

CHAPTER 4

ENERGY EFFICIENCY AND CONSERVATION

4.1 Introduction

Energy is fundamental to a nation's economic development and progress, and it is needed for industry, commercial, and residential activities besides transportation. Therefore, energy security is critical to any nation. Energy efficiency (EE) as discussed in this chapter includes energy efficiency and conservation (EEC). EE may not be attractive as it is not straightforward, and achieving it may involve a combination of measures and technical and financial understanding. It may also involve developing an effective plan for the efficient utilisation of energy. Nevertheless, according to a report by the International Energy Agency (IEA, 2018), it is becomingly increasingly clear that EE can bring many significant economic and environmental benefits.

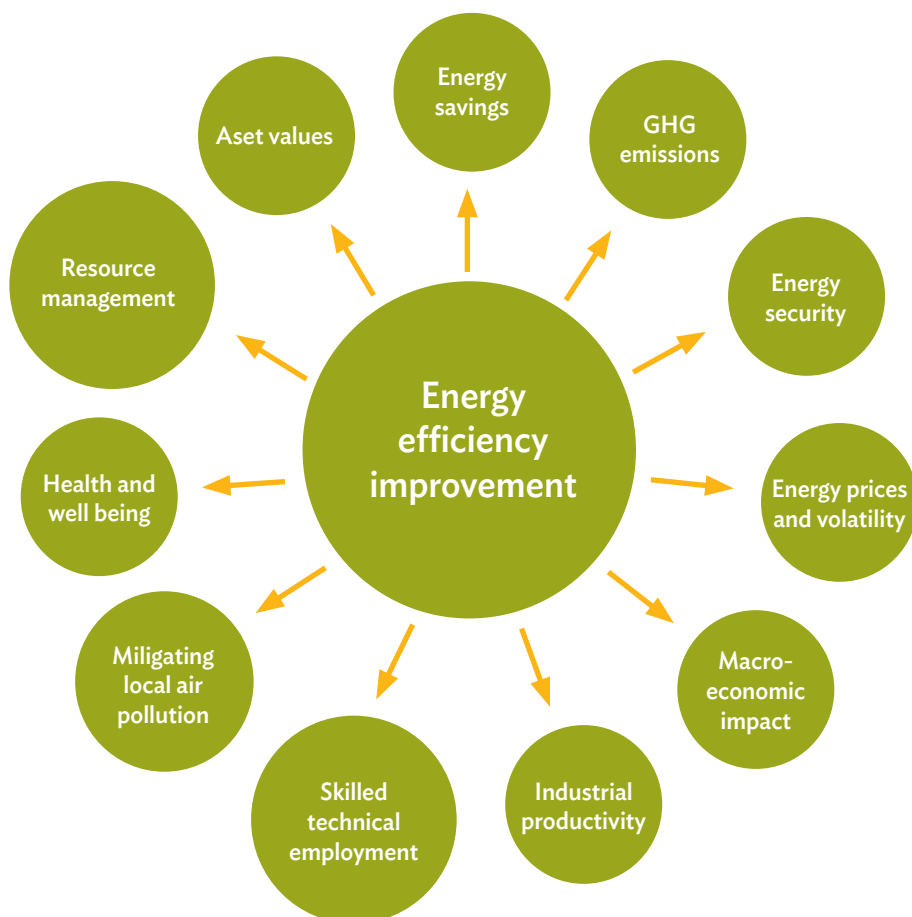
The energy savings brought about by EE improvement strategies can yield a range of benefits. The benefits of holistic and effective EE plans can be summarised as follows:

- (1) Efficient utilisation of energy will improve the self-sufficiency of the energy supply and, hence, energy security.
- (2) Efficient utilisation of electricity will delay the planting up of power plants and, hence, reduce the financing burden on the nation and improve the energy economics.
- (3) Government policies and energy plans on energy EE will help business organisations improve their energy performance, thus reducing both energy consumption and costs, which can translate into improved productivity, eventually resulting in improved national energy intensity.

- (4) Efficient utilisation of energy will help improve the availability of electricity as the available power supply capacities can reach out to a greater proportion of the population. In addition, savings in electricity can delay the planting up of new power plants, which can translate into savings in the financing costs of investments for new power plants.
- (5) An overall reduction in national energy intensity will make positive contributions toward reducing the depletion of energy resources and mitigating the effects of energy use, such as reductions in greenhouse gas (GHG) emissions and global warming.

According to the IEA, EE is ‘the first fuel’. Strong EE policies are vital for achieving the key energy-policy goals of reducing energy bills, addressing climate change, improving energy security, and increasing energy access. Figure 4.1 shows a summary of the multiple benefits of energy efficiency.

Figure 4.1 The Multiple Benefits of Energy Efficiency

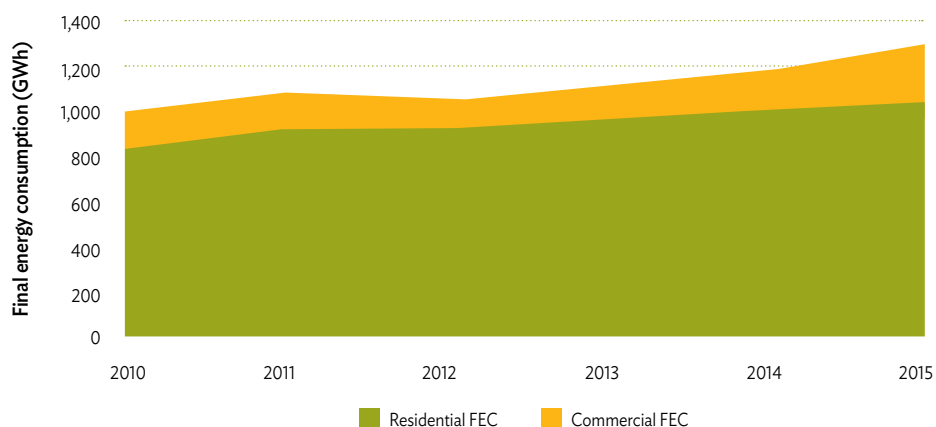


Source: Adapted from IEA (2017).

4.2 Review of the current situation

Based on the historical data from 2010 to 2015, as reported by ERIA (2016), energy consumption in Cambodia has been increasing, as illustrated in Figures 4.2, 4.3, 4.4, and 4.5. The demand for electricity by the residential, commercial, and industry sectors has seen a steeper rise in consumption compared with the overall final energy consumption by all sectors. Figure 4.5 shows that electricity consumption by the residential, commercial, industry, and other sectors in 2015 was more than 2.3 times the demand in 2010.

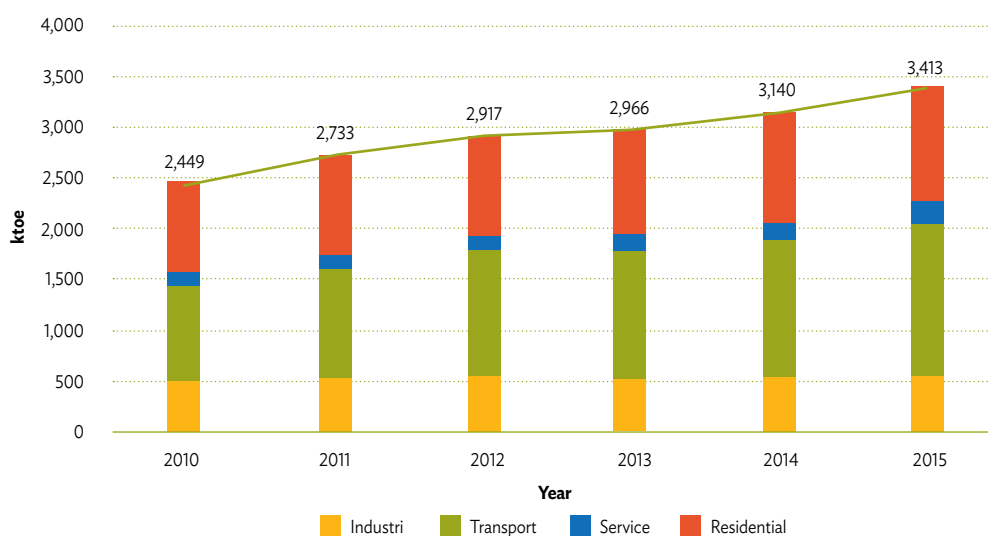
Figure 4.2 Historical Final Energy Consumption by Commercial and Residential Sectors



FEC = final energy consumption, ktoe = kilotonnes of oil equivalent.

Source: Author's calculations; ERIA (2016).

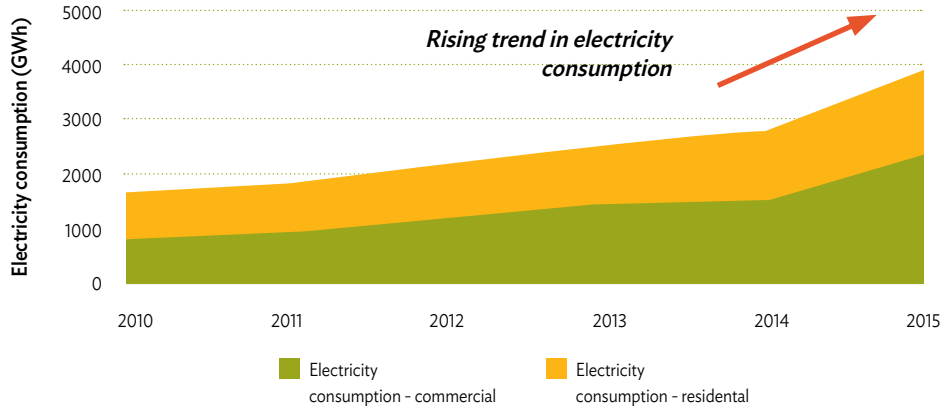
Figure 4.3 Historical Final Energy Consumption by All Sectors in Cambodia



ktoe = kilotonnes of oil equivalent.

Source: ERIA (2016).

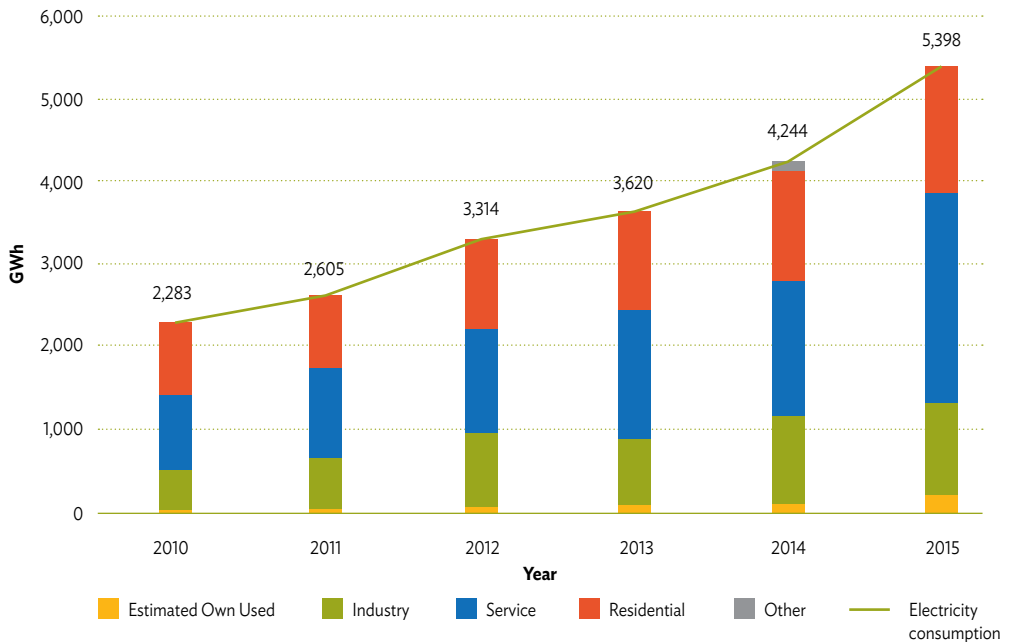
Figure 4.4 Historical Electricity Consumption by the Commercial and Residential Sectors



GWh = gigawatt hours.

Source: Author's calculations; ERIA (2016).

Figure 4.5 Historical Electricity Consumption by the Residential, Commercial, Industry, and Other Sectors

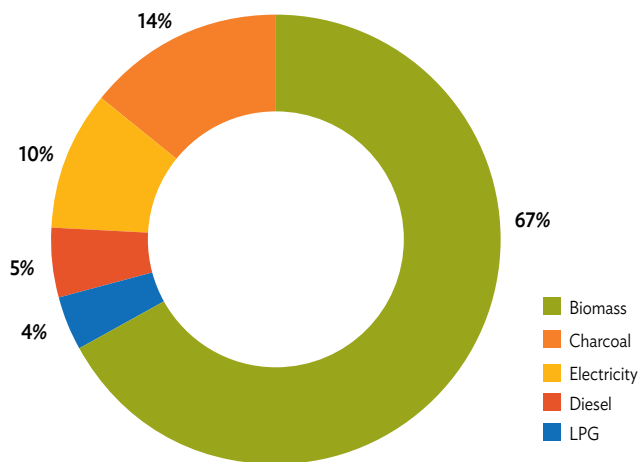


GWh = gigawatt hours.

Source: ERIA (2016).

Figure 4.6 shows the percentage shares of energy sources for the residential, commercial, and industry sectors. However, based on the current trend in energy demand, it is expected that the share of electricity as an energy source will increase, as illustrated in Figure 4.7. The share of electricity demand in 2030 is projected to increase to about 27% from 10% in 2015 under the business-as-usual (BAU) scenario.

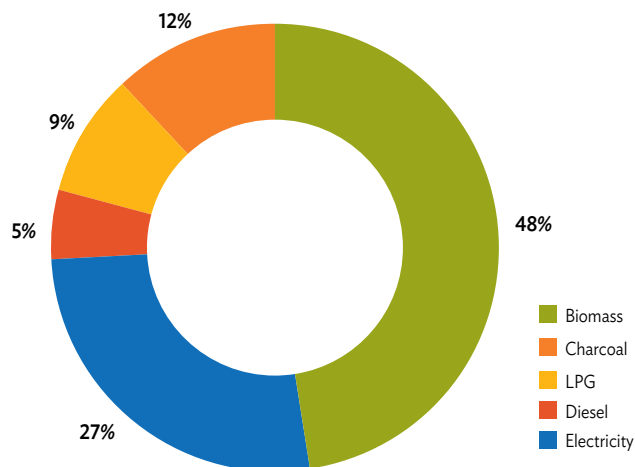
Figure 4.6 Percentage Shares of Energy Sources for the Residential, Commercial, and Industry Sectors in 2015



LPG = liquefied petroleum gas.

Source: Author's calculations based on the Energy Balance Table of Cambodia, 2018.

Figure 4.7 Projected Percentage Shares of Energy Sources for the Residential, Commercial, and Industry Sectors in 2030 Under the BAU Scenario



BAU = business as usual, LPG = liquefied petroleum gas.

Source: Author's calculations based on Energy Balance Table of Cambodia, 2018.

4.3 Review of energy demand trends

4.3.1 Residential sector

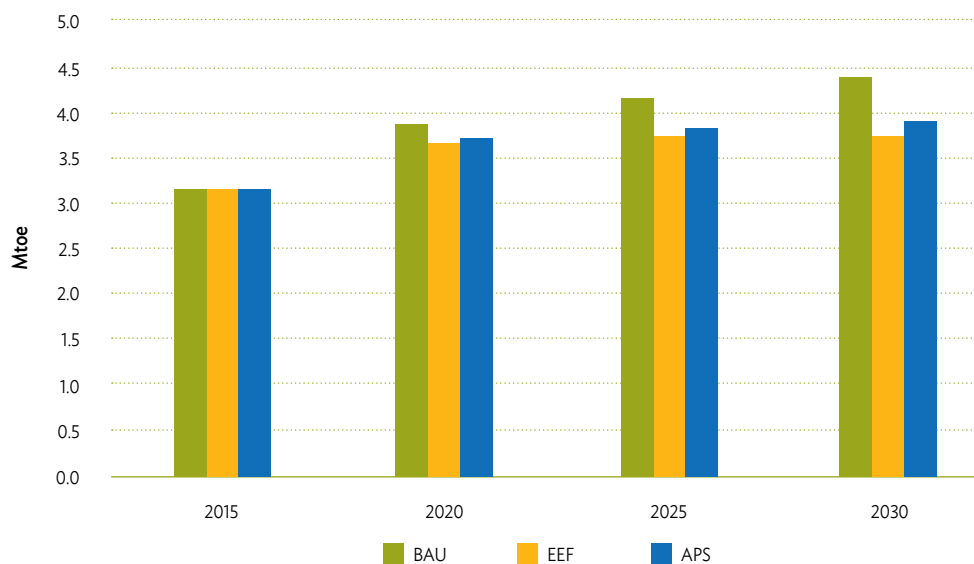
The residential sector consumes much more energy than the commercial and industry sectors, at about 73% of the total energy consumption by these three sectors (residential, commercial, and industry) in 2015. As shown in Figure 4.8, biomass was the main source of energy that catered for the residential sector in 2015, at about 87%. Electricity was next at about 7%, while oil products catered to the remaining demand at 6%. Energy demand for the residential sector is projected to increase. As shown in Figures 4.8 and 4.9, the energy demand by the residential sector by 2030 is projected under the BAU scenario to reach 4.39 Mtoe with an annual average growth rate of 2.3%. Under the alternative policy scenario (APS), the energy demand by 2030 is projected to be 3.9 Mtoe with an annual average growth rate of 1.5%. Under the energy efficiency framework (EEF) scenario, the energy demand by 2030 is projected to be 3.73 Mtoe at an annual average growth rate of 1.2%.

Figure 4.8 Historical and Projected Energy Demand and Energy Sources for the Residential Sector



APS = alternative policy scenario, BAU = business as usual, EEF = energy efficiency framework, Mtoe = million tonnes of oil equivalent.
Source: Cecilya Malik, EBT Cambodia 2018, ERIA.

Figure 4.9 Historical and Projected Energy Demand for Residential Sector Under the BAU, EEF, and APS



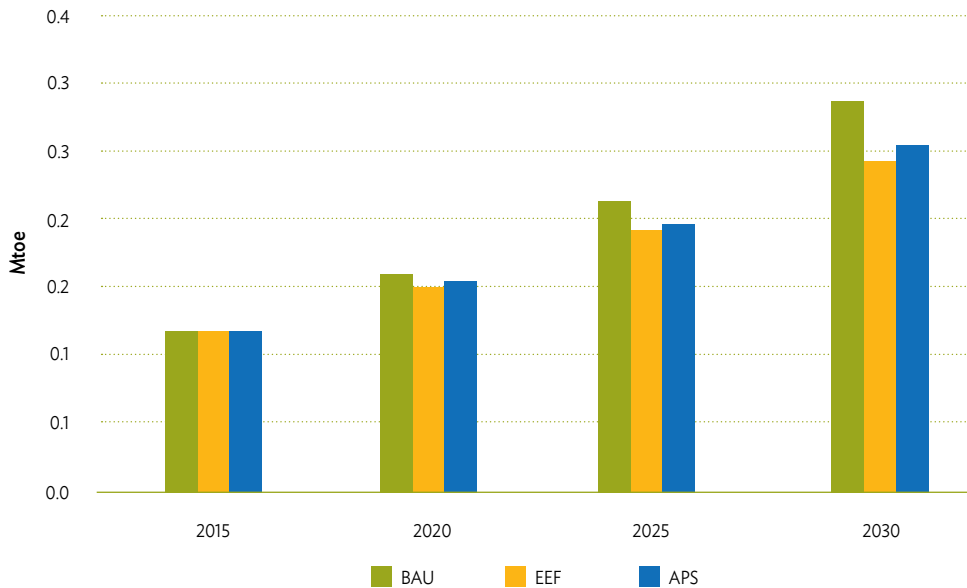
APS = alternative policy scenario, BAU = business as usual, EEF = energy efficiency framework, Mtoe = million tonnes of oil equivalent.

Source: Cecilya Malik, EBT Cambodia 2018, ERIA.

4.3.2 Commercial sector

Amongst the three sectors (residential, commercial, and industry), the total energy demand for the commercial sector is the lowest. In 2015, the commercial sector comprised about 3% of the total demand of the three sectors. However, the rate of increase in the projected demand by this sector is high, at an annual average growth rate of 6.1%. By 2030, the total demand by the commercial sector is projected to increase to 0.29 Mtoe from 0.12 Mtoe in 2015 under the BAU scenario as shown in Figure 4.10. Similarly, under the APS scenario, the total demand is projected to increase to 0.25 Mtoe at an annual average growth rate of 5.2%, while under the EEF scenario, the total demand is projected to increase to 0.24 Mtoe at an annual average growth rate of 4.9%. Therefore, in view of this high projected growth rate, it will be strategic and beneficial to implement EEC plans for the commercial sector.

Figure 4.10 Historical and Projected Energy Demand for the Commercial Sector Under the BAU, EEF, and APS

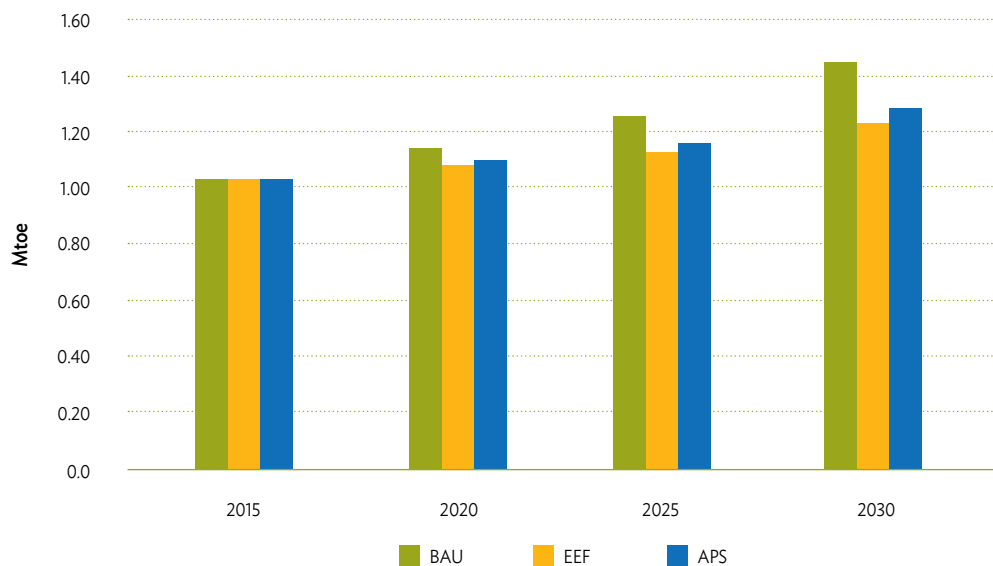


APS = alternative policy scenario, BAU = business as usual, EEF = energy efficiency framework, Mtoe = million tonnes of oil equivalent.
 Source: Cecilya Malik, EBT Cambodia 2018, ERIA.

4.3.3 Industry sector

The industry sector consumes the second-largest share of total energy demand amongst the three sectors at about 24%, compared with 73% and 3% for the residential and commercial sectors, respectively. However, the annual growth rate is not as high as that of the commercial sector. The projected total demand for the industry sector is 1.45 Mtoe by 2030 at an annual average growth rate of 2.3% under the BAU scenario, as shown in Figure 4.11. Similarly, the projected total demand for the industry sector is 1.29 Mtoe at an annual average growth rate of 1.5% under the APS scenario, while under the EEF scenario, the projected total demand is 1.24 Mtoe at an annual average growth rate of 1.2%. Although the growth rate is not as high as that of the commercial sector, it is still important to implement EE plans for the industry sector as the total demand for this sector is relatively substantial.

Figure 4.11 Historical and Projected Energy Demand for Industry Sector Under the BAU, EEF, and APS



APS = alternative policy scenario, BAU = business as usual, EEF = energy efficiency framework, Mtoe = million tonnes of oil equivalent.

Source: Cecilia Malik, EBT Cambodia 2018, ERIA.

4.4 Energy efficiency strategies

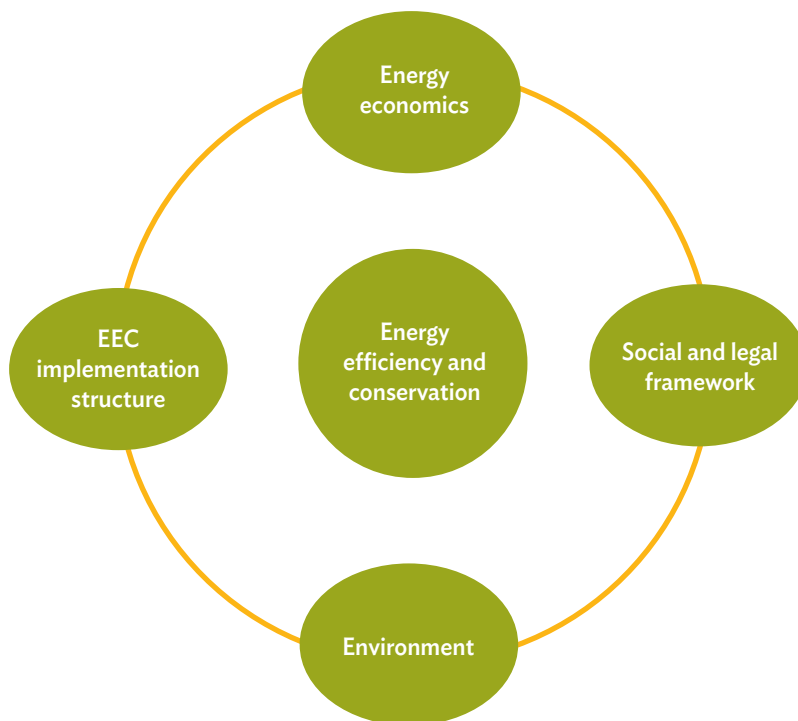
It would be prudent to review and interpret the energy data and trends in the energy demand before establishing EE strategies or setting priorities for the implementation of EE policies. Based on the review of the current situation and energy demand trends discussed above, it is important to note that the following energy situations are prevalent in Cambodia under the BAU scenario:

- (1) Energy demand for the residential, commercial, and industry sectors is on a rising trend.
- (2) The annual average growth rate of energy demand for the commercial sector is the highest at 6.1%.
- (3) The percentage share of electricity demand for the three sectors will increase from its 2015 level of 10% to 27% by 2030.
- (4) The percentage share of the biomass energy source will decrease from its 2015 level of 67% to 48% by 2030, but the combined fuel energy sources, comprising biomass, charcoal, LPG, and diesel, will still be significant at 73% of the total demand for the three sectors by 2030.

- (5) The residential sector consumes the largest share of energy demand amongst the three sectors at about 70.5%, while the industry sector consumes the second-largest share at about 23% in 2015 under the BAU scenario. The share of energy demand by the residential sector is projected to increase to 71.6%, and, similarly, the industry sector is projected to increase to 23.7% by 2030.

In view of the trends in energy demand summarised above, policymakers may consider a holistic and systematic approach to formulating and implementing short, medium, and long-term EEC plans for the efficient use of various energy sources. Figure 4.12 provides an overview of a recommended strategic framework for formulating an EEC plan. The strategic framework comprises four core strategy areas, namely, energy economics, a social and legal framework, the environment, and an EEC implementation structure. The details are described in the following sub-sections. In order to be effective and achievable, the EEC plan should be formulated based on a top-down approach, both from the government's perspective and the private sector's perspective. Nevertheless, the EEC plan should be kept simple, practical, and cost-effective, although EE is not straightforward when compared with renewable energy.

Figure 4.12 Strategic Framework for Formulating an EEC Plan



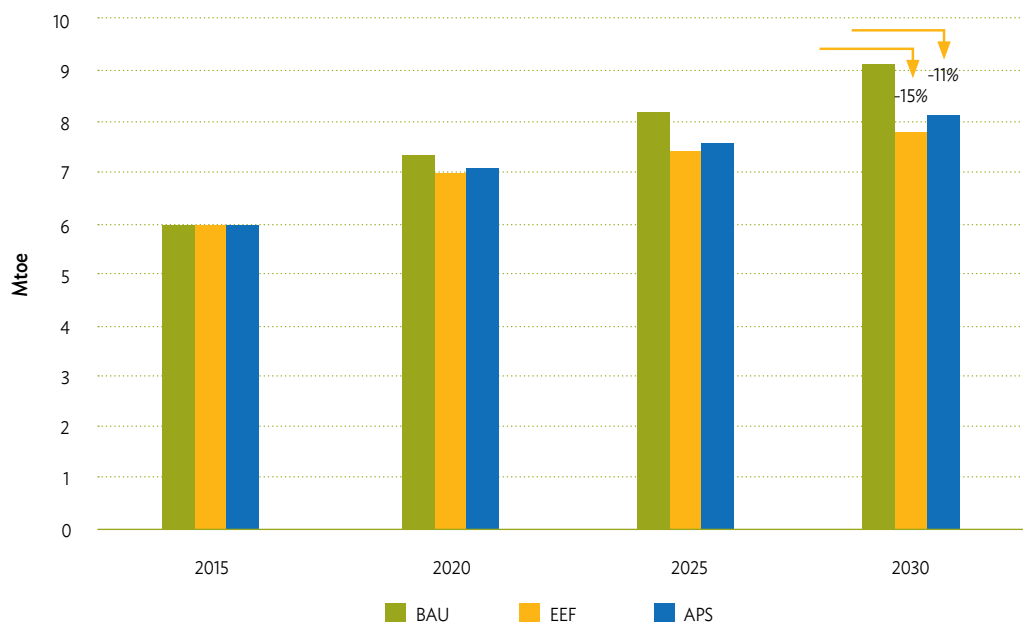
EEC = energy efficiency and conservation.

Source: author.

4.4.1 Energy economics

It should be recognised that EE plans will yield energy savings. EE alone can deliver substantial economic, environmental, and social benefits (IEA, 2018). The energy saved can be translated into an energy resource for the nation as it will become energy available for other economic activities and provide energy supply to a greater share of the population. The savings in electricity consumption are even more significant as every electricity unit of kilowatt hours saved would result in greater savings in fuel energy from power generation. Based on the outlook for energy demand summarised above, it makes economic sense for Cambodia to embark on EEC plans. The benefits of the EEC plans highlighted in Section 4.1 of this report will have a positive impact on the Cambodian economy. It can be seen from Figure 4.13 that an 11% reduction in total energy demand can be targeted under the APS case, while a 15% reduction in total energy demand can be targeted under the EEF case in comparison with the BAU case by 2030. In other words, energy demand will be much greater in future if Cambodia does not embark on an EEC plan now.

Figure 4.13 Historical and Projected Total Energy Demand in Cambodia Under the BAU, EEF, and APS



APS = alternative policy scenario, BAU = business as usual, EEF = energy efficiency framework, Mtoe = million tonnes of oil equivalent.

Source: Cecilia Malik, EBT Cambodia 2018, ERIA.

The economic component of the EEC strategy would result in promoting the growth of EEC technology, equipment, and materials supply. In addition, Cambodia will benefit from skilled manpower capacity building as a result of the EEC plan implementation, which will generate demand for upgraded levels of skilled employment. Therefore, it would be prudent to adopt strong policies to promote and enable EE investments at a reasonable scale. According to the IEA (2018), all investment opportunities in the efficient world scenario are highly cost-effective and would bring significant economic benefits.

4.4.2 Social and legal framework

From the national perspective, the top-down approach is through the government's plan to establish legal frameworks, such as an EEC act or regulations, which should be planned as the 'push' factor instead of a legal framework to mete out penalties. The objective of having legal frameworks is to establish mandatory requirements for efficient energy management and also to empower the department or agency that is tasked with the responsibilities for implementing EEC plans and, consequently, achieving EE and productivity for Cambodia.

For the private sector, the top-down approach requires top management or owners of companies 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 EE practices and energy productivity will eventually benefit business operations.

The top-down approach may not be applicable for the residential sector, except for the legislative building codes, which would require housing developers to build energy-efficient houses and apartments. Similarly, building codes will also cover the commercial sector in terms of energy-efficient buildings. In this regard, the top-down approach will be an important strategy under the social and legal framework strategy.

As part of the social strategies, it is important to create an EEC culture by incorporating EE subjects in education curriculums and conducting EE promotional campaigns for the public in the residential sector and awareness and capacity-building training programmes for the commercial and industry sectors.

4.4.3 Environment

The promotion and adoption of EEC measures and practices will enhance the achievement of a sustainable environment in Cambodia. As part of the EEC targets, the national energy intensity will improve, which in turn will contribute towards improving the carbon emissions intensity.

4.4.4 EEC implementation structure

The third strategy is to establish a means of achieving EE. This can be achieved in many ways, but simple and more direct ways are recommended and summarised as follows:

- (1) Engage professional bodies and stakeholders to incorporate energy-efficient strategies and measures in preparing building codes for the commercial and residential sectors.
- (2) Engage professional bodies and stakeholders to prepare EE standards, including minimum energy performance standards (MEPS) and guidelines for the residential, commercial, and industry sectors.
- (3) Involve professional bodies and stakeholders to establish the labelling of appliances for the residential sector.
- (4) Promote and generate an EE investment environment by
 - a. establishing a competent energy services company (ESCO) business to facilitate and expedite the achievement of energy savings for the commercial and industry sectors;
 - b. establishing green building certification for the recognition of green practices, including EE; and
 - c. providing facilities and investment tax allowance schemes for EE projects deemed beneficial.

It is recommended that formulating the EEC plan should take into consideration the following:

- i. The plan should be cost-effective, such that the use of existing technologies and techniques to achieve EE would be sufficient.
- ii. The plan should be basic and simple in order to facilitate effective implementation.
- iii. Resources need to be allocated for the establishment of the EEC plan.
- iv. The proposed EEC plan should comprise short-, medium-, and long-term plans incorporating EE strategies and measures as described below.

Short-term strategies and measures, 2019–2021

- (1) Identify and establish the responsible department or agency to take charge of the EEC plan.
 - In order to ensure the success of the EEC plan, dedicated and committed resources need to be established. The responsible department or agency will be the custodian fully responsible for formulating and implementing the EEC plan.
- (2) Formulate EEC structure and action plans.
 - The EEC plan should be structured for practical implementation with achievable targets.
- (3) Engage with professional bodies and stakeholders to formulate the EEC plans.
 - Professional bodies and stakeholders should be invited to participate in consultative forums in formulating the EEC plans.
- (4) Develop and implement EE promotional and awareness programmes.
 - Greater awareness of the benefits of EE will give a better chance of achieving success in the EEC plans.
- (5) Develop and conduct EE capacity-building programmes.
 - EE capacity-building programmes are important because the commercial and industry sectors need trained personnel to adopt EE practices in their respective workplaces.
- (6) Develop an EE syllabus for education.
 - In order to achieve sustainability in EE, the younger generations need to be educated on EE culture and practices.
- (7) Develop EE guidelines and standards for the residential, commercial, and industry sectors.
 - EE guidelines and standards provide an important link and means of implementing and achieving EE.
 - EE guidelines and standards should incorporate passive and active EE measures.
- (8) Develop a labelling system for appliances.
 - EE labelling of appliances is useful for achieving energy savings in the residential sector.
 - Distributors and suppliers of appliances are recommended to be trained by the respective manufacturers on the significance of EE labelling and energy-saving potential so that consumers can benefit through better understanding of EE labelling.
 - Distributors and suppliers of air conditioners are recommended to be trained by the respective manufacturers on the sizing and selection of air conditioners in order to avoid the oversizing of air conditioners for all the sectors, but in particular the residential sector, because house owners depend mostly on the

suppliers' and installers' recommendations. Correct sizing and selection will help save capital costs and running costs.

- (9) Develop MEPS for equipment.
 - MEPS specifying minimum energy performance requirements are useful for achieving energy savings in the commercial and industry sectors.
- (10) Prepare building codes incorporating EE.
 - Buildings codes are particularly useful for achieving energy savings in the commercial and residential sectors.
 - Building codes should incorporate passive and active EE measures.
- (11) Prepare efficient energy management regulations.
 - Efficient energy management regulations are mandatory requirements and are key to achieving success in EE in the industry and commercial sectors.
 - Premises that exceed a certain level of annual energy consumption would need to engage a qualified energy manager.
- (12) Initiate EE measures for government buildings.
 - The government can lead in the implementation of the EEC plan by adopting EE practices in government buildings.
- (13) Establish ESCO support services.
 - Competent energy saving and management services provided by ESCOs can help expedite achieving the results of energy-saving strategies and measures.

Medium-term strategies and measures, 2021–2025

- (1) Implement energy management systems for the industry and commercial sectors.
 - Energy management systems provide guidelines for systematic energy management methods and best practices for industry and commercial sectors.
- (2) Establish EE financing infrastructure support and incentive schemes.
 - Financial institutions can help finance investment-scale EE projects.
 - The government may consider investment tax allowances and the waiver of duties for imports of EE equipment.
- (3) Establish EE recognition awards.
 - Awards recognising outstanding and successful EE projects in commercial and industry projects given by the government will help promote the adoption of EE.
- (4) Continue capacity-building programmes.
 - Capacity-building programmes should be continuous, and a higher level of EE training is recommended.

Long-term strategies and measures, 2025–2030

- (1) Develop an EE legal framework.
 - It is recommended that ultimately, a legal framework, such as the establishment of an EEC Act, is developed.
- (2) Develop an energy efficiency indicator (EEI) system for the establishment of benchmarking for the commercial and industry sectors.
 - An EEI system based on the IEA’s EEI methodology (IEA, 2014) should be established.
- (3) Incorporate EE into the education syllabus.
 - For a long-term and sustainable strategy, Cambodia’s education system should incorporate EEC concepts and practices into its syllabus.

Figure 4.14 Suggested EEC implementation structure



EE = energy efficiency, EEC = energy efficiency and conservation.

Source: Prepared by the author.

4.5 Recommendations

- o Strong EE policies are vital for achieving the key energy-policy goals of reducing energy bills, addressing climate change, improving energy security, and increasing energy access. The economic benefits for the implementation of an EEC plan have been highlighted, and the implementation of an EEC plan is highly recommended, which is in line with most other ASEAN countries' aspirations and also the IEA's recommendations.
- o The recommended strategic framework for formulating and implementing an EEC plan is based on four simple, cost-effective, and practical core strategy areas: energy economics, a social and legal framework, the environment, and an EEC implementation structure. The economic component of the EEC strategies would result in promoting the growth of EEC technology, equipment, and materials supply. In addition, Cambodia will benefit from skilled manpower capacity building as a result of the EEC plan implementation, which will generate demand for upgraded levels of skilled employment.
- o Based on the outlook for energy demand, it makes economic sense for Cambodia to embark on an EEC plan. Energy consumption can be reduced in future demand if Cambodia embarks on an EEC plan now.
- o Short-, medium-, and long-term EEC strategies and measures are recommended for implementation in stages, which can be adjusted to suit needs and resource allocations. The EEC plan should be simple, practical, and cost-effective, and it should also be formulated based on a top-down approach, both from the government's perspective and the private sector's perspective. In summary, this recommended EEC plan has identified the needs, means, and action plans to achieve EE and energy savings besides the economic benefits for Cambodia.

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