

Sri Lanka

Sustainable Energy Support

**Implementation and Financing Mechanisms for
Energy Efficiency Improvements in Commercial,
Public, and Industrial Buildings**

Final Report

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Abbreviations and Acronyms

AC	Air Conditioner
ADB	Asian Development Bank
ADB I	Asian Development Bank Institute
AHU	Air Handling Unit
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BEA	Berlin Energy Agency
C&I	Commercial and Industrial
CaaS	Cooling as a Service
CAGR	Compounded Annual Growth Rate
CCC	Ceylon Chamber of Commerce
CCHP	Combined Cooling, Heating, and Power
CCI	Chamber of Commerce and Industry
CEB	Ceylon Electricity Board
CFC	Chlorofluorocarbon
CFL	Compact Fluorescent Lamp
CRISIL	Credit Rating Information Services of India Limited
DSM	Demand-Side Management
E2F	Energy Efficiency Fund
EAS	Energy Audit Service
EC	Electronically Commuted
ECM	Energy Conservation Measure
EDB	Economic Development Board
EE	Energy Efficiency
EEBC	Energy Efficiency Building Code
EEI	Energy Efficiency Improvement
EEI&C	Energy Efficiency Improvement and Conservation
EEM	Energy Efficiency Measures
EER	Energy Efficiency Ratio
EERF	Energy Efficiency Revolving Fund
EESL	Energy Efficiency Services Limited
E-Friends	Environmentally Friendly Solutions Funds
EPACT	The US Energy Policy Act of 2005
EPC	Energy Performance Contracts
ESCO	Energy Services Company
ESD	Energy Services Delivery
ESPC	Energy-Saving Performance Contract
ETTV	Envelope Thermal Transfer Value
EU	European Union
FEDESCO	Federal ESCO of Belgium
FI	Financial Institution

FTL	Fluorescent Tubular Light
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHI	Global Horizontal Irradiance
GoSL	Government of Sri Lanka
GP	General Purpose
GWP	Global Warming Potential
HC	Hydrocarbon
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
HVAC	Heating, Ventilation, and Air Conditioning
IAQ	Indoor Air Quality
IDA	International Development Association
IEA	International Energy Agency
IPMVP	International Performance Measurement and Verification Protocol
IPP	Independent Power Producer
IT	Information Technology
JBIC	Japanese Bank for International Cooperation
JICA	Japan International Cooperation Agency
LECO	Lanka Electricity Company Pvt. Ltd.
LED	Light Emitting Diode
LFL	Linear Fluorescent Lamp
LPD	Lighting Power Density
M&V	Measurement and Verification
MAC	Mobile Air Conditioning System
MEPS	Minimum Energy Performance Standards
MOPE	Ministry of Power and Energy
MTOE	Millions of Tons of Oil Equivalent
NDB	National Development Bank
NDC	Nationally Determined Contribution
NOU	National Ozone Unit
NPLV	Nonstandard Part Load Efficiency Value
NZEB	Net Zero Energy Building
O&M	Operations and Maintenance
ODP	Ozone Depletion Potential
ODSM	Operation Demand-Side Management
PEP	Promotion of Eco-efficient Productivity
PFI	Participatory Financial Institution
PMU	Project Management Unit
PRSF	Partial Risk Sharing Facility for Energy Efficiency
PUCSL	Public Utilities Commission of Sri Lanka

PV	Photovoltaic
RAC	Room Air Conditioner
RCC	Reinforced Cement Concrete
RE	Renewable Energy
RERED	Renewable Energy for Rural Economic Development
RFP	Request for Proposal
RTTV	Roof Thermal Transfer Value
S&L	Standards & Labeling
SEA	Sri Lanka Sustainable Energy Authority
SEER	Seasonal Energy Efficiency Ratio
SIDBI	Small Industries Development Bank of India
SLS	Sri Lanka Standard
SMEs	Small and Medium Enterprises
SPP	Small Power Producer
STES	Seasonal Thermal Energy Storage
T&C	Terms and Conditions
TP	Technology Provider
TR	Ton of Refrigeration
UDA	Urban Development Authority
VAM	Vapor Absorption Chiller
VAV	Variable Air Volume
VFD	Variable Frequency Drive
VRF	Variable Refrigerant Flow
VRV	Variable Refrigerant Volume
WWTP	Wastewater Treatment Plant

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A workshop, held on November 10, 2022, in Colombo, discussed some of the report’s findings and recommendations.

Summary

This report aims to present viable options for implementing energy efficiency (EE) in the buildings sector. It is divided into seven sections. Chapter 1, Introduction, provides an overview of the country's building sector with a focus on EE as well as program objectives, outcomes, and approach. Chapter 2, Technical Assessment of Energy Efficiency Potential, includes findings on energy saving, cost saving, and investments for EE in cooling and lighting for the building sector and reviews the state of the EE technologies in the country, as well as the policy, regulatory, and administrative framework. The potential for energy efficiency in cooling and lighting is summarized in Table 1.

Table 1: Summary of Potential for EE in Lighting and Cooling

Description	Estimates		
	Cooling (Room Air Conditioner [RAC]) (Assessment Period 2022–31)	Cooling (Chiller) (Assessment Period 2022–31)	Lighting (Savings @ Service Life)
Incremental cost of efficient appliance (US\$, millions)	505	11	—
Potential electricity savings (GWh)	4,200	225	2,740
Cost savings through avoided electricity use (US\$, millions)	720	37	300

Chapter 3, National and International ESCO Landscape, covers case studies, best practices, and learnings from global as well as Asian experience. It includes insights from the assessment of the ESCOs in the country. Chapter 4, ESCO Models, details the business models for commercial, industrial, and public buildings and covers roles and responsibilities for all entities involved in implementation

of the ESCO models. The ESCO models, one for the public sector and the other for the commercial and industrial (C&I) sector, are diagrammatically represented as follows:

Figure 1: Model for Public Buildings

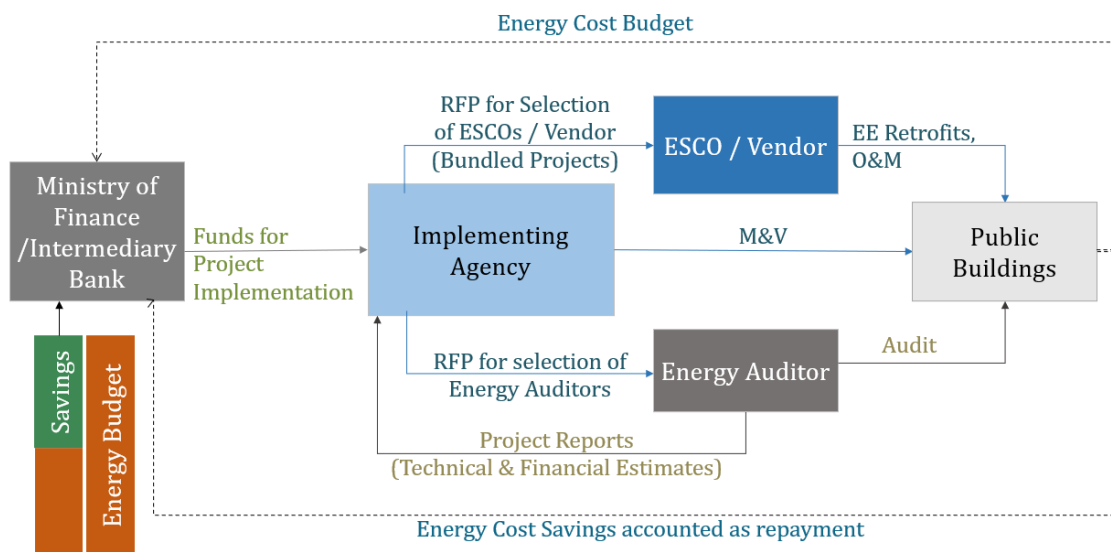
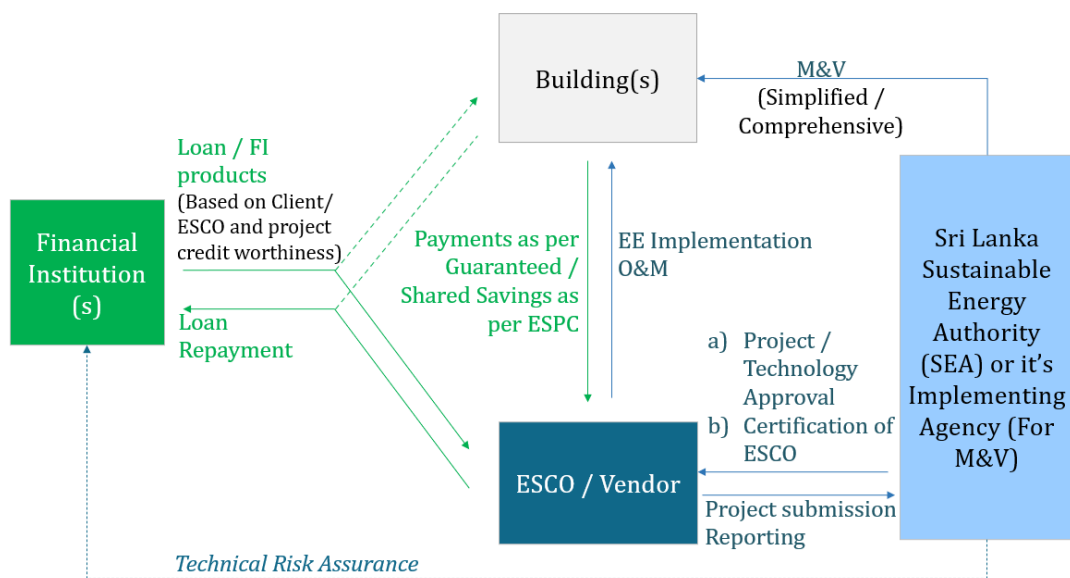


Figure 2: Model for C&I Buildings



Chapter 5, Pilot Project Development, details the approach, review, and status of the pilot projects identified.

1 Introduction

Sri Lanka, an island nation, with a coastline of approximately 1,000 km and a landmass of 65,000 sq. km, has three distinct climate zones—dry, intermediate, and wet—and has a plateau and mountain range rising from its center. These variations in climate lead to different lifestyles, requirements for buildings, and thus different patterns of energy usage. The nation is dependent on imports of fuel and as an island is more vulnerable to sea level rise due to climate change, as well as disasters such as the tsunami in 2004.

In 2015, the Sri Lanka Energy Sector Development Plan for a Knowledge-based Economy 2015–2025 stated that conservation and efficient use of energy is a thrust area for the Government of Sri Lanka and aimed at a target of reducing annual energy demand growth by 2 percent through conservation and efficient use and reducing the carbon footprint of the energy sector by 5 percent by 2025.

The National Energy Policy and Strategies of Sri Lanka (2019) stated that several objectives dealing with access to clean and safe electricity have been achieved (Sri Lanka has achieved 100 percent electrification). The nation aims for sustainable, reliable, and affordable energy supply, and the policy considers its commitment to the United Nations Sustainable Development Goal 7 (Affordable and Clean Energy). At the same time, the nation aims to reach an upper-middle-income level in the World Bank classification, which will require greater energy consumption. The Ministry of Power and Energy, which released the National Energy Policy and Strategies of Sri Lanka (2019), recognizes that energy, the sources of energy, access to energy, and the use of energy all have social, economic, and environmental impacts and that the energy sector will play a role in the nation achieving carbon neutrality.

1.1 Sri Lanka Electricity Sector

According to the International Energy Agency (IEA), although the share of mineral fuels has been increasing in Sri Lanka's energy mix, 40 percent of electricity was still generated from hydroelectricity in 2017. Credit Rating Information Services of India Limited (CRISIL) projected that Sri Lanka's total primary energy consumption is likely to be 16.2 millions of tons of oil equivalent (MTOE) by FY2030, a jump from the 11.4 MTOE in FY2018.¹ CRISIL also noted that Sri Lanka services all coal-based energy demands such as power production or production plants for items such as steel

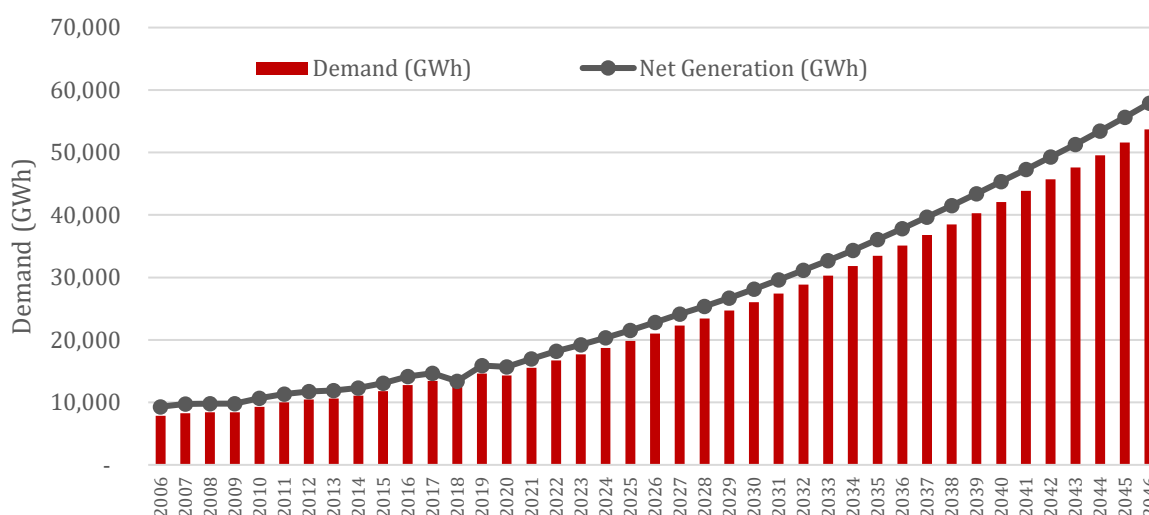
¹ CRISIL (2019a)

through imports, and imports approximately 85 percent of its crude demand and 90 percent of its gas requirements.²

The primary indigenous sources of energy in the nation are hydroelectricity and biomass-based energy sources, which cannot be upscaled to meet the growing energy requirements for a developing nation, which incentivizes the push for long-term energy efficiency (EE) measures such as in the building sector. Sri Lanka also has immense potential for solar and wind energy, which is being scaled up by the government. This is an area for immediate action for the nation as, given that the potential for hydroelectricity has been largely tapped, the increasing energy demand will be met from nonrenewable sources if the renewable sector is unable to meet the requirements.

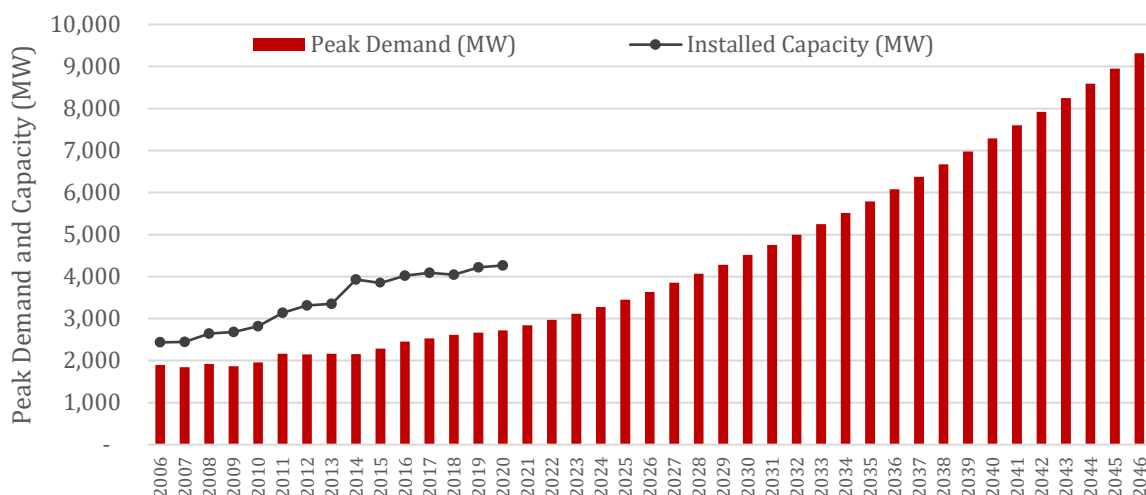
Demand for electricity in the country has been growing at an average rate of about 4.4 percent per year during the last 15 years, while peak demand has been growing at a rate of 2.6 percent per year on average. However, during 2020, demand contracted (by 2 percent, 300 GWh compared to 2019) due to the COVID-19 pandemic. According to demand projections outlined in the Long-Term Generation Expansion Plans 2022–2041, the growth is expected to continue at an average rate of 5.2 percent. The maximum recorded peak demand of 2,717 MW was recorded in 2020. Total net electricity generation in 2020 was 15,714 GWh. At the end of 2020, Sri Lanka had a total installed generating capacity, including rooftop solar, of (approximately) 4,615 MW. This included 2,447 MW of renewable energy (RE) based generating capacity and 2,168 MW of thermal capacity.³

Figure 3: Actual and Projected Electricity Data



² CRISIL Research (2019b)

³ CEB (2021)



Source: Adapted from CEB 2021.

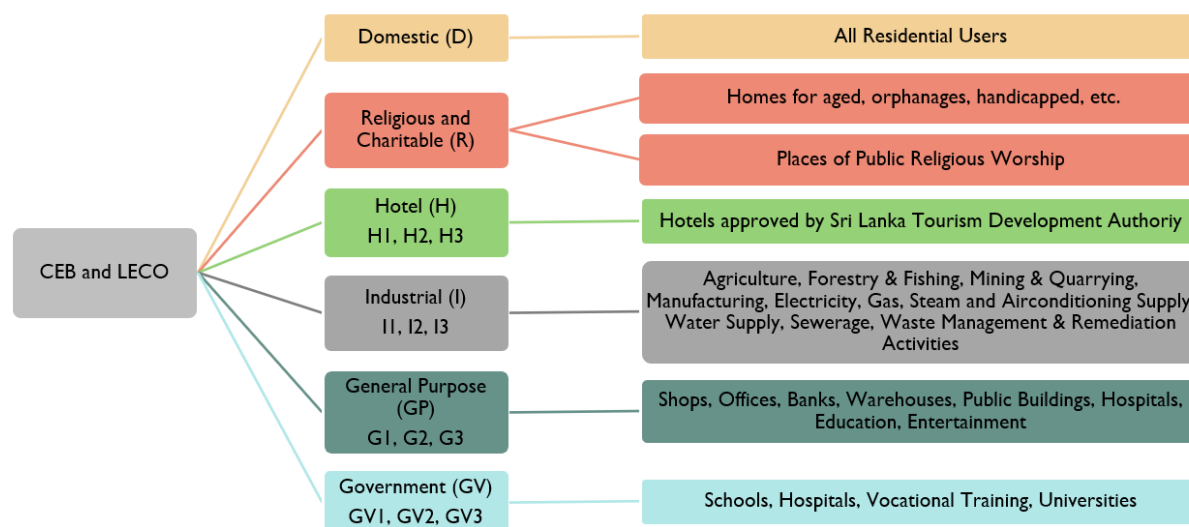
Sri Lanka, being a partner to the Paris Agreement on the mitigation of global climate change-induced impacts, presented its first Nationally Determined Contributions (NDCs) in 2016 to strengthen global efforts, expressing a commitment of 4 percent unconditional and 16 percent conditional reduction of greenhouse gas (GHG) emissions compared to the business as usual (BAU) scenario of the Long-Term Generation Expansion Plan 2013–2032 for the electricity sector. The country is currently planning to further enhance its commitments through the second NDC submission for the electricity sector, by reducing GHG emissions unconditionally by 5 percent and conditionally by 20 percent compared to the BAU.⁴

1.2 Electricity Demand from the Building Sector

Both the Ceylon Electricity Board (CEB) and the Lanka Electricity Company Pvt. Ltd. (LECO) have categorized the electricity consumers based on tariff categories. There are six broad consumer categories—Domestic, Religious and Charitable, Hotel, Industrial, General Purpose (GP), and Government. Each of the tariff types is further categorized based on increasing contract demand and the rate at which supply is delivered and metered. Medium and large consumers of Industrial, GP, and Hotel categories pay for their consumption based on time of use. Domestic consumers can opt for either conventional tariff structure or time-of-use-based tariffs. However, the number of those who have opted for time-of-use tariff plan is abysmally low. While the tariff categorization factors in primary function, there are varied building types, especially within the GP, Industrial, and Government consumer tariff categories (Figure 4).

⁴ Ibid.

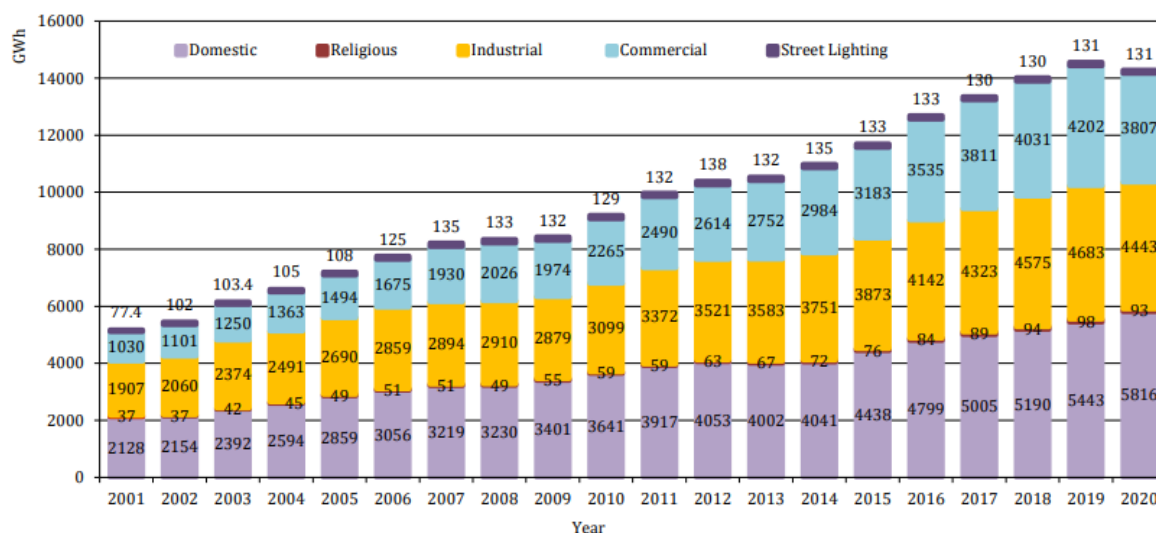
Figure 4: Tariff Categories and Building Types



Source: Adapted from Electricity Tariffs and Charges of Public Utilities Commission of Sri Lanka [PUCSL].

The sectoral electricity consumption (tariff category wise) from 2001 to 2020 is shown in Figure 5. The combined consumption of the commercial and industrial (C&I) sectors (the commercial sector consists of the GP, Hotel, and Government tariff categories) is higher than the domestic sector consumption. Commercial buildings and industrial buildings, which account for 60 percent of the country's energy demand, have witnessed rising energy usage. The domestic, industrial, and commercial sectors have consistently been the largest consumers of electricity over the previous two decades.

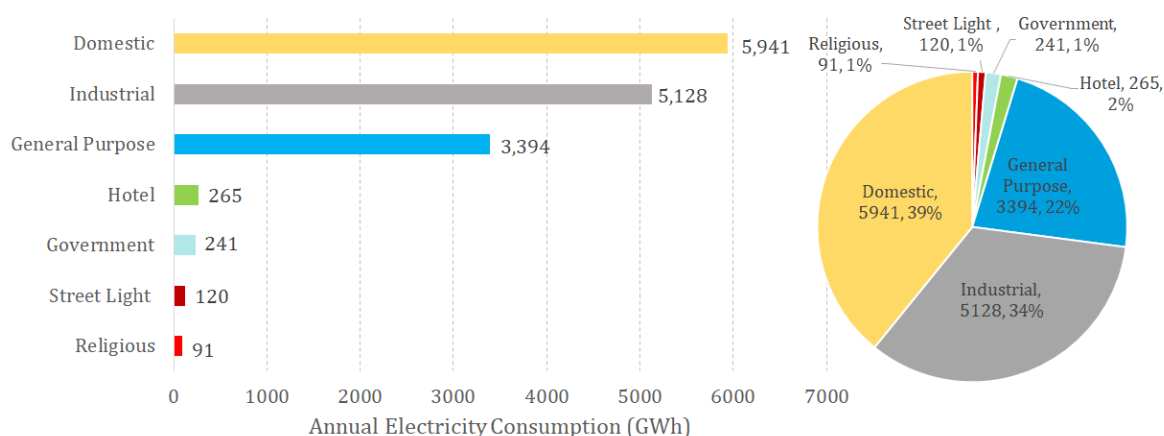
Figure 5: Sectoral Electricity Consumption



Source: CEB 2021.

According to CEB Statistical Digest 2021, the domestic sector contributes to 39 percent, followed by the Industrial sector contributing to 34 percent of the electricity requirement. This is followed by the GP category which has a wide range of building types (explained in Figure 6).

Figure 6: Building Sector's Contribution to Electricity Requirement



Source: CEB 2022.

1.3 Need for Energy Efficiency in the Building sector

Increasing cooling requirement is both a response to and a catalyst to Sri Lanka's vulnerability to climate change. About 10 percent and 12 percent of construction cost of a commercial building in Sri Lanka is attributed to refrigeration and air conditioning system, respectively, with air conditioning systems accounting for between 50 percent and 60 percent of the energy expenses of a typical commercial building.^{5,6} While many of the current cooling systems are old and inefficient, commercial building cooling consumption in comparison to a 2017 baseline is expected to increase fourfold by 2034. This will be more than double the expected residential cooling consumption. The potential for energy savings across public, commercial, industrial, and residential buildings associated with an increase of energy efficiency (EE) could be between 30 percent and 50 percent. Increasing EE would help the nation respond to the economic crisis and manage the rising energy demand connected with buildings, particularly for cooling in commercial and public sector buildings. Implementing effective, clean space cooling systems is in accordance with Sri Lanka's economic, energy, and environmental goals.

1.4 EE Financing Landscape

EE was treated as an additional task incurring heavy additional investment during the late 1990s and early 2000s. However, when clients realized the operational benefits of EE measures in late 2000, they started incorporating EE measures at the design stage itself in new developments. Financing of these building EE activities has been through the usual financing arrangements available for any construction or business operation, despite the EE elements embedded in the investment.

⁵ GoSL (2020).

⁶ At the national level, electricity demand for air conditioning represents 18-20 percent of the total electricity demand.

Financing mechanisms for EE were available since early 2000 as part of climate and environmental responsibility. Environmentally Friendly Solutions Funds (E-Friends) I and II mechanisms⁷ were quite popular among the industries and were used in water and effluent treatment facility construction and improvements. Apart from the plantation sector, where E-Friends loan funding was successfully used for process energy efficiency improvement (EEI) projects, very few investors used these funds for energy-efficient development.

The Promotion of Eco-efficient Productivity (PEP) program executed by the Ceylon Chamber of Commerce (CCC) using funds made available by the Royal Netherland Embassy in Sri Lanka provided grant funding for EE projects (subject to a maximum value of LKR 5 million). About 35 projects financed by the program were related to energy and energy efficiency. A sector-specific energy and water efficiency-related financing and a capacity-building program were executed by CCC using European Union (EU) financing. The program 'Greening Sri Lankan Hotels' under the EU umbrella program Switch Asia provided grants to Sri Lankan hotels to improve efficiency in their energy and water use. The EU offered approximately € 1.5 million for this program.

While the development of RE was the primary focus, the World Bank's Renewable Energy for Rural Economic Development (RERED) project and its predecessor Energy Services Delivery (ESD) project were accessible for some EE technologies. A limited number of EE projects obtained financing from these loan schemes despite the bulk of the disbursements of the scheme being for RE projects.

More recently and at present, significant funding has been made available by Asian Development Bank (ADB) for the RE sector for rooftop solar development. This low-interest loan scheme to install rooftop solar systems under the Battle for Solar Energy initiative of the government is quite popular in the high-end residential sector. Multiple private sector banks are involved in the scheme as participatory financial institutions (PFIs). The process involved is less complicated to evaluate and commit, and therefore, the funding disbursement has been successful.

Table 2: Summary of EE and RE Financing schemes in Sri Lanka

Financing Scheme	Funding Agency	Implementing Agency	Period	Details
E-Friends I	JBIC	Administered by National Development Bank (NDB)	1998–2004	Phase 1 - Loan disbursed ~JPY 2,400 million. The fund consists of two components: (a) A general loan component at concessionary interest rates (b) An interest-free technical assistance loan component.
E-Friends II	JICA		2004–2010	To address environmental issues according to National Energy Policy targeted toward industrial enterprises.

⁷ E-Friend I and E-Friend II are loan schemes supported by Japanese Bank for International Cooperation (JBIC)/Japan International Cooperation Agency (JICA) in 1998 and 2004, respectively. Both these programs offered credit for a very low interest of 6.5–8.5 percent, causing many industries to take part. The attractive interest rate mobilized the capacity of local ESCO industry, and many projects were developed for implementation. However, the project operated in a narrow band of proven technologies and was not meant for introducing new technologies. The project saw replication of success across sectors, such as introduction of variable speed drives in tea withering fans. More than 16 projects got loan funds of LKR 136.884 million for energy saving, mostly in the plantation sector (Source: Wickramasinghe [2009]).

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Financing Scheme	Funding Agency	Implementing Agency	Period	Details
PEP	Royal Netherland Embassy in Sri Lanka	CCC	2006–2008	Eligible projects received a grant of up to 50 percent of the project costs with a ceiling of LKR 5 million. Launched 51 projects, of which 36 were energy-related projects. Instrumental in introducing dendro ⁸ power as an alternative to fossil fuels in industry and popularizing biomass energy technologies in industries.
Energy Services Delivery project	World Bank	DFCC Bank, CEB	1997–2002	Credit loan US\$24.20 million; World Bank (International Development Association [IDA]) grant US\$5.7 million Global Environment Facility (GEF) Establish testing facilities, pilot wind power project, and support CEB on demand-side management (DSM) (National Load Research Project and Evaluation of the Energy-Efficient Lighting Program).
Renewable Energy for Rural Economic Development project	World Bank	DFCC Bank	2002–2011	Project cost – US\$125.70 million; IDA commitment – US\$75 million Primary focus on renewable energy. Grid-connected RE installation of Solar Installed - Number of projects completed = 184.3 MW 116,000 solar home systems with RERED support. EE financing received 0.9 percent of project financing (E-Fund served as a competitor to EE component of RERED).
Greening Sri Lankan Hotels	EU Switch Asia	CCC	2009–2013	Project budget € 1,829,828 (EU contribution: 80 percent) Walk-through audits were carried out in 88 hotels, comprehensive cleaner production audits in 5 hotels, and detailed energy audits in 5 hotels. Addressed 365 hotels to increase their environmental performance. Development of new Green Accreditation Scheme and Environmental Guidelines for New Hotel Developments.

⁸ Dendro power is the generation of electricity from sustainably grown biomass (fuel wood).

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Financing Scheme	Funding Agency	Implementing Agency	Period	Details
Rooftop Solar Power Generation Project	ADB	Ministry of Finance	2018–2022	Credit line of US\$50 million. As of March 15, 2021, the total sub-loan amount is US\$18.53 million and the total disbursed is US\$36.49 million. Long-term debt financing for RE installation. Power generated through rooftop solar photovoltaic (PV) can be integrated through the following three schemes: • Net metering scheme • Net accounting scheme • Net plus scheme
Sri Lanka Energy Program	United States Agency for International Development (USAID)	Government of Sri Lanka	2021–2026	Value of Technical Assistance - US\$18.9 million Aims to improve the cost-reflectivity of electricity tariffs, increase the deployment of RE, improve DSM, and deploy advanced technologies. Expected results: • Increase the pipeline of RE projects to at least 800 MW. • Increase rooftop solar deployment. • Identify priority EE options and support counterparts to implement. • Design a tariff-setting process, including utility data provision, public communication, stakeholder engagement, and regulatory decisions. • Improve energy sector planning. • Improve the competitive tendering processes employed by power sector actors.

2 Technical Assessment of Energy Efficiency Potential

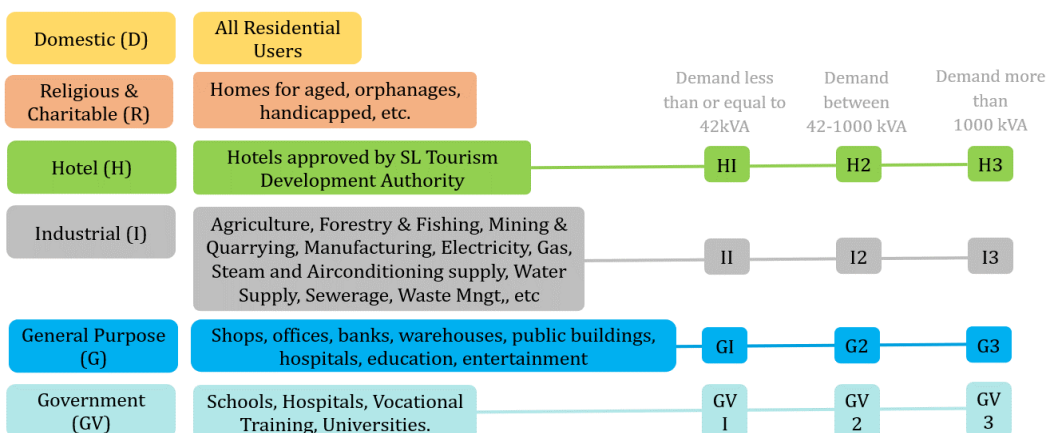
Technical assessment of EE potential in commercial, public, and industrial buildings has been carried out through review of documents from Sri Lanka Sustainable Energy Authority (SEA) and publicly available data sources. The development of representative building load profiles and estimation of the EE potential of different building subsectors in Sri Lanka was based on responses to a questionnaire-based survey sent by SEA to over 250 energy managers. However, the assessment of baseline characteristics on envelope, lighting and cooling relied on sectoral knowledge. The EE potential in cooling has been estimated through review of the sales data provided by the Customs Department and local suppliers of RACs and chillers. The EE potential in lighting was based on the results of a 2019 survey on efficient lighting.⁹

2.1 Building Sector Baseline Development

The CEB and PUCSL categorize consumers based on contract demand. The building sector and subsector identification are aligned with the utility classification as captured in Figure 7.

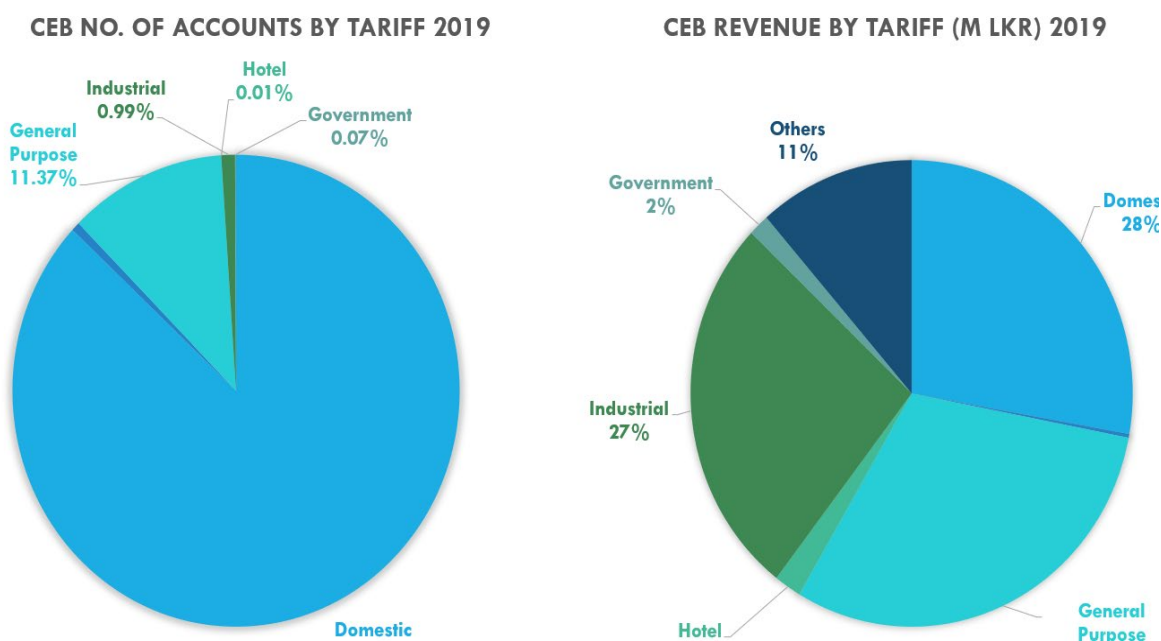
⁹ GoSL (2019a)

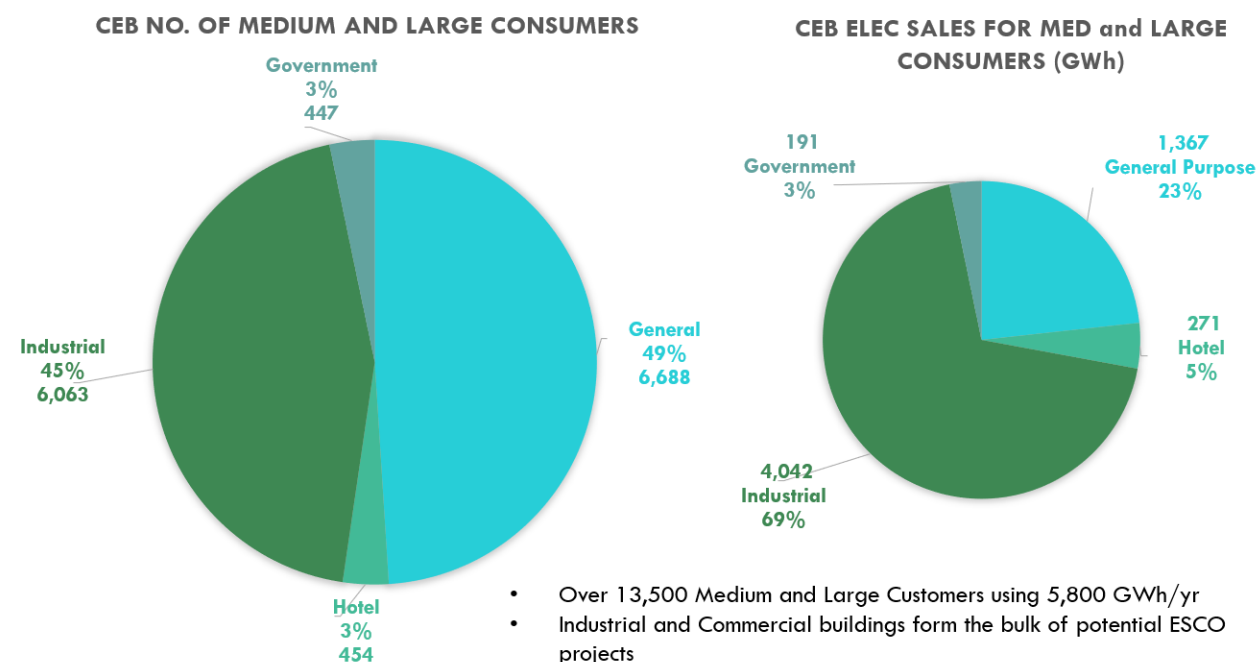
Figure 7: Customer Categories Based on Contract Demand



According to CEB's 2019 Tariff and Sales Data, the number of domestic accounts is an overwhelming 87 percent when compared to other subsectors. However, when considering revenue by tariff, and hence electricity consumption, the industry, government, hotel, and general-purpose sectors contribute toward 61 percent of the revenue. Further, there are over 13,500 medium and large customers utilizing 5,800 GWh/year (approximately 40 percent of the total annual electricity consumption nationwide).

Figure 8: CEB Number of Accounts and Sector-wise Revenue in 2019





Source: CEB 2019.

The baseline/typical envelope (material for roof, wall, and glazing), lighting (type, controls, and sensor), and cooling (technology type) characteristics for different building subcategories were estimated based local stakeholders' insights. Similarly, whether the subsectors have hot water systems and follow facility management practices and what type of submetering is in place have been noted as well. Table 3 is a summary of observations on baseline characteristics.

Table 3: Baseline Assessment of Envelope, Lighting, and Cooling

Building Subsectors	GP1	GP2	GP3	H1	H2	H3	I1	I2	I3	GV1	GV2	GV3
Typical hours of operation in a week	48	48	48	168	168	168	48	96	168	40	40	40
Building envelope												
Wall material	Cement full											
Roof material	Reinforced cement concrete (RCC)			Clay tiles			ZnAl			RCC		
Window Type	Single glazed		Double lazed	Single glazed								
Lighting technology												
Compact fluorescent lamp (CFL) (yes/no)	Yes	No	No	No	No	No	Yes	No	No	Yes	Yes	Yes
Fluorescent (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Light emitting diode (LED) (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lighting sensor and controls	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	No	No
Air-conditioned	No	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Naturally ventilated	Yes	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Mechanical ventilation	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	Yes

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Building Subsectors	GP1	GP2	GP3	H1	H2	H3	I1	I2	I3	GV1	GV2	GV3
Hot water systems	No	No	No	Yes	Yes	Yes	No	No	No	No	No	No
Facility management practices	No	No	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
Submetering												
By energy end use	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	No	No
By floors, function, division, and so on	No	No	Yes	No	No	Yes	No	No	Yes	No	No	No

Note: GP = General purpose, H = Hotel, I= Industrial, GV = Government.

The wall material is consistent across all building subsectors. Cement blocks are commonly used in construction. RCC slabs are mainly used in general purpose (offices, banks, schools, warehouses, shops, restaurants, supermarkets, state institutions, and so on) and government buildings. Hospitality buildings use clay tiles whereas industrial buildings use ZnAl sheets. Single glazing is commonly observed in all building subcategories, except in buildings that have a demand load more than 1,000 kVA.

Fluorescent tubular light (FTL) and LED are used across all subsectors; however, spread of LED technology is still not wide. Lighting controls and sensors are observed in most building subsectors except in those with demand less than 42 kVA and government buildings. A detailed study of the lighting technology according to the building subsector and the potential for energy savings has been carried out in Sections 2.3 and 2.4.

Buildings with contract demand lower than 42 KVA (except those in the Hotel category) are typically naturally ventilated. The industrial sector has a combination of both naturally ventilated and mechanically ventilated spaces.

Hot water systems are primarily seen in the hotel sector. Facility management practices are followed in buildings with contract demand greater than 42 KVA. Buildings under the GV subcategory do not have standardized facility management practices. Submetering too is observed in buildings with contract demand greater than 42 KVA. There is a scope for integrating submetering in government buildings.

2.2 EE Potential

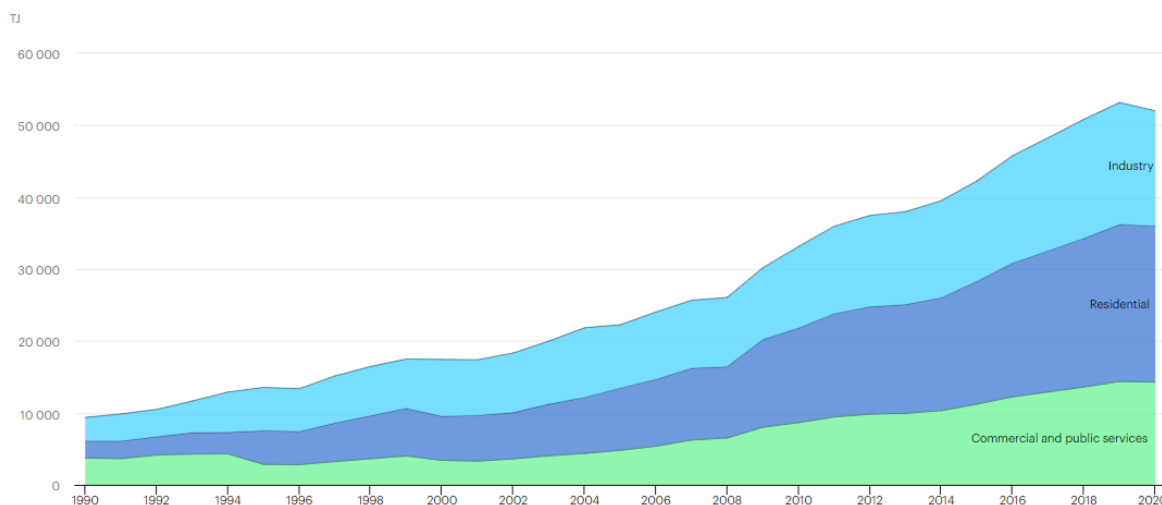
The country's electricity demand increased at an average rate of 5.7 percent during the last five years. The electricity consumption grew from 5,120 GWh in 2000 to 15,714 GWh in 2020. The maximum peak demand of 2.6 GW (2,668.7 MW) in 2019 increased to 2,717 MW in 2020.¹⁰ Figure 9 shows the total energy end use break-up in households and commercial (40 percent), transport (36 percent), and industries (24 percent). In 2021, the share of sales to household customers was 35 percent and to industrial customers was 32 percent, and sales to the commercial sector were 31 percent.¹¹ The Sri Lankan C&I sector comprises a large stock of buildings that contribute to 60 percent of the

¹⁰ CEB (2021)

¹¹ CEB (2022)

national electricity consumption. A major share of electricity is consumed for air conditioning, ventilation, and lighting.

Figure 9: Electricity Consumption by Sector, Sri Lanka 1990–2020



Source: IEA 2022a

IEA estimates that global CO₂ reduction from EE technologies would represent about 34 percent of the total reduction needed to achieve carbon neutrality by 2060, compared to 15 percent for renewables. EE investment could result in substantial energy savings and thus, help improve public finance management. Government of Sri Lanka (GoSL), citing independent studies, assert that investing LKR 11 billion¹² in EEI&C could save LKR 3 billion worth of energy for Sri Lanka, annually. Moreover, investing LKR 135 billion over five years could save up to 1,895 GWh of electricity.¹³

2.3 Potential for Energy-Efficient Cooling

An investment estimate for scaling energy-efficient RAC and chillers in Sri Lanka has been provided in the following sections.

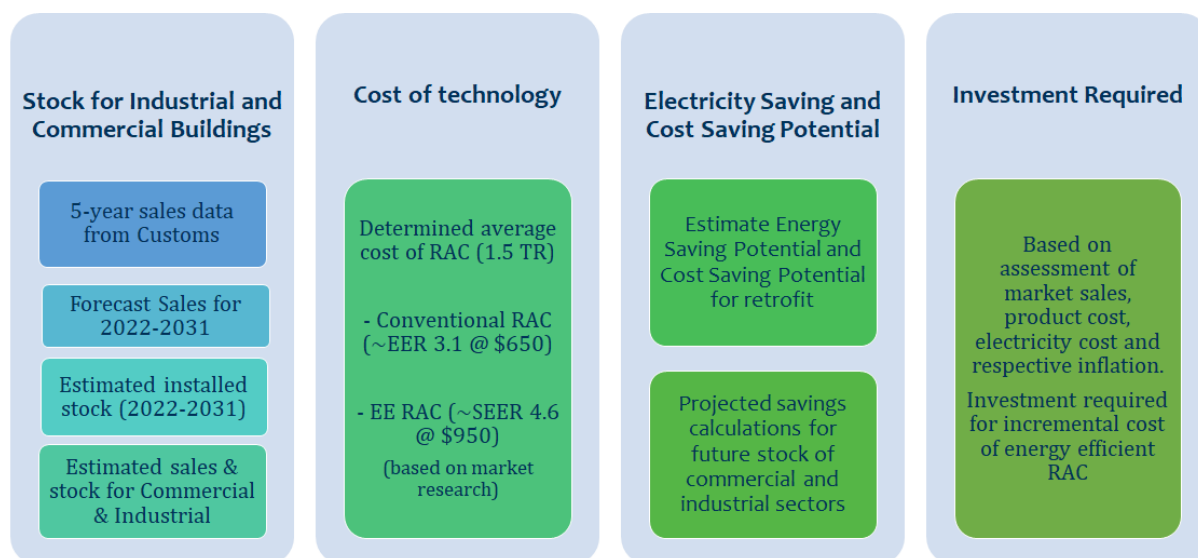
2.3.1 RACs

A four-step methodology was followed for determining the electricity and cost saving potential as well as the investment requirement for scaling and wider adoption of energy-efficient RACs.

¹² LKR 11 billion ~ US\$55 million (1 LKR = US\$0.005).

¹³ Source: <https://www.energy.gov.lk/ODSM/odsm.html>. Accessed on June 1, 2022.

Figure 10: Approach to Estimate EE Potential through Adoption of Energy-Efficient RAC



EE rating program for RAC. Sri Lanka Standard (SLS) 1586:2018, the national standard, providing specifications for EE rating for single split type RAC in Sri Lanka is voluntary and will be mandatory by 2025. The standard specifies requirements for energy efficiency labelling and method for determination of energy efficiency ratio (EER) of single- and three-phase (a.c.), non-ducted split RAC (up to a rated cooling capacity of 11 kW) having fixed compressors, air-cooled condensers, and a single indoor unit. The refrigerant must comply with environmental agreements signed by the government.

Market size of RAC in Sri Lanka. The space cooling appliances (RAC, chillers, and air coolers) market depends on various factors, and demographics is one among them. Space cooling is associated with high ambient temperatures and economic growth. Urban developments like public spaces, industrial buildings, commercial establishments, and households with higher disposable income and aspirations adopt active space cooling. Also, in hot climates, the health, well-being, and productivity of people are claimed to be dependent on cooling.

Sales trend. The average size of the RAC market in Sri Lanka is reported to be ~114,555 units sold per year.¹⁴ According to the Government of Sri Lanka, in 2020, 112,054 units were sold. In 2015–2020, the RAC sales saw ups and downs; however, the sales increased with a compounded annual growth rate (CAGR) of 12.4 percent.¹⁵ The RAC sales from 2015 to 2020, presented in Figure 11, include all the sectors (residential, commercial, GP, and industrial).

¹⁴ Average value calculated based on data from the Department. of Trade, Sri Lanka.

¹⁵ Based on the data from the Department. of Trade, Sri Lanka.

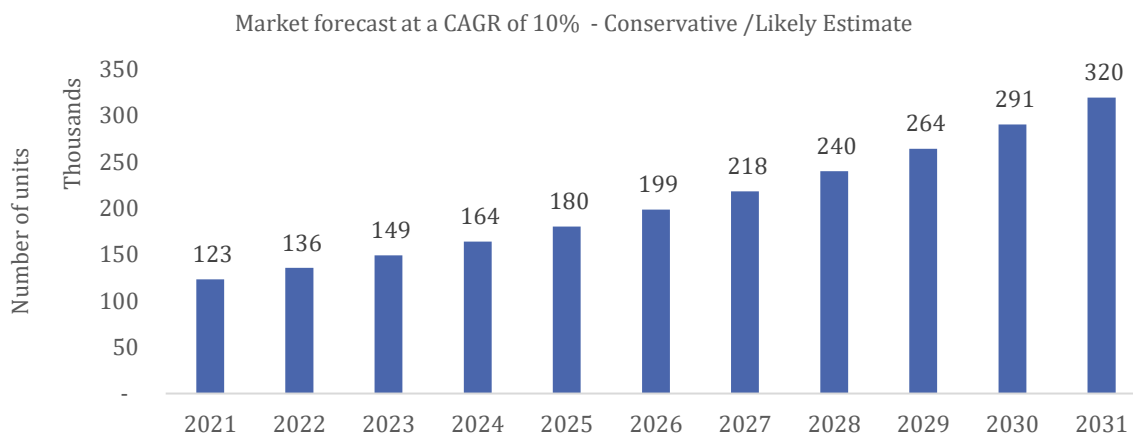
Figure 11: RAC Sales (2015–2020)



Source: Authors based on data from Department of Trade, Sri Lanka

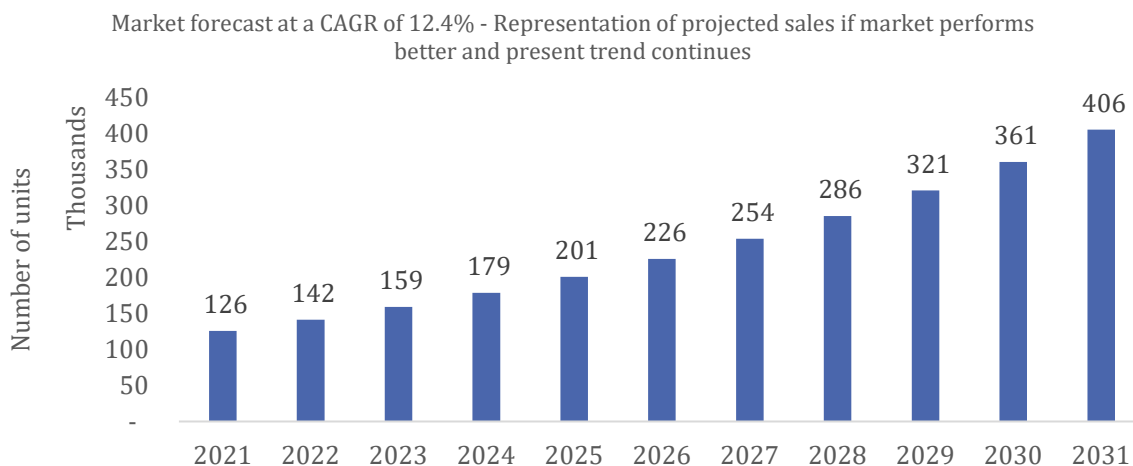
Sales forecast. Based on the primary data received from the Department of Trade, it is estimated that the RAC market will see a considerable growth. The sales are forecast up to 2031 assuming a conservative CAGR of 10 percent. In actual, the market has performed better with a CAGR of 12.4 percent from 2015 to 2020. If the trend continues, then the annual sales could be higher than the forecast in Figure 12 and as shown in Figure 13.

Figure 12: Annual Sales Forecast with CAGR of 10 percent



Source: Authors based on data from Department of Trade, Sri Lanka

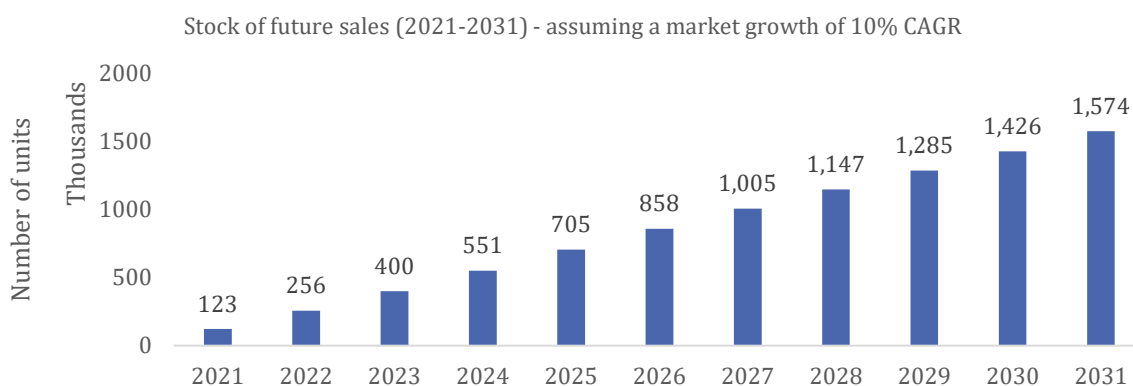
Figure 13: Annual Sales Forecast with CAGR of 12.4 percent



Source: Authors based on data from Department of Trade, Sri Lanka

Stock. Figure 14 presents stock estimates of RAC from 2021 to 2031. The refrigeration capacity of the stock in 2032 of the units expected to be sold from 2019 to 2031 (considering the average lifetime of RAC is seven years) is estimated at 2.3 million tons of refrigeration (TR).

Figure 14: Estimated Installed Stock (2021–2031)

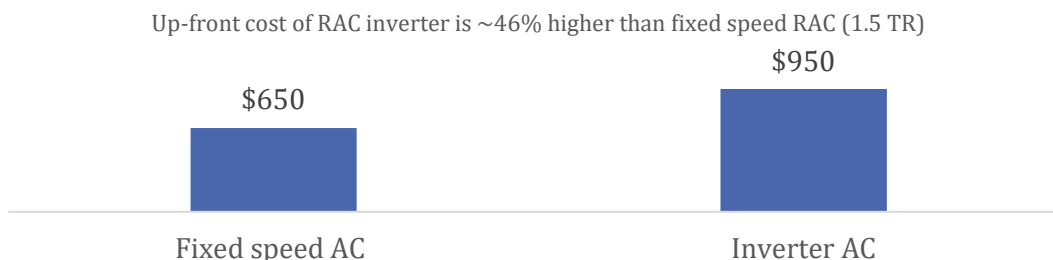


Source: Authors based on data from Department of Trade, Sri Lanka

Price analysis. The price of RAC models was researched from retail websites. The price data were then analyzed to determine the price difference between conventional RAC and energy-efficient inverter RAC available in the country. RAC of cooling capacity 1.5 TR (that is, 18,000 BTU/h or 5.2 kW) is used in majority of the applications. The cost of a 1.5 TR RAC ranges from LKR 99,990 (US\$500) to LKR 189,990 (US\$950). For further analysis, the cost difference between the conventional fixed speed 1.5 TR RAC and energy-efficient 1.5 TR RAC using inverter technology is taken as LKR 60,000 (US\$300).¹⁶

¹⁶ Assumption for currency conversion: LKR 1 = US\$0.005.

Figure 15: RAC Indicative Up-Front Cost



Source: Authors

EE scenario. The Government of Sri Lanka has an EE labelling program for RAC in the country.¹⁷ According to the program, RACs are rated from 1-star to 5-star depending on the EER (W/W). The program is presently under a voluntary labelling regime. The rating table followed in Sri Lanka's EE program has been provided in Table 4.

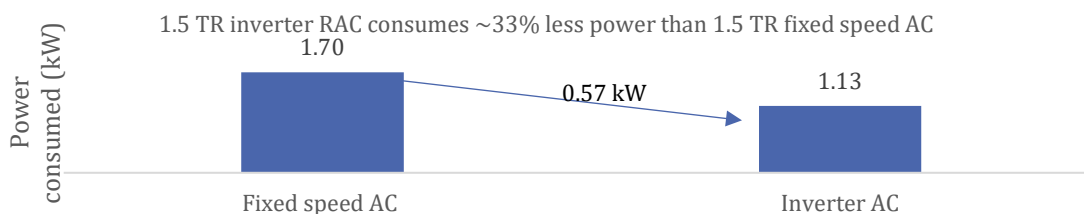
Table 4: EER Range for Star Rating in Sri Lanka

EER	Star Rating
3.55 < EER	5-star
3.35 < EER ≤ 3.55	4-star
3.15 < EER ≤ 3.35	3-star
2.95 < EER ≤ 3.15	2-star
2.75 < EER ≤ 2.95	1-star

Both fixed-speed and inverter type RAC are available in the market. When compared to fixed-speed RAC, inverter RAC operates more efficiently in part load conditions and consumes lesser power. Therefore, inverter RACs are rated on Seasonal Energy Efficiency Ratio (SEER) instead of EER.

A 2-star RAC of 1.5 TR (EER 3.1) was compared with an inverter RAC (SEER 4.66) of the same capacity for determining both the energy and cost saving potential.¹⁸ The power consumption in both cases is presented in Figure 16. The difference in power consumption was 0.57 kW.

Figure 16: RAC Power Consumption



Source: Authors

¹⁷ The Sri Lanka Appliance Energy Labelling Program aims to transform the RAC market by promoting energy-efficient models. The program provides EE labeling of RACs in the country based on EER.

¹⁸ Air conditioner (AC) with EER of 3.1 is representative of the market. Inverter AC with SEER 4.66 is representative of energy-efficient AC

Investment analysis. The investment required for market transformation toward energy-efficient RAC has been estimated based on an assessment of market sales, product cost, electricity cost, and respective inflation. Table 5 contains the assumptions and analyzed data for estimating the investment.

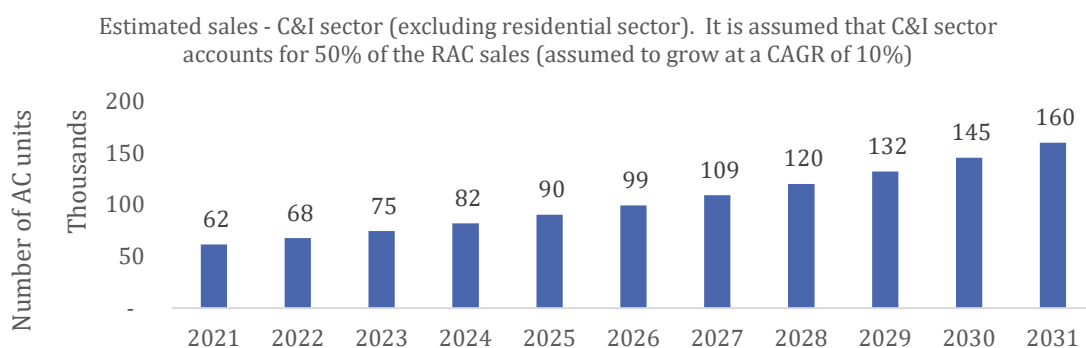
Table 5: Assumptions for Investment Estimation

Parameter	Value
Capacity of AC	18,000 BTU/hour (1.5 TR)
Market growth rate (CAGR)	10%
Cost of electricity (per kWh) ¹⁹	LKR 22.85
Inflation (cost of electricity)	6%
Inflation (cost of RAC) ²⁰	7%
Percentage of RAC market serving the C&I segment ²¹	50%
Hours of usage in a year (hours) ²²	1,600
EE potential for one RAC (kWh/year) ²³	911.5
Payback for the incremental cost per EE RAC ²⁴ (years)	2.9

Step 1: RAC Market Analysis (C&I Segment)

The C&I segment is assumed to be 50 percent of the overall market, as depicted in Figure 17. The estimated stock in the country is accordingly presented in Figure 18 (The entire RAC market sales and stock for the period 2021 to 2031 have been captured in Figure 12 and Figure 14, respectively.).

Figure 17: Forecast - Annual Sales of RAC Catering to C&I Sector



Source: Authors

¹⁹ Tariff plan for general purpose buildings.

²⁰ Based on conservative inflation rate assumption of 6 to 7 percent.

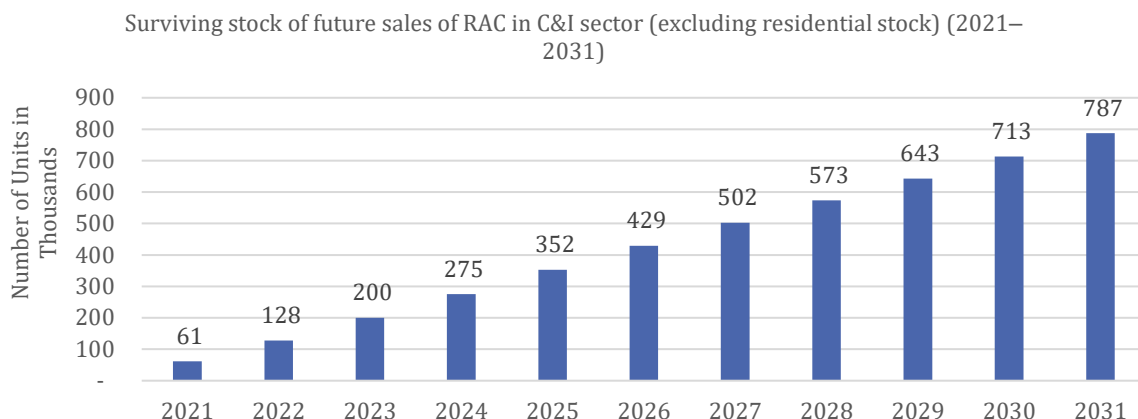
²¹ Investment estimates for C&I segment only. It is assumed that the C&I sector represents 50 percent of the sales.

²² Assumed number of hours of usage based on India's EE program for RAC.

²³ The difference in power consumption between a conventional and energy-efficient RAC (0.57 kW) is multiplied by the annual hours of usage.

²⁴ Simple payback period estimated for the incremental cost investment per RAC.

Figure 18: Estimated Installed Stock Catering to C&I Sector



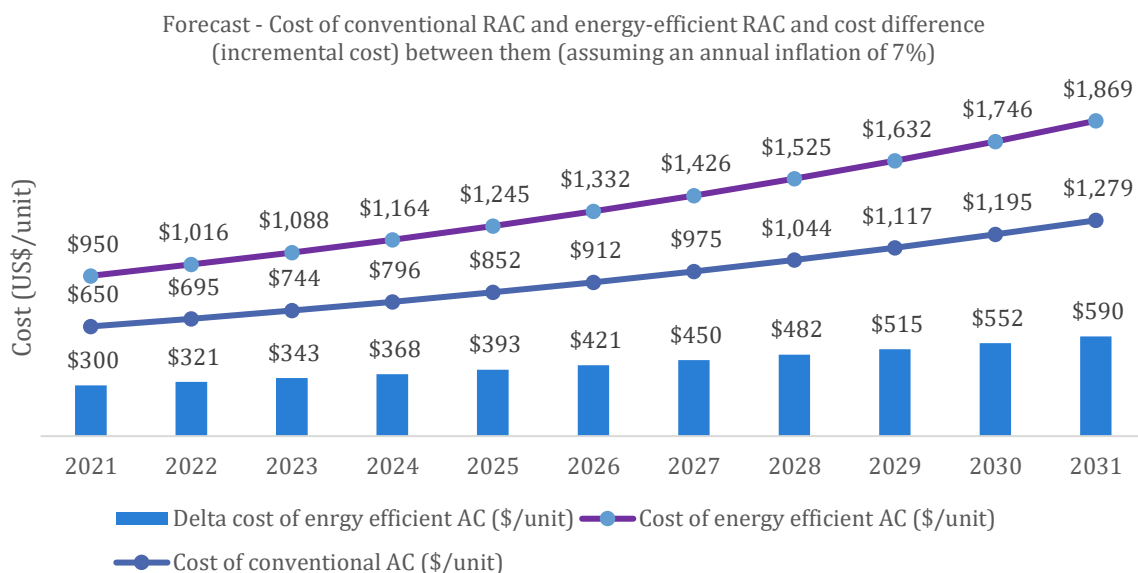
Source: Authors

Step 2: Cost Analysis

Sri Lanka experienced a steep rise in inflation rate recently (12 percent in December 2021). In the past five years, the inflation rate has remained between 4 and 8 percent. To estimate the life cycle cost, the electricity cost and commodity cost of energy-efficient RAC have been forecast considering a conservative annual inflation rate of 6 percent and 7 percent, respectively.

The forecast of the cost of conventional and energy-efficient RAC has been provided in Figure 19.

Figure 19: Forecast - Cost of AC and Difference Cost (Incremental Cost)

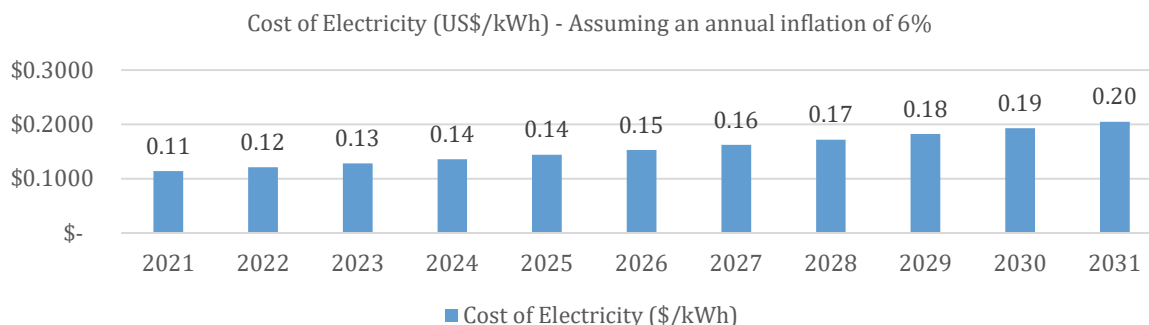


Source: Authors

Similarly, the cost of electricity (per kWh) is forecast till 2031 and plotted in Figure 20. The plot shows the trend with which the cost of electricity is going to increase over the next decade. The

increased electricity cost will directly affect the operational expenses. Hence, it is one of the motivations for switching to energy-efficient RAC.

Figure 20: Forecast - Cost of Electricity

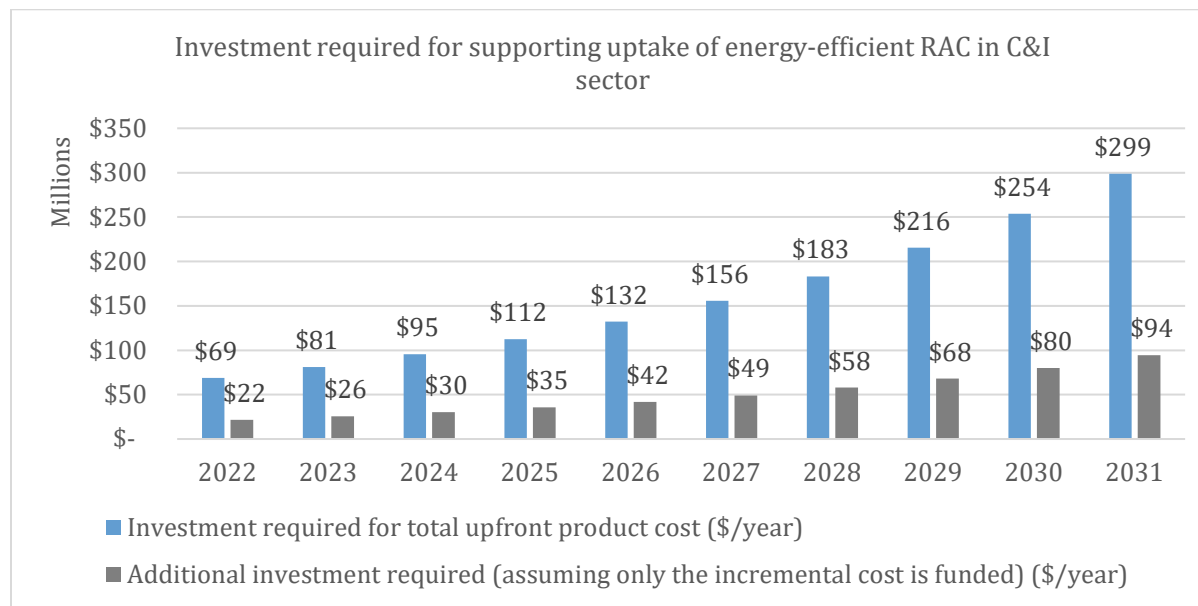


Source: Authors

Step 3: Investment Details

The total investment is the money required to procure the total number of energy-efficient RACs each year. The investment can happen in any one of the two modes, total up-front cost or incremental cost. The investment needed in both cases is plotted in Figure 21. The chart presents the investment analysis considering the up-front product cost, incremental cost, and respective annual sales.

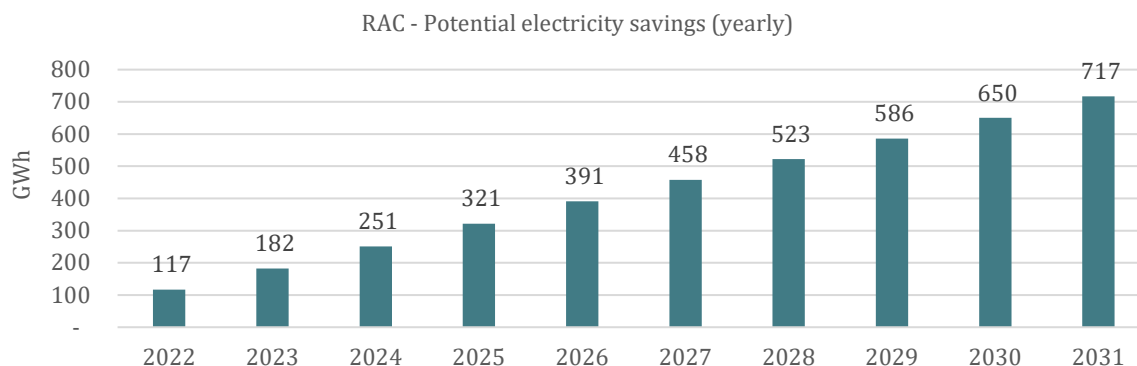
Figure 21: Investment Required for Promoting Energy-Efficient RAC in the C&I Sector



Source: Authors

Energy and cost savings analysis. The potential energy savings in Sri Lanka through the penetration of energy-efficient RAC in the C&I sector is presented in Figure 22. The savings are based on the life of RACs during the assessment period.

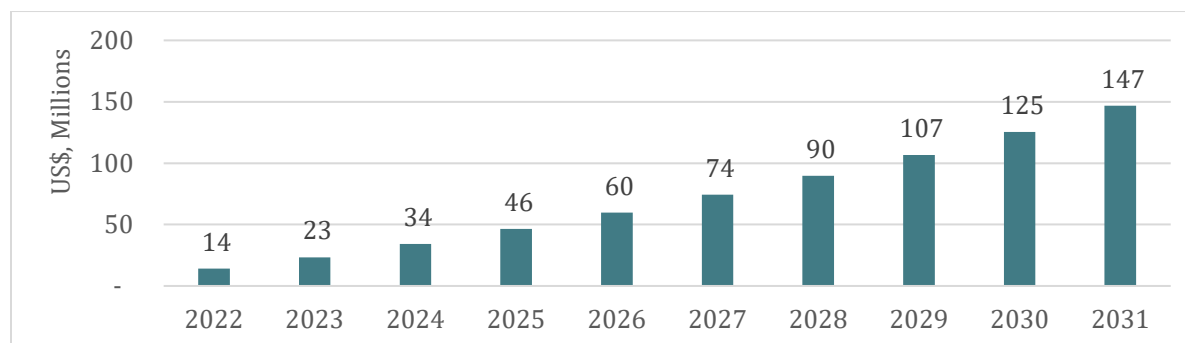
Figure 22: RAC - Potential Electricity Savings in Units



Source: Authors

The potential yearly cost savings are presented in Figure 23. This is a conservative estimate; if the electricity cost increases and subsidized rates are removed, the resultant cost savings could increase further.

Figure 23: RAC - Cost Savings through Avoided Electricity Use



Source: Authors

Summary of investment required and potential national impact for RAC. The results for RAC EE potential are tabulated in Table 6:

Table 6: EE Potential through RAC

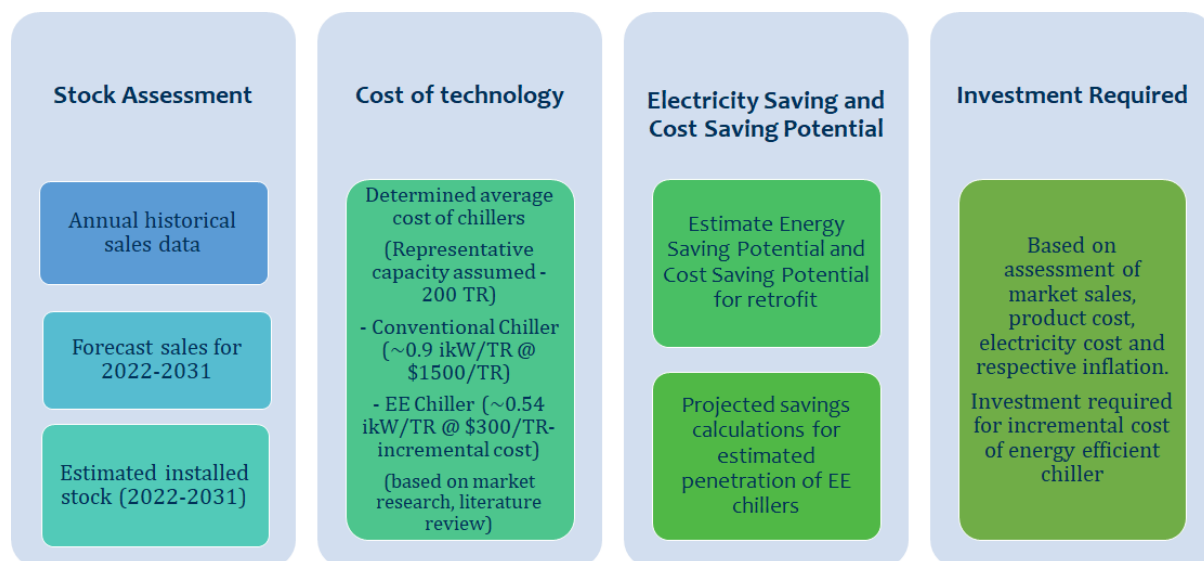
RAC - EE Potential (Assessment Period 2022-2031)		Estimates
Incremental capital investment for energy-efficient RAC (US\$, millions)		505
Potential cumulative electricity savings (GWh)		4,200
Cost savings (US\$, millions) (savings through cost of electricity)		720

2.3.2 Chillers

The assessment focused on the chiller demand ready for replacement in terms of installed cooling capacity, respective monetary value, and so on. The EE potential for chillers has been estimated considering both the existing and upcoming stock of chillers in the country. Some of the old inefficient chillers would be replaced with efficient ones.

A four-step methodology was followed for determining the electricity and cost saving potential as well as the investment requirement for scaling and wider adoption of energy-efficient chiller models.

Figure 24: Approach to Estimate EE Potential through Adoption of Energy-Efficient Chiller



The assessment is based on the chiller sales information received from local suppliers, summarized in Table 7.

Table 7: Information/Datasheet for Chillers

Sr. No.	Parameter	Value	Source/Reference
1.	Average representative capacity of chiller	200 TR (~703 kW of refrigerating effect)	Feedback from local suppliers
2.	Annual market between 2014 and 2018	Ranging from 31 to 51 units sold per year	According to the data from suppliers of Trane, Smardt, and Daikin
3.	CAGR based on the units sold over the last few years	3.9%	Analysis of data received
4.	Annual usage of chiller	12 hours per day for 200 days in a year	Assumption based on experience and inputs from sector experts
5.	Life	15 years	
6.	Part load efficiency (conventional chiller)	0.9 kW/TR	
7.	Energy-saving/efficiency potential in case of energy-efficient chiller	40% (~0.54 kW/TR)	
8.	Annual estimated electricity consumption for a conventional chiller	0.43 million kWh ²⁵	Estimated based on the data above
9.	Cost of representative energy-efficient chiller	US\$700 per TR	Pricing shared by an ESCO in Sri Lanka

²⁵ The annual electricity consumption of a representative conventional chiller. The value has been estimated by multiplying the capacity of the representative chiller in TR, annual usage in hours, and the efficiency in kW/TR.

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Sr. No.	Parameter		Value				Source/Reference																																																																			
10.	Indicative incremental cost needed for an energy-efficient chiller		US\$150 per TR				Based on an actual project cost in Sri Lanka																																																																			
11.	Annual inflation in cost of chiller		7%				Assumption																																																																			
12.	Assessment period		2022–2031				—																																																																			
13.	Cost of electricity (per kWh)		LKR 22.85 (~US\$0.114)				From CEB																																																																			
14.	Inflation (cost of electricity)		6%																																																																							
15.	Payback for incremental cost of energy-efficient chiller		1.52 years ²⁶				Estimated																																																																			
16.	Annual sales, stock in the country, and penetration of energy-efficient chillers	Yearly <table><tr><th>Year</th><th>Annual Market (#)²⁷</th><th>Country Stock (#)²⁸</th><th>Penetration of EE Chillers (#)²⁹</th><th>Market Coverage (%)³⁰</th><th>Stock of EE Chiller (#)³¹</th></tr><tr><td>2022</td><td>42</td><td>160</td><td>21</td><td>50</td><td>21</td></tr><tr><td>2023</td><td>44</td><td>203</td><td>22</td><td>50</td><td>43</td></tr><tr><td>2024</td><td>46</td><td>248</td><td>23</td><td>50</td><td>66</td></tr><tr><td>2025</td><td>48</td><td>295</td><td>24</td><td>50</td><td>90</td></tr><tr><td>2026</td><td>50</td><td>342</td><td>25</td><td>50</td><td>114</td></tr><tr><td>2027</td><td>51</td><td>390</td><td>26</td><td>50</td><td>140</td></tr><tr><td>2028</td><td>54</td><td>439</td><td>27</td><td>50</td><td>166</td></tr><tr><td>2029</td><td>56</td><td>488</td><td>28</td><td>50</td><td>193</td></tr><tr><td>2030</td><td>58</td><td>537</td><td>29</td><td>50</td><td>220</td></tr><tr><td>2031</td><td>60</td><td>586</td><td>30</td><td>50</td><td>247</td></tr></table>						Year	Annual Market (#) ²⁷	Country Stock (#) ²⁸	Penetration of EE Chillers (#) ²⁹	Market Coverage (%) ³⁰	Stock of EE Chiller (#) ³¹	2022	42	160	21	50	21	2023	44	203	22	50	43	2024	46	248	23	50	66	2025	48	295	24	50	90	2026	50	342	25	50	114	2027	51	390	26	50	140	2028	54	439	27	50	166	2029	56	488	28	50	193	2030	58	537	29	50	220	2031	60	586	30	50	247	Analysis of data received and assumption for yearly penetration
Year		Annual Market (#) ²⁷	Country Stock (#) ²⁸	Penetration of EE Chillers (#) ²⁹	Market Coverage (%) ³⁰	Stock of EE Chiller (#) ³¹																																																																				
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2030		58	537	29	50	220																																																																				
2031	60	586	30	50	247																																																																					

The information captured in Table 7 provides a market overview of chillers in Sri Lanka, sales forecast till 2031, and the country's stock. The investment needed toward uptake of energy-efficient chillers and its potential impact in terms of energy savings is discussed next.

- **Investment analysis.** The investment could happen in any one of the two modes, total up-front cost or incremental cost.³²
- **Energy savings analysis.** The savings are based on the life of chillers during the assessment period.³³ The potential yearly energy savings through penetration of energy-efficient chiller is presented in Figure 25.

²⁶ Payback period estimated for the incremental cost investment per EE chiller.

²⁷ Data received from local suppliers in Sri Lanka.

²⁸ Estimated stock of chillers functioning in the country based on the life of chillers.

²⁹ Number of energy-efficient chiller installations in Sri Lanka.

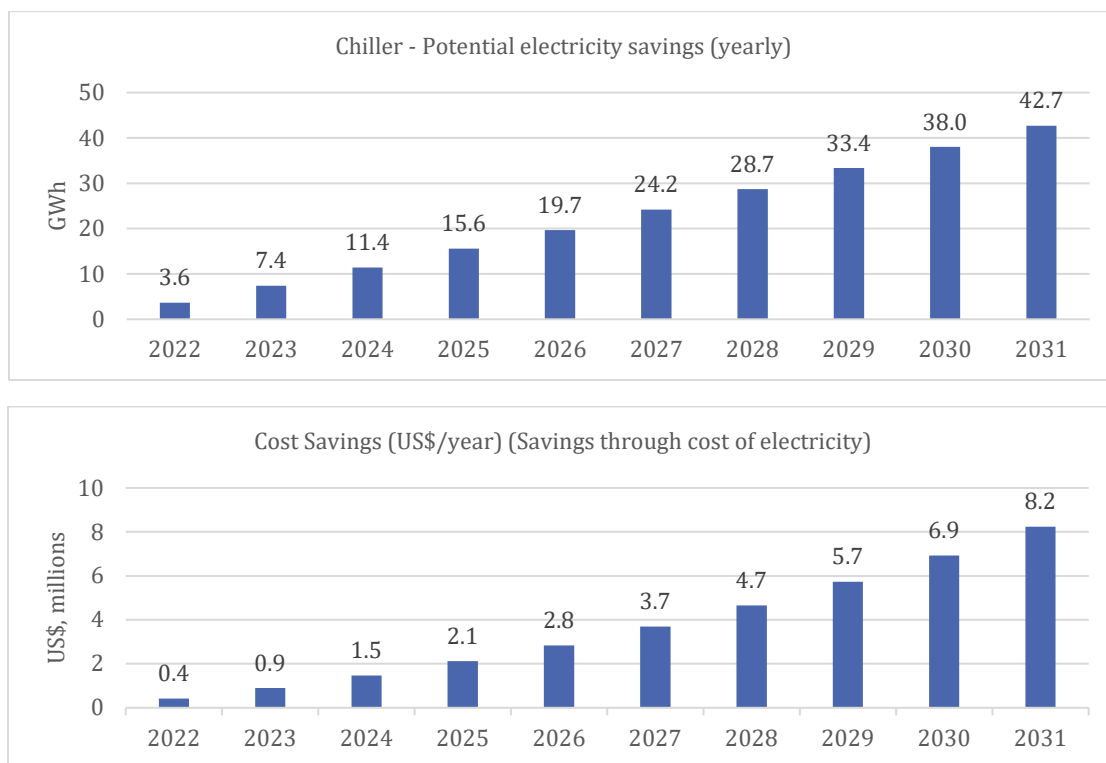
³⁰ Assumption for penetration of energy-efficient chillers in the market. The percentage refers to market share of annual sales.

³¹ Estimated surviving stock of EE chillers in the country during the period of assessment.

³² The cost of EE chiller given in Sr. No. 9 and 10 in Table 7 is multiplied with the yearly penetration of EE chillers given in Sr. No. 16 for estimating the total investment. An annual inflation in the cost of chiller (given in Sr. No. 11) is added in the analysis.

³³ The estimated stock of EE chillers given in Sr. No. 16 in Table 7 is multiplied with the energy-saving potential given in Sr. No. 7 and annual electricity consumption given in Sr. No. 8, to arrive at the potential annual energy savings.

Figure 25: Chiller - Potential Yearly Electricity and Cost Savings



Source: Authors based on Sri Lanka's local suppliers data

- **Cost savings analysis.** The potential cost savings are arrived at based on electricity savings estimated in the previous step and the electricity cost. An annual inflation in the cost of electricity (given in Sr. No. 14 of Table 7) is added in the analysis.

The results for chiller EE potential are tabulated in Table 8.

Table 8: EE Potential through Chiller

Chiller - EE Potential (Assessment Period 2022–2031)		Estimates
Incremental capital investment for energy-efficient chiller (US\$, millions)		11
Potential cumulative electricity savings (GWh)		225
Potential cumulative cost savings (US\$, millions)		37

2.3.3 Summary - Potential for Energy-Efficient Cooling

The summary of the potential in the cooling sector based on the analysis of RAC and chillers, in terms of investment needed and potential impact on electricity and cost savings, is given in Table 9.

Table 9: Summary - Potential for Energy-Efficient Cooling

Potential from Energy-Efficient Cooling (Assessment till 2031)	Estimates
Incremental capital investment for energy-efficient cooling (US\$, millions)	516
Cumulative electricity savings (GWh)	4,425
Cumulative cost savings (US\$, millions)	757

Investments in energy-efficient cooling yield significant energy savings and positive lifecycle cost benefits. The market share of energy-efficient ACs and chillers is small; therefore, they come at a significant price premium. High import duties and other taxes add to the incremental cost of energy-efficient cooling.

Higher consumer demand and bulk procurement of energy-efficient cooling equipment can make the economics even more attractive for consumers. Considering the landed cost of equipment, the investment will be lower by over 30 percent, resulting in an even smaller payback period. High air conditioning usage typically coincides with the peak electricity demand period, and energy-efficient cooling can contribute to a reduction in peak demand as well. Reduced electricity use for cooling results in a direct reduction of fossil fuels for electricity generation.

2.4 Potential for Energy-Efficient Lighting

The 'Survey on Efficient Lighting' report (GoSL 2019b) focused on calculating the potential for lighting EE in the commercial, hotel, industrial, and government sectors. The findings are based on a survey conducted for 100 facilities. The 100 facilities were selected to represent all the commercial tariff categories belonging to the small, medium, and large scales based on their power demand. These include Industry, Hotels, GP, and Government institutes. Small buildings are generally less than 100 m² and large buildings are over 1,000 m². GP is a very large category which includes offices, schools, supermarkets, restaurants, shops, and even warehouses.

Table 10: Sample Size

Sector	Sample Size	
GP		Includes offices, banks, schools, warehouses, shops, restaurants, supermarkets, state institutions, and so on
GP1	25	Demand equal to or less than 42 kVA, area less than 5,000 sq. ft.
GP2	20	Demand between 42 and 1,000 kVA, area between 5,000 and 100,000 sq. ft.
GP3	5	Demand more than 1,000 kVA, area over 100,000 sq. ft.
Hotel		Only registered hotels in the tourist board
H1	3	Demand equal to or less than 42 kVA, area less than 10,000 sq. ft.
H2	10	Demand between 42 and 1,000 kVA, area between 10,000 and 200,000 sq. ft.
H3	2	Demand more than 1,000 kVA, area over 200,000 sq. ft.
Industrial		All types of industries – tea, apparel and textile, steel, glass, cement, food, rubber, and so on
I1	5	Demand equal to or less than 42 kVA, area less than 25,000 sq. ft.

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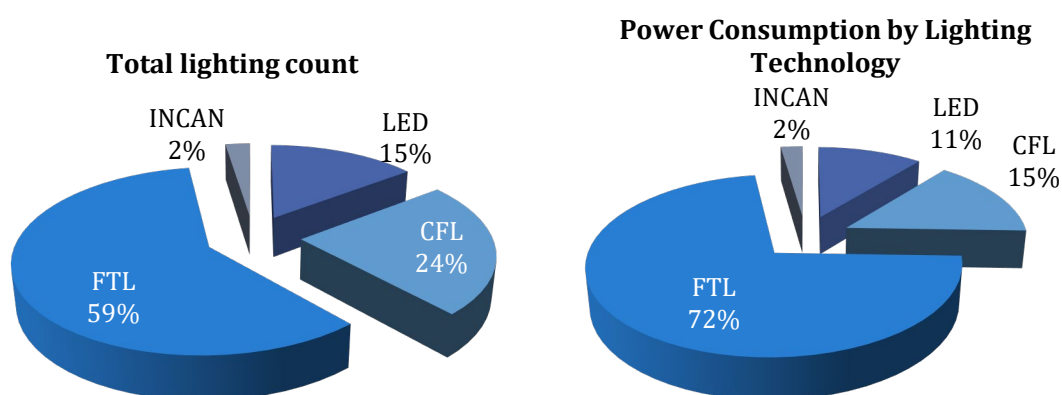
Sector	Sample Size	
I2	20	Demand between 42 and 1,000 kVA, area between 25,000 and 100,000 sq. ft.
I3	5	Demand more than 1,000 kVA, area over 100,000 sq. ft.
Government		Only institutions funded by the national budget not charging fees for the services
GV1	3	Demand equal to or less than 42 kVA, area less than 25,000 sq. ft.
GV 2 and 3	2	Demand more than 42 kVA, area more than 25,000 sq. ft.
Total	100	

Notes: GP = General purpose, H = Hotel, I= Industrial, GV = Government.

Contract demand is based on CEB and PUCSL customer categorization, area is estimated.

FTL and CFL comprise maximum percentage share both in terms of lighting count (83 percent) and the power consumption (87 percent) of the sample surveyed. Survey results are provided in Figure 26 and Figure 27.

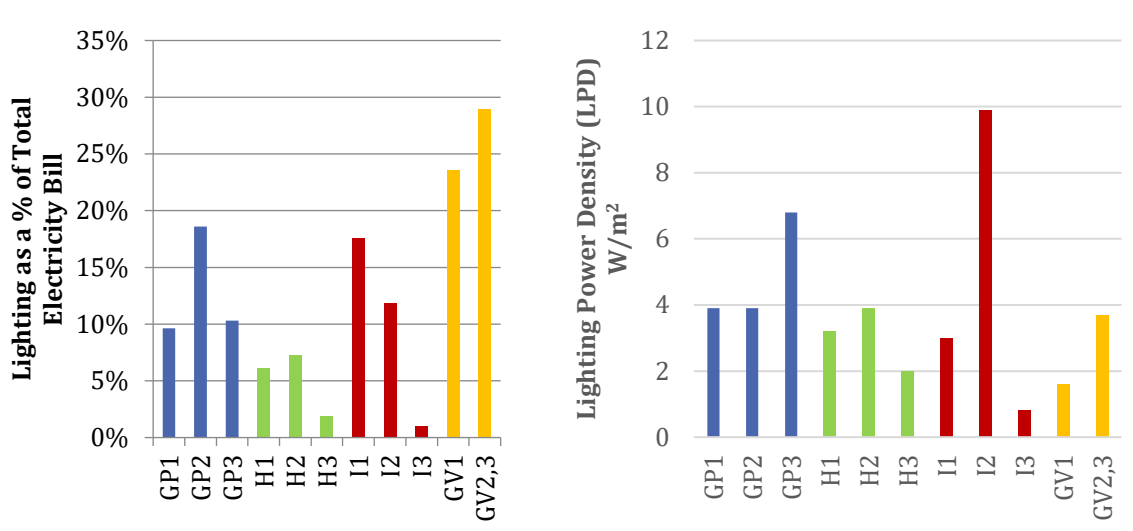
Figure 26: Lighting Count and Power Consumption per Technology



Note: CFL = Compact Fluorescent Lamp, FTL = Fluorescent Tubular Light, INCAN = Incandescent bulb, LED = Light Emitting Diode

Source: GoSL 2019b

Figure 27: Lighting End Use Consumption and Power Densities



Note: GP = General purpose, H = Hotel, I= Industrial, GV = Government.

Source: GoSL 2019b.

Lighting accounts for 23–28 percent of the total electricity consumption in government buildings, whereas in the hotel sector, it varies from 2 percent to 7 percent. One of the causes for this difference in consumption share for lighting energy per sector may be lower LPDs. The hotel and industries sectors have an average LPD of 4 W/m². This value is lower than the LPD according to the Energy Efficiency Building Code (EEBC)³⁴ (maximum LPD for hotel – 6 W/m², manufacturing facility - 8.8 W/m², and warehouse - 4.8 W/m²) in contrast with buildings with larger contract demand, such as GP3 and I2 categories, where LPDs are in the range of 6–10 W/m².

Table 11 provides a sector-wise summary of the electricity savings (both percentage and GWh) due to EE in lighting. It also includes the resultant annual cost savings on electricity bills as well as the investment required for the implementing of energy-efficient lighting in the sector.

Table 11: Sector-Wise Lighting Energy-Saving Potential and Investment

Sector	Sector Total Electricity Consumption (GWh)	Electricity Saving due to Energy-Efficient Lighting (%)	Electricity Saving over Service Life (GWh)	Cost Saving over the Service Life (LKR, millions)	Investment (LKR, millions)
GP1	1,901	5	559.2	14,442	3,850
GP2	1,039	8	496.2	16,206	2,923
GP3	347	7	146.4	3,672	297
H1	3	10	1.8	36	6
H2	222	14	191.4	3,630	669
H3	107	2	10.8	192	29
I1	343	9	180.0	2,304	421

³⁴Table 9.4-I: Lighting power densities using the building area method, p.77

Sector	Sector Total Electricity Consumption (GWh)	Electricity Saving due to Energy-Efficient Lighting (%)	Electricity Saving over Service Life (GWh)	Cost Saving over the Service Life (LKR, millions)	Investment (LKR, millions)
I2	2,200	7	892.8	15,036	6,621
I3	1,780	0.4	47.4	690	431
GV1	6	11	4.2	78	13
GV 2 and 3	185	19	209.4	4,404	505
Total	8,133	6	2,739.6	60,690	15,765
Conversion				US\$300 million	US\$78 million

Source: GoSL 2019b

Key findings are summarized as follows:

- (a) Annual electricity consumption of lighting for the commercial, hotel, industrial, and government sectors is estimated at 884 GWh, which is 11 percent of the total electricity consumption (8,133 GWh).
- (b) Sector split for lighting-related electricity consumption is as follows:
 - Industrial sector - 45 percent
 - GP sector³⁵ - 45 percent
 - Government sector - 7 percent
 - Hotels - 3 percent
- (c) Potential for electricity savings in lighting energy is estimated around 2,740 GWh.³⁶
- (d) Potential cost savings is estimated at ~US\$300 million.
- (e) Investment required for implementing Energy Efficiency Measures (EEM) has been estimated around LKR 15.7 billion (US\$78 million) with a simple payback of 22 months.
- (f) Energy savings of 70 percent can be achieved from replacing the existing fittings with energy-efficient fittings with less hassle for electrical wiring or fixture changes. Of the energy savings, 25 percent can be achieved by daylight harvesting through windows and roof skylights, which is significantly identified in the industrial and some commercial single-storied structures. But the investment for daylight harvesting is as high as LKR 6 billion (~US\$35 million).

2.5 Review of Energy-Efficient Technologies

Viability of a range of passive measures and energy-efficient technologies has been carried out in this section in the context of the commercial, GP, and industry sectors in Sri Lanka. Table 12 includes a

³⁵ This includes office spaces, private hospitals, private schools, government institutions not funded by the national budget, shops, supermarkets, shopping malls, apartment complexes, warehouse facilities, and so on.

³⁶ The annual electricity savings have been estimated (515.3 GWh). The service life of the energy-efficient lighting technology has been considered as 6 years based on discussions. The annual savings have been then derived for 6 years.

list of energy-efficient technologies, mapped against insights on their energy-saving potential and supply chain.

Table 12: Summary of Energy-Efficient Technologies

Sr. No.	Energy-Efficient Measure/Tech nology/System	Affordability					Availability and Accessibility	
		Unit	FOB Cost ³⁷ / Unit (US\$)	As-Is (Baseline) Condition in Sri Lanka	Potential Energy Savings Range (%)	Payback (Years)	Key Suppliers /Brands	Supply Chain
1	Shading	m ²	—	Very commonly used as sunshades for windows, blinds, and double-glazed glass	A typical air-conditioned office can save 8–10% on its annual electricity consumption.	5		Assembled locally
2	Wall insulation	m ²	3.00	Not common, most wall use is clay bricks which is a good insulation.	Less than 5%	5	ICC Dura Board	Manufactured locally
3	Roof insulation	m ²	4.00	Very common to use glass wool/rockwool with double-side aluminum foil	Saving on cooling loads by 5–8% Up to 10% reduction in annual cooling energy use	5	Bluescope and Nawaloka	Assembled locally
4	Reflective paints	m ²	0.30	Not successful and customers complain of no difference	No proof of savings	—	—	Imported
5	Green roof	m ²	—	—	—	—	—	—
6	Daylight/skylight		750.00	Widely used for eco projects as dome type prismatic skylights	Over 50% savings on lighting	3	Suntek	Imported
7	LED	W	1.50	Very common	Over 30% savings compared to fluorescent	2	LED C4 and Lumin	Imported
8	Solar tubes	W	2,000.00	Not common, too expensive for the clients to afford	Over 50% savings on lighting	5	—	Imported

³⁷ Free-on-board value of products (excluding freight).

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Sr. No.	Energy-Efficient Measure/Tech nology/System	Affordability					Availability and Accessibility	
		Unit	FOB Cost ³⁷ / Unit (US\$)	As-Is (Baseline) Condition in Sri Lanka	Potential Energy Savings Range (%)	Payback (Years)	Key Suppliers /Brands	Supply Chain
9	Lighting controls			Not common, very expensive. Minimum cost for a house is US\$1,000.	5–10% energy saving by including daylighting and occupancy sensors		Qbus, Lutron, CBus, and Jung	Imported
10	RACs (super-efficient and lower global warming potential [GWP] refrigerant)	TR	600.00	There is no standard definition for super-efficient in the country. RAC with low GWP refrigerants is not common.	Over 30% savings	3	Panasonic, LG, and Singer	Imported
11	Variable refrigerant volume (VRV)/variable refrigerant flow (VRF) systems	TR	1,600.00	Customers prefer over standard AC as only one outdoor, but cost is very high. Heavy tax as well.	Over 60% savings	5	Daikin, Toshiba, and LG	Imported
12	Energy-efficient chillers	TR	850.00	Commonly used for large projects	Over 40% savings	2	Trane, Carrier, D&B, and York	Imported
13	Heat pumps	TR		Not very common, mostly solar hot water is used.	—	—	—	Imported
14	Tri-generation	TR	—	Not very common	—	—	—	Imported

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Sr. No.	Energy-Efficient Measure/Tech nology/System	Affordability					Availability and Accessibility	
		Unit	FOB Cost ³⁷ / Unit (US\$)	As-Is (Baseline) Condition in Sri Lanka	Potential Energy Savings Range (%)	Payback (Years)	Key Suppliers /Brands	Supply Chain
15	District cooling	TR	—	Not known to be used	20–35% less electricity consumption compared to traditional air-cooled air conditioning systems and individual water-cooled air conditioning systems using cooling towers, respectively. There is also a reduction in up-front capital cost for installing chiller plants at their buildings which account for about 5–10% of the total building cost.	—	—	Imported
16	Solar ACs	TR	—	No major use	—	—	—	Imported
17	Thermal energy storage	TR	—	No major use	—	—	—	Assembled locally
18	Cooling as a service (Caas, not a technology)	TR	—		—	—	—	—
19	Solar PV	kW	1.50	Commonly used and very popular, over 250 MW installation	Over 30% savings on electricity bills	4	Trina and Jinko	Imported
20	Solar water heating	kW	10.00	Commonly used, very popular	Over 90% savings on electricity bills for heating	3	Solar Therm and Access	Assembled locally

2.5.1 Passive Measures

For a tropical country like Sri Lanka, the minimization of solar radiation gains of a building is the key to effective use of passive measures. According to Sri Lanka's EEBC, the country can be divided into three climate zones—Warm Dry, Warm Humid, and Uplands; it is a tropical country with predominantly cooling loads. EEBC has provided guidelines for building envelope such as air-leakage rates, window specifications (visual light transmittance,³⁸ solar heat gain coefficient, and shading coefficient), roof solar reflectance and thermal remittance, and envelope U-values according to different climate zones.

The overall performance of the building envelope is expressed by two indexes—Envelope Thermal Transfer Value (ETTV) and Roof Thermal Transfer Value (RTTV). The EEBC has provided recommendations for both ETTV³⁹ and RTTV⁴⁰ specifically for Sri Lanka. In the absence of an energy code for existing buildings, while undertaking building energy audits, building specifications can be compared to the recommendations provided in the EEBC.

Shading/shading devices. Sri Lanka is an island located at a latitude of 5.9° and 9.8°N and longitudes of 79.79° and 8.1°E. As a result of low latitude, all external surfaces of buildings are liable to receive direct sunlight during the daytime. The sun path for Sri Lanka does not show a great variation unlike other countries which are at higher latitudes. Providing shade to a building through external and internal shading devices helps control the temperature in the building by reducing the exposure to direct sunlight and therefore reducing the requirement for mechanical cooling. A typical air-conditioned office building in Sri Lanka can save 8–10 percent on its annual electricity consumption with appropriately designed shading devices.⁴¹ Conditioned buildings with single-glazed windows will have an increased potential of electricity savings.

Insulation. Thermal insulation reduces the heat ingress or heat loss through walls and roofs. In hot humid climates, the roof is one of the main sources of heat gain. Sri Lanka receives significant amount of solar radiation across all geographical regions. The Global Horizontal Irradiance (GHI) varies between 1,247 kWh/m² and 2,106 kWh/m². In existing buildings, there is a potential for retrofitting roofs and walls to include insulation. Roof insulation could reduce the cooling loads by 5–8 percent and could lead up to 10 percent reduction in annual cooling energy use.⁴²

Cool roof. Roofs that reflect sunlight back into the atmosphere help keep indoor room temperatures lower than the roof surface that absorbs sunlight. Cool roofs use solar-reflective material and can

³⁸ Visual transmittance is the amount of light in the visible portion of the spectrum that passes through a glazing material.

³⁹ According to the EEBC, ETTV considers the three basic components of heat exchange across the external walls and windows—heat conduction across opaque walls, heat conduction across glass windows, and solar radiation through glass windows. These three components of heat exchanges are averaged over the whole envelope area of the building to give an ETTV that represents the thermal performance of the whole envelope. The maximum allowable ETTV would be 60 W/m².

⁴⁰ According to the EEBC, RTTV considers the three basic components of heat exchange across the opaque roof and skylights—heat conduction across opaque roof, heat conduction across skylight, and solar radiation through skylight. The maximum allowable RTTV would be 45 W/m².

⁴¹ Analysis through International Finance Corporation EGDE application tool for a typical commercial office building in Sri Lanka of 10,000 m² with a window wall ratio of 50 percent.

⁴² These savings are averaged for typical commercial building in India, and even higher savings can result in buildings with lower temperature setpoints and longer hours of air-conditioning.

maintain a temperature difference of 6–8°C between ambient temperature and indoor air temperature. This is also a viable option for existing building retrofit projects. Roof solar reflectance and thermal remittance recommendations according to EEBC can be considered.

Daylight and skylights. EEBC recommends criteria for both daylit and skylight areas. However, it is important to use appropriate passive building techniques such as light shelves or shading to reduce glare and direct sunlight inside the building. Increased sunlight inside the building will also increase the cooling requirement; yet, daylight integration with artificial lighting can increase occupant well-being, reducing the dependence on artificial lighting. In buildings undergoing major retrofits, energy services companies (ESCOs) can consider daylight enhancement as an EE measure. There is however much more potential for daylight control integration for existing buildings in Sri Lanka.

2.5.2 Lighting Technologies

Energy-efficient light fixtures (for example, LEDs). There was an exponential growth (yearly averaged around 32 percent) in total import value of LEDs from 2015 to 2017.⁴³ The total count of fluorescent light bulbs is 59 percent, CFL 24 percent, and LED 15 percent in the GP, commercial, and industrial sectors.⁴⁴ Considering that 30 percent of the facilities age between 10 and 15 years, there is a tremendous saving potential in lighting fixtures retrofit to energy-efficient lighting. This has been provided under the Summary Section of this document. LPDs for different functional spaces have been provided under EEBC, which can be used as reference when conducting energy audits.

Solar tubes. These are tubes of polished sheet metal installed in the roof to channel sunlight into the interior. On a sunny day, a 10-inch solar tube may provide the same amount of light as three 100 W bulbs, which is enough to illuminate a 200 sq. ft. room well enough for office work or light a 300 sq. ft. room enough for less visual activities. Solar tubes can be considered in large industrial spaces.

Lighting controls. Lighting controls turn lights off or modulate them according to the requirement for lighting. Types of automated controls are as follows:

- (a) **Scheduling control.** The oldest automated system is setting up a time schedule so that a building's lighting systems are switched on or off at a given time.
- (b) **Occupancy sensing.** Modulate or switch off lights depending on whether there are people in an area or not.
- (c) **Daylighting.** Manipulate light levels based on how much daylight is available in a space.
- (d) **Lumen maintenance.** As lamps in a building age, the system gradually increases light levels to compensate for their deterioration.

ASHRAE 90.1 (Energy Standard for Sites and Buildings Except Low-Rise Residential Buildings) estimates a 5–10 percent energy saving by including daylighting and occupancy sensors. Lighting controls have a huge potential in existing commercial office spaces in Sri Lanka.

⁴³ Analysis of data of import sales.

⁴⁴ GoSL (2019b)

2.5.3 Cooling Technologies

The air conditioning system accounts for around 50–60 percent of a building’s overall energy cost.⁴⁵ Domestic refrigerators and freezers, commercial refrigerators (bottle coolers, display coolers, and chest freezers), industrial refrigerators, cold storages, RACs (split and window), packaged ACs, rooftop systems, VRV/VRF systems, central air conditioning systems (chillers), and mobile air conditioning systems (MACs) are the refrigeration and air-conditioning systems currently used in Sri Lanka. These systems use hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and natural refrigerants, that is, HCFC-22, R-404A, HFC-134a, R-410A, R-407C, R-507A, HFC-32, HC-600a, HC-290, and R-717.⁴⁶ Refrigerants can be classified under two categories—natural and synthetic refrigerants. Ozone Depletion Potential (ODP) and the Global Warming Potential (GWP) of synthetic refrigerants are exceptionally higher compared to natural refrigerants as demonstrated in Table 13.

Table 13: Refrigerant Classification and ODP and GWP Values

Classification	Refrigerant		ODP	GWP
Synthetic refrigerants	Chlorofluorocarbons (CFCs)	CFC-11	1	4,750
		CFC-12	1	10,900
	HCFCs	HCFC-22	0.055	1,810
		HCFC-123	0.020	76
	HFCs	HFC-134a	0	1,430
		HFC-32	0	675
	HFC blends	R-404A	0	3,922
		R-407a	0	1,770
		R407c	0	1,774
		R-410a	0	2,088
Natural Refrigerants	Inorganics	R-717 (NH ₃)	0	0
		R-744 (CO ₂)	0	1
		R-718 (H ₂ O)	0	0
	Hydrofluoroolefins (HFOs)	HFO-1234yf	0	4.7
		HFO-1234ze	0	4.0
	Hydrocarbons (HCs)	HC-290	0	3.0
		HC-600a	0	3.0
		HC-1270	0	1.8

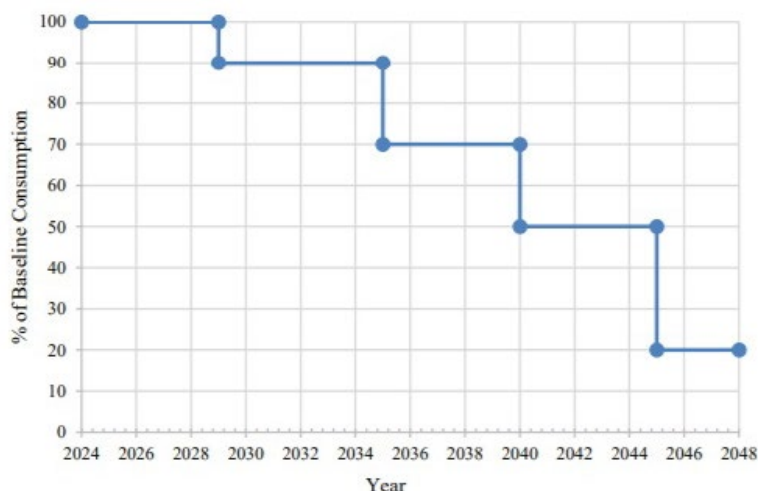
Source: Wijewardane (2021) and Greenhouse Gas Protocol (2014)

Sri Lanka ratified the Montreal Protocol in 1989 and completely phased out high-ODP CFCs in 2008. It has committed to completely phase out HCFCs by 2030. In September 2018, Sri Lanka also ratified the Kigali Amendment to phase down the consumption of HFCs, with the expectation of reaching a plateau of 20 percent of the baseline consumption by 2045, as shown in Figure 28.

⁴⁵ Wijewardane, 2021.

⁴⁶ Ibid.

Figure 28: Kigali Amendment HFC Phase-down Schedule for Sri Lanka



Source: Wijewardane 2021.

Sri Lanka imports HFCs to meet its domestic market demand. In addition, HFCs are used mainly in the Sri Lankan refrigeration and air conditioning/MAC servicing sector. Table 14 shows that the penetration of low/zero GWP refrigerants in the RAC/MAC sector is not yet significant.

Table 14: Imports/Consumption of Different Refrigerants in Sri Lanka (in MT)

Refrigerant	GWP	2012	2013	2014	2015	2016	2017	2018
HCFC-22	1,810	298.4	227.4	211.2	187.4	191.8	160.2	178.9
HCFC-123	76	0.0	0.4	2.1	0.0	0.0	1.98	0.0
HFC-134a	1,430	198.4	215.0	194.3	177.3	143.1	307.4	253.6
R-404A	3,922	14.3	17.8	20.4	26.9	11.3	27.8	15.1
R-407C	1,774	6.6	8.2	6.6	5.0	2.9	6.5	7.9
R-410A	2,088	4.7	8.5	7.1	5.2	12.4	24.7	18.8
R-507A	3,985	4.1	8.0	12.6	5.36	4.2	8.1	8.1
HFC-32	675	0.0	0.0	0.0	0.0	0.8	0.0	5.6

Source: Wijewardane 2021

The report also revealed that the prices of low/zero-GWP refrigerant are significantly higher than those of the high-GWP refrigerants (Table 15).

Table 15: Average Sales Prices of Refrigerants in Sri Lanka 2019

Refrigerant	Price (US\$/cylinder)	Cylinder Capacity (kg/cylinder)	Price (US\$/kg)
HCFC- 22	77	13.6	5.66
HFC- 134a	103	13.6	7.57
HFC-32	74	6.5	11.38
R-404A	103	13.6	7.57
R-407C	111	13.6	8.16
R-410A	100	11.3	8.84
R-507A	114	13.6	8.38

Refrigerant	Price (US\$/cylinder)	Cylinder Capacity (kg/cylinder)	Price (US\$/kg)
HC-290	80	6.5	12.31
HC-600a	40	6.5	6.15
R-717 (Ammonia)	194	65.0	3.00

Source: Wijewardane, 2021

Table 16: EER and Refrigerants for RAC and Chillers in Sri Lanka

	RAC	Chiller
Common types of ACs Available	Split/cassette/standing/ceiling mounted/VRF	Screw/centrifugal/magnetic bearing
Range of EER generally procured in the market	3–5	5–7
Refrigerant types available	R22, R410a, R32, and R407	R22, R404a, R410a, and R134a
Most common refrigerant used	R410a and R407	R410a
Availability of lower-GWP AC systems in the market - brands/model numbers	All brands provide lower-GWP AC systems.	All brands provide lower-GWP AC systems.

Source: Authors

Table 17: Average Refrigerant Breakdown in Different Air Conditioning Sectors (percent)

	HCFC-22	HFC-134a	HFC-32	R-404a	R-410a	HC-290	HC-600a	R-717
Split, larger packaged and VRV/VRF systems – National	69		6		25			
Split, larger packaged and VRV/VRF systems – Colombo	43		23		34			
Split, larger packaged and VRV/VRF systems – Other	75		2		23			
Air conditioning – water chillers	28	28		11	33			

Source: Wijewardane 2021

Unitary ACs (super-efficient and low-GWP refrigerant). Sri Lanka has an EE program (star labeling) for RAC in the country. According to the current program, RACs in the country are rated into 1-star to 5-star categories based on the EER (W/W). For RACs, the 5-star labelled RAC is 3.5 EER. Currently, GWP criteria are not considered in the country. With a global movement toward sustainable public procurement, there is a move toward low-GWP refrigerants for air conditioning. According to United 4 Efficiency draft on ‘Green Public Procurement Technical Guidelines and Specifications for Energy-Efficient Air Conditioners’, GWP will be mandated as ≤ 750 for RACs. When considering ESCO programs for retrofit of unitary ACs, low GWP can be included along with EE. A discussion with the industry and suppliers will be required to assess the market readiness of the air conditioning demand and supply for low-GWP ACs.

Energy-efficient chillers. Chillers are central heating, ventilation, and air conditioning (HVAC) systems used to cool entire buildings. There are four major types of chillers available in the market—screw, scroll, reciprocating, and centrifugal—and the selection of the type of technology used for a

project is based on the initial cost, functional use, size of the cooling requirement, and EE potential. Following is an estimate on the energy-saving potential for high performance in chiller plants. This is based on a study carried out for the National Chiller Energy Efficiency Program with Energy Efficiency Services Limited (EESL) in India.

Table 18: Energy-Saving Potential for High Performance in Chiller Plants

Sr. No.	EE Measures	Energy-Saving Potential (%)
1	Provide secondary pump sets based on building load requirement. By this arrangement, operational energy consumption can be reduced by shutting down the pumps of that zone where AC is not required.	10–15
2	During the building, part load condition by running the chiller at 2°C higher outlet temperature will give the considerable power saving.	5
3	Variable-speed pumping system gives the best efficiency on partial loading.	5
4	Install a control system or chiller manager to coordinate multiple chillers and pumping system.	—
5	Make adjustments to minimize the refrigerant ‘hot gas’ bypass.	2
6	Chiller selection shall be based on Nonstandard Part Load Efficiency Value (NPLV) as maximum time chillers shall be running only partial loading. Also, chillers should have Variable Frequency Drive (VFD); this arrangement will give the best efficiency on part load.	5
7	Use free cooling or air-side/water-side economizer for catering the space cooling demand during favorable ambient conditions.	6
8	Reduce and optimize the piping valve quantities. This will reduce the pressure drop in pipes and tend to reduce the pump pressure head, resulting in a reduction in pump power consumption.	2
9	Variable Air Volume (VAV) boxes and VFD motor/Electronically Commutated (EC) fans in air handling unit (AHU) to optimize the energy consumption at air side based on the building cooling profile.	10
10	The number of dampers in air side in supply air ducts should be optimized resulting reduction in AHU fan pressure drop and fan power consumption.	1
11	Descaling system or scale guard in chiller condenser inlet line will allow condenser water to pass through the system over the heat exchanger surface without depositing lime scale. Resulting heat exchanging capacity of condenser shall not drop down after a long run. Also, this arrangement makes sure there is no decrement in chiller efficiency.	3
12	Increasing the indoor preset temperature at 1°C will reduce the heat load in the space and electrical power requirement of plant room.	6
13	Fresh air flow shall be modulated based on CO ₂ or occupancy.	2
14	Continuous metering and regular maintenance of systems like AHU/Fan Coil Unit (FCU) filter cleaning, air purging from chilled water line and cooling tower sump, and so on will ensure the optimum power consumption of the HVAC system.	6
15	Install only high-efficiency motor like IE3 and IE4 in the system.	10

Sr. No.	EE Measures	Energy-Saving Potential (%)
16	Study part load characteristics and cycling costs to determine the most efficient mode for operating multiple chillers.	—
17	Isolate off-line chillers and cooling towers.	—
18	Establish a chiller efficiency maintenance program. Start with an energy audit and follow-up, then make a chiller efficiency maintenance program a part of continuous energy management program.	—
19	Eliminate excessive, simultaneous heating and cooling.	—
20	Reset out-of-range or inappropriate setpoints during unoccupied periods.	3–5
21	Program equipment operating schedules should match building use.	5–10

Heat pumps. Heat pumps can be used to reject heat from inside a building to the outside via refrigerants and can be used for heating a space by reversing the refrigeration cycle so that heat is transferred from the warmer outside area to the cooler indoor space. A typical heat pump can transfer heat worth three or four times the energy used.

Tri-generation. Tri-generation is the use of natural gas to generate electricity while capturing the waste heat to provide both cooling and heating. This kind of systems are also called ‘Combined Cooling, Heating, and Power’ (CCHP) systems. While these systems must be planned and custom designed for each premise, they have a number of advantages, such as no or reduced use of CFC- or HCFC-based refrigerants, reduction of transmission and distribution losses for electricity since the system is within the premises, high efficiency of up to 90 percent in comparison to the electricity that is produced in power plants which may only convert up to 25 percent, and reduction of up to 50 percent GHG emissions from the current levels.

District cooling. District cooling delivers chilled water to buildings like offices and factories needing cooling. It consumes 20–35 percent less electricity compared to traditional air-cooled air conditioning systems and individual water-cooled air conditioning systems using cooling towers. There is also a reduction in up-front capital cost for installing separate chiller plants for individual buildings. This can be considered for a group of buildings in a campus that are undergoing cooling retrofits and upgrades, since it will involve major infrastructure upgrade as well.

Solar ACs. Regions with high solar irradiation and air conditioning demand such as in Sri Lanka can use solar heat to regenerate the refrigerant in absorption chillers or desiccant in desiccant chillers using solar panels and solar concentrators. These systems require a large amount of space to install the required solar panels and concentrators, higher flow rate of condenser water, greater pump energy, and larger cooling tower capacity in comparison to electric chillers. However, the systems have appealing payback periods when combined with power generation and water heating; very low distribution losses (5–10 percent) in comparison to conventional systems which may have distribution losses of up to 75–80 percent; are less noisy and produce less vibrations; have efficiency in triple effect absorption designs; and do not use CFC, HFC, and HCFC refrigerants.

Thermal energy storage. The different kinds of thermal energy storage can be divided into three separate categories: sensible heat, latent heat, and thermo-chemical heat storage. Thermal energy storages are viable in cases where there is a great differential in time-of-use tariff and for facilities that have 24x7 occupancy. There are a growing number of facilities that use seasonal thermal energy storage (STES). The Drake Landing Solar Community in Alberta, Canada, has now achieved a year-round 97 percent solar heating fraction, a world record made possible only by incorporating STES.⁴⁷ Sri Lanka, being a tropical country, with no requirements of space heating, STES is not viable. However, it can be considered in commercial facilities that have 24x7 occupancy in combination with time-of-day tariff.

CaaS. CaaS is a pay-per-service model for clean cooling systems, which eliminates up-front investment in clean cooling technology for customers who instead pay per unit of cooling they consume, strengthening incentives for efficient consumption. The technology provider is incentivized to install and maintain the most efficient equipment possible, and, when needed, finance providers have the security of owning an operating asset under a CaaS contract with a customer. This cooling business model is cheaper for customers and more profitable for technology providers—due to both reduced electricity consumption and more effective investment in preventive maintenance. CaaS saves up to 23 percent of cooling costs for customers and reduces emissions from electricity use and coolant leakage by up to 49 percent while providing significant profits for both technology and finance providers. CaaS proponents, BASE and K-CEP, have made significant progress toward initial implementation in two countries: the Dominican Republic and Jamaica. Proponents are also pursuing 3–4 larger flagship implementation projects, likely including South Africa, India, and Mexico. This kind of a model is relatively new and can be explored by technology providers in Sri Lanka.

2.6 Review of Policy, Regulatory and Administrative Frameworks

An overview of the legal and organizational structure of the Sri Lankan electricity sector is as follows:

The Ministry of Power and Energy (MOPE) is mandated to formulate and implement policies, programs, and projects pertaining to electricity and RE and all subjects that come under the purview of the institutions within MOPE, as well as promote EE, among other mandates. While many different organizations report to the MOPE and Business Development (BD), CEB, LECO, and SEA are concerned with electricity usage and EE.

CEB was established under the Ceylon Electricity Board Act No. 17 of 1969 and generates, transmits, and distributes power and supplies electricity. At the end of 2017, CEB supplied 71 percent of the total installed grid capacity. It holds the only transmission and bulk supply license in Sri Lanka, as well as four out of five distribution licenses.

SLSEA was established under the Sri Lanka Sustainable Energy Authority Act No. 35 of 2007. Its objectives include aiding in the formulation of the national energy policy; identifying, conserving, and managing all RE resources and appropriate conversion technologies, conversion, and utilization norms and practices; promoting the development of RE projects through private investment; and

conducting research on the development of indigenous resources.⁴⁸ SEA facilitates energy conservation in a variety of ways, such as:

- (a) Introducing the ISO 50001 Energy Management Systems,
- (b) Accrediting energy managers and energy auditors,
- (c) Introducing standards and regulations for appliances and buildings,
- (d) Providing advisory and counselling services,
- (e) Recognizing achievements in the energy sector,
- (f) Developing and implementing sector-specific energy management program,
- (g) Undertaking research and development initiatives for energy conservation,
- (h) Establishing pilot projects in energy conservation,
- (i) Developing ODSM programs, and
- (j) Creating awareness about EE.

SEA is in a unique position to help energy reform work for different stakeholders in Sri Lanka as they have a diverse set of appointed members, including representatives of the Sri Lanka Energy Managers Association, a representative for the development finance banks in Sri Lanka, a representative from the RE industry, and a representative of the CCC, along with ex officio board members from a diverse set of ministries including Power and Energy, Local Government and Provincial Councils, Industries and Investment Promotion, Lands, Agriculture, Plantation Industries, Environment, Irrigation and Mahaweli Development, Transport, Finance, and Science and Technology and the Director General of PUCSL.⁴⁹

LECO is a private limited liability company incorporated in 1983 for electricity distribution in Sri Lanka under the provisions of the Companies Act No. 17 of 1982 and Companies Act No. 7 of 2007. CEB is one of the major shareholders of LECO, and all the other shareholders are also state entities. LECO distributes electricity produced by CEB.

The private sector was again allowed to generate power in Sri Lanka from 1996. Before this, power sector activities were reserved for various state entities, including CEB, since the government took it over in the 1950s. These private sector operators are known as independent power producers (IPPs) and small power producers (SPPs).

The Electricity Reform Act No. 28 of 2002 (ERA 2002) attempted electricity sector reform by unbundling CEB and LECO into at least six independent state-owned companies that would carry out electricity generation, transmission, and distribution. However, this was not implemented, and in 2009, it was replaced by the Electricity Act No. 20 of 2009.

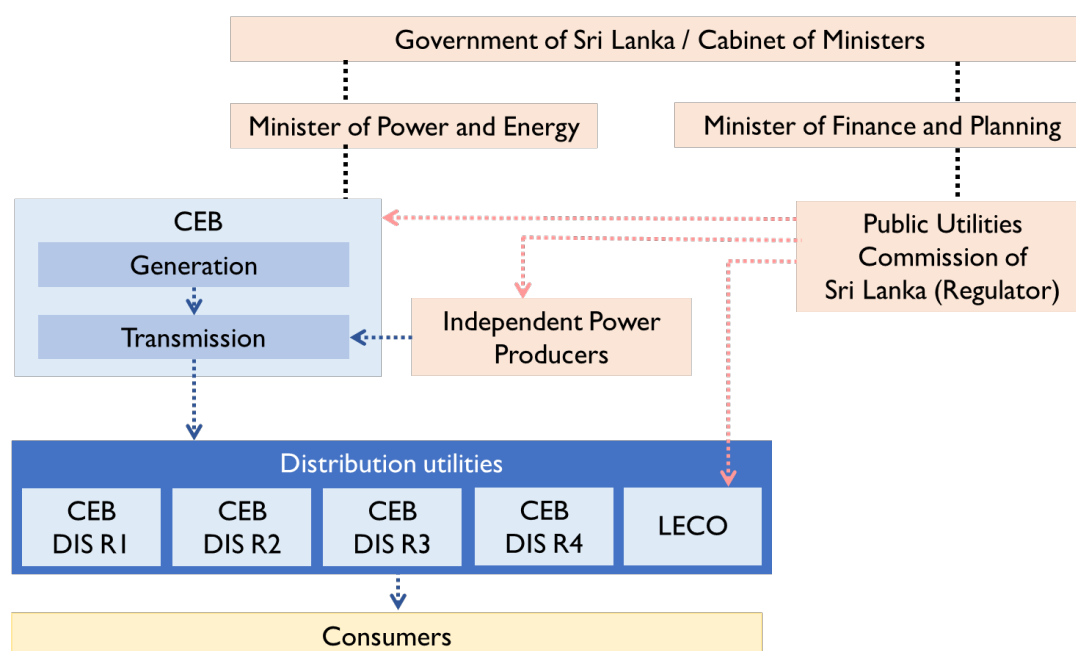
⁴⁸ ADB (2019)

⁴⁹ Sri Lanka Sustainable Energy Authority Act, 2007.

The Sri Lanka Electricity Act, No. 20 of 2009 (EA 2009) is the law that governs the generation, transmission, distribution, supply, and use of electricity in Sri Lanka. It replaces the Electricity Reform Act of 2002 and the Electricity Act (chapter 205). The administration of the provisions of this act vest in PUCSL which was established under the Public Utilities Commission of Sri Lanka Act, 2002. Among the functions assigned to the commission under this act are the promotion of the efficient use and conservation of electricity and the approval of such technical and operational codes and standards as are required from time to time to be developed by licensees.⁵⁰

This act also changed the structure of the electricity market in Sri Lanka by designating CEB as the single buyer and the transmission entity. CEB now holds one generation license (to cover all power plants owned by CEB before EA 2009), one transmission and bulk supply license, and four distribution licenses. IPPs now sell to CEB for transmission of electricity, which is distributed across Sri Lanka via 4 CEB entities as well as LECO.

Figure 29: Sri Lanka Electricity Sector Structure



2.6.1 EE in Sri Lanka

The Government of Sri Lanka (GoSL) started promoting energy efficiency as early as 1985 when the Energy Conservation Fund was set up in response to the second oil crisis. In 2015, the Sri Lanka Energy Sector Development Plan for a Knowledge-based Economy 2015–2025 stated that conservation and efficient use of energy is a thrust area for GoSL and aimed at a target of reducing annual energy demand growth by 2 percent through conservation and efficient use and reducing the carbon footprint of the energy sector by 5 percent by 2025. In 2016, GoSL announced the introduction of DSM activities as part of its NDCs.

⁵⁰ Sri Lanka Electricity Act, No. 20 of 2009

GoSL has reaffirmed its commitment to EE in the National Energy Policy and Strategies of Sri Lanka (2019) which calls for improving energy efficiency and conservation to strengthen the country's energy security. In doing so, GoSL aims to promote efficient use of energy in all sectors and across the energy value chain, engaging both suppliers and users.⁵¹ Commitments toward the buildings' sector and appliances are summarized in Table 19.

Table 19: Commitments of the Government toward EE in Buildings and Appliances

Sr. No.	Commitment	Category	Responsibility
1	Specific energy use in end-user activities will be reduced by 10% of 2015 level by 2023 as part of the national EEI&C program, saving 1,243 GWh of grid electricity generation by 2023.	General including buildings and appliances	SEA
2	Minimum energy performance standards (MEPS) for LEDs and energy labelling for air conditioners, personal computers, refrigerators, ceiling fans, linear fluorescent lamps/ballasts, and induction motors will be enforced by mid-2020.	Appliances	SEA
3	'Energy Manager' scheme will be implemented on a mandatory basis by end 2019 to designated users and extended to the remaining institutional users by 2020.	General including buildings and appliances	SEA
4	Reduced duty and taxation of efficient equipment supported by an accelerated depreciation scheme will be offered to building renovation and retrofitting industry to improve the EE of the existing building stock by 2020.	Buildings	SEA
5	A differential taxation scheme for commercial buildings will be introduced, based on a simplified energy utilization index by end 2020. A similar scheme to support the market for efficient technologies will be introduced by end-2020, through a green procurement process led by the state sector.	Buildings	SEA
6	Lighting standard for street lighting to cater to rural, urban, and major road illumination including other public space lighting requirements will be introduced and implemented on a mandatory basis within 2020.	Appliances	MOPE
7	At least 30% of all government institutional head offices and regional head offices will have teleconferencing facilities to hold tele-meetings by 2021. All main government offices must have teleconferencing facilities by 2020. The participation of officers who require more than 1 hour of travel time to participate at meetings must be discouraged from attending physically and be connected via teleconferencing facilities established at all ministries from end 2019.	General including buildings and appliances	Ministry of Public Administration & Management

⁵¹ GoSL (2019a)

Sr. No.	Commitment	Category	Responsibility
8	A performance-based EEBC for commercial buildings will be made mandatory by end 2019 and a voluntary scheme for domestic sector will be introduced by end 2019.	Buildings	SEA
9	Incorporation of building management systems with a focus on energy management and future opportunities in smart grid-driven automated demand response will be made a mandatory planning criterion for all commercial developments by 2020 by the Urban Development Authority (UDA).	Buildings	Ministry of Megapolis & Western Region Development and UDA

These aspirations require intersectoral industry and government cooperation, and some of these efforts are described in the following sections.

2.6.2 Building EE

The EEBC was first introduced in 2002 as a standard. It was later revised and published as a code in 2008. A second revision of this code, titled the Energy Efficiency Building Code of Sri Lanka, has been completed, and a mandatory requirement for new commercial buildings to comply with the code is expected soon.

The listed purposes of the code are as follows:

- (a) To encourage energy-efficient design or retrofit of commercial buildings and industrial facilities excluding the process energy use and large-scale housing developments, so that they may be designed, constructed, operated, and maintained in a manner that reduces the use of energy without constraining the building function, comfort, health, or productivity of the occupants and with appropriate regard for economic considerations
- (b) To provide criteria and minimum standards for energy efficiency in the design of new facilities or retrofits of buildings, their equipment, and systems within the purview of this code and to provide methods for determining compliance with them
- (c) To encourage energy-efficient designs that exceed these criteria and minimum standards.

All commercial buildings, industrial facilities, and large-scale housing developments meeting any of the criteria stated in the code must meet the energy performance requirements of this code. The criteria are

- (a) Floor area of 1,000 m² or greater,
- (b) Electrical power demand of 500 kVA or greater, and
- (c) Air conditioning cooling capacity above 350 kW_{th} (thermal basis) or heating capacity above 250 kW.

Therefore, this code covers all new constructions—whether whole buildings or additions to existing buildings outside the already existing building envelop that adds to the square footage of the building. It covers different elements of buildings, such as the building envelope, the HVAC systems, the service

water heating systems, the electricity distribution systems, and lighting systems and codifies the requirements for the design of new facilities or retrofits of commercial buildings, industrial facilities, and large-scale housing developments and their equipment and system and additionally even covers situations where an unconditioned part of a building becomes air-conditioned.

Appliance MEPS. Sri Lanka regulates the energy consumption of 7 appliances, including lamps, lamp ballasts, fans, RACs, three-phase squirrel cage induction motors, and refrigerators and freezers. However, only CFLs carry a legally enforced energy performance standard. Energy performance labels are displayed on applicable appliances sold in Sri Lanka since 2000. The common items found in C&I buildings are described in Table 20.

Table 20: MEPS for Appliances Commonly Used in Commercial or Industrial Buildings

Sr. No.	Details
1	SLS 1600: Energy efficiency rating for electric ceiling fans with regulators, 2011 The standard specifies requirements for EE labelling and the method of determination of EE rating of electric ceiling fans having two or more blades with sweep diameter 1,400 mm and associated with regulators having minimum of 5 speed settings. It also provides method of testing for determining the energy consumption and air delivery of electric ceiling fans. It further specifies dimensions, color scheme, and the contents of the EE label.
2	SLS 1200: Energy efficiency rating for fluorescent lamp ballasts, 2012 Specifies a test method for measuring active power loss of magnetic ballasts used with 18/20 W and 36/40 W tubular fluorescent lamps operated on a.c. supplies at 50 Hz, 230 V nominal. It also specifies the requirements and power ratings for assigning star ratings for EE labelling of magnetic and electronic ballasts.
3	SLS 1625: Energy efficiency rating for double capped tubular fluorescent lamps, 2013 This standard specifies requirements for EE labelling of double-capped tubular fluorescent lamps of 18–40 W with pre-heated cathode, operating with or without starter on mains supply of 230 V, a.c. 50 Hz nominal, and method of measurement of electrical power consumption and luminous flux for the determination of efficacy of the lamps for EE labelling. It also specifies dimensions, color scheme, and the contents of the energy label.
4	SLS 1225: Energy efficiency rating for self-ballasted Integral type compact fluorescent lamps for general lighting services, 2016 This standard specifies requirements for EE labelling of self-ballasted lamps, operating on mains supply of 230 V, a.c. 50 Hz nominal, and method of measurement of electrical energy consumption and luminous flux for determination of efficiency of the lamps for EE labelling. It also specifies dimensions, colors, and the contents of the EE label.
5	SLS 1586: Energy efficiency rating for single split type room air conditioners, 2018 This standard specifies requirements for EE labelling and the method of determination of EER of single-phase and three-phase a.c., 230 V/400 V, 50 Hz, non-ducted split ACs of the vapor compression type using a valid refrigerant medium in Sri Lanka up to rated cooling capacity 11 kW, having fixed speed compressors, air-cooled condensers, and single indoor unit. The standard also provides methods of testing for determining the sensible and latent cooling capacities, cooling power consumption, and other performance requirements of RACs. This standard further specifies dimensions, color scheme, and the contents of the EE label for RACs.

2.6.3 Implementation Barriers

Several issues affect the implementation of EE programs for the building sector, including for building cooling and lighting.

Financial barriers. Barriers to the growth of EE in buildings due to the paucity of capital availability and financing. Financial barriers, such as lack of access to affordable financing from financial institutions (FIs), the lack of incentives to participate in EE projects for stakeholders such as FIs or clients, overly leveraged ESCOs, high up-front costs of technology, and EE projects that may be expensive up front.⁵²

Technical barriers. The lack of technical knowledge required to complete the project correctly, difficulties in program design, inability to calculate potential savings, lack of domain expertise within ESCOs in providing performance guarantees for making any shortfall for project design, and so on.⁵³

Informational barriers. The lack of transparency about information that allows for correct project design such as baseline energy consumption, costs, usage, and so on.⁵⁴

Regulatory barriers. Barriers caused due to legal or regulatory reasons, such as not having a comprehensive national energy policy and targets, nonavailability of stringent EE standards, and so on.⁵⁵

Non-implementation of regulations. The existing regulatory framework is not enforced.⁵⁶ In Sri Lanka, although it has been in the regulations for the past several years, mandatory energy consumption reporting and submission of energy management plans by large customers have not been implemented. Similarly, despite efforts to standardize the energy consumption of 7 appliances, only CFL lamps carry a legally enforced energy performance standard and energy performance labels are not displayed on appliances sold in Sri Lanka.

Lack of smart solutions for DSM. Information technology (IT) based ‘Smart’ techniques to manage demand are still at pilot stage and require the use of IT to improved energy management through DSM and demand response techniques.

Market-related barriers. Those barriers that cause hindrance to the creation of a market for EE, such as wrong risk perception (for both lenders and consumers) for the projects.⁵⁷

Awareness barriers. The lack of awareness about EE in buildings can pose a significant barrier to the growth of this sector. Since potential clients are unaware of the service and what it can potentially achieve, they may not understand the requirement for it, or whether their own spaces may benefit from it.

⁵² Fasna and Gunatilake (2020)

⁵³ SEA (2012)

⁵⁴ Ibid.

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ Ibid.

2.6.4 Recommendations

The National Energy Policy and Strategies of Sri Lanka (2019) states that EE will be a primary concern in retrofits, and new building designs will be evaluated for their energy performance on a mandatory basis and that smart technologies, including smart buildings and complete conversion to smart metering, will be ensured to convey price signals to customers, altering the demand profile to reduce the overall cost of supply. The document also states that sustainable neighborhoods will be used as a key design element in urban development with the objective of reducing energy demand.⁵⁸ It is therefore imperative to address all barriers. Some possible solutions for the barriers are listed in Table 21.

Table 21: Recommendations to Tackle Barriers to the Growth of Building EE Projects

Sr. No.	Barrier	Recommendations
1	Financial barriers	- Engaging with FIs about building EE and appliance EE projects so they are aware that such projects are common in the market - Encouraging FIs to develop products that meet the specific requirements of such projects - Provision of financial and taxation incentives for EE projects, including for building EE - Providing risk guarantee programs - To avoid over-indebtedness of ESCOs, regular monitoring of debt indicators shall be done. Also, project baseline and measurement and verification (M&V) approach should be carefully defined so that financial sustainability is maintained.
2	Technical barriers	- Capacity building, such as trainings geared toward certifications for energy managers and energy auditors - Introducing new certifications or higher levels of certifications for interested parties - Mandating certifications and timely certification renewal for industry professionals - Including the most accepted and recent global knowledge as part of certifications
3	Informational barriers	- Providing official templates for asking for information from clients - Providing legal recourse for provably false information - Educating stakeholders about the importance of transparency
4	Regulatory barriers	- Regular updates of existing regulations, such as building EE codes - Regular introduction of MEPS and ratcheting-up of existing standards
5	Non-implementation of regulations	Timely implementation of existing regulations. The Sri Lanka Electricity Act of 2009 briefly provides guidelines and power for enforcement of regulations.
6	Lack of smart solutions for DSM	Taking steps to make IT-based technological solutions available

⁵⁸ Ibid.

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Sr. No.	Barrier	Recommendations
7	Market-related barriers	• Implementing awareness and educational campaigns • Providing risk guarantee programs to lower risk perception
8	Awareness barriers	• Creating awareness and educational campaigns for different stakeholders, including for school children, building owners, FIs, government officials, and others • Establishing an information portal⁵⁹

⁵⁹ Ibid.

3 National and International ESCO Landscape

Over 50 ESCOs are registered with SEA. According to the application for registering ESCOs in 2018, SEA categorized them under three main categories as EEI services, energy audit services, and technology service providers. Table 22 shows a list of ESCOs registered with SEA.

Table 22: List of ESCOs Registered with SEA - 2017

Name of ESCO	Type of Service	Name of ESCO	Type of Service
Ceylon Electro-Mechanical Services (Pvt) Ltd.	TP	Sellcomms Engineering (Pvt) Ltd	TP
Empire Trading Agency (Pvt) Ltd	TP	Mite systems Inc	EAS
EnergySolve International (Pvt) Ltd.	EEI/EAS	Chint Power projects (Pvt) Ltd	TP
Co-Energi (Pvt) Ltd.	EEI/EAS	Magna Engineering and Consultancy (Pvt) Ltd.	EAS
Exergytech	EAS	Mechmar Cochran Lanka (Pvt) Ltd.	TP
ACCESS Energy Solutions (Pvt) Ltd.	EEI/EAS	Forbes Marshall Lanka (Pvt) Ltd.	EEI/EAS/TP
The Energy Team Solutions (Pvt) Ltd	EAS	Energy Management Systems (Pvt) Ltd.	EEI/TP
EnerFab (Pvt) Ltd	EEI/EAS	Simple Engineering (Pvt) Ltd.	EAS/TP
Professional MET Consultancy Services (Pvt) Ltd.	TP	CGI Lanka	EAS
Industrial Solutions Lanka (Pvt) Ltd	EEI/EAS/TP	Anzella Energy Consultancy Services	EEI/EAS
LJ Energy Lanka (Pvt) Ltd	EEI/EAS	Machineries & Equipment Authority	EEI/EAS
GLIDE (Pvt) Ltd	EAS	Strategic Energy Engineering Solutions	EEI/EAS
PricewaterhouseCoopers	EAS	Sun Power Technologies	EEI/EAS
Hayleys Industrial Solutions (Pvt) Ltd.	TP	Aklan International (Pvt) Ltd	EEI
Tekzol (pvt) Ltd.	EAS/TP	Zeus Engineering	EEI

Name of ESCO	Type of Service	Name of ESCO	Type of Service
Clarion International Ltd.	TP	National Cleaner Production Centre	EAS
Carbon Fund (Pvt)Ltd	EAS	B.G. Solar Energy Pvt Ltd	EEI/EAS/TP
Shin Nippon Lanka (Pvt) Ltd	EEI	B.G. Technology	EEI/EAS/TP
Industrial Services Bureau (ISB)	EAS/TP	Industrial Solution Lanka (Pvt) Ltd	EEI/EAS/TP
Industrial Services & Training Center (ISTC)	EAS	Ecotex Holding (Pvt)Ltd	EEI/EAS/TP
Voltas Engineering (Pvt) Ltd.	TP	Vibhawa Consultants	EEI/EAS/TP
Lanka Energy Conservation (Pvt) Ltd.	EEI/EAS	Sri Lanka Energy Manager Association	EEI/EAS
Power Consult (Pvt) Ltd.	EAS/TP	Island Engineering Private Limited	EEI/EAS
Maxtherm Lanka (Pvt) Ltd	TP	Aloka Solar Solution and Engineers (Pvt) LTD	EEI/EAS/TP
Metropolitan Engineering (Pvt) Ltd.	EEI/EAS	SLEMA Energy Service Pvt, LTD	EEI/EAS/TP

Note: TP = Technology provider; EAS = Energy audit services.

However only 2–3 ESCOs are trying to continue services in EE (guaranteed savings model), and the rest have switched to installing RE technologies. SEA does however have a program for certification of auditors and energy managers.

A research study⁶⁰ on the ESCO business model for energy conservation in Sri Lanka identified guaranteed energy saving throughout the entire project life cycle as a core strategy, which is lacking in the existing service practices. Moreover, it identified that the existing energy service practices are lacking in direct value-adding services such as zero risk to the client and indirect service benefits such as arranging of finance, attainment of environment policy, and continuous improvements, to name a few. These were considered during the development of the ESCO business models.

Some additional barriers for the uptake of ESCOs in Sri Lanka were identified as follows:

- (a) There is lack of awareness and interest by industries on the ESCO model and EE in general.
- (b) Sri Lankan rupee depreciation has affected EE investment.
- (c) Static tariff and currency depreciation are key reasons for longer paybacks on EE interventions.
- (d) High financing costs are a hindrance to loans for ESCOs.
- (e) Documentation and lending mechanisms for banks are too complex.
- (f) There is no special allocation of funds for EE.
- (g) Transaction barriers also include lack of energy-saving performance contracts (ESPCs), M&V protocols, credit lines, the smaller size of projects, and ESCOs' financial credibility.

⁶⁰ Ranasinghe and Sandanayake (2020)

- (h) Financial and technical capacity limitations of the ESCOs have prevented them from approaching/convincing industries with awareness and interest in EE investments/initiatives.
- (i) There is uncertainty on future operations/scales of industries to commit on ESCO projects.
- (j) There are legal impediments to secure the project assets as collateral for ESCO loans.
- (k) There is lack of capacity/awareness/interest by FIs to support ESCO business.

3.1 Sri Lanka's Local ESCO Assessment

A local ESCO assessment was carried out through an online survey form and through the first round of consultations with ESCOs in August 2021. The Sri Lanka ESCO Needs Assessment & Identification of Pilot Projects survey form has been provided in Annexure 6.2. The online survey form was circulated among 27 ESCOs by SEA.

ESCO Profile

The following ESCOs participated in the survey:

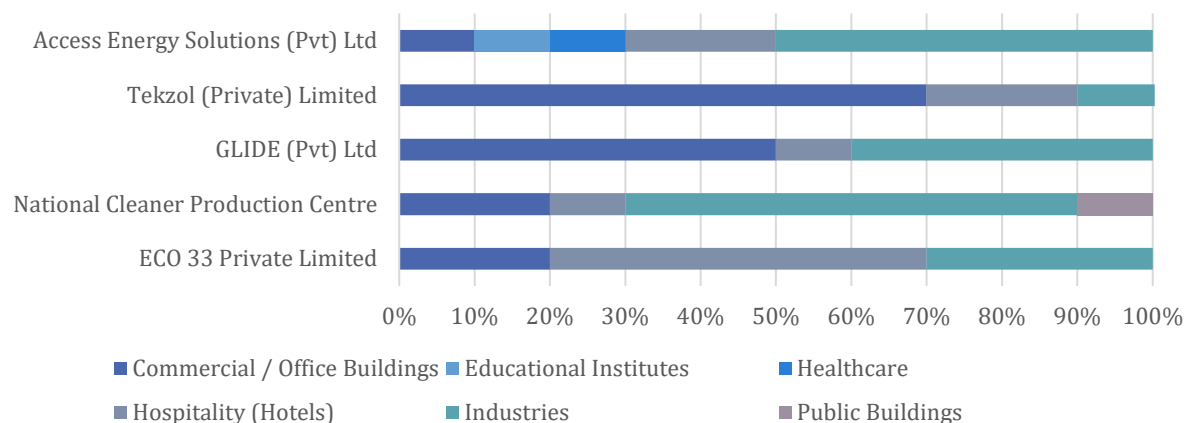
- (a) Tezkol Pvt. Ltd.
- (b) Access Energy Solutions Pvt. Ltd.
- (c) GLIDE Pvt. Ltd.
- (d) ECO 33 Pvt. Ltd.
- (e) National Cleaner Production Centre.

The annual turnover of the ESCOs ranges from LKR 3,300,000 to LKR 200,000,000, and percentage of the overall turnover/business (in Sri Lanka) related to energy performance contracts (EPCs) ranged from 20 percent to 100 percent. Four of the participating ESCOs are stand-alone ESCOs, while one is a subsidiary of a larger organization or utility. Only one ESCO had executed five ESCO contracts in the last five years, and the rest had executed two or fewer such contracts. However, they have all conducted several detailed energy audits in the same period (total 115), of which 36 clients implemented the suggested EEIs (31 percent). Two of the five ESCOs have a standard legally vetted model contract specifying the terms and conditions (T&C) of the EPC and role of the clients, and four of the five follow M&V protocols for ensuring contract terms have been fulfilled.

Type of Clients and Projects

In the last five years, all the participating ESCOs have had experience working with commercial offices, industry sector, and the hospitality sector, and 80–100 percent have been from clients in the private sector.

Figure 30: Type of Client Sector in the Last Five Years

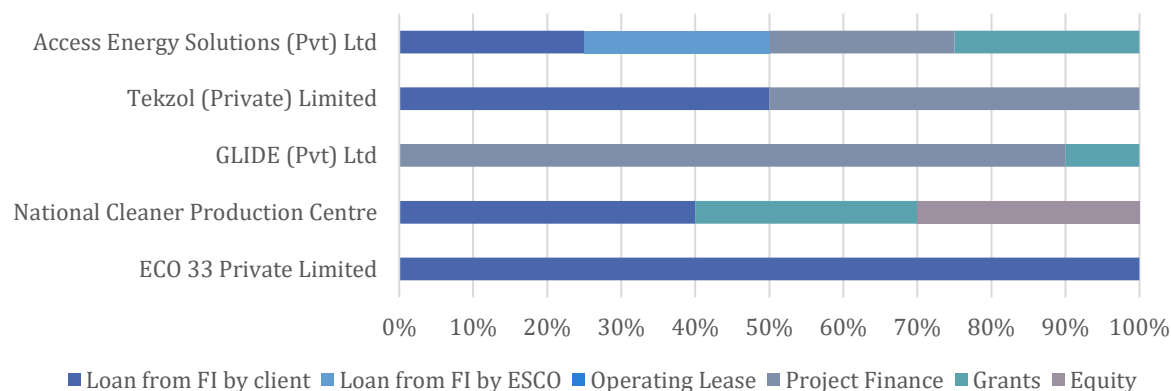


Source: Authors based on online survey responses.

Guaranteed and shared savings ESPCs are both predominant among the participating ESCOs. Typically, ESCOs achieve 15–25 percent energy savings, but the range of savings may be from 5 percent to over 40 percent depending on the project. The typical project duration also ranges from 1 to 6 years (including recovering costs).

There are varied sources of project financing among ESCOs.

Figure 31: Sources of Finance

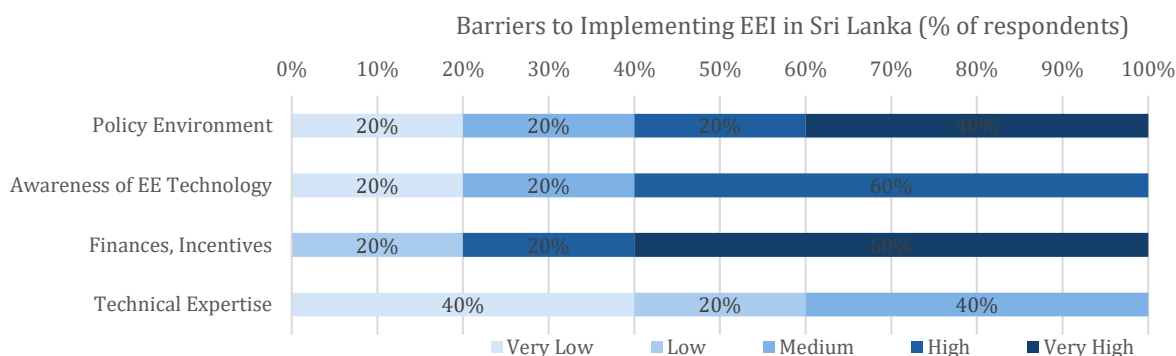


Source: Authors based on online survey responses.

Barriers Identified

The key barriers identified by the ESCOs on the survey have been related to financing and incentives, followed by the policy environment. Technical expertise in comparison is not a barrier to implementing EEI in Sri Lanka.

Figure 32: Barriers to Implementing EEI in Sri Lanka



Source: Authors based online survey responses.

Responses on challenges faced in obtaining viable finance for ESCO projects:

- (a) Low-cost financing
- (b) Lack of accuracy in measuring equipment
- (c) Lack of credibility in savings potential proposed
- (d) Investors/facility owners prioritizing other investments such as expansions
- (e) Key decision makers not aware about the importance of the energy management and cost saving.

Capacity-Building Requirements

The two major avenues where ESCOs reported capacity-building requirements were on understanding and development of transaction modalities and toward development of project proposals. This was followed by requirements on understanding of financing mechanisms. Three of the five ESCOs stated that they require capacity building on energy audit.

Table 23: ESCO Need Assessment Survey Responses

Capacity-Building Requirements (by Order of Priority)	Yes	Maybe	No
Understanding and development of transaction modalities	4	1	
Development of project proposals	4		1
Understanding of financing/funding	3	2	
Energy-efficient technologies	2	3	
Energy audit	3		2

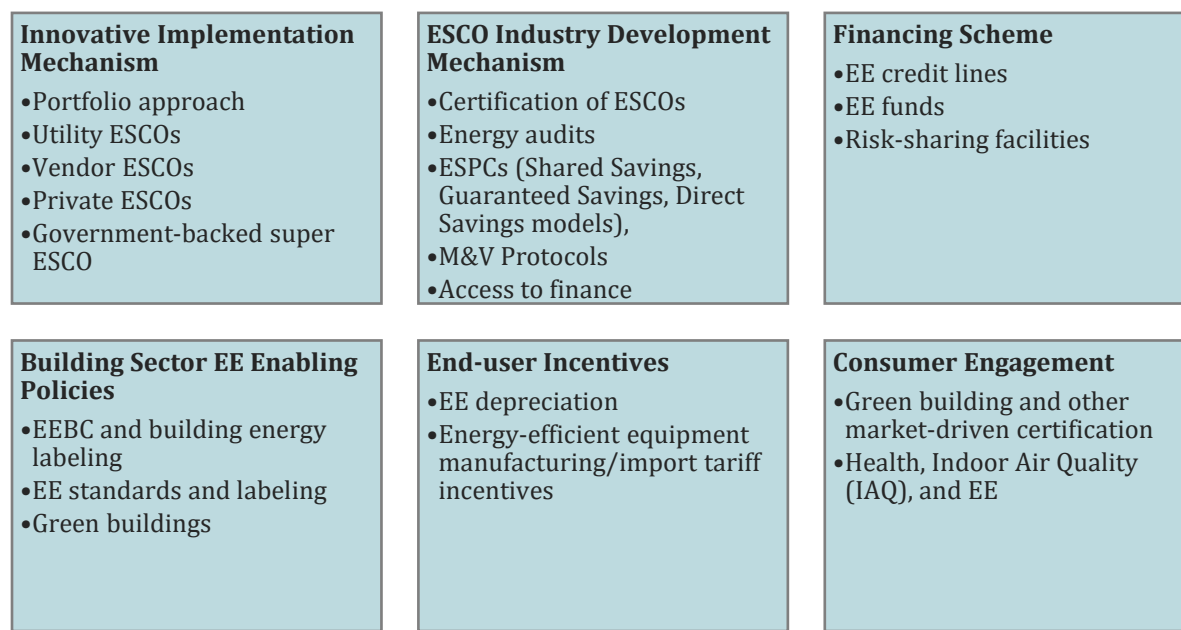
Additional requirements listed by ESCOs in the survey form are as follows:

- (a) Knowledge on simulation software packages
- (b) Equipment Usage, New Energy Policies
- (c) Funding support on awareness workshops and infrastructure development and training

3.2 Potential Strategies for Designing an ESCO Program

Strategies for designing an ESCO program can be encompassed under the following heads. Each of these strategies, through examples, have been detailed in this section.

Figure 33: Integrated Sector Building EE ESCO Approach



3.2.1 Innovative Implementation Mechanism

Portfolio approach. Aggregating various projects under a portfolio can help improve risk-return trade-offs. Pool equity can then be used to invest in multiple projects. Based in the UK, Sustainable Development Capital LLC operates through numerous investment vehicles in Ireland, Asia, and North America and the Europe, the Middle East and Africa region. As an investment partner of technology providers and ESCOs, Climargy⁶¹ has established an investment vehicle in Asia to provide equity funding for EE upgrades, distributed generation, and energy storage projects through shared savings performance contracts and energy off-take agreements. Such a non-bank portfolio equity vehicle broadens the bankable investment opportunities, by serving as new intermediaries to deepen the reach of debt capital to EE project assets.⁶²

Utility ESCOs. DSM is a means for utilities to reduce energy costs on a large scale primarily through reducing consumption during peak hours or shifting the demand from peak hours to off-peak. Utility-led ESCOs effectively serve as a portfolio of small-scale EE projects with lower capital and are governed by a shared savings model. Due to the seasonal availability of hydropower and lack of reserve capacity, the marginal generation cost of Sri Lanka is extremely high, providing enough incentive for CEB to participate in DSM activities to not only reduce operating costs but also avoid

⁶¹ Climargy was established to develop fully financed energy management upgrades for C&I clients in priority growth markets in Asia. It helps C&I facility owners implement EE and other low-carbon energy management upgrades sooner, taking risk and capital decisions outside the typical constraints of their balance sheet.

⁶² Ablaza et al. 2020.

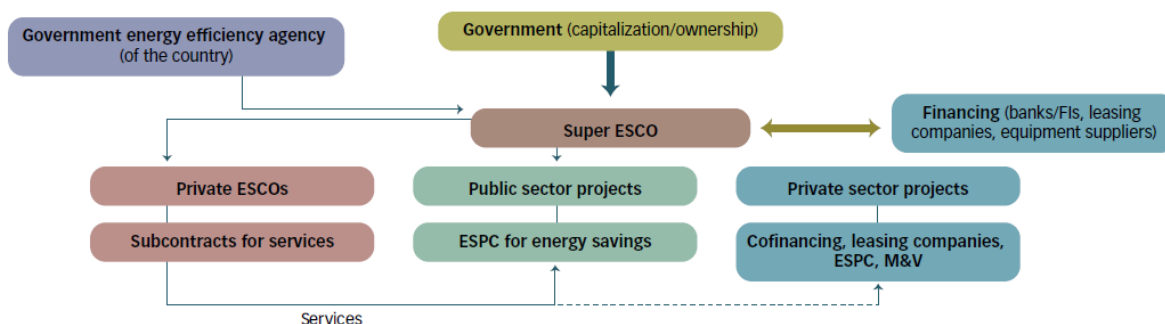
power outages during peak hours. Furthermore, CEB and the electricity regulator are better positioned to bring in structural changes to the consumer tariffs to encourage end-user EE and DSM activities, which can complement the utility ESCO operation.

Vendor ESCOs. Vendor-driven ESCOs are those who use their technology/products for the implementation of energy improvement measures. Vendors can use the ESCO approach to access a wider customer base and promote more efficient, but at the same time, more expensive products, based on the long-term benefits rather than on short-term funding availability. Vendor ESCOs can however be technology biased rather than providing comprehensive energy management services.

Private ESCOs. This is an ESCO classification based on ownership. ESCOs may be privately owned companies, either independent or part of a large conglomerate, state-owned, non-profits, joint ventures, manufacturers, or manufacturers' subsidiaries. The World Bank Partial Risk Sharing Facility for Energy Efficiency (PRSF) project in 2015 is an example of a program that aimed to transform India's EE market through de-risking and enabling private sector ESCOs.

Government-backed/joint mechanisms for super ESCOs. Super ESCOs are large-scale ESCOs established and capitalized by the government, aimed toward achieving a scale capable of taking on multiple EPCs and gaining access to competitive lending terms from FIs. Today, super ESCOs have either been established or are in the process of evolving in seven countries: Armenia (R2E2 Fund), Belgium (Federal ESCO of Belgium [FEDESCO]), China (Fakai Scientific Services Corporation), Croatia (HEP ESCO), India (EESL), Saudi Arabia (Tarshid), and the United Arab Emirates (Etihad ESCO).⁶³ This model could be set up in Sri Lanka with SEA as the government agency (not the utility such as the case in EESL India). Under the act to form 'joint mechanisms', SEA could establish agreements with ESCOs under the umbrella of the super ESCO. SEA mandate being behind this alliance would accelerate ESCOs' development and overcome barriers to undertake projects.

Figure 34: Super ESCO Illustrative Model



Source: World Bank 2018.

⁶³ Ablaza et al. 2020

3.2.2 ESCO Industry Development Mechanism

Certification of ESCOs. Certification of ESCOs enables the credibility of services offered by them. Some of the objectives of certification of ESCOs are to

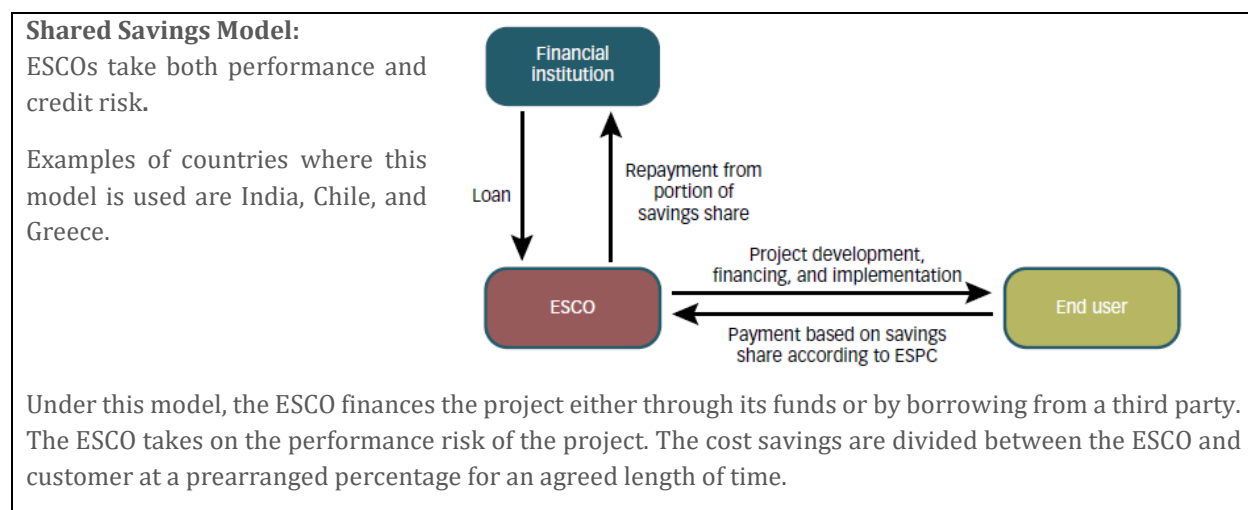
- (a) Be able to accelerate the implementation of EE projects and programs within the context of the government thrust on energy security, soaring energy prices, and climate change mitigation;
- (b) Promote and expand ESCO business as a new emerging business industry in the local market;
- (c) Classify ESCOs in the market according to their area of expertise and financial capability;
- (d) Help inefficient companies avail of ESCO services with least to no-cost investment in EE projects;
- (e) Be able to create more jobs and a stable ESCO business sector to help contribute to the country's economic development and poverty alleviation program of the government; and
- (f) Promote and build up the networks of Sri Lanka-accredited ESCOs in the local market as well as in the regional market.

This mechanism has been used across many countries including the United Arab Emirates and India.

Energy audits. Energy evaluation is a key step toward saving electricity. It is especially important to have a comprehensive understanding of the amount of electricity being consumed. Energy auditing is just the first step toward computing potential energy savings and financing EE. ESCOs conduct energy audits to understand, monitor, and control electricity consumption with the least financial risks. Mandating energy audits has been considered an effective strategy toward addressing ESCO scaling-up barriers (for example, the Philippines and the Republic of Korea)

ESPCs. Most agreements between customers and ESCOs are underpinned by EPCs. The two most common types of EPCs are referred to as shared savings or guaranteed savings models.

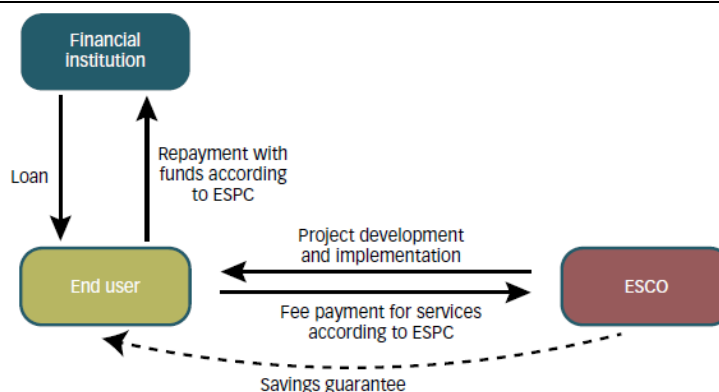
Figure 35: ESCO Implementation Models



Guaranteed Savings Model

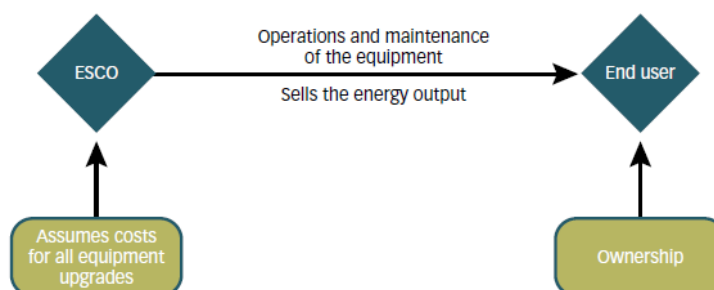
ESCOs take performance risk.

Countries with ESCOs that use this as the main financing model include the Czech Republic, Denmark, Canada, and Thailand.



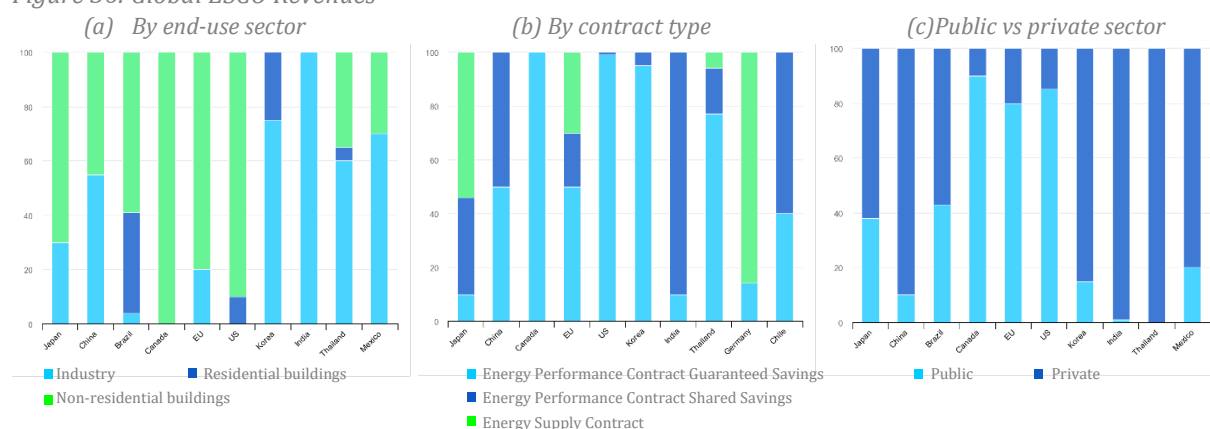
In this case, the customer finances the design and installation of the project by borrowing funds from a third party such as a bank or through leasing the equipment. The ESCO has no contractual arrangement with the bank but does assume the project risk and guarantees the energy savings made. If the savings do not reach agreed minimums the ESCO covers the difference; if they are exceeded, then the customer agrees to share the savings with the ESCO.

Energy supply contracting or chauffage



Source: World Bank 2018

Figure 36: Global ESCO Revenues



Source: IEA 2022b, 2022c, 2022d

The value of the global ESCO market grew 8 percent to US\$28.6 billion in 2017, up from US\$26.8 billion in 2016. There are notable differences in ESCO markets between countries and regions.

The guaranteed savings model has been adopted in countries where there is a high degree of familiarity with project financing, sufficient technical expertise within a banking sector that understands EE projects and the associated risks, and a well-functioning banking structure. Shared savings is still the favored approach in countries where ESCO markets are emerging and are also preferred by super ESCOs, being the basis of their business model.

Access to finance. ESCO financing refers to financing with internal funds of the ESCO and may involve own capital or equipment lease. ESCOs rarely use equity for financing, as this option limits their capability of implementing projects on a sustainable basis. The uncertainty associated with the performance of efficiency measures inhibits third-party EE financing globally. Energy savings insurance has now emerged as a solution offered by FIs, private companies, and insurance companies to reduce the risk of an EE project. Typically, there are two types of insurance packages offered by insurers: technical and credit.

3.2.3 Financing Scheme

EE credit lines/long-term financing sources. End users of EE projects can source funding from third parties via either equity or debt investment. FIs can provide equity funding, and multilateral development banks can provide long-term debts that exceed the project period. Development assistance funds can flow into either large-scale government programs or private investments, which retain ownership of the asset infrastructure. Affordable financing through such mechanisms is valuable for ESCOs and end-users that do not have the base assets to qualify for commercial loans.

ESCO guarantee funds. Under EPCs, there are risks that financial obligations may not be met, resulting from financial shortfalls or technological underperformance by the counterparties. An ESCO guarantee fund functions as an insurance facility that provides various types of guarantee-cover depending on the financial obligation being insured (Ablaza 2020). This reduces uncertainties in EPC cash flow streams, paving the way for ESCOs to take on more projects.

Risk-sharing facilities. A risk-sharing facility is wherein credit risk from EE debt financing is shared between the government and another FI (Ablaza 2020). Such a structure would insulate the government from losses that aggregate from smaller underpayments across multiple ESCO customers but still create an economic incentive for private FIs to participate in the financing process. The World Bank's PRSF Project in India assisted in achieving energy savings with mobilization of commercial finance and participation of ESCOs.

3.2.4 Building Sector EE Enabling Policies

EEBC and building energy labelling. Efforts to score and label buildings for energy performance have been in place internationally for over 15 years. Many countries and a few locations in the United States regularly score and label their existing buildings for energy performance to ensure transparency to buyers, renters, and occupants. This is an important step toward making EE visible and enabling markets to begin to truly value building energy performance. Energy scores and labels

can quantify investments made in a building's EE and RE systems, provide information for prospective buyers or renters, and encourage sellers and property owners to invest in efficiency improvements. Building energy labelling programs can create an enabling policy environment for the market of ESCOs to thrive.

EE standards and labelling. The country's overall EE can be increased by gradually eliminating low-cost, inefficient appliance models and by stimulating the development of more efficient technologies, labels, and standards.

Green buildings. Incentivizing green building ratings for existing buildings can also create a market for ESCOs.

Large-scale government programs. Governments can play significant roles in stimulating the growth of EE markets. Examples of such programs are seen in Malaysia (public-private partnership), the US (PACE program), and so on, wherein the government promotes EE on a national scale. In some cases, the repayment is tied to property taxes.

3.2.5 End-User Incentives

EE depreciation. Depreciation of capital expenditure is being considered in some countries as lucrative options for end users. For example, the US Energy Policy Act of 2005 (EPACT) is considering the inclusion of accelerated depreciation for smart meters and smart grid systems. Currently, US taxpayers recover the cost of smart electric meters and smart electric grid equipment over 20 years. This act allows taxpayers to recover the cost of this property over 10 years.

Energy-efficient equipment manufacturing/import tariff incentives. Fiscal incentives play a vital role in promoting investment in energy-efficient technology and are instrumental in industrial sector development. Such incentives are often provided via a country's tax system and offer tax subsidies, rebates, and tax holidays for investments in energy-efficient technologies. Fiscal incentives are aimed at industrial sector development using high-energy-saving technologies and high-efficiency services. The intervention of such policies is predominant both in developed countries such as Japan and in emerging economies such as China, India, and Indonesia.

3.2.6 Consumer Engagement

Health, IAQ, and EE. Improving IAQ in buildings is a global priority. Often, building EEM are implemented without any consideration of the effects on health. As the buildings prepare for post-COVID-19 reopening, public health and the prevention of pandemics are a high priority for all commercial public and industrial buildings. This will give added urgency to the retrofit and expand the ESCO scope. The ESCO model can be used for retrofitting existing buildings for both enhanced EE and IAQ. Centrally air-conditioned public buildings, government and private sector hospitals, hotels, airports, and metros, which need to meet a high standard of air quality and resilience, could be taken on priority.

3.3 Asia Experience

In most Asian markets, ESCO activity within the industry sector represents the largest share of market activity.⁶⁴ In most cases, ESCO sector development was bolstered by government and development programs that built technical competencies and energy end-user confidence and incentivized pioneer EPC transactions.⁶⁵

Table 24: Comparative Tabulation of ESCO Markets in Asia

Country	Market Potential	Dominant ESCO Business Model	Key Barriers for ESCO Industry Growth	Enabling Government Policies and Programs
China	US\$17.6 billion (2018)	Shared savings	• Lack of commercial financing for small/medium ESCOs • Risk aversion of FIs against EE projects	• Required energy programs and audits for enterprises with the largest energy consumption • Capital subsidies for EE investments • Income tax exemptions for ESCOs
India	US\$300 million (2018)	Guaranteed savings	• Contract enforceability • Low demand for ESCO projects • Large transaction costs for smaller ESCO projects	• Partial risk guarantee facilities and other financial assistance • Standardized contract templates • ESCO accreditation process
Japan	US\$350 million (2017)	Shared savings	• Limited penetration into the public sector	• Energy conservation law • EE standards • Subsidies for energy retrofits
Malaysia	US\$95 million (2018)	Shared savings	• Subsidized electricity tariffs • Lack of technical expertise	• Financial incentives for EE projects under the National Energy Efficiency Action Plan • Efforts within agencies to purchase energy-efficient appliances and conduct energy audits • Capacity-building programs

⁶⁴ Ibid.

⁶⁵ Ablaza et al. 2020

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Country	Market Potential	Dominant ESCO Business Model	Key Barriers for ESCO Industry Growth	Enabling Government Policies and Programs
Thailand	US\$200 million (2018)	Guaranteed savings	• Low demand due to poor understanding of the ESCO business by the private sector • Risk aversion of FIs against EE projects	• Energy efficiency revolving fund (EERF) • Energy Conservation and Promotion Act • MEPS • Energy Efficiency Resources Standard (EERS)
Philippines	US\$160 billion potential (2017–2040)	Shared savings	• Lack of commercial financing for small/medium ESCOs • Risk aversion of FIs against EE projects	• Energy Efficiency & Conservation Act • Mandatory energy audits for qualifying establishments • Fiscal and tax incentives for EE projects
Singapore	Target market, energy users > 54 TJ or Green Mark buildings	Shared savings and energy management contracts	• A slow increase in demand due to the early phaseout of government incentives • Risk aversion of FIs against EE projects • Lack of technical expertise	• Energy Conservation Act • Green Mark Scheme under the Building & Construction Authority (BCA) • Funding and grants from multiple agencies
Republic of Korea	US\$317 million (2018)	Shared savings	• Plateauing demand due to early phaseout of government incentives	• ESCO fund providing financing for EE projects • Mandatory energy audits
Taiwan, China	US\$4.7 billion (2017)	Shared savings and energy supply agreements	• ESPCs only 22% of the total ESCO business • ESCO penetration in manufacturing processes still limited	• Government programs to support the ESCO industry and ESCO promotion • MEPS • Mandatory EE rating labeling

Source: Asian Development Bank Institute (ADBI) 2020 and Asia Pacific ESCO Industry Alliance 2019.

Similar barriers as those in Southeast Asian markets are also seen in Sri Lanka. One of the key barriers for ESCO growth seen across many Asian countries is the risk aversion of FIs against EE projects, which can be addressed through mechanisms such as partial risk-sharing facilities providing guarantees for commercial banks. A supporting policy environment through ESCO accreditation, financial incentives and subsidies, dedicated ESCO fund, mandating energy audits, are some of the best practices implemented across Asian countries.

3.3.1 EESL's Super-Efficient AC Program in India

To integrate EE into India's cooling sector, a super ESCO, EESL, initiated a first-of-its-kind, super-efficient air conditioning program. Consumers can buy the super-efficient air conditioners distributed by EESL at prices that are comparable to the most energy-efficient ACs in the market. These super-efficient ACs will provide 1.5 TR cooling capacity at high ambient temperature while also reducing the cost of cooling by 50 percent. Under the first phase, EESL will distribute 50,000 super energy-efficient and environment-friendly ACs across India by partnering with different state distribution companies.

3.3.2 Partial Risk Sharing Facility for Energy Efficiency (PRSF) in India

In 2015, the Government of India and World Bank signed a US\$43 million grant and guarantee agreement toward the PRSF project. This project consists of two components. The first component supports establishing and operating the facility to provide sub-guarantees to sub-financiers and developing EE markets through end-to-end solutions and M&V activities. The PRSF is managed by the Small Industries Development Bank of India (SIDBI), funded from a GEF contribution, and backstopped by a Clean Technology Fund Guarantee, in the form of contingent finance. The second component supports technical assistance, capacity building, and operations support, among other things. The above two components are designed to strengthen the market-driven EE ecosystem conditions necessary for addressing EE market barriers.

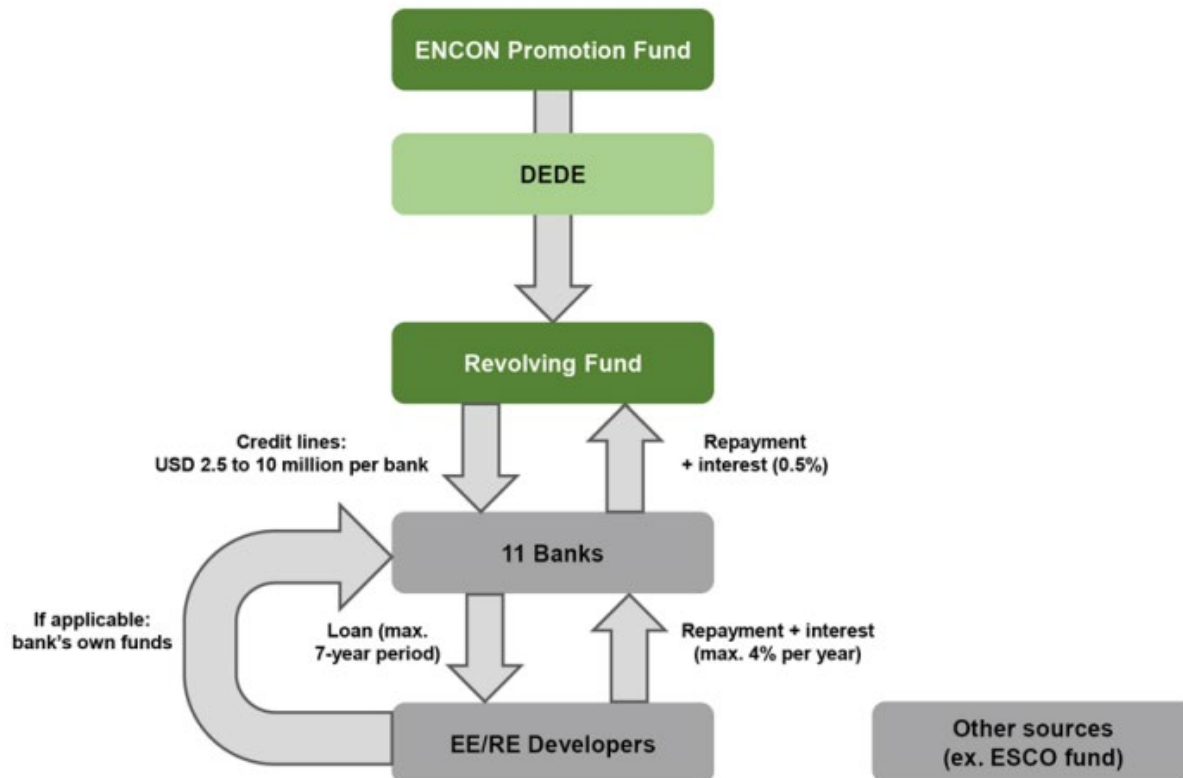
3.3.3 Energy Efficiency Revolving Fund (EERF) in Thailand

An EERF was established in Thailand primarily to address financial barriers of EE projects and stimulate increased participation of commercial banks.⁶⁶ From 2003 to 2010, the EERF funded 335 EE and RE projects totaling US\$453 million in investment, with US\$210 million (or 46 percent) being sourced from EERF disbursements. The EERF reshaped stakeholder involvement in the EE sector. For commercial banks, mobilization of capital increased due to the foundational deal flow stimulated by the EERF at below-market financing rates. From merely matching the funds sourced from EERF disbursements, banks eventually took on more risk and provided more capital as they developed a better understanding of EE projects' technical aspects and business model. Also, as the EERF streamlined procedures and focused on achieving energy savings, the time it took to approve loans (and subsequently the time it took to begin implementing projects) was drastically shortened.⁶⁷

⁶⁶ Wang *et al.* (2013)

⁶⁷ Ablaza *et al.* (2020)

Figure 37: EERF in Thailand



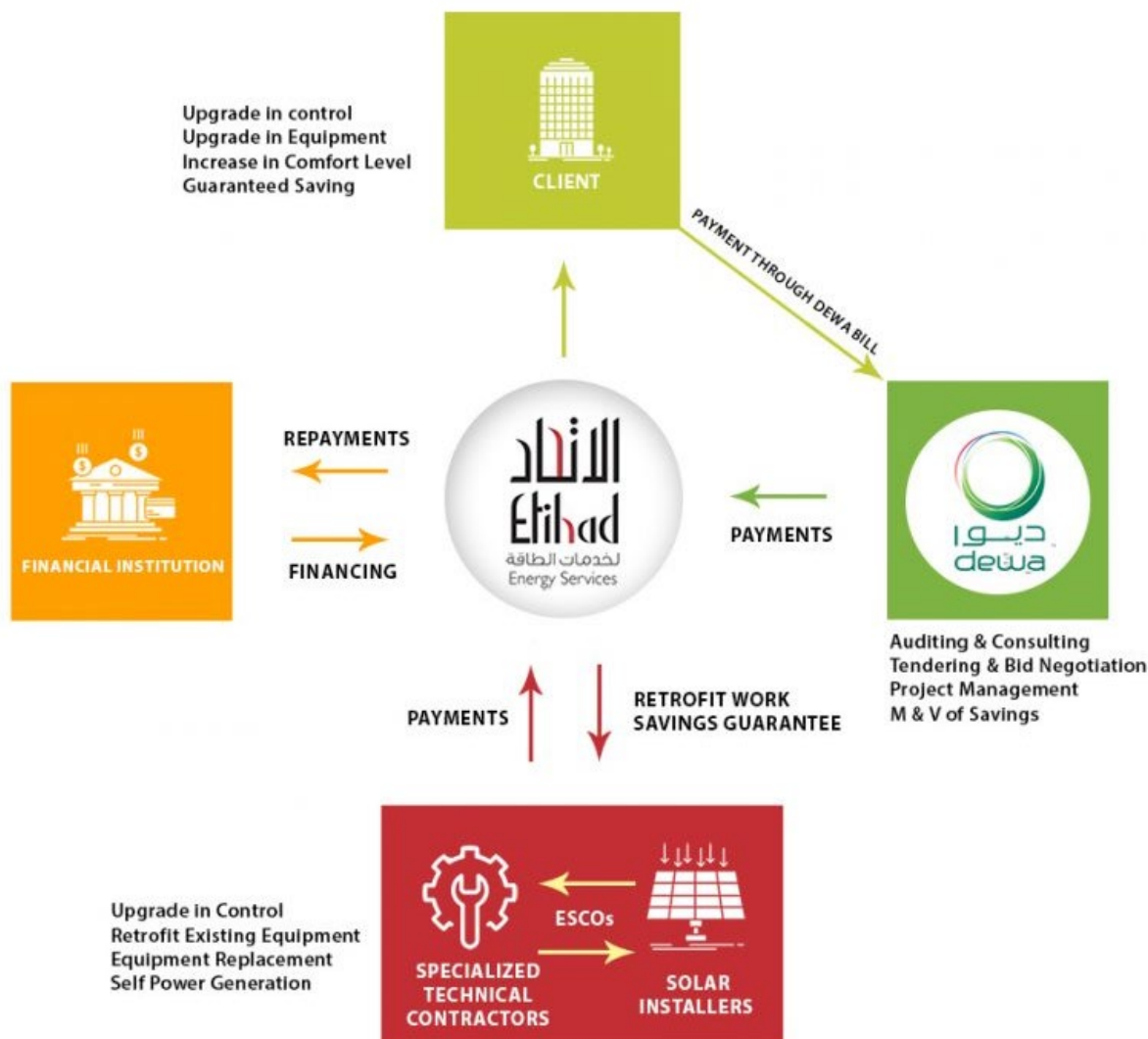
3.3.4 Third-Party Financing in Singapore

The manufacturing sector accounts for more than half of Singapore's GHG emissions, and hence, it has long been a target for cutting energy consumption. Economic Development Board (EDB) Singapore tried to encourage financing for EE projects in industrial and manufacturing facilities by partnering with a commercial fund manager to pilot a third-party financing model that incorporates risk sharing (E2F Singapore 2017). Energy Efficiency Fund (E2F), Energy Efficiency Financing Program, and Resource Efficiency Grant for Energy were some of the programs initiated in Singapore.

3.3.5 The Etihad ESCO in the United Arab Emirates

Etihad ESCO is the official super ESCO organization under the leadership of the Dubai Supreme Council of Energy. Etihad ESCO operates as a middleman between private and public facility owners, ESCOs, and FIs, to act as an effective facilitator to remove market barriers so that energy retrofits happen effectively. As a super ESCO, it does not compete with private sector ESCOs and is focused on organizing and establishing a market for ESCOs.

Figure 38: The Etihad ESCO in the United Arab Emirates



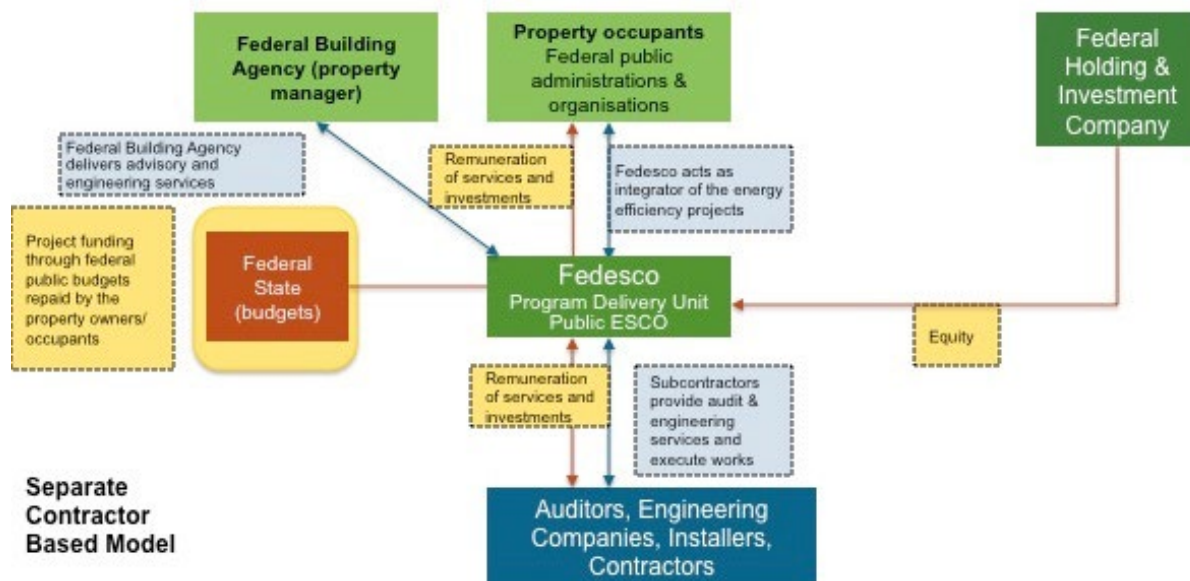
3.4 Global ESCO Experience

A review of global best practices with few examples of ESCO models and financing mechanisms is as follows. Significant examples pertain to Europe dealing with public, commercial, and industrial sectors.

3.4.1 Belgium FEDESCO

FEDESCO was created in 2005 as a public ESCO to study and implement EE projects in 1,800 Belgian federal public buildings. From 2007, FEDESCO first implemented a 'separate contractor' based model, with a strong focus on HVAC (boiler replacement and boiler room renovation), HVAC regulation, retrofitting lighting, co-generation, and roof insulation. FEDESCO thus acted as an 'integrator'. The contractor-based model has been diagrammatically represented in Figure 39.

Figure 39: Contractor-Based Model, Belgium FEDESCO



The working of the Separate Contractor-Based Model is as follows:

- Federal public administrations seeking to reduce their energy consumption contract with FEDESCO for an initial quick scan of their buildings.
- FEDESCO subcontracts the realization of the quick scan to a private auditor with whom it has concluded a framework contract.
- The resulting measures are discussed and budgeted, and a contract is drafted between FEDESCO and the customer.
- FEDESCO outsources the detailed study and technical specifications to private engineering companies. Results are discussed with the Building Agency.
- After approval, FEDESCO organizes a tender to private installers and contractors for the implementation of the works and coordinates the planning and implementation. Onsite works are coordinated by the building agency.
- FEDESCO pre-finances the works out of annual federal public budgets, and customers reimburse FEDESCO, either directly or spread over several years.
- FEDESCO has invested in energy monitoring and bookkeeping and tracks the performance of the EEM.

From 2011, FEDESCO started implementing a parallel model, using EPC contracting, called smartEPC, co-developed with a private facilitator (Energinvest). SmartEPC is effectively a model for maintenance, energy, and comfort performance contracting. The smartEPC contract included a full performance-based maintenance of all the technical installations in the building. The EPC-based model has been diagrammatically explained in Figure 40.

Figure 40: EPC Model, Belgium FEDESCO



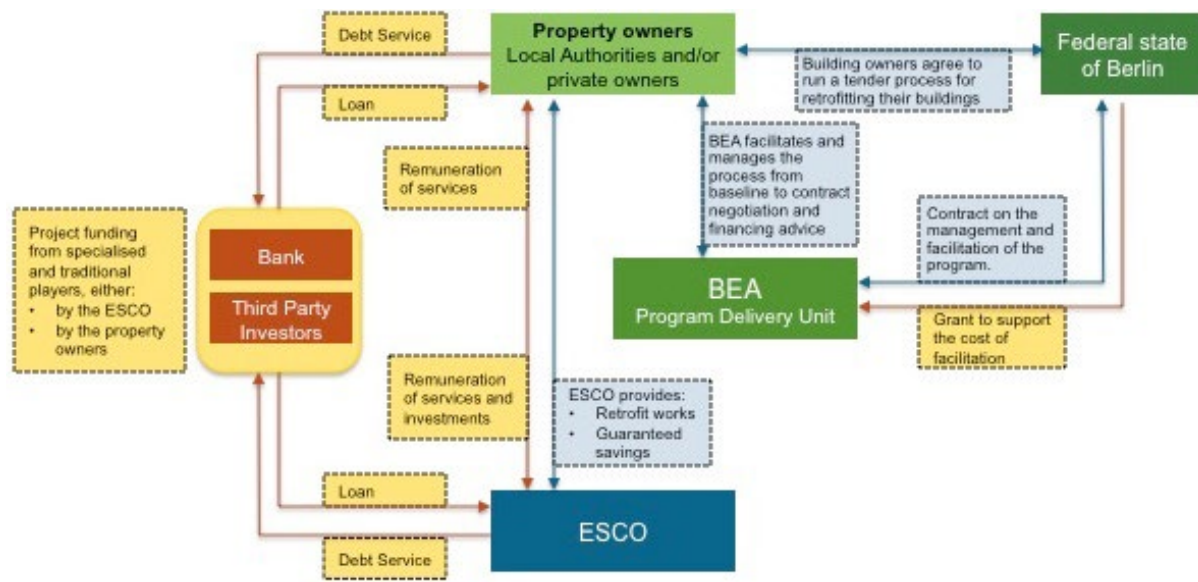
The working of the EPC based model is as follows:

- FEDESCO identifies opportunities for EPC projects with federal administrations and initiates the project based on requirements (energy-saving and maintenance contract).
- FEDESCO subcontracts facilitation activities to a private facilitator/consultant that accompanies FEDESCO and the federal building agency.
- Savings potential is (optionally) being pre-evaluated through quick scans, and detailed technical inventories of buildings are being realized. These technical inventories include condition scores of all technical elements in the building according to the Dutch NEN2767 standard for performance-based maintenance.
- FEDESCO, assisted by the private facilitator, develops standard smartEPC tendering documents.
- The building agency tenders for EPC projects assisted by FEDESCO and the private facilitator.
- M&V services are delivered by FEDESCO and the private facilitator to the building agency.

3.4.2 Berlin Energy-Saving Partnerships

The federal state of Berlin in partnership with Berlin Energy Agency (BEA) initiated the 'Energy Savings Partnerships' in 1996 for improving EE in public buildings in Berlin. The partnerships manage the retrofit of public and private buildings, preparing tenders for works to guarantee reductions in energy consumptions of an average of 26 percent based on EPC with the private ESCO sector. In this program, BEA acts as project marketer, aggregator, and facilitator, as well as financial advisor for the beneficiaries of the program. The program is based on EPC with guaranteed savings. The model has been diagrammatically explained in Figure 41.

Figure 41: EPC Guaranteed Savings-Based Model, Berlin



The working of the EPC guaranteed savings-based model is as follows:

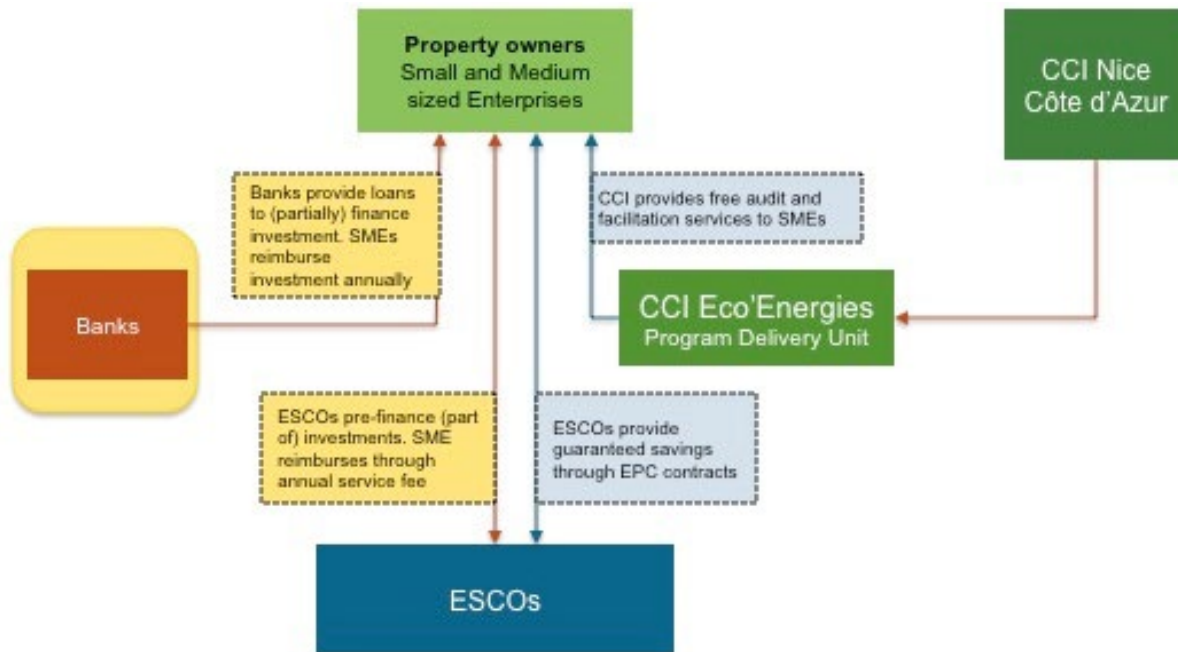
- The federal state of Berlin initiates the energy-saving partnerships between building owners and the ESCOs. The property owners agree to establish an EPC tender process for retrofitting their building to cut back on energy consumption.
- BEA then acts as the independent project manager, facilitating and managing the process from baseline to contract negotiation. BEA also plays the role of projects aggregator, bringing together a number of buildings, from 4 to as many as 150. These pools then issue EPC-tenders.
- The selected ESCOs install the guaranteed EEM and pay for this retrofit up front. The property owners reimburse the investments done by the ESCO over an agreed period—usually 8–12 years—in annual instalments from the energy savings. Typically, around 80 percent of the annual savings are paid to the ESCO. Once the contract has come to term, the property owner benefits from the full energy savings.
- As financial advisor, BEA assists both the property owners and the ESCOs to decide on the reimbursement terms of the investments supported by the ESCO. Funding of the investments is made in a classical way through bank loans taken either by the ESCO or by the property owner.
- BEA can offer its services to the property owners with a considerable discount (50 percent) as a result of the joint 50/50 funding (grant) from the Senate.

3.4.3 Eco' Energies

Eco' Energies is an EE program developed by the Chamber of Commerce and Industry (CCI) Nice Côte d'Azur of the Alpes-Maritimes and Var departments to assist small and medium enterprises (SMEs) in the tertiary and industrial sector by facilitating the energetic renovation of their buildings and/or

industrial sites in the southeast of France. The target groups are hotel, health, distribution, logistics, industry, and office buildings. The CCI pre-identifies the savings potential and invites several preselected ESCOs to develop a proposal for an EPC. This program is one of the only ones in Europe that specifically target the SME sector. The working of this ESCO program is detailed in Figure 42.

Figure 42: EPC Model, Eco' Energies, France



The CCI follows a three-step approach:

- **Identification of the energy savings potential.** Preliminary visit and audit by a representative of the CCI. The ESCO conducts a more detailed audit and makes a preliminary proposal for the energy performance and financing.
- **Establishment of the EPC contract (the CCI assists the customer where necessary).** Drafting and signature of the EPC contract, based on a standard contract, between the ESCO and the enterprise customer. Financing of the works and reimbursement are based on the guaranteed savings.
- **Implementation of the energy savings guarantee.** Execution of the works by the ESCO, guaranteed operations and maintenance (O&M) of the site, for the total contract duration. and follow-up of the guaranteed performance. The average implementation time is 6–18 months. About 90–95 percent of the savings are used to reimburse the investment.

4 ESCO Models

Extensive consultations⁶⁸ were held with ESCOs, FIs, and building owners to understand the market maturity and suitability of the ESCO models for program design and implementation mechanisms developed initially. The findings and conclusions from these consultations are summarized below:

ESCO capacity. Although the concept of ESCO is well understood, the ESCO market is nascent. There are a few small and medium local ESCOs with varied technical and borrowing capacity. Only a limited number of ESCOs have successfully implemented projects, for which they provided up-front financing against a repayment mechanism based on the savings generated. Others clearly prefer that building owners fund the project or take the financing risk. To accommodate both schemes, it is preferred to have a flexible design so that along with the ESCOs, the building owners could also have access to the project funds.

Financing credit and risk assessment. Commercial banks are reluctant to lend to most ESCOs without a credit enhancement mechanism such as corporate guarantees. They also rely on the financial strength of the building owners. The important concerns raised include the selection criteria of the eligible borrowers, the methodology used for determining the interest rate under the credit lines, and creditworthiness and repayment capability of ESCOs. A combination of capacity building, robust ESCOs' technical certification by SEA, third-party verification of energy savings achieved, and credit risk-sharing facility would help alleviate some of these concerns.

Technical oversight of EE investment. SEA could play a key role to reduce the perceived technical risk of EE projects by implementing a transparent certification and recertification process of ESCOs (preferably with the rating scale according to the level of competence), certifying the technical feasibility of the projects applying for financing, and providing monitoring and verification services. Further discussions are needed to ensure that SEA can provide these services with limited administrative bottlenecks.

Building owners' willingness to undertake comprehensive EE investments is dependent on their ability to access financing and their lack of awareness of benefits. Development of the ESCO market combined with adequate financing mechanisms and awareness campaigns will address these challenges.

⁶⁸ Multiple virtual consultations were held with SEA, energy service companies, and FIs between August 2021 and February 2022. The insights and opinions gathered from these consultations are the basis of the ESCO models and program design.

Two different ESCO program models were proposed for the public and private sector and are described next.

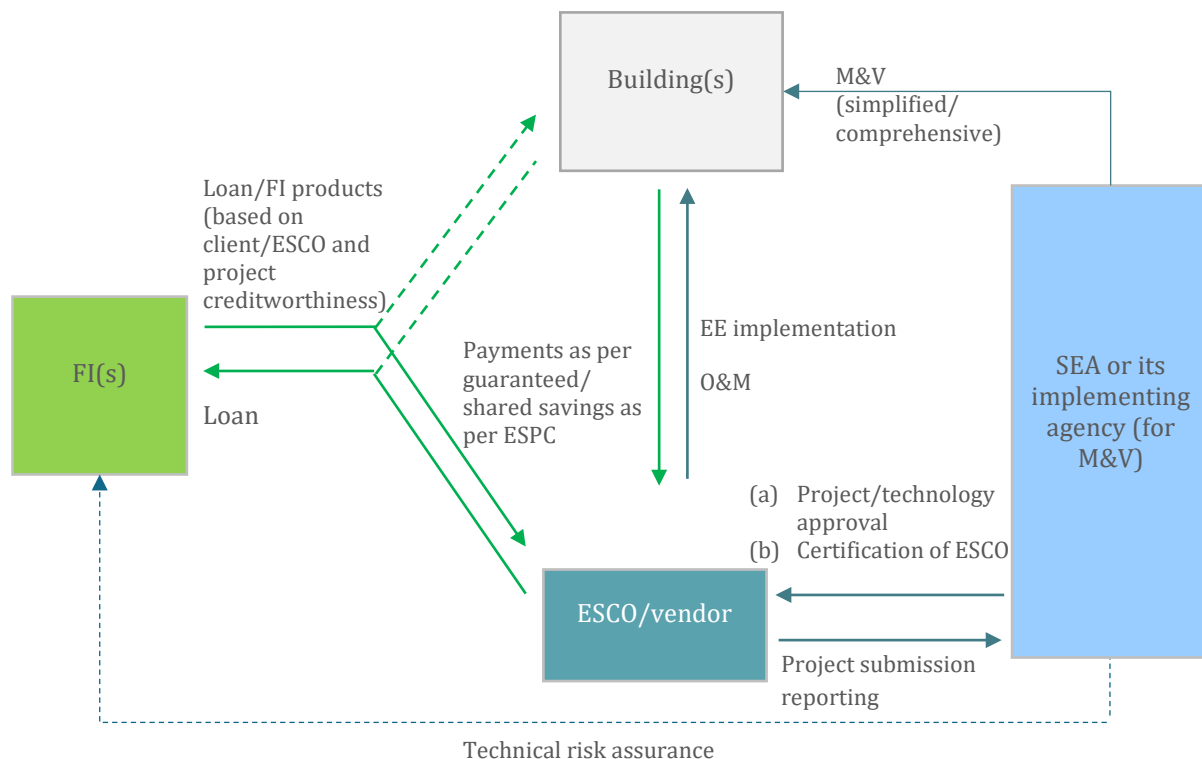
4.1 Model for C&I Buildings

The implementation framework for EE retrofits for the private sector—C&I projects—is based on an ESPC executed between the project client and the ESCO/vendor (technology provider) through deemed, shared, or guaranteed savings mechanism. When interventions involve equipment replacement, like lighting or air conditioning, the implementer would be a vendor. For a larger intervention in a whole building involving passive measures and replacement of active systems, the implementer would be an ESCO.

The financing will be provided by the local FI, to either the building owner or the ESCO based on the entity and project creditworthiness. The technical risk assurance may be provided by SEA. SEA would ensure technical risk assurance through the integration of the following two measures:

- a) Empanelment/accreditation of vendor (technology provider)/ESCO as applicable
- b) Approval of technology and technology specifications or approval of project as applicable.

Figure 43: Implementation arrangements for EE retrofits in commercial and industrial buildings



A working mechanism of the model has been provided as follows:

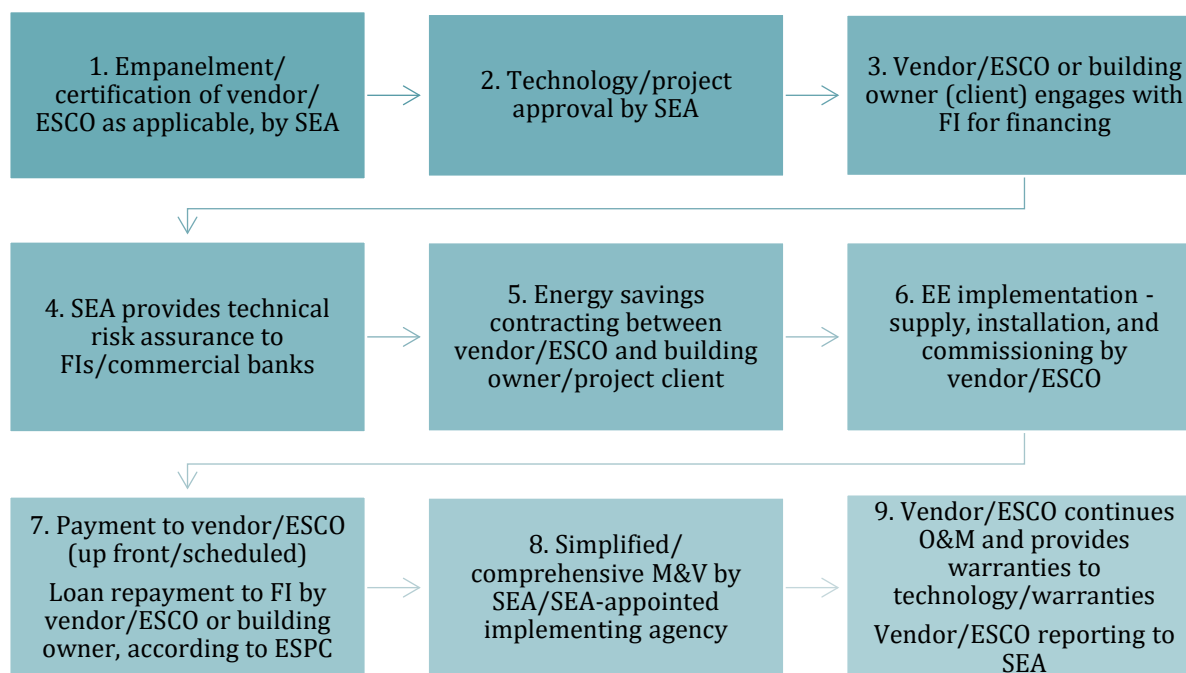
Table 25: Working Mechanism for ESCO Program in C&I Buildings for Both Alternatives

	Technology/Equipment Retrofit	Whole Building/Comprehensive System Retrofit
Step 1	Vendor empanelment as an ESCO by SEA	ESCO certification/accreditation by SEA
Step 2	Technology and specification approval by SEA	Project approval by SEA
Step 3	The vendor/ESCO or the building owner (project client), as the case may be, shall engage with the FIs for loans or FI products.	
Step 4	SEA may provide technical risk assurance ⁶⁹ to the local FIs/commercial banks.	
Step 5	The vendor and building owner (client) agree upon an ESPC based on deemed savings (in case of approved technologies).	The ESCO and building owner (client) agree upon an ESPC based on shared/guaranteed savings.
Step 6	EE replacement/retrofit implemented by vendor/ESCO which includes supply, installation, and commissioning)	
Step 7	Payment/repayment according to ESPC. Post installation and commissioning, the vendor/ESCO shall be paid for the same by the building owner (project client) according to ESPC. Vendor/ESCO or building owner, as the case may be, shall repay the FI.	
Step 8	SEA or SEA-appointed implementing agency shall conduct simplified M&V.	SEA or SEA-appointed implementing agency shall conduct a comprehensive M&V.
Step 9	The vendor/ESCO shall continue O&M and provide warranties to the project. Vendor/ESCO reporting to SEA.	

⁶⁹ The technical risk assurance refers to acceptance of technology in terms of its purpose and projected impact.

The process flow of steps outlined in Table 25 is shared in Figure 44.

Figure 44: Process Flow of Steps for Implementing ESCO Program in C&I Buildings



Model for Public Buildings

ESCOs have a limited capacity to assume public sector credit risk. Additionally, commercial banks cannot directly finance public buildings since their O&M (including any retrofits) is budgeted by the Ministry of Finance. Considering this, a public implementing agency would be identified or formulated for executing ESCO programs in public buildings. The implementing agency⁷⁰ would manage retrofitting of public buildings by procuring the services of ESCOs/vendors as applicable. The agency would contract energy audit firms through a competitive bidding process in selected public buildings to assess the needs (based on audit) and identify the technical potential and prepare financial estimates. Alternatively, the implementing agency could empanel a list of firms based on a defined rate-contract for the audit/initial screening/feasibility assessment work. The standard ASHRAE Level 1 and Level 2 audit could be defined as the scope of services for the audit firms.

Based on the technical and financial report provided by the contracted audit firm, the implementing agency would then hire ESCOs/vendors (as applicable) through a competitive bidding process.

There are two approaches for implementing EE retrofits:

- (a) **Equipment replacement/purchase.** Bulk purchase (public procurement) based on 'deemed savings', for pre-approved technology (specifically, RACs and lighting replacement)

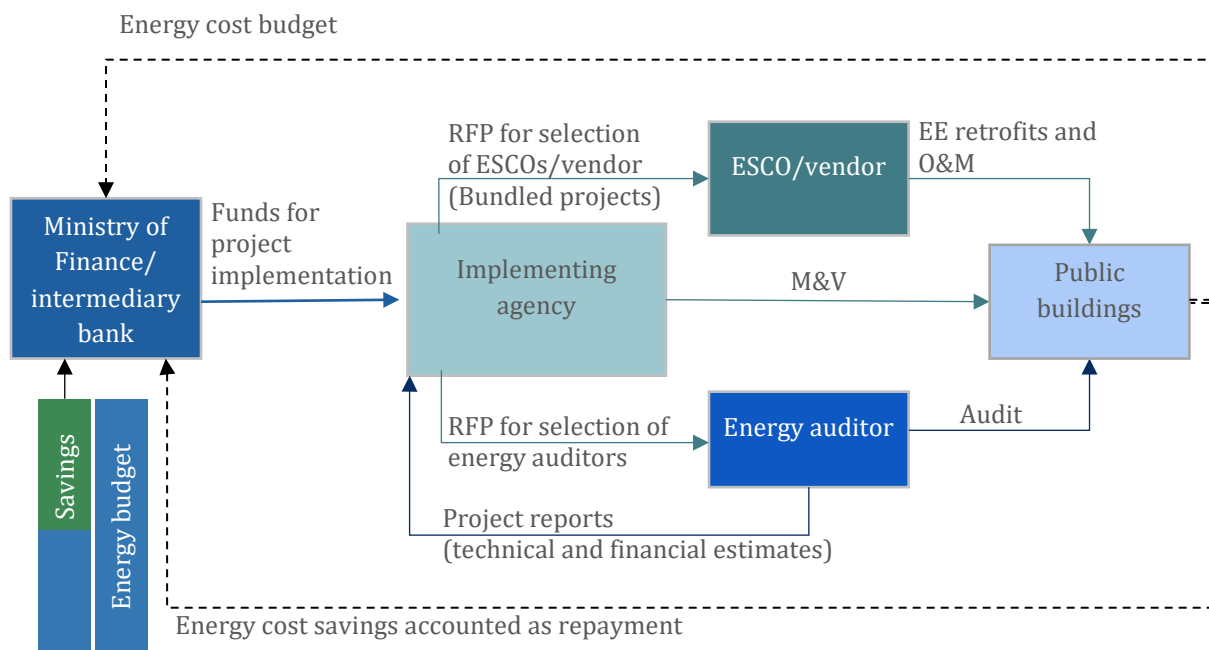
⁷⁰ Some of the potential options for an implementing agency are SEA, CEB, and LECO, an agency appointed by SEA. Considering SEA's concerns about its limited mandate to act as a procurement entity for public building retrofits, further discussions are needed on the role of SEA and alternatives for implementing public buildings retrofits.

and specifications by the implementing agency. The demand aggregation will be based on technical/financial estimates report⁷¹ submitted by the energy auditors. In the case of a technology/equipment-level replacement/purchase, a vendor or technology provider will be engaged.

- (b) **Whole building/comprehensive system retrofit.** Reports from energy auditors will determine the public buildings that require whole building/comprehensive system retrofits. In this case, ESCOs will be engaged.

The implementing agency would provide technical and contract management supervision. The implementation of energy-efficient retrofits or equipment replacement for public buildings will be financed through the Ministry of Finance or intermediary FIs. This would be provided in the form of line of credit/grant/loan. In this model, the energy cost savings accrued by the public buildings would be accounted as repayment. The proposed working mechanism of this model is depicted in Figure 45.

Figure 45: ESCO Program Design for Public Buildings



Note: RFP = Request for proposal.

A working mechanism of the model is provided as follows:

Table 26: Working Mechanism for ESCO Program in Public Buildings

	Technology/Equipment Retrofit	Whole Building/Comprehensive System Retrofit
Step 1	Vendor empanelment as an ESCO by SEA	ESCO certification/accreditation by SEA
Step 2	Public buildings submit the baseline energy cost budget to the Ministry of Finance or the identified intermediary FI.	

⁷¹ The technical/financial estimates report would be based on either ASHRAE Level 1 or Level 2 audit.

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

	Technology/Equipment Retrofit	Whole Building/Comprehensive System Retrofit
Step 3	The FI and implementing agency determine a budget for the energy auditing of public buildings and collate the preliminary EE retrofit requirements from public buildings to determine the pool of buildings.	
Step 4	The implementing agency floats RFP for selection of energy auditors.	
Step 5	The energy auditor(s) conduct an audit and assess the EE potential in the building(s). Based on the assessment, project reports with technical and financial estimates will be submitted to the implementing agency.	
Step 6	The implementing agency aggregates the demand for the equipment/technology replacement by bundling projects as well as identifies buildings that require whole building/system retrofits.	
Step 7	The FI finances the project by providing funds granted/loaned by the respective international development aid organization.	
Step 8	Technology selection based on SEA's approved specifications. ⁷² The implementing agency floats RFP for selection of vendors/vendor ESCOs.	Project approval by the implementing agency. The agency floats RFP for the selection of ESCOs.
Step 9	EE replacement / retrofit implemented by vendor / ESCO which includes supply, installation & commissioning)	
Step 10	The implementing or appointed agency shall conduct simplified M&V (random/sample checks).	The implementing or appointed agency shall conduct a comprehensive M&V based on internationally accepted guidelines.
Step 11	The vendor/ESCO shall continue O&M and provide warranties to the project.	
Step 12	Public buildings will maintain energy cost savings report and submit to FI to be accounted as repayment.	

⁷² SEA would define the minimum specification for EE technologies. It is mentioned in the context of referring to approved specifications. The implementation would be through the respective agency.

The process flow of steps outlined in Table 26 is shared in Figure 46.

Figure 46: Process Flow of Steps for Implementing ESCO Program in Public Buildings



4.2 Roles and Responsibilities

The roles and responsibilities of stakeholders are as follows:

Stakeholders	Implementation Framework for C&I Buildings	Implementation Framework for Public Buildings
Ministry of Finance		(a) Determine budget for EEI in public buildings. (b) Engage with the World Bank (and/or other development aid/international organizations) to determine details/agreement associated with the line of credit/financing. (c) Provide financing for project implementation based on aggregated demand conveyed by SEA. (d) Engage with public building owner for reporting energy cost saving.
SEA	(a) Empanelment of vendors/technology providers (b) Certification/accreditation of ESCOs (c) Technology and specification approval (d) Project approval (e) M&V (simplified/comprehensive)	
	a) Provide technical risk assurance to local financing institutions/commercial banks.	(a) Demand aggregation - facilitating identification of prospective public building for EE retrofits (b) RFP for selection of energy auditors and contracting agreement with energy auditors (c) Review of technical and financial estimates provided in project reports by the energy auditor (d) Approval of project reports and technology specifications (e) RFP for selection of vendors/ESCO for EE retrofit (f) Contracting agreement with vendor/ESCO (g) Facilitation of payment to vendor/ESCO and energy auditor
Local FIs/commercial banks	(a) Provide financing for respective EE project. (b) Evaluate creditworthiness of building owner/ESCO (financial). Technical risk will be assured by SEA. (c) Enter into financial agreement with building owner or ESCO/vendors (as applicable).	
ESCO/vendor	(a) Submit application for empanelment/certification to SEA and maintain the same. (b) Submit project application to SEA for approval and secure technical risk assurance from SEA (if applicable). (c) Implement EE retrofits – supply, installation, and commissioning. (d) Ensure compliance for warranty and necessary services as agreed under the contracting arrangement.	

Stakeholders	Implementation Framework for C&I Buildings	Implementation Framework for Public Buildings
	(a) Identification of prospective buildings for EE retrofits (b) ESCO - Submission of project to SEA for approval (c) Vendor – Submission of technology specification to SEA for approval (d) Engagement with building owners according to ESPC (e) Project reporting to SEA (f) Based on the case, engagement with FIs for (i) Securing loans or financial products for project financing and (ii) Repayment of loan	(a) Engagement with SEA for payment for respective equipment, technology, or service (b) Energy cost saving reporting to public buildings.
Energy auditor		(a) Conduct walk-through audits. (b) Conduct feasibility assessment and design optimization, diagnose performance, and determine operational patterns to improve EE. (c) Report preliminary technical and financial estimates to SEA.
Building owner	(a) Signing of ESPC and engagement with ESCO/vendor and providing of necessary support for project implementation (b) Support in implementation of M&V	
	(a) Reporting to SEA (if applicable) (b) Payments as per ESPC (c) Engagement with FIs for (if applicable) (i) Securing loans or financial products and (ii) Repayment of loan.	(a) Submission of budget for EEI to Ministry of Finance (b) Reporting on energy cost savings to Ministry of Finance and SEA

4.3 SEA's Framework for Facilitating EE Retrofits – Public, Commercial, and Industrial Buildings

SEA can set up a Project Management Unit (PMU) for facilitating EE retrofits in public, commercial, and industrial buildings. The operational framework for SEA/PMU/SEA-appointed agency is key to scaling of EE retrofit. The topics which shall be covered within the operational framework are listed in the following sections. The framework covering these topics can be used as a standard guide for successful implementation of proposed ESCO models.

4.3.1 Standardize Processes and Documentation

- (a) Develop processes and documentation for technology and project approval (application formats).

- (b) Develop standard templates for master agreements with clients, vendors (technology providers), and ESCOs that enable clustering of multiple projects under single contract. These shall encompass the following:
 - (i) Terms of engagement between the parties
 - (ii) Description of model(s) and range of targeted energy solutions
 - (iii) Description of roles, responsibilities, and implementation sharing risks
 - (iv) Basis of compensation of work.
- (c) **Standard ESPCs.** These shall encompass the following:
 - (i) Performance parameters
 - (ii) Implementation schedule
 - (iii) M&V framework - simplified and comprehensive
 - (iv) Legal obligation of parties
 - (v) Payment terms
 - (vi) Performance and penalty clauses for default by parties
 - (vii) Warranties, compensations, and liabilities.
- (d) Develop standard templates for reporting by ESCOs, vendors, and clients on energy cost savings.
- (e) Develop standard project template for energy auditors. These shall encompass
 - (i) Basis of financial estimate,
 - (ii) Baseline (parameters and specifications),
 - (iii) Template for technical recommendations on EE retrofit, and
 - (iv) Project design (feasibility, specifications, and so on).
- (f) Prepare calculators for estimating project costs, evaluation of returns, and repayment on the line of credit received from GoSL.

4.3.2 Project Implementation

- a) Aggregate demand
 - (i) Engagement with potential clients and development of project pipeline
 - (ii) Assessment of technical feasibility of project implementation.

- b) Management of the empanelment of vendors and certification of ESCOs.
 - (i) Establishment of empanelment/certification procedures/protocols
 - (ii) Staffing or training of personnel as deemed necessary to manage empaneling
 - (iii) Preparation of eligibility criteria, terms, and conditions of empanelment/certification: standardized process in the selection of ESCOs
- c) Management and documentation of the contracting of work to vendor/ESCOs (where applicable)
 - (i) Development and floating of RFPs/expressions of interest, including but not limited to scope of work, eligibility and qualification criteria, evaluation criteria, and so on
 - (ii) Evaluation of documentation submitted by vendor/ESCO and award of bids
- d) Measurement, evaluation, and reporting of performance against pre-specified results indicators.
- e) Conduct of M&V (simplified/comprehensive), as applicable.

4.4 ESPC Mechanism

ESPC is a contractual agreement between two parties, one of which is an ESCO and the other the site or building owner, for making the site or building(s) in question more energy efficient through various interventions known as Energy Conservation Measures (ECMs).

ESCOs are companies that develop, design, build, and arrange financing for projects that save energy, reduce energy costs, and decrease O&M costs at their customers' properties. They therefore develop and implement project-specific ECM and assume risk associated with the project—in some cases, they may assume only the technical risk, and in others, both the technical and financial risks.

ESCOs are versatile turnkey service providers which may provide a variety of services, either for greenfield or brownfield projects. Such services may include

- (a) Survey of project site and identification of possible EE mechanisms that may be implemented;
- (b) Calculation of energy used at different parts of the site or energy modelling to understand energy usage;
- (c) Provision of a financial estimate and sourcing of financing for project implementation; and
- (d) Project implementation, commissioning, monitoring, and verification.

Since the implementation of ESCO projects is multifaceted and carries specific technical and financial risk, they require a specialized contract that reflects the various intricacies and performance burdens of each project. Such contracts are called 'performance-based contracts' and are of three major types:

- (a) Deemed savings

(b) Shared savings

(c) Guaranteed savings.

Some ESPCs are more appropriate to a particular type of market or a particular type of project. The guaranteed savings model has been adopted in countries where there is a high degree of familiarity with project financing, sufficient technical expertise within a banking sector that understands EE projects and the associated risks, and a well-functioning banking structure. Both deemed and shared savings approaches are favored in countries where ESCO markets are emerging and are also preferred by super ESCOs, being the basis of their business model.

Deemed Savings Performance Contracts

In the 'Deemed Savings' approach, well-known energy-efficient technologies replace already installed inefficient technologies at the client location. Since the technology is well known, it is easy to estimate the energy that may be saved in case of each replacement. This is because the energy consumption of the technology already installed in the client's location, as well as the new technology that is replacing, is well documented and has been verified over time by the market. Due to the easy availability of this information, the parties can mutually agree to the energy savings (based on agreed usage) that each replacement of old technology with energy-efficient technology will contribute to the project, and the same is noted in the ESPC as a mutually agreed range of energy savings. Since the savings are pre-agreed, in this model, the ESCO is paid a previously agreed amount periodically from the notional savings made due to the deemed energy savings. The deemed savings model is illustrated in Figure 47.

Figure 47: Deemed Savings Performance Model



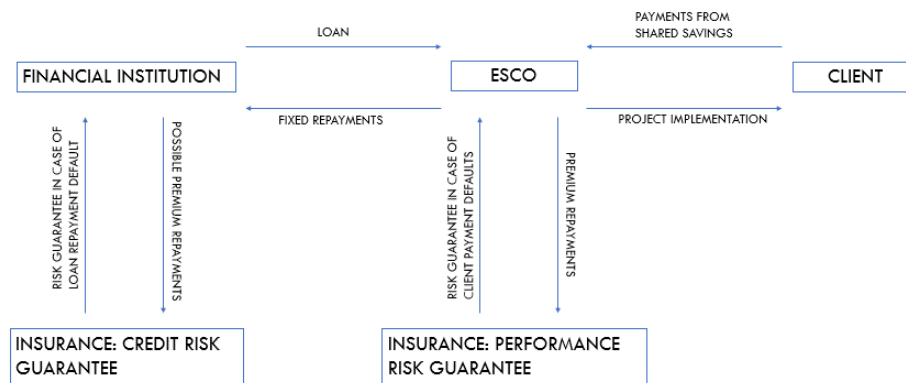
Shared Savings Performance Contracts

In the shared savings ESCO model, the ESCO finances the total up-front capital cost of the project and is totally responsible for repaying the lender. The client pays the ESCO a percentage (or it can be a fixed amount) of its achieved savings from the project, large enough for the ESCO to repay the project investment to its lenders and cover M&V costs and any other associated costs. The ESCO has the contractual obligation to repay the lender. It bears both the financial risk and the technical risk for the project.

- (a) Therefore, the ESCO is paid only if there are recorded savings made due to the ESCO's intervention, and in case savings are not made, the client is not obligated to pay the ESCO. This is the technical risk associated with project failure.

- (b) The ESCO also arranges for financing and is responsible to pay this back to the FI. The ESCO is obligated to repay the FI whether the client makes any payment to the ESCO or not. This is the financial risk associated with the project.
- (c) The ESCO may take an insurance in case of nonpayment from the client for any reason, whether due to performance failure or due to fraudulent behavior or any other reason. At the same time, the FI may take an insurance against the payment due to it from the ESCO. This is illustrated in Figure 48.

Figure 48: Shared Savings Performance Model

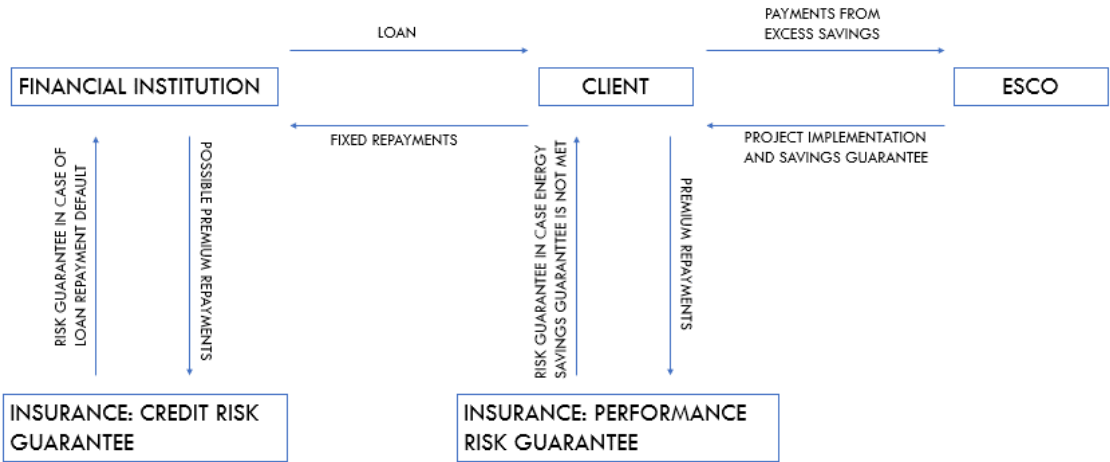


Guaranteed Savings Performance Contracts

In the guaranteed savings model, the ESCO assumes the technical risk of project nonperformance, but the client assumes the financial risk by obtaining financing. The client may pay for the project through equity or debt. The model is illustrated in Figure 49. If an FI is involved, the client pays the FI from the savings made due to the project. The client makes periodic payments to the FI irrespective of whether the project meets savings expectations or not.

- (a) The client pays the ESCO also from the savings made due to the project which are in excess of the savings required to pay the FI.
- (b) The client may take an insurance to guarantee its ability to pay the FI whether or not savings are forthcoming from the project.
- (c) The FI may take an insurance against the client's inability to fulfil the financing contract. However, as discussed in the section on shared savings, it is possible that the FI need not pay a premium, or a market rate premium, for this insurance.

Figure 49: Guaranteed Savings Performance Model



5 Pilot Project Development

The criteria for selecting the pilots were determined in consultation with the ESCOs, as follows:

- (a) Coverage of all building sectors - commercial, public, and industrial
- (b) The relative representation of the selected facility to that of the building sector, in terms of its load profile, energy consumption pattern, and so on
- (c) Ease of implementation and timeline
- (d) Willingness of facility owner toward implementation of EE
- (e) Variety of stakeholders so that there is a greater outreach and number of stakeholders (ESCO's FIs and so on) that can be involved in the 'hands-on' training.

Audit reports of five projects were received, four from ESCOs and one from SEA.

Table 27: Details of Pilot Projects

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
ESCO	Access Energy Solutions Pvt. Ltd.	Access Energy Solutions Pvt. Ltd.	GLIDE	EnergySolve International Pvt. Ltd.	Report submitted by SEA
Type	Educational institute	Industry	Office (4 floors in World Trade Centre - 2, 16, 17, and 31)	Industry/factory	Hospital + cardiac center
Report date/year	04/2016	12/2018	05/2019	07/2021	12/2020
Annual electricity consumption (kWh)	875,825 (Faculty: 675,150; Girls hostel: 100,198)	7,871,531	242,040	2,025,456	6,300,000

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
Maximum demand(kVA)	360	2,067	—	463	1,190
Annual cost (LKR)	18,518,952 (Faculty: 14,513,532; Girls: 2,515,777)	115,441,504	6,636,360	—	142.4 million
Alternative fuel (annual consumption)	—	Biomass from steam boiler (kg): 9,936,522	—	Gas (kg) 600	Diesel oil – 19,800 liters Furnace oil - 224,400 liters
Alternative fuel (annual cost)	—	36,760,030	—	—	Diesel oil LKR 2.06 million Furnace oil LKR 21,5 million
Annual electricity saving (kWh)	280,634	1,011,839	27,510	705,000	—
Demand saved (kVA)	30	—	—	28	—
Annual electricity cost saved (LKR)	6,039,657	20,608,495	749,370	8,978,600	—
Alternative fuel (annual consumption) saved	—	3,846,046 kg (steam) 68,239 kg (firewood)	—	—	—
Annual alternative fuel cost saved (LKR)	—	13,844,861	—	—	—
Investment (LKR)	—	202,718,790	—	40,000,000	—
Areas of intervention	- Library and canteen area = Highest energy consumer - Mainly split type ACs (169), older than 7 years - Incandescent (104), CFL (134),	- HVAC load is 32.23%, lighting is 4.52%, air compressors is 18.32%, and wastewater treatment plant (WWTP) is 5.62% - Three ammonia chillers, two reciprocating chillers (4.15 and 1.57 coefficient of performance), and a Hitachi chiller in	- Airconditioning (27%), lighting (13.6%), servers and uninterrupted power supply (21.3%), kitchen (12%), and equipment (8%) - Daikin VRVs (08) and	- AC (44%), production (27%), compressor (20%), and lighting (9%) - Air-cooled packaged, water-cooled packaged, and split ACs (total 160 TR)	- Diesel generators for backup (800 KVA ×2, 1,000 kVA, 250 kVA) - Grid electricity (86%) and furnace oil (13%) - Old hospital - centrally air-conditioned (2 water-cooled chillers of 120 TR); cardiac

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
	FL tube lights (786), and sodium vapor lights (187) Air-cooled chiller (2.08 kW/TR)	office and production space - Vapor Absorption Chiller (VAM) (0.84 and 0.96) - Standby furnace oil boilers (6 ton and 3.2 ton).	base-building chillers - SEC 16th – 108 kWh/m²/year 17th – 79.23 kWh/m²/year 31st – 30.68 kWh/m²/year (not considering chiller energy consumption) SEC estimated - 147.5 kWh/m²/year - LED lighting except on 31st floor	2 numbers of 75 kW and 1 of 30 kW compressors; 75 kW machines are VFD driven. - LED lighting	center - central air-cooled chillers of 145 TR, 125 TR, two 30 TR water-cooled direct expansion (DX) 3,200 linear fluorescent lamps (LFL) with magnetic ballasts 600 kg/hour fire tube steam boilers 33 electrical boilers having capacities of 10–20 liters - Power factors - 0.93 and 0.83

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
Energy-saving measures	Replace existing ACs with inverter type ACs Savings: 177,400 kWh 3,817,904/- Replace existing lights with LED lights Savings: 67,758 kWh 1,458,269/- Replace existing air-cooled chiller (2.08 kW/RT), chilled water pumps with highly efficient water-cooled chiller and efficient pumps Savings: 35,475 kWh 763,482/- Installing a capacitor bank for the main power supply Savings: 30 kVA, LKR 396,000/- Investment - 500,000/- Payback 16 months	Low-cost option - Switch off the air blower. - Savings: 273 kWh, LKR 3,900 - Switch off the conveyers. - Savings: 1,082 kWh, LKR 15,600 - Fix compressed air leaks. - Savings: 18,259 kWh, LKR 264,300 - Install a motion sensor for exhaust and ceiling fans. - Savings: 2,741 kWh, LKR 39,600 - Investment: LKR 25,000 - Boiler insulation - Saving: 23,239 (kg-firewood), 127,800/- - Investment: LKR 98,000 - Reduce steam generation pressure. - Savings: 80,535 (kg-steam), LKR 286,700	- Installing VFD to kitchen exhaust fans (10,668 kWh, LKR 290,596) - Dimming control for lighting (5,113 kWh, LKR 139,278) - Improving ventilation + reducing AC leakages (4,927 kWh, LKR 134,211) - Lighting management (switching ON/OFF, reducing lux levels) - 5,514 kWh, LKR 150,200 - Replacing linear fluorescent tubes with LEDs (1,288 kWh, LKR 35,085) - Improving cooling tower performance (686 kWh, LKR 18,686)	- Demand management (Savings 20 kVA, LKR 264,000) - Load shifting (LKR 855,000) - Retrofit of the air conditioning system with a water-cooled centralized chilled water system, replacement of packaged units with AHU, and split ACs replaced with FCUs - Savings: 603,000 kWh/year, LKR 6,632,000 - Investment: LKR 40,000,000 - Compressed air system EE management - Savings: 102,000 kWh/year, LKR 1,122,000	- Power factor correction - Old hospital saving: 56 kVA, LKR 672,000 - Investment LKR 1,600,000 - Cardiac center savings 66 kVA, LKR 871,2000 - Investment LKR 1,150,000 - Airconditioning management - avoid idling ACs, auto door closers, sun control films on south walls and minimize heat dissipating equipment in AC space. - Replace existing air-cooled chiller with air-cooled magnetic baring chiller. - Savings: 232,707 kWh, LKR 4,654,131 /year - Investment: LKR 22,000,000 - Replace existing boilers with new oil-fired/biomass boiler (3 options/scenarios with cost benefits have been provided). - Improve condensate
		Mid-cost option Replace fluorescent lamp by LED and install motion sensor			

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
		○ Savings (59,355 kWh, LKR 858,000) ○ Investment: LKR 1,100,000 • Replace motors of WWTP ○ Savings (21,316 kWh, LKR 309,000) ○ Investment: LKR 3,308,000 • Insulation steam valves, glass bottle washers ○ Savings: 67,000 kg-steam; 45,000 kg-firewood, 486,300 kWh, ○ Investment: LKR 1,040,000 • High-pressure air compressor management ○ Savings 58,501 kWh, LKR 846,515 ○ Investment: LKR 70,000		• Power factor correction ○ Savings: 8 kVA, LKR 105,600	- recovery system. • Replace faulty steam traps. • Lighting - replace existing LFLs in wards, offices, clinics, ICU, X-ray department, labs, and so on with LED tubes. ○ Savings: 16,380 kWh/month, LKR 4,586,400/year ○ Investment: LKR 5,200,000 • Lighting management (switch off/on): ○ Savings: 270 kWh/month, LKR 5,400/month • Change the existing overhead lamps in theaters. ○ Savings: 58,320 kWh, LKR 1,286,400 ○ Investment: LKR 720,000 • Avoid idling of lamps. • Evacuated type solar water heaters as feed water to electric boilers and kettles • Roof top solar PV system
		High-cost option • Replacement of VAM and McQuay chillers and load shifting with TES ○ Savings: 169,324 (kWh)			
		2,862,159			

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardanepura General Hospital
		(kg-steam); LKR 18.25 million ○ Investment: LKR 149,850,000 • Replacement of chiller (2×65 TR) with energy-efficient chiller (100 TR) ○ Savings: 625,969 kWh, 9.18 million ○ Investment: LKR 48,691,260 • New technology EC fans ○ Savings: 55,019 kWh, LKR 806,887 ○ Investment: LKR 5,075,000 • Replace failed steam traps ○ Savings: 836,350(kg-steam); LKR 2,977,400 ○ Investment: LKR 520,000			
Potential ESCO model	Both lighting and cooling retrofit potential exists. Considering replacement of existing split ACs, a super ESCO	Both lighting and cooling retrofit potential exists. Guaranteed/shared savings model can be explored.	Limited technical potential. More aligned to energy management/ maintenance of existing equipment. Vendor ESCO model with a	Retrofit potential for the air conditioning system. Guaranteed/shared savings model can be explored.	Both lighting and cooling retrofit potential exists. Complicated system may take a longer duration. Guaranteed/shared savings model can be explored.

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

Project Name	The Faculty of Medicine	Coca Cola Beverages	Huawei Technologies Co (Pvt) Ltd	Quick Tea (Pvt) Ltd.	Sri Jayewardenepura General Hospital
	model can be explored.		lighting control vendor can be explored.		
Status of the project	Planning, project on hold	Planning, all investment projects on hold	Project dropped due to savings being not significant and the difficulties in implementation	Client has decided to proceed with standard equipment to replace existing.	Planning, project on hold
Support needed for implementation of EEM	Funding required for implementation	A funding mechanism to keep the cash flow positive	—	—	Funding required for implementation
Description on key barriers	Investment	—	—	—	Investment
Update on the quantitative information about the project	Investment required will be much higher than estimated. Savings remain the same.	Investment required now will be much higher than estimated. Savings remain the same.	—	—	Investment required now will be much higher than estimated. Savings remain same.
Whether the project can still be covered within the potential pipeline of projects	Yes	Yes	No	No	Yes

Feedback from the pipeline of projects revealed that lack of investment is the major barrier to implementation of EEM. The projects were in planning stages when enrolled and had gone on hold due to requirement of much larger investment than anticipated. Effective funding and funding mechanism are essential to support these projects. While Huawei Technologies Co (Pvt) Ltd. chose to opt out due to difficulties in implementation and insufficient energy savings, Quick Tea (Pvt) Ltd. proceeded with replacement of existing equipment with standard equipment. These factors rendered the two pilots to not be counted under the potential pipeline of projects.

6 Annexures

6.1 Preliminary ESCO Model Designs

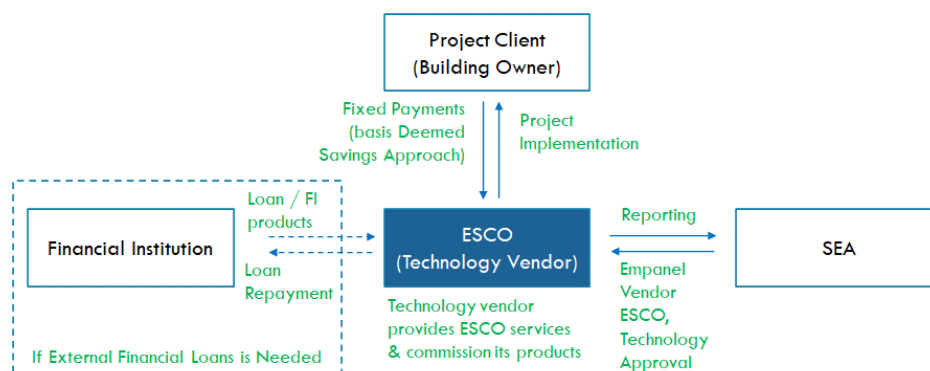
An initial concept for ESCO program design, for different types of EE projects (technology wise) was prepared. This was based on the type of projects as shown below:

Type of Projects	ESCO implementation model
Lighting retrofit and/or control systems	Vendor ESCO model
RACs retrofit	Bulk purchase/aggregator model
Projects with large-scale cooling and complex systems retrofit	Conventional - shared and guaranteed savings

6.1.1 Vendor ESCO Model

Description The technology supplier acts as an ESCO for the EE project and facilitates financing for implementation.

Process flow



Salient features

The vendor ESCO model is a subset of guaranteed savings model and is generally used in those EE projects in which the technology is simple and well established and performance characteristics are reliable.

The 'Deemed Savings' approach minimizes the effort and costs associated with complex M&V procedures.

ESCO takes the financing and technology risks.

Applicable technologies

HVAC, EE lighting and controls, insulation (wall and roof), high performance glazing, EE fans, solar PV, solar water heating, and appliances

Roles and responsibilities	SEA	Identification of technology(ies) and setting of performance specifications Empanelment of technology supplier as vendor ESCO Definition of the reporting requirements for vendor ESCOs Certification of compliance for FI
	ESCO	Independent sample checks Project identification/business development Engagement with project client for project implementation

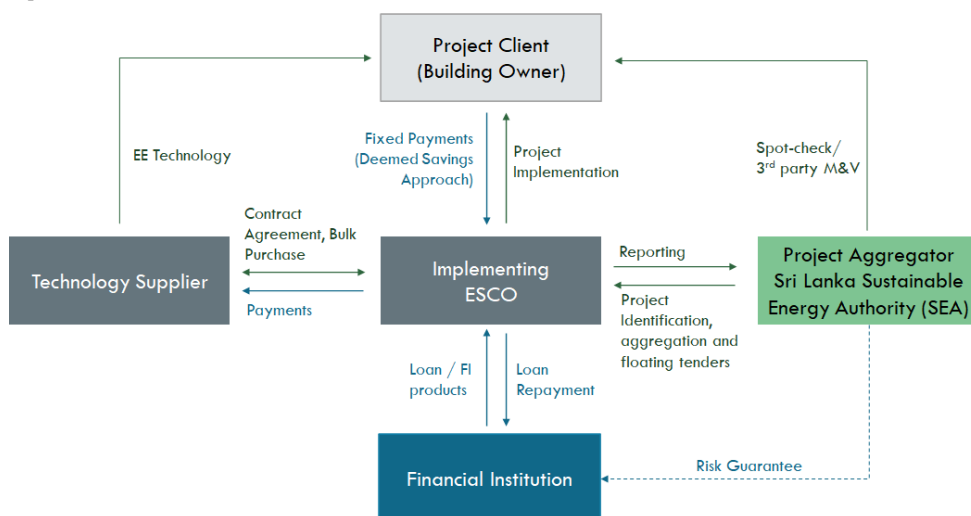
Facility /building	Project investment (own funds)/engagement with the FI for project finance (if the external loan is needed) Technology/service supply. Compliance for warranty and necessary services as agreed under the contracting arrangement Repayment to FIs in line with T&C Reporting of sales as the checkpoint for number of EE technology installed
FI	Repayment to ESCO according to the T&C defined in agreement (up-front payment or performance-based payments based on the savings generated through reduced operating cost) Facilitation of financing for scaling-up of EE investments
M&V	Vendor ESCO sales are proposed as the checkpoint to assess the number of EE technology installed.
Financing	Pre-approval of financial instruments for EE technologies Disbursement of funds based on the information of technology sales Financing through instruments such as EE credit line, guarantee fund, concessional loan, and so on

6.1.2 Aggregator Model

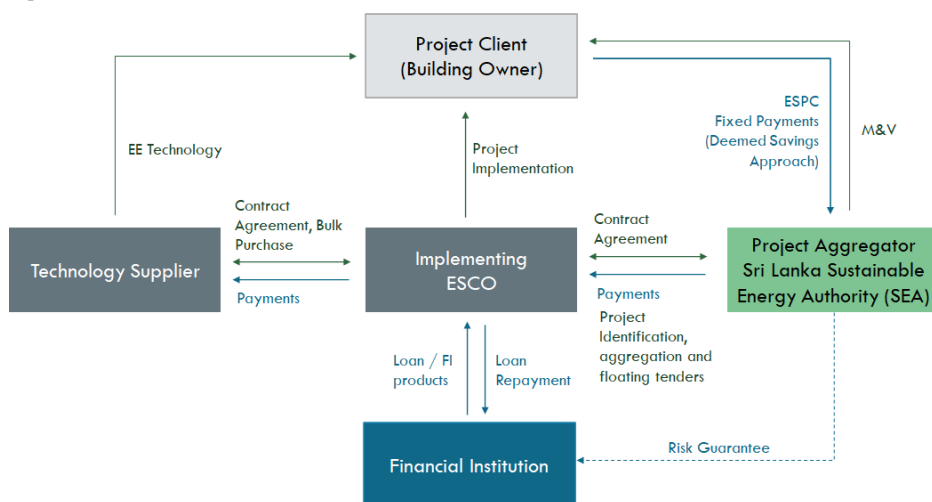
Description	An entity aggregates the demand for EE interventions and ropes in ESCOs for implementation of performance contracting projects and provides risk guarantee to FI. The implementing ESCOs engage with FI for financing and technology providers for product supply.
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Process Flow

Option 1:



Option 2:



Salient Features

- (a) The aggregator ESCO model also works as a subset of guaranteed savings model.
- (b) The equipment can be aggregated in bulk at a given specification. Ordering large quantities of a given specification achieves economy of scale and results in lowering product price.
- (c) **Lower cost to client.** Savings from bulk purchase prices can be passed on to consumers.

The 'Deemed Savings' approach minimizes the effort and costs associated with complex M&V procedures.

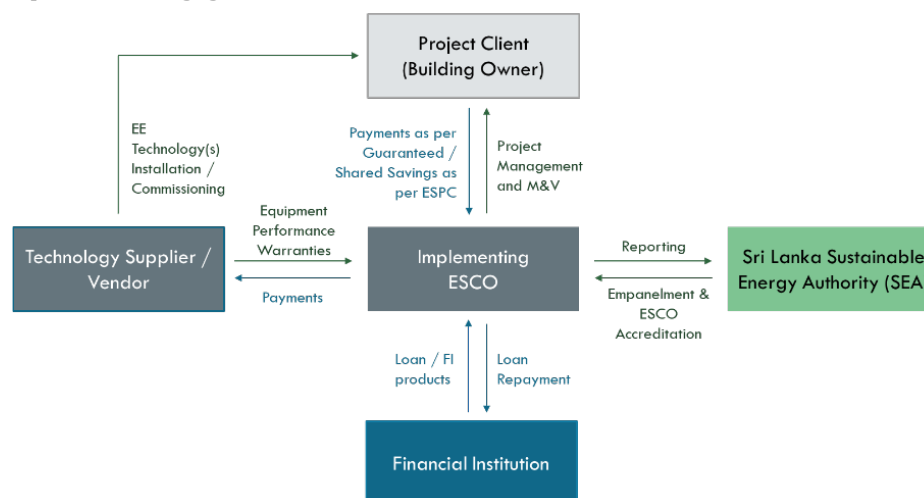
Applicable technologies

HVAC, EE lighting, water heating, street lighting, motor and pumps, and appliances

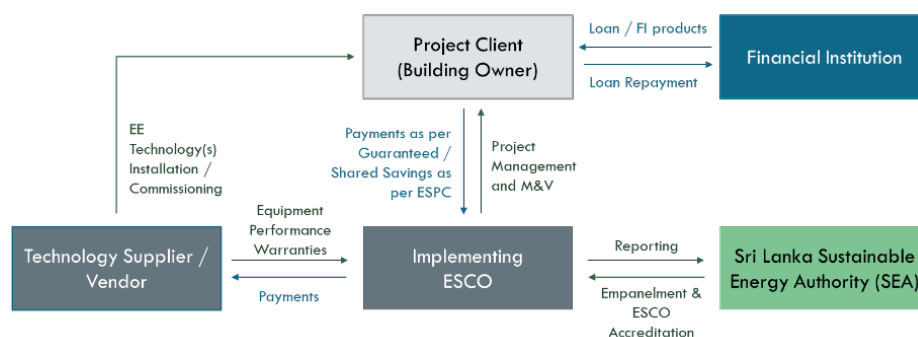
Roles and responsibilities	SEA	(a) Demand aggregator (b) Identification of technology(ies) and setting of performance specifications (c) Empanelment of ESCO through tendering process (d) Definition of the ESCO reporting requirements (e) Certification of compliance for FI (f) Independent sample checks Additional role for option 2 - agreement with project client and receipt of fixed payments (based on deemed savings approach)
	ESCO	(a) Engagement with project client for project implementation (b) Engagement with the FI for project finance (c) Repayment to FIs in line with T&C (d) Contracting with technology suppliers (e) Reporting of number of EE technology installed (Option 1).
	Facility/building	Repayment to implementing ESCO (option 1) or SEA (option 2) according to the T&C defined in the respective agreement (up-front payment or performance-based payments based on the savings generated through reduced operating cost)
	FI	Facilitate financing for scaling-up of EE investments.
	M&V	Number of EE technology sales/installed is proposed as the checkpoint.
Financing	Pre-approval of financial instruments for EE technologies Disbursement of funds based on the information of technology sales/installed Financing through instruments such as EE credit line, guarantee fund, concessional loan, and so on	

6.1.3 Conventional Model

Description	Conventional model based on a shared/guaranteed savings approach recommended for projects with multiple and large-scale requirement
Process Flow	Option 1: FI engagement with ESCO



Option 2: FI engagement with client



Salient features

- (a) Each project model can be customized for best results.
- (b) This model is applicable for long-term projects.

Applicable technologies

Complex/large systems - chillers, thermal storage, district cooling, and tri-generation

Roles and responsibilities	SEA	(a) Empanelment and ESCO accreditation (b) Definition of the ESCO reporting requirements (c) Third-party M&V (optional)
	ESCO	(a) Project identification/business development (b) Engagement with project client for project implementation (c) Engagement with the FI for project finance (Option 1) (d) Repayment to FIs in line with T&C (Option 1) (e) Contracting with technology suppliers (f) Reporting to SEA
	Facility/building	(a) Repayment to ESCO according to the T&C defined in ESPC (Option 1) (b) Engagement with the FI for project finance (Option 2) (c) Repayment to FIs in line with T&C (Option 2)
	FI	Facilitate financing for scaling-up of EE investments.

M&V

Applicable options according to IPMVP framework.

Financing

Financing through instruments such as EE credit line, guarantee fund, concessional loan, and so on

6.2 Survey Form - Sri Lanka ESCO Need Assessment & Identification of Pilot Projects

A survey was created and shared with 27 local ESCOs in Sri Lanka. The online form can be accessed at <https://forms.gle/GjmWc3XH7W4zuVfv9>. Following are screenshots of the form.

Sri Lanka : ESCO Need Assessment & Identification of Pilot Projects.

"Development of Implementation & Financing Mechanisms for Energy Efficiency Improvements in the Commercial, Public & Industrial Buildings Sector in Sri Lanka" is a World Bank funded technical assistance (TA) project, implemented collaboratively by the Sri Lanka Sustainable Energy Authority (SEA) and the World Bank. The technical consultants engaged for the project are Environmental Design Solutions Pvt Ltd. (EDS) of India, EnergySolve International Pvt Ltd (ESI), and Resource Management Associates Pvt Ltd. (RMA) of Sri Lanka.

This project aims to develop business models, financing mechanisms, and associated transaction structures and templates to facilitate the roll-out of EE improvements in the existing buildings sector (public, commercial & industry) through ESCOs. Given the important role of ESCOs in scaling up energy efficiency (EE) improvements in Sri Lanka, SEA is inviting participation from ESCOs to better assess the gaps and needs for implementation of potential EE projects through various types of energy savings performance contracting mechanisms. The TA has been designed using a "learning-by-doing" approach. This will involve capacity building while working together closely with a selected set of project teams – comprising of ESCOs and financial institutions – to develop potentially bankable proposals for EE improvements to be implemented by ESCOs in Sri Lanka.

ESCOs play an important role in scaling EEI in Sri Lanka. SEA is inviting participation from ESCOs to assess their needs / requirements on capacity building and for identification of potential pilot projects for the purpose of creating financially bankable projects that can be eligible for loans, and credit line for energy efficiency improvement implementation. Preliminary information is being collected through this online form. Information shared by ESCOs will remain strictly confidential and will be used only for the purpose of determining ESCOs' requirements for capacity building and towards identification of potential pilot projects.

nidhi@edsglobal.com [Switch account](#)

The name and photo associated with your Google account will be recorded when you upload files and submit this form. Only the email you enter is part of your response.

*** Required**

Email *

Your email

A. Primary Contact Details

What is the name of your Energy Services Company (ESCO)? *

Your answer

Name of Primary Contact *

Your answer

Email id of primary contact *

Your answer

Contact Number (Telephone) *

Your answer

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Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

B. About the ESCO

How many full-time persons are employed by your ESCO company?

Your answer

Is your ESCO a stand-alone Energy Service Providers or a subsidiary of a larger organization or an energy utility?

- ☐ Stand-alone ESCO
- ☐ Subsidiary of a larger organization or utility

How many subcontractors are employed as a result of your ESCO related activities?

Your answer

Do you have any connections /tie-ups with manufacturers for particular EE technologies in the Cooling and Lighting space?

- ☐ Both Cooling and Lighting
- ☐ Only Cooling
- ☐ Only Lighting
- ☐ Neither

What was the overall turnover (in Sri Lanka) of your company (LKR) in the last reported year?

Your answer

Do you have a standard legally whetted model contract specifying the terms and conditions of the energy performance contract and role of the clients?

- ☐ Yes
- ☐ No
- ☐ Other: _____

What percentage of your overall turnover/business (in Sri Lanka) related to energy performance contracts?

Your answer

How do you verify that the contract conditions have been fulfilled?

Your answer

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C. About clients and projects

How many ESCO contracts have you executed in the last 5 years?

Your answer

How many detailed energy audits have you conducted in the past 5 years?

Your answer

How many of these projects implemented EEI?

Your answer

In the past 5 years, which sectors have your ESCO clients typically come from? (Note : Responses should sum to 100%)

	10%	20%	30%	40%	50%	60%	70%	80%	90%
Commercial / Office Buildings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Educational Institutes	☐	☐	☐	☐	☐	☐	☐	☐	☐
Healthcare	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hospitality (Hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Industries	☐	☐	☐	☐	☐	☐	☐	☐	☐
Public Buildings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others	☐	☐	☐	☐	☐	☐	☐	☐	☐

Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

What percentages of these clients are from the private sector and the public sector? (Note : Responses should sum to 100%)

	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Private	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Public	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

What is the most common type of contract among your ESCO clients? (Note : Responses should sum to 100%)

	10%	20%	30%	40%	50%	60%	70%	80%	90%
Energy performance contract-guaranteed savings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Energy performance contract-shared savings	☐	☐	☐	☐	☐	☐	☐	☐	☐
Leasing-based energy performance contract	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐	☐

What percentage of energy savings does one of your typical ESCO projects achieve?

- ☐ Below 5%
- ☐ 5%-15%
- ☐ 15%-25%
- ☐ Other: _____

What is the typical duration of your ESCO contracts?

Choose

How are your ESCO projects typically financed? (Note : Responses should sum to 100%)

	10%	20%	30%	40%	50%	60%	70%	80%	90%
Loan from Financial Institution by client	☐	☐	☐	☐	☐	☐	☐	☐	☐
Loan from Financial Institution by ESCO	☐	☐	☐	☐	☐	☐	☐	☐	☐
Operating lease	☐	☐	☐	☐	☐	☐	☐	☐	☐
Project finance	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grants	☐	☐	☐	☐	☐	☐	☐	☐	☐
Equity	☐	☐	☐	☐	☐	☐	☐	☐	☐
Other	☐	☐	☐	☐	☐	☐	☐	☐	☐

What are the main challenges in obtaining viable finance for ESCO projects?

Your answer _____

What are some of the payment security mechanisms employed in the ESCO contracting, specifically for building sector projects in Sri Lanka?

Payment security mechanisms can be: Escrow account, Letter of Credit, Bank Guarantee, Fixed Deposits, Revolving fund, Trust and retention account, EE Funds created for payment securities, etc.

Your answer _____

What is the prevailing payment cycle in ESCO projects that your organization has adopted in some of recent energy performance contracting projects in the building sector in Sri Lanka?

- ☐ Monthly
- ☐ Quarterly
- ☐ Annual
- ☐ Other: _____

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Implementation and Financing Mechanisms for Energy Efficiency Improvements in Commercial, Public, and Industrial Buildings

D. ESCO's Need Assessment

On a scale of 1 (Very low) -5(very high) please rate the following barriers for implementing EEI.

	1 (Very Low)	2 (Low)	3 (Medium)	4 (High)	5 (Very High)
Technical expertise	☐	☐	☐	☐	☐
Finances, incentives	☐	☐	☐	☐	☐
Awareness of EE technology	☐	☐	☐	☐	☐
Policy Environment	☐	☐	☐	☐	☐

Any other requirements for capacity building / training

Your answer

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Please provide your requirement on capacity building.

	No	Maybe	Yes
Energy Audit	☐	☐	☐
EE technologies	☐	☐	☐
Development of Project Proposals	☐	☐	☐
Understanding and Development of Transaction modalities	☐	☐	☐
Understanding of Financing / Funding	☐	☐	☐

E. Potential Projects for Pilots

Have you recently evaluated or audited a potential project in the building sector (public, commercial, industry) for EE improvements in lighting and cooling? Such a project could also be considered by the SEA for a pilot demonstration (in consultation with the ESCO). Provide the list of potential projects (Name of Client, Building type, location, size).

Your answer

Please provide energy audit reports (if any) for potential pilot projects.

[Add file](#)

E. Potential Projects for Pilots

Have you recently evaluated or audited a potential project in the building sector (public, commercial, industry) for EE improvements in lighting and cooling? Such a project could also be considered by the SEA for a pilot demonstration (in consultation with the ESCO). Provide the list of potential projects (Name of Client, Building type, location, size).

Your answer

Please provide energy audit reports (if any) for potential pilot projects.

[Add file](#)

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