Cambodia's First Solar Park

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Outline of Presentation

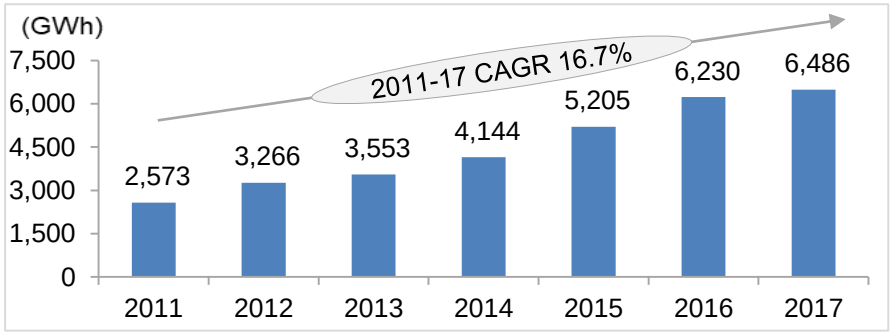
- Cambodia Power Sector Overview
- Solar PV Grid Integration Potential in Cambodia: ADB Study
- RGC and ADB Experience with 10MW Bavet City Solar Plant
- A Structured Approach for Cambodia's National Solar Park Project
- The National Solar Park Project

Cambodia Power Sector Overview

Cambodia Power Sector Overview

- Electricity demand in Cambodia has increased at a CAGR of 16.7% during 2011-17 to reach to 6,486 GWh in 2017.
  - Peak demand reached ~1,000 MW in 2017
- Power generation capacity has increased at CAGR of 21.9% during 2011-17 to 1,867 MW.
- Cambodia relies on power imports from neighboring countries to meets its power demand.
  - Investment in power generation capacity has resulted in reducing the import requirements from ~64% in 2011 to ~19% in 2017.
- Cambodia's electrification rate reached 69% in 2017.

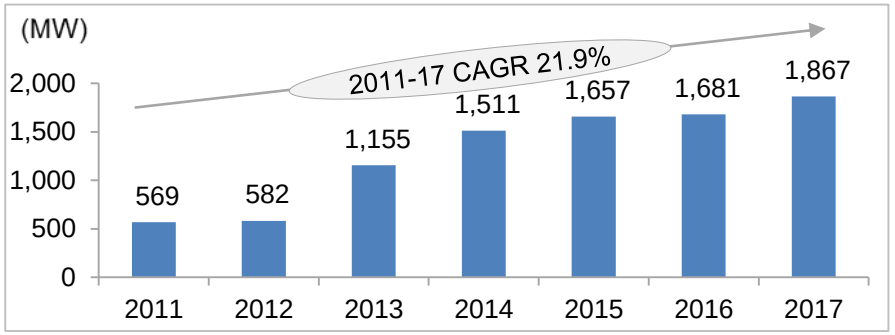
Electricity Demand Growth (2011–2017)



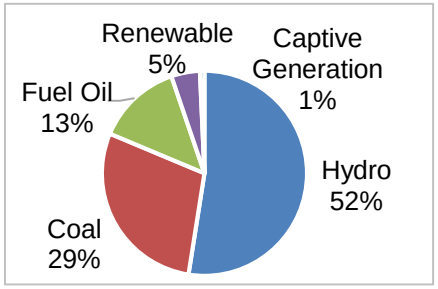
Cambodia Power Sector Overview

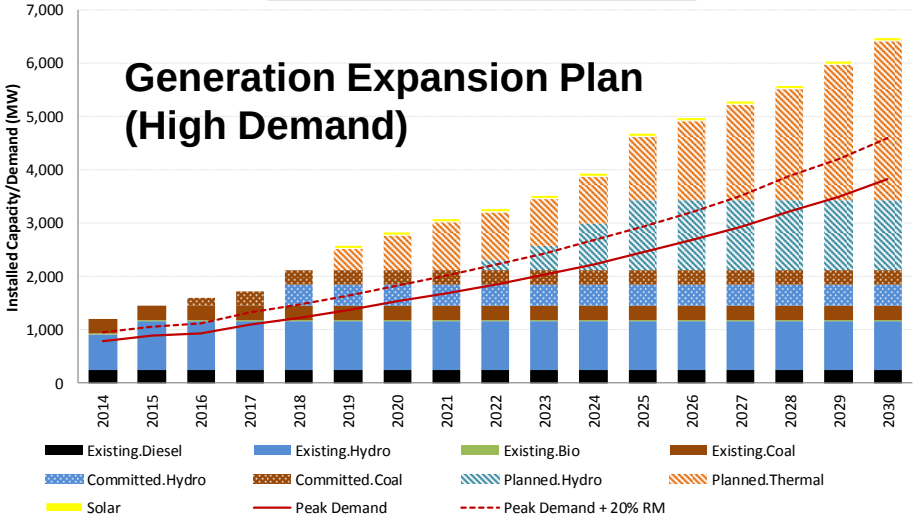
- Coal and hydro are two primary sources of power together accounting for 81% of total installed capacity in 2017.
- The current Power Development Plan calls for major additions of large hydropower and coal-fired generation plants through 2030.

Domestic Generation Capacity Growth (2011–2017)



Generation Mix (2017)

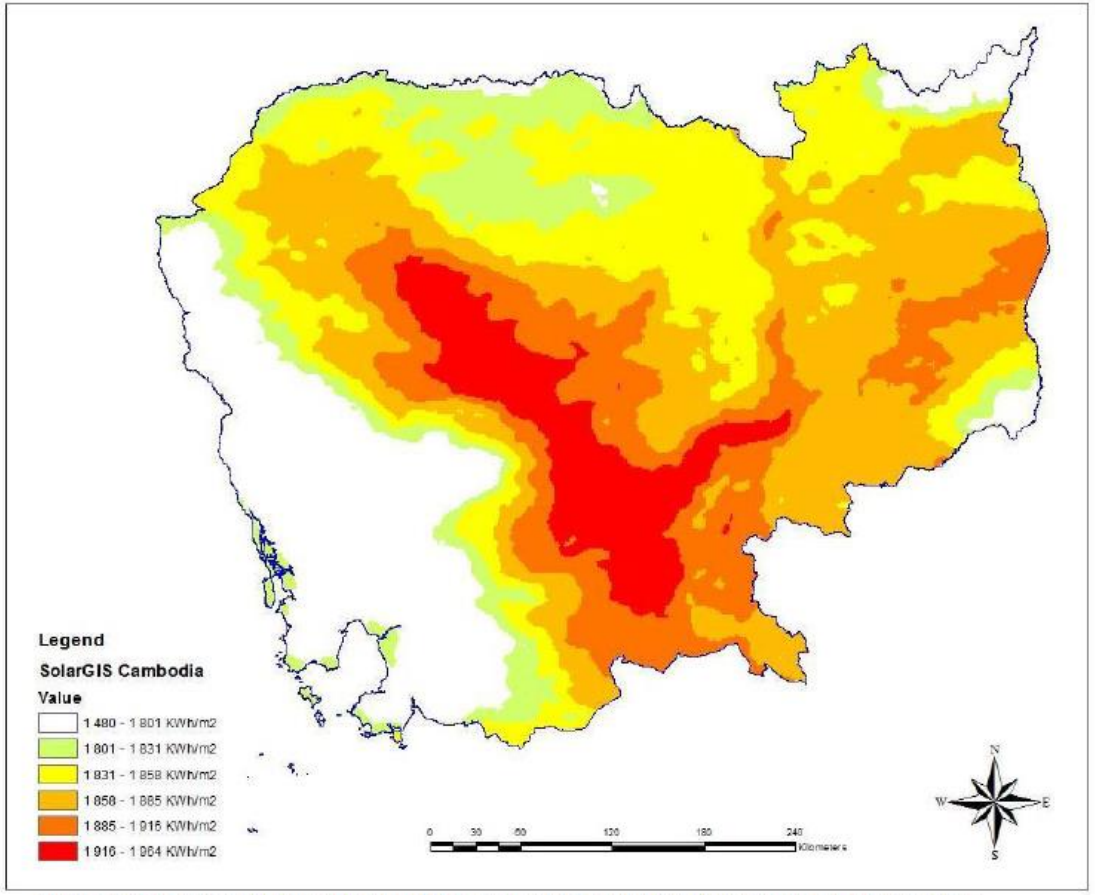




Solar PV Grid Integration Potential in Cambodia (2018-2030): Select Results from ADB Study

Solar Potential in Cambodia is Large and Well-matched with Demand Centers

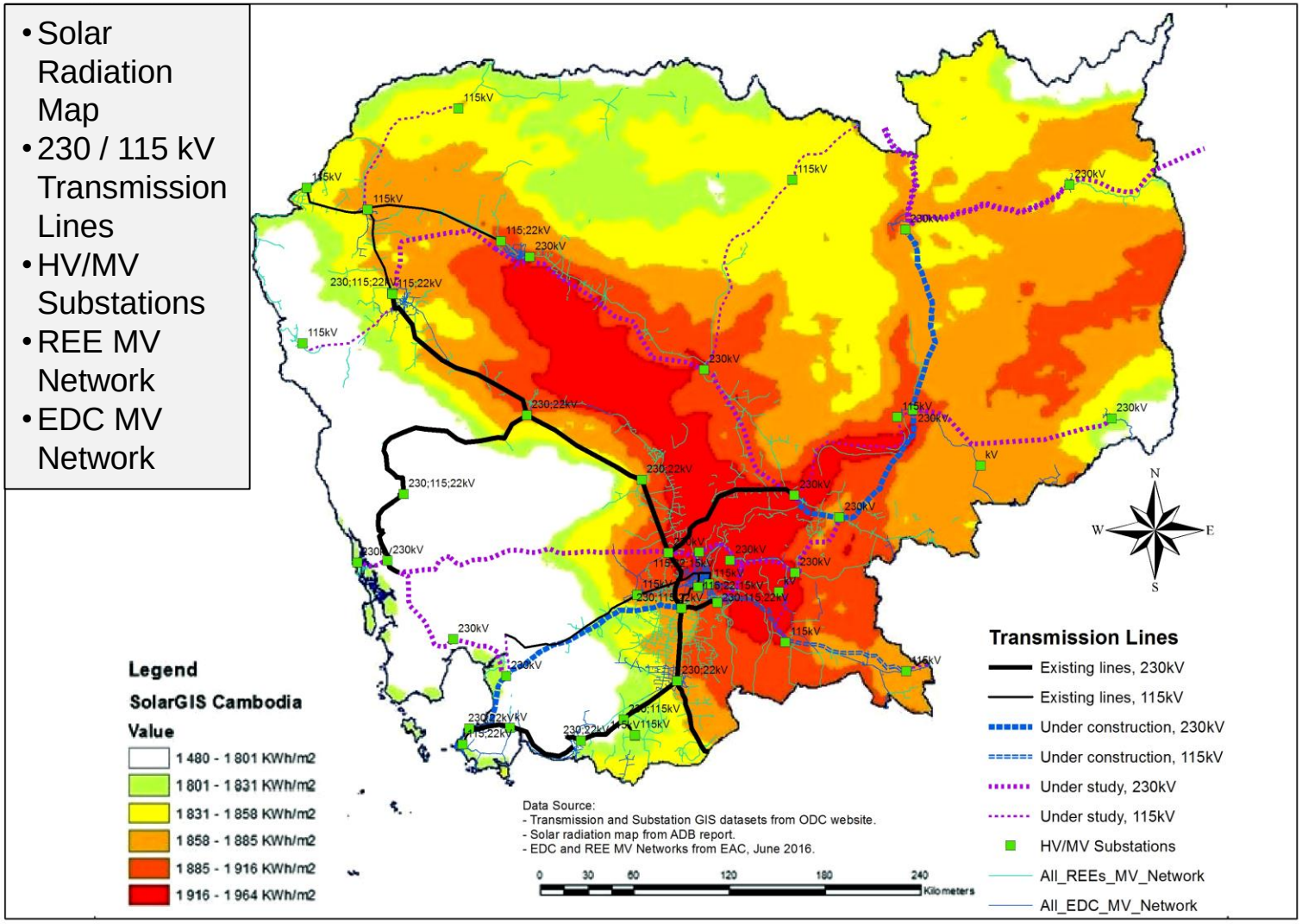
- Excellent solar resource throughout the country
- Irradiance:
  - 1400-1800 kWh/m² is excellent (≥ South Europe).
  - Large areas have > 1800 kWh/m², coinciding with population centres
  - Peak solar resource around the middle of Cambodia covering the major Phnom Penh load center



Average Global Horizontal Irradiation per year (KWh/m2) in Cambodia, obtained from GHI GIS data purchased from Geomodel, 2013.

Solar Resources are Well-matched with Existing and Planned Transmission Lines

- Solar Radiation Map
- 230 / 115 kV Transmission Lines
- HV/MV Substations
- REE MV Network
- EDC MV Network



Key locations:

- **Phnom Penh**
- Battambang
- Bavet
- East Siem Reap
- Kampong Cham
- Kratie
- Kampong Chhnang
- Pursat
- Suong surrounds
- Takeo and Syay Anot

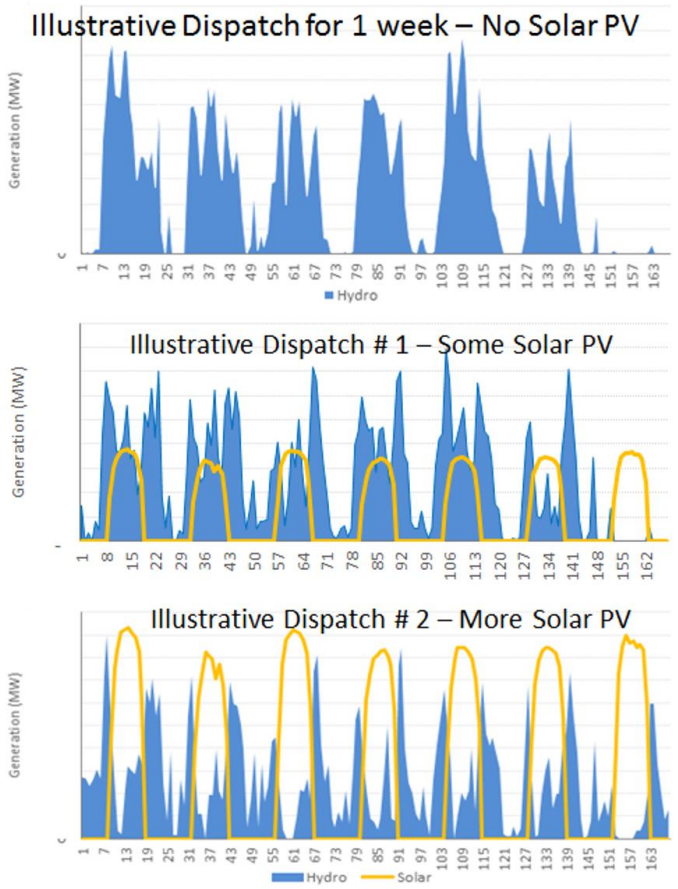
Accounting for demand + transmission + solar irradiation

National Solar PV Master Plan and Road Map

Key benefits that the study identified were:

- Reduced dependency on power imports from neighboring countries
- Reduction in rapidly growing mid-day peak demand,
- Reduced loading levels on transmission lines – leading to loss reductions
- Improvements in management of voltages
- Reduced tightness in supply and demand during the dry season
- Reduced levels of carbon emissions

Illustrative Solar and Hydro Dynamic



Summary Findings

- Considering proximity to transmission, load centers and where the solar resource appears to be at its maximum, several locations have been identified (e.g. Phnom Penh, East Siem Reap, Bavet, Battambang, Kampong Chhnang, etc.)
- Solar and reservoir hydros complement each other very well in Cambodia
- Sufficient ramping capability from hydro and coal units to accommodate all solar scenarios
- Minimal changes to power flows against the base case as the result of collocating solar generation with areas that have good resource potential and high demand
- Generally, reductions in transmission line loading levels are seen with solar PV addition which leads to loss reductions
- The grid can accommodate 100 MW in the near-term with minimal upgrades or operational requirements

RGC and ADB Experience with 10 MW Bavet City Solar Plant

10 MW Solar PV Plant, Bavet City

OVERVIEW

Plant Capacity	• 10 MW
Plant Location	• Bavet, Svay Rieng Province, Cambodia
Project Developer	• Consortium of Sunseap Group and SchneiTec
Off-taker	• EDC
PPA Term	• 20 years
PPP Structure	• Build-own-operate

Financing	• ADB A/ B loan structure
	  • USD 3.6 MN ADB A loan (18 years limited recourse financing)
	  • USD 3.25 MN co-financing by Canadian Climate Fund for the Private Sector in Asia (concessional loan)
	  • USD 2.7 MN ADB B loan by Bred Bank

Tariff	• US cents 9.1 per kWh (Non-escalating). • USD denominated payable up to 20% in KHR and balance in USD.
Key Features	• First utility-scale solar power plant in Cambodia • First competitively tendered renewable energy IPP project in Cambodia • Competitive tariff (below average supply cost for EDC) without FIT or any other government subsidy, evidencing solar power's grid parity • Tender attracted interest from developers based in Thailand, France and Singapore

Source: ADB, Press Articles.

TIMELINE

AMBIENT DESIGN CONDITIONS

Climate	• Tropical monsoon
Average Wind Speed	• 20m per second
Max / Min Temperature	• 40.5 ^{0}C / 13.0 ^{0}C
Relative Humidity	• 76% – 98%
Average Rainfall	• 3,500mm – 4,000 mm

Lessons Learned

Project Implementation

- Weather risk
  - Flood risk
  - Potential project delays due to monsoons
- Logistics and Supply chain
- Land acquisition and compensation
- Insurance and Risk Coverage

Financing and PPA

- No standard PPA for international project finance
- Limited availability of long term debt financing locally
- Significant additional debt funding and transactional related costs

A Structured Approach for Cambodia's National Solar Park Project

Capitalizing on Cambodia's Solar PV Opportunity

- Solar is now affordable, and has reached grid parity in Cambodia, opportunity is to maximize on that potential
- A structured, open, transparent tendering approach increases competition, attracts global players that can deliver low prices
- A National Solar Park Project where EDC buys the land, provides evacuation, addresses the key uncertainty and risk of the project thus driving prices down
- Rapidly deployed within 12 months – faster than any other source of power. Park capacity of 100 MW; tender for Phase 1 of 30-50 MW which can be increased modularly as demand grows
- Availability of concessional funds through ADB drive down prices further
  - SREP and ADB Funds (immediately for solar park, Phase 1) and other sources of climate funds (for subsequent phases)

ADB as a Partner for the National Solar Park Project

- ADB will be a partner to EDC, providing end to end assistance to the project from concept, to feasibility to tendering to funding.
- ADB to serve as transaction advisor to assist the government in doing feasibility study of the project and running a competitive tender process for procuring a private sector partner for EDC (Phase 1)
- ADB to provide concessional money for the transmission, common infrastructure of solar park, and EDC's fund contribution into the project
- ADB will mobilize grant and concessional funding from SREP (total $14 million) and its own source of funds (approx. $13 million)
- ADB's presence as a transaction advisor would send a strong signal to the international market and would help attract best-in-class international developers to invest, and drive down cost of solar
- ADB to also potentially fund the private sector portion of the project by providing a loan and concessional funds from its private sector department as it did in Bavet project

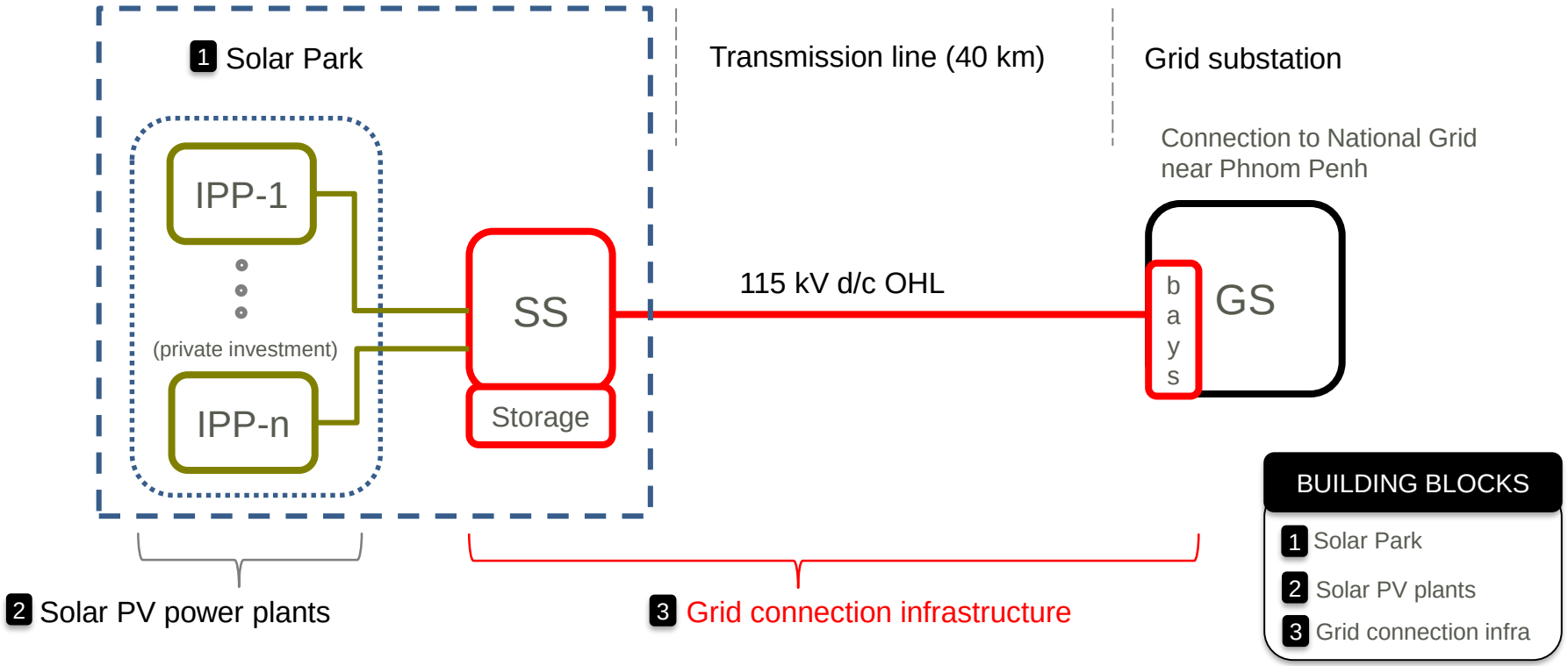
The National Solar Park Project

Cambodia National Solar Park Project

- Support to EDC to build 100 MW capacity national solar park and tender out a 30-50 MW (Phase 1) solar plant
  - Feasibility study to be completed in June 2018
  - Solar Park to be procured in August 2018 and commissioned by mid-2020
  - Tendering of power plant (private sector) to be initiated in August 2018
- Build EDC's institutional capacity for increased use of solar PV generation
- Salient features of the project:
  - Competition: Private sector will bid to set up projects for least cost of delivered power in cents/kwh.
  - Scale: Large program at least 100 MW with multiple projects. Larger project size drives economies of scale and attracts larger, capable power developers
  - Risks will be allocated appropriately among parties (public and private sector) who are in best position to address that risk.

Cambodia National Solar Park Project

The Project at a glance



Project Implementation Schedule

Activity	2018				2019				2020				2021			
	Quarter				Quarter				Quarter				Quarter			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
1. Establishment of Project Management Unit			■													
2. Advance contracting actions for recruitment of PIC			■													
3. Project outputs																
3.1 Solar park and transmission interconnection constructed																
(i) complete land acquisition process			■													
(ii) advertise bidding documents for park and transmission			■													
(iii) award park and transmission turnkey contract				■												
(iv) construction and commission solar park						■	■	■	■	■						
3.2 EDC's institutional capacity for increased use of solar PV generation improved																
(i) prepare tender documents for first 30-50 MW solar generating plants			■													
(ii) procurement and installation of energy storage			■	■	■	■	■	■								
(iii) operational test of energy storage									■	■						
(iv) prepare tender documents for an additional 50-70 MW of solar generating plants									■	■	■	■				
4. Project performance monitoring and reporting																
(i) safeguards monitoring						■	■	■	■	■	■	■	■	■	■	■
(ii) periodic project review						■		■		■		■		■		■
(iii) progress reports						■	■	■	■	■	■	■	■	■	■	■
(iv) audited project/financial statements											■			■		
(v) project closing activities															■	■

DMF = design and monitoring framework; MW = megawatt; PIC = project implementation consultant; PV = photovoltaic
Source: ADB staff estimates.

Thank You

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