ENERGY EFFICIENCY IN BUILDINGS

Accelerating Low-carbon Development in Cambodia

Policy Brief & In-country Case Studies

Table of Content

Proposed Citation

United Nations Development Programme. Energy Efficiency in Buildings - Accelerating low-carbon Development in Cambodia: Policy Brief & In-country Case Studies (2020).

Acknowledgements

UNDP would like to thank all stakeholders who provided input in structuring and developing this report. We would like to express our sincerest gratitude to all individuals who have contributed their time and provided information to the authors. Special thanks to all who submitted information on the in-country case studies.

Disclaimer

The authors and contributors of this publication have taken every precaution to ensure that the content is both current and accurate, errors can occur.

Copyright

by the United Nations Development Programme
53 Pasteur Street, Boeung Keng Kang 1
Phnom Penh, Cambodia

Executive Summary

The building sector is the most significant final energy consumer in Cambodia, with an estimated share of about 52 percent. Residential and commercial buildings consume almost 80 percent of electricity in the country and energy consumption in buildings will more than double until 2040[1].

Introducing energy efficiency regulations in buildings also offers additional benefits of increased competitiveness, employment, and poverty alleviation. It will also contribute to lower greenhouse gas emissions and achieve Cambodia's climate change mitigation targets.

The major drivers of this demand growth are an increase in new building constructions, inefficient energy utilization in existing buildings, raising comfort standards and a continuously increasing stock of electrical household appliances. Therefore, energy efficiency standards and regulations are needed to manage this growing energy demand in buildings and avoid "locking in" inefficient building assets for years to come.

Effective implementation of energy efficiency in buildings has the potentials to save up to 25 percent of the sector's energy demand in 2035[2]. These savings correspond to the annual electricity produced by 10 coal power plants[3]. In response to the COVID-19 crisis, creating an energy efficiency market opens new opportunities for investments and job creation. The following three actions are highly recommended to fill the regulatory gap and achieve a more sustainable development pathways for the buildings and construction sector:

(1) Integrate minimum building energy-efficiency requirements in the building technical regulations that are currently drafted by the Royal Government of Cambodia to reduce rising energy demand and risk of power shortage.
(2) Implement building energy reporting systems, either voluntary or mandatory for large electricity consuming buildings to allow government to collect energy consumption data, which can be used to improve the regulations and design energy efficiency programs. Setting energy reduction targets for such large buildings will also lower electricity bills and reduce operational costs.
(3) Effective enforcement of building energy regulations through independent assessors for compliance check and create a roster of professionals outside the public sector.

[1]International Energy Agency. (2020). Cambodia Energy Balance 2017. Available at https://www.iea.org/data-and-statistics/datatables?country=CAMBODIA
[2]Ministry of Mines and Energy. (2017). National Energy Efficiency Policy 2018-2035 (Draft). Royal Government of Cambodia (RGC).
[3]Each coal power plant with installed capacity of 100 MW and annual generation 4,380 Gig-Watt-hour

1. Policy Context

Between 2019 and 2040, global primary energy consumption is expected to rise by 25 percent until 2040. Global electricity demand will grow at 2.1 percent per year, twice the rate of primary energy demand. Electricity demand growth will be particularly strong in developing economies like Cambodia. According to the International Energy Agency, a sharp pick-up in efficiency improvements is the most critical element that can bring the world towards the Sustainable Development Scenario.[4]

The building sector is the most significant final energy consumer in Cambodia, with an estimated share of about 52 percent equivalent to 3.5 million tonnes of oil equivalent (Mtoe). Residential and commercial buildings consume almost 80 percent of the total final electricity.[5] According to a national forecast, buildings' energy consumption will more than double until 2040.[6]

Unless efforts towards improving energy efficiency are realized, the present growth in annual energy consumption in buildings is expected to continue. That will contribute significantly to the country's greenhouse gas emissions. The major drivers of this demand growth are an increase in new building constructions, inefficient energy utilization in existing buildings and a continuously increasing stock of electrical household appliances.

Building energy performance improvements are critical to achieving the global sustainable development path and combat global warming. Building efficiency codes and regulations are vital tools to improve the energy performance of buildings and equipment by mandating minimum levels of energy performance.

As of 2018, only one out of three countries had a mandatory or voluntary building energy code, and around 42 percent have building energy certifications (Figure 1). This includes countries with mandatory building energy certification policies and those with widespread voluntary building energy certification policies or programs that might have only a few voluntary projects.

The construction industry has experienced strong growth since Cambodia opened to foreign investment in the 1990s. The development of Cambodia towards a modern consumer society implies the rise towards more resource-intensive lifestyles and impacts strongly on how buildings are

[4]International Energy Agency. (2019). World Energy Outlook 2019. Available at https://www.iea.org/reports/world-energy-outlook-2019
[5]International Energy Agency. (2020). Cambodia Energy Balance 2017. Available at https://www.iea.org/data-and-statistics/data-tables?country=CAMBODIA
[6]Ministry of Mines and Energy. (2017). National Energy Efficiency Policy 2018-2035 (Draft). Royal Government of Cambodia (RGC).

designed, built, and operated. Awareness and knowledge of energy-efficient building design and technologies among investors and building professionals is limited.

Building energy regulations could fill this gap and guide investors and developer towards enhancing the energy performance of their buildings, increase asset value, and generate energy cost savings. The government will benefit from a lower energy demand growth that reduces the need to invest in the construction of new power plants.

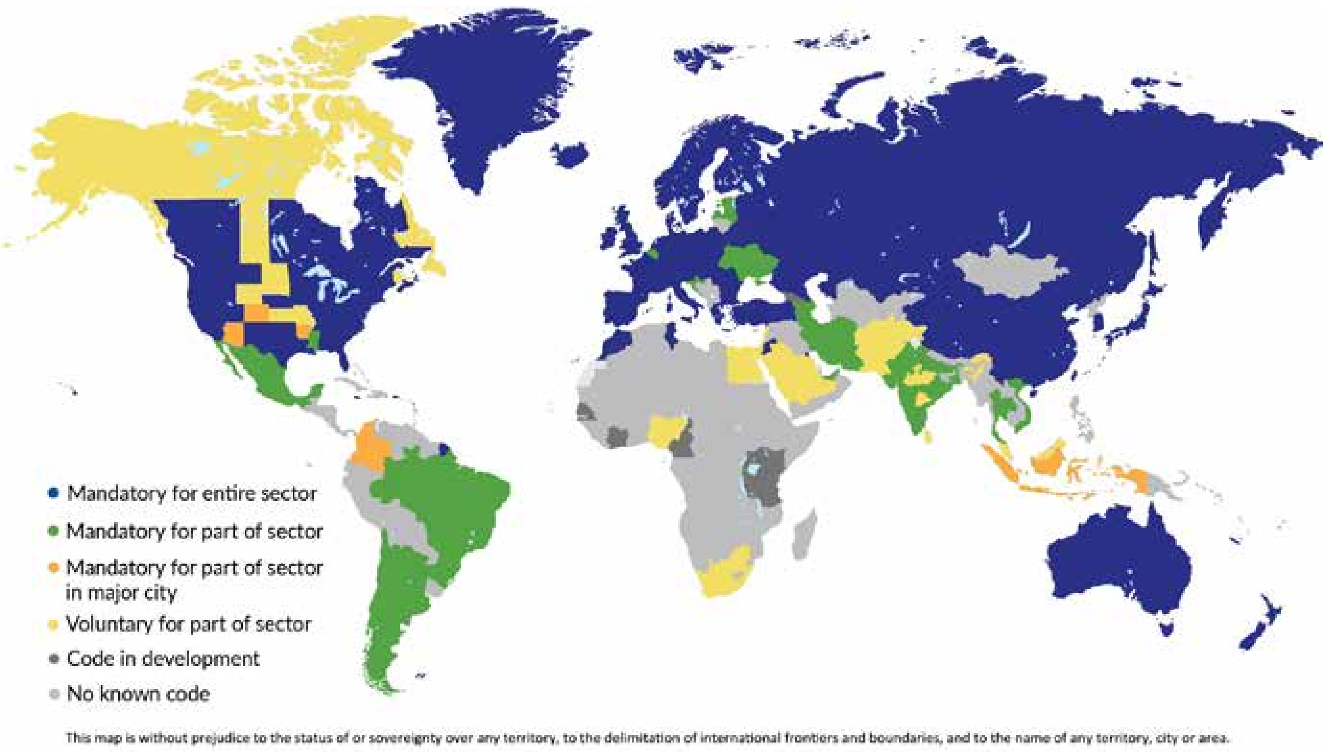


Figure 1: Building energy codes and standards by country, 2018[7]

Building efficiency codes and regulations are tools that set a minimum level of energy and resource efficiency in buildings. No single set of requirements will suit all building types. That means different requirements are typically set for residential and commercial buildings. They commonly focus on measures that optimize the design and construction of buildings and core building services such as heating, cooling, ventilation, and lighting.

Cambodia launched the Construction Law in November 2019, which determines the guiding principles for the regulatory framework of the construction sector. The development of a technical building regulations will follow in the coming years. The incorporation of minimum energy efficiency standards in the regulation is necessary to avoid a “locking in” an inefficient built environment for years to come. Effective implementation of energy efficiency in buildings has the potentials to save up to 25 percent of the sector’s energy demand in 2035.[8]

[7]International Energy Agency (2019) Tracking Buildings, IEA, Paris https://www.iea.org/reports/tracking-buildings
[8]Ministry of Mines and Energy. (2017). National Energy Efficiency Policy 2018-2035 (Draft). Royal Government of Cambodia.

2. Addressing the Barriers

Building energy codes and regulations seek to address common barriers to energy efficient building design. Building developers have little incentive to build energy efficient buildings because the subsequent owners or tenants will pay the energy bills and benefit from lower energy costs. This is called a "split-incentive" dilemma. Certain energy efficiency measure may result in increased initial capital costs for the builder, which take time to recover through energy cost savings. Homebuyers with limited budgets often opt for cosmetic or size-related home upgrades instead of energy efficiency, which hinders the uptake of energy efficiency technologies in residential buildings. Figure 2 outlines these and other common barriers to energy efficiency in the building sector.

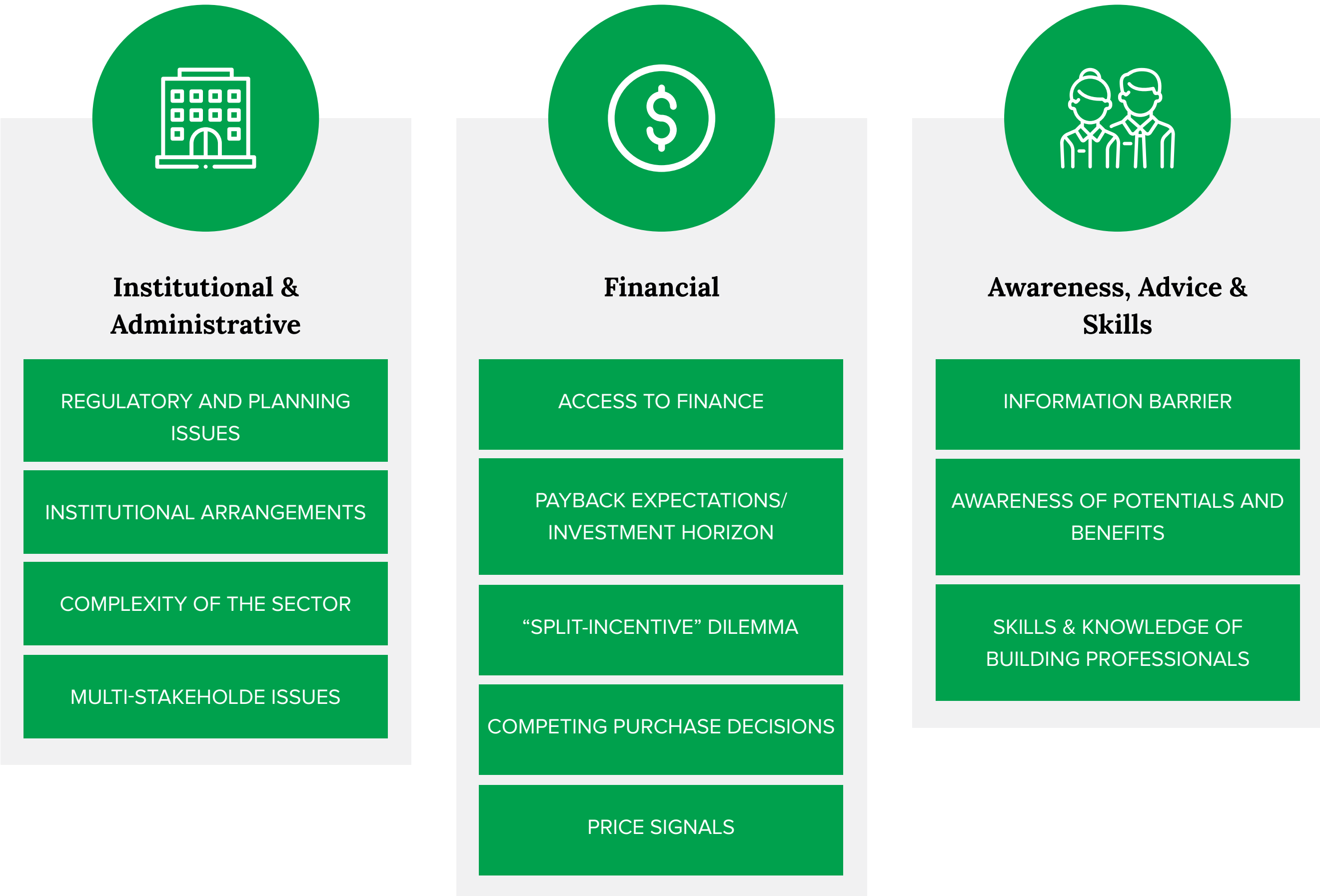


Figure 2: Barriers to energy efficiency in the building sector[9]

[9]Cox, S. 2016. Building Energy Codes – Policy Overview and Good Practices. Clean Energy Solution Center. Available at: http://www.nrel.gov/docs/fy16osti/65542.pdf

3. Building Energy Codes & Standards

Building energy codes and standards are regulatory instruments that specify minimum energy efficiency standards for residential and commercial buildings. Building efficiency codes are commonly designed as prescriptive, simple trade-off, or performance-based codes.

Prescriptive means that the regulations specify performance requirements for
(1) building elements such as walls, roofs, and windows as well as
(2) building equipment such as air-conditioning, lighting, water heating, and controls.

Building Energy Simulation

Building energy simulation (or modelling) is a computerized process that estimates energy consumption of a building design before it is constructed. The software takes as input a description of a building including geometry, construction materials, and equipment (e.g. lighting, HVAC, water heating). It also considers local weather conditions and uses physics equations to calculate the energy use.

The aim of energy modelling is to help architect and engineers to develop comfortable and energy-efficient building designs from concept through to completion. Simple energy models often use monthly calculation while more complex software rely on hourly simulations.

Prescriptive codes can also include expected standards for natural ventilation, shading, and renewable energy integration. The primary form of compliance is through design review and checklists as part of the building permit application process. Simple trade-off codes also prescribe performance for components but allow trade-offs among them. For example, they allow less insulation of walls if high-performance windows are installed. Compliance with these codes is commonly assessed by checking project designs and specifications that refer to appropriate material or component standards, or using simple energy simulation software.

Performance-based codes specify a required maximum level of energy consumption or intensity for the whole building. Building energy modeling must be conducted at the design stage. Compliance is commonly checked by comparing the modeled energy performance of the design with the performance of a reference building of the same type. Various standardized software tools are available to support compliance processes and can be chosen based on unique code features and local considerations.

Scope & Performace Levels

Typically, building energy codes set different energy performance and compliance requirements for residential and non-residential buildings. Requirements might also be set depending on the project type and scale (e.g., landed homes and multi-story apartments).

Policymakers shall implement a regular revision cycle for updating codes to gradually tightening the requirements every three to five years. Some governments introduce new building energy regulations on a voluntary basis to prepare the market. Typically, regulations are made mandatory after two years. Beginning with a standard that raises energy efficiency requirements to levels that are feasible is essential to gain acceptance of the new regulation. However, it is important to give signals that the regulation will gradually be tightened. This approach will also provide time to the development of energy-efficient products, technologies, and services in anticipation of compliance with stricter codes in the future.

Implementation and Compliance

National governments are usually responsible for establishing building codes, while cities and local authorities commonly must implement and enforce them. In Cambodia, building projects of less than 3,000 square metres in total floor area require a construction permit from the provincial and municipal administration while larger developments are approved by the Ministry of Land Management, Urban Planning and Construction (MLUMPC). During the construction period, the municipal and provincial administration is also involved in inspection at construction sites.

Like building code enforcement on structural and safety issues, the following activities are commonly used for checking compliance on building energy regulations:
• conducting a design review that checks the energy requirements,
• ensuring on-site inspections at critical points in the construction process and at the end,
• implementing testing involving commissioning of equipment,
• considering post-occupancy evaluations (currently rarely mandatory), periodic monitoring and reporting,
• applying meaningful penalties for non-compliance, such as withholding design, construction or occupancy approval or using fines, and
• providing incentives to achieve beyond-code performance.

The Law on Construction approved in 2019 sets the main principles of the Cambodia construction code and technical building regulations which is still under development. Among other, the law suggests that compliance shall be checked by a certifier who is licenced by the ministry. The conditions and procedure for compliances checks will be determined by a sub-decree.

The idea to rely on independent assessors or certifiers for compliance check can address the lack of capacity and staff of local authorities. The Independent Assessor model is also used for enforcement of building energy regulations and will create a roster of professionals outside the public sector. An effective quality assurance mechanism is required to address the concerns that independent assessors, as individuals, are likely to be pressured and influenced into approving compliance. The government must also appoint an institute or university to trains the independent assessors, conduct examination and certification.[10]

[10]CARBSE, 2020. The Third-Party Assessor Model For ECBC Compliance And Enforcement. Available at: http://carbse.org/the-third-party-assessor-model-for-ecbc-compliance-and-enforcement/

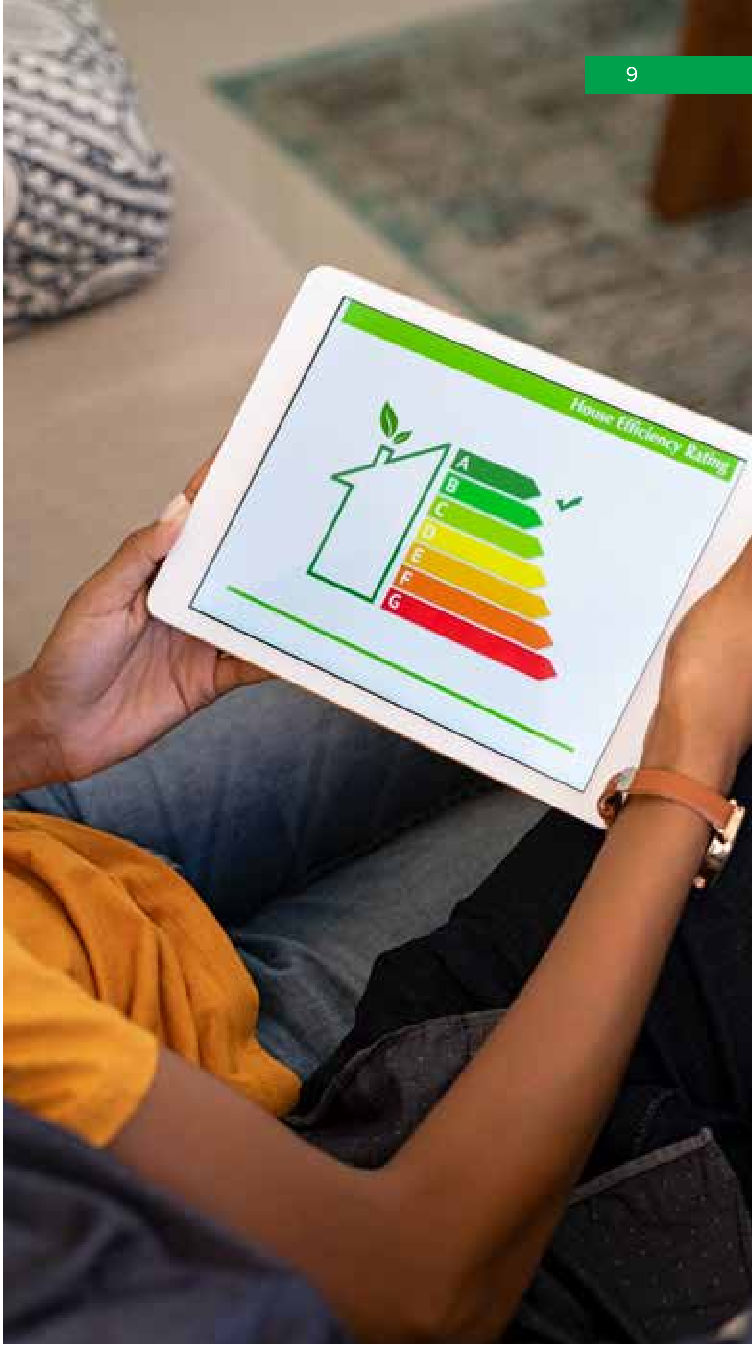
Standards for Existing Buildings

Energy efficiency regulation can also set minimum requirements or specific actions (e.g., lighting retrofit) for existing buildings and building renovations. That slowly improves the energy performance of the existing building stock.

Major renovation, expansions, and floor additions of an existing building in Cambodia falls under the jurisdiction of the Law on Construction. They shall be also carried out according to technical building regulations which is still under development. Integrating minimum requirement of energy performance for renovation project like those for new buildings, will add value to the renovation intervention and ensure that the energy use in existing buildings is reducing over time.

Some countries have introduced voluntary or mandatory building energy reporting systems for large electricity consumers. Knowing the building's energy consumption enables owners, operators, and tenants to make informed management and investment decisions. The collection of general statistical information about energy use in buildings allows governments to do better policy and program design. The public utility Electricite du Cambodge (EdC) might get involved in promoting energy efficiency and expands its business model towards demand side management.

A practical approach to target low-performing existing buildings is to enforce a mandatory periodic energy audit followed by stepwise performance improvement. The energy audit provides data on operational energy performance and can identify energy efficiency measures. For example, the regulators may suggest that high-energy consuming existing building improve their energy use intensity by five percent every year until reaching the performance of the energy code. The purpose of Energy performance certificates (EPC) is to provide information on a property's energy use



and typical energy costs. It is a standardized way of comparing one building with another using a similar approach as appliance energy efficiency labeling. In general, the property seller or landlord is responsible for arranging an EPC to show to prospective buyers or tenants. The knowledge of the property's energy performance enables buyers and investors to consider this information in their decision making.

4. Best Practices

China's Multi-tiered Approach of Building Energy Code Enforcement and Compliance[11]

China implemented a robust approach to enforce building energy codes that involve compliance checks during various stages of construction. Multiple actors are engaged to support the process (see Figure 3).

1 Certified inspection companies, hired by developers, analyze building architectural plans to ensure compliance.

2 Local quality supervision agency reviews compliance report from the inspection company.

3 Local construction administration agency provides a building license following positive compliance report review.

4 Certified engineering inspection companies, hired by the developer, perform building inspections throughout the construction process.

5 Low quality supervision agency also performs compliance checks during the building process.

6 Building projects may also be inspected through random annual inspections conducted through the Minsitry of Housing.

Figure 3: Multi-tier enforcement approach of China Building Energy Code

If a building fails the inspection, the issues can be corrected within 30 days, or the developer is fined. If buildings pass all compliance checks described above, the local construction agency issues occupancy permits.

Singapore's Building Energy Code[12]

In Singapore, the building energy code defines mandatory energy efficiency standards for new residential, commercial, and public buildings with a gross floor area of at least 2,000 square meters. Energy performance criteria are based on a points system, allowing the project to decide which energy efficiency measures to include reaching the 50-point minimum requirement.

The code includes several mandatory prescriptive elements, such as thermal-envelope performance, HVAC efficiency, lighting, airtightness, and sub-metering. Bonus points are awarded for the use of renewable resources. Compliance with the code is checked during design, construction, post-construction, and post-occupancy. Non-compliance penalties consist of fines, refusal of permission to occupy, and refusal of permission

[11]Cox, S. 2016. Building Energy Codes – Policy Overview and Good Practices. Clean Energy Solution Center. Available at: http://www.nrel.gov/docs/fy16osti/65542.pdf

[12]ASEAN Centre of Energy. (2019). Mapping of Green Building Codes and Building Energy Efficiency in Asia - Towards Guidelines on ASEAN Green Building Codes.

80% of the Entire Building Stock to be "Greened" by 2030

Figure 4: Singapore's strategy "Towards a Sustainable Singapore" [13]

to construct. In addition to the energy codes, buildings are required to meet higher efficiency standards under the National Rating Scheme called "Green Mark".

Singapore's objective is to transform 80 percent of its entire building stock into green buildings until 2030 (Figure 4). Therefore, the city state adopted an integrated 'whole-of-government' approach effort to address the issues of standards, codes, and rating tools in close consultation with the private stakeholders. The government established the Energy Efficiency Programme Office (E2PO) to jointly promote and facilitate the adoption of energy efficiency in Singapore. The E2PO is a multi-agency committee led by the National Environment Agency (NEA) and the Energy Market Authority (EMA) and comprises all other relevant government agencies. A dedicated institution to address the implementation of energy efficiency will not only provide centralized information and coordination but also reduce the time for getting approval for incentives and projects.

[13]Building and Construction Authority, 2017. Singapore's Green Building Energy Efficiency Standards. Available at: https://seforallateccj.org/wpdata/wp-content/uploads/2017/04/report_singapore.pdf

Vietnam's mandatory energy code and voluntary green rating system[14]

The Vietnamese code provides mandatory technical standards to achieve energy efficiency in the design and construction and retrofit of civil buildings. The technical requirements covered within the law are for building envelope, ventilation and air conditioning, lighting, escalators and elevators, electric power consumption and service water heating system.

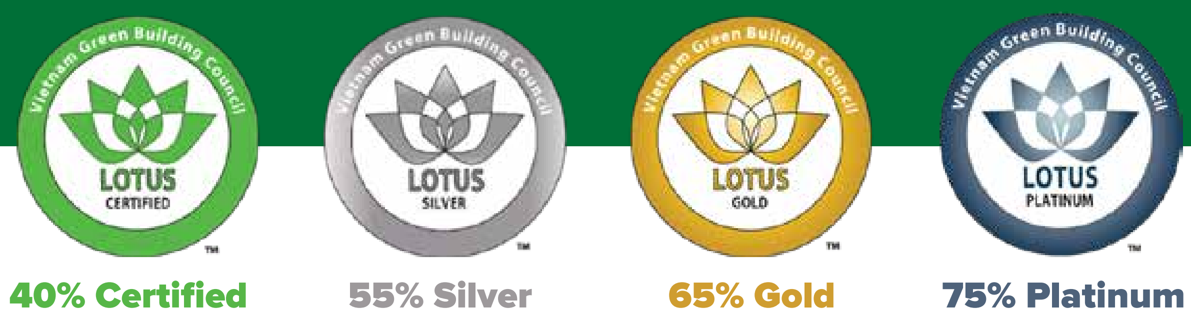


Figure 5: Levels of LOTUS Green Building Rating

The government of Vietnam also introduced a voluntary green rating tool called LOTUS in 2010. LOTUS was formed by the Vietnam Green Building Council (VGBC) based on various international green building rating systems. LOTUS aims to promote green building standards beyond energy efficiency that are specific to Vietnam. LOTUS guides the local construction industry towards the efficient use of natural resources and promotes environmentally friendly construction practices.

[14]ASEAN Centre of Energy (2019). Mapping of Green Building Codes and Building Energy Efficiency in Asia - Towards Guidelines on ASEAN Green Building Codes.

Robust Analysis supports Indonesia's Building Energy Codes[15]

Supporting the design of building energy codes, the government of Indonesia assessed energy savings of various energy efficiency measures in Jakarta's building sector. Sensitivity analysis found that easily implementable measures could allow for energy savings of 30 to 40 percent in new buildings. Implementing these measures through building codes is supporting Indonesia in meeting a high-level target of 30 percent average energy savings in new buildings (see Figure 6)

High Impact Measures	Office	Retail	Hotel	Hospital	Apt.	School
Photoelectric controls (inclusion of controls to maximize daylighting)	18%	11%	NA	17%	NA	10%
Solar shading (addition of horizontal and vertical devices)	17%	11%	18%	18%	8%	2%
Glass performance (higher solar and thermal proper-ties)	15%	6%	16%	14%	11%	5%
Efficient Chillers (higher chiller COP)	11.4%	8%	6%	7%	9%	12%
Variable-speed drives (inclusion of variable drives on pumps)	9%	3%	3%	5%	0.0%	0.0%
Percentage glazing (limiting window-to-wall ration of the facade)	8%	4%	9%	7%	2%	0.0%
Low-energy lights (limiting the power density for artificial lighting)	7%	8%	7%	16%	8%	5%
Thermostat Management (limiting the minimum temperature)	2%	3%	3%	7%	8%	11%
Heat Recovery (adding heat recovery unit to fresh air inlet)	2%	5%	3%	8%	0.0%	0.0%

Figure 6: Energy saving potentials of high impact measures identified for Indonesia's building energy code

[15]Institute for Building Efficiency, (2012). Driving Transformation to Energy Efficient Buildings: Policies and Actions – Building Efficiency Codes and Standards. Milwaukee: Johnson Controls.

Thailand combines Building Energy Regulations with Energy Efficiency Financing

Thailand's Building Energy Code was set under the "Ministerial Regulation Prescribing the Type or Size of Building and Standards, Criteria and Procedures for Designing Buildings for Energy Conservation" (BE 2552). The code addresses the building envelope, lighting, air-conditioning, and heating systems, among others. The compliance of the minimum standards in the building energy code is mandatory for government buildings and voluntary for private buildings at this point.

However, the Thai government is currently incorporating the building energy code into the general building regulation called the "Building Control Act." The enforcement starts with new buildings with a total area of larger than or equal to 10,000 square meters. The building area limit for compliance will be reduced to 5,000 square meters in the second year and 2,000 square meters in the third year. The building energy standard will then apply to nine types of new buildings.

Thailand established the Energy Conservation Promotion Fund (ENCON Fund) even before setting up building energy regulations. The ENCON Fund aims to provide financial support for factories and buildings to invest in energy conservation programs. The most important sub-activity under the ENCON Fund is the Energy Efficiency (EE) Revolving Fund to stimulate investments in large-scale projects. The government used revenues from a petroleum tax as the initial capital of the EE Revolving Fund. The fund provides loans to local banks at a zero percent interest rate and with a seven-year final maturity. In return, banks lend to energy efficiency project owners and developers at a maximum interest rate of four percent. The general principle of the Revolving Fund is that the revenue generated via repaid loans is made available for issuing new loans, which ensures the sustainability of the fund structure.

	Phase 1	Phase 2	Phase 3
Project cost (US$ million)	85.7	94.8	180.5
Revolving fund loan (US$ million)	47.7	47.0	94.7
Payback period (years)	2.4	2.45	2.44
Energy cost saving (US$ million/year)	35.1	38.7	73.8

Table 1: The performance indicators of Thailand's Energy Efficiency Revolving Fund[16]

[16]UNDP, 2012. Case Study Report: Thailand Energy Conservation Fund.

5. Recommendations

Cambodia is now a middle-income country with a booming construction sector that is one pillar of the country's strong economic growth. The government recognized the need for more regulations to ensure the sector's sustainable development by adopting the Construction Law in late 2019.

The Ministry of Land Management, Urban Planning and Construction is currently developing technical building regulations. Integrating minimum energy performance in these technical regulations is highly recommended to mitigate the sharply rising energy demand growth.

Building energy standards and regulations will not only accelerate the low-carbon development of Cambodia but also promote energy security and reduce the investment need in new power supply infrastructure. Developing a sustainable energy efficiency market also offers additional benefits for employment, poverty alleviation, health, competitiveness, and the environment.

The documented in-country case studies (see annex) show that the private sector has taken the first steps to address the wastage of energy and resources in building construction and operation. High electricity prices make investments in energy efficiency economically feasible. The pioneers in energy efficiency can benefit from lower electricity bills, increased property value, and higher competitiveness.

However, market structures are complex, and different actors will have to work together if optimal energy efficiency is to be achieved. Therefore, regulations are needed to assist various actors in overcoming their specific barriers, to strengthen their actor-specific incentives, and to drive the whole sector towards energy efficiency with multiple benefits.

REFERENCES

ASEAN Centre of Energy (2019). Mapping of Green Building Codes and Building Energy Efficiency in Asia - Towards Guidelines on ASEAN Green Building Codes.

Becqué, R. et al. (2016) Accelerating Building Efficiency - Eight Actions for Urban Leaders. World Resource Institute: Washington.

Cox, S. (2016). Building Energy Codes – Policy Overview and Good Practices. Clean Energy Solution Center. Available at: http://www.nrel.gov/docs/fy16osti/65542.pdf

International Energy Agency. (2019). World Energy Outlook 2019. Available at https://www.iea.org/reports/world-energy-outlook-2019

International Energy Agency (2019) Tracking Buildings, IEA, Paris. Available at: https://www.iea.org/reports/tracking-buildings

International Energy Agency. (2020). Cambodia Energy Balance 2017. Available at https://www.iea.org/data-and-statistics/data-tables?country=CAMBODIA

Ministry of Mines and Energy. (2017). National Energy Efficiency Policy 2018-2035 (Draft). Royal Government of Cambodia (RGC).

ANNEX | IN-COUNTRY CASE STUDIES

The following section provides a selection of building case studies from Cambodia that have incorporated energy-efficient design strategies or implemented energy efficiency measures. This documentation aims to show that energy efficiency is a business case where building developers, owners and managers are enjoying the multiple benefits such as reduced operational cost, increased property value and brand recognition.

The example buildings also give an overview of different approaches to address the issue like conducting energy or carbon auditing, using employee engagement in energy management or integrating green building design from the very beginning of a construction project. The buildings listed here are a selection of good practices which the authors were able to document with the available resources. We are aware that many more good examples might exist.

ENERGY AUDIT

AMANJAYA PANCAM HOTEL

How low-cost Measures can reduce Energy Cost?

Amanjaya Pancam hotel has 21 suites, a restaurant, lounges, meeting rooms, and other facilities.

An energy audit showed that the energy consumed by the hotel was above 45,000 kilowatt-hours per month which is equal to average energy cost of 6,300 US-Dollar.
The hotel introduced the recommended low-cost energy efficiency (EE) measures and could reduce its monthly energy consumption to 13,200 kilowatt hours. The energy bills came down by more than 30 percent.

The low-cost measures were:
• Replacement of all the 513 incandescent lamps (60 Watt) by efficient LED light bulbs.
• Replacement of electrical appliances by efficient appliances with a European Energy Efficiency Label.
• Replacement of the dying Air-conditioning system by new energy efficient units (Inverter technology, high EER) and proper maintenance of the systems (every month).
• Installation of cooling window films to reduce solar thermal loads in the rooms.
• Re-design of the gas network at the kitchen.

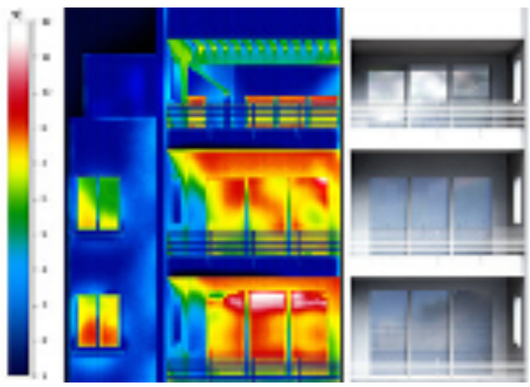
HIGHLIGHTS

Achieved electricity savings of 13,200 kilowatt-hours

More than 30% of energy cost cut-down

Payback time of energy efficiency investment only 1 year

Major savings through efficient lighting, AC maintenance and cooling window films



Picture shows energy losses through building façade

ENERGY SAVING COMPETITION

ATS OFFICE

How gamification can save energy and money?

Behaviour change plays a crucial role in reducing energy consumption. The Energy Efficiency Contest uses gamification as a motor towards more energy-conserving behaviour. ATS conducted an internal energy saving competition with the goal to reduce energy consumption in their offices.

They created six "Green Teams" that competed in saving energy in their respected office space. By installing an energy monitoring system (EMS), ATS could measure the amount of energy and money each team saved in every month. The energy contest was accompanied by internal training sessions, daily motivations & actions, and a monthly quiz. The team that saved most energy at the end of each month, received an award.

During the contest and with the involvement of the whole office team, ATS could identify several energy saving opportunities which led to the following annual savings:

- Air conditioner setting in IT Room: 37% = US$ 906
- Motion sensor: 35%
- Light sensor in restrooms: 39%
- Automatic regulation of hot air extraction: 25% = US$ 7,000
- LED retrofit in Service Engineering Department – 53% = US$ 150
- LED retrofit in Stock Warehouse: 82% = US$ 1,136
- LED retrofit in Bodia Stock: 79% = US$ 1,348
- Air conditioner retrofit in Server Room: 50% = US$ 259
- Energy saving awareness in Aircon use: 19% = US$ 465

Teams	Surface (m^2)	Number of A/C	Monthly consumption (kWh/day/m^2)	Compared to last month
Blue (EES)	51	2	0,47	0%
Orange (AES)	29.7	2	0.31	-3.13%
Red (Sales + admin)	59	2	0.39	-9.3%
Yellow (Finance)	34	1	0.36	-5.26%
Purple (Stock)	18.9	1	0.63	+8.62%
White (Reception + WC)	22	1	0.36	+33.3%

HIGHLIGHTS

Achieved electricity savings through competition 15-20%

Annual energy cost cut-down through:

LED retrofit US$ 2,634

Aircon retrofit & adjustment US$ 1,165

Automatization of hot air extraction US$ 7,000

EDGE CERTIFIED BUILDING

ACLEDA INSTITUTE OF BUSINESS

How green building certification can save energy?

ACLEDA Institute of Business is ACLEDA Bank's business school with and addresses the shortage of higher education institutions in Cambodia. It offers Associate, Bachelor, and Master-degree levels for over 3,000 students in the fields of business, banking, and finance. The building has a net floor area of 25,000 square meters and is the first EDGE[18] certified green building in the country.

The green campus consists of three education buildings, administrative offices, a library, and a dormitory. All buildings are resource-efficient, allowing for a reduced carbon footprint and lower operational costs. The campus uses 35% less energy and 44% less water and 32% less embodied energy compared to a standard building. To achieve annual electricity savings of 707,000 kilowatt-hours, the following key features were implemented:[19]

- Average window-to-wall ratio of 20%
- Good roof insulations
- Natural ventilation for all school building corridors
- Highly efficient air-conditioning system with a high coefficient of performance (COP)
- Solar hot water collector for dormitories
- LED lighting for all internal and external with sensors in corridors and bathrooms.

The investment in solar hot water heating paid back in less than four months.

HIGHLIGHTS

Annual electricity savings of 707,000 kilowatt-hours

Building uses 35% less energy compared to the standard design

Payback time of additional investment between 4.5 and 7.2 years

Major savings through reduced window size, roof insulation, solar hot water collection

[18]EDGE stands for Excellence in Design of Greater Efficiencies and is a green building certification developed by IFC of World Bank Group
[19]https://www.edgebuildings.com/projects/acleda-institute-of-business/

GREEN BUILDING CERTIFICATION

MERCEDES-BENZ SHOWROOM

Designed to achieve 25% energy savings

The Mercedes-Benz showroom in Phnom Penh is one of the few LEED certified buildings in Cambodia. LEED stands for Leadership in Energy and Environmental Design and is the most popular green building certification system worldwide. It covered areas of sustainable sites, water efficiency, energy & atmosphere, material resource, indoor air quality, innovation, and regional priorities.

The Mercedes-Benz showroom building has achieved Gold level certification with 66 out of 100 point. Building energy modelling was applied to optimize the energy performance of the design during the whole project cycle. The building design and construction can achieve up to 25 percent electricity savings compared to a standard design:

Major energy and water savings were achieved through:
• Energy-efficient, UV-blocking solar glass on the showroom.
• LED lighting utilized throughout the building.
• Rooftop solar panels with a capacity of 100 kilowatt.
• Rainwater collection system on the showroom roof with water used for the building's gardens.
• Low-flow plumbing fixtures.
• Environmentally friendly building materials.

The solar system was designed to supply one-quarter of the building's electric needs.

HIGHLIGHTS

Designed to achieve 25% savings in electricity consumptions

Payback time of seven years

Rainwater collection system

Rooftop solar system for green power supply

CARBON AND ENERGY AUDIT

INSTITUTE OF TECHNOLOGY OF CAMBODIA

Voluntary energy audit team

The objective of the carbon and energy audit of the Institute of Technology of Cambodia (ITC) building in Phnom Penh was to design an action plan supporting the implementation of low carbon and energy efficiency solutions. The audit was done by a voluntary audit team, composed of lecturers, staff and students from the university with the guidance of a professional auditor from SEVEA Consulting.[20]

The carbon emissions of the campus activity are estimated at 3,432 tonnes of carbon dioxide equivalent per year. Energy use in the building is responsible for about 20% of total carbon emissions. It is estimated that energy savings between 25% and 50% could be achieved by

- Better insulation of the building envelope
- LED and energy-saving lamps
- Replacement of old Air-Conditioning units by new efficient models
- Lighting control
- Increase of setpoint temperature to 25 degree Celsius

A 10% reduction target of carbon emission for the next three years will lower it by 235 tonnes of carbon dioxide equivalent. The same goal applied to the electricity consumption will lower ITC's electricity bill by 160,000 kilowatt-hours, which represents a financial saving of $32,000.

HIGHLIGHTS

Energy savings between 25% and 50% are achievable

Better insulation of building envelope required

LED light and lighting control with presence and brightness sensor

32,000 US-Dollar of savings in electricity bill feasible within next 3 years

[20]SEVEA (2018). Carbon and Energy Audit of ITC. Mission mandated by Cambodia Climate Change Alliance (CCCA).

GREEN FACTORY BUILDING

BOWKER GARMENT FACTORY

LEED Silver certification brings up to 42% of energy savings

The Bowker Garment Factory in Kandal, is the second LEED-certified project in Cambodia which achieved LEED Silver, making it one of the few LEED-certified buildings in the country. LEED stands for Leadership in Energy and Environmental Design, is the most widely used green building rating system in the world. It provides a framework for healthy, highly efficient, and cost-saving green buildings. LEED categories consider sustainable sites, water efficiency, energy and atmosphere, material resources, indoor air quality, innovation strategies, and regional priorities.

The garment factory achieved Silver level certification by obtaining 55 out of 110 points under LEED for New Construction v2009. A fundamental project commissioning was done to ensure that all the systems and major components of the building were designed and installed according to the operational requirements intended for the building.

Moreover, to achieve energy saving of 42%, a sophisticated indoor lighting system was considered and incorporated to achieved energy savings while enhancing the indoor environmental quality (IEQ) of the space. Major savings were achieved through:

• Lighting power using high-efficient lighting fixtures to reduce light density

• Implemented an Evaporative Cooling Air Conditioner Technology to enhance HVAC efficiency

• Advanced equipment usage in the production line to reduce process load

LEED Scorecard	Silver 55/110
SUSTAINABLE SITES	17 / 26
WATER EFFICIENCY	8 / 10
ENERGY & ATMOSPHERE	20 / 35
MATERIAL & RESOURCES	2 / 14
INDOOR ENVIRONMENTAL QUALITY	3 / 15
INNOVATION	1 / 6
REGIONAL PRIORITY CREDITS	4 / 4

HIGHLIGHTS

Achieved 42% of energy savings compared to a standard design

75% of construction and demolition debris were diverted from landfills

Reduced wastewater generation by 50%

90% of the building occupants had access to quality views

United Nations Development Programme Cambodia

#53, Pasteur Street, Boeung Keng Kang I
P.O. Box 877, Phnom Penh, Cambodia
PHONE: +855-23-216-167
E-MAIL: registry.kh@undp.org