

# Energy Efficiency and Conservation Master Plan of Cambodia

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Prepared by the General Department of Energy, Ministry of Mines and Energy of Cambodia

Supported by the Economic Research Institute for ASEAN and East Asia



## **Energy Efficiency and Conservation Master Plan of Cambodia**

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## Preface

Cambodia's fast economic growth since the 2000s has transformed the country into a market-based economy and enabled it to join regional and global production networks. Garments, textiles, tourism, and agriculture have been the country's fastest-growing sectors, and these sectors have accounted for more exports of manufacturing products and other primary high-quality value-added products to the international market. Investments from around the globe into this region have been driven by a favourable labour force, growth of connectivity and innovation, and regional political stability – driven by peace and the stability of Cambodia's political environment – and harmony amongst the members of the Association of Southeast Asia Nations (ASEAN). Fast economic growth has also lifted the well-being of Cambodia's people through income generation and employment. One key factor behind this strong economic growth was the fast growth of energy consumption during the same period. Energy demand increased threefold, from 3.42 Mtoe in 2000 to an estimated 8.94 Mtoe by 2020. The Economic Research Institute for ASEAN and East Asia (ERIA) forecasts a doubling of energy demand from 2020 to 2040, to reach 15.25 Mtoe in 2040.

The Ministry of Mines and Energy (MME) of Cambodia realises the importance of acting quickly through energy efficiency and conservation (EEC) to curb demand growth whilst maintaining economic growth. The MME is grateful for ERIA's technical support over the past 10 years in helping it to build the foundations of the data and statistics and support the formulation of downstream energy policy regulations and energy policy in Cambodia. This energy efficiency master attempts to define the legal and organisational bases for energy efficiency activities, and suggest ways to create the conditions for enabling Cambodia to reduce its energy consumption. It is hoped the master plan will also guide investment on EEC through appropriate policies to attract foreign and domestic investors in EEC business such as energy service companies and the promotion of efficient uses of energy appliance and energy efficiency building.

On behalf of the ministry, I am very thankful to Prof Hidetoshi Nishimura, ERIA President, who honoured my request for ERIA's support to the MME in formulating the EEC Master Plan. I would like to thank the experts of ERIA and the MME staff for their efforts in producing this important policy document. During the project period, ERIA also conducted capacity-building training, such as on a basic understanding of the EEC and energy service companies. Lastly, the MME would like to show its great appreciation to ERIA for its technical and financial support in publishing this master plan.

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**HE Mr Suy Sem**

Minister of Mines and Energy, Cambodia

July 2020

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## List of Abbreviations

AJEEP	ASEAN–Japan Energy Efficiency Partnership
ASEAN	Association of Southeast Asian Nations
ASHRAE	American Society of Heating, Refrigerating and Air-conditioning Engineers
BEI	building energy intensity
CPD	continuous professional development
DoET&EBP	Department of Energy Technique and Energy Business Policy
EDC	Electricite Du Cambodge
EEC	energy efficiency and conservation
EEI	energy efficiency indicator
EEM	energy efficient management
ECCJ	Energy Efficiency Center of Japan
EMAK	Energy Management Action Network
EPC	energy performance contract/contracting
ESCO	energy service company
GDE	General Department of Energy
GDP	gross domestic product
GHG	greenhouse gas
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IECEE CB	IECEE CB Scheme (IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components) Certification Body Scheme
IRR	internal rate of return
ISC	The Institute of Standards of Cambodia
kWh	kilowatt-hour
kW/RT	kilowatt per refrigeration ton
LED	light-emitting diodes
MEPS	minimum energy performance standard
mil MJ/y	million megajoules per year
MME	Ministry of Mines and Energy, Cambodia
MRA	mutual recognition agreement
SWO	Standard-writing Organisation
S&L	standard and labelling
TFC	total final consumption
TFEC	total final energy consumption
UNIDO	United Nations Industrial Development Organization

## Executive Summary

Energy consumption in Cambodia has been increasing rapidly. According to the Energy Demand and Supply of Cambodia 2010–2018(2019)<sup>1</sup>, one of the energy research reports of the Economic Research Institute for ASEAN and East Asia (ERIA), total final energy consumption (TFEC) grew at 7.2% per annum in 2010–2018. However, its elasticity over gross domestic product (GDP) was 1 because of the 7.2% growth rate of GDP in the same period. The TFEC includes biomass, whose share was significant in Cambodia (biomass share over the TFEC was still 25.5% in 2018). The growth rates of commercial energy, such as oil and electricity, in 2010–2018 were 8.1% and 18.3% per year, respectively, which were much higher than the TFEC. In the future, biomass's 25.5% share in the TFEC will surely be replaced by commercial energy, such as oil and electricity. Thus, Cambodia must formulate and implement energy efficiency and conservation (EEC) policies and programmes to curb commercial energy consumption. Unfortunately, the country has not formulated its EEC programme. Consequently, the General Department of Energy (GDE), Ministry of Mines and Energy, ERIA to come up with the EEC Master Plan for Cambodia.

The GDE plans to formulate many EEC policies and programmes but ERIA just focused on the following five EEC policies and programmes due to their effectiveness, 'quick-acting', and low cost: (i) energy service company (ESCO), (ii) growing of energy managers, (iii) standard and labelling system, (iv) education and campaign, and (v) preparation of energy efficiency indicators (EEIs). ERIA also prepared a 5-year road map (2020–2025) for each EEC policy and programme mentioned above.

Fortunately, energy prices, such as electricity, in Cambodia are relatively higher than those of its neighbouring countries due to the absence of energy subsidies. Thus, owners of many factories and buildings, which have higher energy costs, would like to reduce these costs. Given this situation, the EEC Master Plan firstly suggests that the GDE start installing ESCOs in Cambodia's energy market. The GDE will simply prepare the qualifications of ESCOs and license those that submit their application forms to the GDE. The industry and commercial sectors have a remarkable energy-saving potential, and ESCOs will realise such saving potential by applying their practical expertise and experience on the EEC. However, during the initial stage, the GDE will support ESCOs by providing them with business opportunities – retrofitting existing government buildings and creating advanced EEC designs for new ones.

An ESCO usually consists of energy managers who hold an EEC certificate from a domestic or foreign organisation, such as the Energy Efficiency Center of Japan (ECCJ). Energy managers are key role players in promoting the EEC in Cambodia. Because of their currently limited number, the GDE must increase or grow energy managers. Because of new EEC regulations which will be formulated in a few years, energy-intensive factories and buildings will be designated and mandated to assign energy managers to monitor the premises' energy consumption. Some energy managers will work for ESCOs and engage in EEC consulting work. Others will be independent and engage in energy audit work designated by the GDE. The EEC Master Plan targets 100 energy managers by 2025, and an association of energy managers will be a

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<sup>1</sup> Ministry of Mines and Energy, Cambodia and ERIA (2019), *Energy Demand and Supply of Cambodia 2010–2018*. Jakarta: ERIA. Available at: <https://www.eria.org/publications/energy-demand-and-supply-of-cambodia-2010-2018/>

good place to organise regular advanced EEC lectures for existing energy managers in Cambodia with the strong support of the GDE.

Households in Cambodia will buy additional appliances, such as refrigerators, air conditioners, washing machines, and cooking equipment like rice cookers and microwave ovens. Their criteria for buying appliances are capacity and price. So far, they do not know the energy efficiency level of each appliance because of the absence of a standard and labelling (S&L) system in Cambodia. If households recognise the energy efficiency level of each appliance, their criteria in buying appliances will increase from two to three: capacity, price, and energy efficiency. In other words, they will buy more energy-efficient appliances, and this behaviour will surely realise energy savings in the country's residential sector. But if the GDE will promote an S&L system, it must allocate a large budget to implement such a system, which involves establishing testing laboratories and issuing labels. Thus, a long-term plan is needed to achieve an S&L system in Cambodia.

The GDE staff in charge of the EEC is aware of its promotion, but not the ordinary people. Thus, education and campaign on the EEC are particularly important for the department. Through this programme, the GDE must encourage people to understand the importance of the EEC and its practice, such as switching off electricity frequently, minimising standby power, providing simple shadings to reduce solar heat gains, etc. Also, the education and campaign programme should be linked to the S&L system. EEC education and campaigns are the first step for the GDE to promote the EEC in Cambodia and remarkable energy savings can be expected across the sectors, especially the residential sector.

To measure the amount of energy savings resulting from the implementation of EEC policies and programmes, we need benchmarks or, in other words, the current energy consumption level of appliances, equipment, factories, buildings, and households. The benchmarks are called energy efficiency indicators (EEIs). Generally, the EEIs are estimated based on survey results, which are detailed energy consumption across the sectors. The survey will be done under a new EEC regulation because before the survey, factories and buildings should report their energy consumption data to the GDE. The EEIs will also be updated every 3 to 5 years.

Many East Asia Summit countries have formulated an EEC Act, under which they promote energy savings by implementing EEC action plans. Parallel to installing ESCOs, growing energy managers, and implementing standards and campaigns, the GDE must formulate an EEC Act for S&L and prepare the EEIs. An EEC Act will make voluntary EEC policies and programmes mandatory. It comes with reasonable budget allocation to implement EEC policies and programmes, according to the road map specified by the EEC Master Plan.

# Chapter 1

## Legislative Framework

*Han Phoumin and Shigeru Kimura*

### 1. Introduction

From 1998 to 2018, Cambodia had enjoyed a steady economic growth of 8%, and remarkably achieved a lower middle-income status in 2015 (World Bank, 2020). Strong economic growth was also recorded at 7.1% in 2019. Due to COVID-19, growth is predicted to slow down at 2.5% throughout 2020. However, it will recover by early 2021 when the world economy also starts to recover from the economic shock because of preventive measures affecting the industries and tourism. Energy demand has been known to be the input for economic growth, and its association is very strong. As Cambodia's economy grows, so does its energy demand increase. Based on ERIA's energy outlook and saving potential in East Asia (Kimura and Han, 2019), final energy consumption is expected to double in 2015–2040, during which the industry sector is expected to grow at an average rate of 3.5%, reaching 2.41 Mtoe in 2040, an increase from 1.03 Mtoe in 2015. For the residential and commercial sectors, energy demand is predicted to grow at an average rate of 2% in 2015–2040, reaching 5.67 Mtoe in 2040, an increase from 3.45 Mtoe in 2015. Transport will mark the highest growth rate of 3.9% in 2015–2040, reaching 3.59 Mtoe in 2040, an increase from 1.39 Mtoe in 2015.

As energy demand increases, energy efficiency and conservation (EEC) becomes significant in curbing demand growth whilst maintaining economic growth because the same amount of energy use will lead to a large quantity of output in the economy. Energy efficiency is also known as the hidden fuel and can be translated as an energy resource to the nation as it will become energy available for other economic activities and supply the greater population. Savings in electricity consumption are even more significant as every kilowatt-hour unit saved would result in greater savings in fuel consumption, such as coal and gas, to generate power. The Government of Cambodia now acts swiftly to prepare the necessary power development plan to meet the growing electricity demand in all sectors. Thus, the energy efficiency plan will help avoid building more power plants, as well as help save investment money for the economy. Considering the fast-growing energy demand, appropriate energy efficiency regulations will be needed. Below is the content of the Cambodia Energy Efficiency Regulation to help the Ministry of Mines and Energy (MME) formulate related sub-degrees or regulations.

### 2. Content of Energy Efficiency Regulations

#### 2.1. Objective and legal framework of energy efficiency regulations

The sub-degree or regulations on energy efficiency will define the legal and organisational basis for activities in the field of energy efficiency and aim to create conditions to reduce energy consumption. In this case, the sub-degree or regulations will instruct the MME and involved agencies to develop a comprehensive policy and regulatory framework to achieve energy efficiency in all sectors. Specifically, this regulation aims to promote energy efficiency as part of the country's sustainable development policy by

- applying a system of activities and measures to improve energy efficiency, especially for the end-uses of energy;
- introducing schemes of obligations for energy savings;
- developing the market, and encouraging the provision of, energy efficiency services; and
- introducing financial mechanisms and schemes supporting the fulfilment of the national objective of energy efficiency.

The MME will need to have precise and timely data on energy efficiency to establish energy policy targets and programmes/actions in all sectors. At the first step, it will need to collect energy efficiency data from line ministries/agencies/sectors (administrative or secondary data). In the future, the MME and involved agencies will need to have regular energy consumption surveys of the household, commercial, industry, and transport sectors for the precise targets and policy of energy efficiency.

The availability of accurate, up-to-date information on energy efficiency is essential for assessing the impact of energy savings and contribution to the reduction of greenhouse gas (GHG) emissions. This information will support the government's commitment to report GHG emissions, implement the Kyoto Protocol, and fulfil the commitment during the 2015 United Nations Climate Change Conference or COP 21. The sub-degree or regulations follow the government's initiatives and other ongoing activities that aim to promote energy efficiency in all sectors. The sub-degree or regulations should be adopted following the Prime Minister's order, laying down the procedures for the MME to exercise/implement powers.

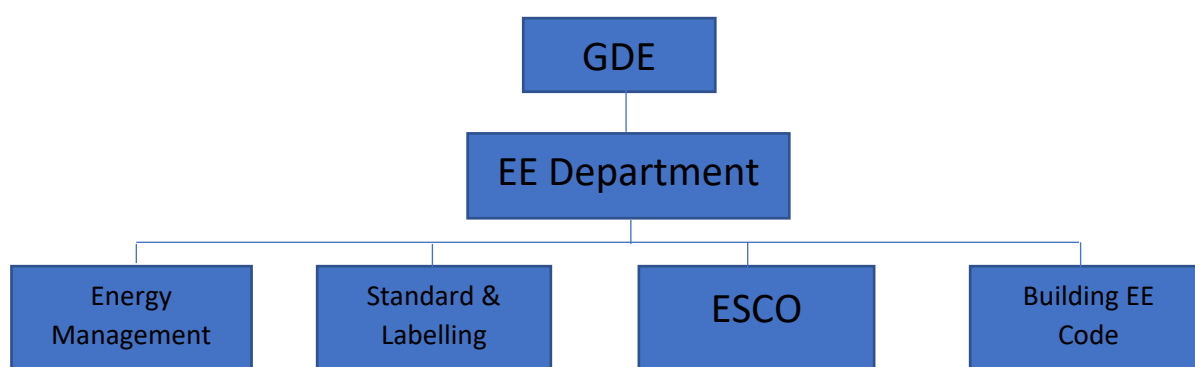
To quickly shift to the required implementing stage of the EEC in Cambodia, this regulation focuses on the following four major EEC topics, plus penalty:

- 1) Energy management system to include energy management and reporting designated premises, education and campaigns, and energy managers;
- 2) Standard and labelling;
- 3) Establishment of ESCOs;
- 4) Building energy efficiency code/guidelines; and
- 5) Penalty, if entities do not follow this regulation.

## **2.2 Institutional framework**

The GDE–MME is in charge of promoting the EEC. This EEC Master Plan for Cambodia recommends that the GDE formulate new sections for the energy efficiency department to implement EEC activities in Cambodia, according to this regulatory framework. Figure 1.1 is a draft institutional chart of the new sections under the energy efficiency department of the GDE.

**Figure 1.1 Draft Institutional Chart of the EEC**



EE = energy efficiency, EEC = energy efficiency and conservation, ESCO = energy service company, GDE = General Department of Energy.

Source: Authors' suggestion.

The four sections shown in Figure 1.1 correspond to the four EEC topics mentioned above. The roles of the four sections are specified below.

### **2.3 Energy management system**

The energy management system aims to establish a structure and system for the implementation of plans to improve energy performance, including energy efficiency, and effective management and reporting of energy use in the commercial and industry sectors in Cambodia.

#### *2.3.1 Energy management and reporting of designated premises*

Factories or buildings that consume energy more than or equal to 3,000,000 kWh/year (or 10,800 MJ/year) shall be classified as designated premises, and shall be required to engage an energy manager to organise energy management, implement energy efficiency measures, and submit an energy management report for the respective designated premises to the Energy Management section under the General Department of Energy.

The Energy Management section shall compile, collate, validate, and analyse the energy consumption data reported in the energy management reports, and establish energy efficiency indicators (EEIs) and energy statistics for the respective sub-sectors of the commercial and industry sectors.

#### *2.3.2. Education and campaigns*

Education and promotion campaigns are important in reaching out to the management and practicing professionals of the commercial and industry sectors, government departments, and the public through a cluster of programme activities. These activities include media campaigns, stakeholders' engagement, holding of technical forums, the publication of pamphlets and guidelines, incorporation of energy efficiency syllabus in the education system, publicity campaigns such as national energy awards, etc. The Energy Management section is also in charge of this action plan.

#### *2.3.3 Energy managers*

As part of energy management, a designated building and/or factory should engage an energy manager, either through an externally sourced or internally developed programme, to ensure that the use of energy in such a building is being managed efficiently. To achieve this, the energy manager needs to set objectives, targets, and plans to achieve such planned targets, besides reporting to the management of

the building and the relevant government authorities. The energy manager should set up an in-house energy management committee or task force in the designated premises to collectively manage and reduce energy consumption. Thus, he or she should be a competent and trained person with management skills, technical knowledge and skills, and is familiar with EEC practices. The Energy Management section is also in charge of accepting registration forms of energy manager candidates, assessing their application, licensing the candidates, and updating the certification through regular capacity-building trainings.

## **2.4. Labelling and standards**

As part of the energy efficiency measures, the use of electrical equipment and appliances is recommended to satisfy the requirements specified in the minimum energy performance standards (MEPS). With MEPS in place, an energy labelling system shall be applied, and registration of equipment and appliances shall be done based on the labelling categories and criteria. This would set an energy benchmark for the equipment and appliances to be purchased and utilised by users. Therefore, any equipment or appliance that meets all the requirements of efficient electricity use shall be affixed with an efficiency rating label in such a form and manner as may be determined by the MME. The standard and labelling (S&L) section is in charge of formulating MEPS criteria of listed appliances and providing energy efficiency labels in collaboration with the Cambodia National Laboratory that verifies MEPS.

## **2.5 Establishment of energy service companies**

Energy service companies (ESCOs) are established to facilitate the uptake of efficient management of energy use in Cambodia through the provision of comprehensive and competent services in energy solutions to buildings and factories. The main goal is to benefit from the implementation of energy efficiency measures.

### *2.5.1 Licensing/registration requirements*

Licensing/registration requirements aim to enhance the professionalism and quality of services offered by ESCOs. This will instil confidence in the energy services sector and promote the growth of the industry.

### *2.5.2 Energy auditing and energy performance contract*

An energy audit is a systematic checking and reviewing procedure to obtain adequate information on the energy consumption profile of a building or an industrial premise to establish its baseline energy consumption before any EEC measure is installed. In addition, the energy audit will identify and quantify cost-effective energy-saving opportunities and report the findings.

An energy performance contract (EPC) is a turnkey service offered by ESCOs to the building or factory owner. The ESCO would finance the installation of energy-saving measures, monitor, and verify energy savings, which shall be shared with the premise owner to recover the costs of financing the project under an EPC agreement.

### *2.5.3 Financing mechanism*

A creative financing mechanism and business model designed to encourage investments in energy efficiency, and the energy performance contract (EPC) needs to be established. Financing institutions play

a key role in establishing and facilitating a business environment for the EPC linking ESCOs, as EEC turnkey service providers, with business entities. The government would play an important role in ensuring that only creditable and competent ESCOs with some financing capabilities would be allowed to register to offer their services.

## **2.6. Building energy efficiency code and guidelines**

Establishing building energy efficiency code and guidelines is important for the implementation of energy efficiency in buildings in view of the rapid development experienced in the country. The criteria that require compliance with the code and guidelines shall be based on the following:

Any building that has a gross floor area exceeding 2,000 square metres shall be required to submit details of code compliance to the Building Energy Efficiency Code section for approval.

The qualified professional appointed by the building owner shall declare that he/she has taken diligent steps to incorporate energy efficiency design measures to comply with the energy intensity requirements of the proposed building.

## **2.7 Penalty**

For effective implementation, the penalty clause, which is important in the energy efficiency sub-degree or regulations, should state that an obliged person who fails to fulfil the determined energy efficiency target for annual new energy savings of a specified amount shall be imposed a fine or a proprietary sanction of a certain amount. For example, the owner of a designated building for hotels or industries, who fails to realise energy savings shall be imposed a fine or a proprietary sanction. The four sections under the energy efficiency department also execute the penalty to the designated premises and ESCOs if they fail to comply with this regulation.

## **3. Conclusion**

The legal framework, such as the sub-degree or regulations on energy efficiency, is an important push factor in establishing mandatory requirements for efficient energy management. It also aims to empower the department or agency tasked with responsibilities to implement EEC plans and, consequently, achieve EEC for Cambodia. For the private sector, a top-down approach requires top management or company owners to undertake efficient energy management practices. The legal framework would require business operations that exceed a certain threshold value of annual energy consumption to adopt an energy management system or practices. The results of energy efficiency practices and energy productivity will eventually benefit business operations by cutting energy costs. The energy efficiency regulation may not be applicable to the residential sector except for the S&L system, which would require households to recognise energy-efficient appliances. Similarly, building codes will also cover the commercial sector in terms of energy-efficient buildings. It is also important to create the EEC culture by (i) incorporating energy efficiency subjects in the school curriculum, (ii) conducting energy efficiency promotional campaigns for the public in the residential sector, and (iii) organising awareness and capacity-building training programmes for the commercial and industry sectors. Finally, promoting and adopting EEC measures and practices will accelerate the achievement of sustainable development in Cambodia.



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## Chapter 2

# Energy Service Company

*Lee Yuen How*

### **1. Introduction**

#### **1.1. What is an energy service company?**

Energy prices in Cambodia, especially that of electricity, are marketed without counterproductive subsidies as far as energy efficiency is concerned. Accordingly, energy (electricity) cost seems to cost more than that of neighbouring countries, such as Thailand and Viet Nam. Thus, the application of economic efficiency policy to promote energy efficiency and conservation (EEC) is one of the options in Cambodia.

ESCO stands for energy service company. It operates a business by providing technologies with the necessary financing to energy users to replace or improve existing energy facilities to save energy. An ESCO will provide services as a one-stop solution for energy efficiency projects, which will ease project implementation as the client does not need to manage all the technical stages in project development, procurement, and commissioning. The ESCO retrieves the investment with the profit generated from the energy saved. On the other hand, it can be a consultancy company specialising in energy audits or energy monitoring services or equipment suppliers of energy-efficient equipment having competency in EEC.

According to the International Energy Agency (IEA) report, the value of the global ESCO market grew 8% to US\$28.6 billion in 2017, up from US\$26.8 billion in 2016. China continues to underpin the global ESCO market, growing at 11% to US\$16.8 billion in 2017. The market in the United States, where ESCOs have been operating for well over 30 years, grew to US\$7.6 billion in 2017. In Europe, the ESCO market remains somewhat underdeveloped compared to other major regions, representing 10% of the global total.

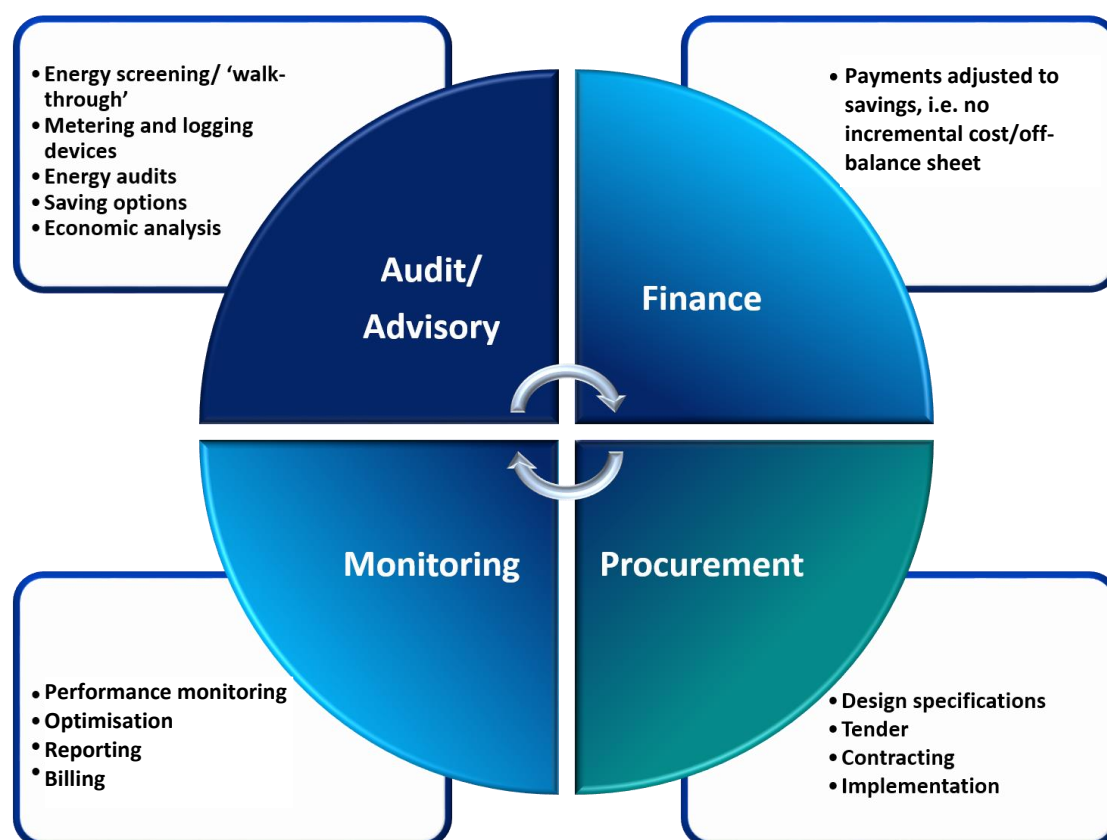
ESCOs have a huge potential role to play in reducing global energy consumption and, therefore, greenhouse gas (GHG) emissions. They could also play a key role in addressing energy shortages and price increases. ESCOs could be a particularly important force for change in developing countries and countries in transition for various reasons.

#### **1.2. Scope of services of ESCOs**

ESCOs provide – either directly or through experienced subcontractors – all services identified by the organisation as needed to implement the energy efficiency retrofit. ESCOs present a comprehensive plan to maximise energy savings whilst meeting the customer's specific facility requirements. ESCOs normally design the project to include multiple conservation measures and to account for interfacing with existing installations.

The scope of ESCO services can be divided into four main categories: (i) energy audit/advisory, (ii) finance, (iii) monitoring, and (iv) procurement.

Figure 2.1: Scope of ESCO Services



ESCO = energy service company.  
Source: Jensen (2017).

### 3. Fundamental operational features of ESCOs

ESCOs have four fundamental operational features. Firstly, an ESCO guarantees energy savings whilst getting the same level of services at a lower energy cost through the implementation of an energy efficiency project. This performance guarantee can revolve around the actual flow of energy savings from a project, stipulating that the energy savings will be sufficient to repay monthly debt service costs for an efficiency project or ensure the same level of energy service at a reduced cost.

Secondly, the compensation of ESCOs is directly tied to the energy savings achieved and, therefore, performance.

Thirdly, ESCOs typically directly finance, or assist in arranging financing, for the installation of the efficiency or energy project to be implemented by providing a savings guarantee.

Fourthly, ESCOs tend to retain an ongoing operational role in measuring and verifying the savings over the financing term. Broadly, the ESCO model can be especially attractive to those considering structural rehabilitation of existing buildings that also focus on energy efficiency retrofits. ESCOs can be an effective instrument in developing the skilled professional job market and stimulating the energy efficiency business in Cambodia.

## 2. Registration and Licensing

The objective of ESCO registration and licensing is to improve the professionalism and quality of services offered by ESCOs to clients. This will enhance confidence and trust in the energy services sector and promote the growth and development of the ESCO industry.

The ESCO registration has the following benefits:

- Developing professional and qualified ESCOs,
- Enhancing the standing and recognition of ESCOs,
- Preventing false claims amongst industry players,
- Regulating and monitoring the services of ESCOs to the public, and
- Arranging and assisting the promotion of ESCO services.

Potential registration and licensing criteria could include a range of services offered, the presence of qualified personnel like the energy manager, financing and project management capabilities, technological and project design capabilities, and measurement and verification capabilities.

With the registration and licensing in place, the government can monitor the quantity and quality of registered ESCOs per year, including the number of audits and implementation of energy performance contracts (EPCs) in the industry. With the information obtained, the government can report the reduction in carbon dioxide emissions and energy savings. All ESCO registration shall be valid for at least 1 year with a yearly renewal requirement. Due to changes of staff over time, yearly renewal should be required to ensure that an ESCO has a qualified person in the company. Continuous effort to conduct training and certification for individuals within the ESCO industry, such as continuous professional development (CPD) approach, could be considered.

## 3. Role of the General Department of Energy

The General Department Energy (GDE) has an important role in ensuring the development of ESCOs in Cambodia. One of its most important roles is to promote the EPCs in government and iconic buildings. This is to improve the energy use of buildings in the country and highlight the benefits of energy efficiency design in new and existing buildings. By taking a lead role such energy efficiency projects in government buildings will yield better results. The government can showcase successful EEC implementation and encourage more entities of the private sector to participate and create the demand for ESCO services.

The GDE has the following roles to ensure ESCO establishment and growth in Cambodia:

- Capacity building, such as training to introduce best practices to local ESCOs to increase competency and knowledge;
- Formulating energy efficiency programmes and laws and regulations;
- Engaging with the private sector to participate in the EPCs and create a market for ESCOs;
- Promoting the development of a standardised contract and monitoring and verification protocols, such as the International Performance Measurement and Verification Protocol, to improve the credibility of ESCOs;
- Creating awareness by sharing success stories of public sector energy efficiency projects;
- Establishing a good registration and licensing process for ESCOs to ensure their competence and reliability;

- Encouraging joint ventures between foreign and local ESCOs to improve the latter's knowledge and experience in implementing ESCO projects.

### 3.1. Sample ESCO application form

Figures 2.2 and 2.3 illustrates the form for ESCO registration and application. The details may be adjusted to suit Cambodian requirements.

**Figure 2.2 Sample of ESCO Application Form (page 1)**

**General Department of Energy (GDE)**  
**Registration and Application for Energy Service Company (ESCO)**

Applicant's Guide  
*Please submit the application to the GDE with the following supporting documents*

No	Description	Submitted
<b>Company Information</b>		
1	Company Registration	
2	Copy of Office Tenancy Agreement or Sales and Purchase Agreement	
3	Company Profile with Organisational Chart, Track Record, and Expertise	
<b>Competent Person</b>		
4	Copy of Applicant's Khmer Identity Card	
5	Copy of Competent Person's (Energy Manager) Khmer Identity Card	
6	Certificate of Competent Person	
7	Copy of Competent Person's Appointment Letter	

#### Section A: Applicant's Information

Picture of Applicant	Applicant's Name:
	Applicant's Identity Number:
	Address:
	Position in Company:

#### Section B: Company Information

1	Company Name:	
2	Company Registration No:	
3	Company Address:	
4	Company Telephone Number:	
5	Company Email:	
6	Company Office (Rented/Owned)	

**Figure 2.3 Sample of ESCO Application Form (page 2)**

Company Directors and Shareholders			
No	Name and Identity Number	Address	Shareholding (%)
1			
2			
3			
4			

**Section C: Information of Competent Person**

1	Competent Person's Full Name:	
2	Certificate Registration Number:	
3	Khmer Identity Number:	

**Section D: Monitoring and Measurement Equipment**

No	Measurement Equipment	Brand	Model	Serial No.
1	Electrical Power and Energy Data Logger			
2	Thermal Energy Data Logger			
3	Flow Data Logger			
4	Others			

**Section E: Declaration**

I hereby certify that, to the best of my knowledge, all the information provided in this form is true and correct and the competent person listed in Section C is working full time in the company.

Applicant's Signature:	-----
Company Chop:	-----
Date:	-----

## 4. Financial Incentives

Financing support structures and funding mechanisms are vital to the success of the ESCO industry and the development of initial ESCO projects in the country. They assist in reducing the initial high costs and risks associated with the project. The governments of most developing countries may not be able to take on this task. However, the Cambodian government should invite international institutions like the World Bank, the Global Environmental Facility, and the Asian Development Bank to support ESCOs financially in the country during the early stages. However, this is only a short-term solution and should be considered as a kick-start before the domestic commercial banks become interested and willing to fund the local ESCOs. It is important to ensure that international organisations should not compete with domestic commercial banks for profitable ESCO projects once domestic banks are willing and able to participate in

ESCO financing. Once this occurs, international agencies and banks could play a secondary role in financing less profitable projects.

For the long-term success of ESCOs, domestic commercial banks must eventually play a role in financing ESCO projects. This requires institutional change and, therefore, a sustained effort over time. For example, domestic banks – as part of their environmental, social, and corporate governance – can introduce reduced interest rates in financial loans for energy efficiency projects. The banks can also introduce capacity building for their bank staff and other stakeholders to understand energy-efficiency financing through ESCOs.

Some other financial incentives can be through income tax exemption or reduction to encourage foreign ESCOs to partner with local ESCOs for knowledge transfer. The government can also exempt duties on imports of energy-efficient equipment for EEC projects.

## 5. ESCO Business Model and Case Study

### 5.1. Energy performance contracting

One key element to promote and encourage investment in energy efficiency in buildings and industries is through energy performance contracting (EPC) undertaken by ESCOs. Under the EPC, ESCOs would design and install energy-efficient systems/equipment for clients in the public, industry, and commercial sectors. ESCOs' remuneration is based on the amount of energy savings obtained from the retrofitting of the energy-efficient systems. After the term of the contract, the subsequent value of the energy savings would entirely belong to the client. ESCOs have been successfully using this model that has been operated in many developed countries for years.

ESCO business models can be divided into two main financial models: shared savings contracts and guaranteed savings contract.

### 5.2. ESCO business model: Shared savings EPC

**Figure 2.4 Shared Savings EPC Business Model**



EPC = energy performance contract/contracting, ESCO = energy service company.

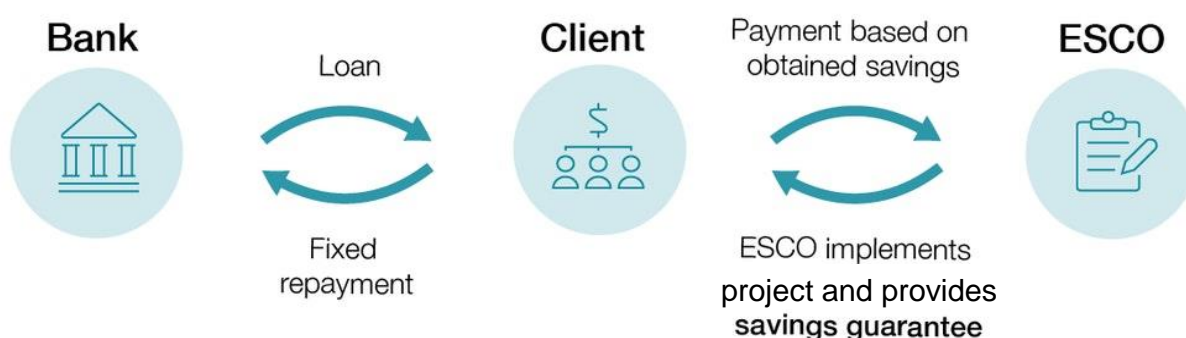
Source: International Energy Agency (IEA) website, <https://www.iea.org/>

With shared savings EPC, the ESCO finances the implementation of energy conservation measures at the customer's facilities. Measured cost savings during the contract period are shared between the client who owns the facility and the ESCO. Usually, the contract specifies that a percentage of the obtained savings goes to the ESCO, which was previously defined by the client and the ESCO. This percentage is highly dependent on factors like the length of the project and project risks.

ESCOs often use a shared savings model, where they are paid a percentage of the costs they save for their client. Shared savings is a more attractive payment method because of its win-win nature. This is particularly relevant for energy efficiency projects. In shared savings projects, ESCOs finance the investment. In such a case, ESCOs take on the performance and credit risks. Through this business model, energy users, energy and technology services companies, financial institutions, and environmental protection workers together create a win-win situation.

### 5.3. ESCO business model: Guaranteed savings EPC

**Figure 2.5 Guaranteed Savings EPC Business Model**



EPC = energy performance contract/contracting, ESCO = energy service company.

Source: International Energy Agency (IEA) website, <https://www.iea.org/>.

In guaranteed savings EPC, the ESCO assumes the risk of the project's performance. The client obtains a bank loan or uses its equity to pay contractually determined fees to the ESCO and the bank and keeps the difference. The ESCO will guarantee a minimum energy savings level (percentage); if savings exceed the guaranteed level, the ESCO or the customer can absorb the savings, depending on the method of payment agreed. Fixed payment contracts mean that all savings belong to the customer whilst payment by a percentage of savings means that all savings beside the ones guaranteed to the client are paid to the ESCO.

Generally, the ESCO business model is for the energy users to improve energy efficiency, reduce energy costs, avoid incurring additional project costs, increase the company's turnover and profitability with the help of financial institutions to ease the financial burden, and contribute to environmental protection and sustainable development.

Demonstration programmes in the public and the private sectors increase awareness of energy efficiency and the role of ESCOs. They also increase ESCO capacity and are key to market creation. Government

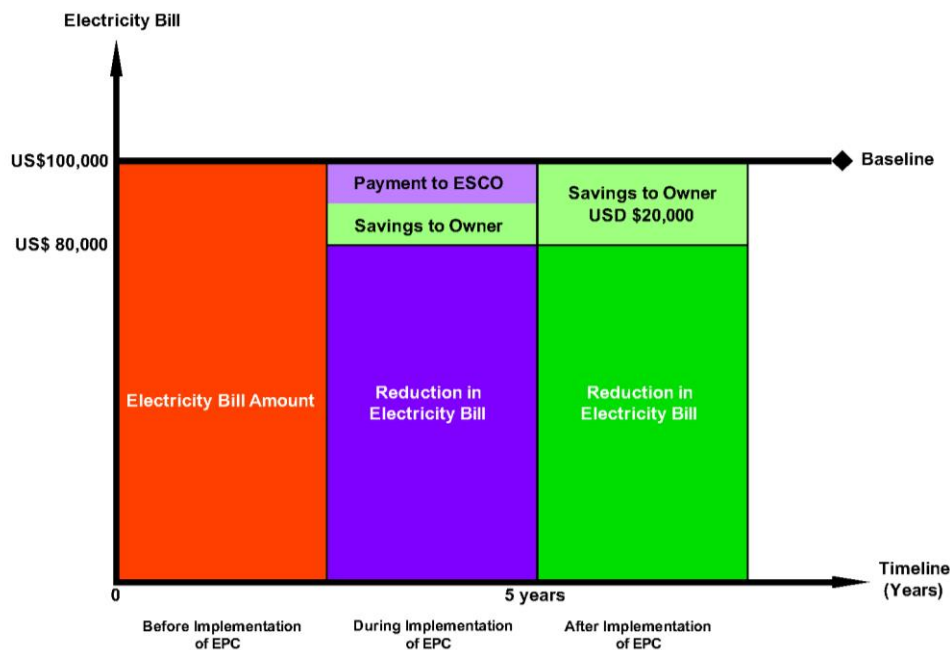


demonstration programmes have been central to ESCO success in developed countries. Government buildings are one of the biggest users of electricity in the world. To promote ESCOs, governments should undertake demonstration projects in public buildings but should not limit these to the public sector. Demonstration projects in various industry sectors and utilities would be very helpful in promoting ESCO success. The government could play a key role in identifying industrial customers or groups of customers. It goes through some of the first steps in terms of getting the client's commitment, defining their contracting and financing terms, getting basic information on their energy cost and consumption and use characteristics, and then delivering to the ESCO community a qualified and decision-ready customer.

#### 5.4. How to implement EPC in government buildings

- 1) Request for proposals, shortlist, and engage the services of an ESCO for an energy efficiency improvement project in a government building.
- 2) Perform an energy audit at a facility to evaluate the level of savings that can be accomplished.
- 3) The ESCO will offer to implement and finance the project.
- 4) Guarantee the savings over an agreed term
- 5) The actual amount to be paid will be based on the agreed sharing value between the ESCO and the owner of the government facility.
- 6) After the agreement ends, the ownership of all the equipment and system installed at the facility will be transferred to the government.
- 7) The government will register and license the ESCO.

**Figure 2.6 ESCO EPC Business Model**



EPC = energy performance contract, ESCO = energy service company.

Source: Umar (2014).

## 5.5. Case study: Shared savings EPC hospital project

### 5.5.1 Project information

The EPC case study involved a hospital with 548 beds using the shared savings business model. The hospital was built in 1987 with a gross floor area of 44,800 m<sup>2</sup>. The average electricity tariff is US\$0.108/kWh. The EPC project scope includes the retrofit and upgrade of the chiller plant system and the LED (light-emitting diodes) lighting. The project was completed within 30 weeks with an EPC contract of 8 years where the savings are split – 80% to the ESCO and 20% to the client. After the contract period, the asset would be transferred to the client without any cost, and the total 100% savings would be enjoyed by the client. The total EPC project cost was about US\$850,000.00, consisting of engineering, consultancy, measurement and verification, procurement of the equipment, and project management and supervision.

The efficiency of the existing chiller plant system was about 1.86 kW/RT (kilowatt per refrigeration ton). However, with the upgrade, improved efficiency of 0.83 kW/RT was achieved whilst the same comfort level, relative humidity, and temperature requirements by the client were maintained. The overall savings obtained in a year was about 2,144,362 kWh equivalent to US\$231,434.00.

The hospital lighting uses the conventional ballast T8 40W 4 feet tube and T8 2 feet tube. There were about 7,000 units of lighting for both sizes. For the lighting retrofit, the existing lighting was replaced with a new LED lighting with a lower power rating of 10.5W for the 4 feet tube and 9W for the 2 feet tube. The total energy savings achieved in a year was about 936,211 kWh, equivalent to a cost savings of US\$101,042.00.

Below is the summary of the EPC project:

- 1) Total electricity savings from chiller plant system annually: 2,144,362 kWh/year
- 2) Total electricity savings from LED lighting annually: 936,211 kWh/year
- 3) Total electricity savings from chiller plant system and LED lighting annually:  
 $2,144,362 \text{ kWh} + 936,211 \text{ kWh} = 3,080,573 \text{ kWh/year}$
- 4) Total electricity cost savings:  
 $3,080,573 \text{ kWh/year} \times \text{US\$}0.108/\text{kWh} = \text{US\$}332,702.00$
- 5) 80% savings goes to ESCO:  $80\% \times \text{US\$}332,702 = \text{US\$}266,161.50$
- 6) Total investment cost by ESCO: US\$850,000.00
- 7) Simple payback period:  $\frac{850,000.00}{266,161.50} = 3.19 \text{ years}$
- 8) Internal rate of return (IRR) = 26.56%

## 6. Road Map for Establishing the ESCO Market in Cambodia (2020–2025)

ESCOs have been promoted in developing countries through various programmes and mechanisms. The support of international development agencies and financial institutions, as well as developing country governments, has been particularly critical to ESCO success. However, other programmes and

mechanisms, including domestic financial institutions, ESCO associations, utilities, and joint ventures with multinational ESCOs, have also played a key role in some countries.

ESCO development has not started in Cambodia yet. Most of the energy efficiency projects are conducted by in-house or general engineering contractors. To kick-start the establishment of ESCOs, a road map is structured in three phases in the GDE guidelines for the planning of establishing ESCOs in the country.

During phase one (2020–2021), promotion and creating awareness of ESCOs are important to develop the industry together, with stakeholders' engagement with agencies such as the GDE, energy efficiency equipment suppliers, Cambodia Constructors Association, Board of Engineers of Cambodia, and factory owners. Although the major impact from energy efficiency is envisaged to be from the private sector, the role of government institutions and government-linked companies are crucial for the successful introduction of energy efficiency initiatives and the EPC project. The government can implement a demonstration project and, through circulars, direct its institutions and ministries to practise energy efficiency in its operations. With the ESCO industry in its infancy, the partnership of foreign and local ESCOs is needed to provide experience and knowledge transfer to the local ESCOs. In addition, registration and licensing requirements for ESCOs would improve trust and regulate the market.

In phase two (2022–2023), with a successful completion of a demonstration project, the government can actively promote the benefits of energy efficiency projects implemented by ESCOs to the public and the private sectors that can increase the take-up rate. The government can share the electricity savings data obtained from the demonstration project with the local financial institution regarding the benefits of financing EPC projects, which can be part of their portfolios soon. Lastly, in phase two, the formation of an ESCO association can play an important role in promoting energy efficiency investments in collaboration with government agencies, banks, and utilities companies. The ESCO association could participate in public outreach programmes, explore the creation of new partnerships, and provide training and capacity building for their members. They can also promote working relationships amongst members, allowing them to collaborate on projects and to take on larger projects that require a combination of various skill sets and financial strength. International partnerships and collaboration amongst ESCOs and ESCO associations are also critical for information exchange and capacity building. ESCOs in developed countries could play an advisory role in countries where they do not wish to fully operate but may engage on a joint venture basis.

For phase three (2024–2025), the government or the agency in charge of ESCOs can prepare the standardised guidelines and mechanism of energy performance and measurement and verification contracts to facilitate the clients' and financial institutions' understanding of ESCOs and other concerns. Tax incentives and import duty exemption for ESCOs and energy efficiency technology within a certain period will spur the growth of the industry. With the incentives provided by the government, the participation of local ESCOs in the industry will increase, and the government can call for EPC proposals for government buildings to further reduce the cost of energy use.

**Table 2.1: Road Map Milestone for ESCOs with Leading and Responsible Organisations**

Phase	Milestone Activities	Target Groups	Organisations Involved	Time Schedule
Phase 1A	Initiation of stakeholders' engagement Promotion and awareness Demonstration project	GDE	Engineering institutions and associations Cambodia hotels, factories, and malls	2 years
Phase 1B	ESCO registration and licensing requirements	GDE and Ministry of Commerce	GDE and Ministry of Commerce	2 years
Phase 1C	Foreign and local ESCO partnership	GDE	Foreign ESCO and engineering institutions and associations	1 year
Phase 2A	Financing mechanism and engagement with local financial institutions	GDE and Ministry of Economy and Finance	Local banks and financial institutions	2 years
Phase 2B	Formation of ESCO Association Cambodia	GDE and Ministry of Commerce	Engineering institutions and associations	1 year
Phase 2C	Promotion of successful pilot project	GDE	Engineering institutions and associations Cambodia hotels, factories, and malls	1 year
Phase 3A	Government tax incentives	GDE and Ministry of Economy and Finance	GDE and Ministry of Economy and Finance	2 years
Phase 3B	EPC standardised guidelines	GDE	*ESCO Association of Cambodia	1 year
Phase 3C	Request for proposal for EPC in government buildings	GDE and Ministry of Public Works and Transport	*ESCO Association of Cambodia	1 year

\* To be established.

EPC = energy performance contract/contracting, ESCO = energy service company, GDE = General Department of Energy.

Source: Author.

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## Chapter 3

### Energy Managers

*Luk Chau Beng*

#### **1. Developing Certified Energy Managers**

Implementing an energy efficiency and conservation (EEC) programme requires the commitment of all parties starting from the government to stakeholders and the public at large. The government shall promote awareness on policies, regulations, guidance, enforcement, and provide support to all stakeholders, including the public, through various forms of mass media and education campaigns. The stakeholders shall support and abide by the regulations collectively to achieve the goals and objectives of these initiatives. Cambodia, through the General Department of Energy (GDE), Ministry of Mines and Energy (MME), is believed to have plans of drafting and implementing new EEC regulations. Whilst waiting for the EEC regulations to be enforced, the GDE can kickstart its intention through awareness programmes and workshops with various stakeholders. This chapter addresses the needs, duties, and methodology of developing energy managers to support the implementation of such regulations.

In meeting these expectations and targets of the EEC programme, a responsible energy professional person called a 'certified energy manager' (CEM), who is well accepted in an energy-intensive organisation, will be appointed to promote and manage energy utilisation efficiently through a systematic energy management system. He will need to use his interpersonal skills to educate and increase awareness, motivate, and create behavioural change in the organisation to adapt to the new energy management concept. With these requirements, the CEM shall be a person proficient in management, information skills, and conversant with technical plant processes and other matters relating to energy management within the business entities.

##### **1.1. Definition of certified energy managers**

A CEM is a person who holds a national energy manager licence from the GDE, MME. Once the new EEC regulations are enforced, the owner of a designated building or factory (refer to Section 6.2) shall engage a CEM to ensure that use of energy in the energy-intensive premises are being managed efficiently. To achieve these goals, a CEM needs to set objectives, targets, and plans to achieve such planned targets, aside from reporting to the management of the premises and to the GDE.

The CEM needs to set up an in-house energy management committee with representation from all departments to collectively manage and reduce energy consumption. Hence, he or she should be technically competent and trained; possess interpersonal, execution, management and information knowledge and skills; and is familiar with EEC practices.

## **1.2. Skills and competence required of certified energy managers**

A CEM clearly requires a mix of hands-on experience on technical plant process and EEC knowledge, and interpersonal, analytical, , and managerial skills, using appropriate tools and techniques to achieve the EEC goals. The five key components of a CEM competence (Oung, 2013) are:

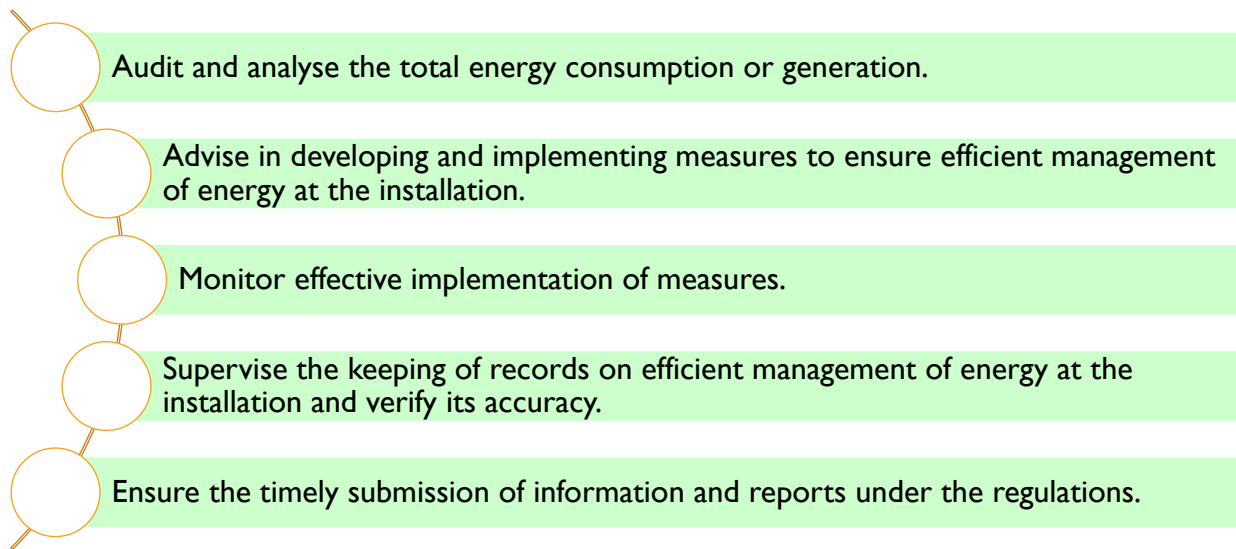
- 1) **Personal management** – managing oneself of EEC behaviour and conserving the use of energy through scheduling and prioritising actions.
- 2) **Interpersonal management** – dealing with the internal organisation and external parties (consultants and contractors), resolving conflicts, facilitating meetings, building an energy-efficient culture, organising resources, delegating tasks, setting business goals and evaluating performance, creating and managing networks, etc.
- 3) **Data information management** – observing, interviewing, measuring, monitoring, and other means of gathering energy consumption data, evaluating, modelling and processing the data, and disseminating energy consumption performance to the management and relevant departments for the success of the energy reduction programme.
- 4) **Execution** – planning and creating a vision for EEC, carrying out risk assessment, identifying opportunities, followed by mobilising tools and resources to reduce energy consumption.
- 5) **Technical competencies** – establishing and following a systematic energy management programme. This includes monitoring, measurement, documentation and reporting, plant process knowledge and energy use, energy audit, energy-saving measures and latest energy-efficient technology.

## **1.3. Duties of certified energy managers**

### **1) Meeting the regulatory requirements**

The CEM is responsible for compiling the in-house documentation to comply with the regulatory requirements of efficient energy management (EEM) of the designated premise. Figure 3.1 summarises what the regulator (GDE) expects from a CEM. The contents of a periodical report by a CEM is shown in section 3.2.4

**Figure 3.1: Functions of Energy Managers under the Regulations**



Source: Electricity Supply Act 1990, Malaysia.

**2) Managing energy use in designated premises.** This includes:

- Understanding how energy resources are being used and shares of energy use by various significant energy users;
- Determining how a change in production or process affects energy consumption; and
- Identifying the effect of future company plans and activities on energy demand and energy cost.

**3) Acting as a centre for energy data information**

- Providing data to the company's management for management reviews and approving organisation improvement plans;
- Providing information on actual energy consumption to all staff of the organisation. This will generate awareness of their effort and achievement and, hence, will motivate staff to monitor and track their targets.
- Installing appropriate online metering at significant energy-user locations to collect and trend such data.

**4) Monitoring energy consumption pattern**

- Assessing the key performance of each significant energy user, analysing the quantity of energy used, and identifying opportunities for improvement; and
- Communicating the energy input and deviations to the identified departments for immediate corrective action as well as planning for long-term improvement.

**5) Energising and promoting engagement from all personnel**

- The CEM needs to get the buy-in from the management and participation of the whole organisation in implementing culture change and creating a network of energy change teams to achieve the organisation's EEC goals.



- Educating the staff on business needs and means to reduce energy consumption.

**6) Managing improvement projects**, liaising with all parties to successfully implement and complete the project.

#### **1.4. Example of focus areas for CEMs on high-impact EEC measures in designated premises**

A CEM should focus and act to manage high-impact EEC measures at the designated premises to optimise energy use, recover waste heat, minimise energy losses, and improve operational efficiency.

- **Industries**

- Good combustion efficiency of fuel
- Optimisation of the usage of waste heat recovery
- Prevention of energy loss due to poor insulation, leakages, and poor heat transfer
- Use of energy-efficient equipment and proper operational control for varying demand
- Efficient use and conservation of electricity
- Substitution of energy

- **Buildings**

- Use of energy-efficient construction materials
- Shading of heat from sunlight into the building.
- Use of efficient heating, ventilation, and air conditioning (HVAC) equipment with proper control of room temperature
- Use of energy-efficient office equipment and fittings, such as lighting with proper operational control

## **2. Registration and Licensing of Certified Energy Managers**

Cambodia is implementing EEC measures in designated premises through the new EEC regulations. The objectives of these regulations are to ensure that energy is efficiently and effectively used, the specific energy consumption and energy costs for designated premises are reduced, the competitiveness of the economy is increased, the dependence on imported fuel is decreased, and the natural environment of the country is protected.

The development and implementation of the new EEC regulations have been suggested to be under the purview of the Department of Energy Technique and Energy Business Policy (DoET&EBP), a department under the GDE. In the National Efficiency Policy, the Ministry of Industry, Mines and Energy (currently MME) declared its willingness to reduce energy demand by 20% and national carbon dioxide emission by 3 million tons by 2035 (MIME, 2013).

In the National Policy, Strategy and Action Plan on Energy Efficiency in Cambodia (MIME, 2013), an estimated saving potential in the industry sector of 20% (garment industry) up to 70% (brick factories) and in the commercial building sector of 20% to 30% is achievable. This can be achieved through (i) regular

training to create awareness and change in people's behaviour in the use of energy; (ii) awareness on the substantial amount of savings that can be achieved in energy and money in their premises; (iii) identifying operational and equipment inefficiency and carrying out regular maintenance, adjustment, or replacement of inefficient equipment; and (iv) use of energy-efficient building materials and passive design principles in buildings.

Amongst the major energy-consuming industries are the textile sector, followed by clay brick fabrication for building construction, rice mills for processing paddy into polished rice, rubber production, and the food sector with particular emphasis on the fabrication office for refrigeration. The energy-consuming entities of the commercial sector are offices, hotels, retail stores, education, industrial, and public buildings.

The new EEC regulations shall include a well-defined registration of designated premises based on energy usage threshold values over a consecutive period (e.g. over 2 consecutive years), qualifications for national certification of CEMs, mandatory training, role and responsibilities of CEMs, renewal process for CEMs, appointment of CEMs in the designated premises, systematic and progressive implementation of energy management at the designated premises, and reporting of CEMs to the GDE.

### **2.1. Establishment of a CEM advisory committee**

In setting up the registration and licensing requirements for CEMs, a CEM advisory committee is first set up to formulate the requirements for the qualifications and registration of CEMs, examination syllabus, scheme of the examination, and registration and licensing of CEMs. The functions of the CEM advisory committee consist of the following:

- 1) Set up the mandatory qualifications for the application and registration of a candidate to the national level certification for energy managers.
- 2) Define the procedure and scheme of conduct of the examination.
- 3) Appoint the committee who will draft the national energy manager certification syllabus. The CEM advisory committee shall review said syllabus and endorse it before sending to the Board of Examinations for approval.
- 4) Review feedback from the industries, the candidates, and the public from time to time regarding the syllabus and procedure of the examination; and recommend measures for the endorsement by the Board of Examination.
- 5) Appoint the controller of examination and other approved officers such as invigilators and panel evaluators responsible for the conduct of the examination. Allow the controller of examination to deal directly with the approved panel of examiners for conducting the examination, and to supervise the secrecy and confidentiality of the printing and distribution of the questions.
- 6) Appoint the panel of examiners for paper setting, criteria of evaluation of papers, and moderation.
- 7) Appoint a vigilance officer to ensure that the examinations are conducted fairly and in a prescribed manner per the rules.
- 8) Approve the examination results and forward its recommendation for the announcement of the results.

- 9) Invite experts and other competent persons to advise the board on matters pertaining to the syllabus, conduct, and scheme of examination.

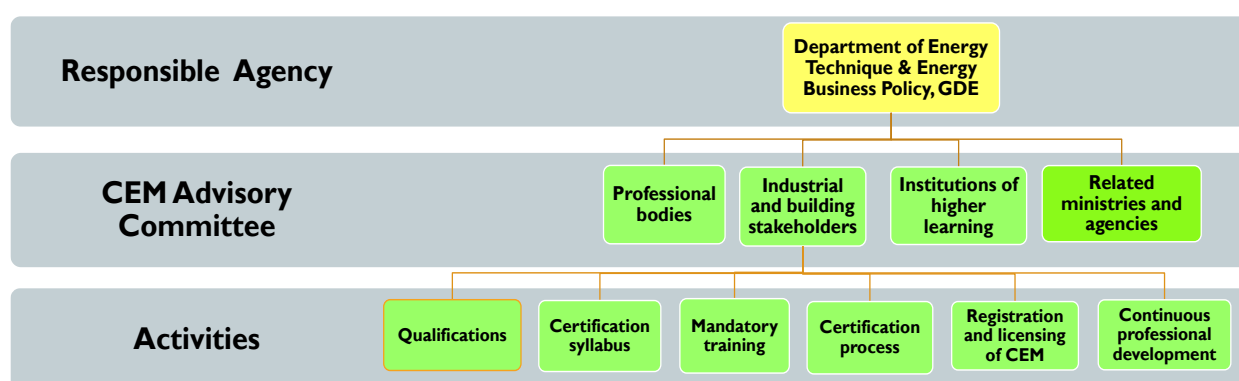
The CEM advisory committee is recommended to be set up under the Board of Examination. The committee consists of the

- Director General of the GDE, MME as the chair of the CEM advisory committee
- Director of the DoET&EBP, GDE as the Secretary
  - He submits a list of organisations, deemed to have influence on EEC activities, to the Board of Examinations for approval to be appointed as members of the committee.
  - Upon the approval by the Board, he then writes to and request each head of these organisations to nominate an EEC expert to be part of the committee.
  - Organisations may include:
    - Primary members consisting of ministries and governmental agencies such as the DoET&EBP under the DGE, Electricite du Cambodge (EDC), Electricity Authority of Cambodia, and other relevant ministries such as the Ministry of Urban Planning and Construction, the Ministry of Labour and Vocational Training, etc.;
    - Manufacturing associations (garment, breweries, rice millers, food industries, brick, chemicals, etc.);
    - Commercial stakeholders (hotels, malls, hospitals, and other commercial buildings);
    - Professional institutions (Board of Engineers Cambodia, etc.);
    - Institutions of higher learning (universities, technical college, and polytechnics).

## **2.2. National accredited qualification and certification for energy managers**

Figure 3.2 shows the activities needed to be set up in developing and implementing the new national accredited qualification and certification process for energy managers.

**Figure 3.2: Overview of Implementation of Energy Managers' Programme**



CEM = certified energy manager, GDE = General Department of Energy.

Source: Author.

### 1) Minimum qualifications

- a) Minimum educational background (e.g. a first degree in engineering, science, and architecture or a higher vocational certificate in engineering)
- b) Minimum working experience in the field of energy management (e.g. 2 years). The experience may include the use of energy in operation and maintenance, planning, and energy auditing. The management of the designated premises must provide evidence of the applicant's experience in energy management.
- c) Completion of the mandatory energy manager training, as detailed in section 3.3.1, that is accredited by the DoET&EBP or the GDE.

### 2) Energy manager's certification syllabus

The suggested list of national certification syllabus for an energy manager covers three sections (Figure 3.3): section 1 covers the basic aspect of regulations, energy management, and energy audit; section 2 covers the fundamentals of electrical and thermal energy; and section 3, a specialisation field, covers energy management in equipment and system using large energy and its savings potential.

**Figure 3.3: Sample Syllabus for Energy Manager Certification Course**

<ul style="list-style-type: none"> <li>• <b><u>Section 1: General Aspect of Energy Management and Energy Audit</u></b> <ul style="list-style-type: none"> <li>• Energy scenario</li> <li>• Energy policy and legislation</li> <li>• Energy pricing</li> <li>• Efficient energy management</li> <li>• Energy audit</li> <li>• Energy reporting and presentation</li> <li>• Measurement and monitoring</li> <li>• Energy performance target</li> </ul> </li> <li>• <b><u>Section 2: Fundamentals of Electrical Thermal System</u></b> <ul style="list-style-type: none"> <li>• Electricity, heat, fluid, fuel, and combustion</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• <b><u>Section 3: Energy Efficiency Potential</u></b> <ul style="list-style-type: none"> <li>• Electric motors, demand controls including variable speed control</li> <li>• Compressed air, fans and blower system</li> <li>• HVAC, refrigeration systems, and cooling tower</li> <li>• Electric heating system</li> <li>• Lighting systems</li> <li>• Boilers, furnaces, and heating systems</li> <li>• Heat exchangers and heat recovery equipment</li> <li>• Pumps and pumping system</li> <li>• Steam systems</li> <li>• Insulation and refractories</li> <li>• Cogeneration and waste heat recovery system</li> <li>• New energy-efficient solutions and technologies</li> </ul> </li> </ul>
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HVAC = heating, ventilation, and air conditioning.

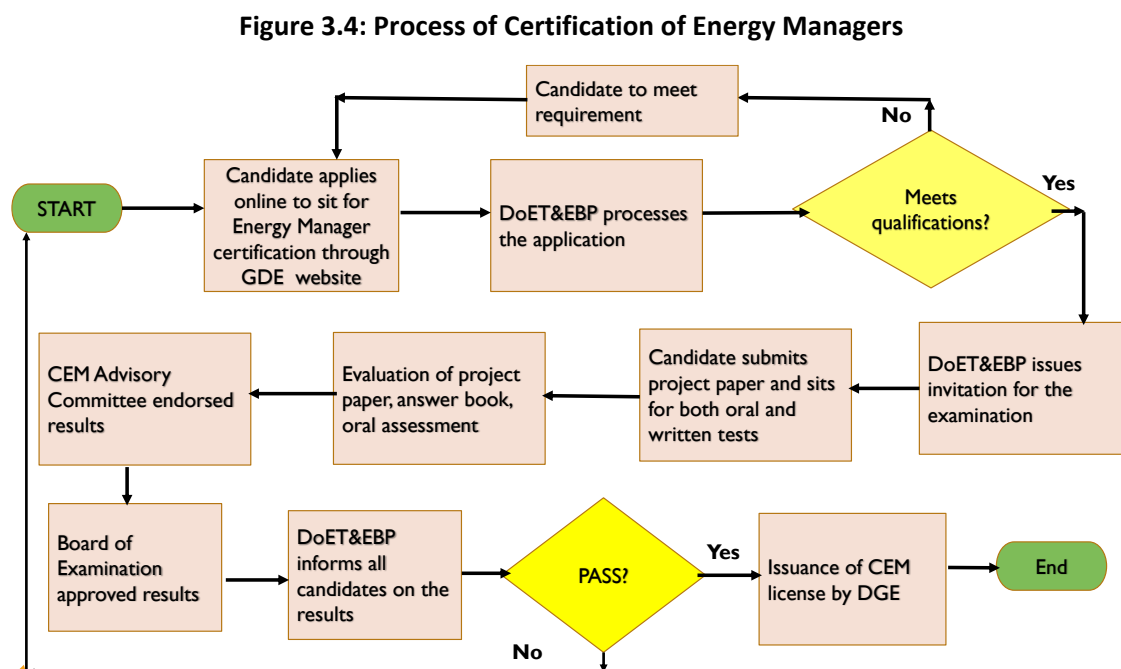
Source: Author.

### 3) The certification process

Figure 3.4 shows the process for the application for CEM certification.

The examination will be conducted according to the approved Energy Manager Certification Syllabus as in section 3.2.2(2). The examination may include a written test with descriptive or numerical questions, an oral assessment, and a project based on EEC exercise carried out at the designated premises by the candidate himself. All candidates are required to achieve the minimum passing marks in all three parts.

The controller of examination manages the examination with the assistance of other officers such as invigilators, a panel of evaluators, and a vigilance officer. After the examination, he then compiles all the marks from the panel of evaluators and sends these to the CEM advisory committee for endorsement. The announcement of the results shall be carried out after the final approval by the Board of Examinations. A CEM licence shall then be issued by the GDE, duly signed by the Board of Examinations.



CEM = certified energy manager, DoET&EBP = Department of Energy Technique and Energy Business Policy, GDE = General Department of Energy.

Source: Author.

### 2.3. Licensing and renewal of certified energy managers

After the GDE announces the results, candidates who passed the examination shall apply for a CEM licence. The GDE shall then issue such licence, to be renewed yearly upon the CEM's submission of the application for renewal, payment of renewal fees, and continuous professional development (CPD) records as required by the regulation.

## **2.4. Content of energy management report required of an appointed CEM<sup>2</sup>**

The CEM shall monitor and report on the efficient energy management (EEM) semi-annually to the DoET&EBP. The report shall include the following:

- 1) Basic information on the business activities of the designated premises, EEM policies and objectives, and EEM committee organisation chart;
- 2) Types and description of energy-consuming system;
- 3) Baseline data for 6 consecutive months before the implementation of the EEM, presented in table and graphical format on the type, quantity, unit of measure of fuel or energy commodity used, and the quantity and unit of measures of each intended output/production, together with the calculated specific energy consumption;
- 4) Current trending similar to baseline data reporting for the next 6 consecutive months after EEM implementation. In addition, a report on energy consumption patterns and energy distribution breakdown shall be presented in line and pie charts, respectively. Finally, a comparison, with comments on the reasons, of the percentage decrease or increase in energy consumption and specific energy consumption of the designated premises.
- 5) List and status, in table form, of all EEM activities and projects being implemented or in progress, cancelled, or rejected in the designated premises; if the proposed activities are being cancelled or rejected, state the reason for rejection.
- 6) Summary of savings from EEM activities and projects in table form, along with the baseline measurement. Current consumption, percentage of savings (estimate and actual), and measuring tools. The current consumption savings achieved must be reported up to a maximum of 1 year to ensure that the designated premise keeps track of EEM performance.
- 7) New EEM activities and/or projects to be implemented with a brief description, estimated energy and cost savings, investment costs, and return benefits.

## **2.5. Role of the General Department of Energy**

The successful implementation of the CEM programme lies in the effective development of CEM requirements in new EEC regulations, awareness and promotion, and implementation and enforcement of the regulations. The role of the GDE is summarised as follows:

- 1) Assign the DoET&EBP, under the GDE, to be responsible for setting up the new EEC regulations. The Economic Research Institute for ASEAN and East Asia (ERIA) shall be pleased to support the GDE in setting up the EEC regulations.
- 2) Appoint the CEM advisory committee to set up the various requirements for the registration and licensing of a CEM under the new EEC regulations. The requirements for CEM includes (i) minimum qualifications; (ii) certification syllabus; (iii) certification process; (iv) registration, licensing, and renewal; (v) penalty and appeal; and (vi) defined designated premises.
- 3) Submit the EEC regulations for the approval of the Minister of Mines and Energy.
- 4) To launch the CEM scheme, generate awareness to the occupants of the designated premises, industries and building associations, government agencies, local institutions of higher learning, and professional bodies.

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<sup>2</sup> Electricity Supply Act 1990, Malaysia. Efficient Management of Electrical Energy Reg. 2008 [P.U. (A) 444].

- 5) Invite international organisations with EEC expertise, such as the Energy Conservation Center, Japan (ECCJ), ASEAN–Japan Energy Efficiency Partnership (AJEEP), Energy Management Action Network (EMAK), United Nations Industrial Development Organization (UNIDO), to assist in setting up the mandatory training for CEMs.
- 6) Invite local energy service providers and local institutions of higher learning to the CEM mandatory training to build their capacity as future local trainer providers.
- 7) Approve and accredit CEM training courses.
- 8) Enforce EEC regulations
  - Registration, licensing, and renewal of CEM; and
  - Registration of the designated premises.
- 9) Receive, review, comment, and communicate regarding the CEM periodical report.
- 10) Make information on EEC activities and achievements available to the public and the Royal Government of Cambodia.

### **3. Certified Training Courses**

The main barriers towards realising the full potential of the EEC are lack of awareness by industry managers and policymakers as well as the lack of widespread education and training on energy management and conservation at all levels of the organisation. To successfully manage EEC at the designated premises, these barriers must first be overcome, together with a change in organisational behaviour towards energy conservation. This success will eventually result in sustainable energy development in Cambodia.

Effective training requires various flexible approaches, including project-based learning, case studies, interactive programmes, quizzes, etc. In many cases, teaching quality and learning experiences are observed to be higher when the trainer modifies and refines the training materials provided based on his or her experience on the subject. Well-experienced and specialised field experts on the technical, management, and commercial aspects are required. Hence, the DoET&EBP would benefit to use this opportunity to engage the assistance of international EEC experts from international organisations such as the ECCJ, AJEEP, EMAK, and UNIDO in identifying the potential gaps, and provide the necessary training and capacity building during this initial stage.

At this stage, the DoET&EBP should also identify and invite EEC professionals from local institutions of higher learning and professional bodies to be prepared as future local trainers under the guidance of these foreign EEC experts. Once they have successfully completed their course, they can set up their own company, develop their own course materials based on the GDE-approved syllabus, and apply to the DoET&EBP to be a licensed training provider.

Training under this section refers to the mandatory training for energy managers as part of the requirements for registration and the mandatory CPD training for renewal of their licence.

### **3.1. Mandatory energy manager training**

The mandatory energy manager course is an approved course based on the approved syllabus (see para 3.2.2 [2]) and conducted by a training provider approved by the GDE. This course will provide the knowledge and skills required by the CEM to execute his duties competently and effectively.

This mandatory training aims to:

- Introduce the principles of energy management with fundamental and specialised knowledge in EEC.
- Improve measurement, verification, and analytical skills.
- Promote investments in energy savings through energy efficiency measures and technologies.
- Lead to reduction in specific energy consumption.

At the end of the mandatory course, participants will be assessed and required to pass all three modes of assessment: (i) a written examination; (ii) submission of an energy audit carried out by the participant at his site covering the assessment, analysis, and recommendation on energy-saving measures and investment appraisal; and (c) an oral interview before a certificate of achievement is issued. Candidates can use this certificate of achievement to apply for their registration as CEM.

### **3.2. Mandatory continuous professional development**

Continuous professional development (CPD) refers to the accumulated hours of training and other EEC activities, which are a prerequisite for the renewal of the CEM licence. The CPD provides CEMs an opportunity to continuously update their skills and knowledge on the current EEC methodology, best practices, efficient technologies, and specialised EEC equipment and system optimisation.

Other activities that form part of the CPD include participating in drafting EEC codes and standards and best practice guidelines, making presentations to share knowledge and experience, and attending EEC-related postgraduate studies.

CPD programmes can be conducted through courses, forums, workshops, and seminars. All CPD courses must be approved with accredited hours by the DoET&EBP. The approved reference code must also be stated on the training providers' advertisement flyers and certificates.

Examples of training organisers are the GDE, energy manager associations, engineering professional bodies, energy service companies (ESCOs), industry and building associations, and other training providers approved by the GDE.

## **4. Setting Up the Association of Energy Managers**

The Association of Energy Managers is a non-governmental and non-profit organisation set up amongst CEMs working in designated premises and ESCOs.

An example of the vision of such association is to develop the professionalism, trustworthiness, and high integrity of CEMs to be recognised nationally and regionally. Its mission shall play an important role in the effective execution of government EEC policies and programmes to achieve a progressive and sustainable Cambodia.



The Government of Cambodia should motivate, encourage, and assist the energy managers' group in setting up such association. Members may comprise CEMs, trainee energy managers, and other stakeholders of local institutions of higher learning and owners of designated premises.

#### **4.1. Objectives of the Association of Energy Managers**

The Association of Energy Managers aims to provide CEMs a platform to network, share experiences amongst its members, create a strong working relationship between government regulators and the owners of designated premises, and help the government achieve its EEC goals. Other objectives include

- ensuring the welfare of its members;
- promoting a healthy competition amongst members of the association through professional services, ethics, and integrity;
- providing professional input and feedback to the regulator about the national planning and execution of government EEC policies, initiatives, and programmes;
- improving the competency, skills, and best EEC practices of its members to develop their business and career path potentials as well as to increase their competitiveness;
- providing awareness on campaigns, financial incentives, or grants to implement energy-efficient solutions and energy auditing through association portals and emails;
- guiding and assisting members deal with the regulators and relevant government agencies.

#### **4.2. Activities of the Association of Energy Managers**

- Collaboration, cooperation, and networking with the DoET&EBP by
  - obtaining and sharing the latest information on any new policies, guidelines, initiatives, activities, and other information to members;
  - jointly organising EEC events such as town halls, forums, and conferences to provide members an opportunity to dialogue and network with the regulator to clarify matters and gain a better understanding of government initiatives and expectations;
  - assisting the government achieve the national EEC goals by disseminating important EEC-related information and motivating owners of designated premises; and
  - bringing up matters faced by the members and discussing with the regulator to ensure smooth implementation of EEC activities and protection of members' welfare.
- Organising activities that enhance the competency, skills, knowledge, and competitiveness of energy managers such as
  - training, talks, conferences, and knowledge sharing;
  - awareness on latest best practices and efficient technology;
  - standard writing, study tours, and visits relating to EEC;
  - working groups amongst association members in carrying out knowledge exchanges, advising members in dealing with authorities; and
  - CPD training programmes for CEMs to renew their licence.

## 5. Road Map for Developing Energy Managers (2020–2025)

Cambodia has yet to draft EEC regulations. Hence, the GDE needs to exert more effort, commit, provide leadership, and deploy resources particularly for the new EEC regulations, which include CEM registration and licensing. Accordingly, the execution of the road map is planned in three phases.

### **Phase 1 (2020–2021): Setting up the regulations for registration and licensing of energy managers**

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- The GDE to appoint the DoET&EBP to be responsible for setting up, implementing, and enforcing the new EEC regulations (2020)
- Government to launch and make public the intents of EEC initiatives (2020)
- Form the CEM advisory committee to develop mandatory criteria, such as the minimum qualifications for registration, certification, and licensing processes; functions and responsibilities of a CEM; requirements for designated premises; reporting and efficient energy management planning; penalties and appeal to be inserted into the EEC regulations (2020)
- Appoint a working committee to draft the examination syllabus (2020)
- Appoint a working committee to draft the EEC regulations (2020)
- The GDE to approve the certification examination syllabus for CEMs (early 2021)
- The minister to approve the EEC regulations (mid-2022).

### **Phase 2 (2021–2023): Awareness training, mandatory energy managers’ training, and developing examination questions**

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- Start developing the mandatory energy managers’ training with assistance from international EEC organisation experts (e.g. ECCJ, AJEEP, UNIDO, EMAK, etc.) (mid 2021)
- Conduct the first mandatory energy managers’ training with assistance from international EEC organisation experts (e.g. ECCJ, AJEEP, UNIDO, EMAK etc.) (end 2021)
- CEM advisory committee to appoint the panel of examiners and start preparing questions (2022)
- Establish examination procedures (2022)
- The GDE to approve local trainers to conduct the mandatory energy managers’ training (2023)

### **Phase 3 (2024–2025): Registration and licensing**

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- The CEM advisory committee to appoint the controller of examination and vigilance officer to organise and conduct the energy managers’ examination (2024)
- Controller of examination to appoint invigilator and support staff to conduct the examination (2024)
- Registration of energy managers (2024)
- Conduct of first energy managers’ examination (2024)
- Licensing of first CEMs (2024)
- Conduct of first CPD training courses (2025)

Table 3.1 shows the project milestones with leading and responsible organisations.

**Table 3.1: Road Map Milestone for Energy Managers with Leading and Responsible Organisations**

	<b>Milestone Activities</b>	<b>Leading Organisation</b>	<b>Involved Organisations</b>	<b>Schedule</b>
Phase 1	<ul style="list-style-type: none"> <li>✓ Government to launch EEC initiatives; Form a task force (including Examination Advisory Committee) to draft Act, regulations, and examination syllabus</li> <li>✓ EEC Act and energy managers' regulations</li> <li>✓ Establish syllabus for energy managers</li> <li>✓ Enactment of EEC Act and its regulations</li> </ul>	- GDE	<ul style="list-style-type: none"> <li>- Professional institutions</li> <li>- Industrial and building associations</li> <li>- Institutions of higher learning and ministries</li> </ul>	Start  3 years 1 year 1 year
Phase 2	<ul style="list-style-type: none"> <li>✓ Start training of energy managers with international energy efficiency organisations</li> <li>✓ Appoint panel of examiners and prepare examination questions</li> <li>✓ Establish examination procedures</li> <li>✓ Approve local trainers for mandatory courses for energy managers</li> </ul>	- GDE	<ul style="list-style-type: none"> <li>- International organisations with expertise in energy efficiency, experts, and stakeholders</li> <li>- Appointed panel</li> <li>- Task force</li> <li>- Local experts on energy efficiency</li> </ul>	1–3 years 1–2 years 1–2 years 1–2 years
Phase 3	<ul style="list-style-type: none"> <li>✓ Set up new EEC regulatory department to manage all EEC matters</li> <li>✓ Appoint controller of examination who then appoints invigilators and support staff</li> <li>✓ First examination for energy managers</li> <li>✓ Registration of energy managers</li> <li>✓ Continuous professional development</li> </ul>	- GDE	<ul style="list-style-type: none"> <li>- GDE</li> <li>- Examination Advisory Committee</li> <li>- EEC regulator department</li> <li>- Training organisers</li> </ul>	1 year ½ year ½ year ½ year ½ year

EEC = energy efficiency and conservation, DoET&EBP = Department of Energy Technique and Energy Business Policy, GDE = General Department of Energy.

Source: Author.

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# Chapter 4

## Standards and Labelling

*Yau Chau Fong*

### **1. Introduction**

Organisations put in place standards to have a basis for making a judgement and a commonly agreed way of doing things within or beyond the organisations. Standards provide requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that materials, products, processes, and services are fit for their purpose.

Labelling is a way of identifying products and/or services; it gives the user a way of recognising such products and/or services and differentiate these via a set of criteria or set standards.

#### **1.1. Energy labelling**

Energy efficiency labels are informative labels affixed to manufactured products indicating a product's energy performance. They provide consumers with the information necessary to make a knowledgeable purchase decision. Some countries mandate that energy labels be displayed on certain electrical products for sale.

Energy rating and labelling have been a cornerstone in the market transformation of household appliances towards more energy-efficient models. They have been successfully applied worldwide in Europe, the United States, Japan, Australia, Thailand, etc. for more than a decade and have resulted in significant improvements in the energy efficiency of the technologies.

#### **1.2. Minimum energy performance standards**

A Minimum energy performance standard (MEPS) provides performance requirements for energy-related products, specifically the minimum amount of energy to be consumed in performing a product's task. Energy performance improvements in consumer products are an essential element in any government initiatives and objectives for energy efficiency and climate change mitigation programmes. Generally, a MEPS is implemented by a government energy efficiency body. The initial stages of a MEPS are voluntary and amendments are then made to the existing act or directive to regulate products, thus, making MEPS mandatory to the respective country. A MEPS generally requires standards to be developed and agreed, followed by setting up of test procedures that provides the measurement of the standards set.

If MEPS were to be made mandatory, only the electrical products that are listed in energy labelling, meeting the requirements of MEPS, are allowed to be offered for sale or used for commercial purposes. Therefore, MEPS and energy labelling are recommended to be used as part of the energy efficiency strategies to improve energy performance in Cambodia.

MEPS generally requires the use of a particular test procedure that specifies how performance is measured. With the MEPS in place, an energy labelling system shall be used, and registration of the equipment shall be done based on the labelling categories or ratings system. This would set an energy benchmark to the equipment used and purchased by end users.

Five member states of the Association of Southeast Asian Nations (ASEAN) – Malaysia, the Philippines, Singapore, Thailand, and Viet Nam – have adopted MEPS and labelling schemes. Some countries that have implemented energy labelling and MEPS are listed in Table 4.1.

### 1.3. Current scenario in Cambodia

Based on the numerous workshops conducted by the Economic Research Institute for ASEAN and East Asia (ERIA) with the Ministry of Mines and Energy (MME), there are already some initiatives to implement MEPS and energy labelling for certain electrical appliances (refrigerator and air conditioning) as a pilot project. The project is now in the final stage of issuance of the draft sub-decree. However, although MEPS and energy labelling are already in progress, no specific road map and finalised initiatives for the entire household equipment are yet in place.

As part of the energy efficiency measures, the electrical equipment used is recommended to comply with the MEPS which, in turn, will reduce the overall power consumption of the said premises. With MEPS in place, an energy labelling system shall be used, and registration of the equipment shall be done based on the labelling categories. This would set an energy benchmark to the equipment. Therefore, any equipment that meets all the requirements of efficient electricity use shall be affixed an efficiency rating label in such form and manner as may be determined by the MME.

The following sections will provide the **current gaps** and **future proposed road map** in implementing MEPS and energy labelling in Cambodia.

**Table 4.1: List of Countries that Adopted Energy Labelling**

	Country	Programme Name	Implementing Agency	Participation Mode
	Malaysia	Energy Efficiency Criteria for Material and Electrical Equipment to Qualify for the Minimum Energy Performance Standards Star Rating	Suruhanjaya Tenaga (Energy Commission of Malaysia)	Mandatory
	China	China Energy Label	The China Energy Label Center; part of the China National Institution of Standardization	Mandatory
	Japan	Uniform Energy Saving Label	Ministry of Economy, Trade and Industry, Japan (METI)	Mandatory
	European Union (EU)	EU Energy Label	National bodies of EU member countries	Mandatory
	United States of America (USA)	Energy Guide	USA Federal Trade Commission	Mandatory
	Indonesia	Energy Efficiency Labelling	Ministry of Energy and Mineral Resources	Mandatory/Voluntary
	Singapore	Mandatory Energy Labelling Scheme	National Environment Agency, Singapore	Mandatory
	Viet Nam	Energy Label	Ministry of Industry and Trade, Vietnam	Mandatory/Voluntary
	Philippines	Philippine Appliance Energy Standards and Labelling Programme	Department of Energy, Philippines	Mandatory
	Thailand	Energy Efficiency Label No. 5	Electricity Generating Authority of Thailand	Voluntary

Source: Author's research and compilation.

## **2. Identification of Relevant Institutions**

Whilst the focus is to develop MEPS requirements, it is also essential to identify the new or existing local institutions and potential agencies to be appointed to carry out MEPS activities.

These include standard-writing organisations (SWOs) for electrical equipment labelling standards, the testing bodies for testing of compliance, and certification bodies for certificates of approval.

### **2.1. Standard-writing organisation**

A standard-writing organisation (SWO), standard-developing organisation, or standard-setting organisation is a firm or entity whose primary activities are developing, coordinating, promulgating, revising, amending, reissuing, interpreting, or otherwise producing technical standards on energy-efficient equipment intended to address the needs of a group of affected adopters.

In most countries, most standards are voluntary; they are offered for adoption by people or industry without the mandate of law. Some standards become mandatory when they are adopted by regulators as legal requirements in particular domains.

### **2.2. Testing bodies**

Testing bodies independently verify compliance of products with energy efficiency standards and regulations. They provide an independent assurance that tests are done according to stated specifications and test methods in the standards produced by the SWOs. Testing bodies also enhance customers' acceptance and confidence on the quality, reliability, and safety of products. They help minimise the risk of consumers buying an inferior product not in compliance with energy efficiency standards or requirements.

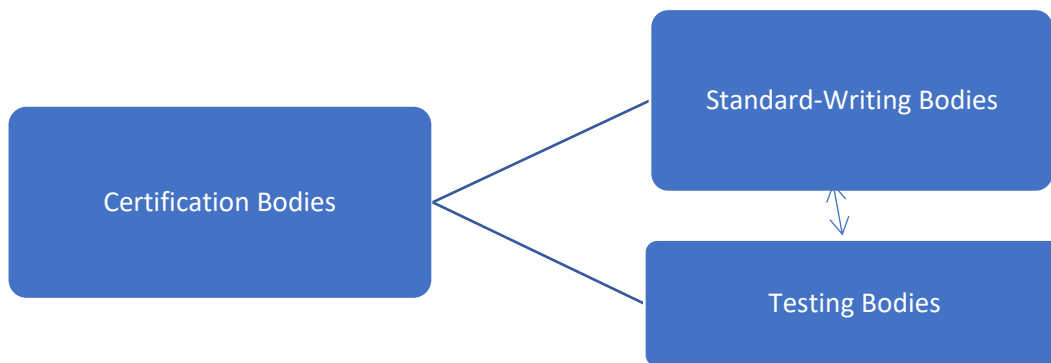
### **2.3. Certification bodies**

Certification bodies are independent bodies responsible for the assessment and accreditation of certain organisations. In our context, they are the SWOs and testing bodies for energy labelling and standards. Certification bodies provide conformity certificates to organisations for their various management systems, individual as well as product manufacturers and service providers. Accreditation is the formal recognition by an independent body, generally known as an accreditation body, that a certified body operates according to international standards.

### **2.4. Setting up of institutions**

In the context of energy labelling and standards, the above institutions should work together to ensure the success of the implementation of labelling and standards (Figure 4.1). The SWOs for electrical equipment labelling standards will produce the required MEPS, which incorporate testing requirements or conformance standards. The testing bodies will then test the respective MEPS-complied products accordingly. The certification bodies will assess the standards made and requirements of testing bodies to ensure both bodies comply with the standards.

**Figure 4.1: Interrelation between Institutions**



Source: Author.

### **3. Selection of Targeted Appliances**

A wide range of electrical appliances are produced in the market for consumers. Targeted appliances to be selected for labelling – such as lighting, refrigerator, air conditioning, fan, television, water heater, washing machine, and others – shall be reviewed in terms of their market availability, distribution, and power consumption contributions to the entire energy utilisation. Hence, the selection of the targeted appliances is suggested to be done in two stages: stage 1 for residential appliances and stage 2 for commercial/industrial appliances and equipment.

The priority for labelling should be given to residential appliances. This is because the preliminary focus is to reach a wider range of, and more common, appliances used in the market compared to commercial and industrial equipment which are more specific and unique. Another consideration is the market share of the product selected for energy labelling and standards to achieve a greater impact in energy savings. Table 4.2 outlines some countries' appliances with MEPS and energy labelling and their status.

#### **3.1. Selection of pilot project appliance**

The MME, through the ASEAN SHINE Programme, initiated a pilot project to set up the MEPS requirements for air-conditioning system. A draft Sub-decree on Energy Efficiency Standard and Labelling for Air Conditioners is in place and approval is being sought.

One or two pilot projects are recommended to be chosen to formulate the necessary MEPS and energy labelling. Besides the air-conditioning system, we are also recommending that lamps be chosen as well. This is in line with the countries that had adopted MEPS and energy labelling. Lamps are also one of the most-used electrical appliances consumed in typical homes with potential for local manufacturing.

After choosing the pilot project, the following steps are recommended to be adopted in producing a good MEPS:

- 1) Select a MEPS rating reference.
- 2) Choose a reference from amongst ASEAN countries to be adopted as guide.
- 3) Form a working group for MEPS and energy label rating, which includes all stakeholders in the country.
- 4) Draft the MEPS requirements.

**Table 4.2: Selected Countries' Appliances with MEPS and Energy Labelling and their Status**

Country	Indonesia	Thailand	Malaysia	Singapore	Philippines	Viet Nam	United States	Japan	European Union	China	Lao PDR	Myanmar	Brunei	Cambodia
<b>Air-conditioning system</b>	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	X	X	X	X
<b>Fan</b>	YES	YES	YES	X	X	YES	YES	X	YES	YES	X	X	X	X
<b>Refrigerator</b>	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	X	X	X	X
<b>Lamp</b>	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	X	X	X	X
<b>Television</b>	YES	YES	YES	YES	X	YES	YES	YES	YES	YES	X	X	X	X
<b>Washing machine</b>	YES	YES	YES	X	X	YES	X	X	X	YES	X	X	X	X

Source: Author, based on respective countries' official websites, as follows:

Indonesia – <http://www.ebtke.esdm.go.id/>

Thailand – <http://labelno5.egat.co.th/>

Malaysia – <https://www.st.gov.my/web/consumer/details/7/2>

Singapore – <https://www.nea.gov.sg/>

Philippines – <https://www.doe.gov.ph/pelsp-ig>

Viet Nam – <http://www.moit.gov.vn/>

United States – <https://www.ftc.gov/news-events/media-resources/tools-consumers/energyguide-labels>

Japan – [https://meti.go.jp/english/policy/energy\\_environment/energy\\_efficiency/index.html](https://meti.go.jp/english/policy/energy_environment/energy_efficiency/index.html)

European Union – <https://ec.europa.eu/environment/ecolabel/competent-bodies.html>

China – <https://en.cnis.ac.cn/>



### 3.2. Common Requirements for MEPS

A few new common criteria are observed and used in setting up MEPS, as follows.

1) Scope

The standards proposed shall define the products that shall be included in the standards. Inclusion or exclusion of products could be based on the product type, power rating, or usage type.

2) Normative standard

The standards set shall have a set of normative reference standards to refer to any existing performance standards, international standards such as the International Electrotechnical Commission (IEC), American Society of Heating Refrigerating and Air-Conditioning of Engineers, etc. and reference requirement for the condition, testing method, and performance.

3) Terms and conditions

The specific terms and conditions shall be identified for the appliances. These include the following:

a) The standards that will depict the parameters to be used to determine the appliance's performance, such as:

- Fan : Coefficient of performance (COP)
- Refrigerator : Energy efficiency factor (EEF)
- Air conditioner : Energy efficiency ratio (EER)
- Television : Energy efficiency factor (EEF)
- Lamp : Efficacy

b) Minimum energy performance standards – the required minimum level of energy will be defined.

Star rating requirements – A range of ratings and requirements to define the level of compliance of the energy performance. The common method will be to categorise the star rating and range, such as star rating 1 to 5. Some appliances such as lamps do not require any star rating.

### 3.3. Choosing a reference from an ASEAN country to adopt as guide

Since some ASEAN countries – such as Malaysia, the Philippines, Singapore, Thailand, and Viet Nam – have energy labelling and MEPS requirements in place, Cambodia can refer to these countries in terms of the requirements because of regional suitability, environmental conditions, and availability of similar regional products.

### **3.4. Formation of working group for MEPS finalisation**

With the above in place, a working group shall be set up to draft the MEPS for a particular appliance. As far as practicable, the working group should involve relevant stakeholders such as the regulators, suppliers, testing bodies, end users, designers, distributors, manufacturers, and others involved in the products.

### **3.5. Typical standards-writing procedure**

After the working group is formed, it would then work on the writing of standards. The publication of standards is the result of an agreement between all stakeholders.

The preparation of the typical new standards involves the following stages: preliminary, proposal, preparatory, enquiry/review, approval, and publication.

The preliminary stage normally consists of projects envisaged for the future but not yet ripe for immediate development – or preliminary work – such as better definition of a project for new work, data collection, or round-robin tests necessary to develop standards, which are not part of the standardisation process.

The preliminary stage is applied for work items where no target dates can be established. This stage can be used to elaborate a new work item proposal and develop an initial draft. These work items are subject to approval according to normal procedures before progressing to the preparatory stage.

The next stage is the proposal stage whereby the preliminary outline of the standard is circulated to stakeholders for feedback before deciding whether to proceed.

During the preparatory phase, a working draft is prepared. The preparatory stage ends when a working draft is available for circulation to the working group members. The committee may also decide to publish the final working draft to respond to particular market needs.

During the enquiry/review stage, the working draft standards are made available and published for comments and/or amendments. If these are relevant, a final draft is then produced.

The final draft is discussed amongst the working group members; if approved, it will be sent for final draft publication or subsequent further approval by higher management.

## **4. Testing Bodies**

Another important element of MEPS and energy labelling is the testing facilities available to carry out the product appliance compliance test to MEPS. We have reviewed the existing lab facilities in Cambodia, which could carry out various tests to comply with the requirements. We have also reviewed the current international and regional labs to assist with the testing to conform with the standards set. Currently, no accredited testing labs in Cambodia exist. There is only an electrical product safety certification scheme by third-party testing.

The Institute of Standards of Cambodia (ISC) via its ISC Product Certification Scheme provides rules for a third-party certification system of conformity assessment through testing and assessment of the factory quality management system. The scheme is imperative for products covered under mandatory standards.

Manufacturers are required to apply for a product registration licence to affix the ISC mark on products. The products are compliant with Cambodian standards and/or those of the International Electrotechnical Commission (IEC). Foreign manufacturers, through a local representative, also need to sign an agreement to use the ISC mark.

Because of the unavailability of a certified test laboratory in Cambodia, the country could, for a start, collaborate with some of the regional test laboratories to carry out the tests accordingly. Numerous internationally accredited test laboratories are available and registered under the ASEAN Secretariat. These are listed as testing laboratories and certification bodies under the ASEAN Sectoral Mutual Recognition Agreement (MRA) for Electrical and Electronic Equipment.

Whilst no existing laboratories or labs are available for immediate acceptance of MEPS and required energy labelling, Cambodia should also develop its own testing bodies and labs. Following are the typical procedures in obtaining test lab competency and accreditation internationally.

#### **4.1. Designation and set-up**

A testing laboratory is to be identified and designated as the testing body for the country. The testing lab shall have the following competencies:

- 1) Accreditation to ISO/IEC 17025 (General requirements for the competence of testing and calibration laboratories) or ISO/IEC 17025:2005, which specifies the general requirements for the competence to carry out tests and/or calibrations, including sampling. It covers testing and calibration performed using standard methods, non-standard methods, and laboratory-developed methods.
- 2) Participating in the IECEE CB Scheme (IEC System of Conformity Assessment Schemes for Electrotechnical Equipment and Components) Certification Body Scheme. The IECEE CB programme is a globally standardised approach to test and verify energy efficiency for electrical and electronic equipment, based on IEC International Standards.

It aims to prevent duplication of testing, reduce costs, and support global trade in a timely manner. The IECEE CB programme will provide proof of compliance to IEC International Standards in terms of energy efficiency in general and, more particularly, in energy performance, and energy consumption. The testing laboratory then obtains the certificate of designation from the designated body.

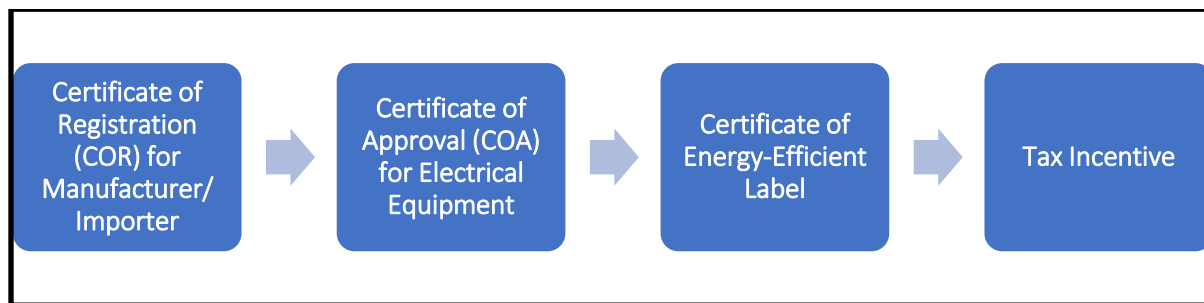
#### **4.2. Nomination and listing in ASEAN**

To ensure that the testing body is also in the ASEAN-designated testing lab list, the country shall nominate the testing lab to the respective committee, JSC EEE (the ASEAN Joint Sectoral Committee on Electrical and Electronic Equipment). Upon approval, the testing lab will be listed in the ASEAN website.

#### **4.5. Registration of MEPS and Energy Labelling**

With standards in place and the testing body set up, the next action shall be the registration of MEPS and energy labelling of the product (Figure 4.2).

**Figure 4.2: Registration Process of MEPS and Energy Labelling of Electrical Appliances**



Source: Author.

### **5.1. Proposed regulations for certificate of registration for manufacturer/importer**

A certificate of registration should be issued to the manufacturer or importer of the product. The certificate will ensure that any person who manufactures or imports any regulated equipment shall apply to be registered. A renewal period for the certificate is suggested to ensure that the registration of the products is active and up to date. The products may include electrical equipment and other household products.

### **5.2. Proposed regulations for certificate of approval for electrical equipment**

Upon the registration of products, the relevant authorities can monitor the approval for electrical equipment. The certificate of approval (COA) could be issued to such electrical equipment. Hence, with the certificate, no person shall manufacture, import, display, sell, or advertise any electrical equipment; any low-voltage equipment which is usually sold directly to the general public; or any low voltage equipment which does not require special skills in its operation, unless the equipment is approved by the authority.

### **5.3. Proposed regulations for energy efficiency label**

With the certificates of registration and approval in place, the manufactured electrical equipment which then meets all the requirements of efficient use of electricity shall be affixed with an energy efficiency rating label in such form and manner as may be determined by the relevant authority. The general minimum requirement shall be a recognised test report which could be produced by any of the following laboratories: (i) lab under IECEE CB Scheme, and (ii) accredited lab by APLAC (Asia Pacific Laboratory Accreditation Co-operation) MRA.

APLAC developed a regional MRA: (i) accredited lab by ILAC (International Laboratory Accreditation Cooperation) MRA, and (ii) lab listed as designated testing laboratory under the ASEAN EE MRA.

### **5.4. Proposed tax rebate**

A tax rebate could also be introduced to encourage the registration and certification of equipment. Some of the tax rebates that could be introduced are those (i)for consumers for every purchase of energy-efficient equipment, (ii)for manufacturer of green products, and (iii)for house developers for use and installation of energy-efficient equipment.

Companies providing services to improve energy efficiency are eligible for the following:

- 1) Pioneer status with an income tax exemption of 100% of the statutory income for 10 years.
- 2) Investment tax allowance of 100% on the qualifying capital expenditure incurred within 5 years.  
The allowance is to be offset against 100% of the statutory income for each year of assessment.
- 3) Import duty and sales tax exemption on energy-efficient equipment that are not produced locally, and sales tax exemption on the purchase of equipment from local manufacturers.

## **6. Role of the General Department of Energy, Ministry of Mines and Energy (MME)**

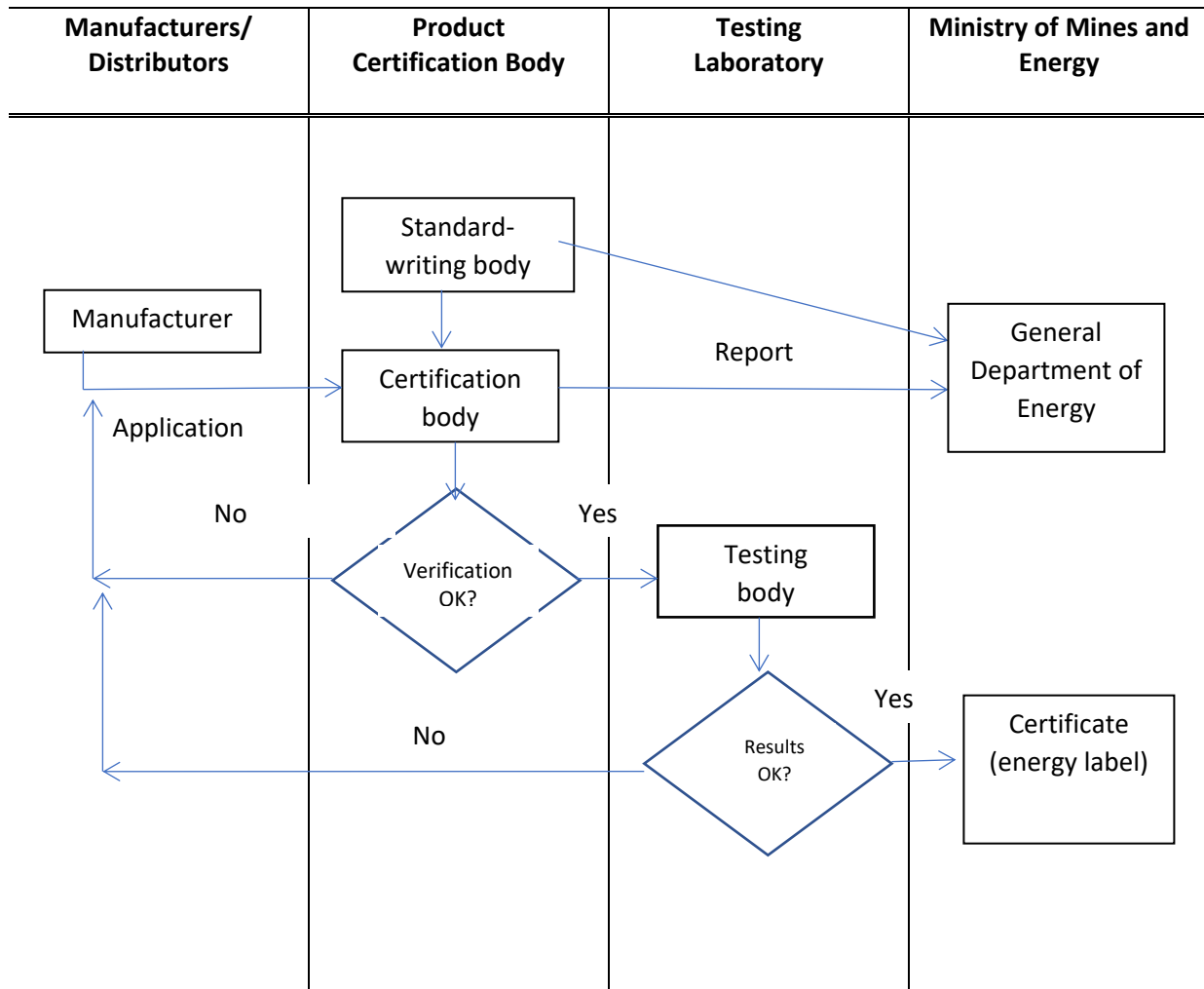
Each stakeholder of MEPS and energy labelling, including the GDEMME, plays an important role in the success of their implementation. The GDE, as the principal regulatory body of energy efficiency projects, has the following functions:

- 1) Coordinate and promulgate the relevant law, regulations, and standards of energy-efficient products and labelling;
- 2) Enforce standards into regulations and laws and conversion of the voluntary requirement into mandatory requirements;
- 3) Issue certificates of approval of electrical products and energy labelling;
- 4) Administer, monitor, and audit approved and disapproved electrical products or energy labelling;
- 5) Review or propose incentives for the use of energy-efficient products or labelling.

## **7. Road Map**

Figure 4.3 summarises the implementation of MEPS and energy labelling.

**Figure 4.3: Flow Diagram of the MEPS and Energy Labelling Programme**



Source: Author.

A detailed road map is to be provided for the setting up of a framework on labelling of energy-efficient equipment (Table 4.3).

This includes the following:

- 1) Moving for inclusion of standards in energy-efficient equipment;
- 2) Identification of institutions/bodies to be involved in setting up labelling;
- 3) Identification of electrical equipment for labelling and its ratings;
- 4) Setting up of testing labs conforming to regional test labs requirements; and
- 5) Registration of the energy labelling product.

**Table 4.3: Road Map and Implementation Programme for MEPS and Energy Labelling**

Phase	Milestones Activities	Target Groups	Organisations Involved	Time Schedule
Phase 1	Stakeholders engagement	GDE	Engineering institutions and associations Regulatory bodies Standard-writing organisations Consumer associations	1 year
Phase 2A	Setting up of registration requirements	GDE	GDE	3 years
Phase 2B	Setting up of certification and assessment bodies/standard-working group/testing bodies for MEPS	GDE and ISC	GDE and ISC	1 year
Phase 3A	Certification and assessment bodies	GDE and ISC	GDE and ISC	1 year
Phase 3B	Standards working group	GDE and ISC	All stakeholders	2 years
Phase 3C	Testing lab	GDE and ISC	Appointed lab	5 years

GDE = General Department of Energy, ISC = Institute of Standards of Cambodia, MEPS = minimum energy performance standard.

Source: Author.

### **Phase 1 Stakeholders Engagement**

The immediate task foreseen at the initial phase is to gather all stakeholders together to develop MEPS and energy labelling. This includes identifying relevant stakeholders such as the regulatory bodies, the SWOs, consumers, engineering institutions, contractors, distributors, manufacturers, design engineers, and others. The discussion and presentation of draft road map for further inputs and additional ideas are being sought from the stakeholders. This is followed by the setting of the terms of reference on MEPS and energy labelling. It is necessary to identify the task force amongst the stakeholders to monitor the following tasks: (i) registration requirements, (ii) certification/assessment, (iii) standard writing, (iv) testing and verification, and (v) enforcement.

### **Phase 2 – Setting Up of Institutions**

The next phase shall be the setting up of institutions and identification of their roles as follows:

#### **1) Certification and assessment bodies**

The role of certification and assessment bodies is to be established.

## 2) Standard-writing organisations (SWOs)

The role of SWOs (standards for MEPS and procedures in developing and finalising a standard) is to be established.

## 3) Testing Bodies

The role of testing bodies (procedures for set-up and compliance to international requirements) is to be established.

### **Phase 3 – Setting up of Registration**

With the institutions in place, relevant amendments to acts, regulations, and circulars shall be made to incorporate changes for MEPS and energy labelling. This includes the registration of electrical products and energy labelling products. Enforcement to monitor the implementation of MEPS and energy labelling shall also be put up to ensure success of the implementation.

### **Phase 4 – Implementation**

The final phase of the road map shall be the establishment of the following institutions: (i) certification and assessment bodies, (ii) SWOs, (iii) Cambodian standard on MEPS, (iv) testing bodies with the establishment of a local test lab for MEPS, and (v) full enforcement of MEPS implementation.

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# Chapter 5

## Education and Campaigns

*Leong Siew Meng*

### 1. Introduction

Energy efficiency and conservation (EEC) is an important agenda in every country's economic development because it contributes to two critical issues common to most economies: energy security and environmental sustainability. As a first step of EEC promotion, a responsible government body should implement its education and campaign programmes. The education and campaign surely contribute to encourage Cambodians to be aware of and acquire interest in EEC. Saving energy, especially electricity through EEC promotion including education and campaigns, can delay the construction of power plants. It can also cost less than generating, transmitting, and distributing electricity from power plants, hence, providing multiple economic and environmental benefits. For EEC programmes to have impact, every aspect of information on EEC activities needs to be disseminated to the whole population nationwide, which includes the business, professional, and academic communities as well as the public.

This chapter discusses various communication and promotion methods for education and campaigns through public and professional forums, printed media with practical EEC information, websites, home energy reporting, school system, etc. EEC activities involve a wide spectrum of methods and technologies, which can be broadly classified as no or low-cost, medium-cost, and high-cost or investment-scale measures. In general, the planning and implementation of education and promotion campaign activities will require both technical input and government administrative effort with commitments.

### 2. Role of the General Department of Energy

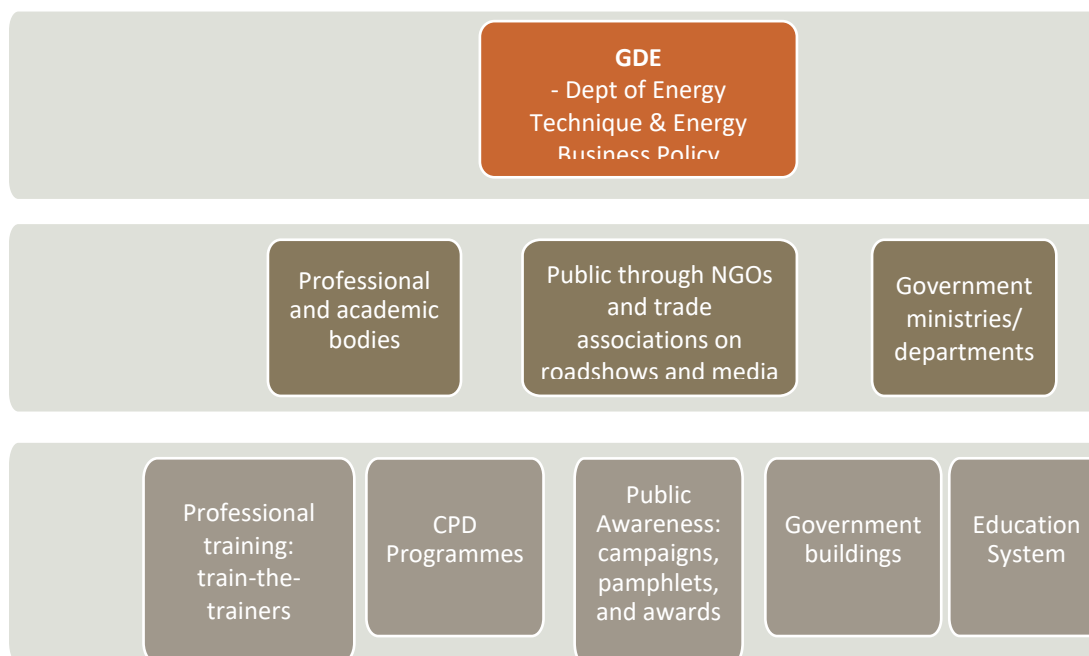
The success of education and campaigns depends on the effective planning and execution of the plans. The functions of the General Department of Energy (GDE) are summarised as follows:

- 1) Plan education and campaign activities, including estimation of budget and resource requirements.
- 2) Generate awareness and interest of EEC in the residential, commercial, and industry sectors.
- 3) Assign a responsible person or a committee to plan and implement EEC education and promotion campaign activities.
- 4) Generate awareness and interest of EEC in the educational system.

Figure 5.1 shows the structure for GDE's roles in organising and interacting with stakeholders in other government departments, professional and academic bodies, and non-governmental organisations. A consultative approach with these organisations and bodies is recommended, such that (i) the professional and academic bodies will provide input in developing professional training and continuous professional development (CPD) programmes; (ii) non-governmental organisations and trade associations will provide input in developing roadshows and media campaigns; and (iii) other government ministries or

departments will provide input in developing EEC programmes of activities for government buildings and school syllabuses.

**Figure 5.1: Structure of GDE's Role in Implementing EEC Education and Campaign**



CPD = continuous professional development, GDE = General Department of Energy, NGO = non-governmental organisation.

Source: Author.

### 3. Content of EEC Education and Promotion Campaigns

There is no single measure to achieve EEC. Therefore, the planning and implementation of EEC education and campaign activities would require a multifaceted approach. This approach can be simplified by categorising various EEC education and campaign activities under clusters of activities (Figure 5.2).

The following describes the various clusters of EEC education and campaign activities:

- 1) **General awareness:** The cluster of general awareness campaigns should be targeted mainly at the public and the household sector. This cluster aims to generate basic awareness amongst the public on the needs and simple ways of energy conservation and savings.
- 2) **Fundamentals:** The cluster on EEC fundamentals should be introductory targeting at the commercial and industry sectors, especially on 'low-hanging fruits' in the EEC. The objective of this cluster is to introduce the concepts and fundamentals of EEC measures to the business communities in the commercial, residential, and industry sectors. For the residential sector, the target would be the housing developers and builders.
- 3) **Roadshows and forums:** This cluster aims to disseminate information on the practices and benefits of EEC measures in various business operations, such as hotels, shopping malls, restaurants, hospitals, and office buildings in the commercial sector, and textile factories, food and beverage

factories, breweries, furniture factories, cement plants, etc. in the industry sector. Regular roadshows and forums will provide updates on EEC practices and government EEC plans.

- 4) EEC information: For the cluster of EEC information, pamphlets, guidelines, and standards, such as minimum performance standards (MEPS), will be developed. This cluster highlights that appropriate selection and use of appliances and equipment will save energy.
- 5) Media campaigns: This cluster aims to generate awareness and disseminate information through printed media, television, and websites to reach out to the whole population.
- 6) Education for professionals: Education is an important part of the EEC campaign because the professionals and practitioners in the commercial and industry sectors are the ones who operate the machineries and equipment that consume energy.
- 7) Education in the school system: Educating schoolchildren and university students would provide the best opportunity to inculcate behavioural changes towards the adoption of the EEC in daily lives. This cluster would involve the development of syllabus in the education system.
- 8) Publicity and national awards: As part of the publicity programmes, national energy awards would provide official recognition of EEC efforts to the commercial and industry sectors. The school system may introduce EEC project competitions and awards to encourage the uptake of EEC practices and culture amongst the younger generations.

**Figure 5.2: Cluster of EEC Education and Campaign Activities**



CPD = continuous professional development, EEC = energy efficiency and conservation.  
Source: Author.

## **4. School Syllabus**

The adoption of EEC concepts and practices by people would involve behavioural changes. The best way to achieve this objective is to start with educating schoolchildren and university students in adopting EEC lifestyles. The development of the EEC school syllabus should consider the elementary, intermediate, and advanced levels. It is recognised that the development of the school syllabus is within the authority of Cambodia's Ministry of Education, Youth and Sport. Therefore, the GDE needs to consult with the ministry and other stakeholders to work out the best arrangement for the development of an EEC syllabus. This section provides guidance and input for the development of an EEC syllabus.

### **4.1. Elementary level**

The elementary level school syllabus aims to educate primary school students on a basic understanding of energy and environment, and the benefits of the EEC. The following topics are recommended to be included in the primary school syllabus:

- 1) Energy and environment
  - a) Types of energy: non-renewable energy (diesel, petrol, natural gas, liquefied petroleum gas (LPG), coal, electricity); renewable energy (solar energy, biomass, biogas, etc.)
  - b) Forms of energy: heat, light, sound, electrical energy, etc.
  - c) Use of energy
  - d) Effects of energy usage on environment
- 2) Energy conservation and energy efficiency
  - a) What is energy conservation and energy efficiency?
  - b) Can energy be saved? What is the difference between energy conservation and energy efficiency?
  - c) Simple and practical ways to conserve energy
  - d) Simple and practical ways to reduce energy consumption
- 3) Benefits of the EEC
  - a) Conserves energy
  - b) Reduces energy
  - c) Reduces energy bills

### **4.2. Intermediate level**

The objective of the intermediate level school syllabus is to target secondary school students with EEC topics that can provide these students greater knowledge and skills. The scientific principles of the EEC to be taught at this level should correspond with the level of science subjects being taught in secondary schools. The following topics are recommended to be included in the secondary school syllabus:

- 1) Conversion of energy sources
  - a) Electricity
  - b) Solar photovoltaic (PV)
  - c) Thermal energy (heat, steam, etc.)
- 2) Application of energy
  - a) Building services (air-conditioning and mechanical ventilation, lighting, refrigerators, lifts and escalators, etc.)
  - b) Transportation
  - c) Medical equipment
  - d) Manufacturing processes
  - e) Building construction
- 3) Principles of EEC
  - a) Energy units and measurements
  - b) Specific energy consumption
  - c) Energy efficiency indicators (EEIs)
  - d) Basic heat transfer
  - e) Basic EEC measures
- 4) Basic EEC problem–based learning project assignment
  - a) Examples: walk-through audit of school facilities; small solar PV project, etc.

#### **4.3. Advanced level**

The objective of the advanced level school syllabus is to target college and university students to impart higher level of skills and knowledge in EEC. The syllabus should be developed to enable students to appreciate and correlate the application of principles learned in their science and technical subjects. The following topics are recommended to be included in the secondary school syllabus:

- 1) Understanding of energy units, conversion, and measurements
- 2) Understanding and application of EEC practices
  - a) Buildings: the concepts of passive and active energy efficiency design measures
  - b) Manufacturing process: understanding of significant energy users and potential energy measures
- 3) Understanding of energy performance data and trending

- a) National energy statistics
  - b) EEI for the commercial sector
  - c) EEI for the industry sector
- 4) EEC problem-based learning project assignment
- a) Examples: Identify and quantify the energy saving potential of a facility through walk-through audit, conduct of interviews, and collection of energy consumption data and other required data. The project assignment will evaluate the economic viability of implementing EEC measures that the student project team identifies.

## 5. Media campaigns

Media campaigns are significant because they can potentially reach out to the masses in the country within relatively short time. Media campaigns can be designed and strategised to reach out to different target groups, for example, household owners, consumers, and business communities. For more effective media campaigns, the GDE should consider using an EEC mascot design that would appeal to the public and capture people's attention and interest.

The objectives of media campaigns under these two broad sections of the population are as follows:

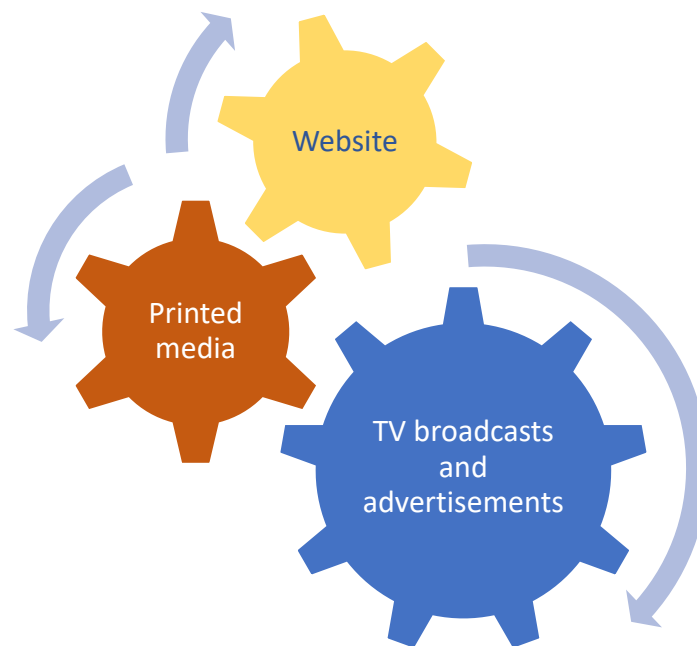
- 1) Household owners and consumers
  - a) Generate awareness on the benefits of the EEC, which can be translated as 'putting money back to their pockets' based on the concept of 'using less energy to obtain the same service';
  - b) Generate positive attitude towards energy efficiency and energy savings, i.e. towards changing behaviour;
  - c) Disseminate information on labelling of appliances and equipment that can help identify energy-efficient products.
- 2) Business communities
  - a) Generate awareness on the benefits of EEC practices that would result in energy-efficient operations;
  - b) Generate positive attitude with confidence towards energy efficiency and energy savings through highlights of success stories or case studies;
  - c) Highlight and educate stakeholders on the availability of energy-efficient techniques through various measures:
    - No/low-cost measures
    - Medium-cost measures
    - Investment-scale measures

- d) Educate stakeholders on the significance of EEC practices towards national energy security, energy equity, and environmental sustainability.

With today's advanced communications, more options are available to disseminate information. Media campaigns can be grouped under three types of action plans as detailed below and as illustrated in Figure 5.3.

- 1) Printed media – newspapers, pamphlets, publications, banners, buntings, and posters.
- 2) TV broadcasts and advertisements – broadcast of EEC events and documentaries, and TV advertisements
- 3) Dedicated EEC website – announcement of EEC activities; energy saving measures for the commercial, residential, and industry sectors; success stories or case studies; new developments in EEC locally and overseas

**Figure 5.3: Methods of Media Campaigns**



Source: Author.

## **6. Pamphlets to Promote Energy Efficiency and Conservation**

Pamphlets for promotional activities have been the traditional method of disseminating information to the public. Despite the advancement in communication, this traditional method of printing and distributing pamphlets is still being practised in many ASEAN countries. EEC pamphlets should be prepared to meet the requirements of the respective sectors. In view of the extensive and technical nature of EEC

information, it is more practical to prepare guidebooks instead of pamphlets for the commercial and industry sectors. Therefore, this section will only address the pamphlet contents for the residential sector.

### 6.1. Contents of EEC pamphlets for households

EEC pamphlets should comprise basic energy-saving tips such as the following:

1) Introduction of EEC at home

a) Explain what energy efficiency is.

Energy efficiency means using energy (which is mainly electricity) wisely, without wasting it, so that its consumption is reduced. Such reduction will mean lesser electricity bills. In other words, practicing EEC can save money.

b) Why is it necessary to use energy efficiently?

The objectives are

- to save fossil fuel (oil, gas, and coal) as increasing energy consumption depletes resources, increases prices (dependent on importation), and produces greenhouse gases (GHGs) that contribute to climate change;
- to preserve the environment; and
- to save on energy (electricity) bills

2) Understanding household electricity consumption, by providing examples

- a) on how to read the monthly electricity bill, i.e. besides finding out the amount to pay, what is the electricity consumption unit?
- b) to illustrate that the air conditioner is the largest energy-consuming appliance in the monthly electricity consumption of a typical household; and to show the energy consumption of an air conditioner, which is based on the power rating of the air conditioner and usage hours.

**Example:**

A typical 1.5 hp air conditioner has a nominal power rating of 1.2 kW and an approximate load factor of 0.6. The estimated electricity consumption for the use of 1.5 hp air conditioner for 5 hours per day for 30 days is given below.

$$\text{Air conditioning kWh} = 1.2 \times 5 \times 0.6 \times 30 = 108 \text{ kWh}$$

If the household used two units of 1.5 hp air conditioners in a month, the estimated total electricity consumption for this household would be:

$$\text{Total air conditioning kWh} = 108 \times 2 = 216 \text{ kWh}$$

If this household's electricity consumption is 500 kWh per month, the percentage share of air-conditioning consumption of electricity would be about 52%.



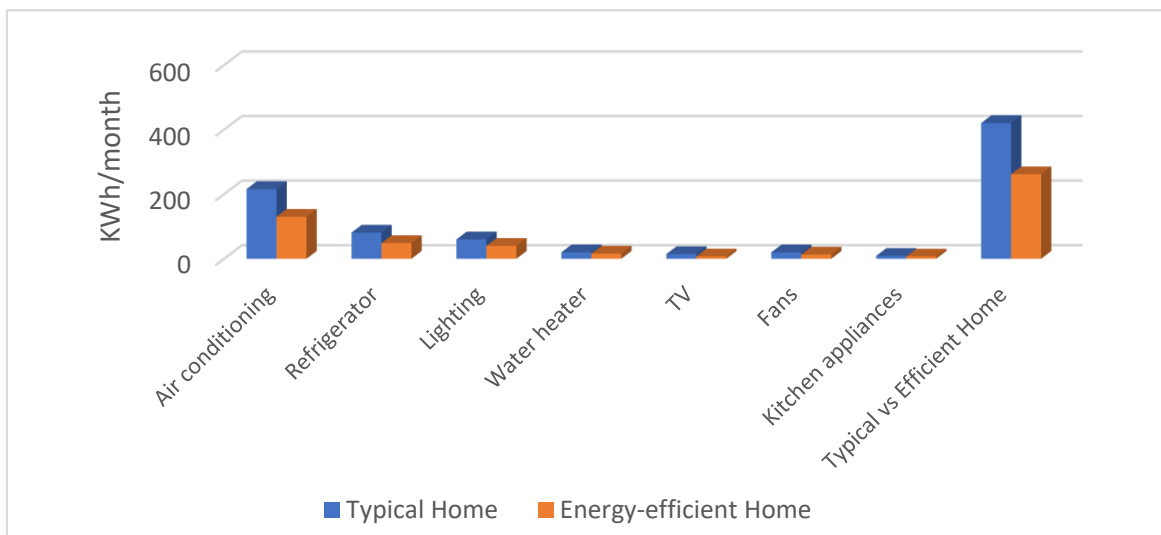
**The key messages of this example are:**

- The largest share of electricity consumption in a typical household in hot and humid climate is the use of air conditioners.
- The electricity consumption of appliances in a household can be reduced by (i) reducing the usage hours, e.g. switch off electrical appliances when it is not required; and (ii) having energy-efficient appliances with lower power rating but can meet the capacity requirements.

**3) Tips on reducing electricity bills at home**

There are opportunities to improve the efficiency of electricity use at home. Wise and efficient use, including the selection of energy-efficient appliances, can conserve energy, save money, and help protect our environment. The primary method is to analyse our electricity usage and assess where it can be comfortably controlled or used more efficiently. One can conduct his/her own energy audit at home. Figure 5.4 illustrates the electricity consumption pattern of a typical home vs an energy-efficient home.

**Figure 5.4: Electricity Consumption of a Typical Home vs an Energy-efficient Home**



Note: Figure 5.4 is for illustration purposes and is not based on actual data.

Source: Author.

Energy-saving tips on reducing electricity consumption of appliances will be useful for household residents. Including these tips on efficient use of appliances in pamphlets is recommended as part of the dissemination campaign on EEC to the public in the residential sector. Tables 5.1 to 5.6 provide practical energy-saving tips for efficient use of common appliances in households.

**Table 5.1: Tips for Efficient Use of Air Conditioners**

<b>Guide</b>	<b>What to Do</b>
1. Installation	<ul style="list-style-type: none"> <li>• Select energy-efficient air conditioners.</li> <li>• Make sure air conditioners are installed away from direct sun rays.</li> <li>• Avoid oversizing; ensure that the air conditioner is the correct size for the room to be air-conditioned.</li> </ul>
2. Operation	<ul style="list-style-type: none"> <li>• Do not block air distribution from air vents.</li> <li>• Check and adjust the thermostat to give a comfortable temperature; the recommended temperature setting is between 24°C and 26°C (in steady state operation).</li> <li>• Close windows and doors to stop air leakages to prevent outflow of cool air and reduce cooling load.</li> <li>• Insulate roof or ceiling and shield windows from the sun to reduce cooling load.</li> </ul>
3. Maintenance	<ul style="list-style-type: none"> <li>• Clean air filter periodically to optimise operation.</li> <li>• Clean the outside coil fins twice a year.</li> <li>• Provide regular maintenance to facilitate efficient operation and prolong the equipment lifespan.</li> <li>• Check and adjust the thermostat for a comfortable temperature.</li> <li>• Check the level of system refrigerant once a year.</li> <li>• Clean the blower unit coils once a year.</li> </ul>

Source: Author.

**Table 5.2: Tips for Efficient Use of Lighting**

<b>Guide</b>	<b>What to Do</b>
1. Installation	<ul style="list-style-type: none"> <li>• Avoid excessively high illuminance level, i.e. too bright for the applications, e.g. 300–400 lux for reading and writing, 150–300 lux for kitchens, 150 lux for bathroom, and 100 lux for bedroom are recommended.</li> <li>• Check that the lights used are energy efficient that has high luminous efficacy, i.e. the ability to emit visible light using less amount of power, e.g. compact fluorescent lamps, LED lamps, etc.</li> <li>• Separate light-switching circuits in large areas, such as the living room, so that unnecessary lights can be switched off when they are not required.</li> <li>• Use timer or photosensor to switch off outdoor night security lights during daytime.</li> </ul>
2. Operation	<ul style="list-style-type: none"> <li>• Switch off lights when not required.</li> </ul>

Source: Author.

**Table 5.3: Tips for Efficient Use of Electric and Microwave Ovens**

<b>Guide</b>	<b>What to Do</b>
1. Oven door gasket	<ul style="list-style-type: none"> <li>• Regularly inspect the door gasket for signs of wear and tear.</li> <li>• Check for defects in the hinges of the oven door.</li> <li>• If any fault on the gasket or hinges is detected, call an authorised person to repair/replace the part.</li> </ul>

Source: Author.

**Table 5.4: Tips for Efficient Use of Home Entertainment Devices**

<b>Things to Check</b>	<b>What to Do</b>
1. Television, personal computer, music player and radio	<ul style="list-style-type: none"> <li>• Ensure that the television, personal computer, and stereo are unplugged when not in operation (standby mode consumes electricity).</li> <li>• Make sure that the energy saver function of the computer is activated when left idle in between activities.</li> </ul>

Source: Author.

**Table 5.5: Tips for Efficient Use of Refrigerators**

<b>Guide</b>	<b>What to Do</b>
1. Selection and installation	<ul style="list-style-type: none"> <li>▪ Select an energy-efficient refrigerator that has an inverter compressor.</li> <li>▪ Avoid using an oversized refrigerator; choose the right capacity of refrigerator to suit your needs.</li> <li>▪ Avoid enclosing the sides of the refrigerator with kitchen cabinets. Leave sufficient gaps to facilitate heat dissipation from the condenser coils, which are normally located at the back of the refrigerator.</li> <li>▪ Do not place the refrigerator in a warm area, e.g. area exposed to direct sunlight or near a stove or oven.</li> </ul>
2. Operation	<ul style="list-style-type: none"> <li>▪ Avoid overloading the refrigerator; unblock or allow space around food in the refrigerator for air to freely circulate.</li> <li>▪ Leave hot food to cool down naturally before storing in the refrigerator.</li> <li>• Keep the compartments closed to avoid unnecessary loss of cold air when door is opened.</li> <li>▪ Avoid opening refrigerator frequently; do not leave the door open for a long time.</li> </ul>

	<ul style="list-style-type: none"> <li>▪ Check the temperature of the refrigerator compartment; 5°C is recommended to be set as the coldest.</li> <li>▪ Check the temperature of the freezer; -18°C is recommended for the freezer.</li> </ul>
3. Maintenance	<ul style="list-style-type: none"> <li>▪ Keep the condenser coils clean. Dust and dirt on the condenser coils will reduce refrigerator efficiency.</li> <li>▪ Check and ensure the door gasket is in good condition by <ul style="list-style-type: none"> <li>- closing the door on a sheet of paper</li> <li>- replace door gasket or adjust the alignment of the refrigerator/freezer if the sheet of paper is easily removed</li> </ul> </li> <li>▪ If the refrigerator is not a frost-free model, <ul style="list-style-type: none"> <li>- check for frost in the freezer compartment;</li> <li>- do not let frost thickness to exceed 6 mm;</li> <li>- switch off to defrost and remove excess water before restarting.</li> </ul> </li> </ul>

Source: Author.

**Table 5.6: Tips for Efficient Use of Electric Instant Water Heater**

<b>Guide</b>	<b>What to Do</b>
1. Installation	<ul style="list-style-type: none"> <li>• Select an energy-efficient water heater with a suitable capacity.</li> <li>• For low-volume requirement such as shower-only water heating, select tankless or demand-type water heater, which can avoid standby energy losses when compared with a storage water heater.</li> </ul>
2. Operation	<ul style="list-style-type: none"> <li>• Fix leaky faucet, showerhead, or pipe.</li> <li>• Avoid setting a high temperature for the shower heater, especially during hot weather.</li> <li>• Reduce temperature setting after the shower is turned on and when lower water temperature can be tolerated.</li> <li>• Avoid prolonged shower time.</li> <li>• Switch off electric water heater when not in use.</li> </ul>

Source: Author.

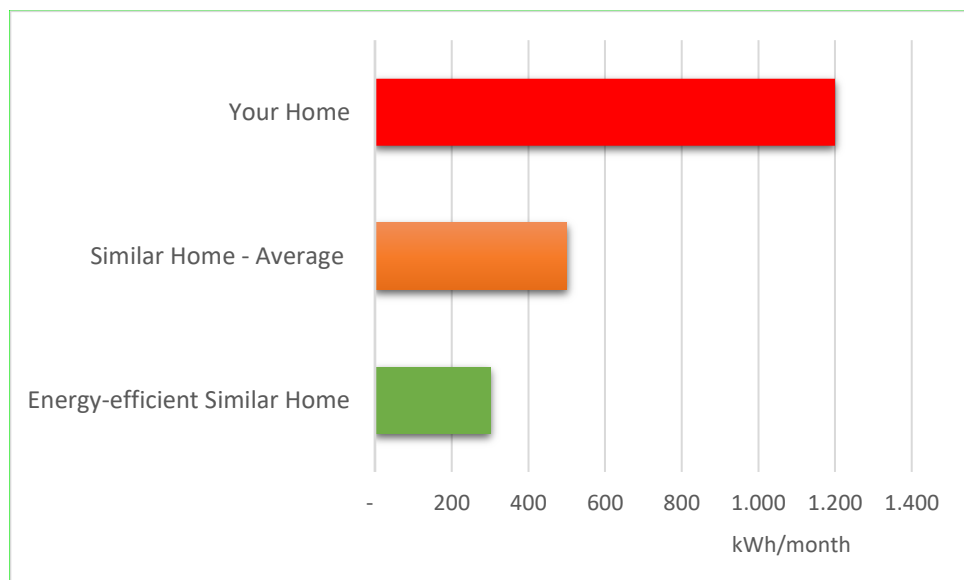
## 7. Home Energy Report

A home energy report is a useful tool to inform household owners if their electricity consumption for the month exceeds the corresponding average consumption per household in their area or district of residence. This reporting aims to provide a friendly feedback to the household owners concerned so that they get a chance to review and try to reduce their electricity consumption based on the recommendations, which will be provided in the home energy reports. It is intended to help household owners better assess their electricity consumption and effectively pay less for their effort in reducing their energy use.

Household electricity consumption data by district or area would be available with the power utility company, the Electricite du Cambodge (EDC). Such data can be put to good use by comparing electricity consumption of their home customers by area or district. As illustrated in Figure 5.5, households whose electricity consumption exceeds the average consumption of similar homes in the same area or district for, say, 3 consecutive months will receive a friendly notification in the form of letters or emails giving the following information:

- 1) A statement that the household concerned has consumed electricity much higher than similar homes in the neighbourhood;
- 2) A graph illustrating the comparison similar to Figure 5.5;
- 3) Energy efficiency tips on how to manage and reduce energy consumption in typical households; GDE's web portal with EEC tips and tools, if available, should be referred to in the notification.

**Figure 5.5: Home Energy Report Comparing Electricity Consumption in the Same Area**

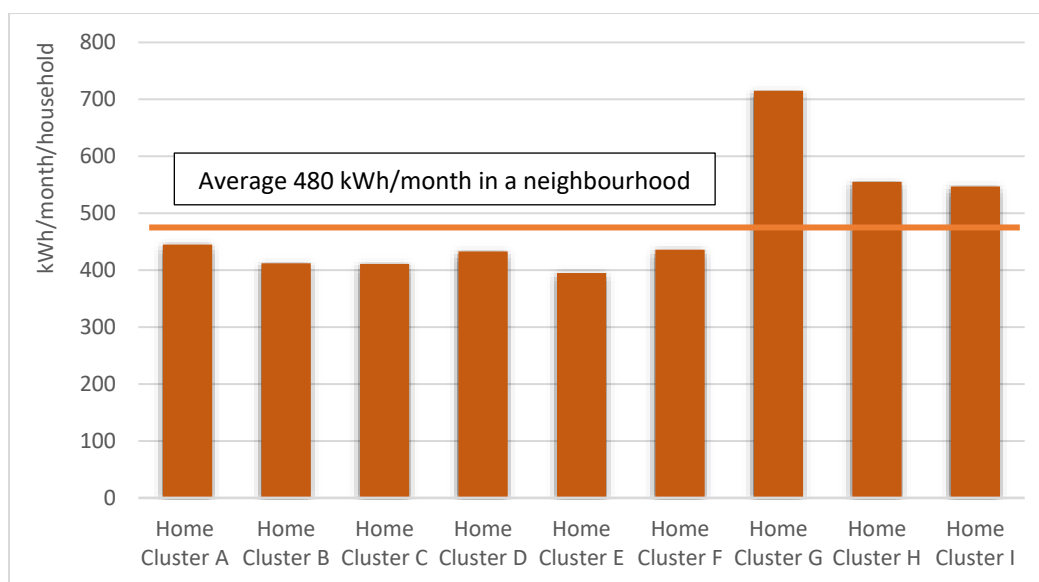


Note: Figure 5.5 is for illustration purposes and is not based on actual data.

Source: Tenaga Nasional Berhad, Malaysia, [https://myelectricitybill.my/green\\_tips.html](https://myelectricitybill.my/green_tips.html)

Figure 5.6 illustrates a method of deriving the average value of monthly electricity consumption based on the electricity consumption data in the neighbourhood of a chosen area or district. Compiling the cluster of average home data to work out the average monthly electricity consumption is a simple method in view of the large amount of data that can be anticipated in data collection and analysis.

**Figure 5.6: Example of Deriving the Average Monthly Electricity Consumption in a Neighbourhood**

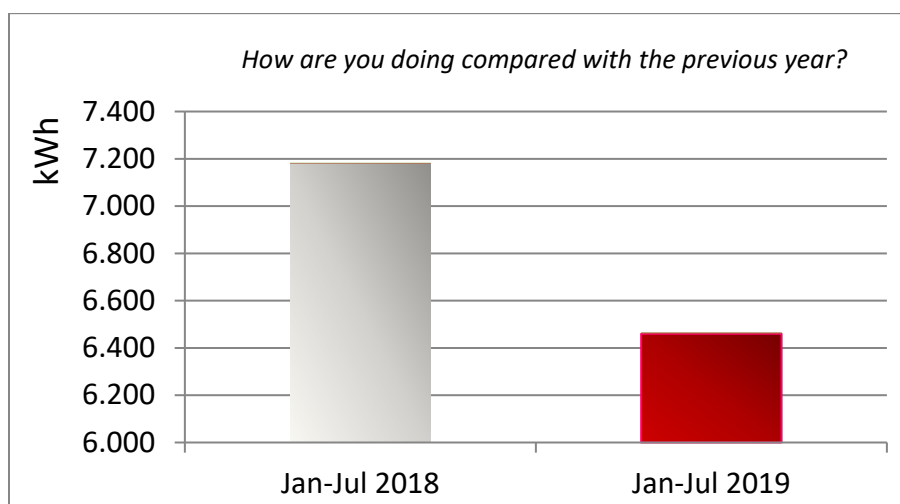


Note: Figure 5.6 is for illustration purposes and is not based on actual data.

Source: Author.

As a follow-up, a feedback report should be sent to homeowners to inform them of their individual household electricity consumption compared with the same period in the previous year. Figure 5.7 illustrates such comparison of electricity consumption for self-monitoring purposes. Such follow-up reporting will be useful and effective to generate continuous awareness and interest amongst homeowners in the residential sector, so that the EEC will continue to be practised in people's daily lives. The points made in the above have shown that home energy reporting is an easy and practical way of generating awareness and interest in people to adopt EEC practices. The implementation of this programme should be worked out and developed by the GDE and the EDC.

**Figure 5.7: Comparison of Personal Electricity Consumption of the Same Period in the Preceding Year**



Note: Figure 5.7 is for illustration purposes and is not based on actual data.

Source: Tenaga Nasional Berhad, Malaysia.

## 8. Road Map (2020–2025)

The key factor for the EEC plan to succeed is to reach out to the masses in the three sectors – commercial, residential, and industry. If the public and business entities are fully aware and interested in EEC practices, people will change their behaviour, which can be translated into energy savings nationwide. Education – through the introduction of EEC topics in the syllabi of primary and secondary schools and universities – should have a greater impact on behavioural change amongst the younger generation. The impact will be great. Overall, this chapter has addressed the task of education and campaigns to reach out to the masses. Table 5.7 outlines the road-map activities, which can be conducted in parallel. Some of the activities may be carried forward to the following year.

**Table 5.7: Education and Campaign Road-map Activities (2020–2025)**

Phase	Description of Activities	Remarks
<b>Phase 1a: 2020–2021</b>	The GDE to head the formation of a task force to plan education and campaigns	To generate interest in EEC campaigns, it is suggested to design and develop an EEC mascot that champions the EE agenda.
<b>Phase 1b: 2020–2021</b>	Conduct EE awareness campaigns, roadshows, mini exhibitions, and technical forums to disseminate information on EEC measures and savings.	Awareness campaigns to generate interests in EEC measures and energy savings
<b>Phase 1c: 2020–2021</b>	Publication of EEC pamphlets	To publish energy-saving tips and measures

<b>Phase 2a: 2021–2025</b>	Based on data collection and analysis, home energy reports to be distributed to affected households	The GDP and the EDC to work out the preparation of home energy reports for distribution
<b>Phase 2b: 2021–2025</b>	Media campaigns	Continuous campaigns through website, printed media, and television
<b>Phase 2c: 2021–2025</b>	EEC school syllabus	Continuous development
<b>Phase 2d: 2021–2025</b>	Professional training courses	Continuous development
<b>Phase 3a: 2022–2025</b>	Technical forums to disseminate information on EEC achievements	To share success stories and experiences
<b>Phase 3b: 2023–2025</b>	Conduct national EEC competitions and awards to recognise EEC efforts and achievements	Commercial and industry sectors

EE = energy efficiency, EDC = Electricite Du Cambodge, EEC = energy efficiency and conservation, GDE = General Department of Energy.

Source: Author.



# Chapter 6

## Data Collection to Establishment of Energy Efficiency Indicators

*Leong Siew Meng*

### 1. Introduction

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

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

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

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

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

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

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

## 2. Regulatory Requirements and Designated Premises

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

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

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

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

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

Note: <sup>a</sup> EEJ (2006).

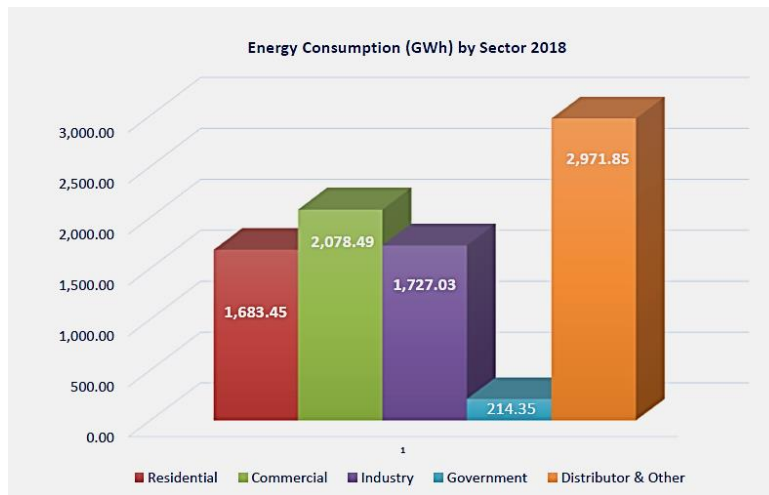
Source: Compilation by author based on the acts and regulations of each country.

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

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

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

**Figure 6.1: Energy Consumption of Cambodia in 2018**



Source: Theangseng (2019).<sup>4</sup>

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

Number of manufacturing factories in 2018<sup>5</sup>: 1,528

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

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

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

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

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

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

<sup>4</sup> Heang Theangseng reported on Cambodia's energy statistics for 2018 at the first meeting of ERIA Research Project FY2019, Working Group on the Preparation of Energy Outlook and Analysis of Energy Saving Potential in East Asia Region, 17–18 December 2019, Jakarta.

<sup>5</sup> Source of information: Open Development Cambodia (<https://opendevelopmentcambodia.net/topics/industries/>)

<sup>6</sup> See footnote no. 4.

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

### **3. Role of the General Department of Energy**

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

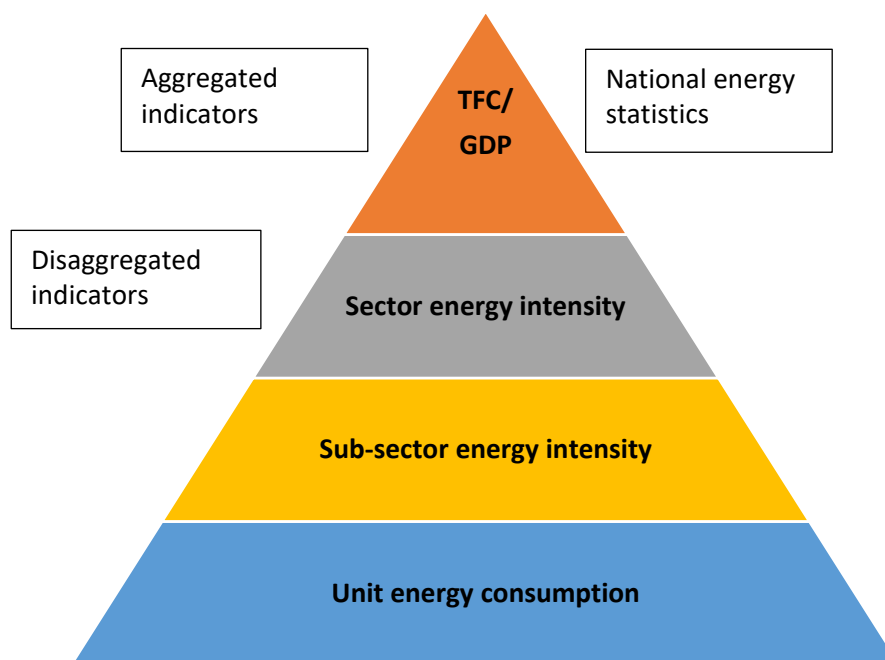
- 1) Establish a dedicated team to plan on data collection.
- 2) Collect, collate, analyse, and update data on a continuous and professional basis, adhering to the principles of non-disclosure practices.
- 3) Establish the EEIs by sector and sub-sector;
- 4) Liaise with and assist/guide the commercial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

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

### **4. Validation and Analysis of Energy Consumption Data**

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

**Figure 6.2: Overview of Energy Indicators Pyramid**



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

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

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

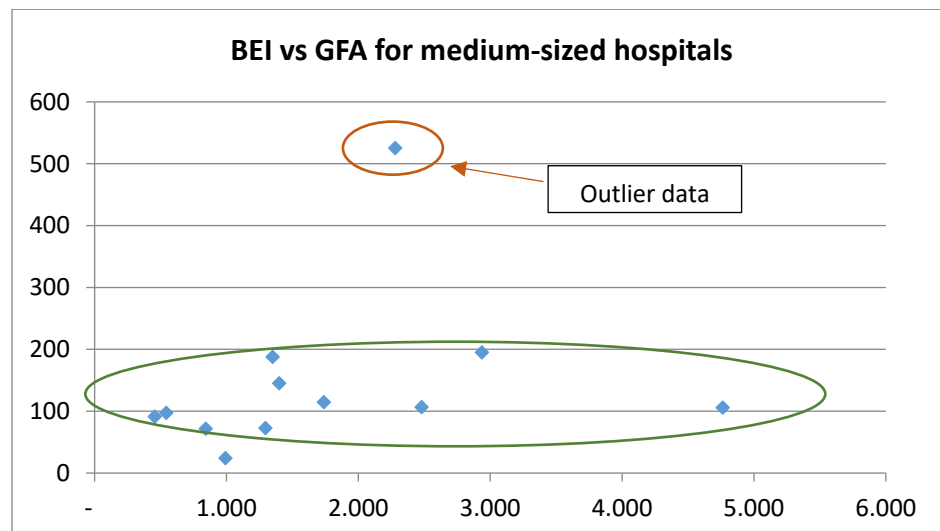
$$\text{Energy efficiency indicator} = \frac{\text{Energy consumption}}{\text{Activity data}}$$

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

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

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

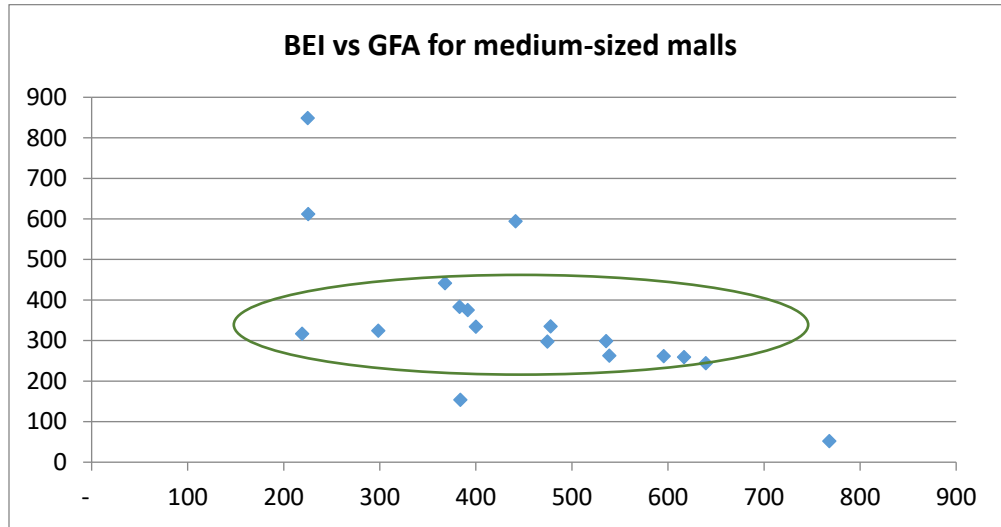
**Figure 6.3: Example on Validation of Data based on Analysis of BEI Values for Hospitals**



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

Source: Author's previous work with ERIA.

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



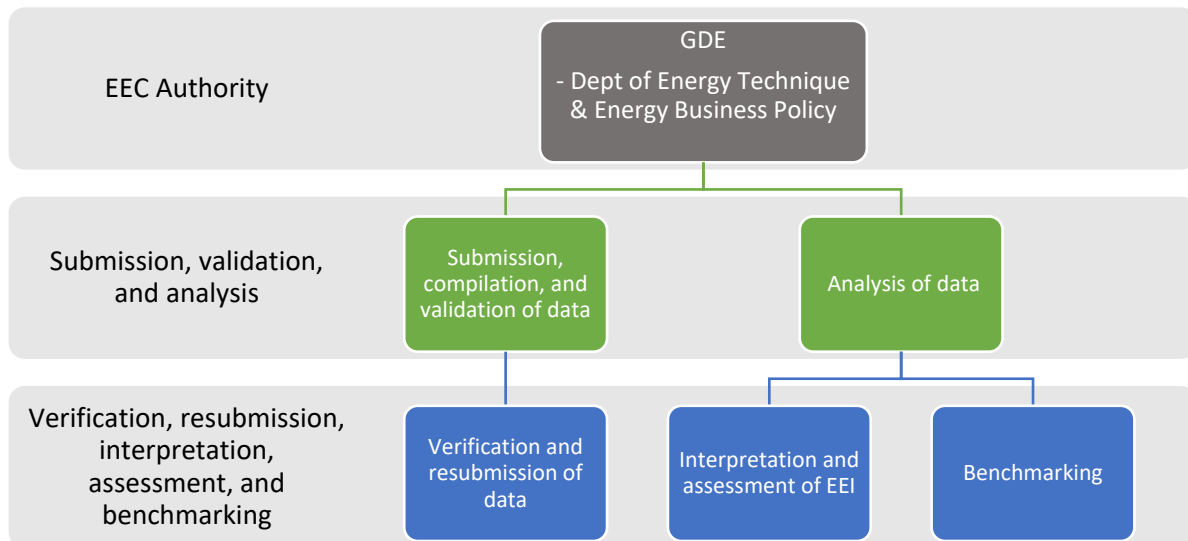
BEI = building energy intensity, GFA = gross floor area.

Source: Author's previous work with ERIA.

## 5. Establishment of EEIs

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

**Figure 6.5: Process of Data Collection and Establishment of EEIs**



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

Source: Author.



### 5.1. Commercial sector

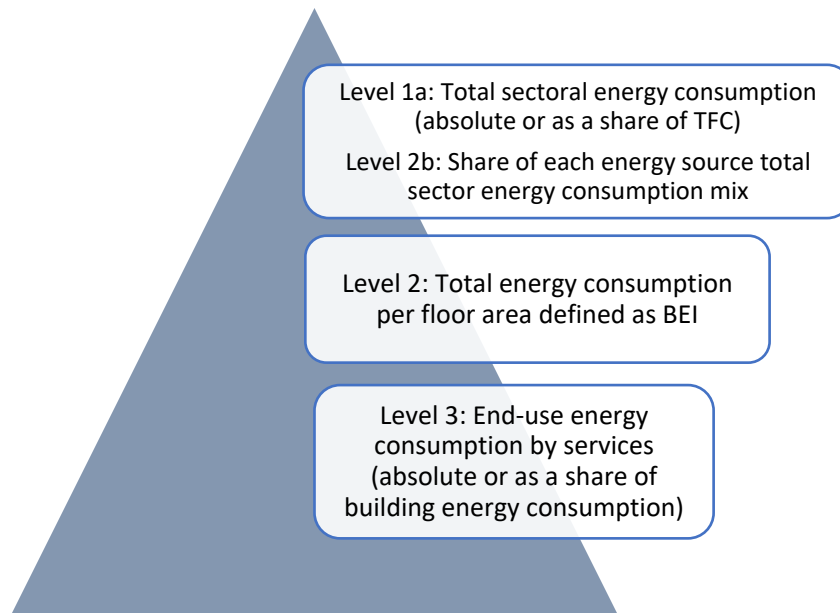
The EEIs in the commercial sector are intensities, which are defined as the ratio of yearly energy consumption (measured in energy unit, kWh) to gross floor area (measured in square metres). To differentiate this EEI from that of the industry sector, this ratio is referred to as building energy intensity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

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

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

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

**Figure 6.6: Pyramid of Commercial Sector Indicators**



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

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

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

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

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

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

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

<sup>a</sup> Suggested minimum BEI values given in Table 6.2 are based on Malaysia's Green Building Index entry level BEI values and are subject to further analyses and verification upon the establishment of EEIs in Cambodia.

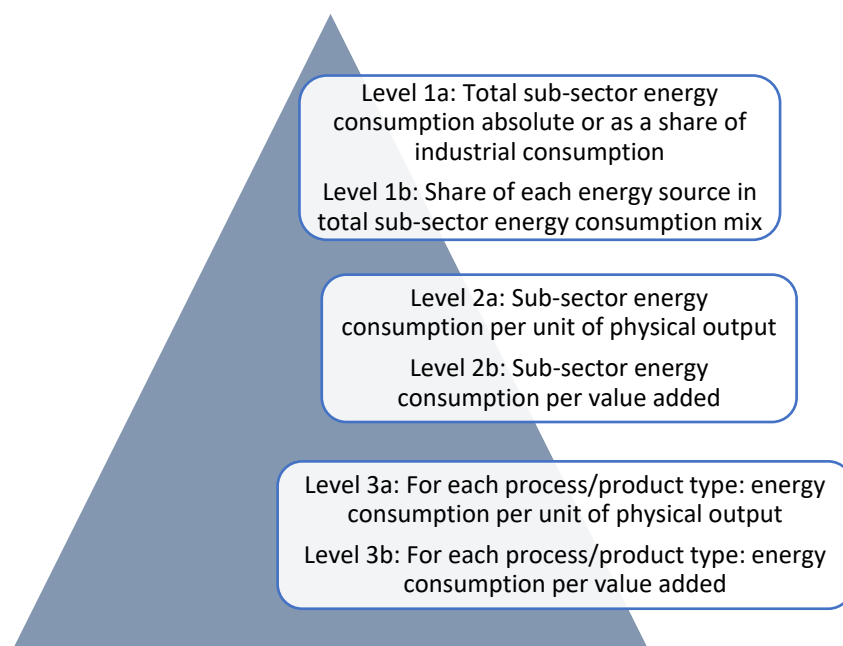
Source: Green Building Index, Malaysia, [www.greenbuildingindex.org](http://www.greenbuildingindex.org).

## **5.2. Industry sector**

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

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

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



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

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

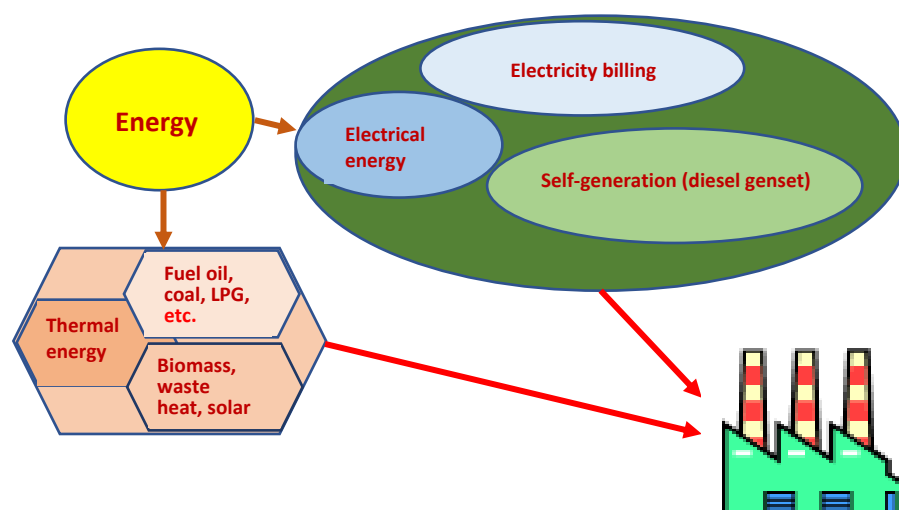
$$\text{Industrial subsector EEI} = \frac{\text{Yearly subsector energy consumption}}{\text{Yearly production output}}$$

Where:

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

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

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



Source: Author and Ir. Luk Chau Beng.

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

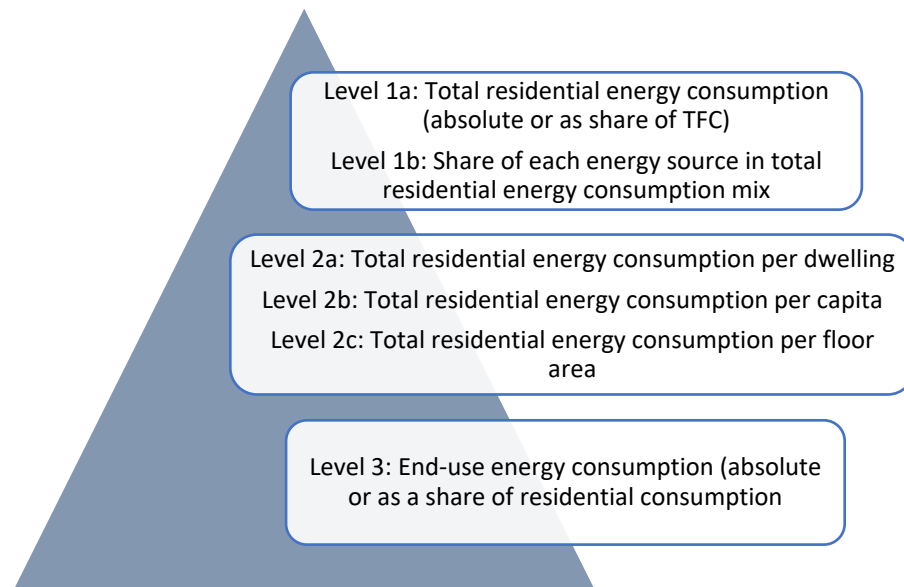
### 5.3. Residential sector

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

<sup>7</sup> Refer to ‘What does the industry sector mean and cover?’, IEA (2014a).

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

**Figure 6.9: Pyramid of Residential Sector Indicators**



TFC = total final consumption.

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

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

## **6. Publication of Energy Consumption Data at the National Level**

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

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

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

## **7. Road Map (2020–2025)**

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

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

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

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

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

**Table 6.3: Recommended Road Map for 2020–2025 Activities**

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

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

Source: Author.

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## Chapter 7

### Conclusions and Policy Recommendations

*Shigeru Kimura, Leong Siew Meng, Han Phoumin*

#### 1. Conclusions

Energy efficiency and conservation (EEC) will be significant in curbing the growth of energy demand and contribute to energy savings and security, whilst maintaining economic growth in the country and applying appropriate EEC policies. Cambodia is one of the fast-growing energy demand countries in ASEAN due to its robust economic growth since 1990s. Thus, an appropriate energy efficiency master plan will be needed in the country to encourage EEC investment and behavioural change of energy consumers under the EEC regulations, so-called the EEC Act. This master plan, based on a practical and effective approach, comprises six chapters summarised as follows:

Chapter 1 specifies the sub-decree or regulations on energy efficiency to lay out the legal and organisational framework for activities in the field of energy efficiency and aims to create conditions to reduce energy consumption. In this case, the sub-decree or regulation guide the Ministry of Mines and Energy (MME) and relevant agencies to develop a comprehensive policy and regulatory framework to achieve energy efficiency in all sectors. The EEC sub-decree or regulations aim to promote energy efficiency as part of country's sustainable development by developing and applying a system of activities and measures for (i) the improvement of energy efficiency at the end-use level, (ii) the introduction of schemes of obligations for energy savings, (iii) the development of the market of energy efficiency services and encouragement of provision of energy efficiency services, and (iv) the introduction of financial mechanisms and schemes supporting the fulfilment of the national objective of energy efficiency. Needless to say, the EEC sub-decree describing the legal framework is important for establishing energy service companies (ESCOs), developing energy managers, standards and labelling, education and campaigns, and preparation of EEIs, which are referred henceforth as the five EEC policies and programmes.

Chapter 2 explains the role of an ESCO, its scope of services, and its importance in the implementation of EEC in Cambodia. The two ESCO business models are presented in the chapter as well: shared saving energy performance contract (EPC) and guaranteed saving EPC. Specific contents with useful information are also provided for the following topics: (i) registration and licensing, (ii) financial Incentives, (iii) ESCO business model, and (iv) a case study for an EPC project in Malaysia. The road map to planning and implementing the establishment of ESCOs in Cambodia are also mentioned. ESCOs have a huge potential role in reducing the country's energy consumption and, therefore, greenhouse gas (GHG) emissions. They play a key role in addressing energy shortages and price increases.

Chapter 3 describes and addresses the needs, duties, and methodology in developing energy managers to support the implementation of EEC in Cambodia. The specific content of this chapter includes (i) the requirements, duties, and expectation of an energy manager; (ii) the formation of the CEM (certified

energy managers) advisory committee to drive the registration and licensing requirements of CEM – which are minimum qualifications, certification syllabus, certification process and registration, licensing and renewal; (iii) mandatory training and international support to kick-start the capacity development of energy managers and train local EEC experts as future local trainers; (iv) formation of an association of energy managers to create a strong working relationship between government regulators (the General Department of Energy [GDE]) and the designated premise owners, to develop members' welfare, and to continuously raise the standard of CEMs' competencies and skills to achieve EEC goals; (v) 5-year implementation road map for developing energy managers. CEMs are essential and responsible to effectively and efficiently manage energy in designated premises to ensure that energy use is fully optimised. Proper selection of suitable personnel who have influence and are accepted by both management and colleagues and have further qualifications with EEC skills and knowledge through training, certification, and continuous development are the key attributes towards successful implementation of EEC management programmes.

Chapter 4 explains the electrical equipment use in promoting energy efficiency by achieving a minimum energy performance standards (MEPS) that, in turn, will reduce the overall power consumption of the said premises, especially households. With MEPS in place, an energy labelling system shall be used, and registration of the equipment shall be done based on the labelling categories. Specific contents are also provided for the following topics: (i) identification of relevant institutions, (ii) selection of targeted appliances, (iii) testing bodies, and (iv) registration of MEPS and energy labelling. The road map to roll out the various stages of the MEPS requirements and energy labelling is also mentioned.

Chapter 5 discusses various communication and promotional methods for education and campaigns through public and professional forums, media campaigns like printed media with practical EEC information, websites and TV broadcast, home energy reporting, school system, and publicity campaigns through national awards. Specific contents with useful and practical information are also provided for the following topics: (i) school syllabus, (ii) media campaigns, (iii) pamphlets for EEC promotion, and (iv) home energy report. A road map to roll out various education and campaign activities in phases is also discussed. In general, the successful planning and implementation of education and promotion campaign activities will require both technical input and committed government support.

Chapter 6 explains the concept of establishing energy efficiency indicators (EEIs), which requires the collection of quality energy and activity data from designated premises in the commercial and industry sectors. Regulatory requirements and designated premises for the commercial and industry sectors are explained. Although the definition of designated premises has been suggested to be based on 3,000,000 kWh/year (or 10 mil MJ/year), further deliberation and review should be made to establish an acceptable threshold value. This value will affect the number of commercial buildings and industrial premises that will be required to submit energy management reports with relevant energy consumption and activity data. The chapter also defines the EEIs for the commercial, residential, and industry sectors, with methodologies including validation and analyses that are based on the concept of energy efficiency indicators pyramid of the International Energy Agency (IEA). The establishment of EEIs is focused on developing sub-sector energy intensity. The importance of developing the EEIs and subsequently benchmark values for each industrial sub-sector, commercial building sub-sector, and each household per

area or district basis has been highlighted. The EEs and benchmark values for the respective sub-sectors will prove to be particularly important and useful for policymakers and the GDE. Publication of energy consumption data nationwide and a road map to roll out phased activities are discussed in this chapter.

Appendix A discusses the case study on the review of energy saving potential in the existing chiller system of a 250-room hotel. This case study demonstrates a method of reviewing and analysing the electricity consumption of the existing chiller system after conducting a walk-through audit and obtaining relevant energy consumption data. The case study was able to identify and analyse the saving potential in chiller replacement with a new and high efficiency chiller and auxiliary equipment. The case study shows reasonable return on investment. More importantly, it provides a useful example of how a walk-through audit can generate useful information and findings on the potential benefits of EEC applications.

## **2. Recommendations**

The GDE will be a key player in promoting EEC in Cambodia. Thus, improvement of the EEC department under the GDE will be a top priority, such as allocating more human and financial resources under the EEC sub-decree. The EEC department of the GDE should work on and prioritise the five EEC policies and programmes mentioned above.

The GDE should start the education and campaign programme by firstly collaborating with Cambodian energy managers. The purpose of the programme is to make Cambodians aware of the EEC; in other words, instilling the EEC in the people's mind through media campaigns. The programme will request Cambodians to apply simple EEC measures – such as frequent switching off of appliances, minimising standby power, reducing the leaking of cool air, installing simple shading devices in buildings, etc. The programme will target reducing waste in electricity consumption in the industry, commercial, and residential sectors. As a second step, the GDE will introduce EEC education in schools and in communities through the school syllabus and EEC leaflets, respectively.

The GDE is also reminded to develop many local energy managers quickly through domestic and/or EEC lecture courses to the candidates. The GDE shall certify and issue the EEC licence to the candidates who qualified in domestic and foreign examinations on EEC. Developing energy managers will surely contribute to the increase in opportunities for energy audits to measure energy consumption in industries and buildings. These audits will help realise the energy saving potential in Cambodia.

The GDE should invite ESCOs, including foreign ESCOs such as from Malaysia and Thailand, to Cambodia's energy market quickly because they will be the key players in conducting EEC consultations to factories and commercial buildings through expedited programmes, such as energy audits. The GDE, in collaboration with the Ministry of Industry and Handicraft, will license the candidates of ESCOs in Cambodia, who send their application forms to the GDE. The country's energy sector is attractive for ESCOs because energy prices are relatively higher than in neighbouring countries due to the absence of energy subsidies. However, the GDE will initially support ESCOs to give them business opportunities through the conduct of energy audits in government buildings.

Standard and labelling (S&L) system is an important EEC policy for the GDE. However, realising this system will take time because the GDE will surely facilitate a testing lab in Cambodia. The department will also establish MEPS for each electricity-intensive appliance such as air conditioner, refrigerator, microwave oven, etc. But linking the S&L system with education and campaign will significantly contribute to saving energy across the sectors, especially in the residential sector. The GDE must start preparing the S&L system to focus on its institutional recognition aspects.

The EEIs are especially useful in measuring the effectiveness of energy use and energy saving amounts achieved through the implementation of EEC policies and programmes. But the EEIs are determined, based on analyses of energy end-use consumption surveys or data collected from the industry and commercial sectors, after approval of an EEC sub-decree or the EEC Act. For example, the GDE will first designate factories and commercial buildings for the survey and collect detailed energy consumption data from the designated entities. This is to determine the EEIs of factories, defined as energy consumption divided by production and EEIs of buildings as energy consumption divided by floor area. The GDE must start preparing the survey or data collection by selecting factories and buildings to be designated, designing the questionnaire, etc.

## Annex

### Case Study: Potential Energy Savings of a Hotel's Chilled-water Air-conditioning System

*Leong Siew Meng and Lee Yuen How*

A case study was carried out at a hotel in Phnom Penh to review and investigate whether its chilled-water air-conditioning system has energy saving potential. In view of the non-disclosure agreement with the hotel, this report on the findings will not reveal the name of the hotel, which had contributed useful information for this study. Nevertheless, we acknowledge with appreciation the hotel management's cooperation in granting permission to visit the air-conditioning facilities and in making energy consumption records available.

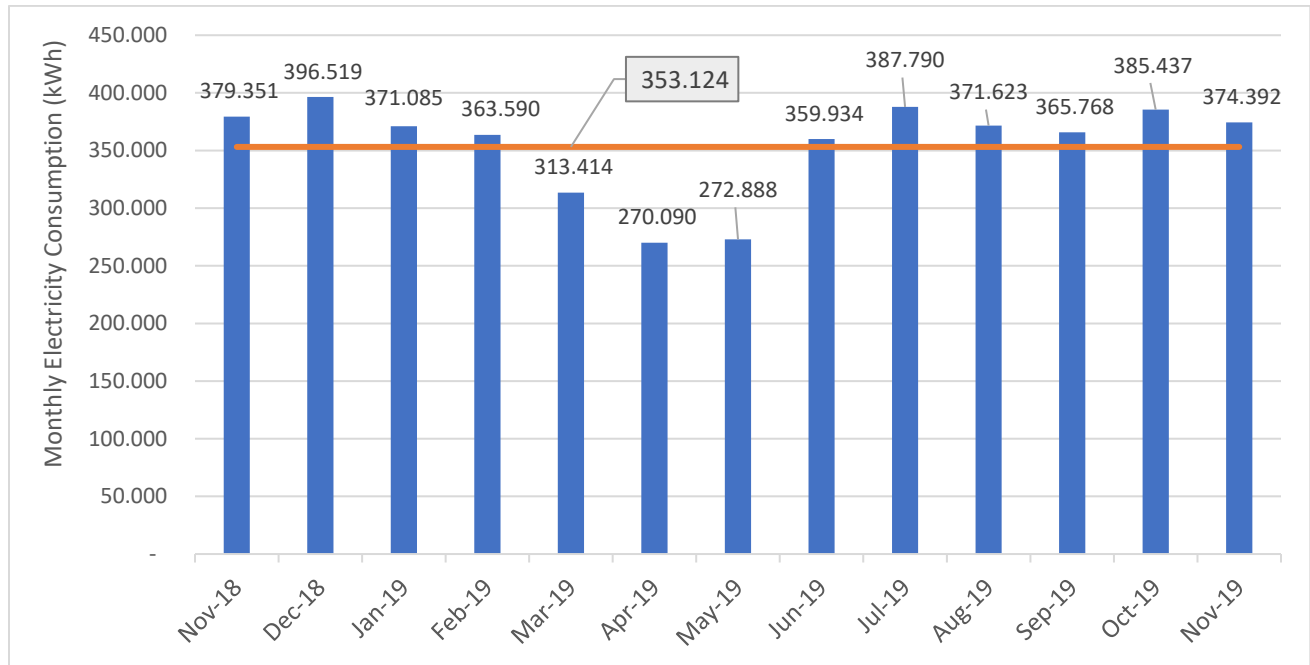
This case study aims to explore any energy saving potential in an existing chilled-water system that has operated for more than 20 years. In view of improved and energy-efficient chillers available in the market, the case study would focus on making a preliminary assessment of the chiller operation. Hotels, operating for 24 hours, would likely have energy saving potential. How this case study was conducted is equivalent to a walk-through audit without any measurement taken; only basic information was obtained. The hotel has 250 rooms, and the technical information obtained is summarised as follows:

- Chillers installed:
  - 2 units of 1,000 refrigerator tons (RT) centrifugal chillers
  - 1 unit of 400 RT screw compressor chiller
- Monthly electricity consumption data is presented in Figure A1.
- Electricity tariff is US\$0.16/kWh

The monthly electricity consumption of the hotel's air-conditioning system from November 2018 to October 2019 was consistent, except for March to May in 2019 (Figure A1). April and May 2019 recorded a dip in electricity consumption. This was because of electricity rationing during these 2 months, which was due to the extremely dry weather that time. Supply of electricity was restricted during this period. The hotel had to generate its own electricity using diesel generator sets during the power outage. The monthly electricity consumption shown in Figure A1 did not include the self-generated electricity because the power generated was to cater mainly to lighting and essential services. The air-conditioning service had to be shut down for a brief period in 2019 during the staggered power rationing arrangement per day. The air-conditioning service was turned on again after the electricity supply was restored during the day. Although the highest consumption per month was recorded in December 2018 (Figure A1), the highest average daily consumption occurred in February 2019 (Figure A2). This was due to the shorter

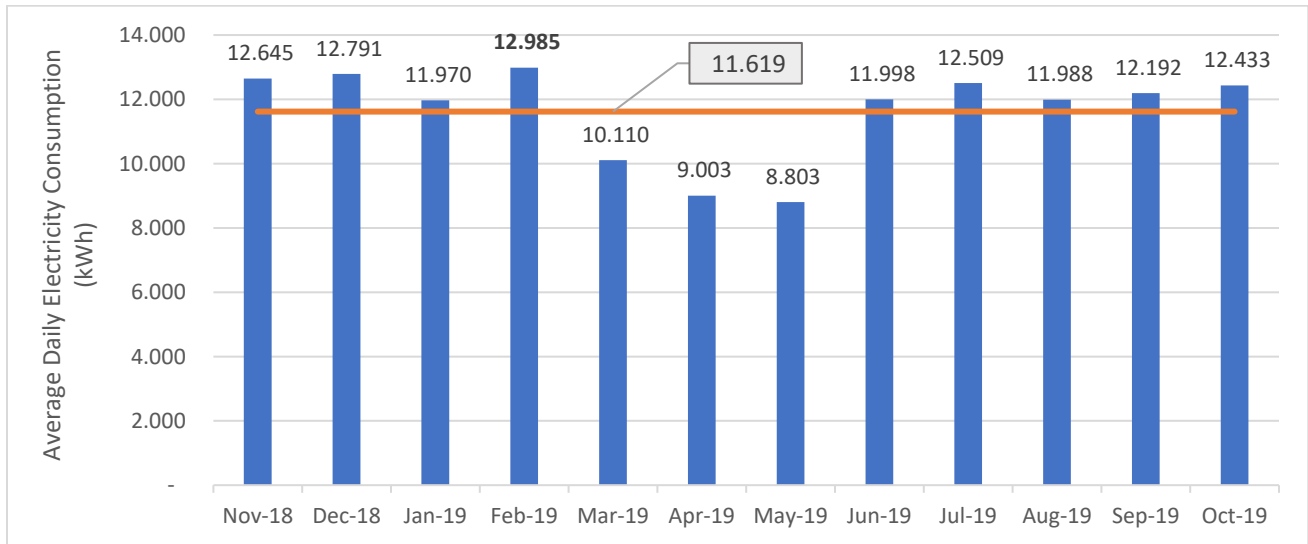
month of February, hence, the highest average daily consumption of 12,985 kW/day. This highest average daily consumption was used to estimate the average daily chilled-water generation load in terms of refrigeration ton and the daily chiller load profile on a worst-case basis.

**Figure A1: Monthly Electricity Consumption (2018–2019)**



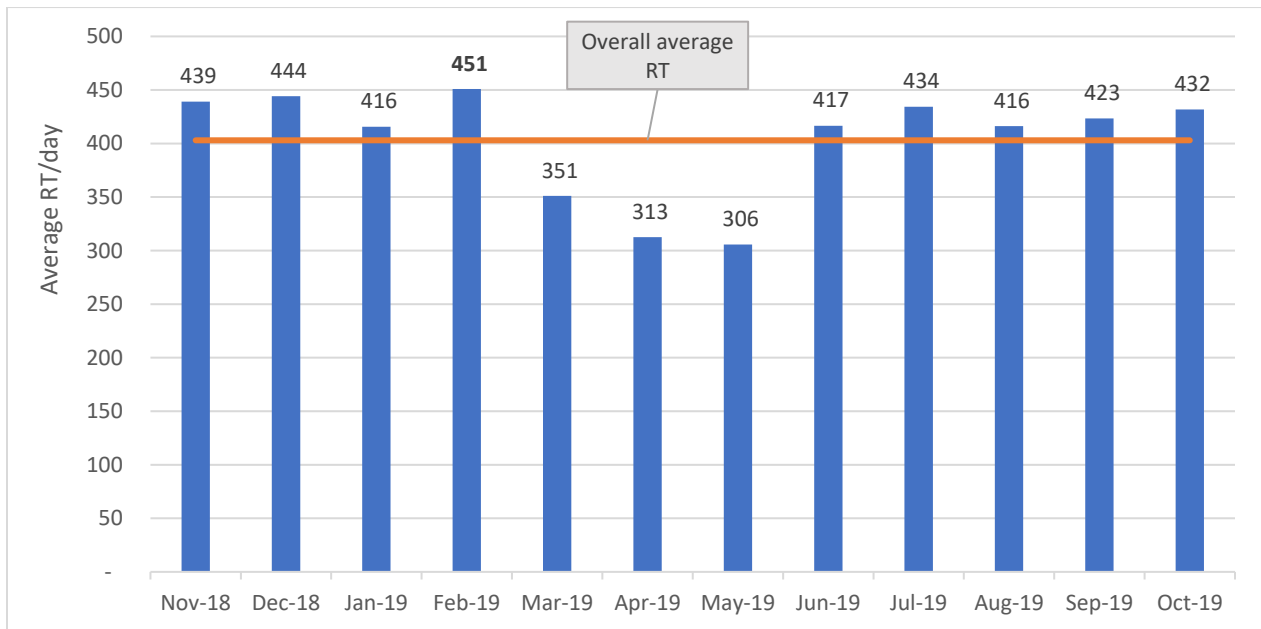
Source: Author, based on the monthly electricity bills provided by the hotel.

**Figure A2: Average Daily Electricity Consumption (2018–2019)**



Source: Author, computed from the monthly electricity consumption provided by the hotel.

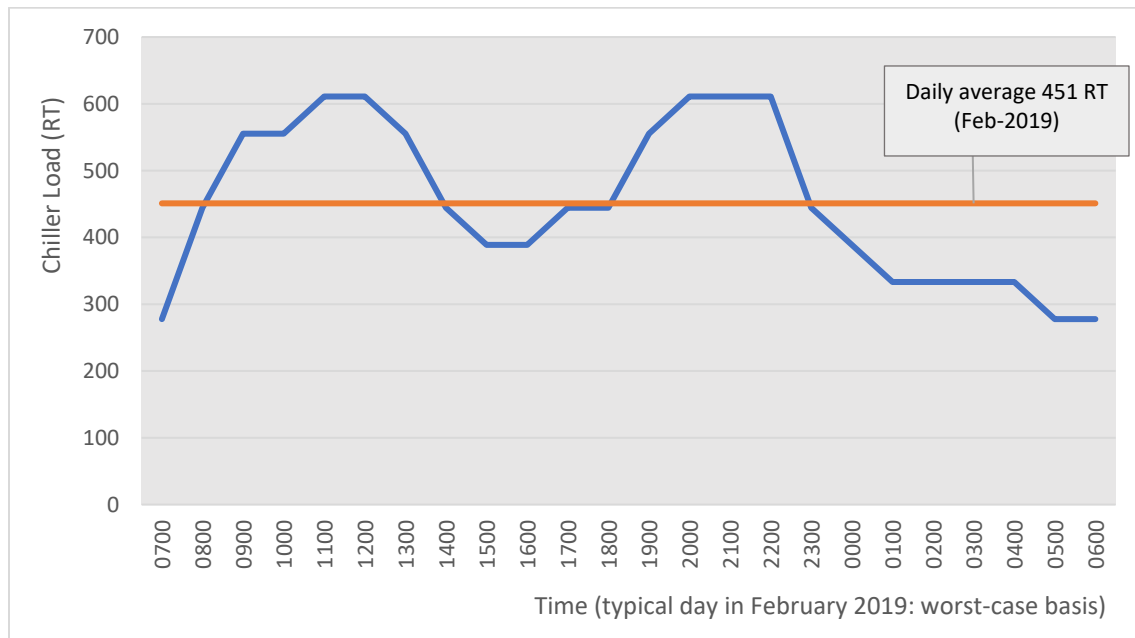
**Figure A3: Average Daily Chilled-water Generation in RT (2018–2019)**



RT = refrigerator ton.

Source: Author, estimated from the highest daily electricity consumption of 12,985 kWh that occurred in February 2019, as shown in Figure A2.

**Figure A4: Estimated Daily Chiller Load Profile Derived from Chilled-water Generation (in RT)<sup>1</sup>**



RT = refrigerator ton.

Source: Author, based on the highest daily electricity consumption in Figure A3 on worst-case basis.

Average daily electricity consumption for each month was computed and is shown in Figure A2. Based on the daily electricity consumption, it is possible to estimate the daily chilled-water generation requirement in terms of refrigerant tons (Figure A3). For estimation purposes, the average system efficiency was assumed to be 1.2 kW/RT (based on industry experience for old water-cooled system and discussion with hotel staff). The average daily chilled-water generation capacities in terms of refrigeration tons were estimated (based on system efficiency of 1.2 kW/RT) (Figure A3). The highest daily average chiller load was 451 RT, which occurred in February 2019 (Figure A3).

Based on the worst-case scenario of 451 RT that occurred in February 2019 (for highest cooling load demand situation), an estimated daily load profile was computed as illustrated in Figure A4. For a detailed study, the proper method is to conduct an energy audit, which would include data logging of a full-day operation of the chiller/s. The purpose of a load profile is to assess the daily cooling load requirements and determine the peak load demand for more accurate chiller selection. Figure A4 shows that the cooling load fluctuates during the daily operation of chillers. The peak load is expected to reach about 610 RT, which usually occurs in mornings and evenings, as described by the hotel operations staff. During the morning and evening operation, it would be necessary to operate the 1,000 RT chiller.

Based on the estimated peak load, a new chiller is selected to compare and evaluate a chiller replacement, in order to examine whether there is any potential to save energy. With this in mind, the following new

<sup>1</sup> Figure A4 is not based on measured hourly loads but an estimated load profile, which was based on the highest estimated daily average chiller load of 451 RT that occurred in February 2019 as shown in Figure A3.



chiller configuration is identified and is used as a basis for comparing with the performance of the existing system:

Proposed new chiller system configuration:

- a) New chiller: Daikin magnetic 550 RT chiller  
Chiller efficiency: 0.575 kW/RT, power input of 316 kW, rated at chilled water 54/44°F, condenser water 87/97°F
- b) Existing chiller: 1 x 400 RT screw compressor chiller  
1 x 1,000 RT centrifugal chiller (optional to retain one unit of existing 1,000 RT chiller, which would become redundant, but hotel operation expressed preference to retain one unit for operation on rotation basis.
- c) Retrofitting of new cooling towers, piping, AHUs and FCUs to be installed.
- d) Estimated cost of chiller: US\$380,000
- e) Estimated retrofitting work: US\$700,000
- f) Estimated design and supervision fee: US\$170,000

This new chiller configuration is expected to efficiently generate chilled water for the hotel's air-conditioning requirements. For estimation and comparison purposes, the hotel's air-conditioning requirements are estimated using industrial practice (rule-of-thumb method) of 2.0 RT maximum cooling load per hotel room, which is estimated slightly on the high side for a 4-star hotel. For proper assessment, the engineering designer's method of evaluating the hotel cooling load requirements – based on the physical dimensions, building orientation, hotel rooms configuration and construction, facilities and amenities – would need to be carried out to compute for more accurate total cooling load requirements. However, for the purpose of this case study, the following are estimated:

- 1) Estimated daily maximum cooling load:  $250 \times 2 = 500 \text{ RT}$
- 2) Estimated average daily cooling load requirement:  $500 \times \frac{451}{610} = 370 \text{ RT} *$

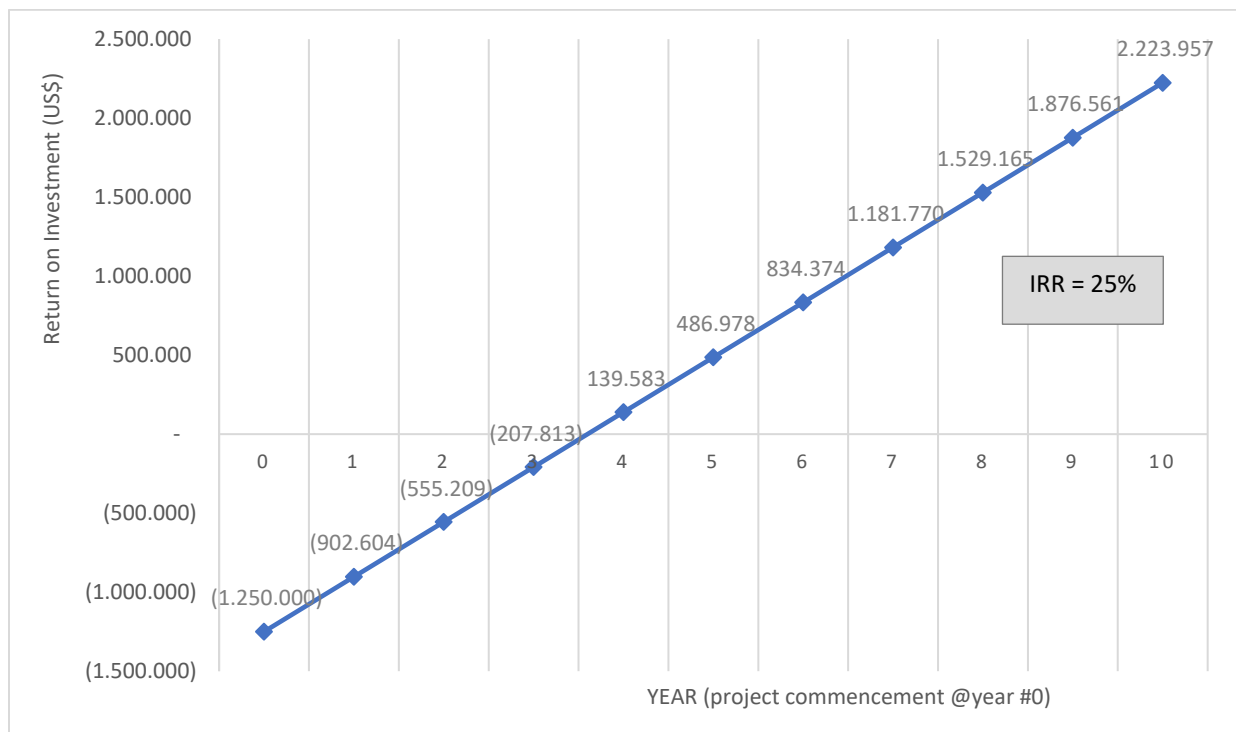
Note: \* The ratio of 440:600 was taken from Figure A4 to compute the average daily cooling load, based on the estimated peak load of 500 RT

- 3) Assuming a system efficiency at 0.75 kW/RT, the estimated daily chiller plant electricity consumption:  $370 \text{ RT} \times 0.75 \text{ kW/RT} \times 24 = 6,660 \text{ kWh}$
- 4) Assuming hotel occupancy rate of 85% (for conservative estimates), estimated new yearly electricity consumption:  $6,660 \times 365 \times 0.85 = 2,066,265 \text{ kWh}$
- 5) Estimated cost of new electricity cost:  $2,066,265 \times \text{US\$}0.16 = \text{US\$}330,602/\text{y}$

The above estimated electricity consumption of the proposed system is compared with the existing records of electricity consumption as follows:

- 1) Based on the records of total electricity consumption from November 2018 to October 2019:  
4,237,489 kWh/y
- 2) Estimated electricity cost of existing operation:  $4,237,489 \times \text{US\$}0.16 = \text{US\$}677,998/\text{y}$
- 3) Estimated electricity saving:  $4,237,489 - 2,066,265 = 2,171,224 \text{ kWh/y}$
- 4) Estimated electricity cost savings:  $\text{US\$}677,998 - \text{US\$}330,602 = \text{US\$}347,396$
- 5) Estimated cost of new chiller, retrofitting and design/supervision work:  
 $380,000 + 700,000 + 170,000 = \text{US\$}1,250,000$
- 6) Estimated simple payback period:  $\frac{1,250,000}{347,396} = 3.6 \text{ years}$

**Figure A5: Cash Flow for Case Study**



IRR = internal rate of return.

Source: Shigeru Kimura and Leong Siew-Meng.

Based on the estimated yearly electricity savings and estimated investment costs, the cash flow and internal rate of return (IRR) were computed (Figure A5). The IRR is estimated to be 25% and the breakeven would occur in the fourth year after project commencement. The cumulative savings in the tenth year of

operation is expected to be about US\$2.224 million. Based on the above, the case study shows that the proposed replacement of old chillers and auxiliary equipment appears to be a viable project. The above assessment was based on the following assumptions:

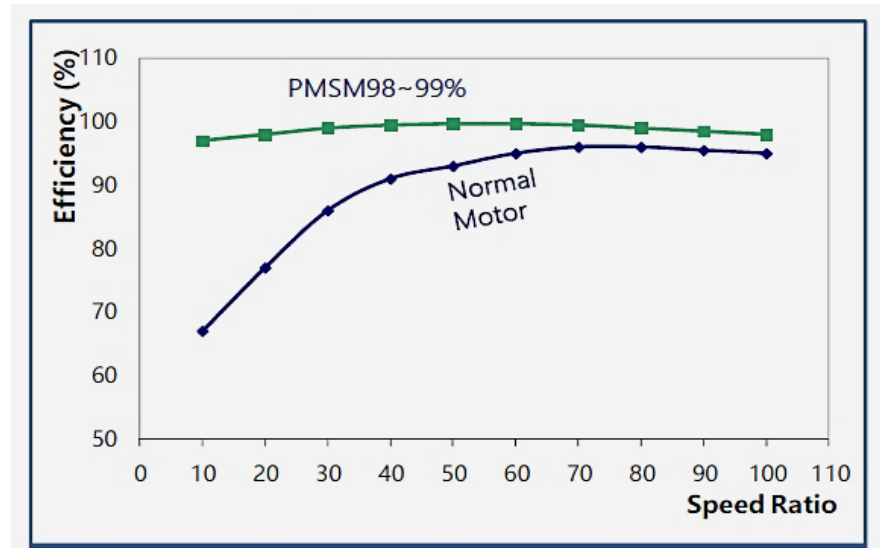
- a) Hotel occupancy rates remain the same every year throughout the period of IRR analysis as that of the study period (i.e. November 2018 to October 2019).
- b) The estimation of the new electricity consumption was based on 85% hotel occupancy rate.
- c) The electricity tariff remains constant at US\$0.16 throughout the period of IRR analysis.

However, the above computation did not consider the following (in addition to previously mentioned exclusions):

**1) Operations and maintenance costs**

- Such costs are assumed to be about the same between the old and new systems, although the manufacturer claims that the maintenance cost of magnetic chillers is lesser due to its state-of-the-art magnetic bearing with oil-free technology and, hence, no requirement for oil change, associated shutdown, and savings incurred on oil accessories compared with conventional chillers.
- The magnetic chiller is expected to provide higher operational savings as it can retain high energy efficiency on part-load operation, compared with lower energy performance at part-load operation for old and conventional chillers (as illustrated in Figure A6). Higher chiller efficiency would yield greater energy savings. Chillers that are highly energy efficient at part-load would suit hotel operations in view of the cooling load fluctuations due to seasonal demands and the fluctuating daily cooling loads. Therefore, the chillers are expected to operate on part-load conditions.

**Figure A6: Comparison of Energy Performance of Chillers at Part-load and Full-load Operations between Magnetic Chillers and Conventional Chillers**



Source: Daikin Applied (Malaysia) Sdn Bhd.

- Consequential operational loss was not considered in the above cash flow and IRR analysis.

## 2) Costs of demolition work due to unforeseen site conditions

- The cost of retrofitting work was only an estimation but the extent of demolition work requirements and constraints at the existing site would require thorough investigations and site survey. The estimated cost of retrofitting work does not include interior design work.
- However, some of the costs may be defrayed by possible resale value of the existing chiller/s subject to the hotel's decision whether to retain any existing chiller.

## Summary of Case Study

Despite some limitations of this case study, there are some interesting findings summarised as follows:

- 1) Through a walk-through audit and available energy consumption and other basic data, energy saving potential can be identified and quantified.
- 2) This case study demonstrates a method to make a preliminary analysis of energy savings and indicative project viability.
- 3) Chiller replacement of old units can offer potential energy savings and reasonable return on investment.

- 4) Walk-through audit can generate useful information and directions for more detailed studies. Energy audit is necessary to determine a project's viability for investment decisions.
- 5) This case study shows that EEC case studies or demonstration projects can showcase the benefits of EEC measures.

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