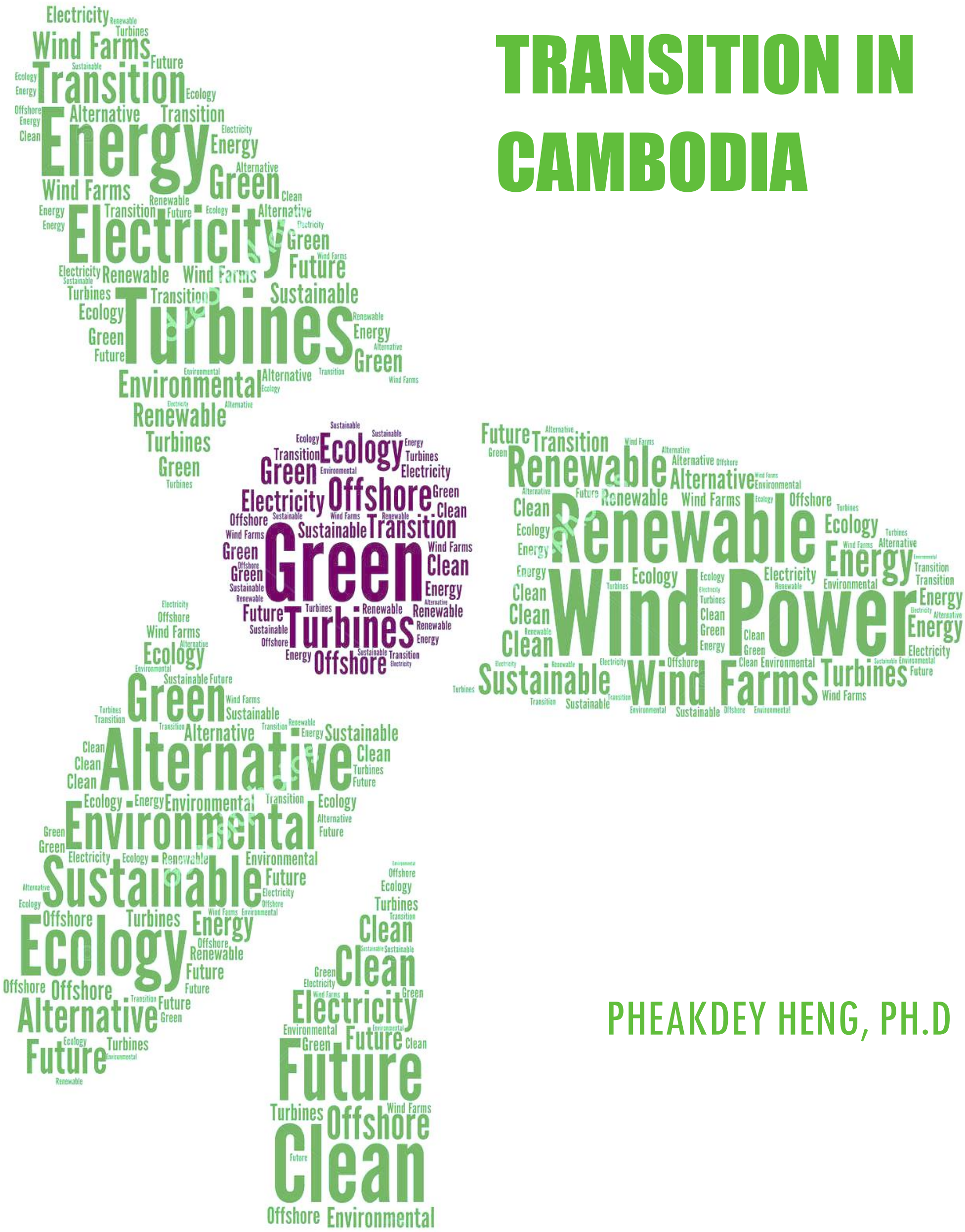
TOWARD A LOW CARBON ENERGY TRANSITION IN CAMBODIA



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ACRONYMS AND ABBREVIATIONS

ASES	Advanced Sustainable Energy Scenario
CCAP	Climate Change Action Plan
CSP	Concentrated Solar Panel
DFIs	Development Finance Institutions
DNI	Direct Normal Irradiation
EAC	Electricity Authority of Cambodia
EdC	Electricité du Cambodge
EUEI-PDF	EU Energy Initiative Partnership Dialogue Facility
FIT	Feed-In Tariff
GHG	Global Greenhouse Gas
GHI	Global Horizontal Irradiation
IEA	International Energy Agency
IFIs	International Finance Institutions
IRENA	International Renewable Energy Agency
kWh	Kilowatt-hour
LCOE	Levelized Cost of Electricity
MME	Ministry of Mines and Energy
MW	Megawatt
NDC	Nationally Determined Contribution
PPA	Power Purchase Agreement
PV	Photovoltaics
REAP	Renewable Electricity Action Plan
RECAI	Renewable Energy Country Attractiveness Index
REE	Rural Energy Enterprises
REF	Rural Electrification Fund
RISE	Regulatory Indicators for Sustainable Energy
SE4ALL	Sustainable Energy for All
SES	Sustainable Energy Scenario
UNFCCC	United Nations Framework Convention on Climate Change

1. INTRODUCTION

In 2017, Global energy demand rose by 2.1% to 14,050 million tons of oil equivalent, more than twice the previous year's rate[1]. Over 70% of this demand growth was still met by oil, natural gas and coal. Globally, 1.1 billion people still lack access to electricity and 2.8 billion are currently without access to clean cooking facilities.[2] Around two-thirds of global greenhouse gas (GHG) emissions stem from energy production and use.[3] This puts the energy sector at the core of efforts to combat climate change.

The world is facing an energy trilemma. First, the reliability of energy supply must be ensured to meet current and future demand (energy security). Energy must also be accessible around the world, particularly in emerging markets, at an affordable cost (energy equity) and at the same time efforts must be made to reduce the carbon footprint of the energy sector (environmental sustainability).

Energy transition is critical in balancing these intertwined yet conflicting goals. Energy transition is a long-term structural change in energy systems. It entails shifting from current energy production and consumption systems, which rely primarily on non-renewable energy sources such as oil, natural gas and coal, to a more efficient, lower-carbon energy mix.

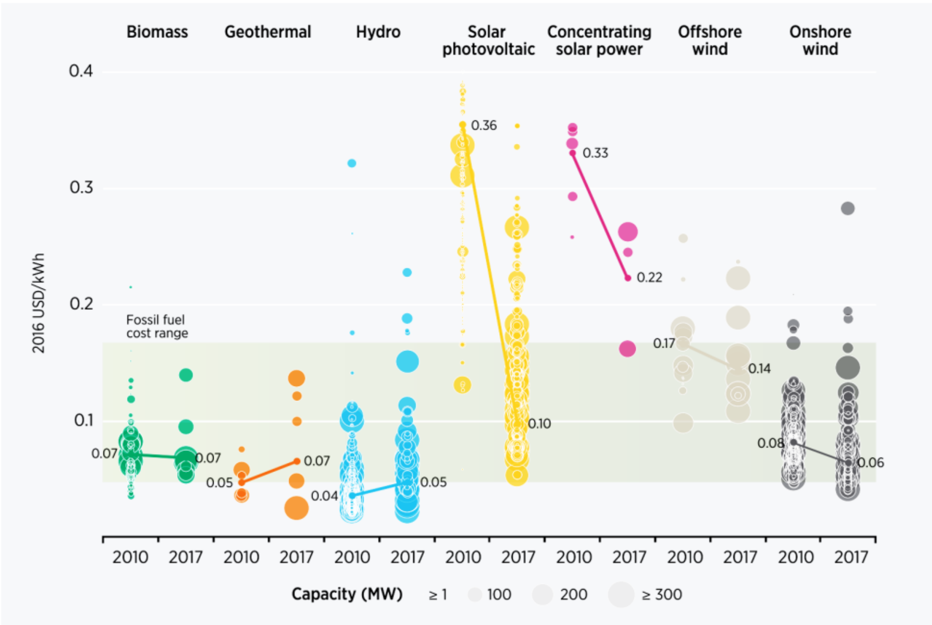
The global imperative to achieve sustainable growth and limit climate change, combined with a rapid decline in costs and rising investment into renewable energy, has put in motion a transition of the way that energy is produced, distributed and consumed.

Clean energy has become increasingly competitive. The global weighted average levelized cost of electricity (LCOE) of utility scale solar PV has fallen 73% since 2010, to US$ 0.10/kWh for new projects commissioned in 2017.[4] Bioenergy-for-power, hydropower, geothermal and onshore wind projects largely fell within the range of generation costs for fossil-based electricity. The global weighted average cost of electricity was US$ 0.05 per kilowatt-hour (kWh) from new

[1] Reuters (2018)
[2] IEA (2015)
[3] IEA (2017)
[4] IRENA (2018)

hydropower projects, US$ 0.06/kWh for onshore wind and US$ 0.07/kWh for bioenergy and geothermal projects.[5]

Figure 1: Global levelized cost of electricity from utility-scale renewable power generation technologies, 2010-2017



Source: IRENA Renewable Cost Database.

Note: The diameter of the circle represents the size of the project, with its centre the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE value for plants commissioned in each year. Real weighted average cost of capital is 7.5% for OECD countries and China and 10% for the rest of the world. The band represents the fossil fuel-fired power generation cost range.

Source: IRENA 2018

Governments have a critical role in accelerating the energy transition. Governments have the responsibility to enact an enabling policy framework that provides long-term certainty for the private sector and ensures a positive environment for the energy transition. Market signals must be put in place to create financial incentives for low-carbon energy solutions.

In this global context, this paper discusses the need for energy transition in Cambodia. It assesses Cambodia's clean energy potential, analyzes the policy environment and discusses the role of the private sector in accelerating the

[5] IRENA (2018)

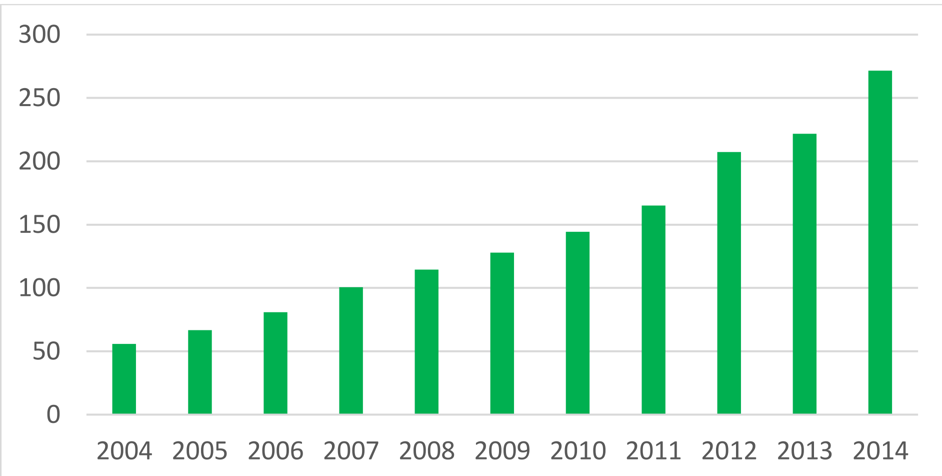
transition towards sustainable energy. The paper concludes with a set of recommendations to address the regulatory barriers and attract sufficient private financing to scale up renewable energy investment and harness wider socio-economic benefits for Cambodia.

1. THE NEED FOR ENERGY TRANSITION IN CAMBODIA

Cambodia's energy sector is at a turning point. The energy demand is growing rapidly; the electrification rate remains relatively low while the electricity tariff is one of the highest in the region. The government is under a growing pressure to bring the cost down, increase electricity access and to do so in a sustainable manner.

Due to the growing population and economy, Cambodia's energy demand is rising rapidly. Electricity consumption has also increased significantly during the last decade. In 2014, per capita consumption of electricity reached 271.4 kWh, more than fivefold increase from 55.7 kWh in 2004[6]. The electricity demand grew by 16.35%, 27.09% and 19.79% in 2014, 2015, 2016 respectively with an average of 21.07% per year[7].

Figure 2: Cambodia's Electric power consumption (kWh per capita)



Source: Author's graph using World Bank's database

[6] World Bank Database, retrieved from https://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC
[7] EAC (2017)

The country's cumulative electricity generation reached 2,283 MW in 2017, 40% of which comes from hydropower. Coal made up the second largest part with about a quarter. Diesel and biomass combined for an additional 15%, with the remainder is imported from Vietnam, Thailand and Laos.[8]

Currently, only around 60% of the population has access to electricity.[9] To meet the rising demand and to increase the electrification rate, the government has put forward an ambitious plan to boost domestic energy production, mainly through the construction of hydropower and coal power plants.

High electricity cost has remained one of the main barriers in doing business and has affected the competitiveness of the country's economy. Households living in Phnom Penh that consume more than 201 kWh per month pays 750 riel ($0.18) per kWh[10]. Customers with a similar consumption level pay only $0.07 per kWh in Vietnam[11] and $0.12 per kWh in Thailand[12].

Cambodia needs energy transition strategies to address its energy challenges. If implemented well, energy transition plans will improve Cambodia's energy security by boosting domestic clean energy generation thereby reducing dependence on imports. Energy transition will also contribute to realizing the government's national goal to increase access to affordable electricity to at least 70% of all households by 2030[13] and its international commitment to reduce emission of 16% from energy sector by 2030 compared with business as usual scenario.[14]

In an ambitious scenario in which clean energy will contribute to at least 87% of the total generation mix by 2050, Cambodia will be able to avoid between 32 to 38 million tons of GHGs emission per year and save between US$ 500 million and US$1.1 billion in fuel cost annually after 2035.[15]

[8] Harris (2018)
[9] MME (2018)
[10] KhmerTimes (2018)
[11] Tuoi Tre News (2015)
[12] Thailand Board of Investment (2014)
[13] EAC (2017)
[14] Cambodia's Intended Nationally Determined Contribution 2015
[15] WWF (2016)

Transition toward clean energy also brings a wide range of socio-economic benefits. Many countries see opportunities in the development of a renewable energy value chain, with the potential to increase income, create jobs, contribute to industrial development and improve livelihoods.

For example, Kopernik, an NGO operating in Indonesia, has employed local female entrepreneurs to sell and deliver solar lanterns, water filters and clean cooking solutions to some of the country's most remote island communities. Since its inception in 2011, the program has employed 4,650 women as clean energy entrepreneurs and provided them with specific training in selling clean energy systems on consignment.[16]

The SNV Biogas program in Viet Nam has installed over 250 000 digesters since 2003, creating employment equivalent to 14.8 person-days per digester and an average of 16 800 full-time jobs.[17] In Myanmar, after the installation of a solar mini-grid by Mandalay Yoma company, women invested in rice cookers and hot plates, saving up to two hours per day from collecting fuel wood and cooking.[18] In rural Cambodia, 1001fontaines introduced solar powered water purification systems that have helped 400 000 people gain access to clean water, bringing significant health improvements.[19]

2. CAMBODIA'S CLEAN ENERGY POTENTIAL

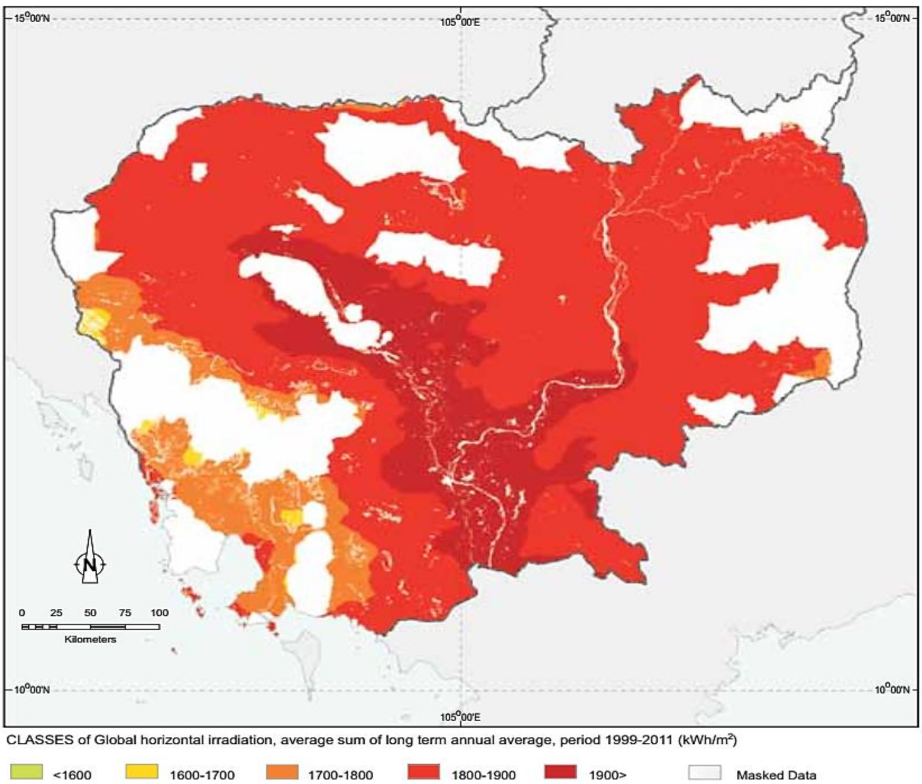
Cambodia has large untapped clean energy potential. Thanks to its rich waterway, Cambodia has the second highest hydropower potential in the lower Mekong basin. So far, only around 10% of the total 10,000 MW has been exploited. By the end of 2016, hydropower generated 929 MW, accounting for 60% of total Installed Capacity and 33 % of total generation sources.[20] While large dams can have negative effects on the environment and people, mini and micro hydropower projects are safer and more environmentally friendly. The

[16] IRENA (2018)
[17] Ibid.
[18] Ibid.
[19] Ibid.
[20] MME (2017)

estimated capacity of these small-scale dams is about 300 MW with present installed capacity of about 2 MW.[21]

With an average of 5 kWh/m2 per day and average sunshine duration of 6-9 hours per day; solar technical potential is estimated at 8,100 MW.[22] Cambodia has about 134,500 square kilometers (km2) of land area that could be suitable for photovoltaics (PV) development.[23] Its Global Horizontal Irradiation (GHI) ranges between 1,450 and 1,950 kWh/m2/year; some 65% of the country is estimated to have GHI levels of 1,800 kWh/m2/year or more. Direct normal irradiation (DNI) is also high, with most of the country having DNI levels of 1,100–1,300 kWh/m2/year.[24]

Figure 3: Areas Potentially Suitable for Solar Photovoltaic Development in Cambodia



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[21] Pheakdey (2015)
[22] ADB (2015)
[23] ADB (2015)
[24] Ibid.

Source: GeoModel Solar; Lahmeyer International

Biomass is the main source of energy for cooking and heating in Cambodia but not for power generation. Biomass only accounts for 0.5% of the total power generation in 2015.[25] Cambodia's biomass generation potential is estimated to be 18,852 GWh per year but currently less than 23 MW is operational.[26] Significant biomass sources are rice husk, sugar cane bagasse, and cassava stems. Harnessing only 10% of the technical biomass and solar potential would avoid the need for most of the planned coal-fired capacity additions.

Wind power is one of the least explored renewable resources in Cambodia. Wind speeds of at least 5 meters per second are available for electricity generation in the southern parts of the Tonle Sap lake, mountainous regions in the southwest, and coastal regions such as Sihanoukville, Kampot, Kep and Koh Kong. The total electrical capacity from wind turbines is estimated at 3,665 GWh per year (about 1,000 MW at 30% load factor).[27]

Despite their abundance, renewables currently contribute only less than one per cent to Cambodia's total electricity mix. In 2017 Cambodia domestically produced 86% of 2,283 MW installed capacity. Of this, coal and hydropower are the two major sources of power, accounting for 35% and 40% respectively.[28]

WWF's 2016 study painted a positive future for a transition to sustainable energy in Cambodia. Two future energy scenarios were proposed. The Sustainable Energy Scenario (SES), where measures are taken to maximally deploy renewable energy and energy efficiency measures to achieve a near-100% renewable energy power sector; and the Advanced Sustainable Energy Scenario (ASES), which assumes a more rapid advancement and deployment of new and renewable technologies as compared to the SES.[29]

Under the Sustainable Energy Scenario (SES), Cambodia would generate more than 53 TWh against a demand base of 62.5 TWh by 2050 with the deficit power being imported from neighboring countries. Solar power would play a central

[25] EDC (2015)
[26] Climate Investment Fund (2016)
[27] Ibid.
[28] Ibid.
[29] WWF (2016)

role in the energy mix, with 46% of the total energy mix, 13% of which being Concentrated Solar Panel. Biomass would generate 21%, while coal and large-scale hydro will contribute 13% and 12% respectively.[30]

Under the Advanced Sustainable Energy Scenario (ASES), by 2030 more than 75% of all generation in Cambodia would come from renewable sources (includes large-scale hydro) and moving towards 100% by 2050. Of the renewable technologies, solar PV would contribute the highest generation share of 27.4 TWh or 55% closely followed by biomass at 20%, hydropower at 13% and onshore wind at 4%. Total installed capacity would increase to almost 24 GW or 14% higher than in the SES as more conventional technologies are substituted out.[31]

Cambodia also has huge energy saving potential. In May 2013, the Ministry of Mines and Energy (MME) issued a draft National Policy, Strategy and Action Plan on Energy Efficiency. It sets an overall goal of reducing national energy demand by 20% by 2035 compared to business as usual projections, with up to a third of the savings identified as coming from reduced electricity consumption. A range of measures was assessed as being likely to yield the following potential savings[32]:

- industry sector: from 20% (garment industry) to 70% (ice factories) – through increased awareness of cost-effectiveness of replacing inefficient equipment;
- residential end-user appliances: up to 50% – by introducing energy efficiency labelling schemes;
- building sector: 20 to 30% – by introducing international benchmarks for new commercial buildings (using appropriate building materials and construction principles, including standardized wiring).
- rural electricity: up to 80% – by reducing Rural Energy Enterprises' (REEs') generation/distribution losses

[30] WWF (2016)
[31] Ibid
[32] MME (2018)

3. CAMBODIA'S REGULATORY ENVIRONEMNT

The regulatory environment of a country is extremely important for an effective energy transition. Well-crafted regulations send clear signals and provide certainty to investors and project developers in the country. A significant challenge for actors in the field of renewable energy and energy efficiency is policy consistency. If the future of related policies is uncertain, risk margins will increase and attracting capital will be more difficult. Thus, a key part in the creation of a regulatory environment for an effective energy transition is clarity and consistency. Investments into renewable energy and energy efficiency face unique barriers, often specific to local conditions, such as the existing regulation for connecting generators to the local grid, and public perceptions of different technologies. Thus, policy measures must be designed to overcome these barriers. The following paragraphs describe a number of key energy-related policies in Cambodia.

Table 1: Key energy policies in Cambodia

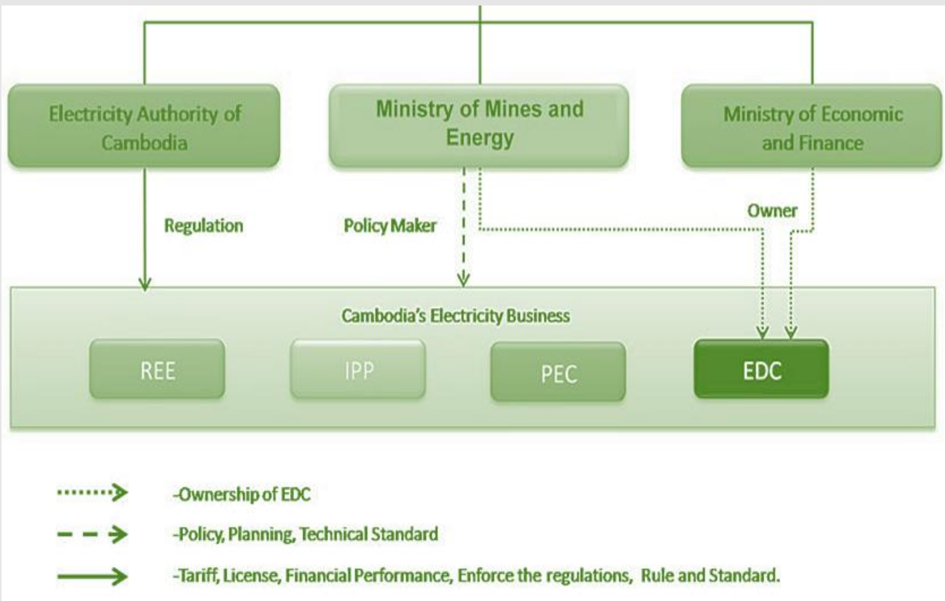
YEAR	POLICY
1999	• Cambodia Power Strategy
2001	• Electricity Law
2006	• Rural Electrification Action Plan
2007	• National Policy on Rural Electrification by Renewable Energy
2015	• Climate Change Action Plan for Mine and Energy Sector • Industrial Development Policy • National Determined Contribution
2018	• Regulations on General Conditions for Connecting Solar PP Generation Sources to The National Grid • National Policy, Strategy and Action Plan for Energy Efficiency • The Environment and Natural Resource Code

Source: Author's compilation

The Cambodia Power Sector Strategy (1999) aims to address the development objectives of the Cambodian power sector focusing in short to medium term measures. The strategy has three priorities (a) establish the enabling environment for an efficient development and operation of the sector (b) attract private sector participation in a transparent and competitive manner, as a way to introduce efficiency, mobilize financial resources and reaching a broader human resource base; and (c) commercialize EDC, including a tariff reform to expand its market share, and availing the support of a foreign utility through a performance based contract and eventual strategic partnership.[33]

The Electricity Law (2001) provides the governing framework for the electric power supply and services throughout the Kingdom of Cambodia. The law covers all activities related to supply of electricity, provision of services and use of electricity and other associated activities of power sector. Key components include (a) establishing the principles for operation of the sectors; (b) establishing favorable conditions for competition, private investment, private ownership and commercial operation of the electric power industry; and (c) establishing and defining the functions of the EAC and the MME.[34]

BOX 1: MAIN ACTORS IN CAMBODIA'S POWER SECTOR



Source: EAC 2017

[33] World Bank (1999)
[34] Royal Government of Cambodia (2001)

Ministry of Mines and Energy (MME) is responsible for developing policies and strategies, power development plans, overseeing the electricity trade with neighboring countries, major investment projects and management of the rural electrification sector. Along with the Ministry of Economy and Finance (MEF), MME is the joint owner of Electricité du Cambodge (EDC).

Electricité du Cambodge (EdC) is a wholly state-owned limited liability company, with responsibility to generate, transmit and distribute electricity throughout Cambodia. Its main functions are supplying electricity, developing the transmission grid and facilitating import and export of electricity to and from neighboring countries.

Electricity Authority of Cambodia (EAC) is the power sector regulator, and is responsible for granting licenses, approving and enforcing performance standards, and determining tariffs, rates and charges for electricity. The EAC may grant various types of electricity licenses, including licenses for generation, transmission, distribution, retail, or a combined license

The Renewable Electricity Action Plan (2002–2012) aimed to provide cost-effective and reliable electricity to rural areas through renewable energy technologies. As part of REAP, the Rural Electrification Fund (REF) was formed in 2005 with World Bank's assistance and transferred to EdC in 2012. Throughout 2013, EdC provided US$4 million in funds for the REF to provide grant assistance for electricity connections to rural households, units of home solar power systems and funds for private licensees to invest in electricity infrastructure in rural areas.

The Rural Electrification by Renewable Energy Policy (2006) aims to create an enabling framework to increase rural electricity rates through renewable energy resources. Its key objective is that by 2020, 100% of rural villages should have access to electricity and that by 2030; at least 70% of the nation should have access to the country's electricity grid. This policy aims to:

- provide access to reliable, safe electricity services, with insignificant impact on the environment;
- encourage the private sector to participate in providing electricity services by renewable energy in the rural areas;
- act as a market enabler through various incentives;
- encourage using renewable energy technologies;

- promote electricity systems by renewable energy at least cost for rural communities, through research and pilot development;
- empower the poor to participate in rural electrification.

In 2013, a National Policy, Strategy and Action Plan for Energy Efficiency was drafted with the support of the EUEI-PDF program. The policy is being revised to limit the scope of the targeted sectors to buildings, industry and transport. the overarching target of the policy is to reduce energy demand by 20% by 2035 relative to the business as usual scenario. The two main goals of this policy are to[35]:

- Improve the management and maintenance of existing infrastructure (e.g. buildings) and industrial processes (e.g. for the use of fuel wood) for increased energy efficiency;
- Increase the transfer and adoption of energy efficient technology (e.g. fuel efficient vehicles and light bulbs) to reduce energy intensity.

In 2015, the government published the Industrial Development Policy with the vision to transform and modernize Cambodia's industrial structure from a labor-intensive industry to a skill-based industry by 2025. This is to be achieved by linking with global value chains, integrating into regional production networks and developing clusters, while strengthening competitiveness and improving productivity of domestic industries, and marching toward developing a modern technology and knowledge-based industry. As part of the strategies to develop the industrial infrastructure, the policy calls for the review of the long-term electricity demand forecast and energy development plans in line with the new vision for economic and industrial development. Energy supply options are also to be reviewed in order to ensure adequate energy supply capacity to major strategic industrial zones.[36]

The Nationally Determined Contribution (NDC) which Cambodia submitted to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 indicates an expected reduction of 27% in greenhouse gas emission by 2030 compared to the baseline scenario, from interventions on energy efficiency and renewable energy. Some of the proposed actions include promoting grid

[35] MME (2018)
[36] Government of Cambodia (2015)

connected renewable energy generation, connecting decentralised renewable generation to the grid, scaling up off-grid electricity such as solar home systems, hydro (pico, mini and micro) and encouraging energy efficiency by end users.[37]

Climate Change Action Plan (CCAP) for Mine and Energy Sector 2015-2018 was developed to provide a roadmap for government's agencies and development stakeholders to promote the energy sector while addressing climate change challenges. CCAP for Mine and Energy sector has four strategic objectives: (1) develop energy policies to meet SE4ALL targets for Cambodia (2) promote climate proof energy infrastructure (3) implement GHGs emission management for the energy sector (4) improve capacity, knowledge and awareness for climate responses.[38]

Initiated and led by the Ministry of Environment, the draft Environment and Natural Resource Code was developed to enable the sustainable development of the Kingdom of Cambodia, through protection, restoration, and enhancement of the environment and its natural and cultural resources. The code covers many environmental topics. The section most relevant to a sustainable energy transition is Book 3, Title 6: Sustainable Energy.[39]

This section aims to achieve sustainability objectives through:

- support and promotion of sustainable energy projects;
- consideration of the Kingdom of Cambodia's international climate change commitments in all decision on energy projects;
- adoption of a clear sustainable energy target;
- consideration of financial incentives to promote sustainable energy projects;
- promotion of environmentally friendly technology;
- support for decentralized sources of energy and mini- and micro-grid systems;
- promotion of household rooftop solar and other household generation and storage systems.

[37] Government of Cambodia (2015)
[38] MME (2015)
[39] MOE (2018)

The code has now been through ten revisions and is expected to be adopted by the government in late 2018.

In 2018, the Electricity Authority of Cambodia issued a set of regulations to clarify the general conditions for installing and operating solar photovoltaic (PV) systems in Cambodia. According to Article 5 of the regulations, consumers can install solar PV systems for their own consumption so long as these systems do not require connection and synchronization with the national grid. However, big consumers (medium voltage consumers) and bulk consumers (high voltage consumers) may consume electricity generated from their installed solar PV and also be synchronised with the national grid[40]. A two-part tariff system comprising charges for both capacity and energy would be applicable to these consumers. The regulations do not mention financial or other incentives for other types of consumers to connect to the national grid.

Overall, Cambodia is still lacking clear policies for the promotion and implementation of renewable energy and energy efficiency projects. Cambodia ranks one of the lowest in ASEAN on the World Bank's Regulatory Indicators for Sustainable Energy (RISE). RISE is a set of indicators which help to compare national policy and regulatory frameworks for sustainable energy and covers 111 countries in both the developed and developing world. The assessment covers countries' policy and regulatory support for three categories of sustainable energy – access to modern energy, energy efficiency, and renewable energy. Twenty-seven indicators are used to provide an overall score for the country, with each indicator using a series of criteria.[41] The resulting scorecard allows a comparison among different countries and support for sustainable energy policies.

For the 2016 RISE assessment, Cambodia was given an overall score of 42%. This places Cambodia into the middle bracket ("yellow bracket") on a world comparison. RISE scores for the ASEAN countries can be seen in Table 2. It can be seen that Cambodia is currently only in front of Myanmar and Laos.

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[40] Supplied power above 380 volts and up to 22,000 volts is considered medium voltage, and any voltage above 22,000 volts is categorized as high voltage

[41] World Bank (2016)

Table 2 RISE indicators for the ASEAN region

8 ASEAN Countries	Energy Access	Energy Efficiency	Renewable Energy	Overall Score
Vietnam	100	71	64	78
Thailand	100	63	60	74
Malaysia	100	52	68	73
Philippines	82	42	67	64
Indonesia	61	34	55	50
Cambodia	70	21	34	42
Myanmar	59	13	43	38
Laos	47	8	46	34

Source: Author's compilation

Cambodia achieves a score 70 out of 100 for energy access making it one of the top countries in the study for this category. Among the eight indicators for energy access, Cambodia scores high on framework for grid electrification, framework for stand-alone systems, utility creditworthiness and electrification plan. Areas that can be improved include utility transparency and monitoring, electricity affordability, scope of the electrification plan and framework for minigrids.

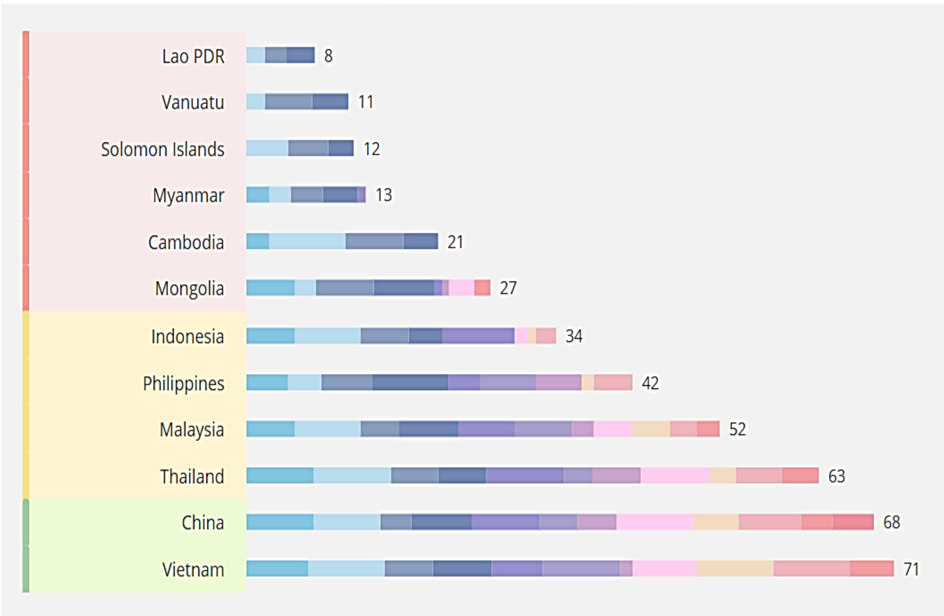
Table 3: Top 10 Countries with the highest energy access score

Top 10 energy access score countries	Energy access overall score	1. Existence of plan	2. Scope of plan	3. Grid electrification	4. Minigrids	5. Stand-alone systems	6. Affordability	7. Utility transparency and monitoring	8. Utility credit-worthiness
India	84	80	75	100	77	69	100	96	76
Philippines	82	100	75	67	85	62	100	87	82
Kenya	82	100	50	67	66	93	100	96	86
Uganda	78	100	63	67	64	93	100	79	59
Tanzania	75	100	50	100	96	73	100	83	0
South Africa	71	100	38	100	10	76	100	96	51
Cambodia	70	80	38	100	65	93	50	46	90
Cameroon	69	80	88	33	65	73	100	67	50
Senegal	69	100	88	100	72	36	50	96	15
Guatemala	68	100	75	50	39	33	100	62	87

Source: World Bank (2016)

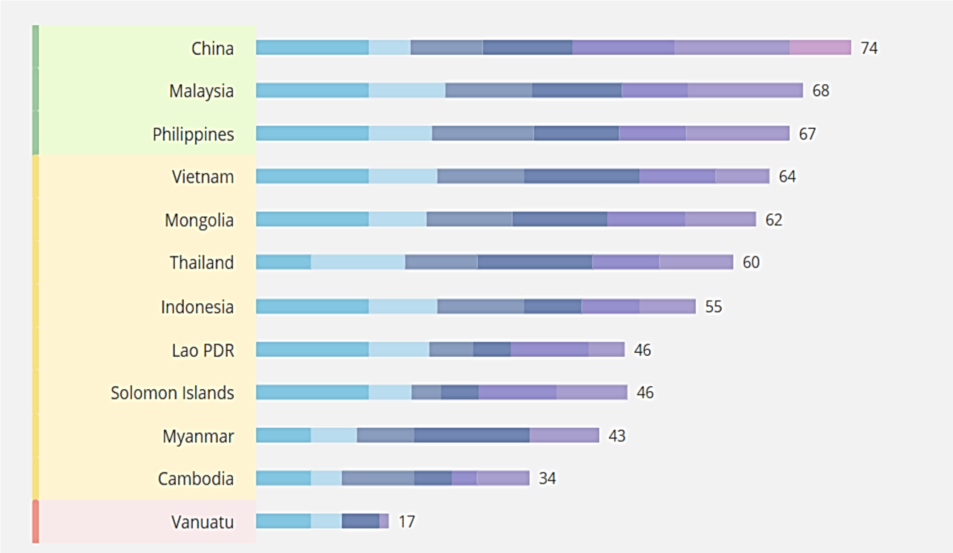
However, Cambodia is one of the region's worst performers on energy efficiency and renewable energy, scoring 21 and 34 out of 100 respectively. Out of the 12 energy efficiency indicators, Cambodia scores zero in eight of them. These include incentives & mandates for large consumers, public sector and utilities, financing mechanisms for energy efficiency, minimum energy efficiency performance standards energy labeling systems, building energy codes and carbon pricing. The score is expected to improve when the National Energy Efficiency Policy is adopted and the recommended priority actions are implemented. For renewable energy, Cambodia performs poorly in legal framework, planning for renewable energy expansion, incentives and regulatory support for renewable energy, attributes of financial and regulatory incentives, network connection and pricing, counterparty risk and carbon pricing and monitoring.

Figure 4: Ranking of energy efficiency score for East Asia and the Pacific



Source: World Bank (2016)

Figure 5: Ranking of renewable energy score for East Asia and the Pacific



Source: World Bank (2016)

BOX 2: REGULATORY ENVIRONMENT FOR CLEAN ENERGY IN THE PHILIPPINES AND VIETNAM

PHILIPPINES

The Philippines have one of Asia's highest electricity rates, partly attributed to the high costs of importing fossil fuels. Increasing energy security and reducing power costs have been key drivers in supporting renewable energy, with the country setting a renewable energy target of at least 20,000 MW of installed capacity by 2040.[42]

The Philippines have seen approximately 20 key policies specific to renewable energy brought in over the last 20 years. Two important legislations enacted to promote renewable energy were the Renewable Energy Act of 2008 and the Biofuels Act of 2006. In terms of energy efficiency, the Energy Efficiency and Conservation Act was introduced in 2012.[43] These acts are supported by the Philippines Energy Plan.

The Renewable Energy Act provides the legal and institutional framework necessary for harmonising policies on the development of renewable energy technologies, to accelerate the exploration and development of renewable resources as well as to increase the utilization of renewable energies. A key component to develop capabilities

[42] Philippine's Department of Energy (2017)
[43] Rosellon (2017)

in the use of renewable energy systems and promote its efficient and cost-effective commercial application are fiscal and non-fiscal incentives.[44]

In 2011 the government launched the National Renewable Energy Program, the “Green Energy Roadmap” for the Philippines. The program is set upon the Department of Energy’s energy reform agenda, which aims to ensure greater energy supply and security for the country. The roadmap sets the target of 20,000 MW of installed renewable energy capacity by 2040, with the program including further policy mechanisms to achieve this. These include renewable portfolio standards, feed-in tariffs, green energy option program, and net metering for renewable energy.[45] The feed-in-tariff (FiT), introduced in 2012 (updated 2015), provides a priority for grid connection of renewable technologies; prioritises the purchase of the renewable energy generated; and provides a fixed tariff for energy fed into the grid for a fixed period of time.[46]

The Biofuels Act adopted in late 2006 went into force in January 2007, mandating various minimum percentages of locally-sourced biofuels (meeting certain standards) to be blended into liquid fuels for motors and engines. It requires a minimum 1% biodiesel blend by volume in all diesel fuels within 3 months of the Act’s enforcement, and 5% bioethanol blend by volume within two years in all gasoline fuels being distributed and sold in the Philippines. These volumes are to progressively increase; for biodiesel to 2% within 2 years, and for bioethanol to 10% within four years.[47]

The Energy Efficiency and Conservation Act institutionalizes energy efficiency and conservation and provides (fiscal) incentives to energy conservation projects. The country also developed an energy efficiency roadmap and an energy efficiency program. The roadmap to 2030 sets a goal of energy saving equal to 10% of the annual final energy demand outlook. The program includes information, education and communication campaigns; standards and labelling for household appliances; and support for energy efficiency projects.[48]

[44] IEA (2017)
[45] ERIA (2016)
[46] IEA (2017)
[47] Ibid.
[48] Reyes (2013)

VIETNAM

Vietnam has established the "Vietnam Renewable Energy Development Strategy 2016–2030 with outlook until 2050", which set the target of 7% of total generation from renewable energy by 2020, 10% by 2030 and 20% by 2050.[49] This strategy is also part of the National Power Development Plan (2016), with both legislations aiming to increase renewable energy generation, diversify energy sources and limit greenhouse gas emissions. Targets set are to reduce greenhouse gas emissions by 5% by 2020, 25% by 2030 and 45% by 2050 respectively.[50]

Another strategy in line with these motivations are the Sustainable Development Strategy 2011–2030, the National Action Plan on Green Growth 2014–2020, and the National Strategy on Climate Change. Both of these strategies identify the need for renewable energy to provide a growing share in Vietnam's energy consumption mix. A national program on energy saving and efficiency has been introduced to save approximately 8% of the total energy consumption of the country in the period of 2016–2020 .[51]

Part of the Renewable Development Strategy is to introduce policy mechanisms to guide renewable energy deployment. For example, large power generation companies will have to reach 3% of renewable power capacity by 2020, 10% by 2030 and 20% by 2050. Renewable energy development will focus on proven technologies, including hydropower, wind power, solar power, biomass energy and biogas. Feed-in tariffs, net metering and preferential taxation policies are also key instruments for increasing renewable energy. One of these taxation policies is that renewable energy projects for power generation are able to claim accelerated depreciation for tax benefits.[52] Projects also receive corporate tax exemptions for the first four years, which reduces to 50% for the following nine years. There are also import tax exemptions and a standardised power purchase agreement template. Independent renewable generation projects can also access support from the Sustainable Energy Promotion Fund.

Some of the strategic goals of the renewable energy strategy are to[53]: (1) prioritize the development of renewable energy for the production of power by increasing the utilization rate to 7% in 2020 to over 10% in 2030; (2) reduce the dependence on imported coal and oil products; (3) increase the proportion of households with solar water heating devices to 12% in 2020, 26% in 2030 and 50% in 2050; (4) scale up the

[49] IEA (2017)
[50] Ibid.
[51] Phuc (2016)
[52] IEA (2017)
[53] Thuc (2015)

application of biogas technologies – from 4 million cubic meters (2015) to 8 million cubic meters in 2020, 60 million cubic meters in 2030 and 100 million cubic meters in 2050; (5) increase the percentage of households using advanced/high performing stoves (30% in 2020, 60% in 2025, and 100% in 2030); (6) increase the production of biofuels (5% by 2020, 13% by 2030, and 25% by 2050); (7) increase the proportion of domestically manufactured equipment in the renewable energy field (30% in 2020, 60% in 2030).

4. THE ROLE OF THE PRIVATE SECTOR

Transition toward sustainable energy is not possible without the involvement of all state and non-state parties. Currently, the world is spending US$9 billion to improve energy access, US$258 billion to double the share of renewable energy in the global energy mix and US$130 billion to double the rate of improvement in energy efficiency.[54] Although global investment has increased steadily over the past decade, investment from both the public and private sectors will need to triple to more than US$1 trillion per year to meet SE4All's ambitious goal of sustainable energy for all by 2030.[55]

While public funding will remain important as a catalyst, a large amount of new investment in renewables will need to be mobilized from the private sector to meet the investment target. The good news is that renewables have become increasingly competitive, so it is achievable to close the investment gap if the world pursues strategies that focus on risk mitigation instruments and structured finance tools to develop a strong pipeline of projects, and to unlock project financing and refinancing opportunities.

Experience from other countries has clearly demonstrated that investing in clean energy will lead to emission reduction and contribute to the social economic development of the country. Fortunately, Cambodia has huge untapped clean energy potential which if well managed can help the country to achieve energy security, improve the electrification rate and contribute to country's emission reduction target.

Transitioning to low carbon energy will be expensive at first but the long term benefits will outweigh the costs. It is estimated that Cambodia will need to invest

[54] SE4ALL (2015)
[55] Ibid.

between US$ 42-48 billion by 2050 to achieve its sustainable energy scenarios.[56] Public financing alone will not be enough to meet these investment needs. The private sector plays a crucial role to fill in the financial gap. Private companies around the world are increasing their investments in clean energy and are committed to investing at scale but they will move into those markets with strong enabling environments for clean energy investment. Thus, governments must take specific actions to accelerate private sector investment in this sector.

BOX 3: GLOBAL INVESTMENT IN RENEWABLE ENERGY

Global investment in renewable energy has grown strongly over the past decade from less than US$ 50 billion in 2004 to US$ 241.6 billion in 2016.[57] Developing and emerging economies overtook developed countries in renewable energy investment for the first time in 2015, but developed countries retook the lead in 2016. Investment in developing and emerging countries dropped by 30% to US$ 116.6 billion, while that in developed countries fell 14% to US$ 125 billion (see figure 5).[58] China accounted for 32% of all financings of renewable energy, followed by Europe (25%), the United States (19%) and Asia-Oceania (excluding China and India; 11%), and the Americas (excluding Brazil and the United States), Brazil, and the Middle East and Africa accounted for 3% each.[59]

For five years in a row, investment in new renewable power capacity (including all hydropower) was roughly double that of fossil fuel generating capacity (Figure 6). Investment in renewables continued to focus on solar power and wind power, although investment in both sectors suffered declines relative to 2015. Solar investment was down 34% to US$ 113.7 billion and wind down 9% to US$ 112.5 billion. Geothermal saw a 17% increase to US$ 2.7 billion, while biomass and waste marked time at $6.8 billion and small hydro at US$ 3.5 billion. Biofuels fell 37% to US$ 2.2 billion.[60]

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[56] WWF (2016)
[57] Bloomberg New Energy Finance 2016
[58] Global Trends in Renewable Energy Investment 2017
[59] Ibid.
[60] Global Trends in Renewable Energy Investment 2017

Figure 6. Global New Investment in Renewable Power and Fuel (2006-2016)

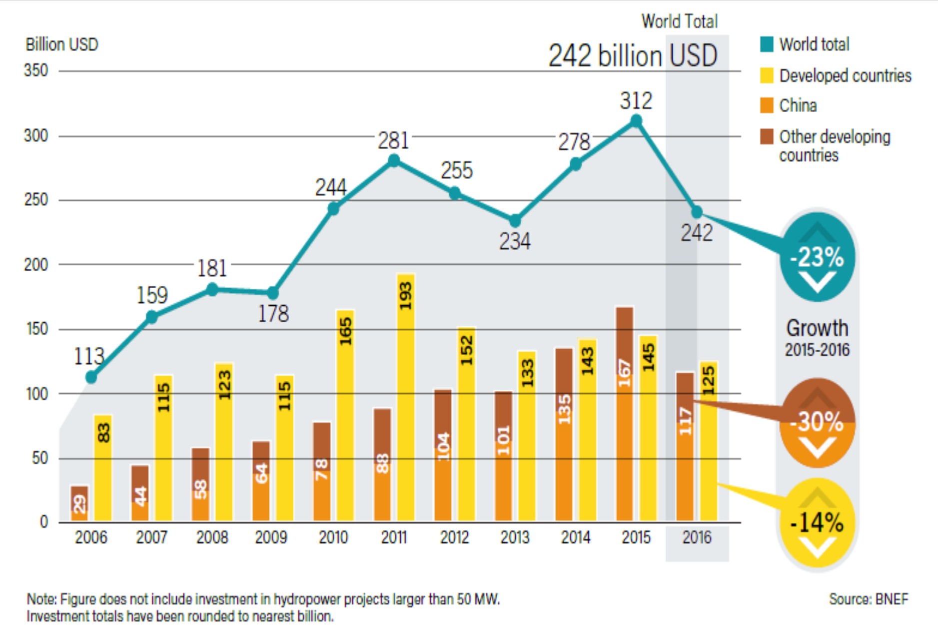
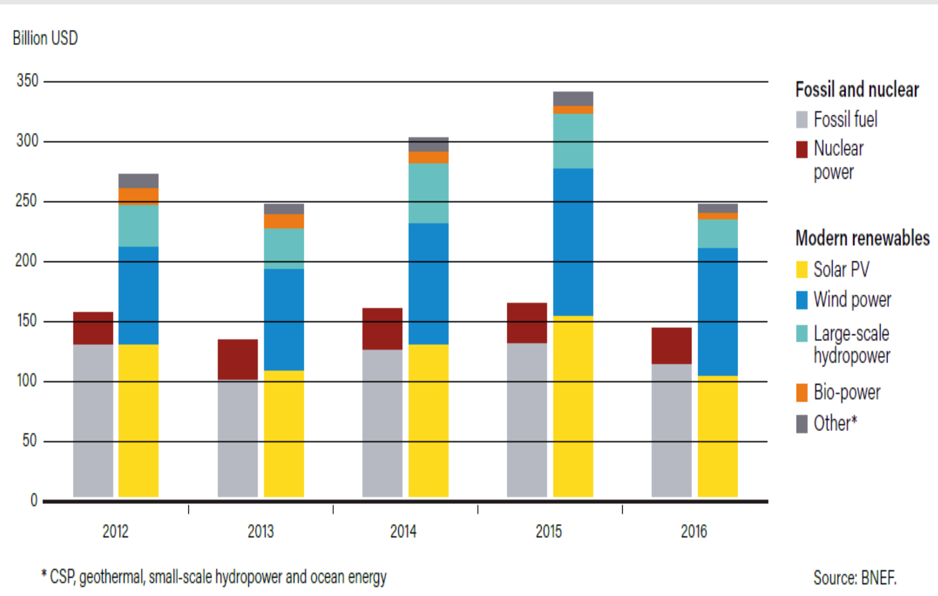


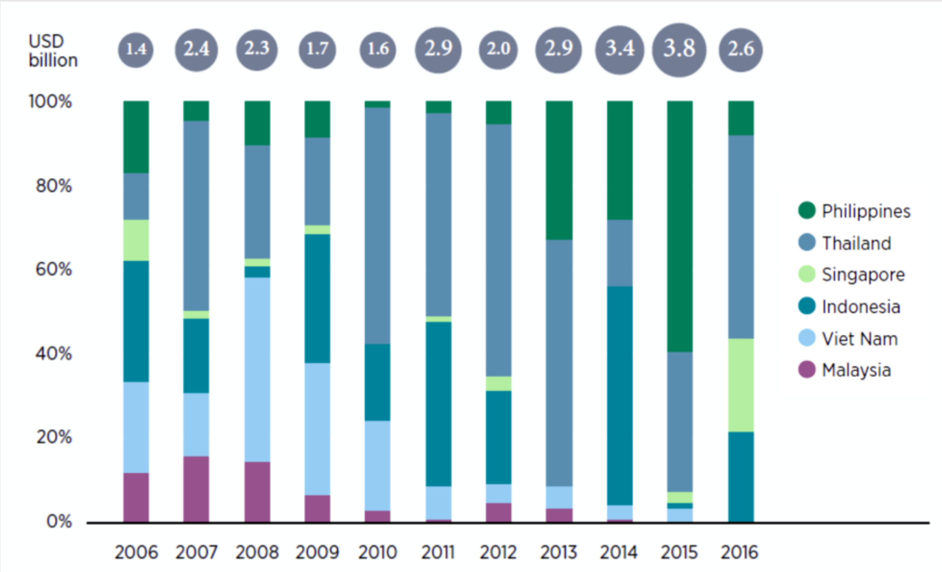
Figure 7: Global Investment in Power Capacity by type, 2012-2016



BOX 4: INVESTMENT IN RENEWABLE ENERGY IN SOUTHEAST ASIA

In Southeast Asia, nearly US$ 27 billion was cumulatively invested between 2006 and 2016[61]. Thailand attracted the bulk of cumulative financing, with over US$ 10 billion invested, or close to 40% of the total[62]. Indonesia and the Philippines followed, each accounting for about 20% of the total cumulative investment.[63] In 2016, renewable energy investment in the power sector (excluding large hydropower) was over USD 2.6 billion.[64] Thailand led the pack, attracting almost US$ 1.3 billion. Indonesia and Singapore followed with US$ 577 million and US$ 575 million, respectively.[65]

Figure 8. Investment in renewable energy in Southeast Asia, 2006–2016 (US$ billion)



The financing needs of the low carbon transition are substantial. IRENA and ACE (2016) found that US$ 290 billion of total investment in renewable energy capacity will be needed in the region to reach the target of securing 23% of primary energy from renewable sources by 2025.[66] This means that renewable energy investment would need to be significantly scaled up to an estimated annual US$ 27 billion. Around US$ 6 billion was invested cumulatively by development banks in renewable energy in Southeast Asia

[61] IRENA (2018)
[62] Ibid.
[63] Ibid.
[64] Ibid.
[65] Ibid.
[66] Ibid.

between 2009 and 2016.[67] The World Bank, Asian Development Bank (ADB) and Japan Bank for International Cooperation (JBIC) were the largest investors, with over US$ 1 billion invested by each.[68]

According to Electricity Authority of Cambodia, investment in the country's energy sector in 2016, by the government and private sector, amounted to US$3.18 billion.[69] Despite the falling cost of clean energy technology globally, investment in renewables (excluding large scale hydropower) has so far remained limited in Cambodia. There are a number of key constraints holding back investment in clean energy in Cambodia.

At the macroeconomic level, Cambodia has experienced stable economic growth in the last 10 years. To improve the investment climate, various incentives are available to foreign investors including 100% foreign ownership of companies, corporate tax holidays of up to eight years, a 20% corporate tax rate after the incentive period ends, duty-free import of capital goods, and no restrictions on capital repatriation. Despite these incentives, investors are still worried about the pervasive corruption, a limited supply of skilled labor, inadequate infrastructure and a lack of transparency in government approval processes. Cambodia ranks 131 out of 190 economies in the World Bank's Ease of Doing Business 2017 index, the third lowest rank in Southeast Asia (Table 4).

Table 4: Ease of Doing Business in ASEAN 2013-2017

Country	2017 Rank	2016 Rank	2015 Rank	2014 Rank
Singapore	2	1	1	1
Malaysia	23	18	18	6
Thailand	46	49	26	18
Vietnam	82	90	78	99
Indonesia	91	109	114	120
Philippines	99	103	95	108
Cambodia	**131**	**127**	**135**	**137**
Lao PDR	139	134	148	159
Myanmar	170	167	177	182

[67] Ibid.
[68] Ibid.
[69] KhmerTimes (2017)

At the policy level, Cambodia lacks a clear renewable energy generation target and a suite of policies to support their uptake. The Cambodian government has acknowledged the importance of renewable energy in national development and poverty reduction plans but has yet to put in place the supportive policies needed to create the level playing field. Without these policies and incentives, even with a conducive sector reform in place, investors will continue to place emphasis on conventional energy options.

According to the new regulations issued by Electricity Authority of Cambodia in January 2018, only big consumers (medium voltage consumers) and bulk consumers (high voltage consumers) are allowed to install solar PV system and synchronize with the national grid. They must also comply with several conditions, one of which is that the maximum capacity of the solar PV (in kw) shall not be more than 50% of the contract demand.[70]There has also been a lack of clarity in relation to utility scale solar generation where the rules for applying for tenders for additional supply under the power development plan are not widely understood. There is also a lack of fair value paid for excess generation sent to the grid such as net metering and fit in tariff.

Clean energy investment is also deterred by the lack of contract standardization. The power purchase agreements (PPAs) are negotiated and awarded on a case-by-case basis and the process is not fully transparent. The processes do not meet international standards and financiers are not satisfied with the perceived risk/return ratio of the projects. Also, the rules and procedures for obtaining, keeping and transferring land-use rights are complicated and uncertain, making access to land for solar energy projects difficult.

Another barrier to attracting private investment in clean energy is the poor state of physical infrastructure. The current grid was built decades ago and was designed primarily for transmitting electricity from large, centralized power plants, most of which use dirty sources like coal and diesel. The low level of resource efficiency of the existing grid has also led to high costs per output unit. Now new technologies are making this approach to electricity transmission—and its supporting infrastructure—increasingly outdated. A modernized grid should be flexible enough to manage the variability of wind and solar resources,

[70] EAC (2018)

and to connect sources of high renewable generation potential to locations of high energy demand.

Access to finance for renewable energy projects in Cambodia is limited as there is a lack of equity funding, high cost of debt finance and a limited length of loan tenure. A lack of experience with renewable energy technologies also means that potential financiers are unable to assess the risks involved. In addition, Cambodia does not have investment and financial vehicles to mitigate risks (e.g. currency inconvertibility risk, power off-taker risk). While various risk mitigation instruments are available and often provided by international and development finance institutions (IFIs and DFIs), many local developers do not have the necessary knowledge and skills to deal with the complex requirements of the IFIs and DFIs in the absence of intermediaries.

Skills availability plays an important role in facilitating the development of clean energy. All the private companies interviewed generally agree that there is a widespread skill shortage of engineers and technicians in all parts of the renewable energy industry in the country. There are also skills shortages in non-technical occupations such as sales specialists, inspectors, auditors, lawyers. In addition, those working in investment finance lack specific skills important for the development of renewable energy. The lack of skills and capacity in entrepreneurship also serve as a barrier to the development of local start-ups and limit access to supporting services from foreign companies needing local partners.

Until recently, Cambodia does not have enough clean energy project pipeline. So far there is only one utility scale solar project in the entire country. In 2016, Singapore-based renewables firm Sunseap Group won the bid to build the first ever 10 MW solar farm in Bavet city, 130km south-east from the country's capital, Phnom Penh. The company invested US$ 12.5 million and had a 20-year PPA with EDC offering to sell the electricity at 9.1 US cent per kWh.

There are a few smaller scale investments driven by local private firms. For example, In June 2016 the Phnom Penh Special Economic Zone (PPSEZ) decided to go green with the installation of two new solar power systems comprising of 400 panels. The system generates about 15,000 kWh per month to meet the special economic zone’s electricity needs of around 10 MW daily load.

In June 2017, Silvertown Metropolitan building, a high-end, 110-unit serviced apartment building in Phnom Penh installed a 68 kilowatt rooftop solar panel system to cut its electricity cost. The system which costs US$ 66,000 supplies about 20% to 25% of the building's electricity needs.

Star8, an Australian-based technology company that sells a wide range of solar products such as solar tiles, solar street lights, an energy efficient resin roof system, and electric vehicles became the capital's first energy independent manufacturing plant when in 2015 the company decided to cover its building with 1,350 solar glass panels. On a sunny day, the building can produce up to 135 kilowatts of electricity in an hour, an ample amount for the assemblage of novel products for commercial and private solar applications.

At the moment, there are around 30 companies providing solar products and implementing small scale projects such as solar lantern, home solar system, rooftop solar, solar water heating, and solar pump. Some of these companies are members of Solar Energy Association Cambodia which was set up in 2015 to represent the solar companies in the country and advocate for solar energy development in Cambodia.

BOX 5: ATTRACTING CLEAN ENERGY INVESTMENT IN INDIA AND THAILAND

INDIA

India was ranked the second-best country in the world in "attractiveness" of renewable energy investment in 2017 by the Ernst Young Renewable Energy Country Attractiveness Index[71], behind China but ahead of the USA. This is based on high scores achieved in the key pillars detailed above.

Investment in renewable energy in India is fueled by strong and consistent economic growth which is forecasted to remain the fastest growing economy within the G20 countries and the world. Trade openness is increasingly driven by a competitive service sector and private investment continues to increase as measures to improve the ease of doing business are implemented.

In addition to the robust economic outcomes, the energy demand is forecast to grow by 4.2% per annum, faster than all other major economies in the world. In India the demand

[71] Ernst Young (2017)

for energy currently exceeds the supply by 3.6% making the energy imperative of this rapidly growing economy particularly attractive to energy generation investment.[72]

Enabling political environment, regulatory and policy factors are key drivers for private investment. India is widely known to have one of the most supportive governments in the world for renewable energy investment. The Indian prime minister, Narendra Modi, had spearheaded the push for solar by the Indian government with impressive results. Enabling policies include;

- Committed and measurable increases in renewable energy targets
- Renewable generation obligation for new thermal or fossil fuel generators
- Renewable energy targets for government entities
- Green energy corridors (transmission networks for RE projects) to facilitate interstate transmission and reduce pressure of supply on current grid infrastructure
- Renewable Energy forecast regulations to ensure performance contracts

India's ability to deliver projects in renewable energy is evident with a strong track record of completed projects and healthy project pipeline. The availability of finance is a key enabler to renewable energy projects with around US$ 34 billion already invested in India to mobilize private climate finance, predominantly in renewable energy, energy efficiency and transport by international development funds. Since then private equity being invested in the Cleantech sector between 2005 and 2014 totaled US$ 3.6 billion.[73] Availability of finance is not considered a barrier in India with local banks supported by international development banks such as ADB and International Finance Corporation (IFC) as well as development partners, such as World Resources Institute, which are very active in supporting to the sector with public/private partnerships and dialogue.

Key to India's attractiveness of investment is the strength of its technical and technological capability. India's ability to deliver on RE projects is evidenced by the rising annual capacity of RE generation which has grown in the last three years at a compounded annual growth rate of 80% to an estimated 16 GW as of September 2017.[74] India is also abundant in natural resources for RE and could easily exceed current ambitious targets such as wind power capacity by nearly eight times its current level at the end of 2015 to 185 GW by 2030. Also, due to an excellent solar irradiance profile, India's PV capacity has the potential for total installed capacity of almost 200 GW by 2030, with additional off-grid capacity.[75]

Overall India ranks highly for private investment in renewable energy based on strong outcomes in all 5 pillars of the renewable energy country attractiveness.

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[72] OECD (2017)
[73] GIZ (2015)
[74] Livemint Crossroads (2017)
[75] IRENA (2017)

THAILAND

Thailand occupies the 31st position in the RECAI 2017, up 6 places compared to 2016. Thailand has vast natural renewable energy resources, strong economy and political stability making it an attractive country for investment in renewable energy.

Thailand's macroeconomics reflects a development success story, moving from a low-income country rating to an upper-middle income country in one generation. Although economic growth has slowed in recent years, Thailand has performed well on The World Bank Ease of Doing Business Rankings achieving a top 50 rating in the last 3 years, ranking 46th out of 190 countries on 2017.[76] In addition, to address the economic contraction, the government is developing a stimulus package that will address the current constraints to growth and create a more inclusive growth model.

Driving Thailand's RECAI ranking are key elements associated with the energy imperative. This country has, in the past, relied heavily on natural gas (64%) and coal (20%) for domestic generation however due to depletion of their natural gas resource, there is a strong impetus to expand and diversify their energy mix to improve energy security and limit reliance on imports.

The government has strongly demonstrated its support for renewables by offering Feed-in-Tariffs (FiTs) with long term contracts in 2014 and successfully encouraged the uptake of solar roof systems in the kingdom. The prime minister, Prayut Chan-o-cha, exhibited his support for renewables by increasing the initial RE target from just 25% to 40% (by 2036) earlier this year. [77] Thailand's Integrated Energy Blueprint (2015), the comprehensive, long term energy plan for Thailand is based on the principles of economy, ecology and security reflecting a commitment to ecology in their energy master plan.

Currently, Thailand leads South East Asia in volume of energy generated from wind and solar. This is highlighted by the substantial number of RE projects completed to date and the level of the county's comfort with solar and wind technology with 99% of the solar projects being utility scale (>1mW) ground mounted systems.

The technology potential of Thailand is strongly supported by abundant natural resources for the generation of RE such as wind, solar and biomass. While the country

[76] World Bank (2017)
[77] APEC (2016)

produces significant volumes of biomass fuel due to the size of the agriculture industry, domestic utilization is low due to the lack of generation facilities. The abundance of RE biomass fuel and the availability of technologies to capitalize on this, presents an excellent opportunity for Thailand to further diversify its energy mix towards higher utilization of biomass.

5. CONCLUSION AND RECOMMENDATIONS

Cambodia's growing need for energy, together with its considerable and untapped resources in clean energy sources point to where the country should be headed in developing its energy sector and infrastructure. Clean energy has the potential to provide Cambodia with improved energy security and help the government in realizing its national and international energy goals. Despite its abundance and economic competitiveness, clean energy still contributes minimally to Cambodia's energy mix.

High energy demand and declining clean energy technology cost have created strong opportunities for private investors, lenders and development finance institutions. Despite the growth opportunities, investors, institutions and companies looking to invest in clean energy projects are faced with legal, financial and logistical challenges.

To profit from the long-term benefits of clean energy, the government needs to effectively engage the private sector. Experiences in other developing countries suggest that leveraging private resources is key to bridge the financial gap to invest in clean energy and to unlock the potentials of clean energy.

To secure private investment, public commitment needs to be demonstrated at the local level. A supportive local regulatory environment can be powerful levers of private investment when carefully combined with energy sector reform, but it must be concrete and go beyond high-level statements of political correctness. Measure must be taken to catalyze private investments and address macroeconomic, regulatory and financing related barriers.

This requires targeted efforts focusing on improving project readiness, facilitating access to finance at the local level and introducing risk mitigation measures. Cambodia can consider the following actions which have led to success in attracting private finance for the deployment of clean energy technologies in numerous countries worldwide:

Setting clear national targets for renewable energy generation is one of the most powerful public interventions in unlocking private investment and finance for renewable energy in developing countries[78]. Clear legally binding national targets send a strong signal of political commitment to market participants. These targets can be designed in relative terms (e.g. share of renewable energy in the energy mix) or in absolute terms (e.g. total capacity of renewable energy to be installed). To be credible, renewable energy targets need to be ambitious but also realistic, fully budgeted, and time-bound. Targets should be accompanied with quantified intermediate milestones that will provide investors with a sense of how fast the renewable energy markets are expected to develop. The achievement of targets also needs to be monitored and reassessed on a regular basis to ensure that clean energy infrastructure growth is sustained.

Creating a level playing field between public and private investors in clean energy market. Clean energy investments often take place in a situation of imperfect competition where a state-owned enterprise (SOE) is the incumbent. Ministry of Mines and Energy and Electricity Authority of Cambodia can design and implement clean energy policy and technology solutions, including legislation for independent power provision. In the long run, the governments may consider embarking on more extensive structural separation of the power sector, whereby multiple actors are encouraged to engage not only in power generation, but also in transmission and distribution. Establishing a more level playing field for private participation in electricity markets will also require that IPPs be guaranteed equal treatment; and that competition authorities and sector regulators possess the appropriate resources and independence to effectively enforce regulations.

A 'one-stop-shop' for renewable energy facilities may be set up to streamline administrative and permitting procedures. This can also help ensure that licensing procedures are transparently and consistently applied. Competitive procurement such as tendering is useful to ensure fair competition in an open

[78] Financing renewable energy in developing countries, UNEP (2012)

electricity market. In addition to being clear and transparent, tenders should consider several dimensions related to the quality of the bid, in addition to price. Since clean energy projects involve complex technologies and contract relationships, the experience of the given applicant with the clean technologies that the government aims to deploy is crucial. Bid design should also minimize opportunities for bid rigging. Information about the procurement process should be made publicly available.

Expanding distributed generation, supported by net metering/billing and financial and fiscal incentives. While the government has been focusing on grid extension and increasing electricity generation from large hydro and coal power plants, more effort must be made to promote decentralized solutions which can complement grid-based solutions to increase access to power to previously underserved areas and provide benefits and potential cost reductions to both the end-consumer and the overall system. Supporting regulatory and pricing policies include the right to generate and sell electricity, tariff regulation and grid-arrival policies. They must be supported with measures to facilitate access to finance, develop local capacity, and standardize equipment.

Developing a pipeline of investment-mature projects requires both financial and technical support from the public and private sectors. Public finance will play an important role in improving project readiness and attractiveness. Public finance institutions can provide bridge finance for early stage projects. There is a need for dedicated national financing vehicles, such as green investment banks, to facilitate, structure and support renewable energy and energy efficiency projects.

Improving capacity of domestic banks is key to improve access to capital at the local-level. On-lending structures that channel concessional finance down to local financial institutions can increase the availability of financing and reduce local banks' risk. Public finance institutions can provide risk mitigation instruments, such as guarantees and subordinated debt instruments, to local and international banks.

Capital markets can be further mobilized to finance renewable energy projects using instruments such as green bonds. While green bonds are in early stages in the region, governments, financial regulators and development finance institutions have an important role to play in their development. The Green Bond Grant scheme introduced by the Monetary Authority of Singapore to incentivize the issuance of green bonds and kick-start market development is an example. Financial regulators also play a catalytic role in regulating green bond issuance to ensure probity and transparency, as well as compliance with industry-wide definitions and procedures. Effective green bonds design should also be attractive to institutional investors, such as pension funds, and therefore help unlock a wider pool of capital for the sector.

Bridging the skill gaps in the clean energy sector through adequate financing and developing human capital in the field. A wide array of skills need to build up among the workforce, in the government ministries, financing institutions and regulatory agencies to sustain clean energy growth and maximize the local employment benefits. Incorporating renewable energy into technical and tertiary curricula, developing training institutes and centers of excellence, meeting international quality standards for renewable energy education and promoting high-class facilities at universities, providing individuals with the appropriate incentives to acquire these skills are some of the initiatives to build local expertise and prepare the workforce for the clean energy field.

Setting up a national energy efficiency promotion program to address the energy efficiency challenges in a holistic and comprehensive manner. The program should serve as a strategic one-stop platform for providing energy efficiency technical, financial and capacity support. Program components may include policy research (for example, to develop EE standards), capacity building (both on the demand and supply side through developing local knowledge base and expertise in energy management and energy efficient processes), and financial mechanism (for example, by offering incentives for EE improvements and the use of EE technologies and equipment).

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Annex 1: Ranking of Renewable Energy Options in Cambodia

Criteria	Biomass	Solar farm	Solar rooftop	Solar mini grid	Solar Home System
Resource Potential	Medium	High	High	High	High
Unexploited market potential	High	High	High	High	High
Availability of sites	High	Medium	High	Low	High
Readiness for implementation	Low	Medium	High	Medium	High
Technology adaptability	Low	Medium	High	Medium	High
Financial viability	High	Medium	Medium	High	High
Consumer acceptability / affordability	High	High	High	High	High

Source: Adapted from SREP Investment Plan for Cambodia

Annex 2: Summary action plan to improve energy efficiency in buildings

Objectives	Activities	Target reduction	Priority (S, L, M)
Energy efficiency of buildings is improved	An energy efficiency building code for new buildings is established	3.00%	S,M
	Existing public buildings are held to a high energy efficiency performance standard	3.00%	S,M,L
	Establishment of an energy database at MME		M,L
	Establish an energy manager program	1.00%	S,M,L
Education and awareness of energy efficiency in buildings has increased	Education of architecture students in energy efficiency (knowledge)	1.00%	M,L
	Education of architects and planners in energy efficiency (basics)		M,L
	An Energy Efficiency Information Resource Center is established		M,L
	Study tours to selected examples of good practice of energy efficient buildings		M,L
	Energy managers are trained and certified	1.00%	S, M,L
Energy efficiency of end-user products has increased	A compulsory national energy efficiency labelling system for household appliances is introduced	1.00%	M,L
	Promotion of improved and efficient cookstoves for rural and urban households	1.00%	S,M,L
	Electricity consumption of household appliances is measured/tested by certified institutions/ laboratories		M,L
	Energy efficiency standards, laws and regulations concerning energy efficiency of end-user appliances are being elaborated and promulgated by government	10.00%	M,L
End user of residential appliances are aware of the concept of energy efficiency and behave accordingly	Education programs in energy efficient behaviour are performed in schools	1.00%	S,M,L
	Publicity campaigns on energy efficient behaviour are published in the public media	3.00%	S,M,L

Source: Draft National Energy Efficiency Policy 2018

Annex 3: Summary action plan to improve energy efficiency in industry

Objectives	Activities	Target reduction	Priority (S, L, M)
The Energy Efficiency is improved	Improvement of energy data collection		S,M, L
	Establishment of an information system		S,M
	Promotion of best practices in energy consumption and generation	2.00%	S, M, L
	Implementation of resource and energy efficiency audits/assessments		S, M, L
	Implementation of pilot generation projects (e.g.: rural electrification, ice industry)		S, M
	Implementation of voluntary as well as of compulsory standards on energy efficiency for large energy consumers	5.00%	S, M, L
	Implementation of energy efficiency/conservation laws/regulations on industrial energy use, and on distribution standards	10.00%	M, L
Capacity building is strengthened	Support the development of energy service companies (ESCO's)		S,M, L
	Technical training for engineers and technicians in the field of energy efficiency, performing energy audits, establishing EMS and implementing energy saving measures in the industry	1.00%	S, M, L
	Development of a compendium of energy efficiency and waste management for the manufacturing and handicraft sector	1.00%	S, M, L
	Increase consumer awareness of rural electrification options and energy efficiency	1.00%	S, M, L
Attention about EE is raised	Organization of awareness raising campaigns about energy efficiency in industry	1.00%	S, M, L
	Provision of financial incentives to companies interested in the implementation of energy efficiency strategies and measures, and to manufacture energy efficient equipment	2.00%	S, M, L
	Development of a green industry award program	2.00%	S, M, L

Source: Draft National Energy Efficiency Policy 2018

Annex 4: Summary action plan to improve energy efficiency in transport

Objectives	Activities	Target reduction	Priority (S, L, M)
Vehicle and Road maintenance are enhanced	Repair and rehabilitate existing road infrastructure and ensure effective operation and maintenance system taking into account CC	2.25%	S,M,L
	Enhance the maintenance and inspection of vehicles	1.50%	S,M,L
	Promote the purchase of fuel efficient and zero emission vehicles (hybrid, electric, Fuel Cell)	1.50%	M, L
Road and traffic management and public transport use is improved	Establish green belts along major road for CC mitigation	1.50%	S,M,L
	Promote integrated public transport systems in main cities	1.50%	S,M,L
Public awareness on EE in transportation has increased	Capacity building and institutional strengthening for the integration of climate change concepts into road and bridge design and development	1.50%	S,M,L
	Raise public awareness about energy efficiency for vehicles and the impact of climate change on the transport sector	1.50%	S,M,L
Fuel quality control and fuel switching has been enhanced and promoted	Assure fuel quality standard by regular gas station auditing/fuel testing	1.50%	S,M,L
	Shift long distance freight movement from trucks to train	1.50%	S,M,L
	Promote the use of biodiesel and bioethanol	0.75%	S,M,L

Source: Draft National Energy Efficiency Policy 2018

Enrich Institute is an independent think-tank dedicated to promoting the implementation of the Sustainable Development Goals (SDGs) in Cambodia. We promote inclusive stakeholders' engagement, provide capacity development program, conduct multidisciplinary research to generate new data, explore novel solutions and support the government and development stakeholders to effectively and efficiently implement activities to achieve SDGs.

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