Federal Ministry
for Economic Affairs
and Energy

MITTELSTAND
GLOBAL
ENERGY SOLUTIONS
MADE IN GERMANY

Der Photovoltaikmarkt in Kambodscha

Das Projektentwicklungsprogramm (PEP)

Intersolar, June 21 2018

Facilitator

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

1. Regional Overview

Germany

GDP =3,478 bn. US$

83 Mio.

GDP per capita: 41,900 US$

GDP growth rate
(2012-2016): **1.3 %**

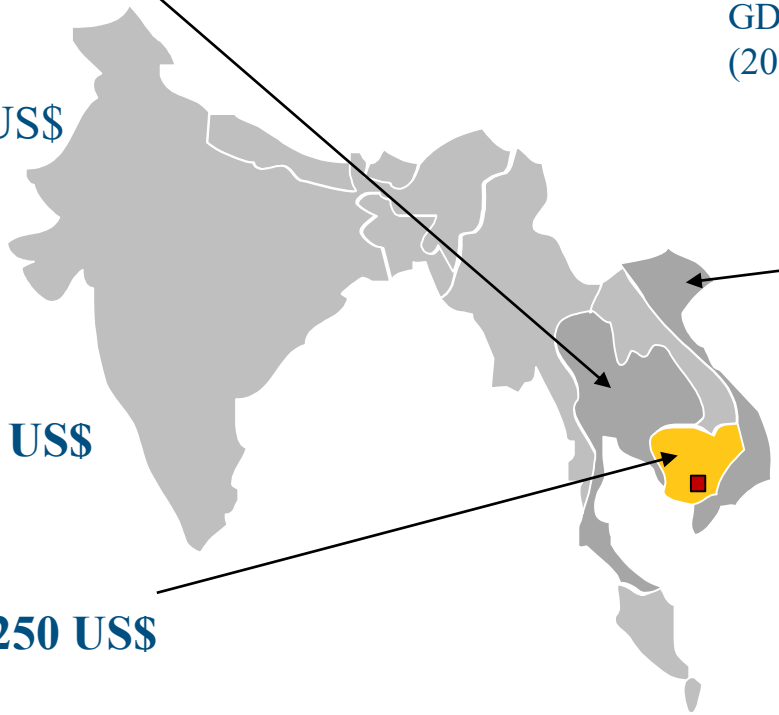
Thailand

GDP = 407 bn. US$

69 Mio.

GDP per capita: 5,900 US$

GDP growth rate
(2012-2016): **3.4%**



Vietnam

GDP = 205 bn. US$

93 Mio.

GDP per capita: 2,200 US$

GDP growth rate
(2012-2016): **5.9 %**

Cambodia

GDP = 20 bn. US$

16 Mio.

GDP per capita: 1,250 US$

GDP growth rate
(2012-2016): 7.2 %

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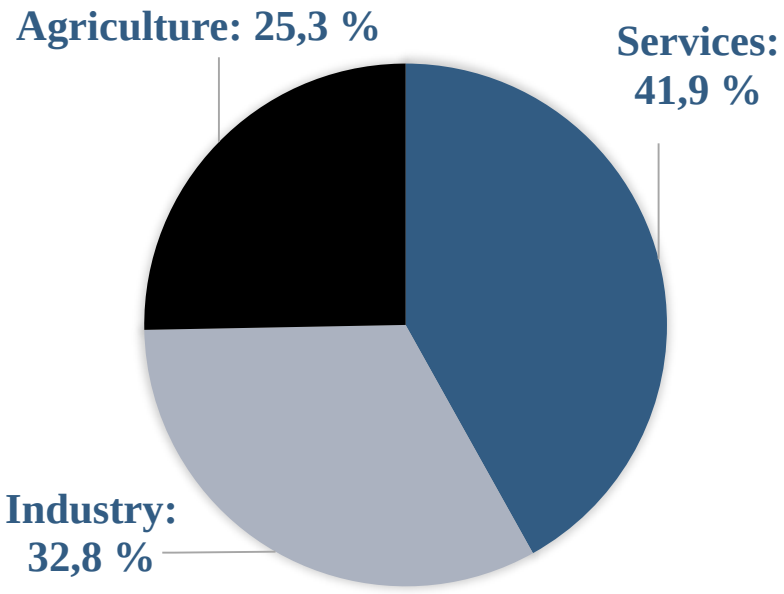
Status: 2016

Source: www.worldbank.org

2. Economy of Cambodia

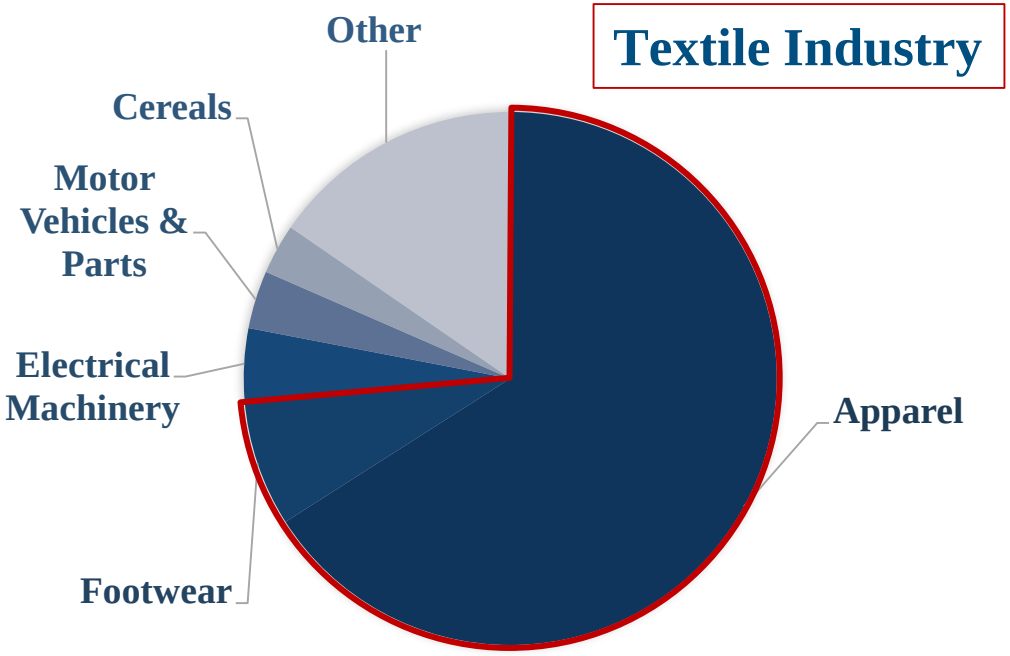
GDP BY SECTOR



Status: 2017

Source: CIA, World Factbook

EXPORT STATISTICS



Status: 2016

Source: UN Comtrade, 2016

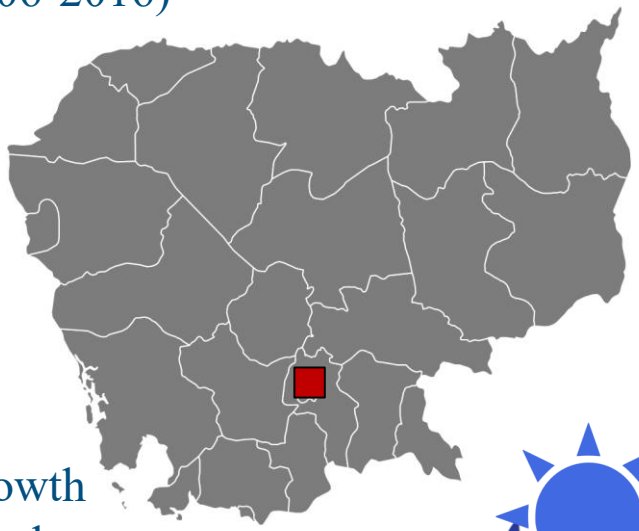
2. Energy Market

Average annual growth of number of electricity consumers (2006-2016)

→ **20 %**

Dependency on imported energy (2015)

→ **53 %**



Average annual growth of electricity demand (2006 – 2016)

→ **19 %**

Annual Growth of primary energy demand (2010 – 2015)

→ **7 %**

Source: Ministry of Mines and Energy, 2016
EAC Annual Report, 2016

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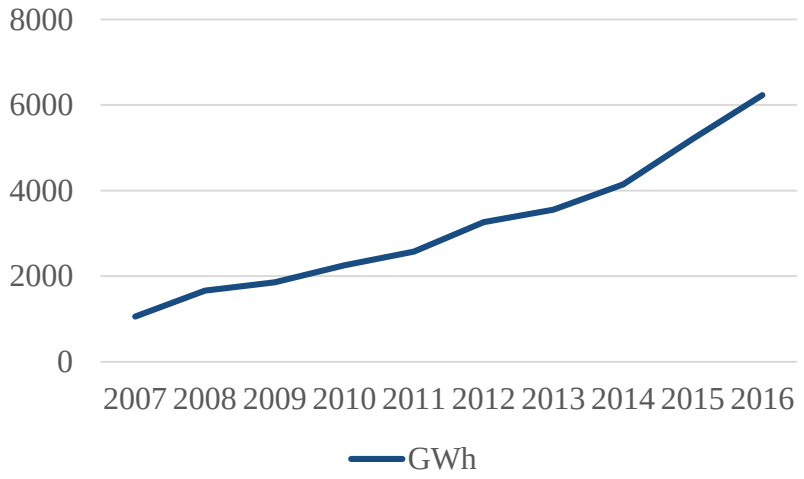
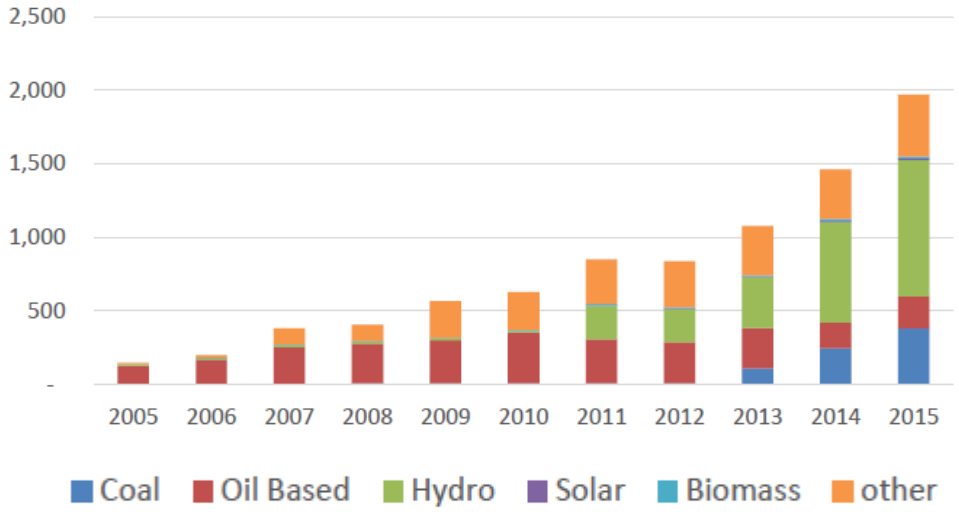
2. Energy Market

Sales of Electricity in Cambodia (2007-2016)



EAC Annual Report, 2016

Electricity Generation Capacity (2005 – 2015)



Ministry of Mines and Energy, 2016

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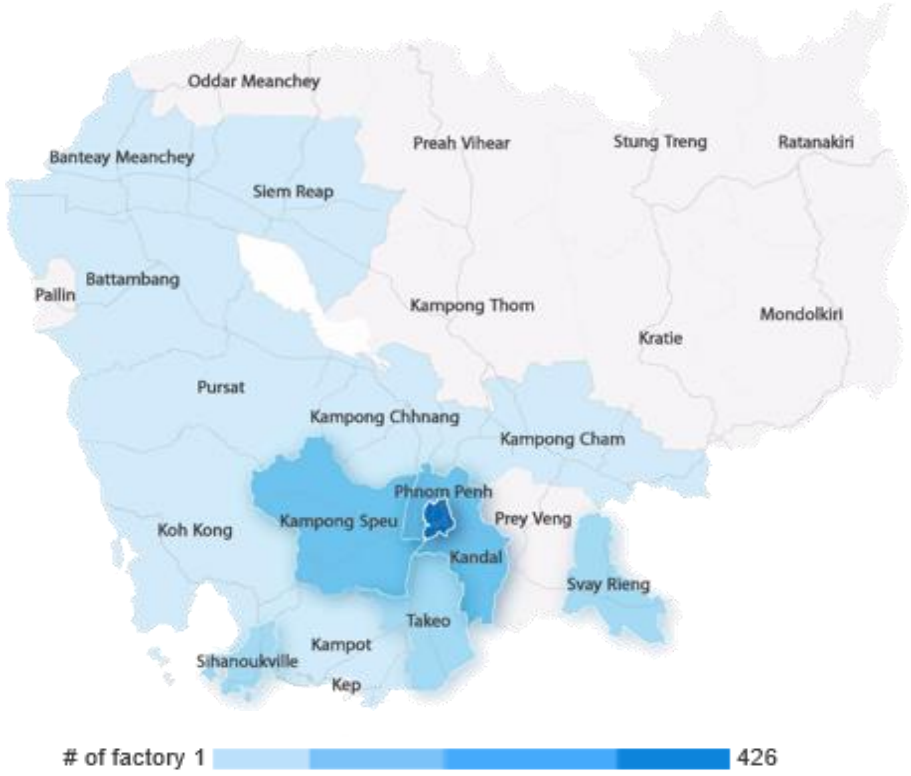
4. Electricity Tariffs – Industry Tariff

Electricity Tariffs for garment Industry	USD ₵ / kWh
Factory 1	21
Factory 2	17
Factory 3	17
Factory 4	22
Factory 5	17
Factory 6	17
Factory 7	19

17 – 22 USD ₵ / kWh

Source: GIZ

Number of garment factories in Cambodia



Source: www.sithi.org

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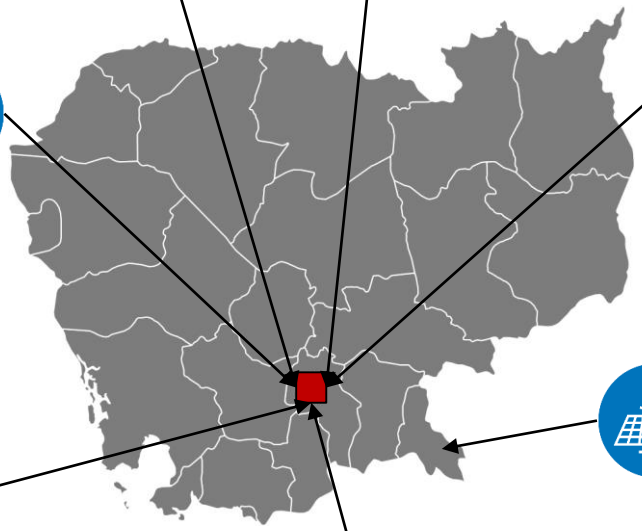
5. Solar PV Projects in Operation

Capital Concord Enterprise Ltd.,
3,100 kWp

Coca-Cola
Grid-connected
2,624 kWp

Sabrina Cambodia Garment
Grid-connected
1,355 kWp



Phnom Penh Special Economic Zone
Grid-connected
2x 63 kWp

Sunseap Group
Grid-connected
10 MW

Sheico Phnom Penh
Grid-connected
858 kWp

ISI Steel Factory
Grid-connected
1000 kWp

Status: 2018

Sources: Green Move Consulting, Comin Khmere, Cleantechsolar, Budget Energy Corp.

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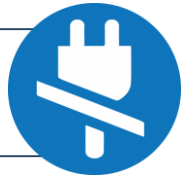
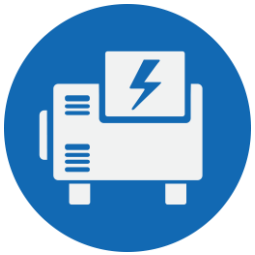
6. Embedded Generation

Power Outages



Indicator	
Percentage of firms experiencing electrical outages [%]	35.3
Number of electrical outages per month	1.4
Duration of a typical electrical outage [h]	1.3
Average losses due to electrical outages [% of annual sales]	3.6
Percentage of firms owning or sharing a generator [%]	40
If generator is used, average proportion of electricity from a generator [%]	9.0

Enterprise Surveys (http://www.enterprisesurveys.org), The World Bank. Status: 2013

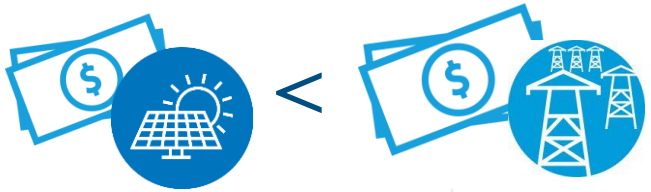


- **Diesel price** = 3,500 KHR/Liter ≈ **88 USD ¢/l** (19/03/2018)
- Litre Diesel / kWh_{el} ≈ 0.3
- Exchange Rate 1 USD = 3991 KHR (19/03/2018)

→ **$LCOE_{Diesel\ Generator}$** ≈ 1166 PKR/kWh_{el}

≈ 29 USD ¢/kWh

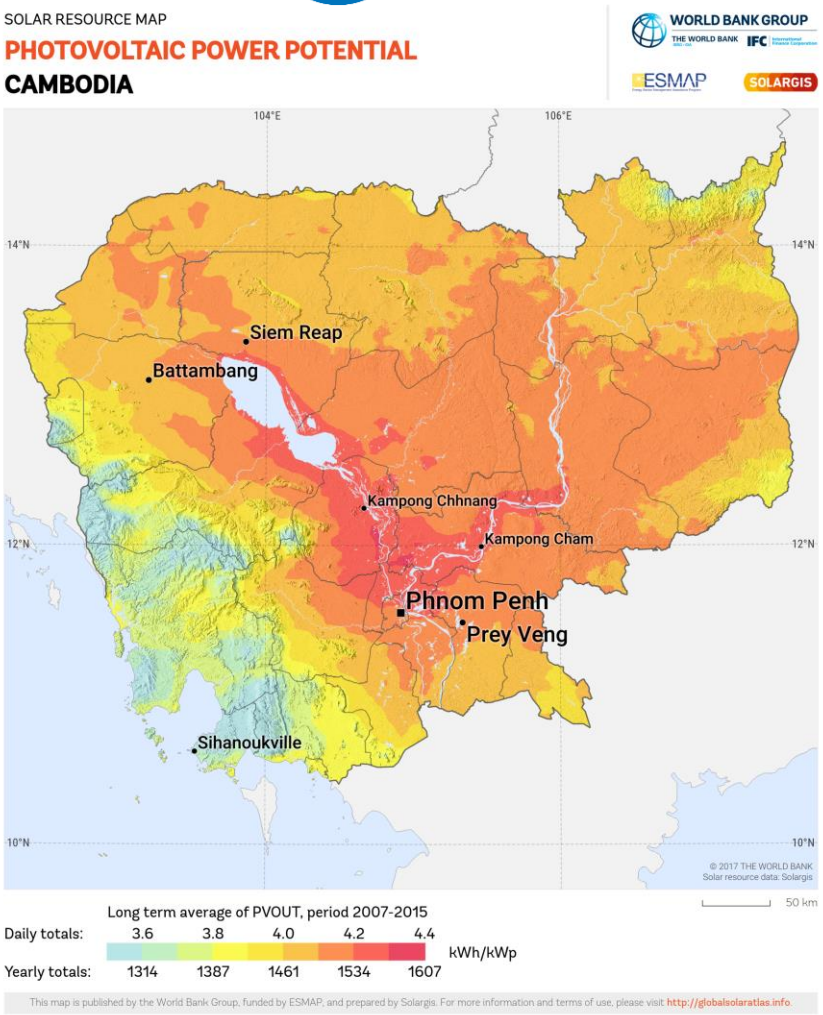
6. Embedded Generation



LCOE of Solar PV Rooftop Systems

Financial Parameters	
PV Capital Cost [USD/kWp]	1000-1700
Annual Maintenance Cost [USD/kWp]	10-25
Annual Discount Rate [%]	8
System's Lifespan [years]	25
PV System Parameters	
Estimated PV Potential [kWh/kWp]	1500
Degradation of PV Modules [%/year]	0,5
Results	
LCOE [USD Cents / kWh]	**7 - 13**

Source: own assumptions



Source: Global Solar Atlas

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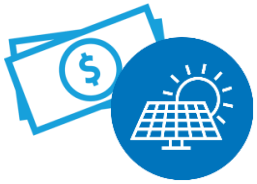
6. Embedded Generation

Off-Grid

frequent Power Cuts



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Regulation on Captive Solar PV in Cambodia

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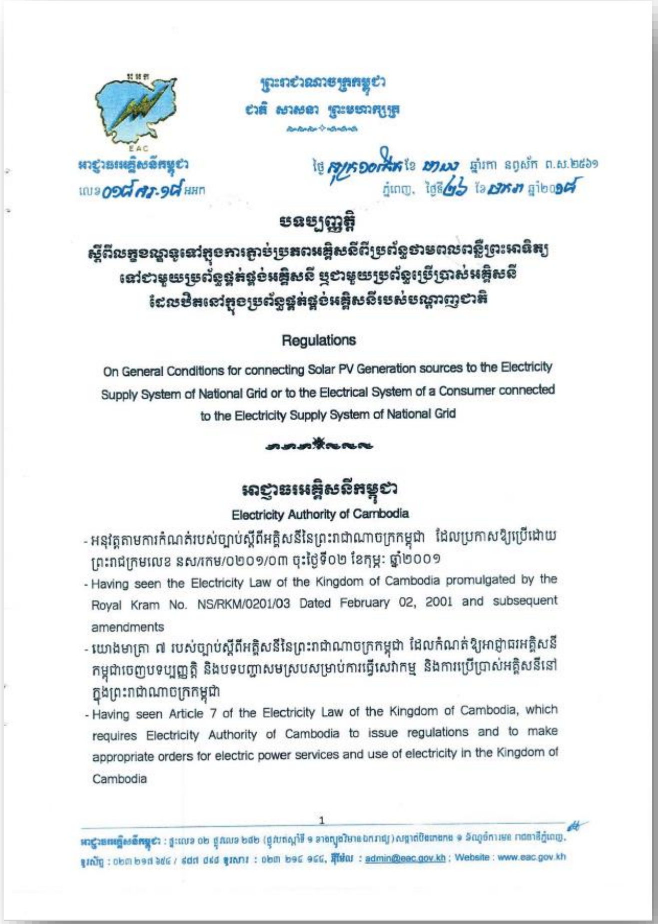
What's new?

- On-grid and off-grid Solar PV for self consumption officially legalized

- Introduction of:
  - Opportunities for Power Purchase Agreements for Solar PV
  - Technical Standards for Solar PV



Regulations

On General Conditions for connecting Solar PV Generation sources to the Electricity Supply System of National Grid or to the Electrical System of a Consumer connected to the Electricity Supply System of National Grid

Electricity Authority of Cambodia

- Having seen the Electricity Law of the Kingdom of Cambodia promulgated by the Royal Kram No. NS/RKM/0201/03 Dated February 02, 2001 and subsequent amendments

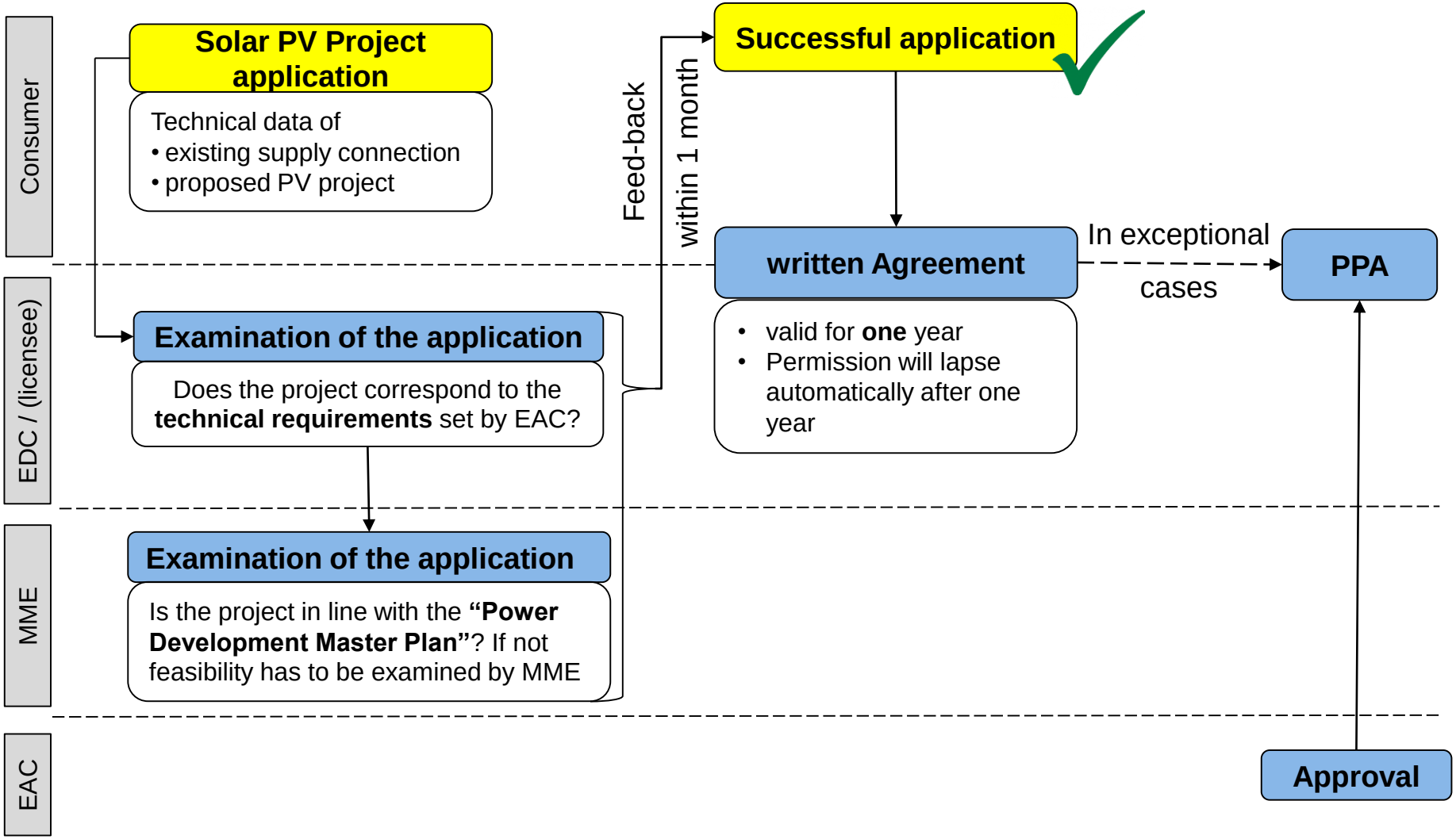
- Having seen Article 7 of the Electricity Law of the Kingdom of Cambodia, which requires Electricity Authority of Cambodia to issue regulations and to make appropriate orders for electric power services and use of electricity in the Kingdom of Cambodia

1

Source: EAC, 2018

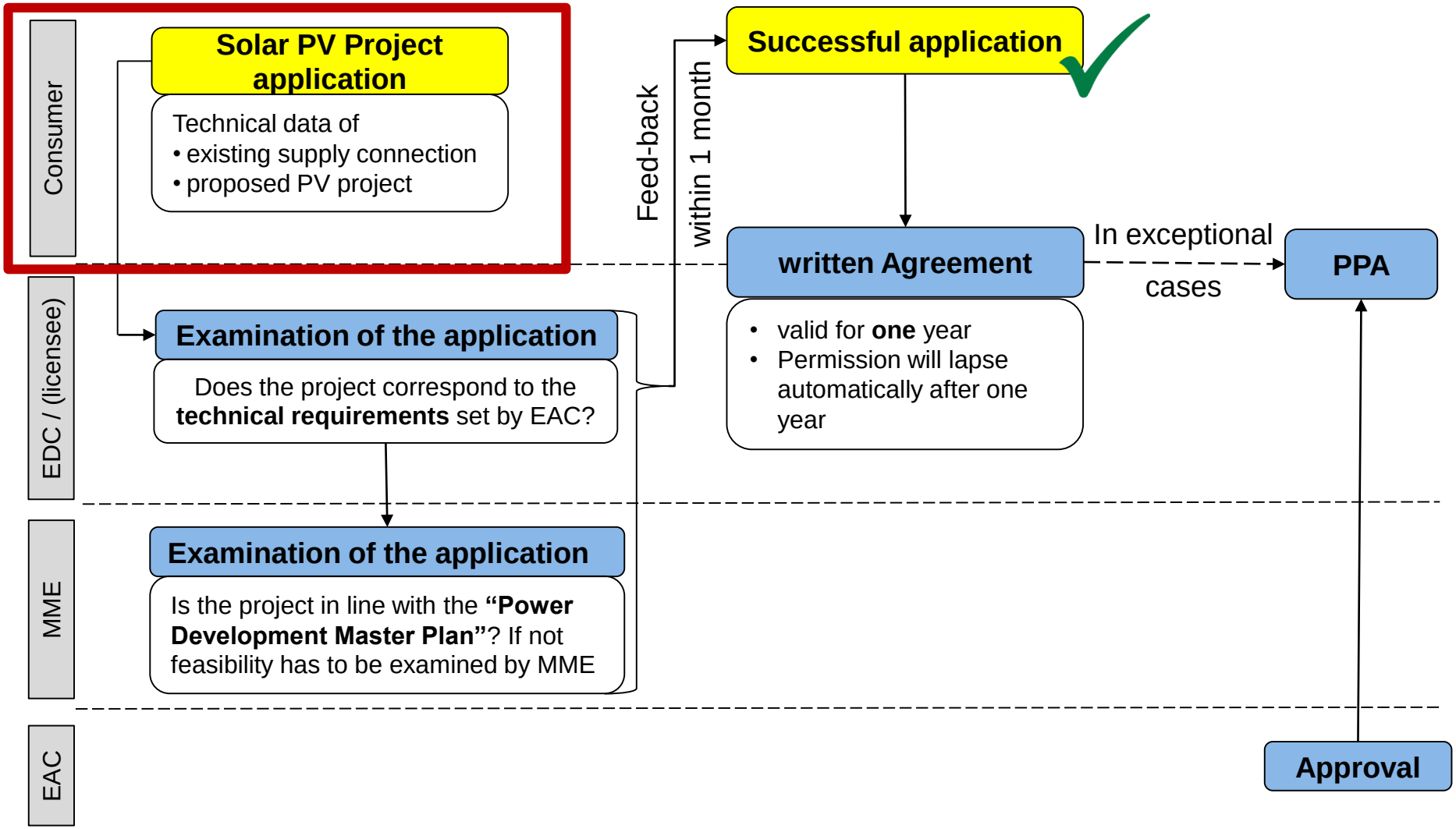
➡ new incentives for the installation of captive Solar PV

Application Process for Captive Solar PV



Source: EAC

Application Process for Captive Solar PV



Source: EAC

Solar PV Project Application

- New regulation applies only to **Big and Bulk Consumers**
  - Big Consumer = Medium Voltage Connection (6.3 kV, 15 kV, 22 kV)[1]
  - Bulk Consumer = High Voltage Connection (115 kV)[1]

  → Low Voltage Consumers are not allowed to install on-grid solar PV Systems

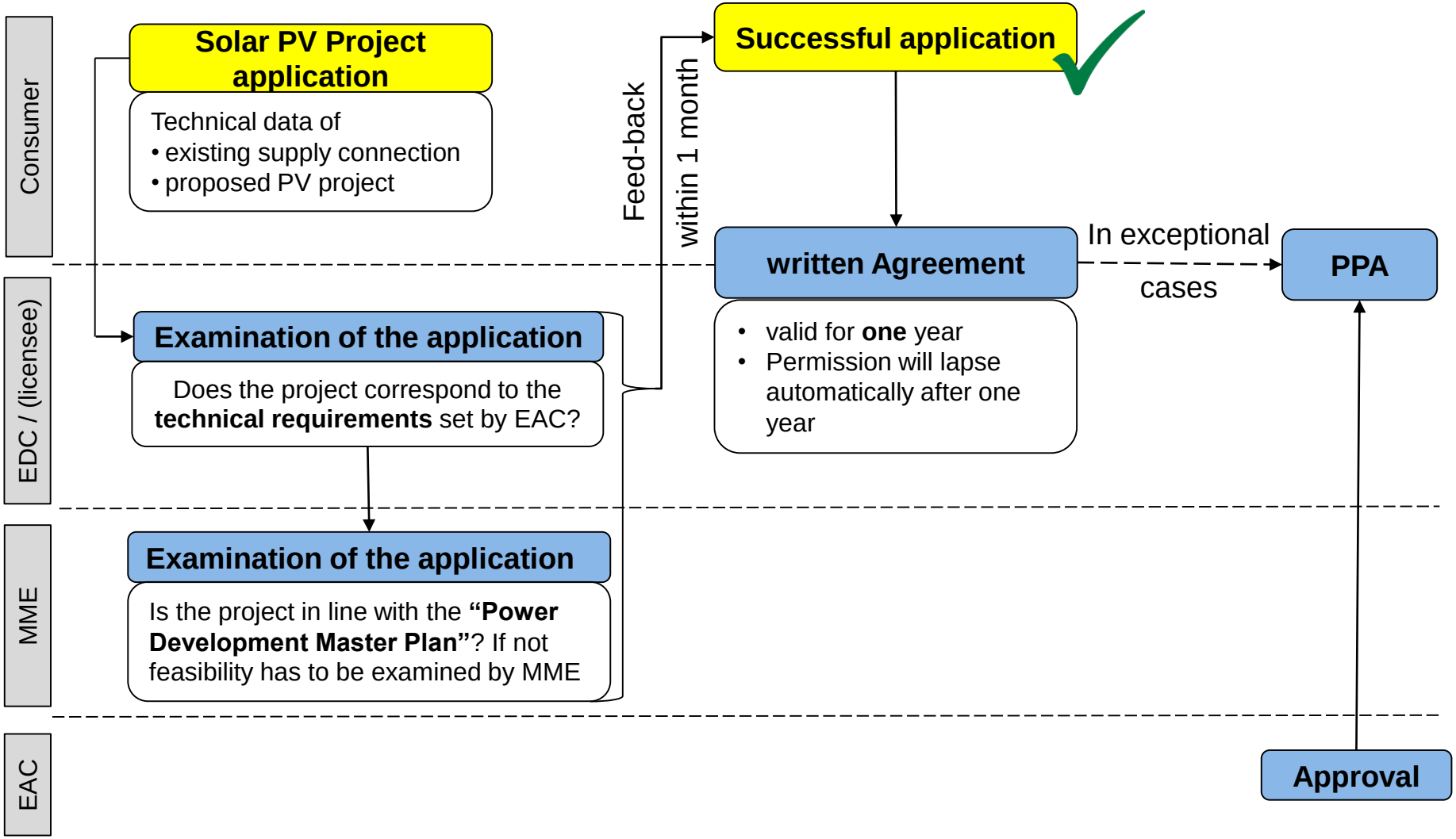
- **Application to be sent to EDC** and to the licensee supplying electricity to the consumer
  (only if the consumer is supplied with electricity by a licensee other than EDC)

- **Official templates** for application are not yet available

- Application has to include **all information** about the existing **supply connection** & the **proposed solar PV** project
  - No more precise information mentioned

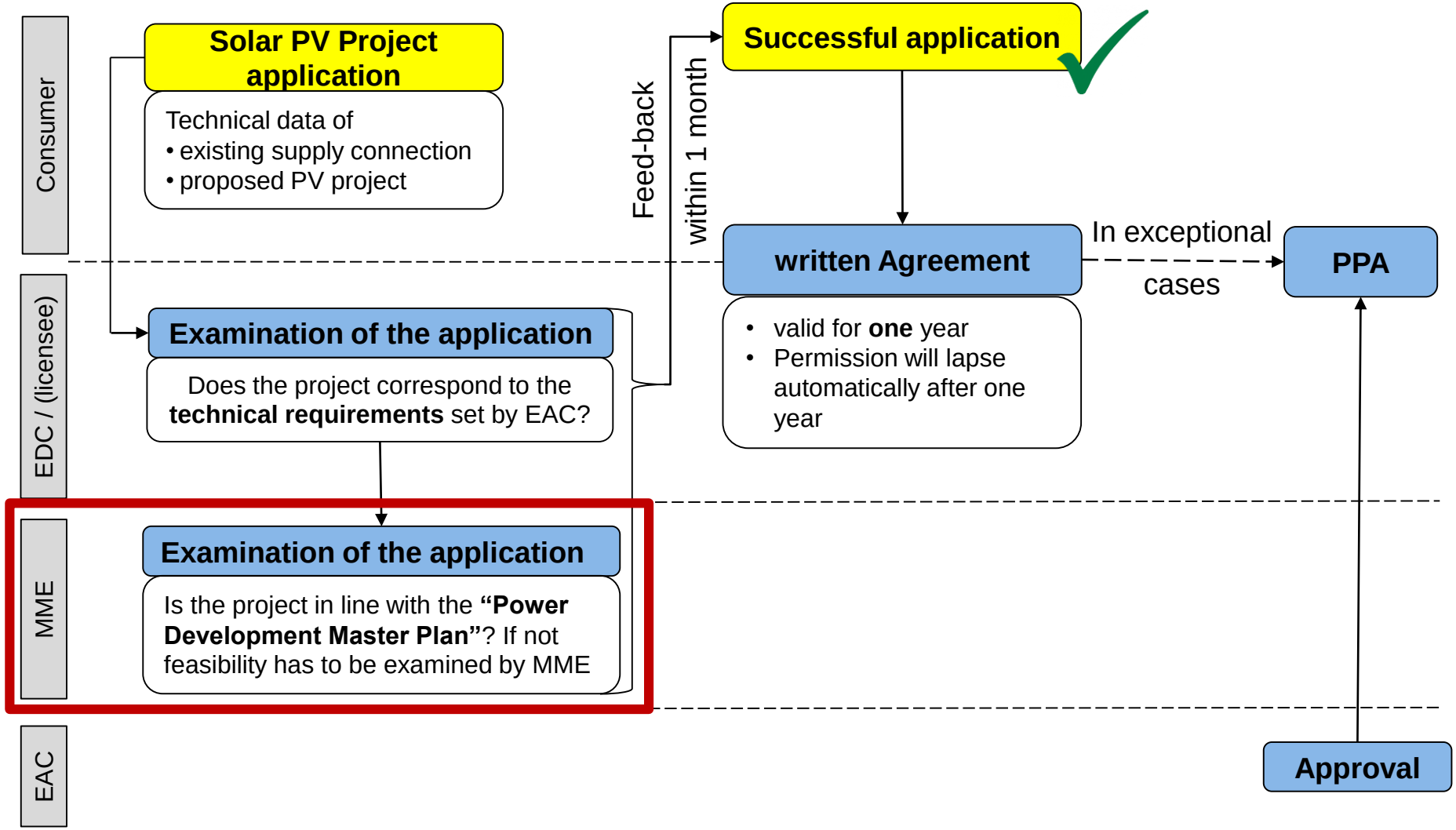
[1] Regulations on General Conditions of Supply of Electricity in the Kingdom of Cambodia; EAC 2003

Application Process for Captive Solar PV



Source: EAC

Application Process for Captive Solar PV



Source: EAC

Power Development Master Plan

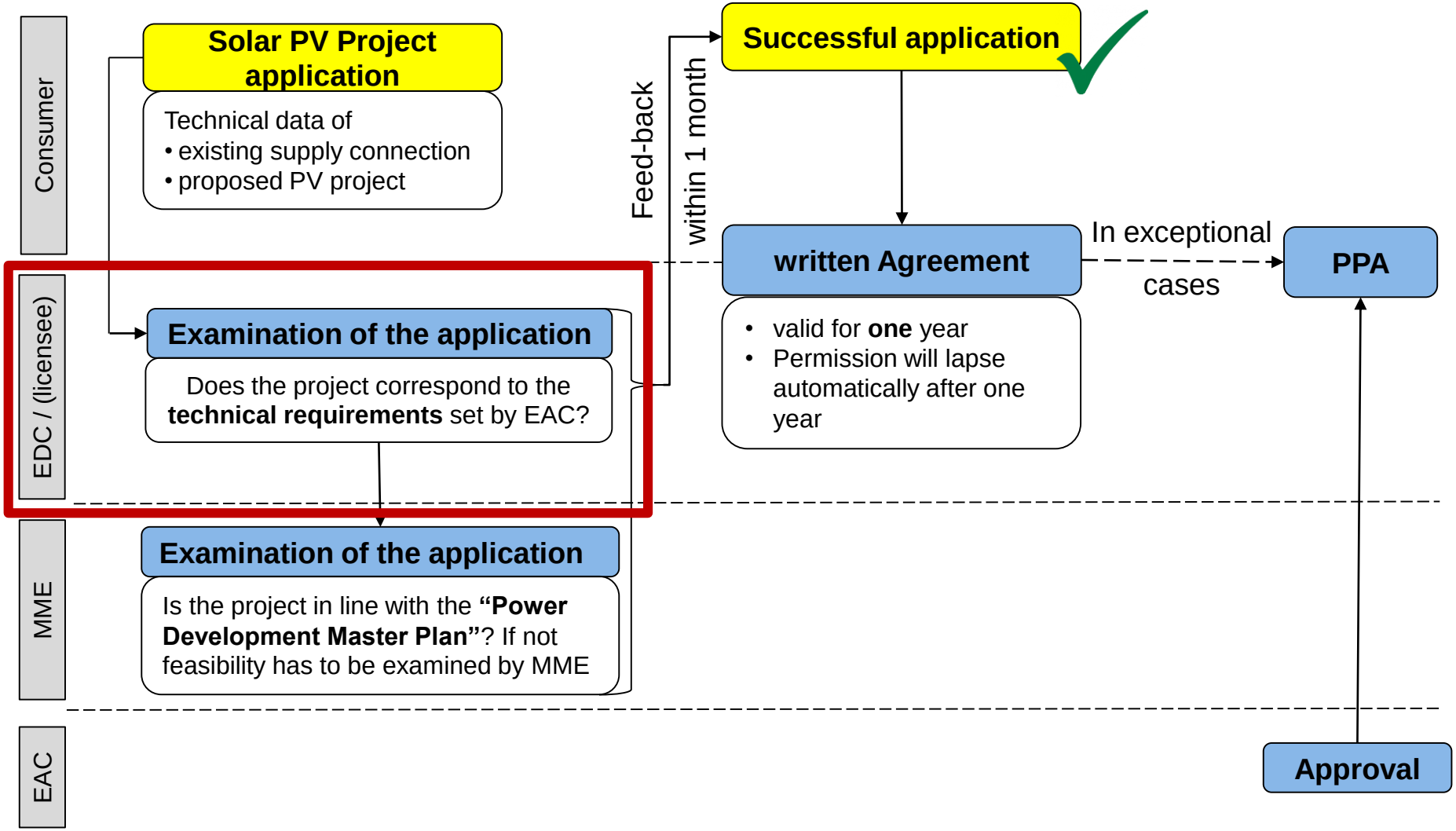
Table 12: Generation Development Plan 2016 - 2025

No.	Project Name	Type	Capacity (MW)	Operation Year
1	135 MW Coal Fired Power Plant (CIIDG)	Coal	120	2017
2	Lower Sesan II	Hydro	400	2018
3	Coal Fired Power Plant I	Coal	100	2019
4	Coal Fired Power Plant II	Coal	120	
5	Coal Fired Power Plant III	Coal	250	2020
6	Coal Fired Power Plant IV	Coal	250	2021
7	Chay Areng	Hydro	108	2022
8	Pursat I	Hydro	40	2023
9	Battambang II	Hydro	36	
10	Lower Sesan III	Hydro	260	
11	Lower Sre Pok III (3B)	Hydro	68	2024
12	Lower Sre Pok IV	Hydro	48	
13	Lower Sre Pok III (3A)	Hydro	300	
14	Prek Liang I	Hydro	72	2025
15	Prek Liang II	Hydro	50	
16	Prek Chhlong II	Hydro	16	
17	Lower Sesan I	Hydro	96	
18	Prek Por	Hydro	17	
19	Lower Sekong	Hydro	190	
20	Thermal I	Coal / Gas	300	
Total			**2,841 MW**	

Source: EDC

For PV Projects not included in the Master Plan, feasibility has to be examined and the project has to be added to the Master Plan

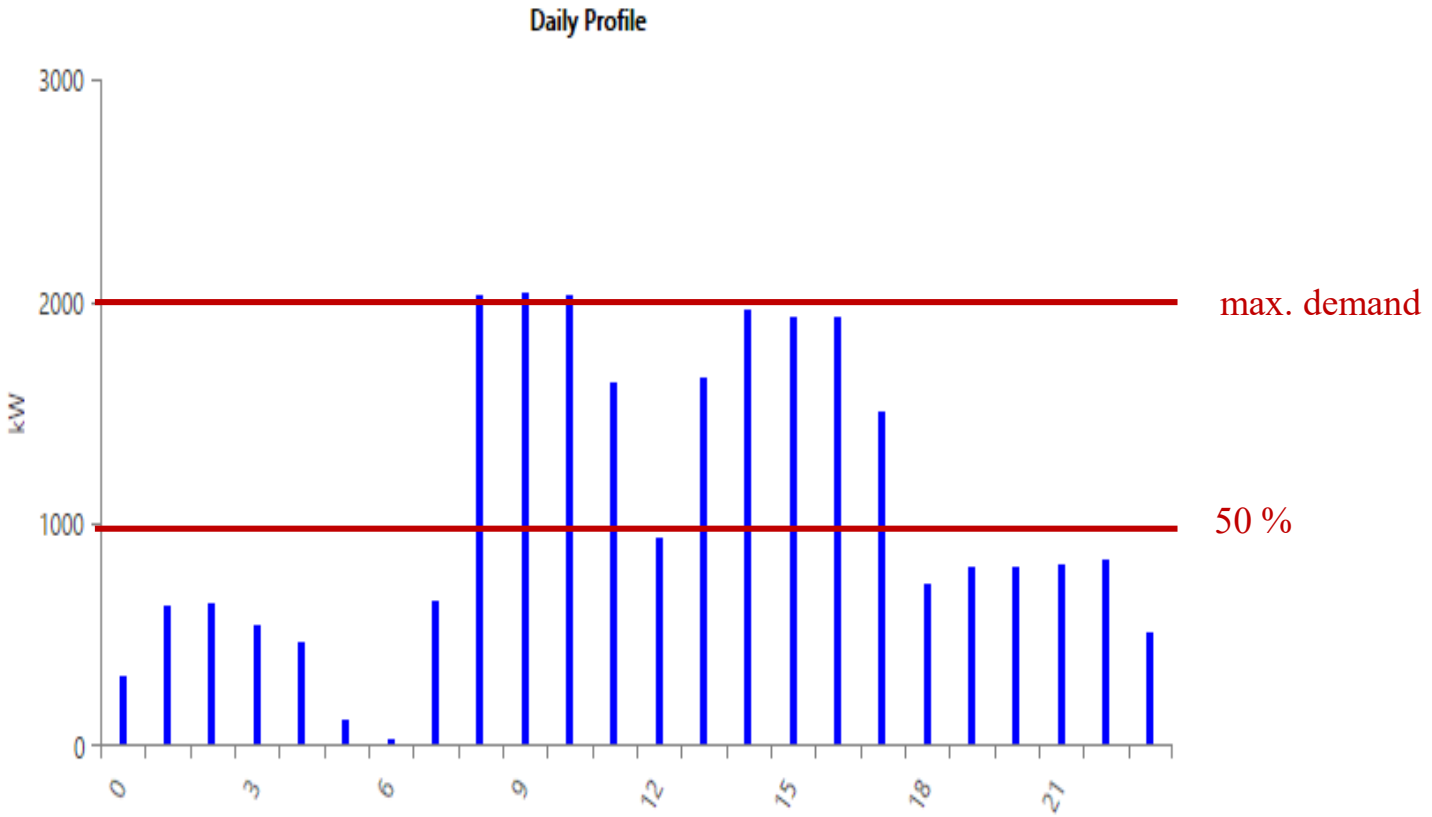
Application Process for Captive Solar PV



Source: EAC

Technical Requirements – Key Points

- **Maximum Inverter Capacity:** 50 % of contract demand in kW

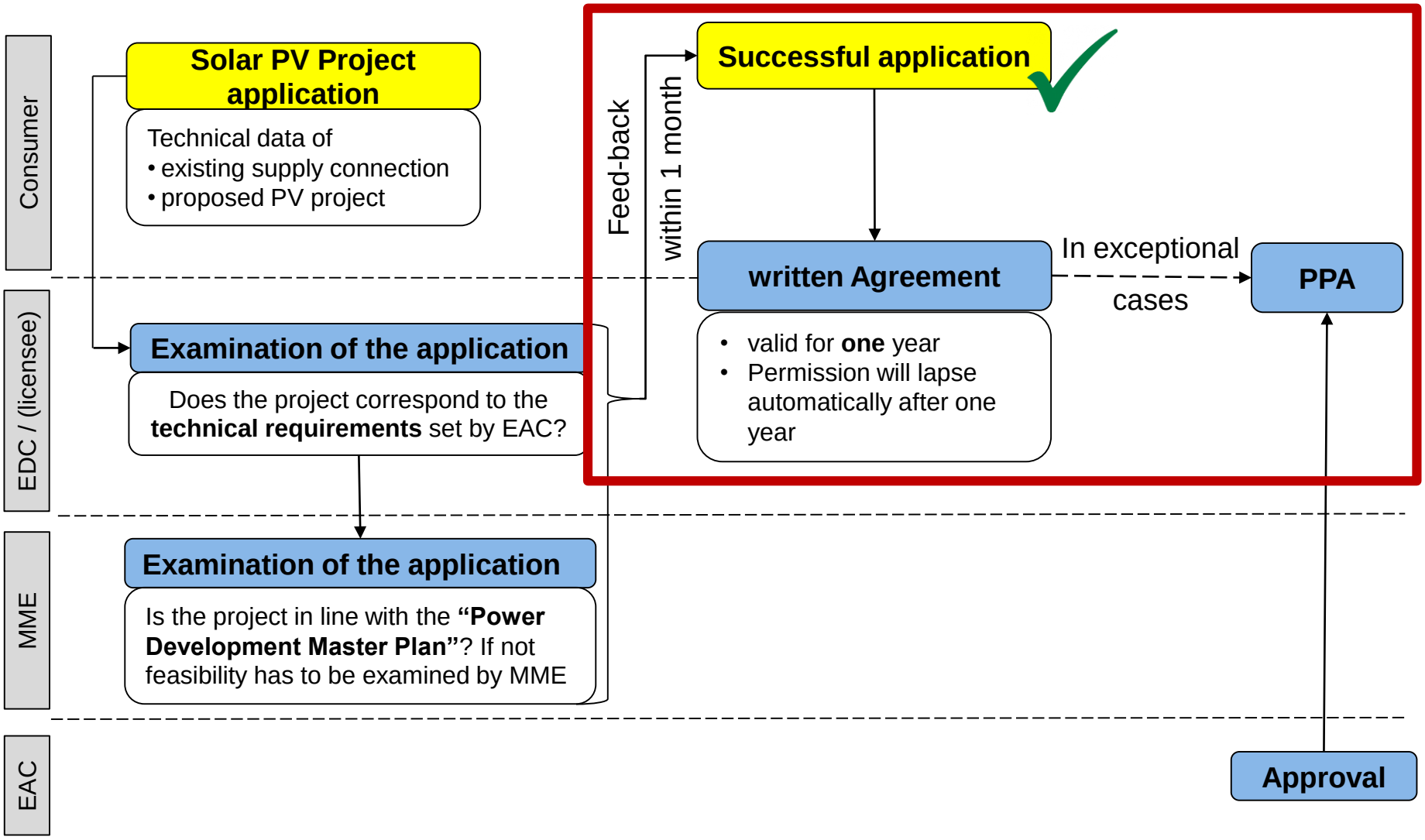


Source: GIZ

Technical Requirements – Key Points

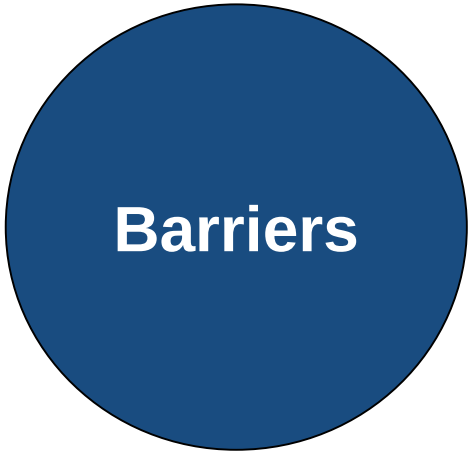
- **Maximum Inverter Capacity:** 50 % of contract demand in kW
- **Excess energy** is not allowed to be fed into the grid
- **Technical Requirements** (anti islanding, harmonic distortion) are **similar to international standards**
- Technical requirements for Photovoltaic systems roughly mentioned in **National Grid Code** (2004) → but no specific information given

Application Process for Captive Solar PV



Source: EAC

Challenges for successful project realization



1. Project agreement
2. Economic Assessment
   a) PPA
   b) Change of Electricity Tariff
3. Limitation of system size

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You are invited!

1st half 2019: German Project Development Training Week in Cambodia

2nd half 2019: AHK Business Trip to Cambodia

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Thank you for your attention

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