Chapter 7

Energy Management Systems and Energy Service Companies

Ong Ching Loon

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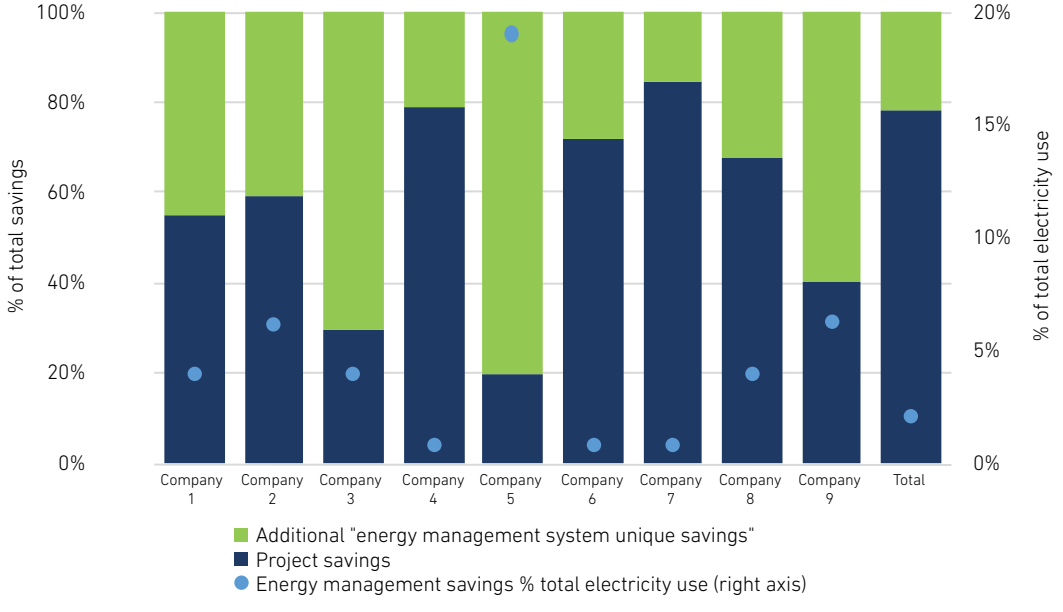
1. Introduction

The energy-efficiency agenda is not new; it began gaining attention during the energy crises in the 1970s when the West, particularly the United States (US), Canada, Western Europe, Australia, and New Zealand, faced substantial petroleum shortages and increased oil prices. The crises led to the creation of various energy-efficiency programmes, one of which was the US's Energy Star programme initiated by the Environmental Protection Agency and Department of Energy. Energy Star aims to improve the energy efficiency of buildings and products, resulting in cost savings and environmental protection.

The benefits of energy efficiency have proven to be huge. As such, besides an energy management system (EMS) introduced by the International Organization for Standardization (ISO) to aid countries with their energy-efficiency targets, the concept of energy service companies (ESCOs) emerged in 1980s, particularly in the US. The International Energy Agency (IEA) highlighted the results of nine companies in developing economies that implemented EMSs under the guidance of the United Nations Industrial Development Organisation (UNIDO) (Figure 7.1).[1]

Figure 7.1. Implementation of Energy Management Systems – Benefits



Source: IEA, Productivity, Multiple Benefits of Energy Efficiency, https://www.iea.org/reports/multiple-benefits-of-energy-efficiency/productivity

[1] IEA, Productivity, Multiple Benefits of Energy Efficiency, https://www.iea.org/reports/multiple-benefits-of-energy-efficiency/productivity

According to Figure 7.1, energy-efficiency projects implemented through EMSs led to electricity savings of over 26,000 megawatt-hours. An additional 8,000 megawatt-hours were achieved from 'EMS- unique' savings; these were linked to improvements in staff awareness of energy efficiency, energy management capability, daily routine operations, and staff accountability. This resulted in total savings of 12%–80% from the baseline.

While EMSs provide a systematic process to improve energy performance continually from in-house energy management teams, energy-efficiency programmes involving medium and high costs – such as retrofitting projects – are executed by competent energy service providers or ESCOs. An ESCO provides a comprehensive range of energy-efficiency and conservation solutions and accepts some degree of financial risk.

To achieve energy efficiency holistically and sustainably, EMSs and ESCOs cannot be mutually exclusive.

2. Energy Management Systems

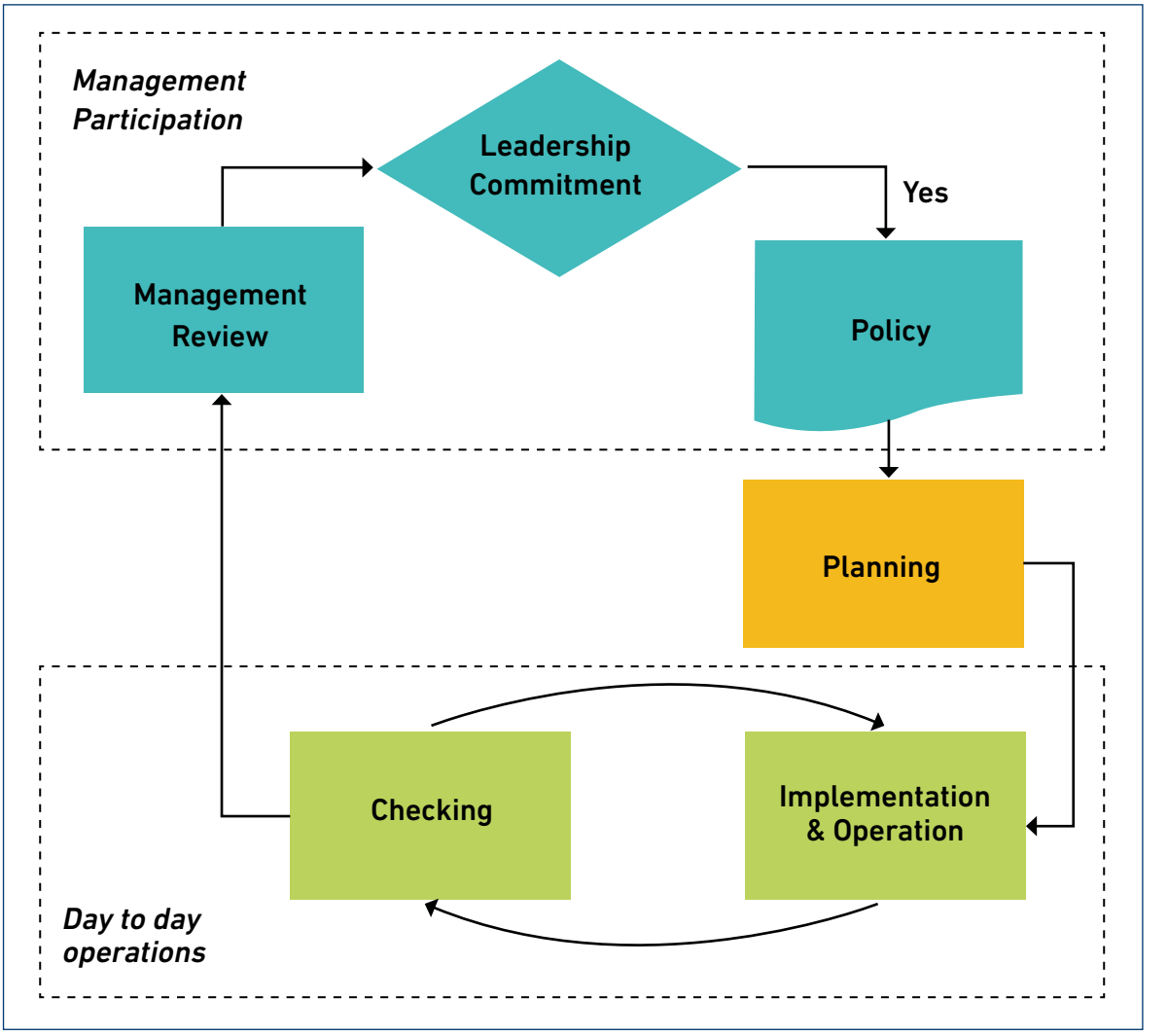
EMSs represent a systematic approach to energy use management. They are not just technical systems composed of computer-aided tools used by operators of electric utility grids to monitor, control, and optimise the performance of the generation or transmission system; an automation system that collects energy consumption data that computes metrics; nor an online monitoring tool that generates graphs and scorecards. EMSs are often misconstrued as building EMSs or building automation systems; these are usually self-generated, in-house practices to energy-saving management processes that are not holistic and integral of all elements to attain sustainable energy performance.

A systematic framework for EMSs is missing. Mostly, standards are used to generate EMSs based on ISO 50001 or the ASEAN Energy Management Scheme (AEMAS) (i.e. an ASEAN system of certification based on excellence in energy management). The fundamental requirement or AEMAS certification rests with ISO 50001, and it was established to support the regional blueprint for the energy sector under *the ASEAN Plan of Action for Energy Cooperation (APAEC)* (ACE, 2023).

ISO 50001 is a framework for developing an effective EMS with the primary objective of improving energy performance for organisations.[2] Energy performance is defined as measurable results related to energy consumption in the context of energy efficiency. An EMS adopts the 'plan–do–check–act' principle for continual improvement, and its broad framework revolves around the following six criteria: (i) leadership commitment, (ii) energy policy, (iii) energy planning, (iv) implementation and operation, (v) checking, and (vi) management review.

[2] ISO, ISO 50001: Energy Management Systems, https://www.iso.org/iso-50001-energy-management.html

Figure 7.2. Main Criteria of an Energy Management System



Source: UNIDO (2015).

2.1. Leadership Commitment

This dictates the core responsibilities of top management of an organisation and that they must be committed to allocate resources (i.e. financial, human, technical, and technological) to an EMS, assign responsibilities and define the roles of those on the energy management team, appoint a management representative, sign and enforce energy policy, give support, and make decisions. While the other five criteria are integral to achieve energy savings, failure of top management to commit to these responsibilities would destroy its implementation.

2.2. Energy Policy

Policy is the beacon of all action plans; the same applies to energy policy. It is essential for an energy policy to define its objectives and commitments. It must mandate complete compliance with national legislation, acts, regulations, and other requirements related to energy-using activities. It must support energy-efficient designs, procurement of energy-efficient products that have minimum energy performance standards (MEPS), and continual improvement. The policy must be communicated to all levels of staff within an organisation. A typical energy policy is depicted in Figure 7.3.

Figure 7.3. Typical Energy Policy

ENERGY POLICY

Cofreth (M) Sdn Bhd, a Facilities Management,Energy Consultancy and Energy Services company is committed to optimise building energy consumption through continual improvement of Energy Management System (EnMS).

The policy governs the following commitments:

1. Comply with all applicable energy related legislation and other requirements;
2. Optimizing building energy performance through procurement of energy-efficient product and services, efficient design and implementation of operational control;
3. Provide necessary resources and information required to achieve objectives and targets;
4. Continually improve energy management system (EnMS) performance through yearly audits and management reviews.

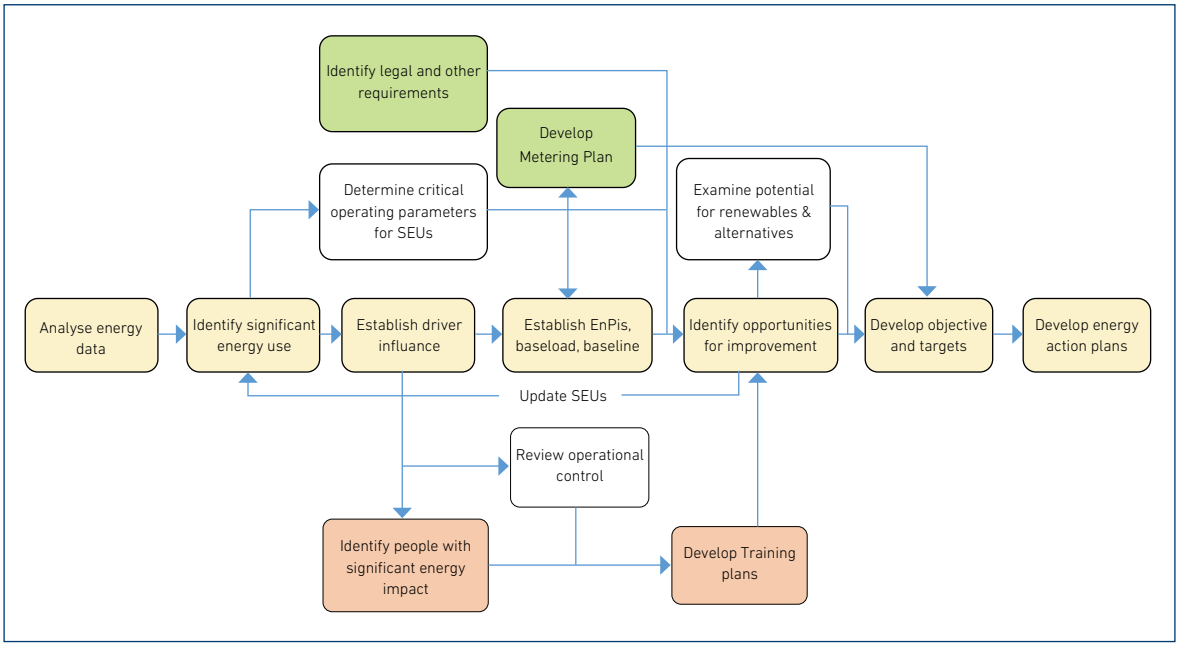
This policy will be reviewed and revised as necessary and communicated to all employees within he organization

Source: Cofreth (M) Sdn Bhd.

2.3. Energy Planning

Energy planning is the most comprehensive requirement, as it reviews the business activities and processes that affect energy use and thus energy performance in a company. It covers the need to develop plans to analyse energy data, identify significant energy users (SEUs), establish drivers of or variables' influence on energy use, energy performance indicators (EPIs), baselines, and baseloads. Opportunities for improvement must be identified, and objectives, targets and energy action plans must be developed. The core workflow is depicted in Figure 7.4.

Figure 7.4. Core Workflow of Energy Planning



SEU = significant energy user.
Source: Author's adaptation of UNIDO's EnMS.

Amongst all of the above work activities, identifying which systems consume the most or least electricity or fuel from past or present energy consumption data is known as identifying SEUs. The purpose is to prioritise energy-saving measures (ESMs) for the highest users to the lowest. Typically, the top five users are in a factory or commercial building. Besides SEUs that are systems-based, people whose involvement in the entire ecosystem of the EMS have an impact on energy use must also be identified as SEUs.

Equally important is establishing energy variables or drivers, as they are the factors that affect energy consumption. Examples of variables are occupancy, operating hours, production volume, external ambient temperature, and cooling degree days.

It is also crucial to have EPIs that provide energy consumption data in simple efficiency ratios or metrics. Energy use intensity covers all types of metrics, and the most commonly used is specific energy consumption or building energy intensity in the format of kilowatt-hours/square metre/year. For data centres, power usage effectiveness is used. There are many parameters to be considered when energy use intensity is computed, and they are generally aligned to the local energy framework or practices.

Energy metrics without baseloads cannot be used as baselines, as metrics or ratios do not necessarily represent total energy consumption. The best method to identify the baseload is linear regression; the energy data value at the intercept of the best fit line against the Y-axis is the baseload. The baseload can also be determined from data logging of an SEU over at least a 24-hour cycle when unwanted energy is consumed during off-production hours or when the business is closed. The baseload is normally ignored, despite the fact that energy is used for nonproductive activities. This is a great opportunity to save energy.

Other important processes are determining opportunities for savings, known as ESMs; developing objectives, targets, and action plans associated with ESMs; and obtaining schedules and resources required to meet the targets. Under ESMs, measures such as no-cost and medium- and high-cost are identified, and with the exception of no-cost measures, the corresponding financial outlay, return on investment, and work schedules are generated. No-cost measures, such as switching off energy-consuming equipment when not being used and setting room temperatures according to the ASHRAE standard of 24oC, can be easily implemented.

2.4. Implementation and Operation

Having completed the energy planning process, action plans – which include operational control of SEUs – should be implemented to achieve energy savings. Often overlooked under operational control are the key areas of operation and maintenance (O&M), competence of service contractors, and methods under which O&M are carried out. Past practices of O&M without operations limits for certain important parameters, absence of service performance indicators, and lack of documentation must be revamped. All stakeholders of O&M must be aware of the need for energy efficiency, and this must be communicated regularly. Maintenance personnel must be technically competent, and associated training and re-training should be scheduled in a structured manner. Implementation in this context includes energy-efficient designs and procurement of energy-efficient equipment, which meet at least MEPS as well as safety requirements.

2.5. Checking

Checking is a daily activity to ensure operating parameters of SEUs do not deviate from set limits and thresholds. Activities include monitoring the energy consumption of SEUs in term of energy use indicator metrics and comparing the data against preceding months (Figure 7.5). This is an effective systematic check to understand any excessive deviation or non-conformity and to identify corrective and preventive actions. Under an EMS, yearly internal audits are required, the frequency of which is recommended to be twice per year. An internal audit process should include developing an audit plan and appointing trained auditors with the objective of checking the performance of the system and compliance with legal and other requirements.

Figure 7.5. Monitoring of Specific Energy Consumption

Yr	Month	m2/mth	Δ(%)	SEC for Utiliteas (kWh/m2mth)										Overall SEC	Δ(%)
		Total Production output		SEC for Chiller	Δ(%)	SEC for Chiller	Δ(%)	SEC for Chiller	Δ(%)	SEC for Chiller	Δ(%)	SEC for Chiller	Δ(%)		
2022	Jan-22	7,631	-8.6%	183.06	4.7%	81.54	9.7%	39.72	14.7%	92.48	4.6%	19.02	15.3%	420.61	7.1%
	Feb-22	7,058	-7.5%	185.21	1.2%	78.49	-3.7%	39.51	-0.5%	89.22	-3.5%	18.32	-3.7%	415.53	-1.2%
	Mar-22	8.036	13.9%	164.8	-11.0%	74.79	-4.7%	39.25	-0.7%	84.97	-4.8%	14.87	-18,9%	382.52	-7.9%
	Apr-22	7,102	-11.6%	208.75	26.7%	80.69	7.9%	43.76	11.5%	95.6	12.5%	15.98	7.5%	450.68	17.8%
	May-22	7,383	4.0%	174.93	-16.2%	78.38	-2.9%	40.04	-8.5%	85.3	-10.8%	15.21	-4.8%	397.79	-11.7%
	Jun-22	8,077	9.4%	138.5	-20.8%	68.56	-12.5%	46.75	16.7%	82.91	-2.8%	14.13	-7.1%	354.71	-10.8%
	Jul-22	7,265	-10.0%	173.93	25.6%	80.36	17.2%	54.25	16.0%	96.46	16.3%	15.74	11.4%	426.81	20.3%
	Aug-22	6,043	-16.8%	200.1	15.0%	98.36	22.4%	55.46	2.2%	117.89	22.2%	19.04	21.0%	496.7	16.4%
	Sep-22	5,202	-13.9%	247.04	23.5%	114.02	15.9%	81.29	46.6%	108.82	-7.7%	21.68	13,9%	580.71	16.9%
	Oct-22	3,158	-39.3%	479.69	94.2%	188.06	64.9%	146.62	80.4%	172.13	58.2%	34.21	57.8%	1,033.38	78.0%
	Nov-22	1,237	-60.8%	1,128.81	135.3%	438.09	133.0%	330.58	125.5%	278.37	61.7%	76.77	124.4%	2,277.43	120.4%
	Dec-22	2,329	88.2%	566.66	-49.8%	233.64	-46.7%	176.93	-46.5%	168.41	-39,5%	44.2	-42.4%	1,196.70	-47.5%
2023	Jan-23	1,554	-33.3%	791.45	39.7%	340.14	45.6%	234.09	32.3%	252.83	50.1%	82.36	86.3%	1,720.82	43.8%
	Feb-23	925	-40.5%	1,421.18	79.6%	639.33	88.0%	423.63	81.0%	392.12	55.1%	129.21	56.9%	3,034.10	76.3%
	Mar-23	3,216	247.7%	448.08	-68.5%	175.86	-72.5%	120.43	-71.6%	121.74	-69.0%	39.49	-69.4%	908.54	-70.1%
	Apr-23	3,401	5.7%	429.08	-4.1%	156.74	-10.9%	107.01	-11.1%	140.06	15.1%	37.11	-6.0%	877.74	-3.4%
	May-23	4,268	25.5%	349.68	-18.6%	132.03	-15.8%	85.31	-20.3%	129.6	-7.5%	31.58	-14.9%	733.48	-16.4%
	Jun-23	5,481	28.4%	289.21	-17.3%	106.67	-19.2%	66.14	-22.5%	103.06	-20.5%	27.41	-13.2%	596.44	-18.7%
	Jul-23	1,173	-78.6%	1,332.59	360.8%	428.5	301.7%	179.75	171.8%	376.19	265.0%	124.05	352.6%	2,483.06	316.3%
	Aug-23	3,169	170.2%	432.44	-67.5%	138.87	-67,6%	39.24	-78.2%	91.45	-75.7%	35.63	-71.3	740.06	-70.2%
	Sep-23	2,194	-30.8%	558.4	29.1%	204.7	47.4%	111.31	183.7%	145.74	59.4%	46.66	31.0%	1,081.00	46.1%
	Oct-23	3,824	74.3%	340.34	-39.1%	119.92	-41.4%	64.62	-41.9%	100.66	-30.9%	28.79	-38.3%	657.3	-39.2%
	Nov-23	3,345	-12.5%	384.25	12.9%	133.31	11.2%	72.06	11.5%	118.77	18.0%	32.63	13.3%	748.63	13.9%
	Dec-23	3,851	15.1%	348.38	-9.3%	122.24	-8.3%	63.81	-11.4%	105.83	-10.9%	29.05	-11.0%	674.7	-9.9%
2024	Jan-24	2,322	-39.7%	546.42	56.8%	202.1	65.3%	104.85	64.3%	166.48	57.3%	45.58	56.90%	1,078.40	59.8%
	Feb-24	3,159	36.1%	372.66	-31.8%	138.24	-31.6%	72.89	-30.5%	114.38	-31.3	34.47	-24.4	736.3	-31.7%
	Mar-24	3,089	-2.2%	424.95	14.0%	153.56	11.1%	80.08	9.9%	134.22	17.3%	39.25	13.8%	838.64	13.9%

CDA = compressed dry air, FCU = fan coil unit, HPCW = hot processed chilled water, kWh = kilowatt-hour, m^2 = square metre, OAC = outdoor air conditioner, PCW = pump for chilled water, SEC = specific energy consumption.

Source: Author and Cofreth (M) Sdn Bhd.

2.6. Management Review

The cycle of an EMS ends with a management review. Again, the frequency of this review is dependent on the issues to be discussed and remedial actions that require top management decisions and support. Annual management review meetings with defined agendas aim to demonstrate to the top management the results of implementing energy-saving action plans and the overall energy performance achieved from an EMS (Figures 7.6–7.8). The meeting sets the plans and targets of energy performance and resources required for the following year. All energy management team members should be mandated to attend the review meeting, which is chaired by top management.

Table 7.1. Example Agenda of a Management Review Meeting

No.	Agenda Item
1	Confirmation of Minutes and Status of Action from Previous Meeting
2	Review of Energy Performance, Action Plans, SEUs, and EPI for last Financial Year (2022/2023) and Plan for 2023/2024 Overall Energy Performance and Improvement Energy Consumption, EPIs, Baselines, Variables, SEUs Energy Objective and Target Achievement Status of Action Plan Implementation with Savings Made
3	Planning for 2023/2024 Energy Objective and Targets New Baseline, SEU, EPI, Variables Action Plan (Opportunity List)
4	Information on EMS Performance, including trends in: Non-Conformities and Corrective Actions Audit Results Analysis of Legal and Other Requirements Evaluation Monitoring and Measurement of Other EMS Performance
5	Review Organisational Context Internal and External Issues Relevant to EMS Needs and Expectations of Interested Parties
6	Review Risks and Opportunities
7	Corrective Actions, Improvement Plans, and Management Decisions Opportunities to Improve Energy Performance Energy Policy EPI and Energy Baseline Energy Objectives and Targets, Action Plans, and Other Elements of the EMS, and Actions to Be Taken if They Are not Achieved Opportunities to Improve Integration with Business Processes Allocation of Resources Improvement of Competence, Awareness, and Communication

EMS = energy management system, EPI = energy performance indicator, SEU = significant energy user.

Source: Cofreth (M) Sdn Bhd.

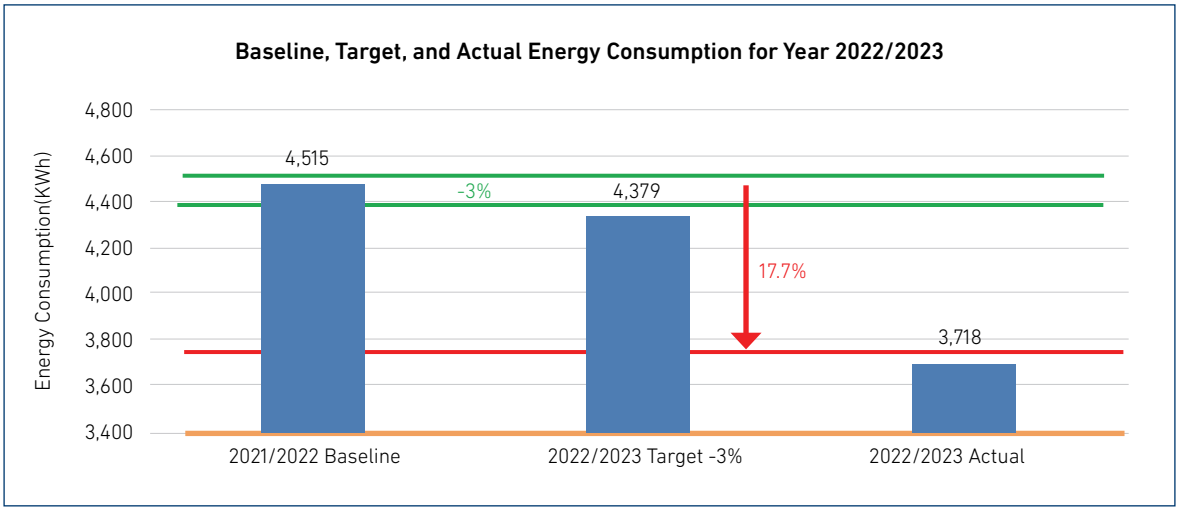
Figure 7.6. Example of Results of Implementing Energy-Saving Action Plans

No	Overall Description of Opportunity	Estimate									Actual						
		Saving		CAPEX	Simple Payback	CO_2 Reduction	% of savings (total building)	PIC	Status	Date	Saving		CAPEX	Simple Payback	CO_2 Reduction	% of savings (total building)	Status
		kWh/yr	RM/yr	RM/yr	years	ton-CO_2					kWh/yr	RM/yr	RM/yr	years	ton-CO_2		
Short Term																	
ST #1	Condensate spray for air-conditioning using Syabas water (for 2 nos ACSU for Server Room & 2 nos for F&A office)	312	147	300	2,0	0,24	0,58%	CT	Completed	17.5.22	1344	634,368	300	0,5	1,05	2,48%	Completed
ST #2	Condensate spray for air-conditioning (For 4nos ACSU at Level 4)	240	113	300	2,6	0,19	0,44%	CT	Completed	15.6.22	240	113,28	300	2,6	0,19	0,44%	Completed
ST #3	Condensate spray for air-conditioning (For 5nos ACSU at Level 3)	120	57	300	5,3	0,09	0,22%	CT	Completed	25.9.22	936	441,792	300	0,7	0,73	1,73%	Completed
ST #4	Replace downlights at Level 2 Meeting Rooms (Venus, Mars & Board Rooms) by LED lights (Qty: 26). Before = 52 units	-	-	-	-	-	-	CT	Completed	30.6.22	5.267	2.225	208	0,09	4,11	9,72%	Completed
ST #5	Replace T8 lighting at staircase to T5 (Qty: 5)	-	-	-	-	-	-	CT	Completed	15.7.22	198	138	36	0,3	0,15	0,36%	Completed
ST #6	Implementation of shading device at Level 4 area	-	-	-	-	-	-	CT	KIV	-	-	-	-	-	-	-	Pending
Total Short Term Action Plans		**672**	**317**	**900**	**10**	**1**	**1%**				**7.984**	**3.552**	**1.144**	**4**	**6**	**15%**	
Long Term																	
LT #1	Installation of tinted glass window	-	-	-	-	-	-	CT	To discuss in EMT Year 2023/2024	-	-	-	-	-	-	-	To discuss in EMT Year 2022/2023
LT #2	Replace faulty/old units of ACSU in the building	-	-	-	-	-	-	"OPC /CT"	To discuss in EMT Year 2023/2024	-	-	-	-	-	-	-	To discuss in EMT Year 2022/2023
Total Long Term Action Plans		**0**	**0**	**0**	**0**	**0**	**0**				**0**	**0**	**0**	**0%**	**0%**	**0,00%**	
Total		**672**	**317**	**900**	**2,84**	**0,52**	**1,24%**				**7.984,48**	**3551,94**	**1144,00**	**4,16**	**6,23**	**14,74%**	

ACSU = air-cooled split units, CAPEX = capital expenditure, CO_2 = carbon dioxide, CT = central team, kWh = kilowatt-hour, PIC = person in charge.

Source: Cofreth (M) Sdn Bhd.

Figure 7.7. Example of the Energy Performance of a Company with an Energy Management System



Source: Cofreth (M) Sdn Bhd.

The key success of an EMS is the reiterative process of top management commitment, energy planning, implementation and operation, checking, and management reviews based on the overarching principle of continual improvement. Implementation leads to lower energy demand and supply and decarbonisation of the environment. Recognising the benefits of an EMS, the Government of Malaysia stipulated EMSs as a provision in the recently passed Energy Efficiency and Conservation Act.

3. Energy Service Companies

ESCO is a generic name; typically, it is a company with personnel specialised in energy solutions to improve energy efficiency with or without financing for an energy-efficiency project. There are various definitions of ESCOs internationally:

(i) **European Union**. An 'ESCO is a natural or legal person that delivers energy services and/or other energy-efficiency improvement measures in a user's facility or premises and accepts some degree of financial risk in so doing. The payment for the services delivered is based (either wholly or in part) on the achievement of energy-efficiency improvements and on the meeting of the other agreed performance criteria', (EU, 2006).

(ii) **US**. Per the Department of Energy, 'ESCOs develop, design, build, and arrange financing for projects that save energy, reduce energy costs, and decrease O&M costs at their customers' facilities. In general, ESCOs act as project developers for a comprehensive range of energy conservation measures and assume the technical and performance risks associated with a project'.[3]

(iii) **Malaysia**. Per the Association of Energy Service Companies (MAESCO), an 'ESCO is a company that provides a comprehensive range of energy-efficiency and conservation solutions and services with or without the ability to undertake energy performance contracting'.[4]

Fundamentally, ESCOs provide energy solutions and can finance and/or implement them. ESCOs in the European Union and US generally finance them and take on the financial or credit risk, while ESCOs in other nations – predominantly in Asia – are generally reluctant to arrange financing due to lower risk appetites. Some of the ESCOs simply do not have the capacity to arrange for finances as well.

3.1. Scope of Work

To implement the medium- and high-cost ESMs identified under EMSs, some works must be contracted to ESCOs, as in-house technical personnel may not have the expertise, capability, and/or resources to carry out ESMs. Typically, the scope of work includes supplying energy-efficient devices and equipment, consultancy services, contract works (e.g. retrofitting and/or new installation) and project management; energy audits; design engineering; project financing; management of energy performance contracts (EPCs); commissioning and services; O&M of equipment and energy-efficient installation; and inspection of energy-efficiency improvement projects.

3.2. Energy Audits

Energy audits are a process to determine the level of energy efficiency of a building, factory, or installation against its energy-consuming equipment and systems. Without them, the owner of these systems does not know if the facilities or systems are energy efficient. It is a process of mining and analysing data, identifying energy-saving opportunities, recommending ESMs with costs and without costs, and computing the return on investment. In most energy audits, there are three levels (Figure 7.9).

[3] Government of the US, Department of Energy, Energy Service Companies, https://www.energy.gov/femp/energy-service-companies

[4] MAESCO, internal, unpublished document.

Table 7.2. Levels of an Energy Audit

Level 1: Walk-through Audit	Level 2: Standard Audit	Level 3: Investment Grade Audit
Walk-through familiarisation	Follow-up from Level 1 audit where available; a comprehensive audit	Inclusive of all scope of works of Levels 1 and 2 with the exception of when only an energy audit of specific systems is requested
Desktop analysis	A minimum of 7 days logging and metering on major energy-consuming equipment of building services or industrial equipment/systems	A minimum of 14 days of logging and metering on major energy-consuming equipment of building services or industrial equipment/systems
Generate energy intensity	Review system design, installation, O&M	Detailed review of processes
Recommend no-cost ESMs	Detail system energy inputs and use	IEQ audit, if required
Written report with broad conclusion	Identify sources of inefficiency	Comfort study, if relevant
	Compute BEI or specific energy consumption index	Include indoor air quality report (if chiller audit)
	Generate load apportioning	Recommend no-cost, medium-cost, and high-cost ESMs
	Provide energy performance indicators	Detailed recommendations on comprehensive ESMs
	Recommend no-cost, medium-cost, and high-cost ESMs	Detailed investment plan using NPV methodology against lifecycle
	Written report and presentation	Written report and presentation

BEI = building energy intensity, ESM = energy-saving measure, IEQ = indoor environmental quality, NPV = net present value, O&M = operation and maintenance.

Source: Author.

A Level 1 audit is a walk-through audit, sometimes known as a preliminary audit. As the title implies, it does not require data logging, and the energy auditor of the ESCO conducts the analysis of energy data from past records. Energy metrics are produced, and the metrics are compared against the EPIs of known sources and/or from industry benchmark data. The desktop analysis, in general, identifies ESMs.

A Level 2 audit is the standard audit process where data mining with energy loggers and portable flowmeters are extensively employed. Unlike a spot measurement audit, which provides a value for each spot measurement, logging for a 24/7 cycle provides the energy-consuming trends or profile of any SEU that was being logged. It depicts the data consumption trend every 5–10 minutes and questions how energy is being consumed. Gaps of operations or wasteful practices are unearthed, and ESMs to close the gaps and to improve energy efficiency can be accurately produced. Through intensive data analysis and where necessary, a more complex mathematical approach by linear and/or multi-variate linear regression is used to generate EPIs or metrics and to ascertain the variables that impact energy consumption. For the standard audit, besides no-cost measures being recommended, medium- and high-cost measures are proposed.

The most comprehensive energy audit is the Level 3 audit, also known as an investment-grade audit. All processes of a Level 2 energy audit are carried out, but the difference is the number of days of logging. Under a Level 3 audit, logging days are increased to 14. Sometimes, indoor environmental quality, covering indoor air quality and comfort surveys, are included in the scope. The key requirement is to recommend ESMs complete with a high level of financial return on investment for decision making.

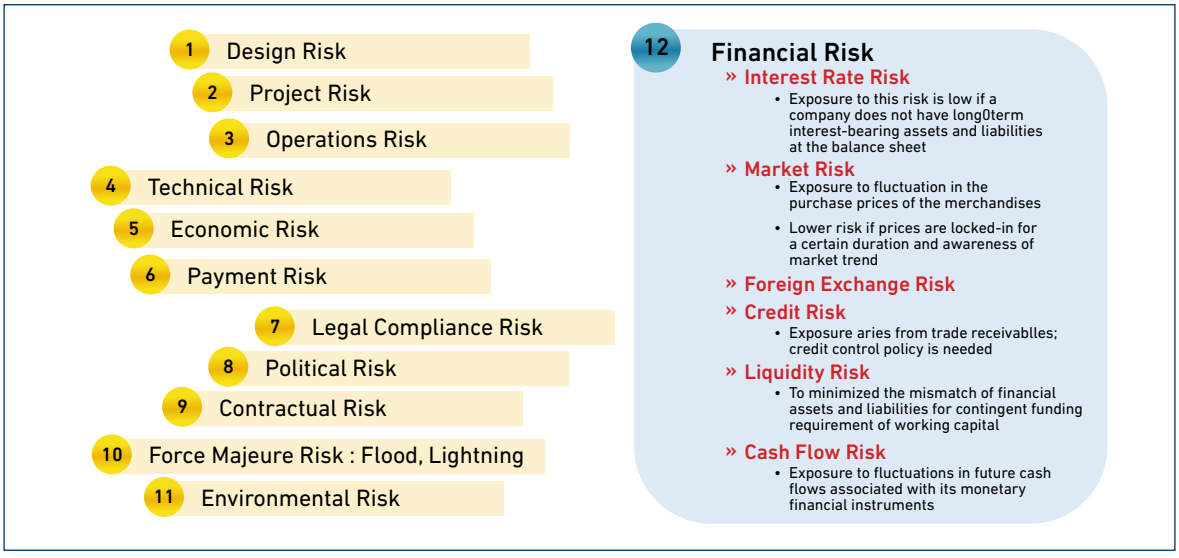
The simple payback method is not conducive to investment consideration; a detailed and comprehensive financial or investment model complete with various sensitivity analysis of cash inflow and outflow and other parameters is required. The analysis must include basic information on the internal rate of return and return on equity, after taking into account the entire lifecycle of a project. A Level 3 audit is the pre-requisite for an EPC.

3.3. Energy Performance Contract

An EPC is a contractual arrangement between a client/building owner and an ESCO of an energy-efficiency improvement project, where investment in that project is funded by the ESCO and repayment of the capital outlay is periodically made through cost savings from reduced energy consumption under a contractually agreed upon level of energy-efficiency improvement. It is also known as off-balance sheet financing. This mechanism relieves the client from the constraint of cashflow, which deters the energy-saving project from being implemented.

Under an EPC where investment comes from an ESCO, it must confront the various risks and plan to mitigate these risks (Figure 7.10). Therefore, it is not unreasonable for an ESCO to incur higher costs for insurance to offset any risks that it can anticipate. Depending on the type of EPC model, under the guaranteed saving model, project financing is undertaken by the client, and the ESCO implements the project and guarantees energy savings.

Figure 7.8. Risks Assessment of Energy Performance Contracts

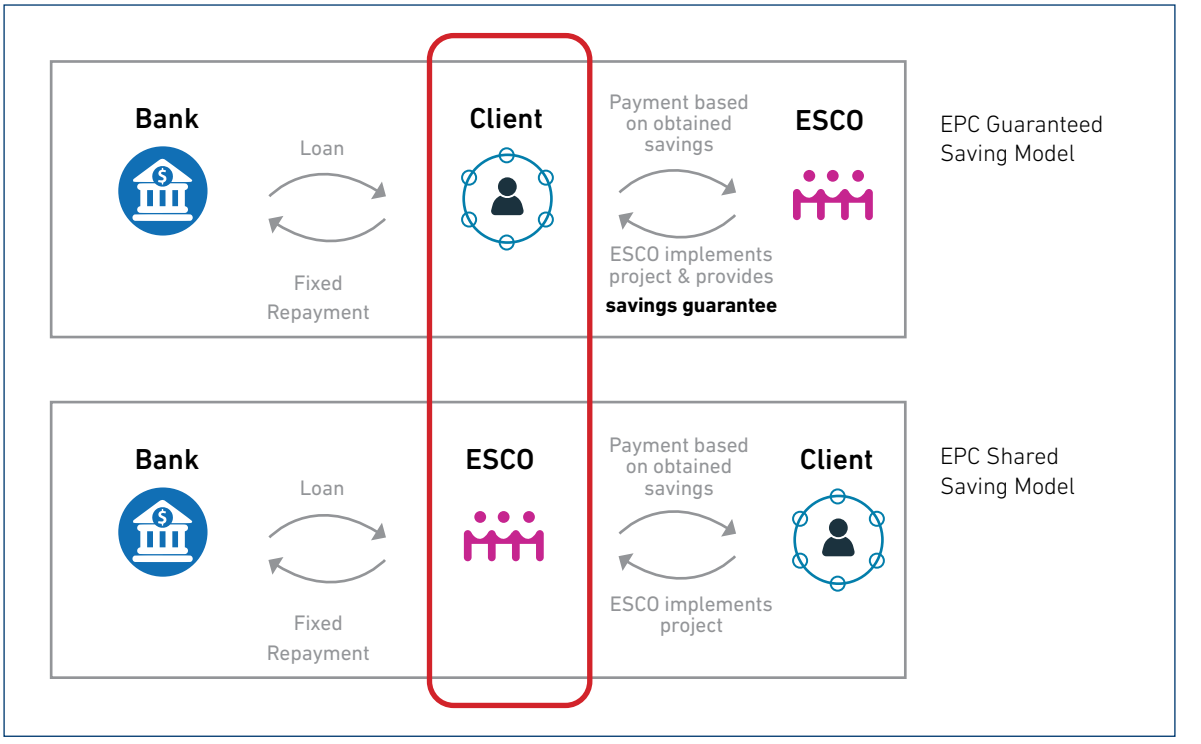


Source: Author.

The energy services industry generally adopts two types of EPC models – the guaranteed saving model and shared saving model (Figure 7.11). The former does not require the ESCO to obtain bank loans or to use its internal funds to finance the capital investment and other costs of the project. The ESCO must, however, guarantee reduction on energy consumption and its corresponding monetary savings and assume all technical and operational risks associated with the project.

Under the shared saving model, the ESCO provides financing for capital expenditures and other expenses, such as project development and implementation costs, and unlocks the asset from the balance sheet of the client. This model is attractive to most companies. Further, the ESCO assumes an additional risk on a loan, which is absent from guaranteed saving model. Payment to the ESCO comes from the energy saved from the project. The net saving after deducting the debt service of principal and interest and cost of O&M is shared between the ESCO and client at a predetermined ratio over the duration of the contract period. ESCOs without strong balance sheets often resist this financing model or are unable to obtain funding from financial institutions.

Figure 7.9. Core Differences between Energy Performance Contracts

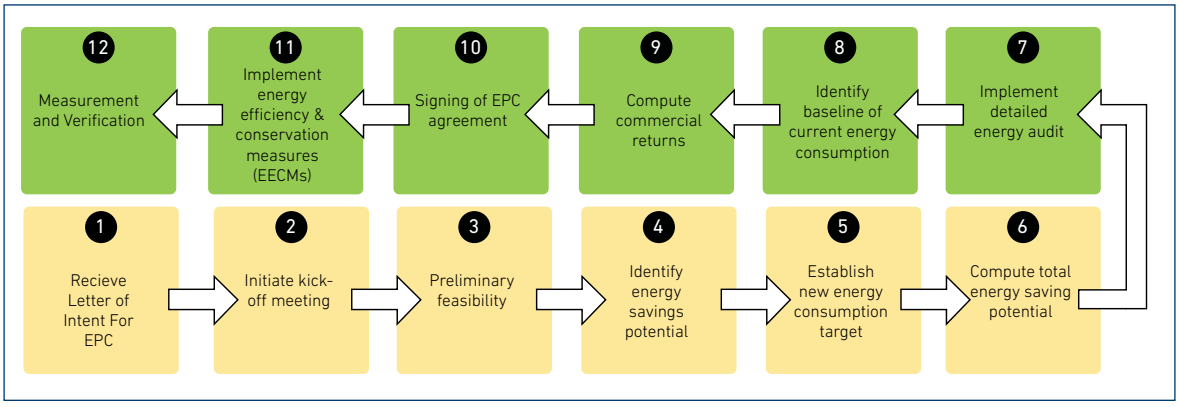


EPC = energy performance contract, ESCO = energy service company.

Source: IEA.

EPCs, however, have been unsuccessful in some countries. The process of EPCs is lengthy (Figure 7.12). There is also no generic EPC template that is acceptable to both the client and ESCO regarding the commercial terms on interest, costs, quantity of guaranteed energy savings, ratio of shared savings, and duration of contracts.

Figure 7.10. Process of Energy Performance Contracts



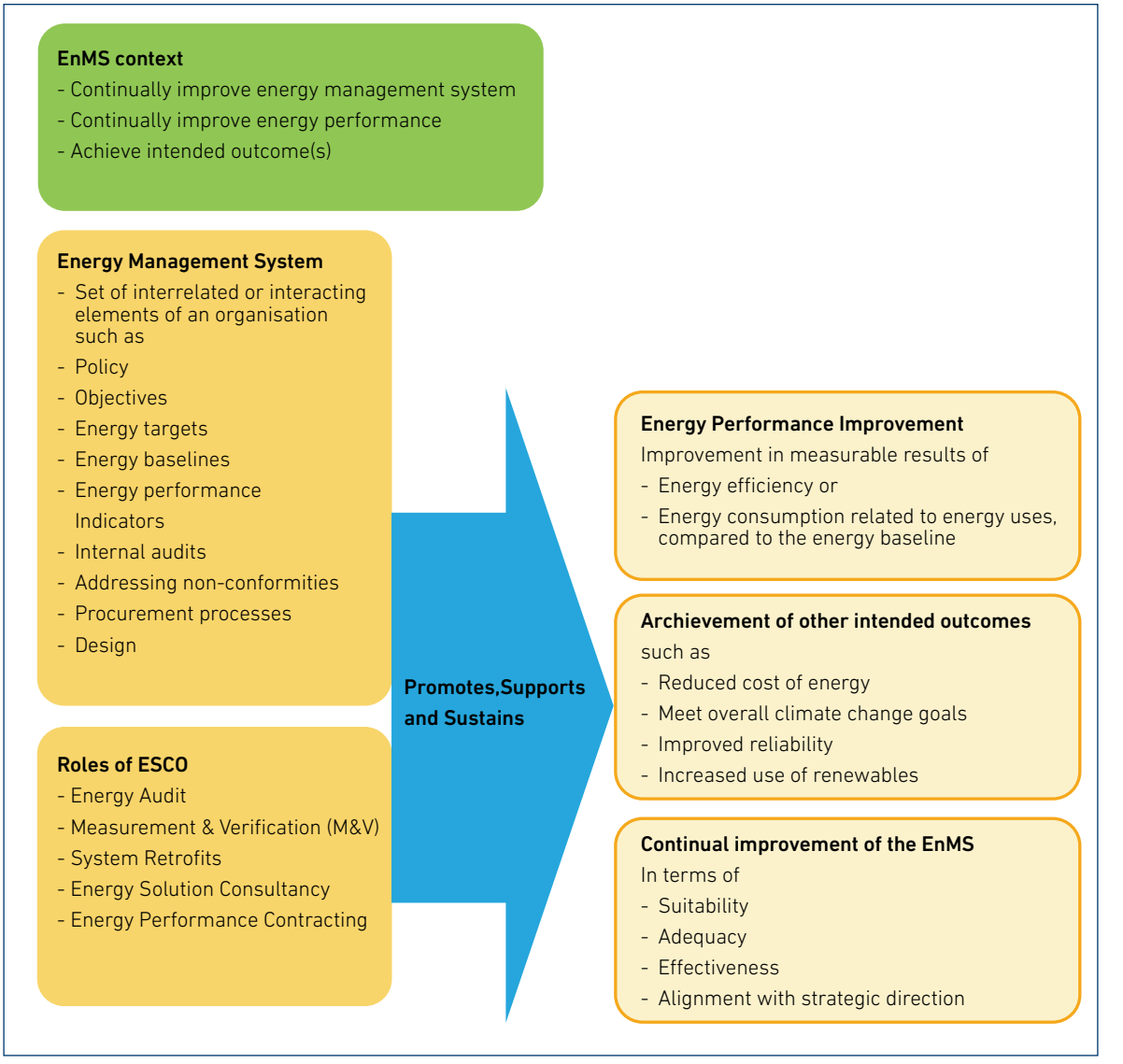
EPC = energy performance contract.

Source: Author.

Yet the numerous benefits of EPCs cannot be understated. In the quest to meet net-zero emissions by 2050 against tight fiscal budgets, a few countries have instituted policies to adopt EPCs for the retrofitting of government buildings. It is believed that EPCs managed with EMSs will expand within the next decade.

The relationship between EMSs and ESCOs for improving energy performance is depicted in Figure 7.13.

Figure 7.11. Relationship between Energy Management Systems and Energy Service Companies



EnMS = energy management system, ESCO = energy service company.

Source: Author's adaption from ISO 50001.

4. Strengths, Weaknesses, Opportunities, and Threats

The strengths, weaknesses, opportunities, and threats for EMSs and ESCOs in Lao PDR are listed in Figure 7.14.

Figure 7.12. Strengths, Weaknesses, Opportunities, and Threats for Energy Management Systems and Energy Service Companies

Strengths			Weaknesses		
Political	:	Has the desire to achieve environmental sustainability	People	:	low awareness on benefits of EE
Economic	:	Implementation of EnMS improves balance of payment	Industry ESCO	:	Absence of accreditation of ESCOs and association
Societal	:	People aware of the need to combat climate crisis	Competency	:	Inadequate qualified and competent energy managers, energy auditors and M&V professionals
Technology	:	Readily available and will be supported by ASEAN and other advanced nations on EE technologies	Tariff	:	Low electricity tariff
Environmental	:	Adopts SDG and practice ESG	Financial Support	:	Financial institutions may not be ready to offer EPC funds
Legal	:	Keen to implement policies which are beneficial to the nation	Financial Capacity	:	Nedds Financial aids
Opportunities			**Threats**		
Markets	:	Vast potential to reap savings from EE	Government Policy	:	Low priority on EE; faltering commitment; vague EE framework; absence of sustainable funding and implementation strategies
People	:	Positive and hardworking people to take new challenge and accept new technologies	Electricity Tariff	:	Barriers to implementation of energy saving measures by consumers
Industry	:	Build capacity of ESCOs and establish an ESCO association	Finances	:	EE loans requirement from financial institutions are too rigid and process is overly bureaucratic. Interest rate is not attractive for ROI
Government Support	:	Commitment of government to implement EE initiatives products on EE	People	:	Low capacity of competent professionals to support the industry; staff from financial institutions (FIs) do not have technical knowledge to assess loan application
Technology	:	Best available technologies (BAT) on EE are available	Competency	:	Inconsistent competency of EE professionals and ESCOs caused resistance towards adoption of EE initiatives

ASEAN = Association of Southeast Asian Nations; EE = energy efficiency; EnMS = energy management system; ESCO = energy service company; ESG = environmental, social, and governance; M&V = measurement and verification; ROI = return on investment; SDG = Sustainable Development Goal.

Source: Author.

The fact that the Government of Lao PDR requested this chapter speaks to the strengths of the nation and its political maturity. The country's energy supply is admirably dominated by hydropower, demonstrating long-term energy supply planning and execution of these plans. These national attributes provide further impetus to attain energy neutrality by 2050.

However, the low electricity price of US$0.024–US$0.045/kilowatt-hour does not bode well for energy efficiency. The low awareness of energy efficiency and lack of competent energy professionals and ESCOs are inherent weaknesses of Lao PDR. Moreover, the absence of a policy framework, legislation, and regulations on energy savings enhance the country's weaknesses. Funding from financial institutions pivots on governmental policies to accelerate energy savings and the number of ESCOs capable of offering shared EPC savings models. The low capacity of competent professionals to support the industry is a huge challenge towards energy efficiency as well. The major threat to these weaknesses is that energy efficiency will not be realised soon enough due to lack of a national energy-efficiency legislative framework.

Against this backdrop of weaknesses and threats lie opportunities for Lao PDR. The opportunities for lower energy consumption are enormous as the efforts to save energy by ESCOs and implementation of EMSs are relatively untapped. As tabulated in Chapter 1, the final energy demand is forecasted to grow from 6.11 million tonnes of oil equivalent (Mtoe) in 2030 to 9.46 Mtoe by 2060, an increase of 1.5 times from 2030. The scenario offers many opportunities to lower energy consumption substantially with the services of ESCOs and implementation of EMSs.

5. Proposed Policy Directions

To take advantage of the vast potential of energy savings through implementation of EMSs and ESCOs, the following short-term (i.e. 1–3 years) and medium- to long-term (i.e. from year 4) policies are recommended.

5.1. Short-Term Policies

(i) **Issue a special order or ministerial directive to implement EMSs**. The directive is to compel all government buildings, government-owned manufacturing plants, and installations consuming more than 500,000 kilowatt-hours/month of electricity to implement EMSs. Private sector buildings consuming energy at a similar threshold may be requested to comply with this directive as well.

(ii) **Fast-track registration of ESCOs**. Local engineering consultancy companies, practicing engineers, and architects who have experience in providing energy services locally and/or working with registered foreign professional engineers or registered ESCOs from any of the ASEAN Member States on transfer of energy-efficiency knowledge can apply for this fast-track registration scheme. This policy would allow Lao PDR to register an initial pool of ESCOs and corresponding professionals to carry out energy audits, energy-efficiency consultancy services, building or facility retrofitting, and EPC services.

(iii) **Implement a national demonstration project**. Amongst the high energy-consuming government buildings or factories, one should be chosen for an energy-efficiency demonstration project to be implemented by a registered ESCO and maintenance staff. The scope of work would be to conduct a Level 3 energy audit, implement energy savings starting from no-cost measures to high-cost measures, implement medium- and high-cost measures with an EPC, and implement an EMS. This project should be completed within 2–3 years, and the energy performance must be reported monthly to the Ministry of Energy and Mines.

(iv) **Build the capacity of energy-efficiency professionals through structured training**. One of the weaknesses is the low capacity of energy-efficiency professionals including energy auditors, energy managers, and measurement and verification professionals. These group of professionals support effective implementation of EMS and the long-term national plans on energy efficiency and conservation.

(v) **Promote energy efficiency and conservation nationally through a communication plan**. Awareness of energy efficiency and conservation is crucial towards lowering final energy use and maximum demand, resulting in a lower increase of energy supply and installed capacity. Promotion of energy efficiency and conservation should cut across all sectors. Stakeholder engagement seminars and workshops are necessary to impart knowledge, and focus should also be on educating families and students through fundamental practices of conserving energy (e.g. any appliance set on standby mode is a waste of energy).

5.2. Medium- and Long-Term Policies

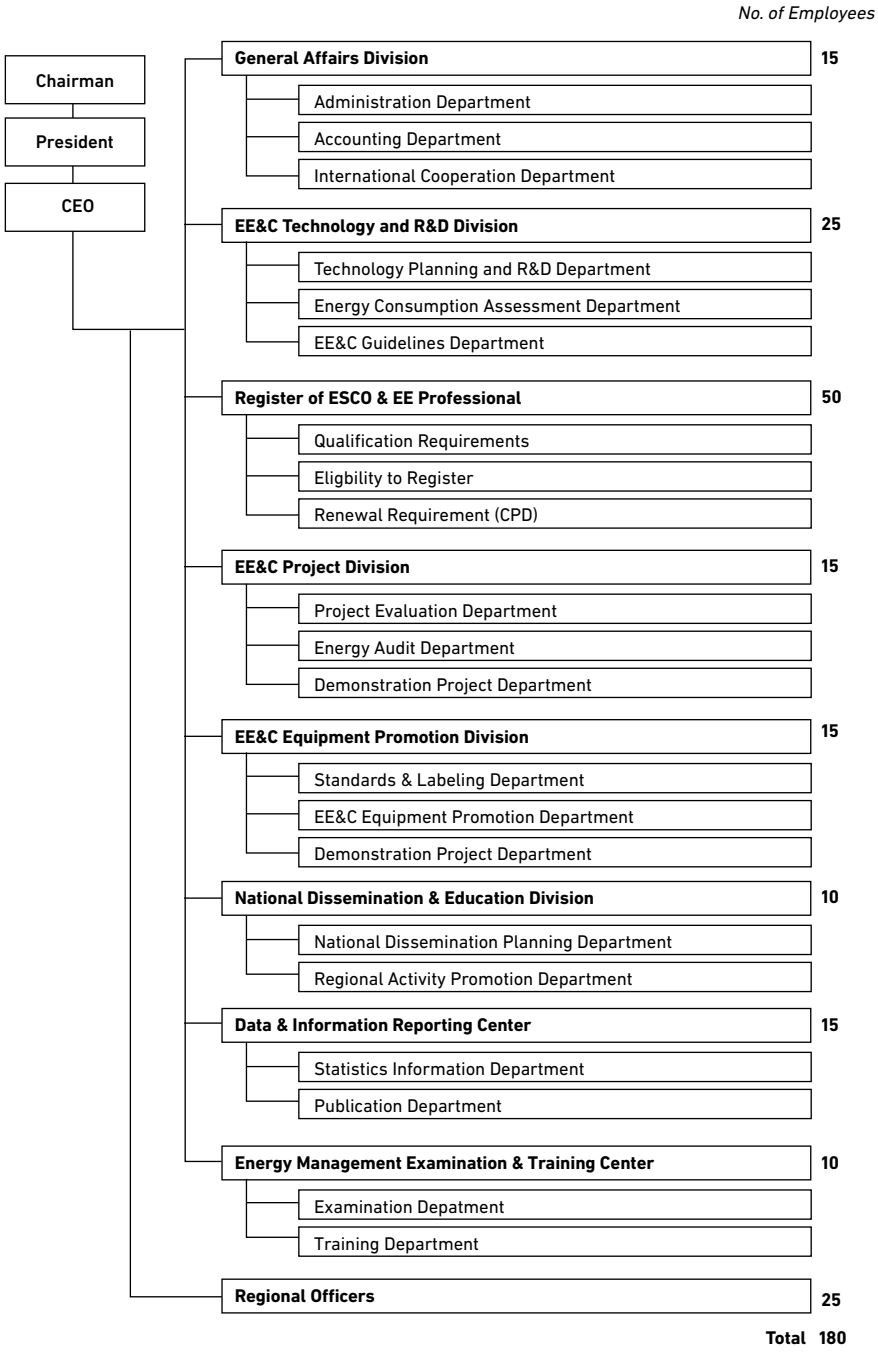
One of the key policies for Lao PDR on energy efficiency and conversation is the eventual enactment of a holistic national decree or legislation. Understandably, the process of developing the act will take considerable time. The following are the recommended medium- and long-term policy directions.

(i) **Legislate a national energy-efficiency and conservation act**. The act should have prescribed premises relating energy efficiency to the industrial, commercial, and residential sectors; prescribed energy-using products; operational requirements to implement EMSs and to carry out energy audits; establish a national implementation agency under the Ministry of Energy and Mines; enable registration of ESCOs, energy managers, energy auditors, and training providers; create a sustainable funding mechanism for energy efficiency including expenditures and conservation of the fund through investment; detail information-gathering power and enforcement provisions; and define general provisions such as publication of information, power of the minister to make regulations, and power of authority to make rules and issue guidelines.

(ii) **Legislate energy-efficiency and conservation regulations**. While an energy-efficiency and conservation act would stipulate the broad provisions of laws, regulations are required for lowering the threshold of prescribed premises to capture more consumers. The regulations should have key provisions such as an obligation to submit information on EMSs; qualification requirements and application process of energy-efficiency professionals; certificates of registration, and detailed functions and duties of ESCOs and energy-efficiency professionals; fee structures for ESCOs and energy-efficiency professionals; required reports from EMSs; and declarations of registered energy-efficiency professionals.

(iii) **Operationalise the implementation agency**. The main functions of the implementation agency as empowered by the proposed act should be to coordinate with prescribed premises, collaborate with government agencies and other bodies, recognise and utilise existing resources and infrastructure, and perform such functions and exercise such powers as assigned. These may include developing guidelines for factories, developing guidelines for buildings, registering ESCOs and energy-efficiency professionals, prescribing guidelines for energy-using equipment, promoting measures for consumers, implementing common measures including distributing financial assistance and incentives, creating a data and information repository centre, and establishing regional offices. The existing energy-efficiency department of the Ministry of Energy and Mines can be expanded into a national implementation agency with adequate human, technical, technological, and financial resources to manage all provisions of the energy-efficiency act and regulations. The typical organisation structure of an implementation agency is in Figure 7.15.

Figure 7.13. Organisational Structure of Implementation Agency



CEO = chief executive officer, EE = energy efficiency, EE&C = energy efficiency and conservation, ESCO =energy service company, R&D = research and development.

Source: Author.

(iv) **Operationalise a sustainable funding mechanism**. The success of any project depends on the timeliness and adequacy of financial resources to meet the budget requirements yearly. It should be independent from the fiscal budget and sustainable to meet the operational budget of the implementation agency, expenditures of energy-efficiency campaigns, and incentives for implementation of high-cost ESMs and others.

(v) **Enhance capacity building through structured trainings**. With growth of the gross domestic product and population in the foreseeable future, final energy demand will increase in Lao PDR. It is hoped that with effective implementation of an energy-efficiency legislative framework, EMSs, and ESCOs, the final energy demand will decouple from the scenario of business-as-usual. The needs for energy-efficiency professionals to support implementation of the act and regulations will grow even faster. The following are subjects of some courses to be conducted for capacity building: ISO 50001 EMSs; energy audits; measurement, reporting, and verification; EPCs; registration, functions, and roles of ESCOs; project management; and ESMs from electrical and thermal systems.

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