissioning certification as offered in the USA to improve the competency of building professionals to commission energy systems.

5. Country focus – Philippines

Building Energy Usage in the context of the National Energy Sector

The Philippines has seen strong ongoing growth in energy use, though the sector picture has been quite mixed. Total residential energy use actually steadily declined between 1990-2010, as the electrification rate rose rapidly, and households replaced traditional and inefficient sources of energy with electricity (which has grown steadily across the period). Both residential and commercial and public services energy demand is growing relatively strongly during the past five years (Figure 16).

Figure 16. Philippines Total Energy and Electricity Final Consumption by sector



Source: https://www.iea.org/countries/philippines#data-browser)

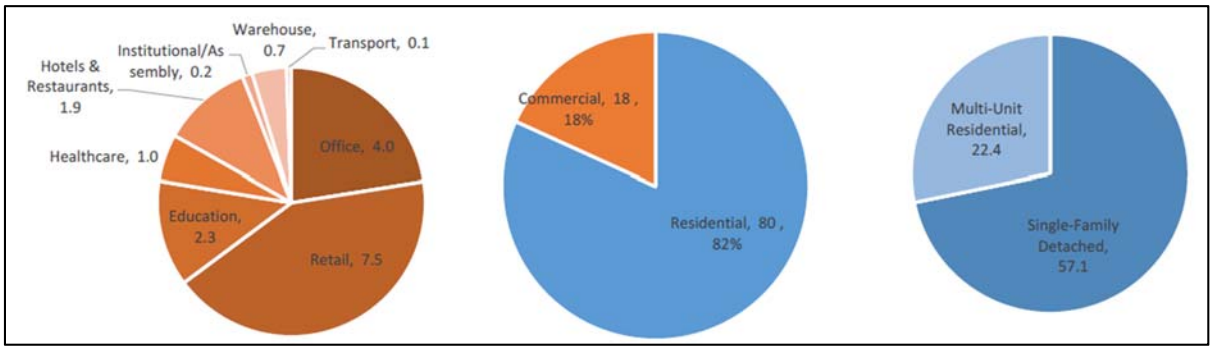
The Philippines market for new building construction has been growing steadily, driven by inbound investment and sharp expansion in residential construction, the hotel and hospitality sector, as well as business process outsourcing. Permits for additional floor space are increasing by ~15% annually, with approximately 20 million square meters of new floor space. This growth has been rapidly blunted in 2020 by the COVID-19 pandemic (PSA, 2020). At the same time, an increasing trend towards outsourcing of knowledge and business processes (including a significant online gambling industry presence) has changed the commercial building usage mix, longer hours of operation and emphasis on different energy uses (e.g., IT and data center management).

Residential energy consumption in the Philippines is dominated by three main end uses: space cooling and refrigeration (56% of consumption), appliances (18%) and lighting (11%). Any efforts at reducing energy consumption in residential buildings should therefore be targeted at these three end-uses (Department of Energy, 2017).

IFC carried out a detailed survey of the Philippines market for new building construction. They estimate the new buildings market for the period 2018-2025 at USD 98 billion or just

under USD 16 billion annually during this period. Furthermore, they estimate the "green buildings" market to account for 14% of this total, or USD 14 billion or USD 1.75 billion annually (IFC 2019, p. 2).

Figure 17. Philippines New Building Construction Market Projections, USD bn, 2018-2025



Source: IFC, 2019

The center chart in Figure 17 shows the market breakdown - four-fifths (82%) residential buildings and one-fifth (18%) commercial buildings. Within the dominant residential sector, the vast majority of the market (USD 57.1 billion) will be for detached, single-family housing, and the balance (USD 22.4 billion) will be in multi-unit residential housing. Within commercial buildings more than three-quarters of new construction will occur in the retail sector (USD 7.5 billion), the office sector (USD 4.0 billion) and education (USD 2.3 billion) (IFC 2019, p. 3).

IFC has documented the cost-effectiveness of undertaking building refurbishments in the Philippines when key plant and equipment is reaching the end of its useful life (IFC, 2017). The ageing building stock in major building districts such as Makati and Ortigas in metropolitan Manila presents significant opportunities for retrofitting and building management programs, coupled with electricity tariffs that are among the highest in ASEAN (PYC Data Center, 2019).

IFC has been very active in surveying and analyzing building electricity consumption in the Philippines, and has introduced its EDGE tool. Table 12 shows comparisons of the intensity of building electricity usage, comparing a 2013 survey with results from a more recent EDGE survey of Philippines buildings (IFC 2019), and minimum compliance with the Philippines Green Buildings Code. The table shows the range of intensities across different building types and indicates that compliance with the Green Building Code minimum requirements would reduce energy intensity by 25% to 37%, depending on the type of building.

Table 12. Comparison of Energy Utilization Index in Philippines Buildings (Units: kWh/m²/yr)

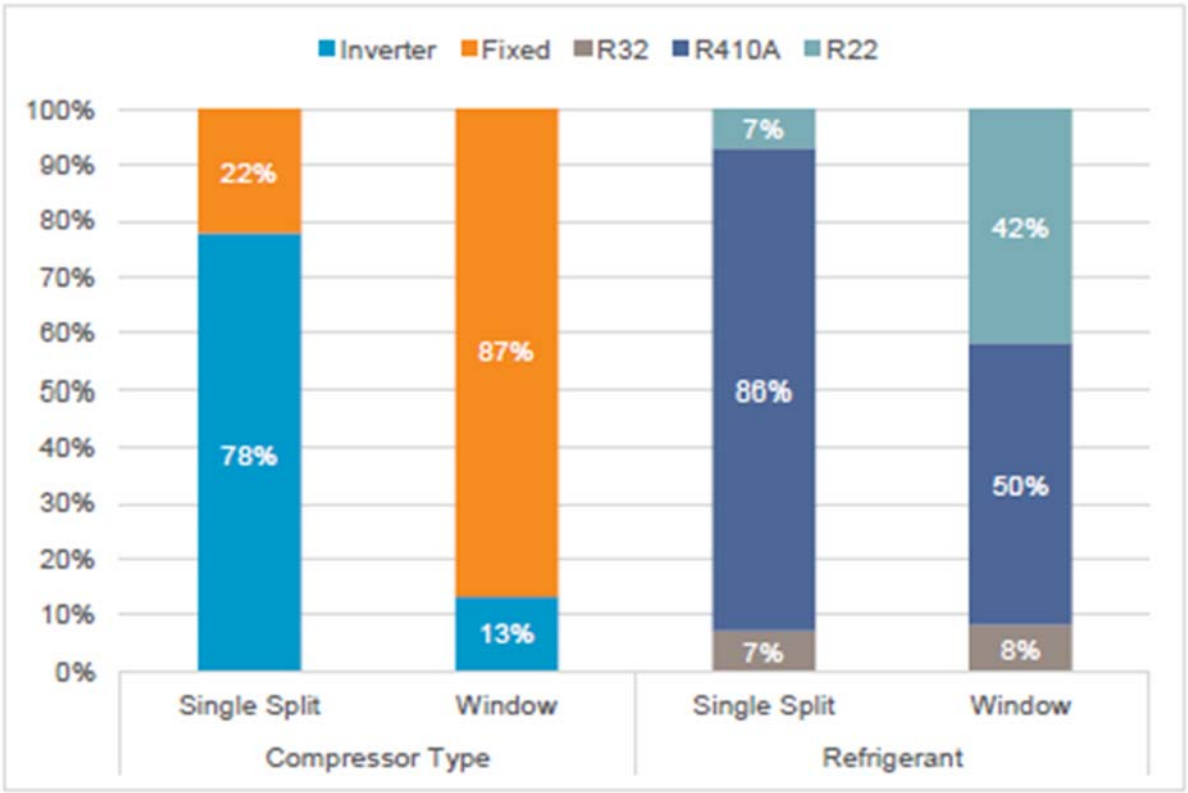
Building Type	IFC-PGBU Survey 2013	EDGE Philippines baseline (2019)	Philippines GB Code, minimum compliance[4]	Reduction in GB Code vs. EDGE 2019 Baseline
Office	345	136	98	28%
Hospital	338	367	263	28%
Hotel	174	342	234	32%
School	131	75	47	37%
Retail (Mall)	336	200	151	25%
Residential Condo	65	65	43	34%

Source: IFC Green Building Code Survey

The market for residential air conditioners in the Philippines was estimated in 2017 to be 800,000 units annually, with an annual growth rate of 5%. The market is made of about 60% domestic models and 40% imported models (CLASP 2019, p. 11).

Figure 18 shows results from a survey done by the international non-governmental organization CLASP on the Philippines air conditioner market (CLASP 2019). It shows that split-system residential air-conditioning units tend to be more technologically advanced in that they tend to have inverters (variable-speed compressor drives, which yield higher efficiencies), and more advanced, less ozone-depleting refrigerants.

Figure 18. Characterization of Compressor Types and Refrigerants in Philippines Air Conditioners

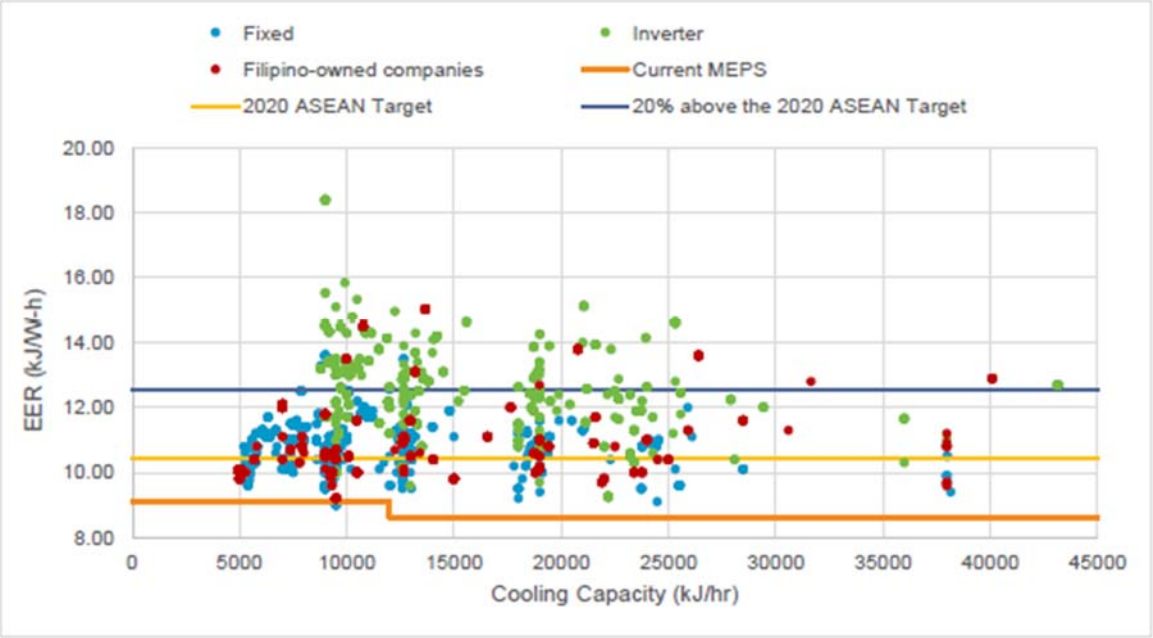


Source: CLASP 2019, p. 5

[4] IFC EDGE calculations.

Figure 19 plots results of data from 999 randomly selected air-conditioner models in the Philippines. The chart has two main take-aways: (a) the use of inverters at any air conditioner capacity have significantly higher efficiency ratios (EERs); and that (b) a significant share of the domestically produced air conditioners do not meet the 2020 target for minimum energy performance of air conditioners (CLASP 2019).

Figure 19. Cooling Capacity vs. Efficiency by Compressor Type in the Philippines



Source: CLASP 2019, p. 6

Summary of Policies aimed at improving Building Energy Efficiency

Energy Efficiency and Conservation Roadmap (2017-2040). In recent years, the Philippines has increased its focus on energy efficiency. One of the first steps was its creation of a long-term Energy Efficiency and Conservation Roadmap in 2017. This Roadmap addressed the piecemeal approach and coverage of energy efficiency policy that was evident prior to that time, and contained recommendations for short- and longer-term actions for the building sector including:

- a cumulative reduction in energy use compared to business-as-usual as forecast to 2040 of 25% for commercial buildings and 20% for residential buildings, representing 2,200 KTOE and annual percentage savings of 1.9% and 1.2% respectively;
- an economy-wide improvement in energy intensity of 3%;
- minimum energy performance standards for key appliance classes;
- a program for cool roofs and insulation in the residential sector;
- retrofitting and retro-commissioning measures for commercial buildings;
- benchmarking and ratings for building information disclosure and reporting;
- consideration of energy efficiency in building codes; and
- financing and industry development measures.

These measures were supplemented with reforms to establish stronger baselining, data collection and monitoring and evaluation regimes, and to establish clearer institutional roles and responsibilities for delivery.

Table 13 shows the ambition of the Roadmap for the buildings sector—with annual energy savings targets of 1.2% and 1.9% for the residential and commercial sectors, respectively, and total savings of 20% and 25% by 2040, compared to business as usual.

Table 13. Indicative Energy Efficiency Targets in the Long-Term Energy Efficiency and Conservation Roadmap

Sector	Annual Energy Savings by 2040 (KTOE)	Implied Annual Energy Savings	Total Savings by 2040
Transport	4,500	1.9%	25%
Industry	3,000	1.3%	15%
Residential	1,000	1.2%	20%
Commercial	1,200	1.9%	25%
Agriculture	300	0.9%	10%
Total	**10,000**	**1.6%**	**24%**

Source: DOE 2017, p. 13

Energy Efficiency and Conservation Act (2019). Building on this platform, in April 2019 the Philippines Government signed a new Energy Efficiency and Conservation Act into law, with subsequent implementing rules and regulations in November 2019. This was a landmark achievement, with energy efficiency in the Philippines formerly empowered legislatively only by a series of Departmental Circulars, Presidential Decrees and informal strategies. The Act places a strong focus on improving efficiency in buildings including state-owned and leased buildings. The Act has far-reaching implementation directives for reporting and acting on energy efficiency opportunities in such buildings; certification and accreditation of energy efficiency professionals, energy auditors and ESCOs; minimum energy performance for sectors (commercial, industrial and transport), product and labeling requirements; energy management, auditing and reporting obligations for energy users with average annual consumption in excess of 100,000 kWh[5]; incentives to

[5] Refers to all forms of energy used during the previous year.

encourage and scale-up EEC project investments, and various measures for institutional coordination and strengthening.

While this new legislative framework provides a solid basis for action on building energy efficiency, new substantive actions are yet to be forthcoming. In recent years, the Department of Energy (DoE) through its Energy Utilization Management Bureau, and the Energy Efficiency and Conservation Division, has raised a range of initiatives that target energy use in buildings, including:

Social Mobilization, *Information, Education and Communication Campaign:* DoE continues to run a range of campaign activities targeted at residential consumers.

Energy Efficiency Standards and Labeling Program: Testing and labeling of household appliances has been the cornerstone of energy efficiency policy for the residential sector given its coverage of the principal consumption appliances used. DoE had support from, among others, the GEF through UNDP under the Philippine Efficient Lighting Market Transformation Project (PELMATP) and the ADB under its Philippine Energy Efficiency Project (PEEP) in developing efficient lighting programs, and implemented it in partnership with the Department of Trade and Industry's Bureau of Product Standards and the Philippines Appliances Industry Association. The testing program is mature and requires appliances and lighting products to meet prescribed minimum energy efficiency levels and to carry an energy label at the point of sale. Covered products include window air-conditioners, household refrigerators and freezers, lighting, televisions, clothes washers and fans; however, enforcement mechanisms and channels for rollout remain under-developed.

Guidelines on Energy Conserving Designs of Buildings: These Guidelines were developed in 2008 as an activity of PELMATP supported by UNDP and GEF. The Guidelines are detailed and aim to prescribe minimum requirements for energy conserving design of new buildings, and provide methods for determining compliance. Presently these Guidelines, covering aspects of the building envelope and mechanical and electrical systems are in the final stages of updating by the DoE with support from EU through the Access to Sustainable Energy Programme (ASEP) and harmonizing the provisions with the Philippine Green Building Code, which is for mandatory compliance under the National Building Code. Unlike its predecessor, the updated version applies not only to new but also retrofit buildings. However, the Guidelines remain voluntary and are not yet linked to the Philippine Building Code, such that there remain no requirements for energy efficiency standards to be implemented in commercial (or residential) building construction (Philippine Green Building Code, 2015).

Efficient Building Initiative: This sub-component of the PEEP aimed to reduce energy consumption and greenhouse gases in the Philippines through introduction of a unified Green Building Certification System, that streamlines existing initiatives into a single nascent system. The Philippine Green Building Council was engaged to development and implement this rating system, leading to the design and launch of the Building for Ecologically Responsive Design Excellence (BERDE) suite of nine rating tools.

Government Energy Management Program: building on circulars and administrative orders that require government agencies to reduce fuel and electricity consumption

by at least 10% and adopt other efficiency measures. Support for retrofitting of lighting in government buildings and public facilities was included, including office buildings, street lighting, traffic lights and other public lighting, to catalyze market uptake through demonstration. DoE's GEMP is a continuing program that requires establishment of energy conservation programs and dedicated staff for each agency, including government departments, bureaus, government owned and controlled corporations, academic institutions and others. DoE conducts awareness raising for government agencies, conducts spot checks on agencies for compliance with the requirements, and recognizes good performers.

Energy Management Systems – Energy Audits: DoE offers a technical service for a minimal fee to commercial buildings (and other large energy using sites) whereby a team of DoE engineers evaluates plant efficiency and recommends energy savings measures.

Government buildings have been a key success story for energy efficiency, with substantial consolidated savings achieved from a large number of government agency reports. A key feature of the GEMP program has been its ability to generate credible monitoring reports about energy use and savings generated, something that has been lacking in other sectors. Consolidated reporting indicates that as much as PHP 2 billion was been saved on energy costs between 2005 and 2013; no reporting beyond that date has been identified (Department of Energy, 2017).

The Department of Public Works and Highways has jurisdiction over building codes, which are enforced at the local government unit (LGU) level by the Department of Interior and Local Government (DILG). In mid-2010, IFC supported the Department of Public Works and Highways, National Building Code Development Office (NBCDO) in the crafting of the Philippine Green Building Code (PGBC). This is the upscaled version of the Green Building Ordinance, mandating measures and benchmarks, piloted by IFC in the City of Mandaluyong. However, despite the inclusion of the PGBC as a Referral Code of the National Building Code (June 2015) and its subsequent mandatory implementation the following year, compliance to the PGBC appears to have largely stalled primarily because of the upskilling of LGUs that would be implementing the PGBC, and the need to enhance information and awareness activities to include building professionals (e.g. developers, designers).

Building envelope measures are a potential gap for future policy focus. JICA figures on house construction suggest that the majority (75%) of houses in the Philippines are constructed with galvanized roofing that provides little thermal insulation. Very cost-effective insulation measures could be deployed to reduce cooling energy load. Studies in the US (see for instance Kolahdoozan and Leite, 2012) have estimated that as much as 19% of cooling energy could be saved simply through better house insulation; this figure is likely to be an underestimate for the Philippines given its tropical climate and the dominance of cooling loads in residential energy use.

Given the commercial attractiveness of many energy efficiency retrofits, Government can use its power as a building occupier to demonstrate the retrofitting of commercial buildings. While this has been tackled with regard to lighting under existing projects, there is now opportunity for government itself to access energy services and showcase deeper investments like cogeneration and air-conditioning systems in government buildings,

explicitly linked to the stated objective of promotion of ESCOs as a funding path for commercial building retrofits. It is noted that the Government trialed an approach to ESCO deployment under the PEEP, which was unsuccessful; however, the lessons from this exercise can still be deployed.

Key activities of agencies, institutions and organizations in building energy efficiency

For such a large country with significant energy efficiency potential the Philippines does not have a strong history of development support for its efforts in the buildings sector.

ADB (Asian Development Bank). ADB has had a series of investments in efficiency-related areas in the past 10 years, notably the multi-faceted Philippine Energy Efficiency Project, in which large-scale procurement and promotion of CFL lamps and government building retrofits were the most successful components. ADB also published a comprehensive assessment and strategy for the Philippines energy sector in 2018 (ADB 2018).

EU-SWITCH. Through its regional programme on sustainable consumption and production, the EU focused on energy efficiency in the Philippines, culminating in its support for the Energy Efficiency and Conservation Roadmap 2017-40.

World Bank. The World Bank implemented the $48m Chiller Energy Efficiency Project for the Philippines from 2010 to 2017 and aimed to reduce greenhouse gas (GHG) emissions by replacing inefficient chillers including Chlorofluorocarbon (CFC)-based chillers and non-CFC-based chillers.

IFC (International Finance Corporation). IFC partnered with the Philippines Green Building Initiative (PGBI) in 2016 to launch the EDGE certification program. The EDGE program has been very active in the Philippines, carrying out building certification, as well as numerous building energy surveys, which fed into an assessment of the market for new residential and commercial building construction and the potential for green building construction (IFC 2019, and see above). IFC has tracked data on the performance more than 90 green building projects across the country through EDGE and other certification initiatives (IFC 2019). It has also been instrumental in working with large local banks BDO and BPI to establish sustainable energy finance programs, by providing risk-sharing facilities, advisory services, and also assisting them to issue green bonds for green building investments.

ENPAP 4.0. ENPAP 4.0 is a non-government, non-profit association of energy management practitioners, professionals and consultants in the Philippines. It is the successor of the Energy Efficiency Practitioners Association of the Philippines (ENPAP, 2000) and its immediate predecessor the Energy Management Association of the Philippines (ENMAP, 2010s). Since 2019, ENPAP 4.0 has served as a catalyst and provided an avenue for knowledge transfer and information exchanges through the conduct of training courses and seminar-workshops, conferences, and developing strategic advocacy positions and policy initiatives with key government agencies on energy efficiency and conservation legislation, technologies and practices. ENPAP 4.0 continued to assume the role of ENPAP as an ASEAN Centre for Energy (ACE) Action

Partner and conducted training courses for the Certification for Energy Managers under the ASEAN Energy Manager Accreditation Scheme.

Philippines Energy Efficiency Alliance (PE2). PE2 is an association of Philippines ESCOs that operates with guidance and oversight from the Philippines Department of Energy.6 PE2 acts as a convener of ESCOs and also facilitator of multi-stakeholder dialogues on energy efficiency policy, regulation, and finance, with the aim of giving the private sector and civil society a platform to provide input into energy efficiency policy and regulation, and to stimulate increased financing and implementation of energy efficiency projects.

World Bank. The World Bank's ESMAP unit has supported the improvement of EE in public buildings in the Philippines by providing technical support over the entire project cycle in the form of energy diagnostics and audits, training and capacity building, design and implementation mechanisms, and advisory services. The program also works in collaboration with the Asia EDGE building certification.

GIZ. Through involvement with the Access to Sustainable Energy Programme (ASEP), C4 (Kigali), and its flagship CASE Energy Transition Programme, GIZ is assisting the Philippines Energy Department in implementing building-related EE programmes for lighting systems, household appliances, and passenger and commercial vehicles. They estimate building EE measures could generate potential annual savings of 3.6 billion pesos (74.5 million USD).

Large property groups. The Philippines real estate market is characterized by several large property groups, including Ayala, SM, Robinson, Filinvest and Megaworld. These property groups develop large scale office buildings, malls, and residential housing (condominiums), and several of them have also developed internal capacity for energy services, performance contracting and financing of efficiency projects in new construction, as well as in retrofits of their existing building stock.

As the new middle class in the Philippines continues to grow a shift is evident towards a preference for living in more integrated living spaces. Mixed use developments offer access to facilities for living, working, and playing. As this continues, property ownership of these developments tends to be with the larger real-estate companies.

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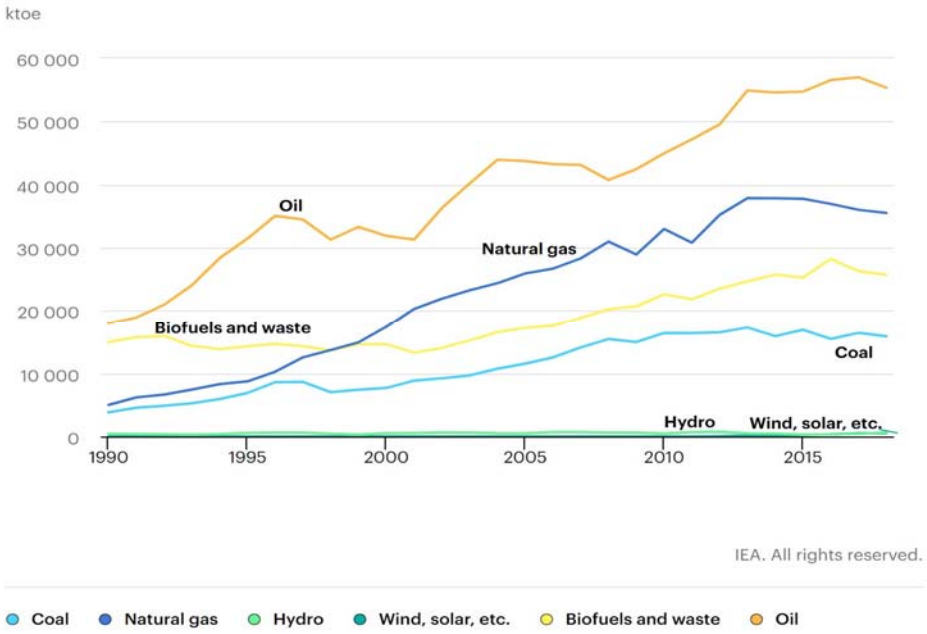
6 The Energy Service Company Association of the Philippines was founded in May 2005, and PE2 was established in 2016 as its successor, in the form of a non-profit civil society organization. See www.p2e.org.

6. Country focus – Thailand

Building Energy Usage in the Context of the National Energy Sector

Energy supply trends by fuel. Thailand has the second highest total final energy consumption in the ASEAN region after Indonesia. The primary fuel is oil (41%), with 26% supplied by natural gas, and 19% from biofuels and waste (Figure 20). While hydropower has provided a small but falling share of electricity, and installation of wind and solar power plants have been increasing, the renewables share in total energy supply remains minimal (IEA 2018).

Figure 20. Total Energy Supply (TES) by source, Thailand 1990-2018

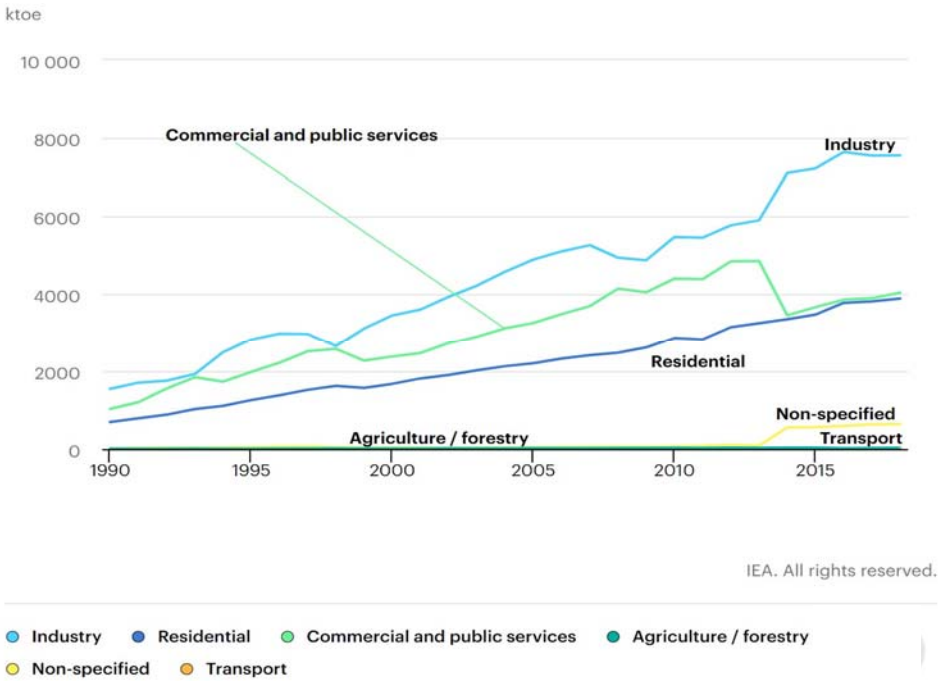


Source: IEA Country Profile Thailand, accessed at https://www.iea.org/countries/thailand.

In terms of final energy consumption by sector, the shares of transportation (32%) and industry (31%) each account for about one-third, while residential consumption accounts for 13% and commercial consumption accounts for 7% (Velautham and Poddey 2018).

Electricity consumption trends. Focusing on electricity consumption (Figure 21) paints a different picture: the industrial sector accounts for just under half (46.7%) of electricity consumption, and the commercial sector (at 25%) and the residential sector (at 24%) sectors each account for one-quarter of electricity consumption (IEA, 2018). Since virtually all of residential and commercial electricity use occurs in buildings, buildings account for about half (49%) of total national electricity usage, or 7,926 ktoe. Overall electricity use in Thai buildings has increased by 20% increase over the past decade (2008-2018, driven by new residential and commercial construction (IEA 2018).

Figure 21. Electricity Final Consumption by sector, Thailand 1990-2018



Source: IEA Country Profile Thailand, accessed at https://www.iea.org/countries/thailand

Since 1995, energy consumption has been growing rapidly in the residential (household) sector, driven largely by increases in per capita income (Yoshida et al, 2020). Average electricity consumption per household is roughly 870 kWh/year for rural areas and 1467 kWh/year for urban areas (Yoshida et al, 2020). This growth in demand is expected to continue, due to population growth and continuing urbanization, with residential energy consumption expected to more than double by 2030 compared to 2010 (Velautham and Poddey 2018).

Energy imports and fuel security. Thailand is a net importer of energy, and energy imports as a share of total energy production runs at 110%. More than half of the energy consumed in Thailand is supplied by energy imports. Net energy imports have risen 52% over the ten-year period from 47.6 Mtoe in 2008 to 72.6 Mtoe in 2018 and is expected to keep rising (IEA 2018). Total energy demand has also continued to rise with urbanization, population growth, and increasing GDP (Praiwan 2020). Thailand recognizes these circumstances and releases short-term five-year energy conservation targets, as well as a long term twenty-year National Energy Efficiency Development Plan (Thailand Power Development Plan, 2018).

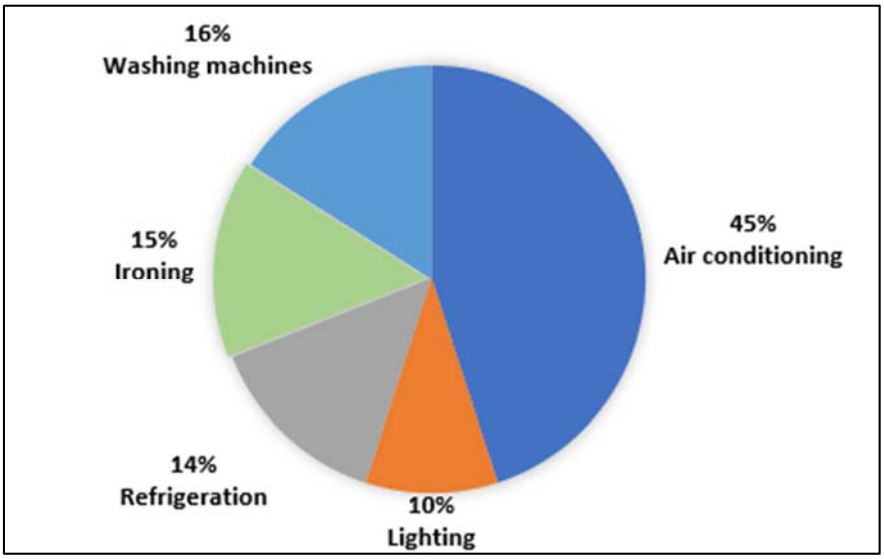
Table 14 sets out the main responsibilities for building energy efficiency between agencies in Thailand.

Table 14. Thai Government Organizations Working on Building Energy Efficiency

Organization	Responsabilities Related to EE
Ministry of Energy	
Energy Policy and Planning Office (EPPO)	Planning of EE policies and EE promotion
Department of Alternative Energy Development and Efficiency (DEDE)	Implementing EE policies,
Electricity Generating Authority of Thailand	Demand Side Management (DSM)
Ministry of Interior	
Department of Public Works and Town & Country Planning	Zoning, Building Code Compliance
Ministry of Industry	
Metropolitan Electricity Authority (MEA)	Demand Side Management (DSM)
Provincial Electricity Authority (PEA)	Demand Side Management (DSM)
Thailand Industrial Standards Institute (TISI)	Technical standards and testing for equipment and appliances
Ministry of Environment and Natural Resources	
Thailand Institute for Scientific and Technological Research	EE research and testing
Ministry of Environment and Natural Resources	
Thai Greenhouse Gas Management Organization (TGO)	Carbon credits, emissions trading, white certificates

There are very few data on end-use breakdown in Thai residential and commercial buildings. Figure 22 and Figure 23 show indicative breakdowns for Thai residential and office buildings, respectively. For Thai residential buildings (detached houses, shophouses, townhouses, apartment buildings) that have air-conditioning, this is by far the dominant end use.

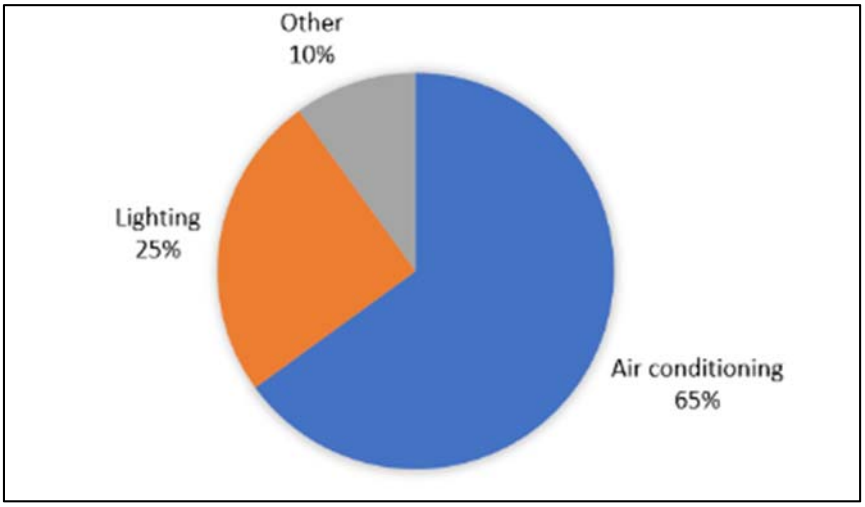
Figure 22. End-use Breakdown of Electricity Consumption in Thai Residential Buildings



Source: Soodaphakdee, 2010

In office buildings, the dominant electrical end use is air conditioning, followed by lighting and other end uses such as pumps and motors, appliances and equipment, and plug loads.

Figure 23. End-use Breakdown of Electricity Consumption in Thai Office Buildings



Source: DEDE 2015

The market for refrigeration and air conditioning (RAC) in Thailand accounts for approximately 20% of the country's total greenhouse gas (GHG) emissions. These emissions can be both direct (from use of refrigerants) and indirect emissions (from energy consumption) (RAC NAMA 2020).

A recent analysis of the Thailand air conditioner (AC) market by CLASP, an international non-governmental organization, provides a useful overview of Thai AC manufacturing, as well sales and efficiency units of air conditioners used in Thailand (CLASP 2019). The report found that Thailand has a highly developed air-conditioner industry and is the second largest manufacturer, after China (Euromonitor, cited in CLASP 2019). Thailand accounts for 9% of global room AC production and 22% of world AC exports (COMTRADE and Euromonitor, cited in CLASP 2019). The Thai AC market has evolved significantly in recent years, and the market share of the more efficient inverter units (which have variable speed compressors) now make up a majority of sales in the popular "2 ton" category (25,000 Btu/hr) (CLASP 2019, p. 9). Significantly, the report finds that high-efficiency ACs are currently quite cost-effective in Thailand, with very short payback periods (CLASP 2019, p. 8).

The CLASP report found that revising the minimum energy performance standards (MEPS) and the category thresholds on the AC energy label could reduce energy consumption by Thai air conditioners by nearly one-fifth (18%) in 2030 and accelerate a market transformation to high-efficiency air conditioners (CLASP 2019, p 7).

Thailand has also developed a RAC NAMA Fund, with support from the German and UK governments. The RAC NAMA Fund was established in 2017 and is operated by Thailand's largest, state-owned electric utility, the Electricity Generating Authority of Thailand. The

total fund amount is 8.3 million Euros[7], and the funds are allocated for conversion of product lines to green cooling products, a credit line for market introduction and sales promotion, support for 0% credit purchase of air conditioners on credit cards, grants for training facility managers, and communication and promotion to stimulate demand for green cooling products (RAC NAMA 2020). Through widespread dissemination of green cooling technologies, the RAC NAMA project aims to decrease emissions due to Thai refrigeration and air-conditioning products by 1.75 million tons of CO2eq by 2030 (RAC NAMA 2020).

Summary of Policies aimed at improving Building Energy Efficiency

Most of the policies focused on energy efficiency in Thailand are released by its Ministry of Energy (MOEN). Within the Ministry of Energy, the Energy Policy and Planning office is responsible the Thailand's national energy policies and plans. These plans include energy conservation and energy-related measures designed to facilitate balance, adequate and efficient supply to the country.

Table 15 presents a summary of policies in Thailand that relate to energy conservation broadly or building energy efficiency.

Table 15: Relevant Policies to Building EE in Thailand

Policy, Rule or Regulation	Description
Energy Conservation Promotion (ENCON) Act No. 2 BE 2550	Promotes use of EE machinery or equipment and materials to contribute to energy conservation. Buildings not complying incur penalties. Comprehensive legislation for industry and building sectors. Mandates ministerial regulations on energy management in designated buildings, building energy code, individuals responsible for energy, high EE standards for machinery and equipment, and energy management auditors.
Thailand Integrated Energy Blueprint (TIEB) 2015	Prepared by the Ministry of Energy to cover the period of 2015-2036 it includes the following five plans: (1) The Power Development Plan (PDP), (2) The Energy Efficiency Plan (EEP), (3) The Alternative Energy Development Plan (AEDP), (4) The Oil Development Plan, and (5) The Gas Development Plan.
Energy Efficiency Development Plan (EEDP) 2011-2030	The original EE plan released covering the period of 2011-2030, the first plan aimed to reduce energy intensity by 25% by 2030 based on 2005 levels. Enforces the Energy Conservation Promotion Act 1992.
Energy Efficiency Development Plan (EEDP) 2015-2036	This plan expanded on the original EEDP. It outlines mandatory, voluntary, and complementary measures towards the countries EE targets. The mandatory measures include building energy codes on new buildings and energy labelling on equipment. Voluntary measures cover supporting financial tools to support change to EE

[7] Equivalent to about USD 9.8 million and THB 300 million in November 2020 exchange rates.

	equipment such as LEDs. Complementary measures cover human resource development, technology R&D on EE, and public awareness.
Energy Conservation Promotion Act 1992	The 2007 amendment established the Minimum Energy Performance Standards (MEPS) and energy efficiency labelling.
Building Energy Code 2009	The Minister of Energy issued Ministerial Regulation B.E. 2552 (2009) which defines applicable Types and Sizes of Buildings as well as Standards, Criteria and Methods of Designing Energy Conservation Buildings. The Thai Building energy code applies to all, newly erected buildings in Thailand which have a floor area of more than 2,000 m^2 Under the Building Control Act, the building envelope, lighting, air conditioning (AC) and the hot water system must comply with BEC requirements. The BEC allows using of renewables, specifically photovoltaics. So far, the Thai BEC has been implemented only in the public sector (since 2013).
Building Energy Code 2021	According to the BEC roadmap stated in Thailand's Integrated Energy Blueprint (TIEB) 2015, BEC enforcement should have been implemented in the private sector in 2019. However, the implementation has been postponed to 2020. The Ministry of Energy will also promote building labelling systems and zero energy buildings, which will be a guidance for the BEC tightening in the future.

Much of the EE policy in Thailand revolves around five-year energy conservation plans and the Thailand Integrated Energy Blueprint (TIEB). Since the TIEB is designated as a five-year plan, a new plan is due for development in 2020, though has not yet been released.

In addition to regulations and policies, several EE financing schemes are managed in Thailand by government ministries, ESCOs, and other stakeholders. The ENCON act established the Energy Conservation Promotion Fund (ENCON Fund) in 1992. The ENCON Fund is financed through a levy on petroleum products and provides financial support for large ("designated") factories and buildings that are required to upgrade the energy efficiency of their facilities. The ENCON Fund also provides support for voluntary programs that include promotion and communication around energy conservation and pilot projects and programs that demonstrate new technologies and approaches.

The Energy Efficiency Revolving Fund (EERF) is a major sub-activity of the ENCON Fund that was established in 2003 under the Department of Alternative Energy Development and Efficiency (DEDE). EERF's objective is to stimulate investments in large-scale industrial projects. Its initial capital fund was created by the government via revenue from a petroleum tax. The EERF facilitates debt financing for EE and RE projects by providing loans to banks at a 0% interest rate and with a seven-year maturity (Velautham & Poddey 2018). Using the EERF loans, banks can lend to EE project owners/developers at a maximum interest rate of 4%.

Another financing scheme, in addition to the ENCON Fund, is the Energy Services Company (ESCO) Fund. The ESCO fund was also created by the DEDE and encourages

EE and RE project investments. Channels used by the ESCO fund include equity investments, venture capital, equipment leasing, carbon markets, technical assistance, and credit guarantee facilities. It also facilitates Certified Carbon Credits on the international carbon market (IEPD).

Building Energy Code and Certifications

Thailand has had some form of a building energy code since the early 1990s when a category of large, "Designated Buildings" were required to have certain minimum levels of overall thermal transfer value, lighting density, and cooling energy use. These requirements were not enforced, however. During the early 2000s, the Ministry of Energy, with assistance from DANIDA, developed a more comprehensive building energy code, which was still at that time voluntary (Velautham and Poddey 2018).

In 2009, the Minister of Energy issued the Ministerial Regulation B.E. 2552 (2009), which defines applicable types and sizes of buildings as well as standards, criteria and methods of designing energy efficient buildings. The Thai Building energy code applies to all newly erected buildings in Thailand that have a floor area of more than 2,000 square meters. Under the Building Control Act, the building envelope, lighting, air conditioning (AC) and hot water system must comply with BEC requirements. The BEC allows the use of renewables, specifically photovoltaics. So far, Thailand's BEC has been implemented only in the public sector. According to the BEC roadmap stated in Thailand Integrated Energy Blueprint (TIEB) 2015, The Thai BEC should have been implemented in the private sector in 2019. However, implementation was postponed to 2020. The BEC will be integrated with the current building permit process under The Department of Public Works and Town & Country Planning.

To support enforcement of the BEC standard, DEDE developed a BEC calculation tool and guidebooks for designers and owners to design their buildings according to the requirements. Furthermore, 2,500 BEC auditors have been trained and registered to evaluate and verify the building design before proceeding with construction permission.

In 2018, a new BEC was announced for new buildings with a plan to expand the BEC to several categories of new buildings. New buildings with an area greater than 10,000 sq m must comply by 2018, those with areas between 5,000-10,000 sq m must comply by 2019, and new buildings of 2,000-5,000 sq m have until 2020 to comply (Praiwan 2018).

According to the BEC report 2019 by DEDE, from 2009 to 2019, 803 buildings (two-thirds private buildings, and one-third public buildings) were evaluated according to BEC standard. The estimated energy savings are 48.5 ktoe/year.

There are also several different schemes for green buildings being actively used in the Thai commercial building market. For Thai clients, the main scheme is the TREES (Thai Rating of Energy and Environmental Sustainability) certification scheme, with 102 buildings certified. For international clients, the two schemes in use are the LEED (Leadership in Energy and Environmental Sustainability) certification scheme, with 200 buildings certified; and a newer, German initiative, DGNB (German Sustainable Building Council), with 4 buildings certified.

Key activities of agencies, institutions and organizations in building energy efficiency

- **UNDP.** From 2013-2017 UNDP partnered with the Department of Alternative Energy Development and Efficiency and the Ministry of Energy to fund the adoption of the new Thai Building Energy Code in eleven different demonstration sites. The major donor for the project was the Global Environment Facility and the budget was set at $4.4 million. They also promote EE in commercial buildings through trainings and newsletters.

- **GIZ**. While GIZ tends not to focus on building EE in its work in Thailand, it has been supporting the Green Climate Fund (GFC) Readiness and Preparatory Support Programme II to scale up Thailand's climate finance readiness. The aim is to engage more stakeholders with the fund and create a viable pipeline for clean energy investment projects in the country.

- **AFD.** AFD has actively supported development of energy efficiency policies in Thailand. In addition to policy research and support, AFD is also part of the SUNREF program which is its green finance label. They are currently partnered with the local Kasikorn Bank in proposing financing mechanisms to promote energy efficiency and renewable energies in the construction sector.

- **IEA.** While not very active in the Thai building sector, IEA has been working towards improvements in energy data and statistics across demand and supply in Thailand, leading to more timely submission and publication of Thai energy data.

- **DANIDA.** DANIDA was active in Thailand in the early 2000s, providing assistance in design and implementation of the 30% Standard Measures Program (for buildings and factories); the $50 million Energy Efficiency Revolving Fund; and the Building Energy Code (see above). DANIDA implemented a Low Energy Housing program in cooperation with MOEN during the late 2010s and since then have been active in EE in Thailand. Work on promoting EE in buildings helped the push towards the revised building code and a subsidy scheme for investing in EE equipment. Additional work in regional energy planning helped the development of the Local Energy Planning Centre which was established within the Ministry of Energy.

- **Thai-German Programme on Energy Efficiency Development Plan (TGP-EEDP).**[8] This program supported development of energy efficiency programs and standards that contribute to reductions in CO_2 emissions. The program worked to (a) establish uniform baseline criteria for all energy efficiency measures and support the improvement of energy data management; (b) support development of Thailand's EE policies and plans; (c) contribute to the development of new and improved energy standards; and (d) strengthen existing and planned support instruments and programs including a Standard Offer Programme and an Energy Efficiency Resource Standard (EERS).

- **IFC.** IFC launched a $70 million risk-sharing facility for energy efficiency in Thailand in 2019. The facility also receives support from the World Bank's Clean Technology Fund. IFC is active in supporting energy efficiency projects in the country.

[8] For more information, see https://www.thai-german-cooperation.info/en_US/thai-german-programme-on-energy-efficiency-development-plan-tgp-eedp.

- **CIF (Climate Investment Funds).** CIF has a $300 million investment plan for Thailand, with a goal to increase Thailand's share of alternative energy to 20% by 2022 and reduce GHG emissions by 15% based on a 2012 baseline. Their main current EE program is the $0.5 million Technical Assistance Facility—Asia Green Development Program: Scaling Smart Energy and Efficiency Solutions that was created with ADB. However, most of their investment strategy is through the Clean Technology Fund, which focuses more on renewable energy than energy efficiency.

Thailand has identified the importance of ESCOs in the implementation of its 20-year Energy Efficiency Development Plan (Seeley and Streitferdt, 2015.). The government supports ESCOs through the Energy Conservation Promotion Fund's subsidy scheme and Energy Efficiency Revolving Facility which provides low-interest loan for EE investments through commercial banks. Active support is also given through technical and financial assistance by using tax incentives and the Thai ESCO fund. International support for Thai ESCOs has been provided by GIZ and other international cooperation programmes. Thailand also has an active local chapter of the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE), that administers educational seminars, training courses and exchange of best practices from the region for building practitioners.

ESCOs most active in the market include (Thailand ESCO Information Center, 2020):

- Johnson Controls International (Thailand) Co., Ltd.
- Engie Services (Thailand) Co., Ltd.
- Vesta PMS (Thailand) Co., Ltd.
- Energy Conservation Systems (Thailand) Co. Ltd.
- Azbil (Thailand) Company Limited
- Signify Commercial (Thailand) Co., Ltd.
- Electricity Generating Authority of Thailand
- Metropolitan Electricity Authority

Despite government support, the Thai ESCO market still faces several barriers. The current ESCOs are generally small and often lack the technical and financial resources for delivering large projects. Surveys have found that potential ESCO clients have difficulty understanding ESCO proposals resulting in a lack of trust.

7. Country focus – Vietnam

Building Energy Usage in the context of the National Energy Sector

Vietnam is the third largest ASEAN member state by population and the third largest consumer of energy with a total final energy consumption of 62.21 Mtoe in 2018 (GSO, 2019). As shown in Table 16, energy consumption is dominated by industry, which accounts for just over half (54%) of consumption. Transport is the second largest sector, accounting for 20% of consumption, followed by households (16%) and commerce and other services (5%).

Table 16. Energy Consumption per Economic Sectors in 2018

Sector	Total energy sources (Mtoe)	Proportion (%)
Industry and Construction	33.58	54%
Agriculture, forestry and fishing	1.26	2%
Transportation	12.45	20%
Commerce and other services	2.90	5%
Households	9.65	16%
Non-energy consumption	2.37	4%
Total final energy consumption (TFEC)	**62.21**	**100%**

Source: General Statistics Office of Vietnam https://www.gso.gov.vn

Vietnam saw rapid economic growth as it transformed from an agricultural economy to an industry-based economy over the past two decades (Velautham and Poddy 2018). Between the years of 2005-2014 the service and industrial sectors experienced average annual growth rates of 7% and 6.2% respectively (Wanniachchi et. al. 2016). The country is experiencing increasing population, rapid urbanization, an increased appetite for goods and services, and rapid growth in the industrial and service sectors.

In 2018, total electricity consumption was 192 million kWh (EVN annual report, 2019). Just over half (55%) of total final electricity is consumed in the industry and construction sectors; and one-third (32%) is consumers in the residential and office sectors (at 32%). Commercial hotels and banks account for just 6% (EVN annual report, 2019). Therefore, buildings make up a significant segment and driver of total electricity demand in Vietnam. During 2013-2018, overall national power demand increased by 10.6% annually.

According to the National Power Development Plan (Revised PDP VII)[9], power demand is expected to grow by 8.7% annually during 2016-2030. Domestic power supply increased from 38.4 GW in 2015 to 60 GW in 2020 and is expected to more than double (to 130 GW) by 2030. These conditions are exerting pressure on energy securities in Vietnam to meet socio-economic growth's demand.

[9] Decision No. 428/QD-TTg on the Approval of the Revised National Power Development Master Plan for the 2011-2020 Period with the Vision to 2030.

The Vietnam National Energy Efficiency Program (VNEEP) for 2019-2030[10] set a target to save 5% to 7% of total energy consumption during the period 2019-2025. Measures to achieve these targets include requiring that Designated Energy Users (DEUs)[11] set up an energy management system; setting a target of at least 80 green and energy-efficient buildings by 2025 and at least 150 green and energy-efficient buildings by 2030; and creating an Energy Efficiency and Conservation Fund.

With the urbanization of Vietnam, 35-40% of energy consumption is in urban areas and driven by high-rise buildings such as hotels, office buildings, commercial centers, and industrial zones (VNEEP study, 2020). The energy intensity of high-rise buildings can be seen in Table 17.

Table 17. Energy Consumption per Occupied Air-conditioned Area

Type of Building	Energy Intensity
Office	195 kWh/m^2/year
Library	195 kWh/m^2/year
Retail/Shopping malls	220 kWh/m^2/year
Hotels	240 kWh/m^2/year
Hospital	325 kWh/m^2/year

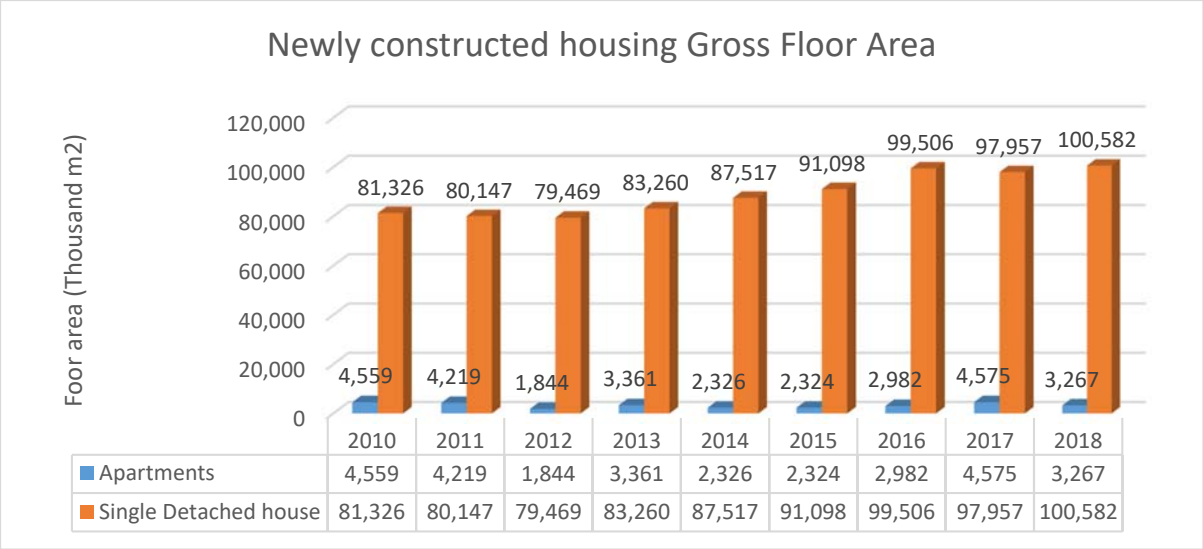
Source: RCEE – NIRAS Study. 2020

In addition to the growth of energy consumption in commercial buildings, the gross floor area of newly constructed single detached houses grew by 23.7% from 2010 to 2018. The growth in floor space of both newly constructed single detached houses and apartments can be seen in Figure 24.

Figure 24. Growth of Floor Area in Newly Constructed Housing

[10] Decision No.280/QD-TTg on approval of the National Energy Efficiency Programme (VNEEP) for the period of 2019-2030.

[11] The building sector accounted about 15% of all the DEUs in 2019.



Source: General Statistics Office in Vietnam https://www.gso.gov.vn

The Growth of Air Conditioning

The Vietnamese air-conditioning market is segmented into residential and commercial/industrial end-user segments. Residential air conditioners (RACs) account for the vast majority of units (~90 - 95%)[12]. Some of the major players operating in the Vietnamese air conditioner market include Panasonic Vietnam Co., Ltd.; Daikin Air Conditioning Vietnam JSC; LG Electronics Vietnam Haiphong Co., Ltd.; Toshiba Carrier Vietnam Air Conditioning Co., Ltd.; and Sharp Electronics (Vietnam) Co. Ltd. With a population of more than 96 million people, Vietnam is seen as a promising air-conditioning market (GSO, 2019). The potential growth is huge, as air conditioners are now present in just 17% of households, according to the British research firm Euromonitor International (Vu Minh, 3 June 2018).

Summary of Policies aimed at improving Building Energy Efficiency

Energy efficiency in Vietnam is regulated by the Law of Energy Efficiency and conservation (LEEC), which splits responsibility between the Ministry of Construction (MOC) for buildings and construction material sectors; and the Ministry of Industry and Trade (MoIT) for energy efficiency activities. MOIT also takes a role as the national coordinators to implement and harmonize national efforts on energy efficiency and conservation (EE&C).

Buildings are recognized in the Vietnam National Energy Efficiency Plan, 2019-2030 as one of the key drivers to improve energy performances and meet the plan targets. The importance of building EE is identified in several national EE policies. However, the emphasis on building EE is relatively narrow and tends to focus on new buildings as well as DEUs in the industrial and commercial sectors.

[12] 90% of these are split-type RACs with a cooling capacity less than 1.5 tons (180,00 BTU/h)

Table 18 presents a summary of policies that relate to energy conservation and building energy efficiency in Vietnam.

Table 18: Relevant Policies to Building Energy Efficiency in Vietnam

Policy, Rule or Regulation	Description
Law of Energy Efficiency and Conservation (LEEC) - No. 50/2010/QH12	The first law relating to energy efficiency and conservation in Vietnam. Contains an individual Article (Article 26) for the building sector. The Law also has a chapter regulating DEUs, including in building sector.
The Vietnam National Energy Efficiency Program (VNEEP) 2019-2030	This is the third national energy efficiency program in Vietnam. In the building sector, the program sets targets and identifies activities for 2025 and 2030 that promote green and energy efficient buildings, eco-cities, and an accreditation scheme for EE buildings.
The National Targeted Program on Energy Efficiency and Conservation 2012-2015	There was a program targeted at the building sector. The program focused on compliance with the Vietnam Energy Efficiency Building Code for new and renovated buildings, application of new materials and technologies, energy efficiency awards, and other related activities.
The Vietnam Energy Efficiency Building Code (QCVN 09: 2013/BXD)	Enacted by Ministry of Construction, this is the national technical guide on building EE. It provides mandatory technical standards for EE in the design, construction, and retrofit of civil buildings. Requirements include efficiency improvements in the building envelope, HVAC systems, lighting systems, escalators and elevators, service water heating systems, and overall reductions in electric power consumption.
National Green Growth Strategy and Action plan	Specific tasks for promoting energy efficiency in the building sector include: implementing energy efficiency programs in construction; development and issuance of regulations, criteria, and guidelines for green and energy efficient buildings; formulation of mechanisms and policies to support and promote investment in green building investment; and capacity building for stakeholders.

A review of VNEEP activities during 2006 – 2015 found that actual energy savings were around 3.4% during 2006-2010, and 5.6% during 2012-2015 (RCEE-NIRAS, 2016). A number of donors contributed technical assistance to support the activities in this program, including the World Bank, ADB, UNIDO, GEF, UNDP, SIDA, JICA, and DANIDA.
Building on the experience and results of the VNEEP during 2006-2015, the VNEEP 2019-2030 was designed with economic incentives to encourage EE and conservation. Some key activities relating to building are shown in Table 18.

Key activities of agencies, institutions and organizations in building energy efficiency

- **IFC EDGE Program.**[13] The EDGE building certification has an active Vietnam program. As of October 2019, they have certified 1,581,890 square meters of floor

[13] See https://edgebuildings.com.

space (Duong, 2020). They work closely with the Vietnam Green Building Promotion Program which advertises the benefits of green buildings to consumers and lobbies the government to offer incentives. Financial backers of the promotion program include Capital House, Phuc Khang Corporation, CEO Group, FLC Group and the Vietnam Real Estate Association.

- **ADB.** The Vietnam Smart and Energy Efficient City Project (SEECP) began in late July 2020 and aims to help provinces and cities achieve their goals from VNEEP 3 and the Green /Smart Cities initiatives. SEECP supports building roadmaps for minimizing climate change impacts, implementing smart street lighting systems, and improving EE in public buildings. The six cities and provinces that have been chosen to participate are Can Tho, Da Nang, Ha Noi, Hai Phong, Quang Nam, and Quang Ninh.

- **UNDP.**[14] The UNDP program, Energy Efficiency Improvement in Commercial and High-Rise Residential Buildings in Vietnam (2016-2019), aims to reduce the intensity of GHG emissions in the building sector. The project objective is to improve improved energy performance in commercial and high-rise residential buildings in Ho Chi Minh and Hanoi through (1) improvement and enforcement of VEEBC; (2) building market development support initiatives; and (3) building energy efficiency technology applications and replications.

- **GIZ, AFD, and French Environment and Energy Management Agency (ADEME).**[15] These donors manage the Programme for Energy Efficiency in Buildings (PEEB) in which Vietnam is one of the receiving countries. The lead executing agency in Vietnam is the Ministry of Natural Resources and Environment. The programme provides technical expertise and financial resources to support large-scale projects for increasing EE in buildings. The programme was initiated in 2017 and is expected to wind down at the end of 2020.

- **DANIDA.**[16] DANIDA ran an EE project in Vietnam from 2013-2016 called "Low carbon transition in the energy efficiency sector". One of the two main components was focused on building EE and aimed to improve capacity for implementing EE in large building improves in line with the VNEEP energy savings targets on 5-8%. The implementing Vietnamese body was the Ministry of Construction.

- **APEC.** APEC regularly runs workshops and seminars evaluating the Energy Efficiency programs in Vietnam. Their publications involve peer reviews of EE and low carbon energy policies in Vietnam. Other work includes training projects in-country on energy efficiency.

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[14] See https://www.vn.undp.org/content/vietnam/en/home/operations/projects/environment_climate change/energy-efficiency-improvement-in-buildings.html.

[15] See https://www.peeb.build.

[16] See https://vietnam.um.dk/en/green-growth/low-carbon-transition.

- **USAID Vietnam Clean Energy Program.** The five-year USAID Vietnam Clean Energy Program (VCEP) ran between 2012-17, and had an overarching objective to accelerate Vietnam's transition to climate resilient, low emission sustainable development. The Program focused on energy efficiency in the building sector, and supported the Ministry of Construction to implement and monitor the Vietnam Energy Efficiency Building Code. VCEP trained over 3,000 government officials, practitioners and university lecturers on energy efficient, high performance building design; green building design and certification; commissioning of buildings to ensure that planned savings actually happen; and energy simulation software. The program also helped improve the operation of over 21 local organizations and institutions.

Other noteworthy initiatives include:

- **Vietnam Federation of Civil Engineering Associations (VFCEA).** This organization developed the current Vietnam Energy Efficiency Building Code, while the Vietnam Green Building Council (VGBC) has developed and now administers the LOTUS rating tool, for more advanced green buildings.
- **ASHRAE**. In February 2020, a Vietnam Chapter of the American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) was established. ASHRAE Thailand is the host chapter of the new Vietnam section. ASHRAE administers educational seminars, training courses and exchange of best practices from the region for building practitioners.
- **ESCOs.** The ESCO market in Vietnam is undeveloped. The Ministry of Industry and Trade (MOIT) is currently piloting ESCO models and has an ESCO establishment and registration process. MOIT and the Ministry of Finance are currently working together. Other barriers facing ESCOs include cheap energy costs, low awareness of energy efficiency, high transaction costs for relatively small projects, high perceived risks, and a legal framework and enforcement that does not support the energy performance contracting (EPC) approach.

Technology developments

Lighting technology. In Vietnam, smart LED lights are gradually replacing traditional lighting equipment. According to the latest report from LEDinside, a division of market research company TrendForce, the LED lighting market in Vietnam is estimated to have an annual growth rate of 20.6% and is forecast at 60 million USD by 2020.[17] Due to the outstanding characteristics of LEDs in terms of luminous efficiency, longevity, mechanical durability, energy saving and environmental protection, this lighting technology become more popular today.

Thanks to the increase in domestic production and the industrial growth, LED lighting products have been assembled by Vietnamese manufacturers using imported

[17] From a summary of the report: https://www.ledinside.com/intelligence/2017/10/ledinside_vietnam_lighting_market_to_become_the_spotlight_in_emerging_countries.

components. The Vietnamese lighting market has gradually eliminated its high dependence on imported products and become healthier. Some of manufacturers of LED lighting equipment in Vietnam include: Phillips, Panasonic, Dien Quang, and Rang Dong. LED manufacturers in Vietnam apply advanced and modern technologies from many different countries in order to design and supply suitable products to meet Vietnam market demand. All LED fixtures must address minimum energy performance standards and be labelled before being sold in the market.

Sensors and control applications. Sensors and controls are not produced domestically and are imported. Such equipment is often supplied as part of automatic building control systems.

Indoor Environment Quality. In high-rise buildings in Vietnam, low volatile organic paints and coatings (VOC) are popularly used. Indoor concentrations of VOCs are typically much higher (up to 10 times higher) than outdoor concentrations and can cause significant health problems for people who regularly stay indoors. VOCs are released from a variety of products (e.g. paints and lacquers, cleaning supplies, construction materials and furniture, office equipment).

8. Smaller and Emerging ASEAN Markets – Brunei Darussalam, Cambodia, Laos, Myanmar, and Singapore

About this Chapter

Other than the five countries covered by preceding chapters, the remaining countries in ASEAN are either smaller, developed economies (Singapore and Brunei Darussalam) or less developed economies that are not as market-ready for concerted building energy efficiency initiatives (Cambodia, Laos and Myanmar). Taken together, these five countries account for just 11% of ASEAN's total final energy consumption. This study therefore gives shorter coverage to these countries, while identifying major trends and any issues that could be of relevance to future regional building energy efficiency initiatives in the region.

Singapore is a special case, in that it is a high energy consumer with a very advanced building sector. This is reflected in the fact that, while Singapore comprises only 0.9% of ASEAN's population, it consumes 5.1% of its total final energy. Singapore is also acknowledged for its leadership in energy efficiency initiatives and established institutional capacity, and has been active as a 'test-bed' for possible approaches that may be deployed more widely in the region (LBNL, 2020). Commentary on Singapore therefore focuses not on the domestic opportunities for further building energy efficiency, but on such opportunities for further regional collaborations.

Building Energy Usage in the context of the National Energy Sector

Brunei

Commercial and public buildings accounted for approximately 50% of total electricity consumption in Brunei in recent years (BNERI, 2020). The largest energy-consuming appliances in buildings are cooling systems, with air-conditioners and chillers used for long hours throughout the year in the equatorial country.

According to energy use surveys carried out in various commercial buildings, average building energy intensity in Brunei ranges from between approximately 227-275 kWh/m^2/year for office buildings depending on size; 308 kWh/m^2/year for retail buildings, and approximately 300-350 kWh/m^2/year for other buildings such as hospitals, hotels and mosques. These figures place the energy intensity of Brunei Darussalam's buildings on a comparable level with ASEAN's other more developed economies such as Singapore and Malaysia (ERIA and BNERI, 2020).

Cambodia

In Cambodia, ongoing economic growth and increasing energy needs have meant that the policy relevance of building energy efficiency is strong. Energy demand in the country increased threefold from 3.42 Mtoe in 2000 to an estimated 8.94 Mtoe by 2020, with a further doubling of energy demand to reach 15.25 Mtoe forecast for 2040 (ERIA, 2020).

Since the year 2000, Cambodia's Ministry of Land Management, Urban Planning and Construction (MLMUPC) has approved 43,136 construction projects on a total land area of 114 million square meters and an investment capital of more than US$43 billion (Ministry of Information, 2018). In terms of breakdown of building energy use, cooling is a large area of focus, given high degree-days, the existing cooling access gap and rising incomes in the country. It was already estimated in 2016 that space cooling and refrigeration accounts for approximately 50% of household energy use in Phnom Penh, and this figure is rising (UNDP, 2020).

Lao PDR

The economy of Lao PDR is growing at more than 7% per annum, a trend which is expected to continue (AGEP, 2020). Final energy consumption is growing just as quickly, driven by the pace of industrialization and urbanization, meaning that energy efficiency is a growing priority for both addressing energy system constraints and maintaining international competitiveness. The residential sector is by far the highest contributor to total final energy consumption, much of which is fuelwood and charcoal (biomass). Reflecting its relatively small industrial sector, buildings also make up a disproportionate amount of electricity consumption in Lao PDR, accounting for as much as 60% of demand (ERIA, 2020). As noted in Chapter 2, the overall building sector energy requirements of Lao PDR are dwarfed by its much larger neighbors in the region.

Myanmar

Similar to its neighbors in the region, Myanmar has experienced rapid growth in demand in recent years, especially following the opening up of the country and increased inward foreign investment. Inadequate energy supply infrastructure is a major problem for economic development, with Myanmar having one of the highest populations in Asia without access to modern forms of energy (REN21, 2019). Many rural areas are increasingly adopting off-grid solar power to bridge this access gap.

In Myanmar, it is estimated that nearly 80% of houses are currently made of wood or bamboo, but as the economy grows the number of residential, commercial and industrial buildings made of brick, concrete and other construction materials is likely to rise (Spectrum, 2017). Similar to Lao PDR and Cambodia the population is relatively rural (approximately 70% of the total population), and residential buildings make up a proportionally high component of energy consumption, accounting for 29% of total final energy consumption and almost 50% of electricity demand in 2016 (ERIA, 2020). Biomass, which accounted for as much as three-quarters of total energy consumption in recent years, is primarily consumed by the rural population. Commercial buildings are not as significant, but are growing rapidly, while typical commercial building size remains smaller than average.

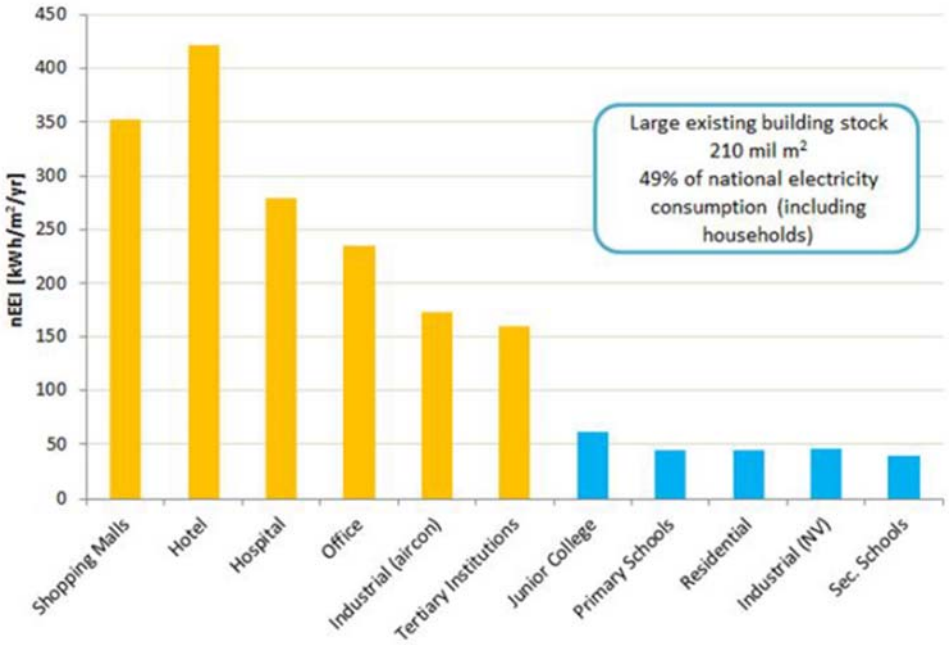
Singapore

Singapore stands above its ASEAN neighbors in terms of its level of development, overall energy use, and level of sophistication related to building energy efficiency measures.

Detailed information and benchmarking data exist about the Singapore building sector, its energy use by subsector, and impacts of existing energy efficiency programs. A brief snapshot of this status follows below:

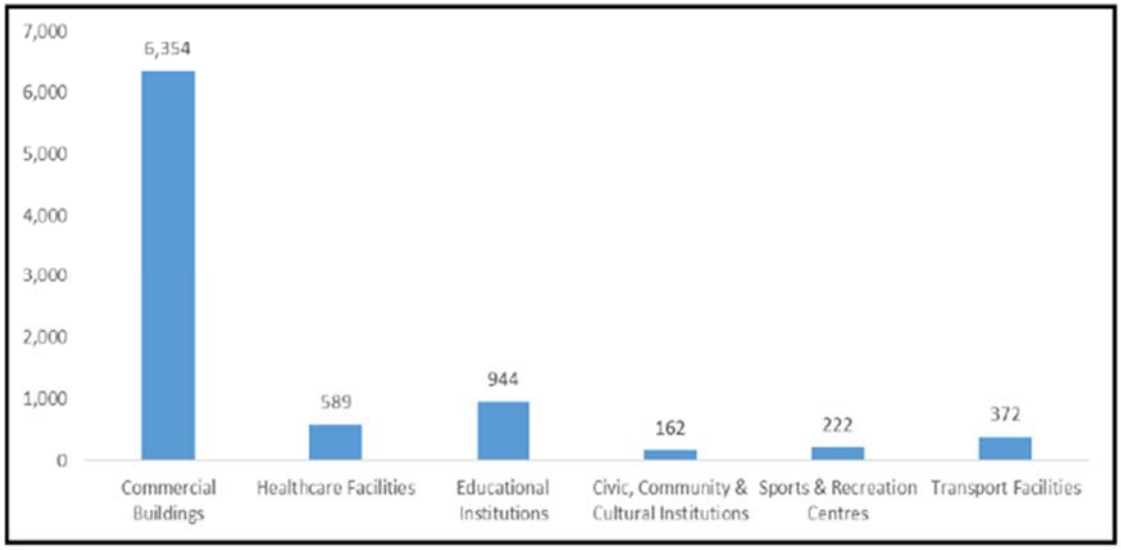
- Nominal GDP per capita for Singapore's 6 million people is approximately USD 58,000, more than 12 times the ASEAN average (IMF, 2020).
- Singapore's energy trajectory reflects more stability than other countries in ASEAN with emerging and more rapidly growing economies. Singapore's electricity system demand has increased from about 42 TWh in 2008 to about 53 TWh in 2018, at a compound annual growth rate (CAGR) of 2.4%. Peak demand grew from 6,073 MW to 7,370 MW over the same period at a CAGR of 2.0%. In terms of expected growth, between 2020 to 2030, both the annual system demand and system peak demand are projected to grow at a CAGR of 1.5-2.1% (EMA, 2019).
- Singapore's building stock of 210,000,000m^2 consumes roughly half of national electricity consumption, split as 31% commercial and 19% residential. Despite this, buildings only account for 14% of national greenhouse gas emissions due to the predominance of emissions from industrial activity. The most intensive building types in terms of energy use are hotels, shopping malls and hospitals (Figure 25), though overall commercial office space is the largest buildings sub-sector, dwarfing other usage (Figure 26).

Figure 25. Energy Consumption in existing building types, Singapore



Source: BCA, 2012

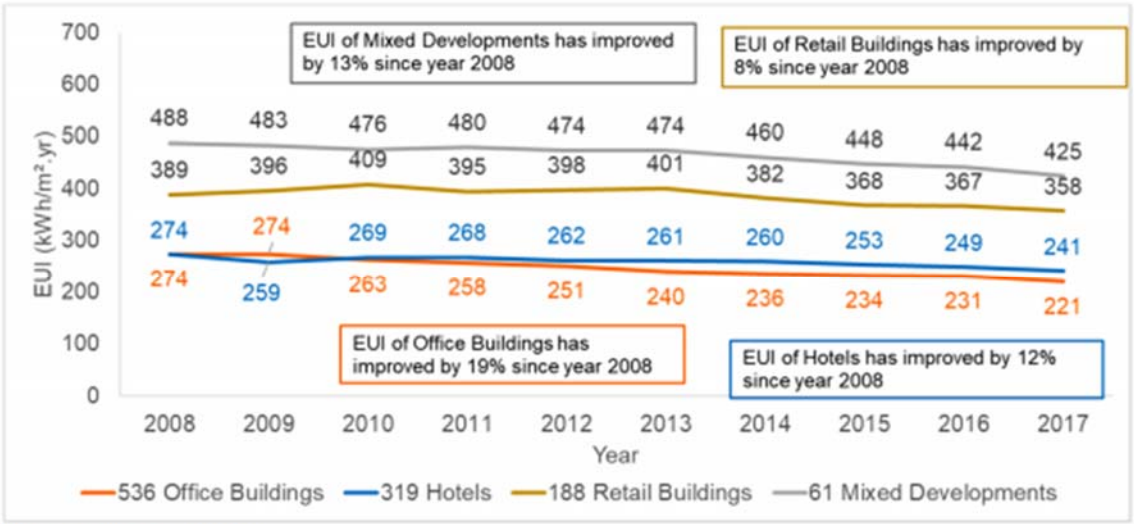
Figure 26. Total Electricity Consumption (GWh) by building type, Singapore



Source: BCA Building Benchmarking Report, 2018

- Cooling dominates building energy use, in keeping with the findings in other ASEAN countries. Cooling accounts for as much as 60% of commercial building energy use, with lighting accounting for a further 15% (Chua et al, 2013).
- The building sector has seen gradual improvements in efficiency through a wide range of initiatives. In recent years, energy use intensity (EUI) has decreased by an average of 11%, with greater improvement in office. hotel, and mixed development buildings (Figure 27).

Figure 27 Energy efficiency trends in Singapore's Commercial Buildings, 2008-17



EUI = energy use intensity.

Source: BCA, 2018

Summary of Policies aimed at improving Building Energy Efficiency

Brunei

Government responsibilities for building energy efficiency in Brunei Darussalam rest with:

- Ministry of Energy and Industry (MEI) - oversees Deputy Minister and Permanent Secretary of Energy and Industry, and is responsible for energy efficiency and conservation policy, planning and implementation through its National Energy Efficiency and Conservation Committee (NEEECC).
- The Ministry of Development (MoD) - in charge of Department of Building Services (DBS), the authority of the building control and construction industry.
- Brunei National Energy Research Institute (BNERI) - supports MEI in achieving EE&C and Renewable Energy targets.

Fossil fuel-rich Brunei Darussalam produced an Energy White Paper in 2014, that set out an ambitious target to reduce energy intensity by 45% by 2035 over 2010 levels (MEMI, 2014). However, the efficiency measures subsequently outlined remain aspirational and lacking in substantive detail, while supply, generation and export are the thrust of energy sector settings and priorities.

Most building sector energy efficiency initiatives have to date been directed at public sector buildings. MEI, in collaboration with MoD, launched Energy Efficiency and Conservation Building Guidelines in May 2015 that provided minimum requirements for energy-efficient design and construction. MoD has since updated these regulations (2017) related to space, light, and ventilation; structural, construction, and fire requirements; electrical installations; earthworks, roads, and water; and drainage and sewerage. Originally, the guidelines were only made mandatory for public buildings; MoD is planning to extend the mandatory requirement of the guideline to all commercial buildings by end 2020. Via the MoD, in 2016 Brunei Darussalam also launched a green building rating system known as Brunei Accredited Green Unified Seal (BAGUS). The benchmark to for government office buildings in Brunei Darussalam to reach for accreditation under BAGUS is 175 kilowatt hours/m^2/year.

A lack of technical capacity is a limiting factor in the development of more efficient buildings. MEI is gradually building the capacity of energy managers in government buildings through training and a certification scheme for energy auditing and management, with plans to expand this to the private sector. Initiatives to increase awareness of energy efficiency have similarly focused only on the public sector.

Cambodia

Key responsibility for building energy efficiency-related issues in Cambodia rests with the Ministry of Industry, Mines and Energy (MIME), and the Ministry of Land Management, Urban Planning and Construction (MLMUPC), responsible for implementing green building codes.

Cambodia's efforts toward energy efficiency are nascent, yet recent developments suggest it is increasingly prioritizing demand-side energy efficiency measures. Relatively high energy prices due to the absence of energy subsidies, low energy security, and ongoing demand growth reinforce this prioritization. In 2017, a National Policy, Strategy, and Action Plan on Energy Efficiency was prepared by MIME in cooperation with the

European Union (EU) Energy Initiative Partnership Dialogue Facility and KnowlEdge Srl (Bassi and Rey, 2017). Under this plan, by 2035, the MME will commit to (i) reducing national energy consumption by 20% compared to business-as usual projections; and (ii) reducing national carbon dioxide emissions to 3 million tons annually, or 28.5 cumulative million tons from 2017 to 2035, relative to the business-as-usual scenario. However, this plan was never formally adopted.

In July 2020, with assistance from ERIA and Malaysian private sector counterparties, the Cambodian General Department of Energy (GDE) within MME published a new Energy Efficiency and Conservation Master Plan. This Master Plan focuses on a limited number of policies and programmes that could be readily introduced due to their claimed effectiveness, low introduction cost, and possibilities for quick implementation: (i) promotion of energy service companies (ESCOs), (ii) building capacity of energy managers, (iii) a standard and labelling system, (iv) education and awareness campaigns, and (v) preparation of energy efficiency indicators (EEIs). ERIA also prepared a 5-year road map (2020–2025) for each EEC policy and programme area mentioned above.

While these plans have been recently developed, it is unclear what (if any) action has actually been taken to date, nor if action is adequately coordinated with other key processes; for instance, a new Construction Law was issued in December 2019 to provide regulation of Cambodia's growing construction sector, but did not refer to energy requirements for new buildings. Moreover supporting regulations would be required to establish many of the legislative foundations for future energy efficiency actions in the building sector, including reporting and implementation obligations for large energy users including commercial buildings, or establishment of energy efficiency building codes and guidelines (with a suggestion that buildings of over 2,000m^2 would need to comply). AJEEP (Scheme 3) is currently providing policy consultation support for Cambodia and Lao PDR on establishing an operable energy efficiency and conservation legal and regulatory framework, however the status of this effort is unclear. According to AJEEP, Cambodia is targeting the launch of energy efficiency labels for air conditioners by the end of 2020.

Lao PDR

Ostensibly, in Lao PDR the Ministry of Energy and Mines (MEM) and its Department of Energy Policy and Planning have carriage of energy efficiency issues, while the Ministry of Public Works and Transport (MPWT) is in charge of building construction. However, the Lao PDR government has not established a concerted institutional framework through which energy efficiency would be implemented. There is no agency explicitly tasked with progressing an energy efficiency agenda in the country, nor is there a policy that broadly deals with this issue. Despite lacking these over-arching institutional arrangements, the Lao PDR Government has announced a 'general' energy savings target of 10% for the period through 2025.

In the words of UN Environment (2018), energy efficiency activities in Lao PDR have been 'haphazardly' implemented through support from international donor agencies without proper capacity building programmes for MEM and other relevant institutions. Over the past decade there have been sporadic efforts to develop energy use databases,

conduct energy audits in selected public buildings, and implement energy efficiency measures in pilot sites. While some results have been achieved, efforts have generally not been sustained after funding for such programs has lapsed.

A 2018 amendment to the Lao PDR Electricity Law mandates the Ministry of Energy and Mines (MEM) to develop policies to implement energy efficiency and conservation measures (and similarly, for the use of alternative forms of energy). A new EEC policy was drafted in 2017, however it has never been enacted.

Additional implementing regulations will be needed to support the policy and develop a functional EEC framework. As noted above, the AJEEP has supported Lao PDR in this effort, and a draft Energy Efficiency and Conservation Decree and regulations for a standards and labelling framework have been submitted to the Lao PDR government early in 2020, which is pending approval.

Myanmar

The Ministry of Industry is responsible for Myanmar's energy efficiency policies, and established an Energy Efficiency and Conservation Division in 2014. Supporting roles are played by the Ministry of Electricity and Energy (MOEE) and the Ministry of Construction (MOC), which has a fully dedicated department for energy in the building sector and plays key role in energy efficiency improvements in buildings.

Energy efficiency is promoted as part of the National Energy Policy published in 2014, and a National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar was developed in 2015 with support from the Asian Development Bank. It sets a target to reduce national electricity demand by 12% by 2020 and biomass consumption by 2.3% by 2020, and 20% electricity demand reduction by 2030, relative to a 2012 baseline. It also sets out energy efficiency activities and expected savings potential for commercial, residential and public builidng sectors as shown in Table 19.

Table 19. Expected savings levels in the National Energy Efficiency and Conservation Policy, Strategy and Roadmap for Myanmar (2015)

Sector	Sub-Sector	Saving Potential (%)			EE Technologies Proposed
		Min	Max	Average	
Commercial	Office Buildings	20	30	25	HE Lighting, ACs, Office Equipment through MEPS
	Restaurants	20	35	25	HE Lighting, ACs, LPG cooking, Solar water heating
	Hotels	20	35	30	HE Lighting, ACs, LPG cooking, solar water heating
	Commercial Sector: Average Saving Potential (%)			**25%**	
Residential	Urban Households	25	40	30	HE Lighting, refrigeration, MEPS for appliances, SHW, LPG cooking
	Rural Households	25	40	30	HE Lighting, refrigeration, MEPS for appliances
	Residential Sector: Average Saving Potential (%)			**30%**	
Public Sector	Public Buildings	20	30	25	HE Lighting, ACs, Office Equipment through MEPS
	Hospitals	20	35	30	HE Lighting, ACs, LPG cooking, SWH, cogeneration
	Schools	20	30	25	HE Lighting, ACs, Office Equipment through MEPS, Boilers, SWH
	Public Lighting	35	65	50	LED, HPS street lighting
	Public Sector: Average Saving Potential (%)			**25%**	

Myanmar's Nationally Determined Contribution (NDC) under the Paris Agreement on climate change also includes actions on energy efficiency of industry and cook stoves.

Myanmar has significant potential in its industrial and commercial activities for substantial savings in energy consumption. In the commerce sector, office buildings and hotels continue using inefficient incandescent lighting and electric hot water systems and significant energy savings could be achieved through the use of high LED lighting and solar hot water; cooling (both airconditioning and refrigeration) is another key potential.

Given the prominence of residential biomass use in rural areas, the adoption of efficient technologies for cooking would make a significant contribution to quality of life for rural households, by enabling affordable and reliable energy supply and potentially more efficient outcomes. The current market penetration of energy-efficient products such as lights, air conditioners, refrigerators, and other home appliances for the residential sector is quite low. Most electrical products are imported mainly from the China and India and have no labeling for energy performance. Energy rated products from Thailand are available in some stores, but with an extremely low market share due to the cost differential. Therefore, in considering energy efficiency in residential buildings, there is potential for significant savings through the introduction of minimum energy performance standards and energy labeling schemes for key appliances.

Beyond high level statements of intent to incorporate energy efficiency aspects in new building design and refurbishment of existing buildings, there is little detail on Myanmar's planned energy efficiency activities for the building sector. Currently, there is no official energy efficiency certification that can be applied to new commercial buildings or those that have been refurbished to meet higher standards. An initial recommendation for a Green Building Certification System for Myanmar has been introduced into the Myanmar

National Building Code 2016 as drafted by representatives from the Building Engineering Institute (BEI) Green Building Committee, though it is not yet adopted or enforced (Lwin and Panuwatwanich, 2020). The recommendation is proposed for new construction, extension and retrofitting of commercial building types (excluding religious buildings, lowcost housings, and the public buildings by the government or other non-government organizations) of more than 100,000 sq. ft area within Yangon and other urban areas. It also references the International Green Construction Code (version 2) and the green building design guide developed by the Building and Construction Authority of Singapore.

The new proposed section of the Code provides green building criteria and basic requirements for energy-efficient building design in Myanmar, and is relatively comprehensive covering energy usage, using low embodied energy materials, considering air circulation and natural lighting, utilizing renewable energy, rainwater harvesting, greywater and wastewater, occupancy comfort, lighting levels and air quality, emission reduction, reducing urban heat island effects, and decreasing both pollution and landfill waste.

Some buildings in Myanmar have been certified under the Singapore Building Construction Authority's Green Mark scheme. For example, the Sedona Hotel's new Inya Wing and Junction City shopping mall have met Green Mark's requirements to specify as a certified green building.

Singapore

As noted, Singapore is very advanced in both its initiatives and its level of efficiency as related to the building stock. Key policy measures introduced in Singapore go well beyond other ASEAN countries, and are both comprehensively implemented and well-studied. In many cases, Singapore acts as a testbed for policy approaches that may work in the region, and a focal point for the strengthening of capacity in ASEAN building energy efficiency measures.

Domestically, the National Environment Agency together with the Energy Market Authority have joint oversight of the Energy Efficiency Programme Office (E2PO), a multi-agency committee that jointly promotes and facilitates the adoption of energy efficiency in Singapore. Policy development for building energy efficiency in Singapore is also led by the Building and Construction Authority (BCA). Key measures that have wider import for the ASEAN region include:

- Singapore's mandatory **building code** for residential and non-residential buildings applies to all new building works, which include a gross floor area of at least 2,000 m^2. Energy performance criteria are addressed by the level of environmental performance outlined according to a points-based system, which will allow a project to decide which efficiency initiatives should be included in order to meet the 50-point minimum requirement. The code does include some mandatory prescriptive elements for both building types, including thermal envelope performance, HVAC efficiency, lighting, airtightness and sub-metering.
- The BCA produces an annual **building energy performance benchmarking report** for commercial buildings with a high level of detail including state of technologies

in use, energy use intensity and trends in energy use performance. This is a valuable resource for assessing the impact of any energy efficiency intervention. In 2018 this report included coverage of 1,654 buildings down to a size of 115m^2, with a combined Gross Floor Area (GFA) of 33 million m^2 and total annual electricity consumption at 8,478 GWh at a compliance rate of 96%.

- There are extensive **resources for designers and building owners** in adopting suitable green building solutions. For example, the Green Buildings Innovation Cluster (GBIC) incorporates a research program, a demonstration facility, and a Super Low Energy Building (SLEB) Smart Hub to serve as a repository of information and knowledge on appropriate technologies and implementation methods.
- The **GreenMark building rating scheme** was established in 2005 and is the most developed in the region, with high level of penetration: in 2018 as many as 3,200 building projects had been awarded a Green Mark rating, representing more than a third of Singapore's gross floor area.
- At a macro level, Singapore has developed supporting policy to implement more **sustainable green building precincts**, such as through investment in district cooling in greenfield areas like Marina Bay, that centralizes the production of chilled water and distribute to surrounding buildings for air-conditioning.
- In terms of **financial incentives**, the Building Retrofit Energy Efficiency Financing (BREEF) scheme, facilitated by BCA and participating financial institutions, offer financing to pay the upfront costs of energy retrofits of existing buildings, through an energy performance contract arrangement. BREEF can cover the cost of equipment, installation and professional fees up to SGD 4 million or 90% of costs, whichever is lower. There are also cash incentive payment schemes for building owners that wish to pursue Green Mark ratings, undertake audits, and undertake other energy improvement works.
- The **ESCO sector** is relatively well developed given the size of the Singapore market, with at least 22 registered ESCOs and many more certified professionals under the schemes for accreditation run by the Energy Efficiency Programme Office.
- In support of technology innovations Singapore's **Building Energy Efficiency R&D Roadmap**, developed in 2013 by Nanyang Technological University, Singapore (NTU) with extensive consultation, is a key reference for future energy efficiency action for the building sector both domestically and in the region. The Roadmap sets out current and future pathways for building energy efficiency-focused technologies, and is comprehensive across a range of options currently under limited consideration in the rest of ASEAN, including integrated design, building envelopes and facades, air-conditioning, and building management and information systems (NTU, 2013).

Key activities of agencies, institutions and organizations in building energy efficiency

<u>International agency efforts in supporting building energy efficiency</u>

Singapore and Brunei are typically not recipients of international donor support, so this commentary focuses on programs for the other countries covered by this Chapter (Cambodia, Lao PDR and Myanmar). Significant recent initiatives in building energy efficiency for these countries in recent years include:

Cambodia

- UNDP maintains an ongoing level of support to the Royal Government of Cambodia on energy efficiency, which is broadly based and covers a range of building sector issues.
- UNESCAP and UN Environment are embarking on an effort to support Cambodia in developing a National Action Plan for Cooling, which should be approved in 2021, and contains important measures for building energy use related to cooling.

Lao PDR

- Most international efforts to support the energy sector in Lao PDR target the energy security issues and hydropower sector. UN Environment is processing a GCF readiness grant related to support for standards and labeling policy.
- In 2019, the World Bank has initiated a $6m clean cookstove project to generate environment and gender benefits for targeted households, through a switch to clean, energy efficient gasifier cookstoves using biomass pellets across selected provinces.

Myanmar

- ASEAN Center for Energy (ACE), Asian Development Bank (ADB) and United Nations Industrial Development Organization (UNIDO) have had energy efficiency promotion activities in Myanmar during recent years, however none of these appear to be ongoing, and have not been specifically targeted at the building sector.
- UN Environment's United for Efficiency initiative has actively supported Myanmar to develop its minimum energy performance standards for key appliance classes.
- Since 2016, ECCJ has implemented a capacity building project under bilateral cooperation between Myanmar and Japan for establishing an Energy Conservation Law, that can become the core of energy efficiency promotion. Most recently, ECCJ has also provided support for the establishment of a qualified energy manager system and introduction of energy conservation guidelines for industry.

Singapore is a regional hub for many of ASEAN's building sector service and technology providers. Some of the key supporting agencies and institutions in Singapore include

- Energy Efficiency Programme Office – administers grants and incentives to promote energy efficient practices.
- The Building and Construction Authority (BCA): administers Building Control regulations and the regionally influential Green Mark Scheme. Formulates and implements codes and regulations related to buildings, and has developed the Research, Development and Demonstration Roadmap to Low Energy Buildings.
- Energy Market Authority (EMA): Leads adoption of energy efficiency through the Energy Efficiency Program Office.
- Enterprise Singapore: Determines which Singapore energy efficiency standards to approve.

- Singapore Green Building Council (SGBC): Oversees the Singapore Green Building Product (SGBP) Certification Scheme. The Scheme is recognized under the BCA certification framework.
- Energy Studies Institute at the National University of Singapore: The Energy Efficiency and Conservation Division of ESI has been very active in researching and examining energy efficiencies in the industrial, commercial and household sectors, as well as in land and sea transport. They have a strong body of knowledge on the behavioral aspects of energy efficiency, regulatory reforms and pricing geared to promoting energy efficiency and conservation.

As noted, these institutions have an important role to play not only in improving Singapore's building energy efficiency performance, but also in potentially providing regional benchmarks and expertise for other activity in less developed economies of the ASEAN region.

9. Conclusions – Building Energy Efficiency Gaps and Opportunities in ASEAN

This study has canvassed a wide range of issues related to building energy efficiency, and its potential as a tool for improving energy security, economic competitiveness and reducing greenhouse gas emissions.

ASEAN is a region of contrasts in terms of its member states' sizes, energy and economic circumstances. Singapore and Brunei are small, highly developed city states, while Indonesia is the world's fourth largest country by population, and Cambodia and Lao PDR are among the least developed countries in Asia. Accordingly, gaps and future opportunities for building energy efficiency are many and can be defined on different axes, including by geographic, by technology, by policy and by market sector. This high-level study has revealed many potential lines of inquiry that could form the basis of future collaborative research and further development, as outlined below.

- **Consistent approaches and common methodologies for classifying types, status and energy performance of the building stock.** In conducting this research, it quickly became evident that comparable data on building types, especially within commercial building subsectors, was not widely available. To date, there has not been a widely accepted, regionally consistent approach to building energy performance benchmarking. Benchmarking is a strategy for improving building performance and provides a common metric to allow buildings in the market to practically and cost-effectively assess their energy efficiency relative to similar buildings. This data can then support decision-making. In 2014, USAID attempted to build such a regional ratings tool, which was trailed in the hospitality sector in Indonesia, however the tool did not receive ongoing internal support and ultimately lapsed. In more recent times, the BETTER tool co-developed by Johnson Controls, Lawrence Berkeley National Laboratories and the World Resources Institute could be used to raise the collaboration effort and as the basis of a regionally accepted benchmark.

- **ESCO sector development and improved confidence in energy savings for retrofit projects**. While promising much as a delivery business model, ESCOs in the region continue to under-perform, due to persistent barriers to the understanding and acceptance of energy efficiency performance risk by financiers. Concerted efforts to build capacity in important areas such as energy performance contracting techniques, measurement and verification (M&V) planning and execution, auditing capabilities and energy manager training can be important precursors to increased building energy efficiency activity. This can be reinforced with products designed to improve financier understandings of energy efficiency projects, as well as aggregation mechanisms that can allow similar projects to be bundled thereby increasing project sizes and reducing the proportional fixed costs of financing.

- **Financing for building energy efficiency through green bonds**. Financing for building energy efficiency activities are largely absent in the smaller countries of ASEAN, however there is substantial progress in the issuance of green bonds for the building sector. An area of focus for further research could be to better understand the market appetite for building-related green bonds and the

measures that can be taken to provide confidence in bond transactions, as a means of facilitating the growth of energy efficiency financing for the building sector in ASEAN, and upskilling the region's financiers in gaining a better understanding of financial risks related to energy performance of more efficient buildings.

- **Cooling and air conditioning technologies**. From every angle afforded by available data, cooling requirements in ASEAN form the lion's share of energy requirements, both in terms of current requirements and future growth. A focus on cooling in buildings as a research theme would be highly relevant and could explore numerous thematic streams including through business models (e.g. 'cooling as a service' provided under an ESCO configuration), technology (e.g. research into non-vapor compression types, automation and control systems, improving the use of natural ventilation and other passive cooling strategies, and advanced window coatings), policy (e.g. noting that Cambodia and Indonesia are currently producing National Cooling Action Plans), and standards (e.g. examining product availabilities and manufacturing, with a view to phaseout of HFCs in line with the Kigali amendment to the Montreal Protocol).

- **Harmonization of building codes and ratings**. An area for further study may be in the harmonization of codes and their enforcement, allowing ASEAN member states to learn from each other and adopt consistent benchmarks and measures related to minimum energy performance requirements. All countries in ASEAN have attempted to adopt some form of energy efficiency requirements into their building codes and construction requirements, with varying degrees of success. There is an opportunity to use the successful model created by ASEAN-SHINE for appliance standards harmonization and to apply this to building codes. Similarly, there has been a proliferation of national green building ratings which all apply slightly different criteria to their green building concepts, and which could benefit from a more streamlined approach. There may be opportunities to establish common standards for specific building types such as hospitals, data centers or cold storage facilities, as these use cases will likely have similar design criteria regardless of their location in ASEAN.

- **Focus on Indonesia, Philippines, Vietnam as the locus of impact for policy and finance-related initiatives**. For different reasons, the countries of Indonesia, the Philippines and Vietnam are recommended as the focus of further action. Indonesia is the largest country in ASEAN and is virtually untapped in terms of realizing building energy efficiency potential; the Philippines has enacted an ambitious new law that can serve as a backdrop to future efforts to engage building owners and technology suppliers; and Vietnam has high levels of energy usage coupled with high growth rates, underscoring the energy efficiency imperative. However, institutional inertia and lack of local capacity for implementation is a defining feature of all three countries. Of the other countries, Myanmar appears poised for new building energy efficiency initiatives in terms of policy readiness, particularly for the residential sector. Singapore and Malaysia are best placed to lead additional research and development efforts on building energy efficiency technologies.

- **Economic benefits of building energy efficiency**. Robust information to inform the potential of energy efficiency was found lacking in the conduct of this study, which could be useful to help inform understandings of the economic impacts of pursuing more widespread building energy efficiency initiatives in a given location, and the multiple resultant social and economic co-benefits that might accrue alongside energy savings. An example is in the consideration of the employment impact of energy efficiency in buildings, or in measuring impacts of more efficient buildings on property values or leasing rates for buildings in the ASEAN region.

Further scoping work in any of these recommended areas would need to be undertaken, to design interventions and identify partners and take actions forward.

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