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Acronyms

ADB	–	Asian Development Bank
CDP	–	Capacity Development Program
CO_2	–	Carbon Dioxide
GDP	–	Gross Domestic Product
GHG	–	Greenhouse Gas
GMS	–	Greater Mekong Subregion
EAC	–	Electricity Authority of Cambodia
EDC	–	Electricité du Cambodge
INDC	–	Intended Nationally Determined Contribution
IPP	–	Independent Power Producers
MME	–	Ministry of Mines and Energy
M&E	–	Monitoring and Evaluation
PEC	–	Provincial electricity companies
REE	–	Rural Electricity Enterprises
RE	–	Renewable energy
REF	–	Rural Electrification Fund
RGC	–	Royal Government of Cambodia
SEAC	–	Solar Energy Association of Cambodia
SEZs	–	Special Economic Zones
SHS	–	Solar Home Systems
SREP	–	Scaling-up Renewable Energy Program

WEIGHTS AND MEASURES

kVA (kilovolt-ampere)	– 1,000 volt-amperes
kWh (kilowatt-hour)	– 1,000 watts-hour
W (watt)	– unit of active power
kW (kilowatt)	– 1,000 watts
MW (megawatt)	– 1,000 kilowatts
GW (gigawatt)	– 1,000,000 kilowatts

NOTE

In this report, “$” refers to US dollars.

$ 1 = KHR 4,000

Proposal Summary

1. The proposed Scaling-up Renewable Energy for Low Income Countries Program Investment Plan (SREP IP) will assist the Royal Government of Cambodia (RGC) in undertaking renewable energy sector development for energy security, sustainable economic growth, and poverty reduction. The proposed investment plan is designed to help remove principal barriers impeding investments in renewable energy resources development. For the sustainable renewable energy growth in Cambodia, the activities under the proposed investment plan will also include addressing the knowledge, institutional and capacity building needs of the government institutions, mitigation of risk concerns of private sector through appropriate policy instruments; strengthen government capabilities in renewable energy sector planning, project formulation and design, addressing environmental and social issues, implementation arrangements and organizational structure for successful projects completion; supervision and monitoring; and dissemination of information. The indicative financing plan is presented in Table PS-1, and the results framework is presented in Table PS-2. The total estimated funding assumes that ADB contributions will cover 25% of total project costs, and that SREP cofinancing will facilitate additional private sector investment (financing plans for individual projects will be determined during project preparation; see additional discussion in main text). The conceptual approach of the IP is presented in Figure PS-1.

Table PS-1: Indicative Financing Plan ($ million)

	SREP [a]	ADB	Private Sector	Govern-ment [b]	Total
Component 1: Solar Energy Development Program					
Subcomponent 1: Solar Energy Development					
Solar Home Systems	4.0	4.0	4.0	5.0	17.0
Solar Mini-grids	2.0	2.0	4.0	5.0	13.0
Project Preparation	*0.65*	-	-	-	*0.65*
Subcomponent 2: Accelerating Solar Power through Private Sector					
Rooftop Solar Systems	6.0	8.0	32.0	-	46.0
Utility-scale Solar Farm	8.0	12.0	40.0	-	60.0
Project Preparation	*0.65*	-	-	-	*0.65*
Subtotal	**21.3**	**26.0**	**80.0**	**10.0**	137.3
Component 2: Biomass Power Project	5.0	5.0	15.0	-	25.0
Project Preparation	*0.4*	-	-	-	*0.4*
Subtotal	**5.4**	**5.0**	**15.0**		**25.4**
Component 3: Policy Support and Public Awareness	3.0	-	-	-	3.0
TOTAL	**29.7**	**31.0**	**95.0**	**10.0**	**165.7**

Note: [a] Excludes Investment Plan Preparation Grant (IPPG) of US$ 0.3 million
[b] Government contribution to Rural Electrification Fund

2. The development objective of the investment plan is to improve supply and utilization of renewable energy sources to all categories of consumers including the rural poor in remote areas. The development objectives of the investment plan will be achieved through: (i) provision of adequate amount and appropriate financing modality to support the development

of commercially viable renewable energy resources for power generation; (ii) capacity building to strengthen the government's capability to implement the project; enforce related laws, regulations, and standards; and (iii) conduct, with the participation of the private sector bodies/organizations and civil society, a nationwide renewable energy awareness campaign through print and electronic, radio, television, other medium with focus on rural communities to create consumer awareness. It will also include a program for launching a year of renewable energy in Cambodia with a multitude of activities across the nation.

Table PS-2: Results Framework for SREP in Cambodia

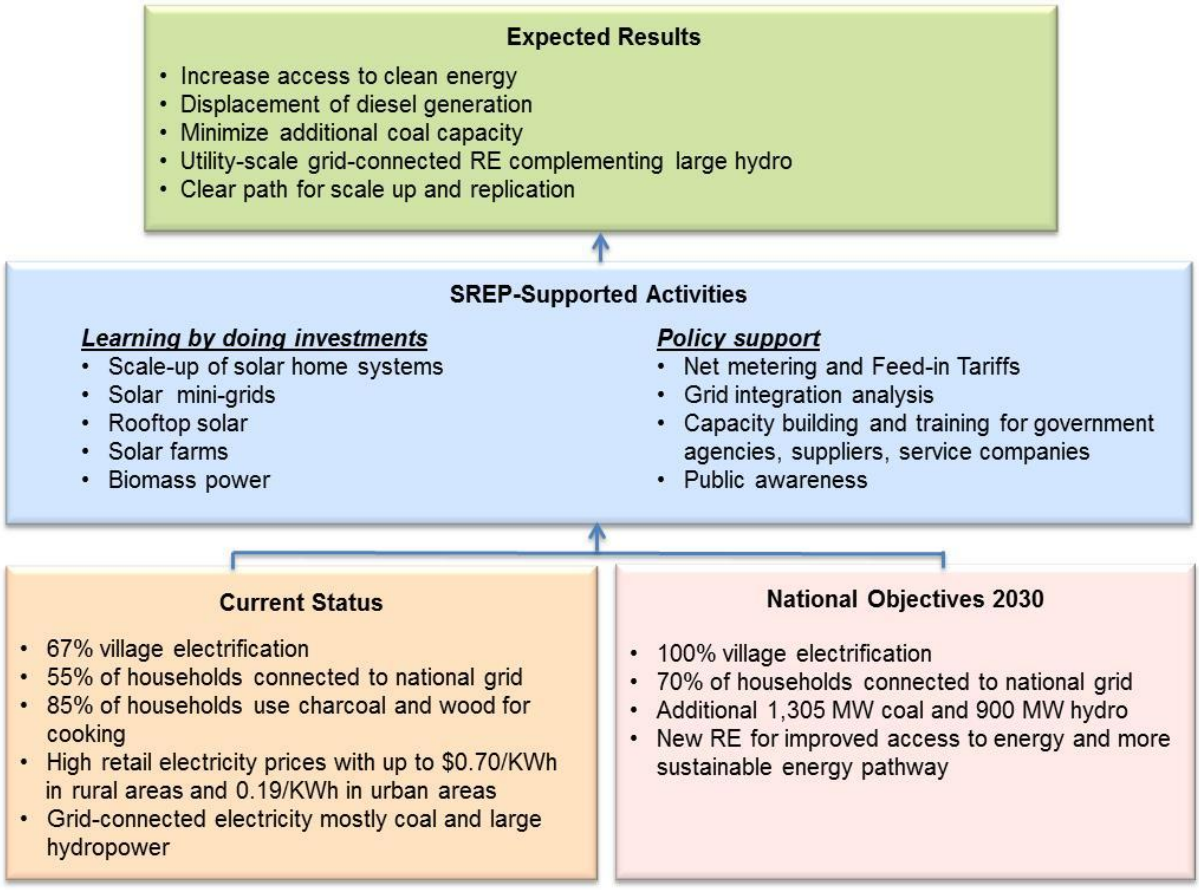
Results	Indicators	Baseline	Targets	Means of Verification
SREP Transformative Impacts				
Support low carbon development pathways	Percentage of total households with access to electricity[1]	55% in 2015	70% by 2030	MME
	RE capacity (MW) and annual electricity output (GWh/y)	Capacity: 60 MW in 2014 [a] Output: 158 GWh/y	Capacity: 150 MW by 2023; 200 MW by 2030 Output: 394 GWh/y by 2023; 526 GWh/y by 2030	MME
	Increased annual public and private investments ($) in targeted subsector(s)	$84 million	$210 million in 2023 and $280 million	MME
SREP Outcomes				
1. Increased supply of renewable energy	Annual electricity output from RE as a result of SREP interventions			SREP Projects, MME
	Installed capacity	0	78 MW	
	Design Output	0	184 GWh/y	
2.New and additional sources for renewable energy projects	Leverage factor ($ finance from other sources compared to SREP funding)	0	1:4	SREP Projects M&E, MME
3. Increased access to modern energy services	Number of women and men, businesses and community services benefiting from improved access to electricity and fuels as a result of SREP interventions	0	460,000 people or around 92,000 households Male: 223,100 Female: 236,900	SREP Projects M&E, MME
4. Greenhouse Gas emissions mitigated	CO_2 emissions reduction	0	97,000 tCO_2e/year	MME, MOE

CO_2 = carbon dioxide, GWh/y = gigawatt-hour per year, MME = Ministry of Mines and Energy, MW = megawatt, M&E = Monitoring and Evaluation, tCO_2e = tons of carbon dioxide equivalent.

Note: [a] Does not include large hydropower

Figure PS-1: SREP Investment Plan Conceptual Framework

[1] The Revised SREP results framework (2012) indicates that this indicator should be a "National measure of 'energy poverty' such as the Multi-dimensional Energy Poverty Index (MEPI), or some equivalent mutually agreed measure." Energy poverty is a multi-dimensional problem which includes problems associated with a lack of access to sufficient energy supply, a lack of access to clean energy, and a lack of access to affordable energy. For this purpose, energy access is used to measure poverty.



kWh=kilowatt-hour, MW=megawatt, RE=renewable energy.

I. Country Context

A. Geography and Demography

3. Cambodia is situated at the heart of the Greater Mekong Subregion (GMS) with a land area of 181,035 square kilometers (km^2). It is bordered by Thailand and the gulf of Thailand in the West and South respectively, Viet Nam in the East, and Lao PDR in the North. It has a total population of about 15 million (3.16 million households), of which 51.5% are female and 48.5% are male. The country has a young population with more than half of the population under age 25 and almost one-third is under 15. Approximately 80% of the population lives in rural areas. The country is slowly urbanizing with its urban population rising to 21.4%, up from 19.5% in 2008. The capital city Phnom Penh, with 1.69 million residents, is larger than all other urban areas combined representing 11.5% of the total population and 53.7% of the urban population.

4. The country experienced conflicts and civil war over the last four decades which reduced economic growth to almost zero, and demolished most human capital and infrastructure assets. Since the 1990s, the RGC has undertaken an unprecedented rehabilitation, development and expansion program. However, because of the competing demand of other sectors of the economy on the limited national budget, investment allocation in the electric power sector has always been far less than the total investment needed for the sector development. Recognizing the problems, and constraints, the international community recognizes the current operations and the status of the country's electric power sector as highly commendable. However, RGC recognizes that much more has to be done for sustainable economic growth to improve quality life of its people

B. Economy

5. The economy has grown by an average of 7.8% per annum over the period 1994 to 2011. In 2014, the Gross Domestic Product (GDP) growth rate was 7.2%. Agriculture and forestry play an important role in the economy, accounting for a quarter of GDP, while manufacturing and tourism also contribute significantly to economic development. The robust growth in services and expanding export industries drove economic growth of 7.2% in 2014. Agriculture slowed but industry and services expanded, maintaining economic growth at just above 7% for the third consecutive year. Industry grew by an estimated 10.5% on strong demand for Cambodian garments and footwear in the European Union. Increased private consumption, fueled by higher household incomes, contributed much of the GDP growth from the demand side. The government's development policy for 2013 to 2018 targets average annual economic growth at 7% and a reduction in the poverty rate by at least 1% per year. The current government policy framework puts great emphasis on commercializing agriculture, building urban infrastructure, supporting the development of the private sector, expanding vocational training, and strengthening social protection for the people.

C. Poverty

6. The prevalence of poverty has dropped from nearly 100% in 1979 to 39% in 1993, and 30.1% in 2007. In 2011, the difference in income poverty rates between households headed by women and those headed by men appear very small. In terms of energy poverty, only about 55% of the household population has access to electricity; one of the lowest rates in Southeast Asia. While urban areas enjoy 100% electrification, about 50% of the rural population has access to electricity from alternative off-grid sources or grid-supplies. The limited access to modern energy such as electricity and liquefied petroleum gas means that over 85% of households use traditional biomass such as firewood and charcoal for cooking; households who have no access to electricity are dependent on the use of candles, kerosene and batteries for lighting[2].

D. Climate Change

7. Cambodia is classified as highly vulnerable to the impacts of climate change, due to a combination of increased climatic hazards (mainly floods and droughts), increases in population density, and low levels of human development. The intensity and frequency of floods and droughts has increased, and changes are occurring in heat and rainfall patterns. In Cambodia, the major source of greenhouse gas (GHG) emissions in the energy sector is fossil fuel combustion. All oil products are imported as there are no oil production and refining activities in the country. In 2012, energy-related GHG emissions consumption amounted to 25.85 million tons of carbon dioxide equivalent ($MtCO_2e$) and per capita emission of 1.74 tCO_2e. Both primary energy consumption and GHG emissions at least doubled over the past ten years. Cambodia is among the lowest emitting countries in the world. In terms of country ranking, Cambodia ranks 103 out of 184 countries on total GHG emission; and 143 out of 181 countries on per capita emission[3].

E. Energy Supply and Demand

8. Sustainable energy supply is a prerequisite for sustainable development. No country has developed and will develop without access to reliable and affordable energy. Energy directly impacts on people, communities and countries in terms of economic growth, health, security, food and education. Sustainable energy is thus a key enabler of sustainable development for all countries and all people.

9. The challenges in the energy sector of Cambodia are enormous, among which one of the most pressing is the foreign exchange outflow required for imported petroleum products. The government expenditures on imported energy, particularly petroleum products, have stymied investment in the development of the country's alternative energy resources. Reducing energy

[2] Source: Cambodia Sustainable Energy for All Rapid Assessment and Gap Analysis, 2013 http://www.se4all.org/sites/default/files/Cambodia_RAGA_EN_Released.pdf

[3] Source: CAIT Climate Data Explorer. 2015. Washington, DC: World Resources Institute. Available online at: http://cait.wri.org Based on 2012 total GHG emissions (excluding Land-Use Change and Forestry) country rankings.

imports will expand the fiscal space for undertaking energy sector development and other social sector programs that will help improve quality of life. To achieve its objectives, the government plans to optimize the fuel mix to reduce dependence on imported petroleum products. As Cambodia has an abundance of renewable energy resources that can be utilized for power generation, MME is updating plans[4] to support the development of renewable energy resources including biomass, hydro, solar, and wind.

10. According to the International Energy Agency (IEA), total primary energy supply and total final energy consumption in 2013 was dominated by biomass (see Table 1). About half of total final energy consumption was in the form of biomass for residential, reflecting the fact that most consumers still rely on traditional biomass for energy. Total per capita energy consumption in 2013 was about 0.35 ton of oil equivalent (TOE). The commercial, industry, and residential sectors account for 78% of total energy as shown in Figure 1. The energy balance has changed significantly since 2013, with more than 450 MW of new domestic coal and large hydropower capacity coming on line (see further discussion below). According to IEA data, domestic coal production in 2013 was 96,000 tons; the existing coal fired power plants are dependent on imported coal.

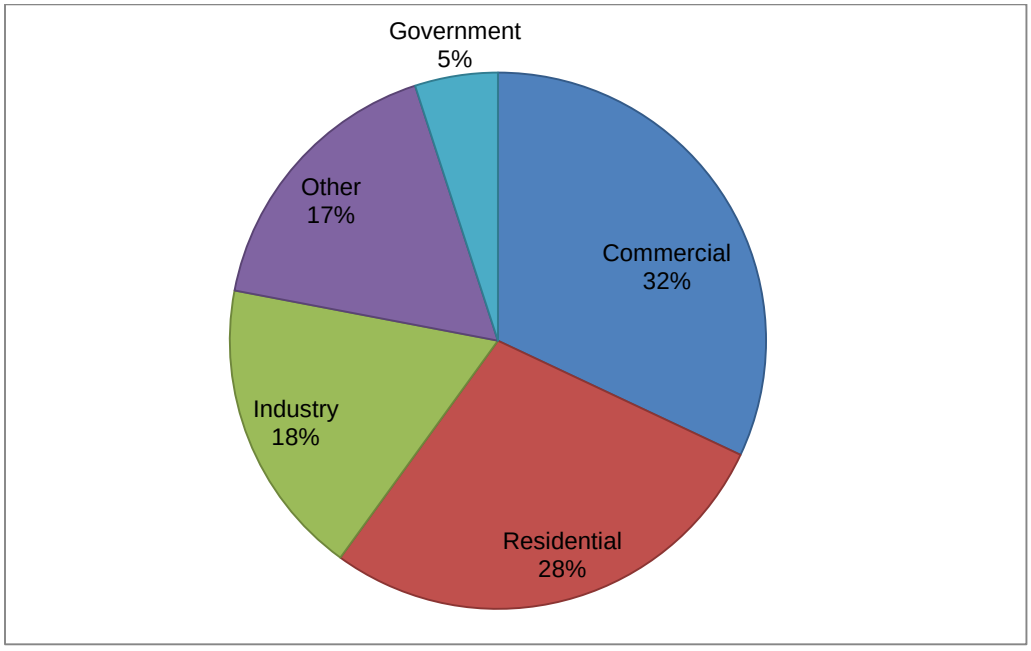
Table 1: Cambodia Energy Balance, 2013 (thousand tones oil equivalent, KTOE)

Categories	Coal[5]	Oil Products	Hydro	Biofuels & Wastes	Electricity	Total
Production			87	3,999		4,087
Imports	46	1,730			176	1,952
International Aviation Bunkers		-65				-65
Total Primary Energy Supply	**46**	**1,665**	**87**	**3,999**	**176**	**5,974**
Electricity Plants	-46	-153	-87	-4	153	-137
Other transformation				-571		-571
Energy Industry Own Use					-2	-2
Losses					-43	-43
Total Final Consumption		**1,512**		**3,425**	**284**	**5,221**
Industry		77		773	52	901
Transport		1,170				1,170
Residential		120		2652	144	2915
Commercial					79	79
Non-specified		127			10	137
Non-energy use		19				19

Source: IEA Energy Balances of Non-OECD Countries 2015

[4] The Master Plan Study on Rural Electrification by Renewable Energy in the Kingdom of Cambodia (MME-2006)
[5] Combination of domestic and imported coal

Figure 1: Energy Consumption Pattern by Sector, 2012



Source: International Conference on Green Growth and Energy for ASEAN, 2014

11. Imported petroleum products are the main source of commercial energy for industry, transport, and the residential and commercial sectors. Kerosene is used for residential lighting and liquefied petroleum gas is commonly used for cooking. Fossil fuels are projected to further increase, with demand for petroleum products driven mainly by demand for diesel and gasoline as the country becomes more motorized and passenger cars more common, and coal use increases for power generation. At the household level, firewood dominates energy consumption: over 85% of households depend on firewood and charcoal for cooking. Charcoal use is dominant in urban households while firewood use is dominant in rural households. Urban households are estimated to use less biomass with 1.5 kilogram (kg) per household per day, compared to rural households which are estimated to use 5 kg per household per day[6] Taking into account lifecycles of these fuels, the use of equivalent wood stock from cooking with charcoal is higher than using firewood.

F. Institutional Framework

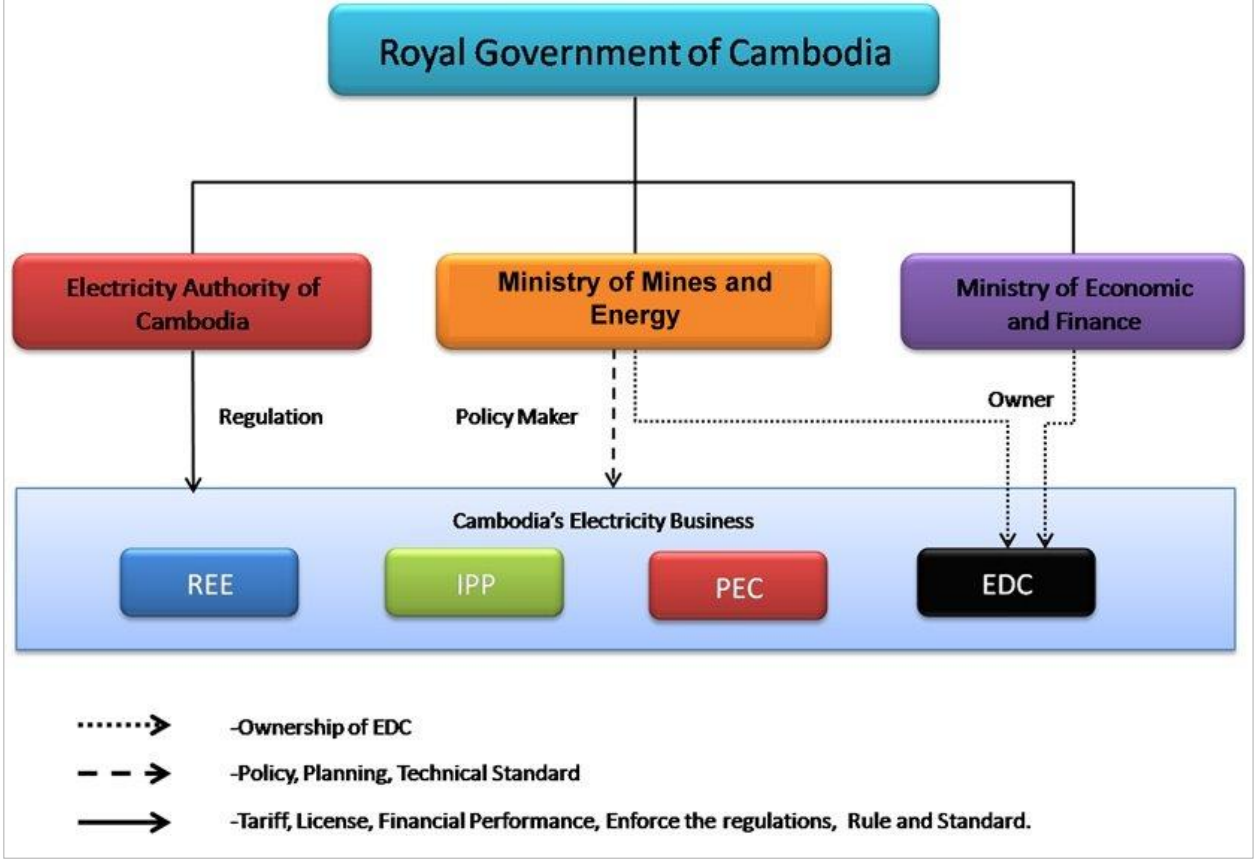
12. The current energy sector organization has been established pursuant to the enactment of the Electricity Law in 2001. The Ministry of Mines and Energy (MME) is the main agency responsible for setting and administrating government policies, strategies and planning in the energy sector including setting technical standards. The agency has three core departments: (i) the Department of Energy Development, which is responsible for energy and electricity planning (21 staff); (ii) the Department of Hydropower (22 staff); and (iii) the Department of Technical

[6] Source: Cambodia Sustainable Energy for All Rapid Assessment and Gap Analysis, 2013 http://www.se4all.org/sites/default/files/Cambodia_RAGA_EN_Released.pdf

Energy, which is responsible for renewable energy (other than hydropower) and energy efficiency (37 staff). To promote the development of biomass energy, the government has formed a ministerial bioenergy program committee, which includes the Ministry of Economy and Finance; the Ministry of Environment; and the Ministry of Agriculture, Forestry and Fisheries, in addition to MME. The electric power sector structure is illustrated in Figure 2. Beginning in the 1990s, given the need for rapid addition of electricity supplies to support economic growth, new generation capacity has been developed mainly by the private sector.

13. The Electricity Authority of Cambodia (EAC) is an autonomous government agency created under the passage of 2001 Electricity Law and is responsible for regulating electricity services. It is responsible for the issuance of rules, regulations and procedures and monitoring, guidance, coordination of the operators in power sector both suppliers and consumers including requiring them to follow the policy, guidelines, and technical standards issued by MME. EAC has to ensure that the provision of services and the use of electricity shall be performed efficiently, qualitatively, sustainably and in a transparent manner. All power service suppliers must be licensed by the EAC.

Figure 2: Electricity Power Sector Structure



EDC = Electricite du Cambodge, IPP = independent power producer, PEC = provincial electricity company, REE = rural electricity enterprise.

14. Electricité du Cambodge (EDC) is a state-owned utility responsible for generation transmission, and distribution. It is owned jointly by MME and the Ministry of Economy and Finance. EDC mainly supplies the capital city, Phnom Penh. EDC buys power from independent power producers (IPPs, mainly joint ventures of Cambodian and foreign investors), and is responsible for power imports. Many rural areas are supplied by rural electricity enterprises (REEs), which operate as licensees, buying power from EDC and selling power into local distribution networks, and may have their own generation assets (typically diesel). Provincial electricity companies (PECs) have operated as integrated utilities at the province and sub-province level; these organizations have mostly been phased out in favor of REEs and IPPs.

G. Policies and Regulatory Frameworks

15. The government has two overarching policy targets: (i) by 2020, all villages in the country should have access to electricity; and (ii) by 2030, at least 70% of total households in the country should have access to quality grid-supplied electricity. Achieving these two main targets depends on the utilization of all types of electricity sources and the participation from relevant stakeholders.

16. The government's energy policy is aimed at: (i) supplying adequate energy at affordable rates; (ii) ensuring the reliability and security of electricity supply to facilitate investments and advance national economic development; (iii) encouraging the socially acceptable development of energy resources; and (iv) promoting the efficient use of energy and minimizing detrimental environmental effects resulting from energy supply and consumption.

17. 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 (i) establishing the principles for operation of the sectors; (ii) establishing favorable conditions for competition, private investment, private ownership and commercial operation of the electric power industry; and (iii) establishing and defining the functions of the EAC and the MME.

18. The electricity tariffs in Cambodia are higher than those in neighboring countries, reflecting the high cost of petroleum-based generation and the fragmented power supply system in the country, as well as inefficiencies in power generation and transmission infrastructure. In Phnom Penh, households pay about $0.18/kWh and industrial consumers pay as much as $0.21/kwh. Tariffs are even higher outside of Phnom Penh with about $0.70/kWh and the supply is even less dependable.[7]

19. Retail electricity tariffs established by EAC for 2016 through 2020 are summarized in Table 2. Retail tariffs is expected to decline reflecting the drop in the overall cost of supply as the share of imports and diesel-based electricity decreases and supplies from lower cost coal and hydro

[7] Source: USAID 2015: Private Financing Advisory Network (PFAN) – Asia Program, The Business Case For: Solar PV in Cambodia

plants increases. EDC's weighted average cost of supply in 2014 and 2015 has been estimated at $0.1067/kWh and $0.095/kWh respectively.[8] The tariffs REEs can charge to residential consumers have been reduced to $0.20/kWh. Lifeline tariffs are in place for poorer consumers. The tariff regime through 2020 indicates possible opportunities for captive and distributed RE generation where electricity can be sold directly to consumers in the range of $0.12 – 0.18 / kWh. Utility-scale projects selling directly to EDC will need to achieve grid parity in the foreseeable future to be economically attractive. In all cases, policy support and concessional finance will be required to jump-start and accelerate RE development (a logical entry point for SREP support, discussed in later sections of this document).

Table 2: Retail Electricity Pricing ($/kWh)

Type of Consumers	2016	2017	2018	2019	2020
Industrial and commercial customers					
Purchase from grid substation	0.126	0.126	0.126	0.126	0.126
Purchase from national grid	0.172	0.1675	0.165	0.163	0.162
Purchase from provincial grid	0.1675	0.165	0.164	0.163	0.162
Residential customers					
Supplied by EDC	0.2175	0.1925	0.1875	0.185	0.1825
Supplied by licensees (REEs)	0.20	0.1975	0.1925	0.19	0.1875
Subsidized tariff for poor households and agriculture					
Urban consumers with use below 50 kWh/month	0.1525	0.1525	0.1525	0.1525	0.1525
Rural consumers with use below 10 kWh/month	0.12	0.1185	0.1155	0.114	0.1125
Pumping in agriculture sector; use from 21:00 - 7:00 hours	0.12	0.1185	0.1155	0.114	0.1125

EDC = Electricité du Cambodge, kWh = kilowatt-hour, REEs = rural electricity enterprises.
Source: EAC, 2016

H. Electricity Supply and Demand

20. Electricity consumption has increased significantly during the last decade. In 2015, per capita consumption of electricity reached 400 kWh, more than fivefold increase from 66.5 kWh in 2005 (World Bank Database). Power consumption is forecasted to grow at 9.4% per year until 2020, which will require more than 50% increase in energy output to keep pace with demand growth. This will mainly be driven by population increase, accelerated economic activity, and rural electrification.

21. The electricity supply currently does not meet the basic demand, where 24-hour supply of electricity is not assured and the quality of electricity is not reliable. According to the Power Demand Plan of the Kingdom of Cambodia in 2007, electricity demand is expected to show a

[8] Source: Cambodia – In Depth Study on Electricity Cost and Supplies, Final Report March 2015. Prepared by William Derbyshire, Economic Consulting Associates.

rapid increase until 2020. From 2002 to 2011, the annual electricity demand growth rate in the country was 16.3%. This demand growth was met mainly by imports from Thailand and Viet Nam; imports have declined since 2013 as new domestic coal and hydro plants have come online (see Table 3 below). As the energy demand in Phnom Penh grew a bit faster with an average growth rate of 17% during the same period, the share of the City of Phnom Penh in the total electricity demand was further increasing (multiplied by 4.8 since 2002) covering now at least 80% of the country's total electricity consumption.

22. Electricity coverage remains low despite the progress that has been made. Out of 13,935 villages, only 67% have transmission lines in their villages.[9] The electrification rate grew to 55.0% in 2015, which is up from 20.3% in 2007. Yet, about half of the entire population still has no access to electricity.

23. The total installed generation capacity as of 2015 was 1,569 megawatts (MW) which produced 4,448 gigawatt-hours (GWh), accounting for about 74% of total grid-supplied electricity. In 2015 an additional 1,572 GWh was imported from Viet Nam, Thailand, and Laos. Domestic production has significantly increased from 2013 to 2015, reducing imported electricity from more than 56% in 2013 to about 26% in 2015 (see Table 3). Hydropower accounts for the largest share of domestic capacity and output, with coal second, and diesel third, and industrial (captive) generation fourth. Biomass power and generation by small licensees (mainly Rural Electricity Enterprises) account for less than 1% of supply.

Table 3: Grid-supplied Electricity Composition and Recent Trends, 2013-2015

Power Sources	2013			2014			2015		
	MW	GWh	%	MW	GWh	%	MW	GWh	%
DOMESTIC									
Biomass	14.57	6.04	0.1	16.57	2.90	0.06	16.57	38.04	0.64
Coal	110.00	168.05	4.20	110.00	840.33	17.83	368.00	2,210.14	36.9
Diesel	275.89	487.25	12	176.98	159.90	3.39	218.00	117.69	1.96
Hydro	344.10	1015.54	25.10	682.1	1,829.78	38.82	927.00	1,988.38	33.20
Industrial	23.16	75.27	1.9	23.16	56.46	1.20	23.16	78.8	1.32
Small Licensees	26.27	16.86	0.4	16.38	29.46	0.63	16.38	15.20	0.25
Subtotal	**793.99**	**1769.01**	**43.7**	**1025.19**	**2,918.83**	**61.93**	**1,569.11**	**4,448.25**	**74.27**
IMPORTS									
Lao PDR	2.0	10.73	0.3	2.0	13.77	0.29	4.00	17.37	0.29
Thailand	95.5	579.6	14.3	135.5	524.20	11.12	135.5	243.88	4.07
Viet Nam	196.25	1691.31	41.8	196.25	1,256.23	26.65	277.00	1,280.06	21.37
Subtotal	**293.75**	**2281.64**	**56.4**	**333.75**	**1,794.20**	**38.07**	**416.50**	**1,541.31**	**25.73**
TOTAL	**1087.74**	**4050.65**	**100.0**	**1358.94**	**4,713.03**	**100.0**	**1,985.61**	**5,989.56**	**100.0**

GWh = gigawatt-hour, MW = megawatt, PDR = People's Democratic Republic of.
Source: Ministry of Mines and Energy, *Updated Power Development and Exchange*, presented at The 19th RPTCC Meeting, 16-17 November, 2015.

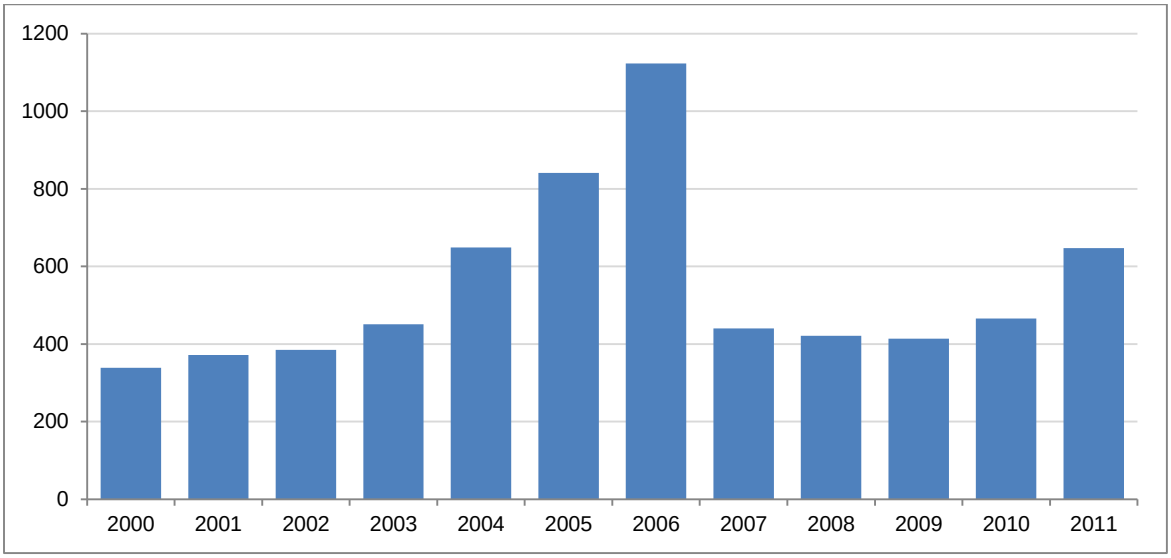
24. Cambodia remains partly dependent on imported electricity. Import from Viet Nam is at 22 kV through a number of connections and at 230 kV through Viet Nam – Takeo - Phnom Penh 230 kV line. Similarly import from Thailand is at 22 kV through a number of connections and at 115

[9] Source: Update of Energy Sector in Cambodia (Fact Sheet by MME and EAC)

kV through Thailand - Banteay Meanchey - Battambang and Siem Reap line. Import from Laos is at 22 kV to Steung Treng area.

25. In 2011, Cambodia was importing about 26,000 barrels of refined petroleum per day, with International Monetary Fund (IMF) data showing the value of imported oil fluctuating enormously between 2000 and 2011. This exacerbates concerns about energy security, as do expectations of an increase in the international price of oil over time. Figure 4 below presents the value of oil imports into Cambodia during the period 2000-2011.

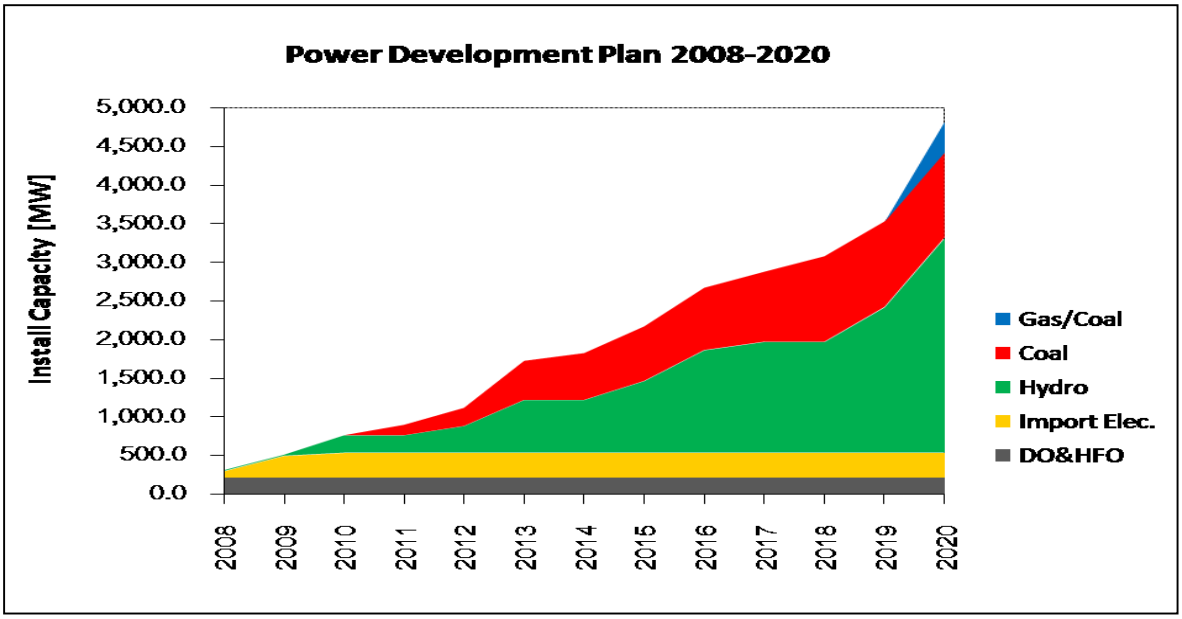
Figure 3: Value of Petroleum Imports ($ Million), 2000-2011



Source: IMF, 2011

26. Based on Cambodia's Power Development Plan 2008-2020, coal and hydropower are expected to continue to dominate growth in new capacity during the next several years (shown in Figure 4 and Table 4).

Figure 4: Cambodia Power Development Plan, 2008-2020



DO = diesel oil, HFO = Heavy Fuel Oil.
Source: Ministry of Mines and Energy, *Updated Power Development and Exchange*, presented at The 19th RPTCC Meeting, 16-17 November, 2015.

Table 4: Power Development Plan for Generation

No.	Project / Lead Developer	Fuel Type	Installed Capacity (MW)	COD
1	Kamchay Hydro Power Plant / Sinohydro (China)	Hydro	19	2011
2	Kirirom III Hydro power Plant	Hydro	18	2013
3	Stung Atay Hydro Power Plant / Datang (China)	Hydro	120	2013
4	200 MW Coal Power Plant (I) in Sihanouk Province - Phase 1	Coal	100	2013
5	Lower Stung Russei Chrum Hydro Power Plant / Huadian (China)	Hydro	338	2014
6	Stung Tatay Hydro Power Plant / China National Heavy Machinery Corporation	Hydro	246	2015
7	700 MW Coal Power Plant (II) -Phase 1	Coal	270	2014-2015
8	700 MW Coal Power Plant (II) -Phase 2	Coal	100	2017
9	700 MW Coal Power Plant (II) -Phase 3	Coal	100	2018
10	200 MW Coal Power Plant (I) in Sihanouk Province - Phase 2 / CIIG (Cambodia) and Erdos Hungjun (China)	Coal	135	2016
11	Lower Se San II Hydro Power Plant / Huaneng (China)	Hydro	400	2017
12	700 MW Coal Power Plant (II) -Phase 4	Coal	100	2018
13	Stung Chay Areng Hydro Power Plant / Sinohydro	Hydro	108	2019
14	700 MW Coal Power Plant (II) -Phase 5	Coal	100	2019
15	Sambor Hydro Power Plant	Hydro	450 / 2,600	After 2020
16	Coal Power Plant (III) or Gas Power Plant	Coal/Natural Gas	400	After 2020
17	Stung Treng Hydro Power Plant	Hydro	900	After 2020
TOTAL			**5,374 / 6,679**	

COD = commercial operations date, MW= megawatt.
Source: Ministry of Mines and Energy, *Updated Power Development and Exchange*, presented at The 19th RPTCC Meeting, 16-17 November, 2015.

II. Renewable Energy Sector

A. Renewable Energy Resource Potential

27. Renewable energy (RE) potential is high but resources remained mostly untapped[10]:

- **Biofuel**: Jatropha plantations cover about 200 hectares (ha); palm oil about 4,000 ha with possible expansion to 10,000 ha; and sugar cane with 20,000 ha. There is one commercial plant producing ethanol from cassava: production capacity is 36,000 tons per year ethanol from 100,000 tons of cassava.
- **Biogas**: Effectiveness of small-scale biogas has been demonstrated by a number of different projects. The National Biodigester Programme (NBP) installed over 23,000 household size biodigesters since 2006. About 11.8 million cubic meters of biogas can be produced annually in Cambodia, which is 7.4 MW of generation capacity from commercial farms only.[11] The use of animal wastes to generate high quality gas for cooking has significant economic, health, social and environment benefits for poor rural households.
- **Biomass**: Generation potential is estimated to be 18,852 GWh per year (approximately 35 times EDC generation output in 2002), but less than 23 MW is operational. Significant sources are rice husk, sugar cane bagasse, cassava stems, etc.
- **Hydropower**: Potential is more than 10,000 MW; installed capacity was 927 MW in 2015, with several more large projects under development.
- **Solar**: High potential with average of 5 kWh/m2/day and average sunshine duration of 6-9 hours per day; technical potential is estimated at 8,100 MW based on estimated energy output of 14,781 GWh/y.
- **Wind**: Potential is estimated at 3,665 GWh/year (about 1,000 MW at 30% load factor), but only a small percentage of it is being tapped. Detailed wind mapping will be required to identify feasible utility-scale projects. The southern part of the Tonle Sap lake, mountainous districts in the southwest, and coastal regions such as Sihanoukville, Kampot, Kep and Koh Kong have annual average wind speed of 5m/s or greater.

28. Of these resources, hydro appears attractive mainly for larger projects. Wind is not as attractive in terms of the scale of the resource, and no detailed wind mapping has been conducted to support utility-scale wind farms. Solar and biomass appear more promising as these are widely distributed around the country. Solar is particularly attractive given the rapid declines in system costs during the last several years; land availability is not a constraint for large-scale development. Biomass is also attractive as an energy resource in rural areas where agriculture dominates the economy. The technical potentials of biomass and solar noted above are more than 500% of total grid-supplied electricity output in 2015 (see Table 3 above). Harnessing only 10% of the technical biomass and solar potential would avoid the need for most of the planned coal-fired capacity additions. Converting technical potential to actual RE capacity and output will require some changes to the policy framework so that development risks are reduced and commercial financing

[10]Source: Sovanna (2010): The Current Status of Renewable Energy, Energy Efficiency Development in Cambodia, MME October 2010, Lao PDR

[11] Source: UNIDO as cited in http://www.phnompenhpost.com/business/biogas-power-rural-areas

is made available. Experience in other developing countries in the region (e.g., Thailand and India) provides valuable lessons learned in designing appropriate policy interventions to facilitate accelerated market development, especially for solar energy.

29. RE resource development and technology deployment in Cambodia is mainly in initial demonstration stages. To date, only about 980 MW RE capacity has been developed which largely is hydropower. Table 5 enumerates the existing RE projects in the country.

Table 5: List of Existing RE Projects in Cambodia, 2016

Agency	Type of Project	Capacity (MW)
1. Korea International Cooperation Agency (KOICA)	Solar PV Battery Charging Station	0.11
2. United Nations Industrial Development Organization (UNIDO)	Solar Battery Charging Station	0.04
3. Japan International Cooperation Agency (JICA)	Solar Pumping	0.78
4. Rural Electrification Fund (REF)	Solar Home System	1.87
5. Prime Minister Project	Solar	2.00
6. Private Company	Solar	21.30
7. Electricity Authority of Cambodia (EAC)	Biomass	22.64
8. Private Company	Hydro (> 10 MW)	929.43
9. Others	Micro hydro	0.60
Total		**978.77**

Source: MME, 2016

B. Renewable Energy Policy Framework

30. Cambodia's renewable energy development and rural electrification policies are linked. The government's energy policy is aimed at: (i) supplying adequate energy at affordable rates; (ii) ensuring the reliability and security of electricity supply to facilitate investments and advance national economic development; (iii) encouraging the socially acceptable development of energy resources; and (iv) promoting the efficient use of energy and minimizing detrimental environmental effects resulting from energy supply and consumption. The goals of the government's rural electrification program are as follows:

- providing safe, reliable, and affordable electricity to rural communities in a way that minimizes negative impact on the environment;
- providing a legal framework that encourages the development of renewable energy sources by the private sector to supply electricity to rural communities;
- supporting renewable energy initiatives;
- promoting the adoption of renewable energy technologies by setting electricity rates in accordance with the Electricity Law (2001);
- promoting the use of least-cost forms of renewable energy in rural communities, through research and testing of grid and off-grid options; and
- supporting electrification in disadvantaged rural communities through funding assistance, training, and other means.

31. The key provisions of the National Policy on Rural Electrification by Renewable Energy are 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 to the poor involving in rural electrification to participate.

32. The government is targeting full electrification of villages by 2020 and 70% household electrification via the national grid by 2030 (see Figure 5 and Table 6). The village electrification target involves about 14,000 villages (with almost 2.5 million households). The main components of rural electrification are an expanded power grid; diesel stand-alone, mini-utility systems; cross-border power supply from neighboring countries; and renewable energy (solar, wind, mini and micro hydro, biogas, biomass). In the short- and medium-term, small village hybrid grid systems will also have an important role.

Figure 5: Rural Electrification Goals

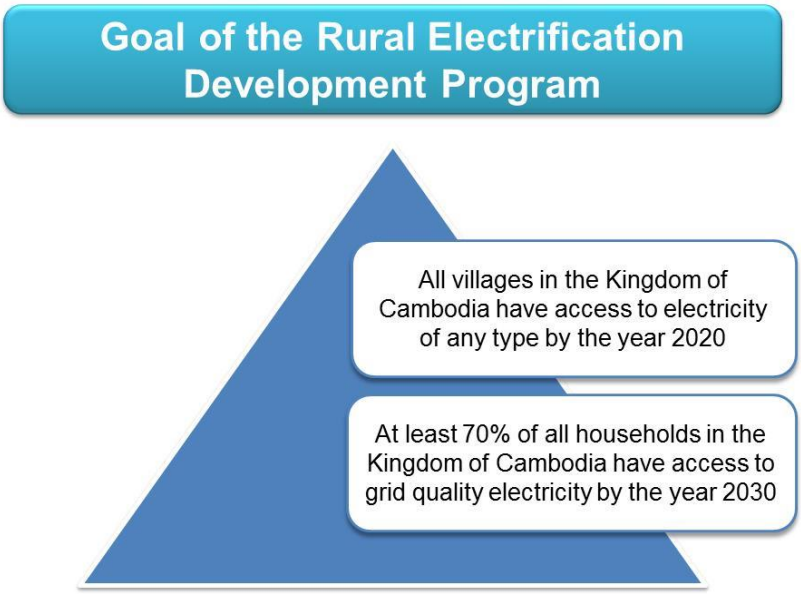


Table 6: Progress Expected from the Extension of the National Grid

Rural Area	2013	2014	2015	2020	2030
Connect to household	50%	51%	55%	65%	70%

Supply to village	55%	56%	67%	100%	100%

C. Incentive Program: The Rural Electrification Fund

33. To help meet its rural electrification targets, the government established the Rural Electrification Fund (REF) with the help of a loan from the World Bank and a grant from the Global Environment Facility. The REF administers grants in support of rural electrification using both conventional technology and renewable energy technologies such as solar, mini and micro hydro, and biomass. Since 2008, the REF has carried out the following initiatives:

- To encourage electricity licensees to expand their networks, the REF has provided them with grant assistance of $45 for each newly connected household.
- To assist rural households living in remote areas:
    - The REF has purchased in bulk 50,000 units of solar home systems (SHSs) on a tax-exempt basis and sells them to rural households in remote areas at cost, less a subsidy of $100, to be repaid in installment without interest;
    - The REF bears the transportation and installation fees, and repayment charges;
    - The REF bears the yearly maintenance fee until repayment (or the supplier bears the fee for the first year), while the purchaser is responsible for the replacement of defective parts; and
    - Once the required installments are made, ownership of the SHS is transferred to the household.

34. The REF was integrated with the EDC in 2012 and is now implementing three joint programs:

- Solar home system program, retaining the above incentive mechanism;
- Power to the Poor Program, which provides interest-free loans of $120 per household to cover the expenses for connection, deposit, meter installation, and wiring, to be repaid in 36 monthly installments; and
- Assistance for the improvement of existing electricity infrastructure in rural areas for the development of new infrastructure, involving loan guarantees, interest-free loans of up to $100,000, or a combination of grants and interest-free loans.

35. The REF-supported program is considered to be successful to date in expanding services through private licenses in rural areas, but can be improved and expanded. Key lessons learned are: (i) product quality needs to be improved and supported with after-market operations and maintenance (O&M) support, which can be achieved through extended warranty periods and appropriate O&M contract provisions; (ii) multiple vendors should be engaged to ensure some competition and maintain downward pressure on system installation and O&M costs.

D. Community-based Renewable Energy Development for Poverty Reduction in Remote Areas of the Country

36. The challenges facing economic development efforts in remote areas for poverty reduction are varied and complex and include: (i) lack of employment creation; (ii) lack of electric power to sustain economic development; (iii) limited livelihood opportunities; (iv) limited human capital investment and development; (v) lack of financial services for the poor; and (vi) piecemeal approach to poverty reduction and limited over-arching anti-poverty programs. The community-based renewable energy projects will help to (i) meet local electricity demand in an environmentally and socially sustainable manner; (ii) improve access to modern electricity services in rural areas; and (iii) improve standards of living for the poor through provision of community-level infrastructure.

37. Due to the high cost of grid extension and the lack of alternative resources, onsite RE projects appear to be the most cost-effective power source for remote areas, but scaling up deployment will require more detailed resource assessments to develop commercially viable projects. The increased use of RE-based electric power will produce local environmental and health benefits such as reduced exposure to indoor air pollution (mainly through displacement of kerosene for lighting), reduced local air pollution from diesel-fired generator sets, and direct economic benefits from the reduced need to purchase, transport and store petroleum fuels in remote areas for power generation, heating and cooking. In the long term, consumers can be expected to switch to electricity for cooking and reliable supplies grow. In addition to the environmental benefits, community-based RE projects will create opportunities for economic development, social empowerment and alleviation of poverty in underdeveloped and remote communities. The RE projects will also reduce greenhouse gas emissions that would otherwise be produced from diesel-based generator use.

38. The framework for RE development specifically for remote areas would be strengthened with the assistance of the proposed SREP investments, as well as defining the strategy to be followed in the medium to longer terms. The frame work would place increased emphasis on the design, demonstration, and pilot testing of dispersed off-grid, community-embedded, and stand-alone RE systems, including their financing and marketing modalities and integration with other social and physical infrastructure development (e.g., poverty alleviation, rural electrification). The framework should list potential RE projects, outlining priorities and sequencing, along with funding requirements which would be based on completed studies and prototype evaluations with specific RE and market targets and funding arrangements.

E. Key Factors for Sustainability of Community-based Renewable Energy Development

39. Sustainability of the community-based RE projects is primarily linked to the capacity built up within the communities themselves. Key factors which would be addressed during program

design include the effective implementation of the community mobilization process, and the provision of technical and capacity building support to the communities to ensure the effective operation and maintenance of the system. The focus would be to (i) develop self-reliant and self-managed organizations in the target communities; (ii) promote information dissemination, awareness building, and knowledge sharing with other remote community areas; and (iii) build strategic partnerships with the private sector and civil society.

F. Empowerment of Women in Community-based Renewable Energy Development

40. Women are the mainstream users and often providers of household energy in villages. Without their active involvement, renewable energy projects will not succeed. Women are not only the main users of household energy, but also influence if not make many family purchases related to energy. The role of women is a critical not only in household matters but also for the community at large. To encourage women to be involved in renewable energy development programs, an entrepreneurship program, designed and targeted exclusively for women's participation, is planned to be organized. The "Village Women Entrepreneurship" program would include special incentives and concessions so that they may invest in the renewable energy development in their respective areas and be a part of regional development and poverty reduction. To motivate women to set up renewable energy development projects, they would be extended special concessions, such as favorable financing terms, and fee waivers on loans, legal expenses, documentation charges, etc.

G. On-going Energy Programs and Projects

41. The proposed interventions to be supported by SREP will be linked with the on-going programs and projects summarized in Table 7.

Table 7: On-going Energy Programs and Projects

Donor / Project Title / Budget ($) / Project completion date	Project Description
ADB Rural Energy Project (formerly Rural Energy Pilot Project) $10.92 million, 2013-2017	The project targets: (i) electrifying up to 13,460 households in Svay Rieng Province by extending the 22 kilovolt medium-voltage sub-transmission line and the low-voltage distribution network and installing meters; (ii) promoting the use of up to 90,000 improved cookstoves with higher efficiency in rural areas of Kampong Cham Province; and (iii) developing the capacity of Electricity Authority of Cambodia (EAC) which is the regulatory body overseeing the power sector. ADB will administer a grant of $6.110 million provided by the Government of Australia.
ADB Medium-Voltage Sub-Transmission Expansion Sector Project	The project will expand the supply of reliable and cost effective grid-electricity in Kampong Thom, Kampong Cham, Siem Reap, Kandal and Banteay Meanchey province in Cambodia. It will (i) expand the electricity transmission infrastructure by constructing 2,110 kilometer (km) of 22

Donor / Project Title / Budget ($) / Project completion date	Project Description
(former name: Rural Electrification Project) $ 66.29 million, 2013-2017	kilovolt (kV) sub-transmission lines, (ii) support the implementation of the project, and (iii) improve the operational effectiveness and efficiency of EDC
ADB Second Power Transmission and Distribution Project $ 52.36 million, 2006-2015	The Project will complement previous investments in the transmission and distribution facilities. It will (i) extend the 230 kilovolt (kV) transmission line from Kampot to Sihanoukville; (ii) build associated substations and bulk supply distribution facilities; and (iii) carry out institutional development and capacity building for EDC.
AFD, Green Microfinance	A $6 million line to 3 MFIs (VisionFund, Kredit and LOLC) to broadcast solar home systems through microcredits all over Cambodia. A 2 million EUR subsidy from EU is used for technical assistance to coordinate the project (coordination between MFIs and solar suppliers, marketing and communication, good solar initiative management) and incentive grant for the solar suppliers (objectives of network expansion and after sales services development)
IFAD, Building Adaptive Capacity through the Scaling-up of Renewable Energy Technologies in Rural Cambodia (S-RET) $4.6 million, 2016-2020	The planned implementation period of S-RET is 4 years. Implementation will commence in the second quarter of 2016 and will be completed in the first quarter of 2020. The cost of GEF-funded S-RET is US$ 4.6 million.
UNIDO, Reduction of GHG emission through promotion of commercial biogas plants in Cambodia, $1.5million 2015-2019	The project will augment the usage of biogas technologies for electricity generation in commercial animal farms by converting the methane emitted from animal waste into energy for productive uses. Implementing partners: Ministry of Environment (MoE) and Ministry of Agriculture, Forestry and Fisheries (MAFF)
UNIDO, Access to Clean Energy for Productive Uses in Cambodia, $577,000, 2012-2016	The project aims at increasing clean energy access for productive activities in off-grid communities by solar PV and enhancing the capacities of local fabricators of biomass gasifiers leading to availability of locally manufactured high quality biomass gasifiers.
SNV Cambodia, National Biodigester Program	SNV Cambodia and the government's National Biodigester Program have supported the development of a commercial market for household biodigesters since 2005. The first phase of the program (2005-2012) concentrated on the introduction, promotion and dissemination of the technology and on setting up sector infrastructure. The current phase (2013-2015) has a strong focus on private sector development and on strengthening all actors to ensure long-term sustainability and ultimate independence from donor funding. The program is supported by EnDev, a multi-donor fund managed by the German development agency GIZ. There are additional linkages with the IFAD PADEE program.

Donor / Project Title / Budget ($) / Project completion date	Project Description
	By 2014, SNV's program had contributed to the establishment of 66 biodigester companies, which have built more than 20,000 biogas plants in Cambodia. Another 9,000 biodigesters could be built by 2015.
SNV Cambodia, Waste to Energy for the Rice Milling Sector in Cambodia	In collaboration with government, the public and private sectors, and the Federation of Cambodian Rice Millers Association (FCRMA), SNV is introducing clean and efficient gasification technology. Millers can fuel their machinery with the waste rice husks, allowing them to reduce their bottom line and be more competitive in the export market. The Waste to Energy for the Rice Milling Sector in Cambodia project is funded by the European Union and Foundation Ensemble.
SNV Cambodia, Solar Microfinance Program	The project aims to broaden access to energy for 25,000 households in off-grid locations in rural Cambodia by enabling a sound supply of quality solar products and microcredit; and by triggering demand from households. The Solar Microfinance Program is funded by the French Development Agency AFD and the European Union. To lower the initial investment barrier for rural households, the Solar Microfinance Program collaborates with three leading Cambodian Microfinance Institutions (MFIs) which develop Cambodia's first dedicated solar microcredit offer for their customers.
SNV Cambodia, Advanced Clean Cooking Solutions	SNV is implementing the Advanced Clean Cooking Solutions (ACCS) program to introduce proven advanced clean cooking technologies to Cambodia and Lao PDR. These activities will result in a self-sustaining commercial sector for advanced clean cooking solutions with private entities as main actors.

AFD = Agence française de développement, EDC = Electricité du Cambodge, IFAD = *International Fund for Agricultural Development*, EU = European Union, IFAD PADEE = International Fund for Agricultural Development Project for Agricultural Development and Economic Empowerment, MFIs = Microfinance Institutions, PDR = Peoples Democratic Republic of, PV = photovoltaic, SRET = Scaling-up of Renewable Energy Technologies in Rural Cambodia.

H. Critical Constraints and Recommended Policy Actions

42. The key issues and critical constraints on RE development and recommended policy actions are summarized in Table 8. The proposed investments and associated capacity development have been elucidation with these considerations in view.

Table 8: Key Issues on Renewable Energy Resource Development and Institutional Structure

Key Issues and Critical Constraints	Appropriate Government Policy Actions
1. Renewable Energy Resources Development	
Lack of access by private sector investor to appropriate tariff structure and financing mechanisms to undertake accelerated development of renewable energy resources (RES) are the major impediments and constraints.	The Government recognizes that private sector involvement will be crucial as about 80-85% of investment is expected to come from the private sector sources, consistent with the current practice of private sector development of conventional generation assets. The Government to establish an appropriate tariff structure for RE development by private sector to ensure adequate return on investment, and for funding sustainability.
One of the critical constraints delaying implementation of renewable energy projects in Cambodia is the availability of financing in the amount and terms required owing to the lack of long-term debt market. Renewable energy have high front end capital cost per kwh installed which calls for debt with much longer maturity than is usually available in the market.	The Government will continue to maintain dialogue with and seek assistance from multilateral and bilateral agencies (like the Asian Development Bank, World Bank, JICA, USAID, and other development partners) to provide new and innovative financing instruments through their private sector arm that would enhance the provision of private capital, goods and services. Appropriate policy and financing instruments will be determined for specific projects during identification and preparation stages. Government would encourage joint venture partnership with foreign investors, manufacturers, developers, and licensees; and also encourage the participation of the national universities and colleges and other stakeholders to undertake research and development covering renewable energy resources and facilitate the development of technologies suitable for Cambodian requirements. There appears to be an economic case for providing some financing subsidies in the initial phase of renewable energy development program because of their positive externalities both locally and globally. The subsidies will be designed to kick start an infant industry but will have a limited time span.

Key Issues and Critical Constraints	Appropriate Government Policy Actions
For expanded private sector participation under competitive environment and for sustainable private sector investment, the provision of feed-in tariff and net metering as a stated policy of RGC, are considered essential in the scaling up of renewable energy development in Cambodia.	The MME has initiated discussion/consultation with relevant department/agencies including EDC for the provision of feed-in tariff and net metering as a government policy instrument, especially for rooftop solar. Utility-scale grid-connected RE plants selling to EDC may need some policy support in the near-term.
Need for improved transparency, governance, and fair play.	RGC should implement market-based reforms; create competitive sector structure; strengthen market regulations to ensure investor confidence. Policy framework should focus on creating competition as the driving force for improvement and private sector participation as a vehicle for creating a competitive environment building on private sector experience with conventional power plants.
Need of a clear policy thrust on renewable energy for the rural areas.	There exists a Government Policy Framework for the Development of Renewable Energy specifically for the remote areas, as well as a strategy for the medium to longer terms. The policy places increased emphasis on the design, demonstration, and pilot testing of dispersed off-grid, community embedded, and standalone renewable energy systems.
There is lack of consumer awareness on benefits and opportunities of renewable energy; lack of stakeholder/community participation in energy choices and renewable energy projects.	The Government plans are to have a nationwide awareness campaign and declare 2017 as a year of Renewable Energy Year.
2. Institutional Structure and Capacity Building	
A large number of RGC departments, agencies and offices are involved in the renewable energy development programs. A major challenge is to ensure that these entities work to their respective strengths in an integrated manner towards delivery of the national objectives.	To address the sector efficiency improvement, and to avoid duplication of efforts, there is a need to restructure and consolidate the sector entities for a better and improved delivery of services to the people.

EDC = Electricité du Cambodge, JICA = Japan International Cooperation Agency, MME = Ministry of Mines and Energy, RGC = Royal Government of Cambodia, USAID = United States Agency for International Development.

III. Contribution to National Energy Roadmap

43. Inadequate power supply has emerged as one of the most serious infrastructure constraints on sustainable economic growth in Cambodia. Electric power supply will need to increase at least as fast as economic growth to eliminate suppressed demand and meet future demand growth, i.e., energy supply needs to increase about 10% per year for the foreseeable future. Expanding electricity supply above 10% per year from 2015 output means that electricity output will need to increase by 61% by 2020, 259% by 2025, and 417% by 2030. The RGC recognizes that additional investments in traditional commercial power supply sources alone will not be sufficient to bridge the demand-supply gap. The heavy reliance on fossil fuels in the energy mix imposes major environmental concerns at the national, regional, and global levels, with respect to conventional pollutants and GHG emissions which impose substantial environmental, social, and economic costs. The RGC therefore considers it essential that the country must ease growth in fossil fuel energy consumption, curb upward pressure on energy prices, and improve energy security. Large hydropower projects may also require some re-engineering to become more sustainable.

44. Although many RE options appear very attractive compared to petroleum-based generation, commercial development has not occurred at scale mainly due a weak policy framework, and partly due to development of large hydropower and coal-fired power plants which have attracted the bulk of commercial finance given their much lower risk profiles. One of the key near-term challenges is to modify the energy development framework so that the benefits of RE versus fossil fuels can be monetized and delivered as up-front project finance. Alternatively stated, the business model for energy development needs to include use of “natural capital” as well as traditional finance.

45. The RE resource base – biomass, hydro, solar, and wind – is sufficient to displace all diesel generation in the foreseeable future. As noted above, the technical potential for biomass and solar is more than 500% of total grid-supplied electricity in 2015, theoretically sufficient to cover projected above 10% annual growth in electricity supply through 2030 noted above. Harnessing 10% and 50% of the biomass and solar potential would cover electricity demand growth projected through 2020 and 2030, respectively. Harnessing 20% of biomass and solar potential would avoid the need for most or all of the planned coal-fired capacity additions. Commercial operation of 200 MW of solar capacity operating 5 hours per day would be sufficient to cover Cambodia’s Intended Nationally Determined Contributions (INDC) for energy industries. Clearly, RE resources can make a major contribution if development can be accelerated in the near future.

46. When RE reaches grid parity, energy sector transformation can be accelerated, but initiating the transformation presents a classic “chicken and egg” situation which is heavily loaded with first-mover risks. It is impossible to determine with certainty how much new RE output is

required to reach a tipping point in Cambodia, but experience in other developing countries can provide some hints. For example, India embarked on an ambitious solar development program with a concerted effort beginning in 2008, with large-scale solar parks under development by 2011. By 2014, more than 3,000 MW of new utility-scale solar capacity had been installed. By 2015 power purchase agreements were being negotiated at $0.09 and less, which is at parity with the national grid supply, and at parity with power plants using imported coal. The experience in India is noteworthy and instructive for other developing countries: the success in mobilizing commercial RE development at scale was facilitated by extensive dialogue between the government, private sector developers and investors, and regulatory agencies. This resulted in public-private collaboration, whereby state-level electric utilities took the lead in early project development to reduce up-front risks to IPPs and commercial investors. The risk-reduction efforts facilitated tendering of large-scale projects on a tariff basis (a reverse-auction model), with all bids coming in below the benchmark tariffs established by the Central Electricity Regulatory Commission; for the most part the success to date has not relied on FiTs. Closer to Cambodia, Thailand has also introduced FiTs and other incentives during the past several years with good results: solar capacity has increased from almost zero in 2010 to 2,600 MW by the end of 2016.[12]

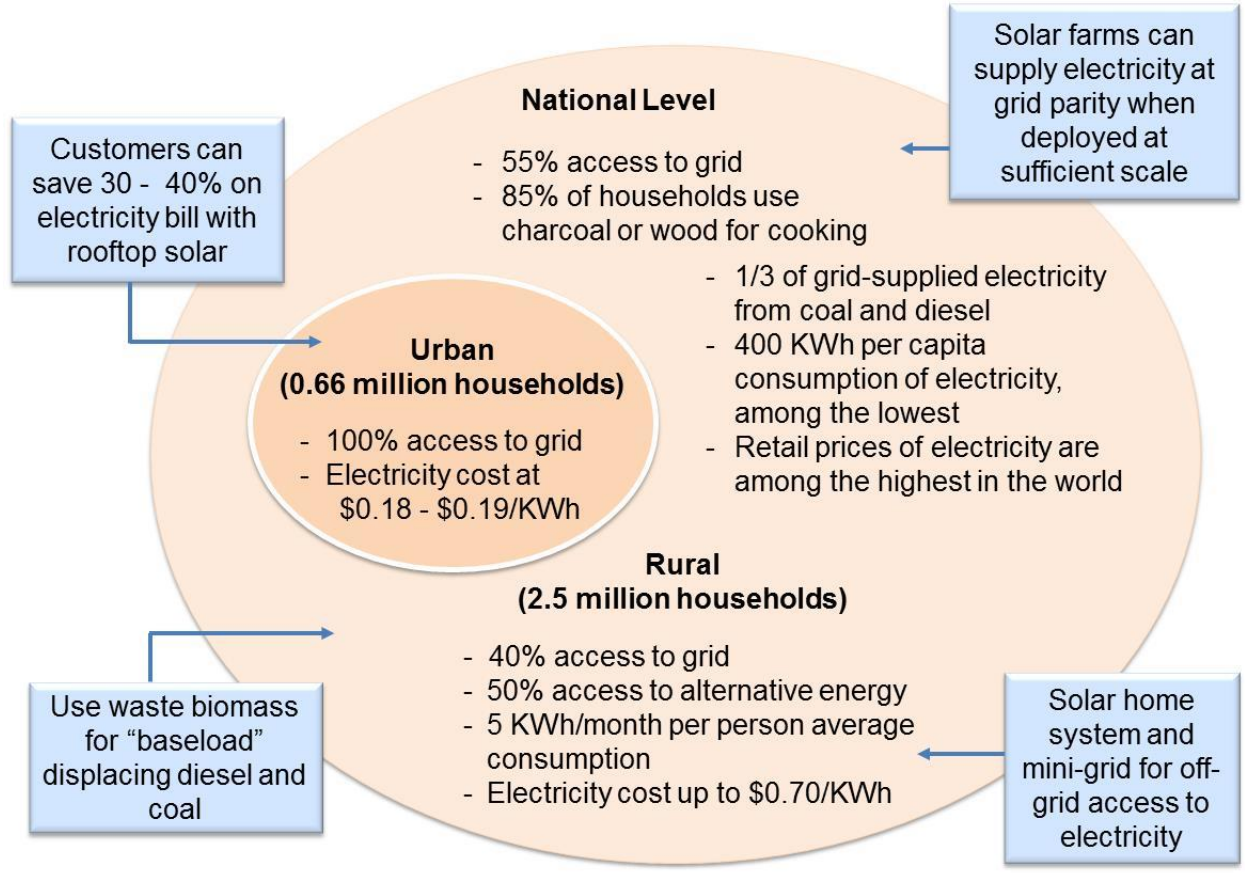
47. In Cambodia, SREP can be catalytic in facilitating successively larger RE-based energy services via a combination of learning-by-doing investments complemented by policy evolution. A logical entry point is solar and biomass installations in areas where diesel generation dominates electricity supplies, including rural and peri-urban areas. Additional entry points are rooftop solar and solar farms, where new RE installations are for the most part competing against the grid mix. All of these investments and activities will require some grant and concessional financing (in the near term) due to the lack of long-term financing. Figure 6 illustrates the country and sector context and possible entry points for SREP support.

48. SREP also supports the implementation of the Cambodia Climate Change Strategic Plan 2014 – 2023, a national framework for engaging stakeholders in a participatory process for responding to climate change to support sustainable development. Among its strategic objectives are: promotion of low-carbon planning and technologies to support sustainable development, improvement of energy security and strengthen institutions and coordination frameworks for national climate change responses, shift towards a green development path by promoting low-carbon development and technologies, and promotion of public awareness and participation in climate change response actions.

49. The investments envisioned for SREP cofinancing will have environmental and social co-benefits, mainly in the form of avoided emissions of conventional pollutants and GHGs. Co-benefits are summarized in Annex C.

[12] Source: http://www.bangkokpost.com/business/news/940317/solar-market-projected-to-be-radiant?platform=hootsuite Thailand has been the beneficiary of support from the Clean Technology Fund, and lessons learned from utility-scale RE development will be considered for SREP cofinancing in Cambodia.

Figure 6: Country and Sector Context and Possible SREP Entry Points



kWh=kilowatt-hour.

IV. Prioritization of Renewable Energy Options

50. The prospective renewable energy developments to be considered for SREP support were evaluated against a set of criteria and prioritized accordingly. The criteria reflect RGC strategic objectives, and the clear recognition that SREP funding should be used to overcome barriers to RE options (i.e., the combination of resources, energy conversion and utilization technologies, and end-use applications) that will have the potential to have a transformative impact on the energy sector. The criteria considered included:

(a) **Resource potential:** Large renewable resource potential for sustainable production operation as expansion and accelerated development is an important consideration for the SREP transformational impact;
(b) **Unexploited market potential.** The extent to which the resource is already exploited versus the technical potential; as noted in Section II, biomass and solar appear the most attractive on this basis.
(c) **Availability of sites:** Availability of large number of sites for the RE installations;
(d) **Readiness of implementation:** RE systems that are already in use in Cambodia and are readily available for additional implementation. RE options were ranked higher if there was reasonably good data on resource availability and potential sites or projects. Prospective RE options without good resource data were ranked lower or not considered.
(e) **Technology adaptability:** Technology adaptability by existing technical skills in the country and the ease of learning the operational activities by the broad based Cambodian consumer base;
(f) **Financial viability:** RE systems that are proven in Cambodia to be financially viable with cost -competitiveness with other existing operations for energy generation.
(g) **Consumer acceptability and affordability:** Consumers' willingness to pay.

51. Solar energy development ranked the highest with biomass power second. Wind energy was not included as there is very little data available. A systematic wind mapping could be undertaken in Cambodia as part of the policy support component of this IP. Mini-hydro was not a preferred option by the RGC because of low water availability during summer and the periods of drought which are becoming frequent in Cambodia as well as its poor performance in the past. Similarly, biogas and waste- to- energy was not included due to their poor performance in Cambodia. Table 9 summarizes the ranking of RE options.

Table 9: Ranking of Renewable Energy Options against Selection Criteria

Criteria	Biomass	Solar Farm	Rooftop Solar	Solar Mini-grid	Solar Home System
Resource Potential	**Medium** Significant resources available from a variety of agricultural residues; however need improved arrangements to secure feedstock	**High** Significant solar resource available in Cambodia with an average of 5 kWh/m^2/day			
Unexploited market potential	**High** Lack of subsidy for small and large scale project; and lack of available and affordable financing/loans	**High** Lack of grants and soft loans that can de-risk the first RE projects. Solar energy sector is still small with 25 solar companies.			
Availability of sites	**High** Substantial potential sites available	**Medium** Available sites mainly in special economic zones	**High** Substantial commercial and residential rooftop potentials in Cambodia	**Low** On-grid rural areas with high tariffs and sufficient day load usage	**High** Sufficient off-grid remote rural areas
Readiness for implementation	**Low** All power plants, including spare parts are imported; some are imported from unreliable suppliers	**Medium** Some companies are technical capable for large-scale projects.	**High** Some companies are experienced in implementation	**Medium** Depending on agreement with REE and EDC. No technical issues	**High** Solar companies are experienced in implementation
Technology adaptability	**Low** Low technical capacity to operate the plant and lack of spare part available in the country	**Medium** Technical capacity is available	**High** Technical capacity is available and applied	**Medium** Technical capacity is available	**High** Technical capacity is available and applied
Financial viability	**High** Viable compared to petroleum-based generation	**Medium** High capital costs and long pay-back time due to limitations in policy framework and regulatory uncertainty		**High** Viable compared to petroleum-based generation	
Consumer acceptability / affordability	**High** EDC sells electricity to REE at price of 14.70 cents per kWh. REE will be happy to buy electricity power at below price offered by EDC. It could be between 12 and 13 cents.	**High** Competitive against diesel generation	**High** Competitive against diesel generation	**High** Very competitive against diesel generation and offers 24 hours access to electricity	**High** Competitive against diesel generation; however subsidy is needed for pro poor households

EDC = Electricité du Cambodge, kWh/m2 = kilowatt-hour per square meter, RE = renewable energy, REE = rural electricity enterprises.

V. Program Description

52. Recognizing the multi-sectoral dimension of RE development for addressing climate change challenges, the IP is designed to facilitate national efforts of shifting to a low-emissions economy that provides employment opportunities with some specific focus on reducing poverty in rural areas and urban margins, and a broader view of the medium- to long-term prospects for RE. Given the immaturity of RE development in Cambodia, the IP must have flexibility in terms of project definition and implementation to adjust to changing circumstances and new opportunities, including uncertainty in the national policy framework and financial markets. The IP promotes systematic and expanded development of RE resources to support access to energy and productive end use of energy through a combination of mutually-reinforcing physical investments and technical assistance for improved policy framework. The physical investments include solar and biomass energy development, while the technical assistance includes (i) human development and capacity building, (ii) public awareness campaigns to facilitate RE project development and implementation, (iii) a proposed "Year of Renewable Energy in Cambodia"; and (iv) investment preparation activities.

53. The main outcomes/benefits of the proposed investment plan will be (i) an improved policy framework to enable commercial RE development at progressively larger scale; (ii) commercial scale RE demonstration which is replicable and scalable; (iii) mobilization of private investment into RE development; (iv) reduced reliance on fossil-fuels resulting in foreign exchange savings and avoided emissions of conventional pollutants and GHGs; (v) reduced pressure on forest resources; and (vi) improved energy security through diversification of supply. The conceptual approach of the IP is presented in Figure 7.

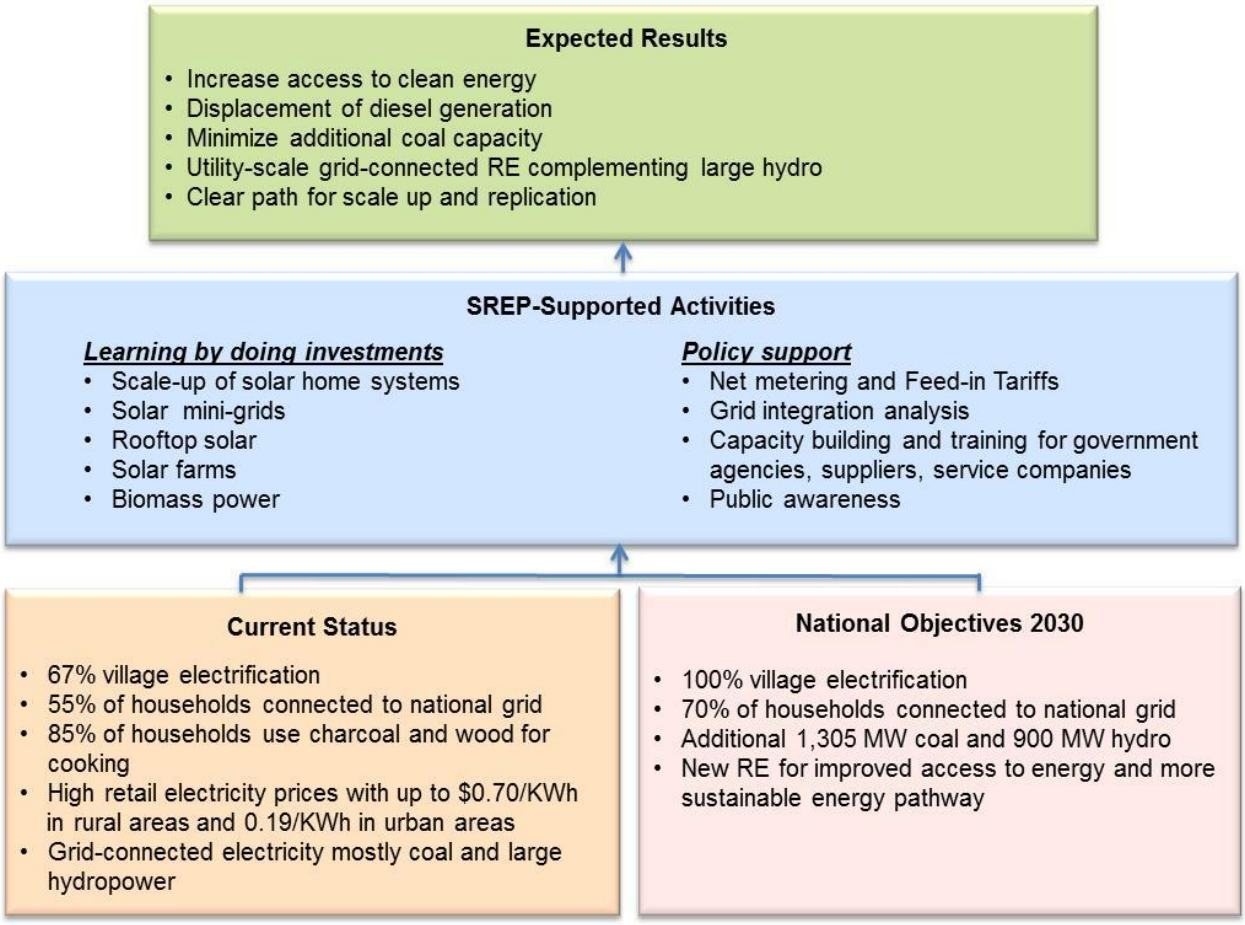
A. Strategic Issues

54. Energy policy evolution is needed including new policy and financing instruments. At the national level time-bound RE capacity and output targets can be defined using Sustainable Development Goal 7 (increasing access to modern energy services) and Cambodia's INDC for energy industries as a starting point. For example, the INDC includes avoided GHG emissions of 1.8 million tCO_2e/y by 2030, which could be met by having 200 MW of solar PV in operation by 2030. Using this as a starting point, more ambitious national targets can be set, with policy guidance for EDC and REEs to facilitate market growth with expanded private sector investment.

55. The RE market can evolve quickly due to changes in tariffs for REEs (noted above). The RGC will continue to subsidize the $0.20/kWh tariff but the subsidy to REEs should be phased out as soon as possible to encourage shift from diesel-based generation to cheaper RE-based generation, and to direct government funds to support grid expansion or other sectors (e.g., education and health). Solar and biomass both should be feasible at levelized cost of electricity (LCOE) less than $0.20/kWh. Benchmark tariffs can be established, against which RE projects

can be competitively tendered; the resulting price discovery would then inform elucidation of FiTs (especially for rooftop solar). Adherence to high quality technical standards and incorporation of after-sales operation and maintenance support are critical for all types of new RE installations and operations.

Figure 7: SREP IP Conceptual Approach



kWh=kilowatt-hour, MW=megawatt, RE=renewable energy.

56. Because the RE policy framework is subject to change, and given the fact that electricity generation in Cambodia is delegated to the private sector, the candidate investments are indicative at best. As the SREP focal point for Cambodia, MME will provide overall guidance for implementing the IP. Most of the project concepts will be developed under the leadership of the ADB Private Sector Operations Department (ADB-PSOD); the exception is the proposed expansion of solar home systems (SHS) and introduction of solar mini-grids, which will be developed under the leadership of the ADB Southeast Asia Energy Division (ADB-SEEN). Details of project structure, financing instruments, and implementation arrangements will be determined during project preparation; lessons learned from prior RE development in Cambodia (and other countries including developing countries in Asia) will inform project design.

Component 1: Solar Energy Development

57. Continuing advances in technology and decline in installed system costs mean that the solar energy prospects can evolve fast enough to run ahead of policy development. Alternatively stated, prospective solar development can inform policy-making. For example, captive generation projects which compete against petroleum-based generation may become attractive for commercial development in the absence of major government policy changes. Successful commissioning of such projects provides "price discovery," which in turn can inform tariff policy. Based on stakeholder consultations during IP preparation, 4 types of solar investments are proposed which are discussed below.

a. Solar Home Systems

58. The solar home systems (SHS) program takes a dual approach with both a social and sector development program for the different social classes in rural areas. The social program provides pro-poor access to affordable energy with 80 Watt (W) SHS for poor households, while the sector development program aims upscale delivery to households who show demand and willingness to pay for 100 W or larger SHS.

59. The social program with the 80W SHS will be a design advance on the existing program from the Rural Electrification Fund (REF), which currently offers 50W SHS with a $100 subsidy and 4-year installment plan that results in a monthly cost of only $1. As price have declined, SHS of 80W or larger are now affordable and these larger SHSs better address the needs and wants of poorer households compared to the 50W model currently offered by REF. The model can provide cheaper electricity and generate electricity beyond basic needs, with multiple benefits such as education (extra study time), social (watching television) and health (fan to ward off mosquitoes).

60. The program will target delivery of 10,000 SHSs, including after-sales service and operations and maintenance support. Based on expected cost for the SHS and some pro-poor subsidy contribution, the repayment cost will be around $0.10 per day. Compared to the costs of battery charging, households will have a 45% direct saving on daily expenditures. Building on the experience of REF and other donor-supported programs, the SHS package should include a television set; with SREP support the program would include more efficient television rated at 10 - 25 W consumption which cost around $70-$150.

61. Based on the experience of the on-going AFD/SNV program there is rural market demand for 100W to 250W SHSs. These larger systems give the household the option of adding a pumping system for water well and/or micro enterprise creation. A program for the larger SHS will be designed and developed to build on the experience of the ongoing SHS activities, and accelerate service delivery. Existing solar supply companies can develop their own strategy for

this segment, but would have to comply with the quality standards set by the 'Good Solar Initiative' program.[13]

b. Solar Mini Grids

62. Solar mini-grids provide the capability to scale up from SHS to a village-level micro-utility providing energy services to 50 to 100 households with a nominal system capacity of 10 kW. Mini-grids are inherently more challenging than SHS: for a mini-grid to work cost-effectively it needs sufficient day-loads to avoid the usage of a battery bank.[14] There are no known solar mini-grids in Cambodia today, so pilot projects will be identified in villages with some commercial activities that require expanded energy supply. Experience of other developing countries in the region will inform the design of appropriate business models for mini-grid deployment, e.g., the SREP-supported programs in Nepal and Bangladesh. Mini-grids appear attractive in remote rural villages where electricity services presently costs around $0.75/kWh. Solar mini grids could lower costs to around $0.25/kWh, based on estimated cost of a 10 kW system with battery storage of around $55,000; SREP cofinancing could further reduce levelized costs by reducing the cost of financing.

63. A critical design point that needs to be addressed is future connection to the national grid. Once a village is connected to the grid, electricity would theoretically be available at prevailing EDC tariffs; today the EDC tariff is lower than the $0.25/kWh target cost noted above. At the moment, EDC is expanding the national grid faster than the targets set by MME for 2030. However, the target for 100% grid-connected villages is still 15 years away and continued decline in solar system costs indicate that mini-grids may be a permanent solution as the system costs would be mostly amortized after 10-15 years. Project preparation will include analysis to determine appropriate financing arrangements so that mini-grids are future-proofed for possible connection to the grid. Preliminary assessment indicates that about 65% of the investment costs would need to be covered by grants.

64. The SHS and mini-grids are proposed for implementation through EDC and REF. Some re-tooling of operations will be required, which will be identified and addressed during project preparation. Based on prior experience, key changes will include (i) improved quality standards for solar systems (following the Good Solar Initiative guidelines), (ii) appropriate contract provisions for extended warranty and O&M support, and (iii) executing multiple contracts for solar system installation and services to ensure competition. The resulting "REF v2.0" will be the implementing agency.

[13] The Solar Energy Association of Cambodia has 25 member companies, of which 4 have been certified under the Good Solar Initiative. Supplier credit has not been provided for the SHS programs to date, but this might be a feature of the scale-up SHS program.

[14] Considering that solar power systems are still at a relatively early stage of use in Cambodia, this component will focus on identifying installations that do not require batteries for viability; this approach is intended to keep system design simple and minimize costs. As experience is gained, batteries can be introduced in later stages, taking advantage of global cost reductions expected in the next several years.

c. Rooftop Solar Systems

65. The solar rooftop market could be on the order of 400 MW to 500 MW, but policy and financing barriers need to be eliminated to create a market for electricity consumers to become producers ("prosumers"). As system costs continue to decline, the potential savings to consumers are on the order of 35% to 40% of the current monthly payments. The most cost effective market for solar energy is for customers with daytime usage of the rooftop-generated energy, wherein battery storage is not required. Eliminating batteries makes the payback time of the systems more attractive as battery storage accounts for about 40-50% of the total costs. A key barrier at present is the lack of net metering and FiT especially for commercial consumers: weekends and holidays in Cambodia total up to about 120 days per year. Without an appropriate off-take pricing arrangement, about 33% of the annual generation output would either be wasted or simply not generated which is clearly a sub-optimal outcome.

66. Introduction of net metering in a pilot phase is strongly recommended as an appropriate policy instrument. With net metering, the grid takes any surplus energy output, eliminating the need for batteries, and is the obvious solution to optimize the capacity and cost-effectiveness of each solar rooftop system. If the Net Metering System is introduced, the saving could increase up to about 100%, that is, an individual consumer could effectively zero out the monthly electricity bill. This conclusion is based on recommendations of the Solar Energy Association of Cambodia, the Green Business Committee from Eurocham, and feedback from private sector developers. Lessons learned in the pilot phase can serve as input for policy development. Net metering will allow optimization of rooftop capacity and full utilization of all energy output. The potential for transformation exists, as the market potential for commercial and industrial buildings is estimated at 400 – 500 MW and the additional energy can be absorbed by the grid at zero effective cost to EDC.

67. The residential market also has high potential but has different characteristics than the commercial and industrial market. Residential projects will have smaller installed capacity and typically show highest consumption outside the business hours. System capacity is normally optimized on an annual or monthly basis, while commercial and industrial systems are normally optimized on a daily or weekly basis. The residential market can be developed if a policy is in place to reward residential consumers for supplying surplus electricity to the grid during the day. A net-metering policy should consider annual variations since peak residential demand occurs in the dry season (mainly due to air conditioning load) when hydropower output is at a minimum.

68. An appropriate net metering policy can be developed based on experience from other countries and the knowledge base of existing solar companies in Cambodia. The policy and regulatory framework will need to evolve in order to unlock the market. In this context, SREP can provide grant support for advisory services including policy formulation, pilot program design, drafting of appropriate power purchase agreements (PPA), etc.

d. Solar Farms

69. Solar farms are the most promising opportunity for rapid scale up in the near term. At present MME reports only 1 MW of installed capacity with an insignificant contribution to the grid. Market development is in its infancy, but there is potential for several hundred MW in the near term.[15] Two market segments appear promising: (i) projects within Special Economic Zones (SEZs), and (ii) grid connected projects selling output to EDC.

70. Solar farms located in SEZs are more attractive in the near term due to regulatory simplicity: each SEZ has a license to distribute electricity to the member companies within the SEZ. Solar capacity can be scaled to SEZ demand and PPAs can be executed for captive generation without any direct intervention on the part of EDC and EAC. There are 30 SEZs with special incentives to attract direct foreign investments, including tax incentives. One local solar energy company (Kamworks) has reportedly signed a contract for an 8 MW project in the Vihear Sour SEZ.[16]

71. Traditional IPP projects face classic first-mover risk. Solar developers report that commercial financing is non-existent at interest rates and tenors necessary for financial viability. Outside SEZs there are no tax exemptions which make it harder to finance large scale projects. MME, EDC, and EAC are taking action to jump-start solar farm development. MME is currently tendering a 10 MW project (located near the Viet Nam border in the town of Bavet), with an offered off-take price of less than $0.10/kWh. Five technical proposals were received of which four were qualified for further consideration; financial proposals will be reviewed in mid-May 2016. The experience of this project will inform further development and design of large scale projects, especially future projects which sell electricity directly to EDC. Assuming that a power purchase agreement is executed for less than $0.10/kWh, a single project cannot be expected to transform the energy sector: there will be still be a need for concessional support to accelerate solar development as has been the case in other developing countries.[17]

72. ADB's Private Sector Operations Department (ADB-PSOD) will take the lead in identifying multiple solar farms, with an initial target of at least 3 installations of 5 MW each. The total capacity supported by SREP cofinancing is expected to be on the order of 60 MW, and will be determined during project preparation. Additional notes on the project concept are presented in Annex D.

[15] For example, a Thailand-based company, Global Purify Power, is developing 225 MW of aggregate capacity in the provinces of Kampong Speu, Kampong Chhnang, and Takeo; the output will be sold to businesses and factories (no other details are available).

[16] Intermittency of solar output will become an issue when penetration reaches around 20% of grid-connected capacity. In the near term this is not expected to be an issue, as grid-connected solar will be complemented by existing hydro plants.

[17] For example, Thailand has benefited from $170 Million in concessional finance from the Clean Technology Fund (CTF), which has been instrumental in financing several utility-scale solar and wind projects. Prior to mobilization of CTF, some grant funds were used to support the first utility-scale solar project. In parallel with the CTF co-financed activities, the government introduced additional tariff incentives which have been instrumental in solar energy growth. This is a good example of learning-by-doing investment complemented by policy evolution, as is envisioned for Cambodia with SREP support.

Component 2: Biomass Energy Development

73. Biomass has the second highest potential after solar, and appears attractive because the resources are widely available and biomass power plants can provide baseload power in areas where diesel generation dominates. Biomass power plants are a logical part of plantation-based agro-industries where cogeneration and even tri-generation (combined power, heat, and cooling) designs may provide the best return on investment depending on the location of a specific plant. Feedstock include rice husk, sugar cane bagasse, corncobs and corn straw, waste wood from cashew and rubber processing. The technical potential is estimated at more than 18,000 GWh/y, or about 3,000 MW. The actual market potential could be as high as 500 MW, but only 22.64 MW has been installed, which is less than 2% of grid-connected generation capacity and well below 1% of total domestic generation output.

74. Biomass is inherently more complicated than other forms of RE because feedstock must be secured and energy production technology should be tailored to feedstock as well as energy end use, e.g., power only versus cogeneration or tri-generation. Cambodia has some experience with biomass gasification technology using rice husk, but feedstock security has been a major challenge because as much as 33% of paddy rice is exported without milling.

75. The prospective market opportunities are based on the REE selling price of $0.20/kWh versus prospective biomass cost of production ranging from $0.12 – 0.14/kWh. The macro-economic prospect is attractive as biomass power is a form of industrial cleaner production which can displace petroleum-based generation, and biomass power output can complement hydropower during the dry season.

76. SREP cofinancing is proposed to support at least 2 prototype projects of 1.5 MW each which can be quickly replicated; the target capacity is a total of 10 MW. Two candidate projects have been identified in Battambang and Kampong Cham province where feedstock availability is good, and an additional candidate project of 5 MW located in a SEZ has been identified for consideration. Additional sites and projects will be identified during project preparation. Additional notes on the proposed investments in biomass power development are presented in Annex D.

Component 3: Policy Support and Public Awareness

a. Policy Support

77. The solar and biomass investment concepts will be pursued in parallel with technical assistance for policy evolution and capacity building covering several key areas. MME needs capacity building so that it can facilitate policy changes, introduce new modalities e.g., public-private partnerships (PPPs), and apply lessons learned from other developing country experience (e.g., India and Thailand). PPAs should be standardized for different categories of RE projects to facilitate bankability of new projects. This should include a template PPA for solar farms, and

a template PPA for rooftop solar. The rooftop solar could be expanded to comprise (i) a template PPA for rooftop owners and other offtakers, and (ii) a template PPA for selling to EDC based on net metering. Technical assistance for PPA standardization will include legal advisers to assist in development of bankable projects,

78. EAC may need assistance to anticipate rapid evolution of RE development and to facilitate the types of investments outlined above. The rooftop market will require a FiT and net metering to evolve, as well as clear regulatory signal so that EDC takes and pays for all surplus power. In general, EDC will need to provide open access and be allowed to take a wheeling charge so that connection of new RE capacity is a revenue-neutral or revenue-positive proposition. RE suppliers and service companies can benefit from training on installation, operations and maintenance to ensure reliability and durability of new projects. This should build on the Good Solar Initiative and could include "barefoot engineering" approaches. Training requirements specific to solar and biomass investments can be addressed during preparation of those projects. Training syllabi will be elucidated based on further review of the various donor and MDB activities, and additional support from development partners will be encouraged.

79. A comprehensive Capacity Development Program (CDP) is needed to accelerate knowledge transfer to and within MME. This will includes identification of best practices to enhance sector improvements, corporate governance, and for overall improvement of MME's operational performance. The CDP is designed to ensure availability of skills, and needed institutional structure in attaining the MME's Management vision, goals and objectives for the short-, medium-, and long-term. The capacity building program will assist MME in establishing the institutional structure best suited for the Cambodian environment, and introduce measure for monitoring compliance and policy oversight.

80. The current organizational set up of MME appears to be adequate in meeting the operational requirements. However, a human development and capacity building program is needed for its operational activities, which are discussed below. Staff are hardworking, diligent, and have good working attitude, but lack certain specialization, particularly: planning, energy economics, economic and financial analysis, costs and cost analysis, banking and financial services, environmental and social engineering, environmental and social mitigation measures. Some retraining is possible but new recruitment will also be necessary in these areas. Under the proposed capacity development program, MME would select a group of qualified and experienced senior staff (middle and top management) and provide training for undertaking a long term planning of sector development and investment planning.

81. The human development and capacity building program will include three elements, namely: (i) Formulation of policy framework, strategy, and sector development plan; (ii) Review and recommendations on appropriate institutional arrangements and organizational set up for implementing a national RE program; and (iii) Development and design of RE capacity building program with implementation arrangement/mechanism; training topics, duration, and resources

requirements; preparation/compilation of manual; and linkages with regional institutions / organizations for sharing/conducting training programs.

82. Additional priorities include corporate management and planning, which is specific to MME and EDC. Environmental and social safeguards policies also need to be updated, which applies broadly to all government agencies involved in the energy sector. These topics are described briefly below.

83. The planning process involves close coordination with other ministries, sector entities, and industrial and commercial sectors, private sector activities and involvement, to have the knowledge and full understand of their operations and needs; the rate of GDP growth; which sectors will get priority; timeframe when additional electricity will be available to meet the domestic energy demand and possibly for export to other countries; and how will the growth of the energy sector be financed (e.g., surplus revenue from energy sale, private sector, foreign investors, borrowings, tax revenue etc.). The long-term (strategic) plan helps identify the true energy demand and supply gap; and to plan for investment to bridge the gap. These long-term plans are indicative and require regular updates because of changing factors (macroeconomic factors, economic growth, industrial and consumption growth rate not being the same as projected and other factors that are beyond the control of the energy sector).

84. It is extremely important for RGC to update and implement national environmental and social safeguard policies and procedures and build capacity in line with international good practices. This is particularly relevant if coal and large hydropower remain high priorities, as these types of projects are problematic with respect to long-term sustainability. Training will be provided for environmental and social impact assessment, and possibly for application of sustainability rating systems.

b. Public Awareness

85. Public awareness campaigns are a necessary ingredient in energy sector transformation. This is particularly true for solar energy development given the rapid declines in system costs: the system costs and levelized costs of solar electricity in 2012 are obsolete, but planners and policy-making bodies may not be aware of the progress being made in achieving grid parity in other countries. Likewise, many consumers may not be aware of the potential benefits of rooftop solar. There are a host of issues in biomass energy development including potential competing land uses for food versus non-food crop production and potential impacts on forest conservation that need to be addressed in a systematic and transparent manner. The RGC also needs to consider soliciting additional support in meeting its INDCs under the Paris Climate Change Accord.

86. A public awareness campaign will be developed comprising 2 strategic aspects: (i) an internally-oriented campaign to support project development and implementation; and (ii) an

externally-oriented campaign to attract new investment and support from development partners. The external campaign will be the “Year of Renewable Energy in Cambodia” in 2017. These campaigns will be further outlined and elucidated pending endorsement of the IP.

VI. Financing Plan

87. Table 10 presents the indicative financing for the proposed investment components.

Table 10: Indicative Financing Plan ($ million)

	SREP [a]	ADB	Private Sector	Govern-ment [b]	Total
Component 1: Solar Energy Development Program					
Subcomponent 1: Solar Energy Development					
Solar Home Systems	4.0	4.0	4.0	5.0	17.0
Solar Mini-grids	2.0	2.0	4.0	5.0	13.0
Project Preparation	*0.65*	-	-	-	*0.65*
Subcomponent 2: Accelerating Solar Power through Private Sector					
Rooftop Solar Systems	6.0	8.0	32.0	-	46.0
Utility-scale Solar Farm	8.0	12.0	40.0	-	60.0
Project Preparation	*0.65*	-	-	-	*0.65*
Subtotal	**21.3**	**26.0**	**80.0**	**10.0**	137.3
Component 2: Biomass Power Project	5.0	5.0	15.0	-	25.0
Project Preparation	*0.4*	-	-	-	*0.4*
Subtotal	**5.4**	**5.0**	**15.0**		**25.4**
Component 3: Policy Support and Public Awareness	3.0	-	-	-	3.0
TOTAL	**29.7**	**31.0**	**95.0**	**10.0**	**165.7**

Note: [a] Excludes Investment Plan preparation grant (IPPG) of US$ 0.3 million
[b] Government contribution to Rural Electrification Fund

88. The long-term investment for RE scale up to contribute to energy sector transformation is on the order of at least $1 billion, assuming ultimate capacity of 1,000 MW. Because of competing demands of other sectors of the economy, the government has already delegated electric power generation to the private sector. Any public sector capital outlay will be limited by necessity. As discussed in the preceding section, the enabling environment for commercial investment will need to evolve and improve rapidly. The financing plan presented in Table 10 is therefore indicative and subject to change. The total investment envisioned assumes that ADB contributions will cover 25% of total projects costs, and that SREP cofinancing will facilitate additional private sector investment (financing plans for individual projects will be determined during project preparation). Financing instruments will be identified during project preparation and may include grants, loans, equity, risk-sharing, guarantees, and output-based aid. Experiences from previous and on-going RE programs in Cambodia and other developing countries will be drawn upon to inform project design and financing arrangements. The principle of minimum concessionality will be applied; alternatively stated, precision-guided subsidies will be used to maximize the effectiveness of

SREP cofinancing.[18] ADB will assist the RGC in seeking support from other development partners. Recognizing the need for long-term financial support, a second phase of financing may be proposed based on progress during the first 2 years of implementation, which could include potential support from SREP (if new financial resources are made available), the Green Climate Fund, and other sources.

[18] For example, in 2010 ADB-PSOD utilized a small grant from ADB's Clean Energy Financing Partnership Facility (CEFPF) as part of the construction contingency funds for a 55 MW solar project in Thailand which was the first utility-scale thin-film solar PV plant in Asia. At the time the project was being designed, construction contingencies for solar plants were higher than conventional plants by a factor of 10 or more, i.e., about $200,000 per MW of solar versus $15,000 – 20,000 for a conventional gas-fired power plant. A $2 million grant was approved as a standby contingency fund, which was ultimately not required for project commissioning; the grant was returned to ADB's CEFPF. In this instance, the leverage on the grant funds was effectively infinite since the CEFPF grant was not expended on the project.

VII. Responsiveness to SREP Criteria

Table 11: Responsiveness to SREP Investment Criteria

SREP Investment Criteria	Solar Energy Development Program	Biomass Power Project
Increased RE capacity and increased access to energy via RE	Strategic focus on scalable solutions for access to energy and productive end use of energy including (i) solar home systems, mini-grids, (iii) rooftop systems, and (iv) solar farms. Aggregate RE capacity of at least 68 MW and energy output greater than 124 GWh/y directly supported by SREP.	Strategic focus on access to energy and productive end use of energy through use of waste biomass for electricity production. The proposed power installations are replicable and scalable. SREP will support 10MW biomass capacity with energy output of 60 GWh/y.
Low-emissions development	Cambodia has an opportunity to diversify its energy supply mix and shift toward low emissions development with solar and biomass. Solar and biomass potential is estimated to be well over 1,000 MW, which can contribute significantly to reduced reliance on unsustainable fossil power. Commercial development of these priority resources can be expected to facilitate future development of wind power. From the total aggregated solar and biomass capacity, an estimated 97,000 tCO_2e of GHG emission is expected to be reduced.	
Affordability and competitiveness of RE	Off-grid solutions can be delivered well below the cost of existing petroleum-based generation. On-grid solutions will initially require concessional financing support, but installed costs are expected to decline rapidly on successive installations and achieve grid parity in the near term. All solar components are expected to benefit from declining system costs in the near term.	Biomass power can be delivered at parity with grid power in rural areas where REE delivers power supplied by EDC. Biomass power can be delivered below the cost of diesel-based generation when feedstock is secured at low cost.
Productive use of energy	Solar home systems and mini-grids will provide households and villages expanded and improved electricity supplies for lighting, fans, refrigeration, radio, and television. Successively larger installations will expand productive end-use of energy which enhance income and welfare of rural communities. Rooftop and solar farms provide on-grid capacity for residential, commercial, and industrial consumers, with benefits accruing from long-term cost savings.	Additional capacity and output will support enhanced productivity in the agricultural sector.
Economic, social, and environmental development impact	For solar home systems and mini-grids, additional economic benefits will result from expanded commercial use of energy. Social benefits will accrue from access to electricity for lighting, refrigeration, and home appliances.	Economic benefits will result from reducing the cost of electricity supply to consumers. Social benefits will indirectly accrue from expanded energy supply in rural areas dominated by agriculture.

SREP Investment Criteria	Solar Energy Development Program	Biomass Power Project
	All solar components will provide economic benefits by reducing the cost of electricity supply to consumers. Environmental benefits will accrue from reduced use of petroleum fuels for power generation.	Environmental benefits will accrue from using biomass which would otherwise be disposed as waste, which will reduce use of petroleum fuels for power generation.
Economic and financial viability	The solar home systems and mini-grids will be economically viable based on avoided costs of petroleum-based generation. Rooftop and solar farms will become commercially viable with credit enhancements provided by concessional finance.	Biomass power will become commercially viable with credit enhancements provided by concessional finance.
Leveraging of other financing	SREP funds will catalyze private sector development with overall leverage of about 1:4. The demonstration impact of the proposed solar program and biomass power project, along with policy evolution, are expected to result in replication and scale up in the near-term, with potential for as much as 500 MW of RE capacity in the medium to long term.	
Gender	Women and children will benefit from the affordable and reliable electricity. Women can extend their work hours, while children can study at night. . Potential gender benefits to be assessed during project preparation.	
Co-benefits	Co-benefits will be mainly in form of reduced air emissions from diesel generation which will reduce impacts on public health.	

EDC = Electricité du Cambodge , GWh/y = Gigawatt-hours per year, MW=megawatt, RE = renewable energy, REE = rural electrification enterprise, SREP= Scaling Up Renewable Energy for low-income countries Program.

VIII. Implementation Potential with Risk Assessment

89. Table 12 describes the implementation potential of SREP IP in terms of risks associated, mitigation measures, and level of residual risk.

Table 12: Implementation Potential and Risk Summary

RISK	DESCRIPTION	MITIGATION	RESIDUAL RISK
Policy and Regulatory Framework	Weak institutional and legal framework to support RE investments. The government does not have RE generation targets. Slow progression on the drafting and approval of framework and policies.	The capacity building program targets improvement in national RE regulatory and policy framework, which will cover the introduction of policies on net metering, FiT, and fair value tariffs to make investments in solar and biomass more attractive. A sector development plan will also be drafted, with Sustainable Development Goal 7 and Cambodia's Intended Nationally Determined Commitments to the Paris accord as starting points.	Medium
Institutional Risks	Limited institutional capacity which might prevent a well-planned and coordinated introduction of RE services targeted at rural development	Another component of the capacity building program is the review of institutional structure and recommendations of appropriate organizational set-up to ensure proper coordination among involved agencies. This will be complemented by a tailored capacity building activities among selected staff of MME, EAC, EDC, REF and private sectors to strengthen their technical knowledge and skills for managing various RE systems (including technologies for net metering), and for long-term development planning.	Low
Financial Risk	Lack of benchmark tariffs and Feed-in Tariffs (FiT) to support bankable power purchase agreements.	The introduction and institutionalization of net metering and FIT will make investment payback times more attractive and reduce cost of capital.	Low
Social and environmental risks	Limited institutional capacity for addressing social and environmental issues	Project preparation will cover due diligence to assess potential environmental and social impacts of the proposed solar and biomass projects to ensure that the government and ADB safeguards requirements are complied.	Low
Renewable resource uncertainty	RE technology outputs may be lower than expected due to seasonal variation. Issues on RE technology reliability need to be addressed.	The project preparation will assess technical viability of solar and biomass. Solar energy is abundant in the country, thus low risk. However for biomass, there is a need to develop a system for collection and management of feedstock. Site selection for the proposed project will ensure availability of feedstock such as rice husks, and corncob and straw. Site	Low for solar. Medium for biomass.

RISK	DESCRIPTION	MITIGATION	RESIDUAL RISK
		should be close to the off take area to have time/cost efficient logistics. Based on early experience with solar home systems deployed through REF, a minimum 2-year guarantee period will be required from suppliers of SHS and mini-grid systems. For rooftop and solar farms, similar guarantees will be required, and provision could be made for an extended operations and maintenance period.	

EDC = Electricité du Cambodge, EAC = Electricity Authority of Cambodia, FiT = Feed-in Tariffs, MME = Ministry of Mines and Energy, RE = renewable energy, REF = Rural Electrification Fund, SHS = solar home systems.

IX. Monitoring and Evaluation Framework

90. A monitoring and evaluation (M&E) system will be established by the Government, in cooperation with ADB and other donor partners, for the purpose of tracking and reporting on progress in achieving SREP objectives and outcomes. The M&E framework will be coordinated by the Ministry of Mines and Energy. Table 13 summarizes the proposed M&E framework for Cambodia's SREP IP.

Table 13: Results Framework for SREP in Cambodia

Results	Indicators	Baseline	Targets	Means of Verification
SREP Transformative Impacts				
Support low carbon development pathways	Percentage of total households with access to electricity[19]	55% in 2015	70% by 2030	MME
	RE capacity (MW) and annual electricity output (GWh/y)	Capacity: 60 MW in 2014 [a] Output: 158 GWh/y	Capacity: 150 MW by 2023; 200 MW by 2030 Output: 394 GWh/y by 2023; 526 GWh/y by 2030	MME
	Increased annual public and private investments ($) in targeted subsector(s)	$84 million	$210 million in 2023 and $280 million	MME
SREP Outcomes				
1. Increased supply of renewable energy	Annual electricity output from RE as a result of SREP interventions			SREP Projects, MME
	Installed capacity	0	78 MW	
	Design Output	0	184 GWh/y	
2.New and additional sources for renewable energy projects	Leverage factor ($ finance from other sources compared to SREP funding)	0	1:4	SREP Projects M&E, MME
3. Increased access to modern energy services	Number of women and men, businesses and community services benefiting from improved access to electricity and fuels as a result of SREP interventions	0	460,000 people or around 92,000 households Male: 223,100 Female: 236,900	SREP Projects M&E, MME
4. Greenhouse Gas emissions mitigated	CO_2 emissions reduction	0	97,000 tCO_2e/year by 2020	MME, MOE

CO_2 = carbon dioxide, GWh/y = gigawatt-hour per year, MME = Ministry of Mines and Energy, MW = megawatt, M&E = Monitoring and Evaluation, tCO_2e = tons of carbon dioxide equivalent.

Note: [a] Does not include large hydropower

[19] The Revised SREP results framework (2012) indicates that this indicator should be a "National measure of 'energy poverty' such as the Multi-dimensional Energy Poverty Index (MEPI), or some equivalent mutually agreed measure." Energy poverty is a multi-dimensional problem which includes problems associated with a lack of access to sufficient energy supply, a lack of access to clean energy, and a lack of access to affordable energy. . For this purpose, energy access is used to measure poverty.

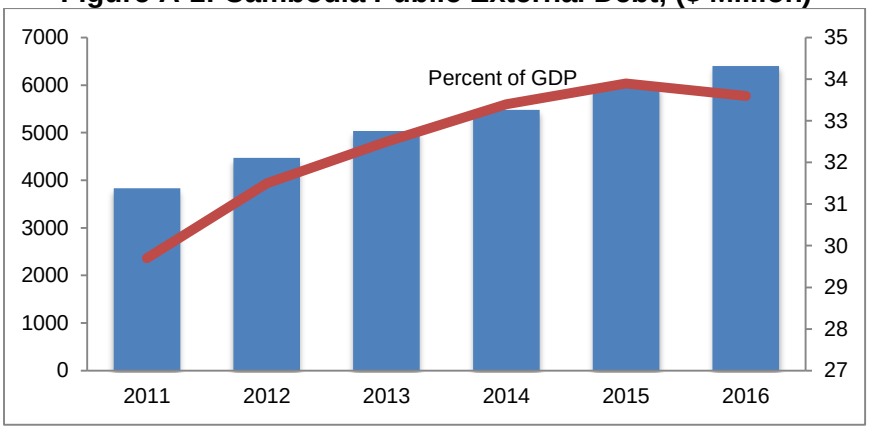
Annex A: Assessment of Cambodia's Absorptive Capacity

A. Debt Sustainability

Cambodia is among the fastest developing economies in recent years. In 2015, the country has sustained solid economic growth and expected to remain robust in 2016 with 7.0% projection. Garment and footwear manufacturing, construction, and services contributed strongly to the economic growth in 2015. Domestic demand remained strong, accommodated by low inflation and high credit growth. Inflation averaging 1.2% in 2015 is the lowest since 2009. The government's fiscal consolidation efforts narrowed the deficit, excluding grants, to an estimated 2.4% of GDP in 2015 from 3.5% in 2014 (ADB Asian Economic Outlook, 2016).

The International Monetary Fund (IMF) 2015 debt sustainability analysis shows that Cambodia is at low risk of debt distress; however, it continues to be vulnerable to growth, exports, fiscal shocks, and the materialization of contingent liabilities. Country's external public debt rose from $5.4 billion in 2014 to an estimated $5.9 billion in 2015, equal to 33.9% of GDP. Large exchange rate depreciation or export shocks could potentially have a major impact on the debt dynamics, including loose fiscal policy.

Figure A-1: Cambodia Public External Debt, ($ Million)



Source: IMF Cambodia Country Report, 2015

Cambodia's external public debt is one of the lowest among major developing countries. Large share of public debt is sourced out from bilateral sources, which increased from 50% in 2009 to 69% in 2014. China is the country's largest bilateral creditor, contributing to about 62% of the total bilateral debt stock and about 90% of bilateral debt disbursement during the past three years. External debt disbursement is projected to average about $550 million annually over the next five years, or about 2.5% of GDP.

Cambodia has practically no domestic debt. The Government targets to focus more on mobilizing domestic revenue and raising government deposits (i.e., savings, not borrowings) than issue domestic debt over the medium term.

The vulnerability of the country's debt sustainability requires continued structural reforms to increase the economy's resilience against external shocks, and to mobilize fiscal revenues. The government remains committed to reduce fiscal deficit and maintain debt-to-GDP ratio below 30% over the medium term to ensure debt sustainability and to secure stronger fiscal buffer over the longer term. At the same time, the government's policy of avoiding non-concessional borrowing has also been a key factor in sustainable debt management. Moreover, the debt management committee has recently revised the debt policy framework, which now includes a ceiling on government guarantees at 4% of GDP. The authorities have also designated a contingency fund account for contingent liabilities related to enterprises in the power sector.

Table A-1: Cambodia Public External Debt by Source, 2014

	$ Millions	Share of Total External Debt	% of GDP
Total	**5,483.5**	**100.0**	**33.1**
Multilateral	1,696.8	30.9	10.3
Bilateral	3,786.6	69.1	22.9

Source: IMF Staff Report for the 2015 Article 5 Consultation – Debt Sustainability Analysis

B. Institutional Capacity

The Ministry of Mines and Energy will serve as focal point and the executing agency for the SREP Investment Plan (IP). The Electricité du Cambodge (EDC) will be the implementing agency for the proposed SREP projects. The preliminary implementation schedule is outlined in Table A-2 below. For the successful implementation of the SREP, extensive capacity building program will be conducted among selected staff of the MME.

The proposed Capacity Development Program (CDP) will be a major undertaking under the proposed SREP IP. This program will accelerate the knowledge transfer at MME of best practices to enhance their respective capabilities for sector improvements, corporate governance, and for overall improvement of MME's operational performance. The capacity building program is designed to ensure availability of skills, and needed institutional structure in attaining the MME's Management vision, goals and objectives. The capacity building program will assist MME in establishing the institutional structure best suited for the Cambodian environment, and introduce measure for monitoring compliance and policy oversight. The implementation of the program covers the short-, medium-, and long-term capacity building requirements.

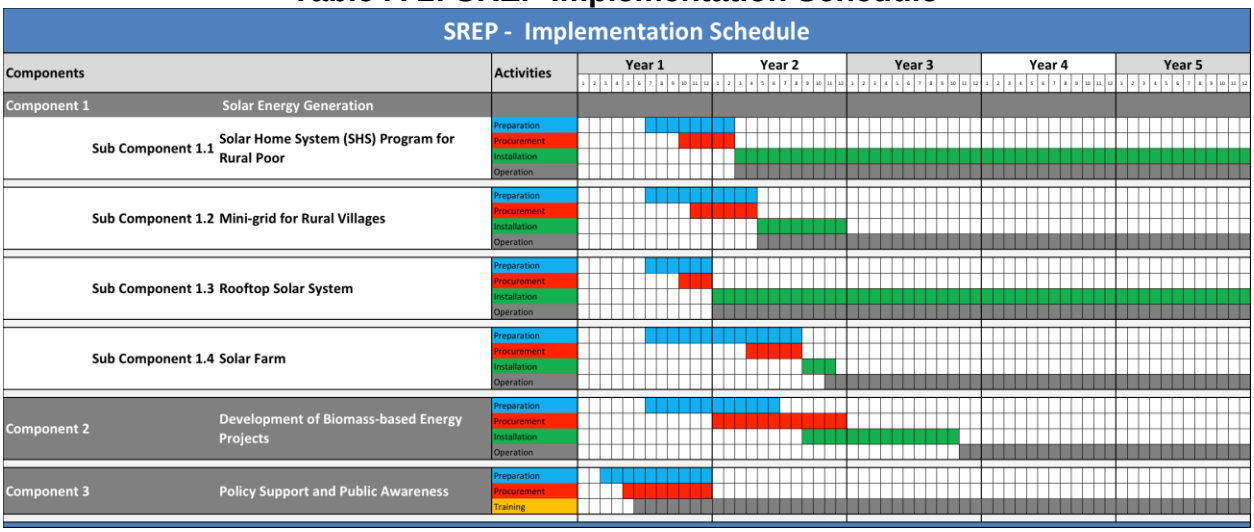
The capacity building program will include three components, namely:

(a) formulation of policy framework, strategy, and sector development Plan;

(b) review an recommendations on appropriate institutional structure/ organizational set up for implementing RE program;

(c) development/design of RE capacity building program with implementation arrangement/mechanism; training topics, duration, & resources requirements; preparation/compilation of manual; and linkages with regional institutions/organizations for sharing/conducting training programs.

Table A-2: SREP Implementation Schedule



Annex B: Stakeholder Outreach

Integral to the development of the SREP IP for Cambodia is the engagement of various stakeholders to inform them on SREP objectives, solicit inputs and feedbacks on the proposed investments, and its development outcomes and impacts. Stakeholders were composed of representatives from government agencies, development partners, civil society organizations, local and international non-government organizations, and private sector.

Series of consultations with a number of government agencies were undertaken in developing the IP. Table B-1 below provides the list. The government recognizes that Cambodia's development of renewable energy (RE) sources is very slow. RE resource development and technology deployment is mainly in initial demonstration stages. SREP support is needed to overcome barriers, including financing of physical investments and assistance for policy evolution. The Ministry of Mines and Energy (MME) highly supports solar and biomass energy development given the high technical potentials and market size for these two RE resources in the country.

Table B-1: List of Government Agencies Consulted

Institution	Name/Title	Contacts
Ministry of Economy and Finance (MEF)	H.E. Hem Vanndy, Undersecretary of State H.E. Pen Thirong, Deputy Director General Mr. Yi Sokthearith, Chief Multilateral Cooperation 1 Mr. Ohan Sopanhavorn	023 427 798 hemvanndy@hotmail.com
Ministry of Planning (MOP)	Mr. Nop Rannavuth, Deputy Director General	
Council for Development of Cambodia (CDC)	Mr. Chea Vuthy, Deputy Secretary General	
Ministry of Mines and Energy (MME)	H.E. Victor Jona, Director General Mr. Toch Sovanna, Director, Department of New and Renewable Energy	012 918 401 jvictor.mime@gmail.com 017- 85 69 27 tochsovannamme@gmail.com
Ministry of Agriculture Forestry and Fisheries (MAFF)	H.E. San Vanty, Undersecretary of State	
Ministry of Rural Development (MRD)	Mr. Dok Doma, Deputy Director of Water Supply	dokdoma@gmail.com
Rural Electrification Fund (REF)	Mr. Loeung Keosela, Director Mr. Kim Rithy, Deputy Director,	089 267 071

Institution	Name/Title	Contacts
	M&E	
EDC	Dr. Praing Chulasa, Deputy Managing Director, Planning & Techniques Mr. Rann Seihakkiry, Deputy Director of Coporate Planning and Projects Mr. Nong Sovanneth, Assistance Project Manager	012 444 968 chula.praing@gmail.com 012 533 570 rs_kiry@hotmail.com sovannethnong@yahoo.com
MME Petroleum Department	Mr. Chea Socheat	
Ministry of Environment	Mr. Chuop Paris, Deputy Secretary General Mr. Thy Sum, Director Climate Change Department	
Electricity Authority of Cambodia	Mr. Badri Prasad Rekhani Electrical Engineer and Regulatory Expert	012 652 016 bprekhani@yahoo.com

21 January 2015, 1st Stakeholders Consultation Workshop

The first consultation workshop aims to orient stakeholders on the objectives of the SREP, its benefits and the modalities of its implementation in Cambodia to ensure a common understanding. CSOs, NGOs, private sector investors, technology suppliers and financial institutions attended the workshop.

Feedback from the various stakeholders indicates that there is potential value-addition to be created with SREP support for larger scale RE development, exploitation of the full spectrum of RE resources, application of a variety of RE technologies for various end-users, and opportunities to employ new financing and business models for RE development. For example, SREP might be utilized to assist Rural Electricity Enterprises with RE systems to reduce diesel generation; this assistance might be delivered with support from existing micro-finance institutions.

Table B-2: List of Private Sector, CSOs and NGOs Consulted

Institution	Name/Title	Contacts
Private Sector		
Solar Partners Asia Cambodia Ltd	Mr. Jim Gramberg, CEO	info@solarpartners.asia jim@solarpartners.asia 017661500, 023 99 03 00
EcoSun Energy Cambodia	Mr. Sun Mao, Director	ecosuncam@gmail.com 023 6664666 016 958 035/ 855 12 635 865 077 776 818, 097 8381525
Khmer Solar Ltd	Mr. Ford Thai, President	info@khmersolar.com 012 78 78 36 / 011 911 922 /

Institution	Name/Title	Contacts
		016 83 00 38 / 010 32 33 28
Foreign Trade Bank of Cambodia	Mr. Mean Channarith, Official	narith@ftbbank.com 023 724 466 /722 466
Chief (Cambodia) Specialized Bank Plc.	Mr. Thul Kosal, Legal and Compliance Manager Mr. Sok Samnang, Deputy Marketing Manager	thulkosal@yahoo.com, samnang.sok@chiefholdings.com.kh tola.vann@chiefholdings.com.kh 023 430 888
The Small-Scale Sustainable Infrastructure Development Fund, Inc.	Russell J. deLucia, President Elizabeth Friend	delucia@s3idf.org Elizabeth@s3idf.org
Rural Development Bank (RDB)	Miss Ou Sarinda, Credit Officer	admin@rdb.com.kh 023 220 810/811
Comin Khmer Co., Ltd	Keo Moly, Business Development Manager	ckadmin@comin.com.kh keomoly@comin.com.kh 023 885 640-8 011 967 679 / 12 652 698
Energy Saving Supply Co.; Ltd	Mr. Tes Bunheang, Sale Manager	tes.bunheang@ess.com.kh 012 222 515; 023 33 80 20
National Bank of Cambodia	Ms. Ponn Dalyn, Deputy Director, Economics Research Dept Ms. Sun Chhavivann	info@nbc.org.kh 012 211 422 / 023 722 563/722 221 012 882 973
CSOs/NGOs		
The Asia Foundation	Mr. Silas Everett, Country Representative	cambodia.general@asiafoundation.org 023 210-431
SNV Cambodia	Mr. Jon Exel, SNV Senior Renewable Energy Advisor Jason Steele, Sector Leader Renewable Energy	cambodia@snvworld.org JSteele@snvworld.org JExel@snvworld.org 012 267 099; 023 994 562
Cambodian NTFP Development Organization (CANDO)	Heang Sarim, Executive Director	candodevelopment@gmail.com 023 630 2237 / 75 645 1000 092 286 383
Forum Syd	Mr. Tep Chansothea, Program Officer-Climate Change Mr. John Week, Communication Officer	chansothea.tep@forumsyd.org 023 221 147 012 70 50 72

5 May 2016, 2nd Stakeholders Consultation Workshop

The second stakeholders consultation workshop aims to bring together different stakeholders to give updates in the preparation of the country's renewable energy investment plan, discuss criteria used for the selection of renewable energy technologies, present the proposed priority projects and potential development impacts, and solicit feedbacks and suggestions to further improve the plan.

The workshop was comprised of morning and afternoon sessions. Representatives from private sectors, developers and non-government organizations participated the morning session, while development partners attended the afternoon session. Discussion with the private sectors and NGOs focused mainly on the lack of solar energy pipeline in the country, lack of policy framework such as net metering and FiT to attract private sector participation, and strategies for capacity building in managing and implementing RE technologies, including the after sales service. One suggestion is to link proposed capacity building activities with on-going efforts from different organizations such as World Bank and GIZ projects.

Table B-3: List of Private Sector, CSOs and NGOs Consulted

Organization	Name	Contact details
Private Sector/Developers		
Asian Gateway	Ms. Sen Chandany, Manager	dany@asiangateway.co.jp
Camagra – Cambodia Office	Prof. Nir Atzmon, GM Field Operation	info@camagra.net nir.atzmon@gmail.com 023 215 816 / 023 991 161
Cambodia Solar	Khim Bunlene, General DIrector	bunlene.camsolar@gmail.com 090999996
EcoSun Energy Cambodia	Mr. Sun Mao, Director	ecosuncam@gmail.com 023 6664666 / 016 958035/ 855 12635 865 / 077 776818
Japan Development Institute Ltd. (JDI)	Tsumio Hatsukade, Senior Consultant	hatsukade@jditokyo.com +81-3-5280-7707 +81-90-9398-3904
Nexus	Ms. Nodira Akhmedkhodjaeva, Program Development Director	n.akhmedkhodjaeva@nexusfordevelopment.org
NRG Solutions	Mr. Jack Pegle, Business Development Manager	jack@nrg-renewables.com
Lighting Engineering Solutions	Mr. Sokun Sum, Chief Executive Officer	Sokun@lightingengineeringsolution.com Sum.sokun168@gmail.com (855) 15 518 111
Solar Energy Association Cambodia (SEAC) / Eurocham Greenbiz Committee	Ms. Romina de Jong, Secretary/ Vice Chairman Ms. Pauline Ronteix	romi.dejong@gmail.com
Solar Partners Asia (Cambodia), Ltd.	Mr. Rogier Van Mansvelt, Chief Technical Office	+855 (0)12 304332 / +855(0) 23 99 03 00
Solar Partners Asia (Cambodia) Ltd	Mr. Jim Gramberg, CEO	info@solarpartners.asia jim@solarpartners.asia 017661500, 023 99 03 00

Organization	Name	Contact details
Soma Energy	Mr. Adisorn Masaw Mr. Leuk Dana, Marketing Manager	masawa@somaenergy.com.kh danaleuk37@gmail.com
CSOs/NGOs		
Cambodia Climate Change Network	Mr. Udom Kong, Network Coordinator	coordinator@cccn.org.kh +855 17 94 98 86 +855 15 92 44 51
Cambodia Development Resource Institute	Mr. Nong Monin, Researcher	monin@cdri.org.kh
Enrich Institute	Mr. Pheakdey Heng, PhD, Founder & Chairman	hengpheakdey@yahoo.com
Forum Syd	Mr. Khieng Sochivy, Country Manager Mr. Tep Chansothea, Programme Officer Environment and Climate Change	+855 (0) 23-22 11 47
Live & Learn	Mr. Socheath Sou, Director	socheath@gmail.com 855 (89) 300 307
NGO Forum	Mr. Hoc Menghoin, Project Coordinator	menghoin@ngoforum.org.kh
Royal University of Agriculture (Academe)	Dr. Kunthy Sok, Vice Rector	skunthy@rua.edu.kh s_kunthy2005@yahoo.com 012 831 243
SNV Cambodia	Dennis Barbian, Associate Adviser Renewable Energy Market Development	DBarbian@snvworld.org +855 12 617 438 / +855 23 994 562 / +855 23 994 563

In the afternoon session, each development partner discussed their ongoing and planned RE projects. Participants agreed that a regular donor coordinative meeting is helpful to inform everyone and avoid duplication of interventions. For example, UNDP will conduct a study on FIT and net metering in 2017 which SREP projects will benefit. AFD, on the other hand, is currently implementing the Green Microfinance Project providing credit line to three microfinance institutions in Cambodia and technical assistance for coordination and incentives for solar suppliers.

Table B-4: List of Development Partners Consulted

Organization	Name	Contact details
Agence Française de Développement (AFD)	Mr. Glen Andre	andreg@afd.fr
International Fund for Agricultural Development (IFAD)	Mr. Karan Sehgal, Portfolio Officer, RE Technologies Environment and Climate Division	k.sehgal@ifad.org +855 102 290 47
International Finance Corporation	Mr. Sukim Mel, Operations Officer	smel@ifc.org 017 888 352

Organization	Name	Contact details
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH	Mr. Sokhai NOP, Advisor-Planning and Budgeting Climate Finance Readiness (CF Ready)	sokhai.nop@giz.de + 855 23 663 8370 + 855 23 663 8370 + 855 78 83 89 85
Japan International Cooperation Agency (JICA)	Mr. Chhorn Chamna, Program Officer, Infrastructure Division	ChhornChamna.CM@jica.go.jp +855-(0) 23-211 675 +855-(0) 23-211 673-4
KfW	Mr. Kob Math, Coordinator	077414477
United Nations Industrial Development Organization (UNIDO)	Mr. Narin Sok, Senior Representative	N.SOK@unido.org
United Nations Industrial Development Organization (UNIDO)	Mr. Ngov-Veng Chheng, National Project Coordinator	N.CHHENG@unido.org
United Nations Development Programme (UNDP)	Phearanich Hing, Climate Change Policy Analyst	phearanich.hing@undp.org +855 23 216 167, Ext: 232 +855 23 216 251/721 042

Annex C: Co-Benefits

This Annex provides a list of co-benefits that are expected from the implementation of SREP investments.

Table C-1: Co-Benefits Associated with SREP Impacts and Outcomes

Results	Co-benefits	Description
Support low-carbon development pathways by increasing energy security	Avoided GHG emissions	The proposed investments on renewable energy will result to reduced reliance on fossil fuel and forest resources, thus help reduce potential GHG emissions. The implementation of the projects will directly avoid an estimated 97,000 tCO_2e/year which otherwise be produced from diesel-based generator use. Moreover, the awareness campaign component will help improve customer's perceptions on the value and benefits of renewable energy. It will create a customer-driven market on renewable energy thereby increasing potential for more GHG emission reduction.
	Employment opportunities	The community-based renewable energy projects will facilitate the creation of employment opportunities. The technical and capacity building support, which aims to ensure effective operation and maintenance of the system, will create long-term employment among local community members. The creation of a viable RE market will encourage participation among private sector investors. As a result, value-added employment will be created in solar and biomass industries, including manufacturing and energy services.
Increased supply of renewable energy	Increased reliability	SREP will help diversify the country's current energy mix by supporting the installation of about 68 MW of solar capacity and 10 MW of biomass. The implementation of the projects will increase availability and reliability of energy supply in the country, which currently does not meet demand and 24-hour supply of electricity is not assured. Women will equally benefit from better security and reliability of supply. Women are the mainstream users of energy.
New and additional resources for renewable energy projects/ programme	Reduced cost of RE	SREP investments are expected to displace about 184 GWh worth of diesel per year. It will help reduce dependence on expensive fossil fuels and accelerate the development of solar and biomass energy in the country, which currently is at initial stage. The successful demonstration of these RE technologies will enable and encourage private sector participation which will help establish RE cost competitiveness as against diesel-based generation.

GHG = greenhouse gas, GWh = gigawatt-hour, MW = megawatt, RE = renewable energy, SREP = Scaling-up Renewable Energy Program, tCO_2e = tons of carbon dioxide equivalent

Annex D: Project Concept Notes

Component 1: Solar Energy Development Program

Problem statement

1. Solar is one of the best potential renewable energy (RE) resources in Cambodia with respect to scalability, potential applications, resource and technology risks, and speed of deployment. Cambodia's installed generation capacity in 2015 was 1,569 MW with energy output of 4,448 GWh. The technical solar energy potential is estimated at 8100 MW, with near-term market prospects of 400 MW to 500 MW which could provide 730 to 913 GWh per year[20], which is around 17% of total energy output in 2015. While this represents a small percentage of total energy output, the potential financial and economic savings are substantial. In areas served by petroleum-based generation costing around $0.70/kWh, there are compelling prospects to deliver access to electricity for productive end uses at much more affordable rates, especially to the poorest consumers. In grid-supplied areas, solar can save consumers as much as 40% on their monthly bill, but the solar prospect is still viewed as unfeasible.

2. The market remains largely undeveloped due to (i) psychological barriers due to past experience with sub-standard equipment and lack of after sales service and maintenance; (ii) financial barriers in the form of upfront capital costs and lack of commercial financing; and (iii) absence of clear policy support and instruments such as feed-in tariffs (FiTs), net metering, open access for grid interconnection issues, tax incentives, and licensing procedures. Despite these constraints, there is a nascent domestic solar industry with 25 companies. The Solar Energy Association of Cambodia (SEAC) has noted that a clear policy framework is needed so that capital can be mobilized to support solar development at progressively larger scale.

Proposed contribution to initiating transformation

3. Given the constraints noted above, the solar industry needs both a policy "pull" and a market "push." There are opportunities to develop utility scale solar farms in special economic zones (SEZs) and rooftop solar which would demonstrate the viability of solar for mainstream energy applications. Solar home systems (SHS) can be scaled up and deployment can be accelerated to deliver more affordable energy to bottom-of-the-pyramid consumers. The existing solar industry can deliver this market push if concessional financing is introduced. The policy pull requires intervention to develop appropriate instruments including FiTs, net metering, grid connectivity, etc., in parallel with the learning-by-doing gained through the market push.

4. Four types of installations are proposed: (i) scaled up SHS program, (ii) solar-powered village scale mini-grids, (iii) rooftop solar, and (iv) utility-scale solar farms. SREP funds would be utilized to take out up-front development risks and buy down the cost of capital to facilitate private

[20] Assuming 5 hours per day of output at rated capacity.

sector installation and operation and maintenance of solar systems. For solar farms and other installations where some power is sold to the grid, SREP funds could cover part of the cost difference as necessary between solar output and EDC's benchmark tariff of $0.09/kWh. Lessons learned from other developing countries in Asia will be taken into consideration during project design and implementation. SREP and/or other development partners will fund the capacity development and advisory services for policy evolution including FiTs, net metering regulations, new power purchase agreements, and other incentives.

Implementation readiness

5. The SHS and mini-grid investments will be supported by ADB's public sector operations (ADB-SEEN), while the rooftop solar and solar farms will be developed by ADB's Private Sector Operations Department (ADB-PSOD). The public sector operation will deliver SREP as cofinancing through the updated Rural Electrification Fund operations (REF v2.0, discussed in the main text) to support the solar home systems and mini-grids. The rooftop and solar farms will be supported by ADB-PSOD through a combination of concessional loan and other appropriate instruments. Specific funding mechanisms need to be identified and agreed to, so that SREP grant funds will catalyze private investment without over-subsidizing developers and service providers. To the extent practical, SREP funds will be deployed as output-based aid, i.e., disbursed based on achievement of solar development milestones. Project preparation will be required to identify the appropriate financing modalities and implementation arrangements: two preparation grants are requested, one for ADB-SEEN and one for ADB-PSOD. Subsequent to endorsement of the IP, project preparation will take 6-12 months, with SREP funding approval in first quarter of calendar year 2017 at the earliest.

Rationale for SREP financing

6. Lack of commercial financing, limited policy support, and off-take price risks are major barriers to commercial solar development, which can be addressed with concessional financing. The program will support growth of the solar industry through expanded delivery of solar systems by existing private sector solar companies. The sector reforms will promote policy evolution to create a viable self-sustaining market for solar energy services. Table D1.1 presents performance and results indicators.

Table D-1: Results Indicators and Targets

Results	Indicators	Baseline	Targets	Means of Verification
SREP Project Outcomes				
1. Increased supply of renewable energy	Installed capacity	1 MW	> 68 MW	Project review missions
	Design output	0	124 GW/h[a]	
2.Increased access to modern energy services	Number of women and men, businesses, and community services benefiting from SREP interventions	0	310,000 people or 62,000 households [b]	MME
3. Increase in investments from private sector in solar energy	$ invested	0	$ 136 million	Annual reports of energy companies, technology vendors

Results	Indicators	Baseline	Targets	Means of Verification
4. Greenhouse Gas emissions mitigated	CO_2 emissions reduction	0	> 66,000 tCO_2e/year [c]	MME, MOE
SREP Inputs				
5. Capacity building activities	Workshops/training on solar installation, operations and maintenance for consumers, service providers, Rural Electrification Enterprises (REEs) Workshops on solar development policy, tariff setting, feed-in tariff design, power purchase agreements, etc.	0	X training workshops conducted X workshops conducted	Project implementation reports and ADB review missions

ADB = Asian Development Bank, CO_2 = carbon dioxide, MME = Ministry of Mines and Energy, MOE = Ministry of Environment, tCO_2e = tons of carbon dioxide equivalent.

Notes: [a] Calculated based on 5 hours a day x 365 days a year

[b] Calculated based on 400 kWh per person per year current average consumption.

[c] Assumes 0.533tCO_2e/MWh, displacing a combination of grid-supplies and diesel generation.
Reference: The International Renewable Energy Agency (IRENA), Renewable energy opportunities and challenges in the Pacific Islands region "Palau", August 2013. With 10 years of operation from 2020-30, the avoided GHG emissions represent about 25% of Cambodia's Intended Nationally Determined Contributions for Energy Industries.

Table D-2: Financing plan

	SREP	ADB	Private Sector	Govern-ment [a]	Total
Component 1: Solar Energy Development Program					
***Subcomponent 1:* Solar Energy Development**					
Solar Home Systems	4.0	4.0	4.0	5.0	17.0
Solar Mini-grids	2.0	2.0	4.0	5.0	13.0
Project Preparation	*0.65*	-	-	-	*0.65*
***Subcomponent 2:* Accelerating Solar Power through Private Sector**					
Rooftop Solar Systems	6.0	8.0	32.0	-	46.0
Utility-scale Solar Farm	8.0	12.0	40.0	-	60.0
Project Preparation	*0.65*	-	-	-	*0.65*
Total	**21.3**	**26.0**	**80.0**	**10.0**	**137.3**

Note: [a] Government contribution to Rural Electrification Fund

Table D-3: Project preparation timetable

Milestone	Date
SREP Updated IP Endorsement	Q2 / 2016
SREP funding approval	Q1 / 2017
ADB Board/Management consideration	Q3 / 2017

Project Preparation Grant

The RGC is requesting project preparatory grants for the two subcomponents of the Solar Power Development Program.

Table D-4: Project Preparation Grant Request for Solar Power Development Program: Solar Energy Development (Solar Home Systems and Solar Mini-grids)

SREP Project Preparation Grant Request			
Country/Region:	Cambodia	**CIF Project ID**#:	
Project Title:	*Solar Energy Development (Solar Home Systems and Solar Mini-grids)*		
Tentative SREP Funding Request (in US million total) for Project at the time of Investment Plan submission (concept stage)::	*Grant: $5 million*	*Loan: $1 million*	
Preparation Grant Request (in $):	$650,000	MDB: Asian Development Bank	
National Project Focal Point:	Dr. Praing Chulasa, Deputy MD, EDC		
National Implementing Agency (project):	Electricite' du Cambodge		
MDB SREP Focal Point and Project Task Team Leader (TTL):	*SREP Focal Point:* Christian Ellermann Climate Change Specialist Asian Development Bank	*TTL:* Rehan Kausar Unit Head, Project Administration Southeast Asia Department Asian Development Bank	

Description of activities covered by the preparation grant:

A preparation grant is required for (i) detailed feasibility study for off-grid, mini-grid and grid-connected rooftop solar and utility-scale solar farm solar generation; (ii) solar energy resource assessment; and (iii) due diligence which covers:

a. Technical. Appropriate technology for solar power will be assessed, particularly related to operating and maintenance requirements.
b. Economic and financial. Economic and financial analysis will be undertaken of the project in accordance with ADB's financial management and analysis and economic analysis guidelines.
c. Procurement. Procurement capacity assessment of EDC and the subsidiary Rural Electrification Fund (REF) will be undertaken. Procurement packages will be prepared.
d. Institutional Capacity. Capacity assessment of EDC and REF will include procurement capacity, project management capacity and financial management capacity.
e. Safeguards, Social, Poverty and Gender. All safeguards will be addressed according to the ADB Safeguard Policy Statement, June 2009. Environmental assessment will ensure environmental impacts are mitigated. Land acquisition and impact on indigenous peoples will be assessed and resettlement and indigenous peoples plans prepared, as required. Social, poverty and gender analysis will be conducted. A gender action plan will be prepared.

Outputs:	
Deliverable	**Timeline**
(a) Detailed FS	10 months after Notice to Proceed (NTP)
(c) Due Diligence Report	10 months after NTP
(d) Grid Stability and Control Strategy	12 months after NTP
(e) Project identification and pre-feasibility	12 months after NTP

Budget (indicative):	
Expenditures	**Amount ($) -** estimates
Consultants	450,000
Equipment	10,000
Local workshops/seminars	30,000
Travel/transportation	50,000
Others (admin costs/operational costs)	60,000
Contingencies (max. 10%)	50,000
Subtotal	**650,000**
Other contributions:	
• Government	-
• MDB	-
• Private Sector	-
• Others (please specify)	-
Total Cost	**650,000**
Timeframe (tentative) Expected Board/MDB Management approval date: *Project Preparation Technical Assistance approval: January 2018*	
Other Partners involved in project design and implementation: •	
If applicable, explanation for why the grant is MDB executed: The Government of Cambodia has requested ADB to execute the grant due to its limited capacity in handling the timely contractual preparation of such a consultancy.	
Implementation Arrangements (incl. procurement of goods and services)**:** The executing agency will be EDC. The implementing agency will be REF will be established to review project progress, coordinate inter-ministerial activities and guide the Project Management Unit (PMU), which will be established within REF. The PMU will be supported by implementation consultants. All equipment and civil works procurement will be carried out in accordance with ADB's *Procurement Guidelines* (2010, as amended from time to time). Consultants will be recruited in line with ADB's *Guidelines on the Use of Consultants* (2013, as amended from time to time), through consulting firm or individual selection method. The procurement method would be international competitive bidding (ICB).	

Table D-5: Project Preparation Grant Request for Solar Power Development Program: Accelerating Solar Power through Private Sector (Rooftop Solar Systems and Utility-scale Solar Farm)

SREP Project Preparation Grant Request			
Country/Region:	Cambodia	**CIF Project ID**#:	
Project Title:	*Accelerating Solar Power through Private Sector (Rooftop Solar Systems and Utility-scale Solar Farm)*		
Tentative SREP Funding Request (in $ million total) for Project at the time of Investment Plan submission (concept stage):	*Grant: $3 million*	*Loan: $11 million*	
Preparation Grant Request (in $):	$650,000	MDB: Asian Development Bank	
National Project Focal Point:	Dr. Praing Chulasa, Deputy MD, Electricite' du Cambodge		
National Implementing Agency (project):	Electricite' du Cambodge		
MDB SREP Focal Point and Project Task Team Leader (TTL):	*SREP Focal Point:* Christian Ellermann Climate Change Specialist Asian Development Bank	*TTL:* Shuji Hashizume Investment Specialist Private Sector Operations Department Asian Development Bank	

Description of activities covered by the preparation grant:

A preparation grant is required for (i) detailed feasibility study for mini-grid and grid-connected rooftop solar and utility-scale solar farm solar generation; (ii) solar energy resource assessment; and (iii) due diligence which covers:

f. Technical. The following technical aspects will be assessed: (x) appropriate technology for solar power, particularly related to operating and maintenance requirements; (y) grid integration study to ensure stability of the grid after completion of the proposed project; and (z) for rooftop solar and mini-grid in particular, study on net metering what are the technical challenges and its mitigation measures.

g. Economic and financial. Economic and financial analysis will be undertaken of the project. In the context of Cambodia, the following will be taken into account in particular: (x) expected and acceptable range of tariff level based on the average generation cost and return to project developer, and (y) complementarity with hydropower plants, as solar generation can save energy (and thus water) from the hydropower plants during dry season.

h. Safeguards, Social, Poverty and Gender. All safeguards will be addressed according to the ADB Safeguard Policy Statement, June 2009. Environmental assessment will ensure environmental impacts are mitigated. Land acquisition and impact on indigenous peoples will be assessed and resettlement and indigenous peoples plans prepared, as required. Social, poverty and gender analysis will be conducted. A gender action plan will be prepared as appropriate.

In case the project preparation grant is directly extended to the private sector for an unsolicited proposal, the cost should be reimbursable by the project sponsor upon actual materialization of the project. In case the grant is extended to the government, or the proposed project does not materialize, the costs will not be reimbursed.

Outputs:	
Deliverable	**Timeline**

(a) Detailed FS	10 months after Notice to Proceed (NTP)
(c) Due Diligence Report	10 months after NTP
(d) Grid Stability and Control Strategy	12 months after NTP
(e) Project identification and pre-feasibility	12 months after NTP
Budget (indicative):	
Expenditures	**Amount ($) -** estimates
Consultants	$500,000
Equipment	
Local workshops/seminars	$20,000
Travel/transportation	$50,000
Others (admin costs/operational costs)	$15,000
Contingencies (max. 10%)	$65,000
Subtotal	**$650,000**
Other contributions:	
• Government	-
• MDB	-
• Private Sector	-
• Others (please specify)	-
Total Cost	**$650,000**

Timeframe (tentative)
Expected Board/MDB Management approval date: *Project Preparation Technical Assistance approval: January 2017*

Other Partners involved in project design and implementation:

-

If applicable, explanation for why the grant is MDB executed:
The Government of Cambodia has requested ADB to execute the grant due to its limited capacity in handling the timely contractual preparation of such a consultancy. The private sector may also need the grant to undertake a feasibility study and due diligence due to nascent stage of renewable energy sector in Cambodia, although the costs should be reimbursed by the private sector upon materialization of an actual project from such a study. If reimbursed, the funds can be recycled for another feasibility study.

Implementation Arrangements (incl. procurement of goods and services)**:**
The executing agency will be either EDC or the private sector developer. The implementing agency will be either EDC or ADB. All equipment and civil works procurement, if any, will be carried out in accordance with ADB's *Procurement Guidelines* (2010, as amended from time to time). Consultants will be recruited in line with ADB's *Guidelines on the Use of Consultants* (2013, as amended from time to time), through consulting firm or individual selection method. The procurement method would be international competitive bidding (ICB).

Table D-6: MDB Request for Payment for Project Implementation Services (MPIS)
Solar Energy Development (Solar Home Systems and Solar Mini-grids)

SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES **MDB Request for Payment of Implementation Services Costs**			
1. Country/Region:	Cambodia	**2. CIF Project ID**#:	
3. Project Title:	***Solar Energy Development (Solar Home Systems and Solar Mini-grids)***		
4. Request for project funding (US million):	*At time of country submission (tentative): $6 million ($5 million grant and $1 million loan)*	*At time of project approval:*	
5. Estimated costs for MDB project implementation services	*Initial estimate - at time of Country submission: $ 428,000* *Final estimate - at time of project approval:*	*MDB: Asian Development Bank* *Date: May 2016*	
6. Request for payment of MDB Implementation Services Costs:	√ First tranche: **$ 214,000** ☐ Second tranche: *n/a*		
7. Project financing category:	a - Investment financing - additional to ongoing MDB project ☐ b- Investment financing - blended with proposed MDB project √ c - Investment financing - stand-alone ☐ d - Capacity building - stand alone ☐		
8. Expected project duration (no. of years):	5 years		
9. Explanation of final estimate of MDB costs for implementation services:	*Not applicable*		
10. Justification for proposed stand-alone financing in cases of above 6 c or d: not applicable			

Table D-7: MDB Request for Payment for Project Implementation Services (MPIS)
Accelerating Solar Power through Private Sector
(Rooftop Solar Systems and Utility-scale Solar Farm)

SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES **MDB Request for Payment of Implementation Services Costs**			
1. Country/Region:	Cambodia	**2. CIF Project ID**#:	
3. Project Title:	***Accelerating Solar Power through Private Sector (Rooftop Solar Systems and Utility-scale Solar Farm)***		
4. Request for project funding (US million):	*At time of country submission (tentative): $14 million ($3 million grant and $11 million loan)*	*At time of project approval:*	
5. Estimated costs for MDB project implementation services	*Initial estimate - at time of Country submission: $ 428,000* *Final estimate - at time of project approval:*	*MDB: Asian Development Bank* *Date: May 2016*	
6. Request for payment of MDB Implementation Services Costs:	√ First tranche: **$ 128,000** ☐ Second tranche: *n/a*		
7. Project financing category:	a - Investment financing - additional to ongoing MDB project ☐ b- Investment financing - blended with proposed MDB project √ c - Investment financing - stand-alone ☐ d - Capacity building - stand alone ☐		
8. Expected project duration (no. of years):	5 years		
9. Explanation of final estimate of MDB costs for implementation services:	*Not applicable*		
10. Justification for proposed stand-alone financing in cases of above 6 c or d: not applicable			

Component 2: Biomass Power Project

Problem statement

1. Biomass has been designated as the second highest priority for renewable energy (RE) development with SREP support. Cambodia's installed generation capacity in 2015 was 1,569 MW with energy output of 4,448 GWh. Technical biomass energy potential is at least 500 MW[21], of which only 22.64 MW has been installed for commercial operations. Scaling up the installed capacity by a factor of five to 100 MW could provide about 600 GWh per year[22], which is 13.6% of total domestic energy output in 2015. While 100 MW represents a small percentage of capacity and energy output compared to a large coal or hydropower plant, the scale up and replication potential would still be at least 5; biomass power lends itself to distributed generation in rural agricultural areas served mainly by diesel generators. The potential environmental benefits are substantial in terms of avoided ecological degradation and public health problems associated with coal and large hydropower. Modern biomass power plants exhibit production costs of around $0.12/kWh, which compares favorably to petroleum-based generation costing around $0.70/kWh.

2. The biomass potential remains largely undeveloped due to (i) higher upfront capital costs than other generation technologies; (ii) unavailability of commercial financing; (iii) lack of technical expertise to develop and operate generation units; (iv) logistical challenges of collecting and delivering biomass to power plants; and, (v) absence of clear policy support and instruments such as feed-in tariffs (FiTs) and renewable portfolio standards. A clear policy framework is needed so that capital can be mobilized to support biomass power development at progressively larger scale.

Proposed contribution to initiating transformation

3. As is the case with the solar sub-sector, biomass power needs both a policy "pull" and a market "push." There are opportunities to deploy commercial biomass power at progressively larger scale which would be particularly beneficial in rural areas where agriculture dominates the local economy. EDC sells grid-supplied electricity to Rural Electrification Enterprises (REEs) at a price of $0.147/kWh, while the proposed biomass plants are expected to be viable at a price of $0.12-0.13/kWh.

4. The proposed biomass power project will start small, with 2 or 3 installations of 1.5 – 5 MW capacity each. SREP funds would be utilized to take out up-front development risks and buy down the cost of capital to facilitate private sector installation and operation and maintenance of the power plants. If necessary, SREP funds could cover part of the cost difference between EDC's price to REEs of $0.147/kWh and the price required to make the biomass units financially viable. Lessons learned from other developing countries in Asia will be taken into consideration during

[21] Based on available information, potential is about 150 MW for rice husk, 125 MW for rubber wood wastes, and at least 300 MW for sugar cane bagasse.

[22] Assuming 6,000 hours per year operation at rated capacity.

project design and implementation. SREP and/or other development partners will fund related capacity development and advisory services for policy evolution including FiTs and other incentives.

Implementation readiness

5. The proposed physical investments are proposed for support by ADB-PSOD. Specific funding mechanisms need to be identified and agreed to, so that SREP grant funds will catalyze private sector development. To the extent practical, SREP funds will be deployed as output-based aid, i.e., disbursed based on achievement of solar development milestones. Project preparation will be required to identify the appropriate financing modalities and implementation arrangements. Subsequent to endorsement of the IP, project preparation will take about 12 months, with SREP funding approval anticipated in second quarter of calendar year 2017.

Rationale for SREP financing

6. Lack of commercial financing is the main barrier to commercial biomass energy development, which can be addressed with concessional financing. The project will demonstrate the viability of modern biomass power for grid-connected supply in agricultural areas. The parallel sector reforms will promote policy evolution to create a viable biomass energy subsector, with replication and scale up potential of more than 500 MW. Table D-7 presents performance and results indicators.

Table D-7: Results Indicators and Targets

Results	Indicators	Baseline	Targets	Means of Verification
SREP Project Outcomes				
1. Increased supply of renewable energy	Installed capacity	1 MW	> 10 MW	Project review missions
	Design output	0	60 GW/h [a]	
2.Increased access to modern energy services [on-grid solar power]	Number of women and men, businesses, and community services benefiting from SREP interventions	0	150,000 people or around 30,000 households [b]	MME
3. Increase in investments from private sector in renewable energy	$ invested	0	$25 million	Annual reports of energy service companies, technology vendors
4. Greenhouse Gas emissions mitigated	CO_2 emissions reduction	0	> 31,000 tCO_2e/year [c]	MME, MOE
SREP Inputs				
5. Capacity building activities	Workshops/training on solar installation, operations and maintenance for consumers, service providers, Rural Electrification Enterprises (REEs) Workshops on solar development policy, tariff setting, feed-in tariff design, power purchase agreements, etc.	0	X training workshops conducted X workshops conducted	Project implementation reports and ADB review missions

ADB = Asian Development Bank, CO_2 = carbon dioxide, MME = Ministry of Mines and Energy, MOE = Ministry of Environment, tCO_2e = tons of carbon dioxide equivalent

Notes: [a] Calculated based on 5 hours a day x 365 days a year
[b] Calculated based on 400 kWh per person per year consumption target.
[c] Assumes 533 tCO_2e/MWh, displacing a combination of grid-supplies and diesel generation

Table D-8: Financing plan

	SREP [b]	ADB	Private Sector	Govern-ment [a]	Total
Component 2: Biomass Power Project	5.0	5.0	15.0	-	25.0
Project Preparation	*0.4*	-	-	-	*0.4*
Total	**5.4**	**5.0**	**15.0**		**25.4**

Table D-9 Project preparation timetable

Milestone	Date
SREP IP Endorsement	Q2 / 2016
SREP funding approval	Q2 / 2017
ADB Board/Management consideration	Q4 / 2017

Project Preparation Grant

The RGC is requesting for project preparatory grant for the Biomass Power Project.

Table D-10: Project Preparation Grant Request for Biomass Power Project

SREP **Project Preparation Grant Request**			
Country/Region:	Cambodia	**CIF Project ID**#:	
Project Title:	**Biomass Power Project**		
Tentative SREP Funding Request (in US million total) for Project at the time of Investment Plan submission (concept stage)::	*Grant: $0*	*Loan: $5 million*	
Preparation Grant Request (in $):	$400,000	MDB: Asian Development Bank	
National Project Focal Point:	Dr. Praing Chulasa, Deputy MD, Electricite' du Cambodge		
National Implementing Agency (project):	Electricite' du Cambodge		
MDB SREP Focal Point and Project Task Team Leader (TTL):	*SREP Focal Point:* Christian Ellermann Climate Change Specialist Asian Development Bank	*TTL:* Shuji Hashizume Investment Specialist Private Sector Operations Department Asian Development Bank	

Description of activities covered by the preparation grant:

A preparation grant is required for (i) detailed feasibility study for biomass generation; (ii) biomass resource assessment; and (iii) due diligence which covers:

a. Technical. Appropriate technology for biomass power will be assessed, particularly related to feedstock and operating and maintenance requirements.
b. Economic and financial. Economic and financial analysis will be undertaken. Particular attention will be paid to (i) sustainable tariff level, and (ii) economics of feedstock supply.
c. Safeguards, Social, Poverty and Gender. All safeguards will be addressed according to the ADB Safeguard Policy Statement, June 2009. Environmental assessment will ensure environmental impacts are mitigated. Land acquisition and impact on indigenous peoples will be assessed and resettlement and indigenous peoples plans prepared, as required. Social, poverty and gender analysis will be conducted. A gender action plan will be prepared as appropriate.

Outputs:	
Deliverable	**Timeline**
(a) Detailed FS	10 months after Notice to Proceed (NTP)
(c) Due Diligence Report	10 months after NTP
(d) Grid Stability and Control Strategy	12 months after NTP
(e) Project identification and pre-feasibility	12 months after NTP
Budget (indicative):	
Expenditures	**Amount ($) –** estimates
Consultants	$320,000
Equipment	
Local workshops/seminars	$10,000

Travel/transportation	$30,000
Others (admin costs/operational costs)	$10,000
Contingencies (max. 10%)	$30,000
Subtotal	**$400,000**
Other contributions:	
• Government	-
• MDB	-
• Private Sector	-
• Others (please specify)	-
Total Cost	**$400,000**

Timeframe (tentative)
Expected Board/MDB Management approval date: *Project Preparation Technical Assistance approval: January 2017*

Other Partners involved in project design and implementation:

-

If applicable, explanation for why the grant is MDB executed:
The Government of Cambodia has requested ADB to execute the grant due to its limited capacity in handling the timely contractual preparation of such a consultancy. The private sector may also need the grant to undertake a feasibility study and due diligence due to nascent stage of renewable energy sector in Cambodia, although the costs should be reimbursed by the private sector upon materialization of an actual project from such a study. If reimbursed, the funds can be recycled for another feasibility study.

Implementation Arrangements (incl. procurement of goods and services)**:**
The executing agency will be either EDC or the private sector developer. The implementing agency will be either EDC or ADB. All equipment and civil works procurement, if any, will be carried out in accordance with ADB's *Procurement Guidelines* (2010, as amended from time to time). Consultants will be recruited in line with ADB's *Guidelines on the Use of Consultants* (2013, as amended from time to time), through consulting firm or individual selection method. The procurement method would be quality- and cost-based selection (QCBS).

Table D-11: MDB Request for Payment for Project Implementation Services (MPIS)
ADB Biomass Power Project

SCALING UP RENEWABLE ENERGY IN LOW-INCOME COUNTRIES **MDB Request for Payment of Implementation Services Costs**			
1. Country/Region:	Cambodia	**2. CIF Project ID**#:	
3. Project Title:	***Biomass Power Project***		
4. Request for project funding ($ million):	*At time of country submission (tentative): $5 million (loan)*	*At time of project approval:*	
5. Estimated costs for MDB project implementation services	*Initial estimate - at time of Country submission: $ 428,000* *Final estimate - at time of project approval:*	*MDB: Asian Development Bank* *Date: May 2016*	
6. Request for payment of MDB Implementation Services Costs:	√ First tranche: **$ 214,000** ☐ Second tranche: *n/a*		
7. Project financing category:	a - Investment financing - additional to ongoing MDB project ☐ b- Investment financing - blended with proposed MDB project √ c - Investment financing - stand-alone ☐ d - Capacity building - stand alone ☐		
8. Expected project duration (no. of years):	5 years		
9. Explanation of final estimate of MDB costs for implementation services:	*Not applicable*		
10. Justification for proposed stand-alone financing in cases of above 6 c or d: not applicable			

Annex E: Independent Quality Review

The matrix below presents the reviews and comments of Mr. Mike Allen, external reviewer, based on the draft SREP Investment Plan for Cambodia dated 6 May 2016. The review of the Investment Plan has been undertaken ahead of the submission of the plan to the SREP Sub-Committee. The matrix also presents the responses from the Government and the SREP technical team on the comments raised by the external reviewer.

Comments	Responses
General Comments on the Investment Plan	
1. The Investment Plan (IP) as submitted appears to offer a balanced approach to undertake what is suggested are important steps to build on a relatively immature renewables industry in Cambodia.	Thank you.
2. The focus on extending experience with solar home systems (SHS), and exploring opportunities with mini-grids for rural villages, appears sensible; the opportunity to look at the potential for large scale rooftop systems and utility scale solar farms is perhaps equally important if renewables are to begin to build a significant role in providing clean electric power generation. Given the immaturity of the solar market in Cambodia, and a number of obvious institutional and implementation challenges, the IP could be strengthened by providing more evidence that there is an active private sector interest in investing in such markets. It is recognised that there are a number of small enterprises that have been engaged in the solar PV industry for some years but again the current strength of this group, and its ability to make real contributions under the growth strategy outlined, has yet to be documented.	Biomass and solar resource are attractive in that both can be developed with technologies that are scalable and replicable. Smaller projects, such as rooftop systems and mini-grids, can be community-developed and -owned. Larger systems can be built out in modular fashion, which minimizes the up-front capital barrier faced by rooftop solar and other utility-scale projects. In all cases envisioned for SREP cofinancing, the challenge will be to identify appropriate project structures where development risk can be minimized so that RE investment is attractive in the mainstream rather than only to "frontier" entrepreneurs seeking unrealistic financial returns. With the passage of the Electricity Law in 2001, the private sector has taken the lead in the generation subsector. Although most of the generation capacity is conventional coal and large hydro, there is a nascent RE industry which is poised for rapid growth. The Solar Energy Association of Cambodia (SEAC) has 25 members, of which 4 have secured the "Good Solar Initiative" certificate. There are several international firms which are interested in utility-scale solar and biomass power projects; details are not available for all candidate projects but various private developers have identified at least 250 MW of aggregate capacity for commercial development. In short the generation subsector is already a private sector domain, and the learning curve for private sector development has been minimized to some extent. As noted in the draft IP, some policy evolution is needed to jump-start RE investment

Comments	Responses
	and accelerate development, but a wholesale restructuring of the sector to introduce private participation is not necessary. In early 2016, the Ministry of Mines and Energy (MME) floated a tender for a 10 MW solar project which attracted 5 international firms (from France, Singapore, and Thailand), of which 4 technical proposals were qualified for further consideration; the outcome of this tender is of great interest since the request for proposals specified an off-take price of less than $0.10/kWh which is essentially EDC's average cost of supply, i.e., grid parity. Negotiation of a power purchase agreement at grid parity would indicate that the technical solar potential can be harnessed at scale. As noted in the revised IP, if this first 10 MW project is successful, a single project cannot be expected to transform the sector, therefore SREP cofinancing will still play a meaningful role in catalyzing additional commercial investment to accelerate RE development. It is not unreasonable to believe that LCOE for utility-scale solar would decline below grid parity in the near term, which is the tipping point for electricity sector transformation. The economic potential will grow as installed system costs decline relative to end-use applications; e.g., solar charging for electric vehicles may be competitive versus petroleum fuels at a levelized cost well above $0.10/kWh.
3. As planning proceeds for projects under the IP / SREP, it will be important that the effective integration of any renewable energy projects within the national energy plans is clear before final commitments to their implementation. Part of the IP's justification for SREP support is that the proposed projects will assist as practical demonstrations of what could be achieved with wider support from the private sector (and other funders). This assumption should be revisited as each project is better defined.	Agreed. The RGC recognizes the need for effective integration, and has requested ADB to provide technical assistance for a grid integration study, as well as assistance for other policy evolution (e.g., net metering policy and FiTs). The RGC has also engaged other development partners in dialogue on these issues. The generation sub-sector is reserved for private sector developers, but as noted in the IP, most of the generation assets are conventional coal and large hydro plants. RE development faces classic first-mover risks; therefore new RE projects, especially utility-scale solar and biomass are expected to have a strong impact on opening up the market. In particular, commercial financing is not available at interest rates and tenors that make RE financially viable; this is a key entry point for concessional financing to facilitate jump-starting the RE market.
4. While the IP recommends that the potential for biomass energy projects be explored, the plan acknowledges the key challenges that the biomass industry faces. In particular, the security of (year round)	Biomass power is more challenging than solar and other RE resources, as noted in the draft IP (and as acknowledged by MME and project developers). This resource is attractive mainly due to the widespread

Comments	Responses
fuel supply is critical; many well-intentioned biomass projects have failed when fuel volumes are not as anticipated.	availability and scalability, with prospects for modular development to enhance lifecycle viability. Depending on the technology employed, a typical biomass project could start out with 1 to 2 MW of capacity and expand up to 5 to 10 MW, and possibly larger depending on feedstock security (the radius of capture for successful biomass projects is typically 1 day driving time). The best opportunities for biomass are in areas where (i) there is captive feedstock, (ii) petroleum-based generation is still dominant, (iii) there are opportunities to displace imported electricity, and (d) biomass could complement hydropower output in the low-flow season. These issues will be investigated during project preparation, and project proposals will be advanced only if due diligence indicates that risks can be successfully mitigated and managed.
5. The IP suggests that there is a substantial level of potential renewable resources; caution is necessary that these figures are treated appropriately. While solar PV can be installed relatively quickly hydroelectric, and to some extent biomass options, are often slower and more complex developments.	As noted in the draft IP, harnessing about 20% of the technical (theoretical) potential of biomass and solar resources would provide the equivalent of total electricity supply in 2015. Clearly, translating this theoretical potential into real energy output is not a trivial exercise, but the conditions are reasonably good for SREP to catalyze new investments in RE that can facilitate future transformation of the energy sector. The generation sector is essentially reserved for private sector developers, there is a nascent RE industry, and Cambodia can take advantage of experience gained in the region, especially in solar energy development.
6. Given the stated urgency to increase power production in Cambodia, and reduce some of the reliance on imported electricity, any plan will require flexibility. It is also important to ensure that choices reflect the true costs of development and that while feed in tariffs or similar subsidies may be considered important to open the renewable market, this should not be at the cost of longer term sustainability or inadvertently impacting the prices that end users must bear.	Cambodia has some coal reserves with modest domestic production, and some prospective oil and gas reserves but no commercial production and no refining capacity. The country is 100% reliant on imported petroleum products. Traditional biomass accounts for the bulk of total primary energy supply. A key starting point is that prospective RE will not be competing against a fully developed and integrated domestic coal and petroleum industry. Depending on the specific project location and end-use application, RE will compete against petroleum-based generation at a cost of $0.25/kWh or higher, imports at grid-supplied electricity at $0.126/kWh or higher. FiTs and concessional financing are needed to jump-start and accelerate RE development, but are not expected to be required in the long-term.
7. The overall investment proposal that the SREP funds will help seed	See notes below on Financing.

Comments	Responses
makes assumptions about significant additional investments that will be secured through MDBs and the private sector. Confirmation of the commitment from these sources should be a key element in making a final decision on the provision of funds under SREP.	
Financing	
8. The table suggests that US$ 30 million of SREP funding is expected to catalyse more than four times as much investment, a large portion of it from the private sector (as equity or debt), and the public sector lending windows of the ADB. The IP however does not substantiate that these sources have been tested or any additional (albeit potential) commitments made by the private sector. It does however identify a number of current multilateral and bilateral programmes but it is unclear how their implementation links with work proposed under the IP itself. The reliance of the overall plan on significant co-funding from the ADB and the private sector needs to be tested thoroughly to ensure that commitments are in place before SREP funds are released. There is complexity in funding with blended financing, or using PPPs, and this should not be underestimated as its resolution will impact on project execution timelines.	The generation subsector is a private sector domain, so in a sense there is no "testing" required with respect to mobilizing private participation. A key intent is use a modest amount of grant and concessional finance to crowd in commercial financing for RE development. The overall investment envisioned assumes that ADB funds cover 25% of total project cost and that SREP cofinancing leverages additional funds. The ADB contribution may be higher for a public sector operation (in this case for solar home systems and mini-grids), while the 25% contribution is a hard rule for ADB's Private Sector Operations Department (ADB-PSOD). Note all project-related funds will be disbursed in parallel, hence it will never be "SREP first", i.e. the SREP funds for projects will not be released unless there are commitments from the private sector. ADB-PSOD has financed a transmission line project in Cambodia, and is about to close a gas-fired IPP in Myanmar, both with significant co-funding from private sector. Therefore the appetite from private sector investors and financiers is always there even in frontier countries like Cambodia. Experience in other countries in the region also indicates that the expected leverage is within the realm of imagination. For example, in Thailand, ADB-PSOD utilized a small grant from ADB's Clean Energy Financing Partnership Facility (CEFPF) as part of the construction contingency funds for a 55 MW project which was the country's first utility-scale thin-film solar PV plant. At the time the project was designed, construction contingencies for solar plants were higher than conventional plants by a factor of 10 or more, about $200,000 per MW of solar versus $15,000 – $20,000 for a conventional gas-fired power plant. ADB financing was approved in 2010, including a $2 million CEFPF grant which was used as a standby contingency fund; this grant was ultimately not required for project commissioning. In this instance, the leverage on the grant funds was effectively infinite since

Comments	Responses
	the CEFPF grant was not expended on the project.
Specific Comments on Investment Plan	
Comments on Components 9. Acknowledging the limited experience in Cambodia in undertaking renewable projects to date, with the exception of modest SHS activities, the projects and focus suggested for support through SREP appear reasonable. The main concern is in implementation capacity and a clear demonstration that other funders / investors can be attracted to support the initial and subsequent programmes. The expansion of the SHS market and exploration of the potential for mini-grids would seem an achievable goal, based on current capacity and experience within Cambodia. The diagram below offers a clear explanation of the expected outcomes from the SREP support. In moving to larger scale PV installations, it also needs to be recognised that while the SHS, solar rooftop installations and solar parks use the same fundamental PV technology, there are significant differences in scale, investment, power sales agreements, operations and maintenance and underlying risks in developing and operating large scale grid connected PV installations.	Subsequent to endorsement of the IP, the scope of technical assistance for project preparation and policy evolution will be further refined. The technical assistance will include developing standardized power purchase agreements for different applications, e.g., rooftop solar with net metering versus a more traditional IPP business model. For the various solar systems envisioned, experience gained in Cambodia as well as other countries will be applied to project design and technical specifications.
10. The challenges of biomass developments have been noted in the IP. Opportunities that have succeeded are often linked to captive power developments where fuel comes from in-house operations. Such facilities require an appropriate policy structure that allows for partial sale of power into the grid, often on a non-firm basis.	See notes above regarding prospective biomass opportunities and conditions for successful development. Captive generation that competes against diesel generation is the most promising starting point. Selling surplus into the grid may require policy support in terms of a short-term FiT or viability gap funding arrangement so that the off-take is revenue-neutral to EDC.
11. The IP notes that there are a number of institutional and capacity issues that need to be addressed to ensure that the proposed programmes can be considered. It is noted that one of the critical issues is that: "*A large number of RGC departments, agencies and offices are involved in the renewable energy development programs. A major challenge is to ensure that these entities work to their respective strengths in an integrated manner towards delivery of the national objectives"*	After decades of conflict which destroyed most of the energy infrastructure as well as human capital, the situation in Cambodia stabilized in the early 1990s and the country has been rebuilding itself since then. In the past 25 years, the energy sector has been rebuilt, with the electricity network integrated to some extent with the neighboring countries of the Greater Mekong Sub-region (GMS), specifically Lao PDR, Thailand, and Viet Nam. Electricity imports have declined in the past several years and are expected to continue declining as new generation capacity comes online. Coal and large hydro plants accounted for about 70% of total electricity supply in 2015, and under

Comments	Responses
This is a common issue in emerging economies and its resolution can be quite a challenge – it will require strong and clear leadership from a high level in government if this is to be resolved in the near term. A clear indication within the IP of government commitment to addressing these issues would be of considerable importance.	business-as-usual coal and large hydro will account for most of the programmed capacity expansion during the next 5 years. Compared to many other post-conflict countries (including those with endorsed SREP IPs) Cambodia's progress in the energy sector has been remarkably good, and current development trends indicate continued strong growth in capacity additions, energy output, and rural electrification. However, the continued reliance on coal and large hydropower is not sustainable in the long run. The IP includes technical assistance for capacity building and a public awareness campaign which will include all relevant agencies.
Compliance with SREP Goals	
Catalyse increased investments in renewable energy: 12. The plan suggests how it is anticipated that SREP investments and programme support will help attract other donor and private funding. As noted this is an aggressive plan with SREP funding the basis for what is anticipated would see significant leverage of other funds. This has yet to be clearly demonstrated as achievable. As yet there is no clear confirmation of a reasonable level of private sector interest and capability.	See notes above noting that generation is reserved for the private sector; the policy framework is quite clear. On this basis, conventional generation assets have been developed by IPPs, and a nascent RE industry exists that is poised for growth. A key main barrier to RE development is lack of commercial financing. SREP cofinancing will help eliminate the first-mover risk. The overall investment envisioned assumes that ADB funds cover 25% of total project cost and that SREP cofinancing leverages additional funds. The ADB contribution may be higher for a public sector operation (in this case for solar home systems and mini-grids), while the 25% contribution is a hard rule for ADB's Private Sector Operations Department (ADB-PSOD).
Enabling environment 13. The IP acknowledges that there are a number of unaddressed hurdles to renewable implementation; there are strategies and an allocation of responsibilities to particular agencies to address these. Without prior engagement with these agencies it is hard to assess whether these tasks can reasonably achieved by these entities. This process will require strong leadership at a senior level and close monitoring as the success in establishing a sound enabling environment will be a key control on the value of the SREP investments.	Agreed. The IP includes technical assistance for capacity building and a public awareness campaign which will include all relevant agencies.
Increase energy access:	

Comments	Responses
14. The need for increased access to energy is clear. The SREP support will help accelerate this in some areas but is also being targeted at grid connected supply which generally may have limited impact on improving access at an individual level. Mention is made of SREP funds being used to reduce cost / increase affordability; use of funds for these purposes needs to be judicious to ensure that any subsidies, their impacts and eventual withdrawal are carefully considered.	The IP notes the governments targets for grid extension and household electrification rates. Based on these targets, a combination of off-grid (scaled up SHS and solar mini-grids) and on-grid utility scale RE is required. SREP cofinancing will be deployed following the design principle of "precision-guided subsidies."
Implementation capacity: 15. It is suggested that the responsibilities for final implementation of various segments of the SREP supported programme have yet to be confirmed. The capacity and skills to execute the programme as outlined should not be underestimated. There is an allowance for financing policy work, training and up-skilling but this needs to be carefully targeted to ensure a balance between support to senior management and those at an operational level for whom the challenges in a new market can be very real.	Subsequent to endorsement of the IP, the scope of technical assistance for policy evolution will be further defined to ensure complementarity with the proposed physical investments. As noted above, the generation subsector is
Improve the long-term economic viability of the renewable energy sector: 16. The renewable energy sector in Cambodia is understood to be relatively small and has been largely focused on off grid SHS activities, with public subsidies under-writing much of the larger programmes. The IP suggests a number of private sector entities have been engaged in the domestic PV market but provides no detail of their size and commercial capacity. This information would be an important addition to the IP. In addition, meetings with stakeholders are noted but there is no concrete summary of how the private sector views the planned SREP interventions. Again this additional detail would help provide reassurance about the collective support for what the IP is proposing. It is often suggested that SREP funded activities will drive a more focused and sustainable basis for future growth; there needs to be increased private sector engagement and this will only occur, on a sustained basis, when regulatory and pricing signals are clear and acceptable to the market. SREP funds must therefore be directed into projects where conditions are conducive to ensuring such	The draft IP has identified key lessons learned from previous and ongoing programs, mainly the need for extended after-market operations and maintenance support for solar home systems (which is also applicable to mini-grids). Key policy issues have also been identified, for example the need for net metering and feed-in tariffs to support rooftop solar development. Additional evaluation of prior programs will be undertaken as necessary as a first step in project preparation (an exhaustive analysis of prior and ongoing programs will not change the government's overall decision to pursue biomass and solar). Lessons learned from other projects and programs in other countries will be applied, including experience on other projects with cofinancing from SREP and the Clean Technology Fund.

Comments	Responses
outcomes. As noted, care must be taken to avoid inappropriate subsidies that cause market distortions.	
Transformative impact: 17. The limited spread of the proposed SREP investments in Cambodia is seen as pragmatic given the current energy market status, focus on electricity access and a need to enhance the enabling environment. Given the renewable sector is immature, it is not to be expected that there will be major transformations in the market through SREP alone but, if well managed and executed, the proposed programme should help promote the nascent renewable energy sector in the country. Experience suggests that demonstration projects with specialist funding, such as SREP, will not necessarily ensure that an attractive commercial market place results quickly. Their design is critical to allow an easier transition to subsequent projects that may have limited access to concessional finance.	Agreed. SREP can help initiate the move to transformation, but as noted in the IP, the tipping point is when RE is delivered at grid parity. For solar, it is not unreasonable to expect that utility-scale projects can achieve grid parity in the foreseeable future. This observation is supported by the fact that 5 bidders responded to the MME tender for a 10 MW solar plant, with an advertised off-take price at grid parity. Cambodia does not have a true "national" grid as yet, but rather a collection of grids. Therefore "grid parity" is location specific. While solar can be expected to achieve grid parity anywhere, biomass may only achieve grid parity where diesel generation is still dominant, or in areas served by imported electricity that is higher than EDC's average cost of supply. The IP outlines a combination of learning-by-doing investments complemented by policy evolution which will be critical to a viable RE sector in the medium to long term that is not reliant on subsidies. The policy analysis should also recognize that fossil power has implicit subsidies that need to be fully accounted for in long-term planning.
Comments and Suggestions	
18. The IP demonstrates the effort that has gone into the background research, stakeholder consultation and evaluation of potential options that could be supported under SREP funding in Cambodia. There are however areas where this consultation could be better documented. As noted the level of funding and suggested leverage appear reasonably aggressive, given the nascent nature of the renewable industry and little indication of a clear private sector interest. Reassurance on government and stakeholder response to the focus of the IP will be important in building its credibility.	See notes above regarding private sector participation and leverage.
19. The attraction of the private sector into grid connected projects is recognised as challenging but part of the SREP programme will be to test the practicality of PPP projects and this experience can only be of value in determining the best models for future expansion of the energy sector.	See notes above about private sector participation. The SHS and mini-grids projects will have a PPP modality in that ADB funds and SREP cofinancing will be channeled to an updated REF. For the on-grid projects, the learning curve is relatively shorter as there are is already an established IPP business model.

Comments	Responses
Off grid activities, beyond the current SHS work, may be more immediately attractive to the private sector and care should be taken to ensure that the availability of SREP funds does not discourage this participation.	
20. The IP comments on the problem that a lack of appropriate finances generates in attracting the private sector. It is critical that "demonstration" projects are carefully designed, sited and executed; access to concessional finance alone at this stage (under the SREP programme) will not necessarily result in attracting funding that continues to encourage a broader engagement of the private sector.	See notes above re: private sector participation and expected leverage. SREP funds will be deployed as cofinancing, not as stand-alone concessional finance.
21. The private sector will be drawn to support renewables where the returns that they offer match or exceed those that can be achieved through other investments (in energy or other sectors). This will require a realistic and sustained tariff regime, a level playing field for all technologies and consistent policies and regulations; power projects are by their nature long term and nothing unsettles investors (and financiers) more than an unpredictable policy environment.	Agreed and this is the basis for SREP to support technical assistance for policy evolution. As noted in the IP, technical assistance is expected to cover net metering and FiT policies (mainly to support rooftop solar), and capacity building for MME and other government agencies including the electricity regulator EAC.

CLIMATE INVESTMENT FUNDS

SCALING-UP RENEWABLE ENERGY PROGRAMME (SREP)

INVESTMENT PLAN FOR CAMBODIA

Review undertaken by

Dr Mike Allen

10th May 2016

1.0 Introduction

The review of the Investment Plan for Cambodia has been undertaken ahead of the submission of the plan to the SREP Sub-Committee of the Strategic Climate Funds, within the Climate Investment Funds at the World Bank.

These notes are based on a review of the draft plan dated 6th May 2016. A number of minor queries have been raised by email and are reiterated in these notes. It is expected that these issues will be addressed in preparing the final draft of the IP before its submission.

It should be noted that the reviewer has not visited Cambodia as part of this review, nor been involved in the preparation of this plan. The lack of a visit to Cambodia and any contact with the ministries, agencies, institutions and various stakeholders necessarily limits the personal background knowledge but the nature of the situation is common to many such economies in the region. The reviewer has some understanding of the energy issues facing Cambodia through work undertaken from other personal engagements.

The Investment Plan (IP) as submitted appears to offer a balanced approach to undertake what is suggested are important steps to build on a relatively immature renewables industry in Cambodia.

The focus on extending experience with solar home systems (SHS), and exploring opportunities with mini-grids for rural villages, appears sensible; the opportunity to look at the potential for large scale rooftop systems and utility scale solar farms is perhaps equally important if renewables are to begin to build a significant role in providing clean electric power generation.

Given the immaturity of the solar market in Cambodia, and a number of obvious institutional and implementation challenges, the IP could be strengthened by providing more evidence that there is an active private sector interest in investing in such markets. It is recognised that there are a number of small enterprises that have been engaged in the solar PV industry for some years but again the current strength of this group, and its ability to make real contributions under the growth strategy outlined, has yet to be documented.

As planning proceeds for projects under the IP / SREP, it will be important that the effective integration of any renewable energy projects within the national energy plans is clear before final commitments to their implementation. Part of the IP's justification for SREP support is that the proposed projects will assist as practical demonstrations of what could be achieved with wider support from the private sector (and other funders). This assumption should be revisited as each project is better defined.

While the IP recommends that the potential for biomass energy projects be explored, the plan acknowledges the key challenges that the biomass industry faces. In particular, the security of (year round) fuel supply is critical; many well-intentioned biomass projects have failed when fuel volumes are not as anticipated.
The IP suggests that there is a substantial level of potential renewable resources; caution is necessary that these figures are treated appropriately. While solar PV can be installed relatively quickly hydroelectric, and to some extent biomass options, are often slower and more complex developments.

Given the stated urgency to increase power production in Cambodia, and reduce some of the reliance on imported electricity, any plan will require flexibility. It is also important to ensure that choices reflect the true costs of development and that while feed in tariffs or similar subsidies may be considered important to open the renewable market, this should not be at the cost of longer term sustainability or inadvertently impacting the prices that end users must bear.

The overall investment proposal that the SREP funds will help seed makes assumptions about significant additional investments that will be secured through MDBs and the private sector. Confirmation of the commitment from these sources should be a key element in making a final decision on the provision of funds under SREP.

2.0 Specific Comments on Investment Plan

2.1 The Country Energy Policy

It is noted in the IP that there have been a limited number of programmes to encourage the uptake of renewables, particularly focused on rural communities.

The main thrust of the country's energy policy is stated to be:

> *The government has two overarching policy targets: (1) by 2020, all villages in the country should have access to electricity; and (2) by 2030, at least 70% of total households in the country should have access to quality grid electricity. Achieving these two main targets depends on the utilization of all types of electricity sources and the participation from relevant stakeholders.*

In terms of specific renewable energy developments, the IP notes:

> *Cambodia's renewable energy development and rural electrification policies are linked. The government's energy policy is aimed at: (i) supplying adequate energy at affordable rates; (ii) ensuring the reliability and security of electricity supply to facilitate investments and advance national economic development; (iii) encouraging the socially acceptable development of energy resources; and (iv) promoting the efficient use of energy and minimizing detrimental environmental effects resulting from energy supply and consumption. The goals of the government's rural electrification program are as follows:*
>
> - *providing safe, reliable, and affordable electricity to rural communities in a way that minimizes negative impact on the environment;*
> - *providing a legal framework that encourages the development of renewable energy sources by the private sector to supply electricity to rural communities;*
> - *supporting renewable energy initiatives;*
> - *promoting the adoption of renewable energy technologies by setting electricity rates in accordance with the Electricity Law (2001);*

- *promoting the use of least-cost forms of renewable energy in rural communities, through research and testing of grid and off-grid options; and*
- *supporting electrification in disadvantaged rural communities through funding assistance, training, and other means.*

The key provisions of the National Policy on Rural Electrification by Renewable Energy are 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 to the poor involving in rural electrification to participate.*

The government is targeting full electrification of villages by 2020, and 70% household electrification by 2030. The village electrification target involves about 14,000 villages (with almost 2.5 million households). The main components of rural electrification are an expanded power grid; diesel stand-alone, mini-utility systems; cross-border power supply from neighbouring countries; and renewable energy (solar, wind, mini and micro hydro, biogas, biomass). In the short- and medium-term, small village hybrid grid systems will also have an important role.

2.2 Proposed SREP Programme

The IP outlines the rationale for the proposed SREP programme and its structure as follows:

Recognizing the multi-sectoral dimension of RE development for addressing climate change challenges, the IP is designed to facilitate national efforts of shifting to a low-emissions economy that provides employment opportunities with some specific focus on reducing poverty in rural areas and urban margins, and a broader view of the medium- to long-term prospects for RE. Given the immaturity of RE development in Cambodia, the IP must have flexibility in terms of project definition and implementation to adjust to changing circumstances and new opportunities, including uncertainty in the national policy framework and financial markets. The IP promotes systematic and expanded development of RE resources to support access to energy and productive end use of energy through a combination of mutually-reinforcing physical investments and technical assistance for improved policy framework. The physical investments include solar and biomass energy development, while the technical assistance includes (i) human development and capacity building, (ii) public awareness campaigns to facilitate RE project development and implementation, (iii) a proposed "Year of Renewable Energy in Cambodia"; and (iv) investment preparation activities.

The main outcomes/benefits of the proposed investment plan will be (i) an improved policy framework to enable commercial RE development at progressively larger scale; (ii) commercial

scale RE demonstration which is replicable and scalable; (iii) mobilization of private investment into RE development; (iv) reduced reliance on fossil-fuels resulting in foreign exchange savings and avoided emissions of conventional pollutants and GHGs; (v) reduced pressure on forest resources; and (v) improved energy security through diversification of supply.

2.3 Financing

The table that follows summarises the anticipated SREP financing, co-financing and potential private sector financing leverage.

Table 14: Indicative Financing Plan ($ million)

	SREP	ADB	Private Sector	Government [a]	Total
1. Solar Energy					
Solar Home Systems	4.0	4.0	4.0	5.0	17.0
Mini-grids for Rural Villages	2.0	2.0	4.0	5.0	13.0
Rooftop Solar Systems	6.0	8.0	32.0	-	46.0
Utility-scale Solar Farm	8.0	12.0	40.0	-	60.0
Project Preparation	*1.5*	-	-	-	*1.5*
Subtotal	**21.5**	**26.0**	**80.0**	**10.0**	137.5
2. Biomass Energy Projects	5.0	5.0	15.0	-	25.0
Project Preparation	*0.5*	-	-	-	*0.5*
Subtotal	**5.5**	**5.0**	**15.0**		**25.5**
3. Policy Support and Public Awareness	3.0	-	-	-	3.0
TOTAL	**30.0**	**31.0**	**95.0**	**10.0**	**166.0**

Note: [a] Government contribution to Rural Electrification Fund

The table suggests that US$ 30 million of SREP funding is expected to catalyse more than four times as much investment, a large portion of it from the private sector (as equity or debt), and the public sector lending windows of the ADB.

The IP however does not substantiate that these sources have been tested or any additional (albeit potential) commitments made by the private sector. It does however identify a number of current multilateral and bilateral programmes but it is unclear how their implementation links with work proposed under the IP itself.

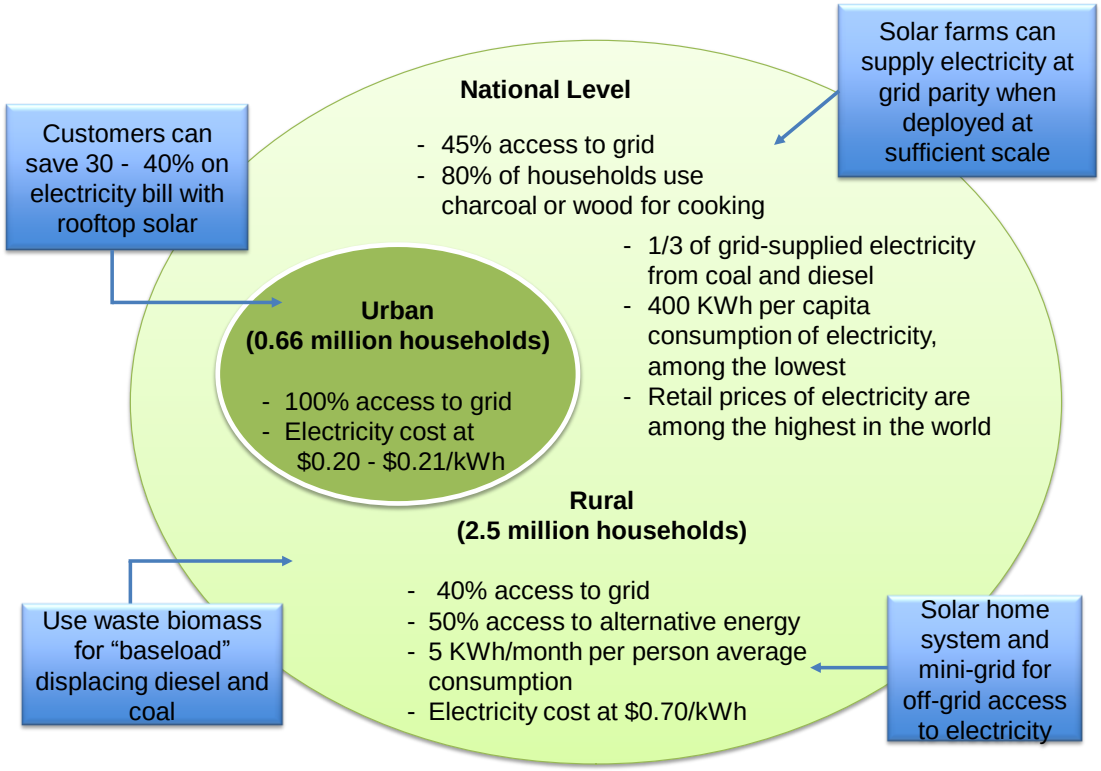
The reliance of the overall plan on significant co-funding from the ADB and the private sector needs to be tested thoroughly to ensure that commitments are in place before SREP funds are released. There is complexity in funding with blended financing, or using PPPs, and this should not be underestimated as its resolution will impact on project execution timelines.

2.4 Comments on Components

Acknowledging the limited experience in Cambodia in undertaking renewable projects to date, with the exception of modest SHS activities, the projects and focus suggested for support through SREP appear

reasonable. The main concern is in implementation capacity and a clear demonstration that other funders / investors can be attracted to support the initial and subsequent programmes.

The expansion of the SHS market and exploration of the potential for mini-grids would seem an achievable goal, based on current capacity and experience within Cambodia. The diagram below offers a clear explanation of the expected outcomes from the SREP support.



In moving to larger scale PV installations, it also needs to be recognised that while the SHS, solar rooftop installations and solar parks use the same fundamental PV technology, there are significant differences in scale, investment, power sales agreements, operations and maintenance and underlying risks in developing and operating large scale grid connected PV installations.

The challenges of biomass developments have been noted in the IP. Opportunities that have succeeded are often linked to captive power developments where fuel comes from in-house operations. Such facilities require an appropriate policy structure that allows for partial sale of power into the grid, often on a non-firm basis.

The IP notes that there are a number of institutional and capacity issues that need to be addressed to ensure that the proposed programmes can be considered. It is noted that one of the critical issues is that:

> "*A large number of RGC departments, agencies and offices are involved in the renewable energy development programs. A major challenge is to ensure that these entities work to their respective strengths in an integrated manner towards delivery of the national objectives*"

This is a common issue in emerging economies and its resolution can be quite a challenge – it will require strong and clear leadership from a high level in government if this is to be resolved in the near term. A clear indication within the IP of government commitment to addressing these issues would be of considerable importance.

3.0 Compliance with SREP Goals

Key focuses within the SREP programme can be summarised under the following headings; the response of the IP to each of these aspects is noted in the following comments.

Catalyse increased investments in renewable energy:

The plan suggest how it is anticipated that SREP investments and programme support will help attract other donor and private funding. As noted this is an aggressive plan with SREP funding the basis for what is anticipated would see significant leverage of other funds. This has yet to be clearly demonstrated as achievable. As yet there is no clear confirmation of a reasonable level of private sector interest and capability.

Enabling environment

The IP acknowledges that there are a number of unaddressed hurdles to renewable implementation; there are strategies and an allocation of responsibilities to particular agencies to address these. Without prior engagement with these agencies it is hard to assess whether these tasks can reasonably achieved by these entities. This process will require strong leadership at a senior level and close monitoring as the success in establishing a sound enabling environment will be a key control on the value of the SREP investments.

Increase energy access:

The need for increased access to energy is clear. The SREP support will help accelerate this in some areas but is also being targeted at grid connected supply which generally may have limited impact on improving access at an individual level. Mention is made of SREP funds being used to reduce cost / increase affordability; use of funds for these purposes needs to be judicious to ensure that any subsidies, their impacts and eventual withdrawal are carefully considered.

Implementation capacity:

It is suggested that the responsibilities for final implementation of various segments of the SREP supported programme have yet to be confirmed. The capacity and skills to execute the programme as outlined should not be underestimated. There is an allowance for financing policy work, training and up-skilling but this needs to be carefully targeted to ensure a balance between support to senior management and those at an operational level for whom the challenges in a new market can be very real.

Improve the long-term economic viability of the renewable energy sector:

The renewable energy sector in Cambodia is understood to be relatively small and has been largely focused on off grid SHS activities, with public subsidies under-writing much of the larger programmes. The IP

suggests a number of private sector entities have been engaged in the domestic PV market but provides no detail of their size and commercial capacity. This information would be an important addition to the IP.

In addition, meetings with stakeholders are noted but there is no concrete summary of how the private sector views the planned SREP interventions. Again this additional detail would help provide reassurance about the collective support for what the IP is proposing.

It is often suggested that SREP funded activities will drive a more focused and sustainable basis for future growth; there needs to be increased private sector engagement and this will only occur, on a sustained basis, when regulatory and pricing signals are clear and acceptable to the market. SREP funds must therefore be directed into projects where conditions are conducive to ensuring such outcomes. As noted, care must be taken to avoid inappropriate subsidies that cause market distortions.

Transformative impact:

The limited spread of the proposed SREP investments in Cambodia is seen as pragmatic given the current energy market status, focus on electricity access and a need to enhance the enabling environment. Given the renewable sector is immature, it is not to be expected that there will be major transformations in the market through SREP alone but, if well managed and executed, the proposed programme should help promote the nascent renewable energy sector in the country.

Experience suggests that demonstration projects with specialist funding, such as SREP, will not necessarily ensure that an attractive commercial market place results quickly. Their design is critical to allow an easier transition to subsequent projects that may have limited access to concessional finance.

1.0 Comments and Recommendations

The IP demonstrates the effort that has gone into the background research, stakeholder consultation and evaluation of potential options that could be supported under SREP funding in Cambodia. There are however areas where this consultation could be better documented. As noted the level of funding and suggested leverage appear reasonably aggressive, given the nascent nature of the renewable industry and little indication of a clear private sector interest. Reassurance on government and stakeholder response to the focus of the IP will be important in building its credibility.

The attraction of the private sector into grid connected projects is recognised as challenging but part of the SREP programme will be to test the practicality of PPP projects and this experience can only be of value in determining the best models for future expansion of the energy sector.

Off grid activities, beyond the current SHS work, may be more immediately attractive to the private sector and care should be taken to ensure that the availability of SREP funds does not discourage this participation.

The IP comments on the problem that a lack of appropriate finances generates in attracting the private sector. It is critical that "demonstration" projects are carefully designed, sited and executed; access to

concessional finance alone at this stage (under the SREP programme) will not necessarily result in attracting funding that continues to encourage a broader engagement of the private sector.

The private sector will be drawn to support renewables where the returns that they offer match or exceed those that can be achieved through other investments (in energy or other sectors). This will require a realistic and sustained tariff regime, a level playing field for all technologies and consistent policies and regulations; power projects are by their nature long term and nothing unsettles investors (and financiers) more than an unpredictable policy environment.