

# Renewable Energy Guidelines on

## Solar PV Rooftop Implementation: Thailand

Version 1.0



E-Guidebook  
October 2017

# Imprint

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## Publisher

- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- USAID Clean Power Asia

Version 1.0

Bangkok, October 2017

## Disclaimers

Highest effort has been given to ensure and maintain accuracy of the Guidelines. Regulations and procedures for RE project development in Thailand are complex, include numerous actors and are likely to be changed or updated over time. It is therefore not possible to cover all aspects and eventualities of RE project development with these Guidelines. The Guidelines are regularly updated in order to ensure correctness and completeness. However, GIZ / USAID and its implementing partners cannot be held responsible for any use of the Guidelines. The Guidelines shall not, in any case, replace or be used instead of existing laws, regulations and official guidelines issued by the relevant authorities in Thailand.

Suggestions, feedbacks and updates are very welcome and can be addressed to [Thachatat.Kuvarakul@giz.de](mailto:Thachatat.Kuvarakul@giz.de) and [Sunee\\_Moungharoen@abtassoc.com](mailto:Sunee_Moungharoen@abtassoc.com). The guidelines will be updated periodically to account for changes in government policies, and can be accessible at location <http://usaidcleanpowerasia.aseanenergy.org>

# Foreword



## Thomas Chrometzka

*Director Energy Programme, GIZ Thailand*

Abundant resources and increasing demand for energy make Southeast Asia a region of rich potential for solar energy. Germany is an energy transition pioneer phasing out fossil fuels and increasingly incorporating renewables in the country's energy mix. Vast experience gained in this process has made German products and know-how one-of-a-kind in the renewable energy sector. The “German Energy Solutions” Initiative matches the demand in Southeast Asia with German solutions creating a triple win effect for local markets, German and Southeast Asian businesses as well as end-Facility Owners.

Coordinated and financed by the German Federal Ministry for Economic Affairs and Energy (BMWi), the “German Energy Solutions Initiative” is undertaken in cooperation with various partner organizations. The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the German Thai Chamber of Commerce are implementing the initiative in Thailand facilitating sustainable German-Thai business partnerships.

Working closely with end-costumers, project developers and investors in Thailand's solar market, GIZ identified the need to facilitate the PV rooftop market by creating an easy to follow step by step implementation guidelines. GIZ and USAID joined forces to tackle this need.

As prices for solar panels are coming down, solar becomes more competitive. However, stemming the initial investment for the solar system remains a challenge. This challenge can be addressed by the increasingly more popular Third-Party Ownership (TPO) models. TPOs take away the high upfront investment on end-costumer side and hold the promise of making solar energy accessible to a larger group of users. This is just one of the many aspects that is addressed in the following PV Implementation Guidelines including practical tools and checklists serving the needs of both sides: end-costumers and solar companies.

*“...As prices for solar panels are coming down, solar becomes more competitive...”*



# Foreword



## Angela Hogg

*Director, Regional Environment Office, USAID Regional Development Mission for Asia*

For many years solar electricity was considered too expensive compared with fossil fuel prices. Today, the costs of solar power are more affordable, and in many countries an investment in self-consumption pays for itself. Thailand is experiencing more and more commercial and industrial facility owners investing in solar photovoltaic (PV) rooftops as a means to cut their electricity costs and contribute to clean energy targets. Despite the economic viability of solar projects, however, regulatory hurdles, a lack of trusted information (such as from technical to financing options) and tools to assess economic viability continue to be a challenge.

*“...We believe the tools in this E-Guidebook will unlock the solar PV rooftop market in Thailand.”*

The United States Agency for International Development (USAID) Clean Power Asia activity is a regional clean energy program that increases investment in grid-connected renewable energy. The activity supports governments in the Lower Mekong -- with links to all ASEAN Member States -- in high renewable energy scenario power planning. USAID Clean Power Asia is also helping to establish an effective policy, regulatory and technical environment for low emissions growth in the power sector, while simultaneously attracting public and private-sector investment in renewable energy development.

Through USAID Clean Power Asia’s partnership with Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Thailand, we hope the **Renewable Energy Guidelines on Solar PV Rooftop Implementation: Thailand** will help clarify the permitting and licensing processes and provide the necessary tools to unlock the solar PV rooftop market in Thailand.



# Abbreviations

BOI	Board of Investment
BOO	Build Own and Operate
COD	Commercial Operation Date
CoP	Code of Practice
DEDE	Department of Alternative Energy Development and Efficiency
EPC	Engineering, Procurement and Construction
ERC	Energy Regulatory Commission
GIZ	The Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
IEC	International Electrotechnical Commission
kWp	Kilowatt peak
MEA	Metropolitan Electricity Authority
MoU	Memorandum of Understanding
O&M	Operation and Maintenance
PEA	Provincial Electricity Authority
PPA	Power Purchase Agreement
PV	Photovoltaics
RE	Renewable Energy
SAO	Sub-District Administration Office
TPO	Third Party Ownership
USAID	The United States Agency for International Development



## About the Guidelines

Scope of the guidelines  
Terms used in the guidelines  
...

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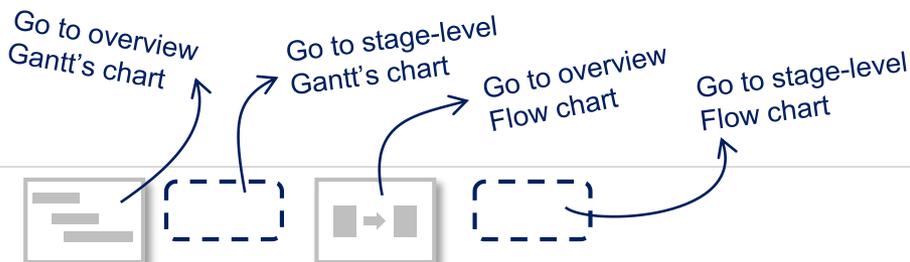
## How to use the Guidelines?

This electronic guidebook is an interactive PDF file. Buttons in this guidebook help reader to navigate through the contents in systematically ways.

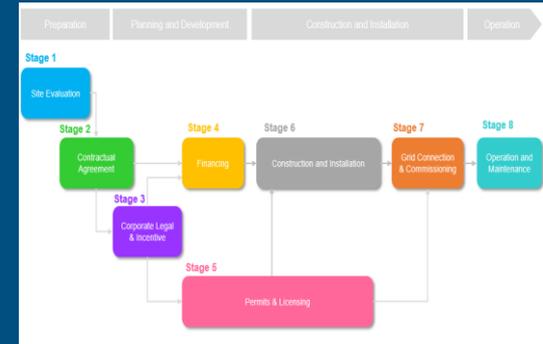
Buttons in this guidebook are highlighted with a shadow.



Navigation bars are located below every page in the guidebook. Readers can quickly go back to overview the chart from any page. Classical page turning (next page / previous page) is also possible.



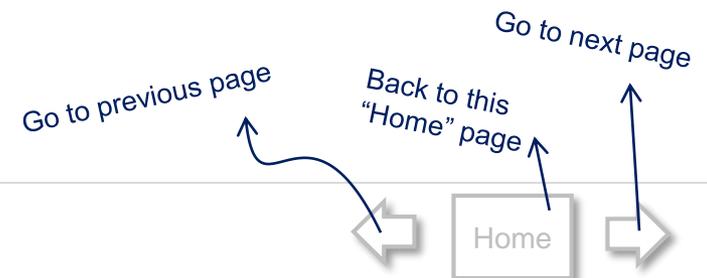
## Procedure Step-by-step



Guidelines to implement rooftop PV projects for self-consumption in Thailand. This guidelines visualizes the procedure in two formats: Gantt's Chart and Flow Chart.

Gantt's Chart gives a sense of timeframe required to complete each stage while Flow charts provide more clarity in terms of relationship between different stages.

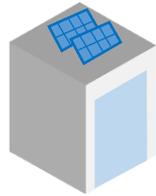
Page 8



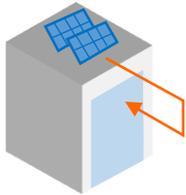
# About this E-Guidelines

## Scope of the Guidelines

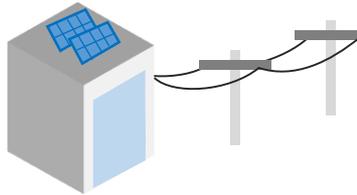
### Included



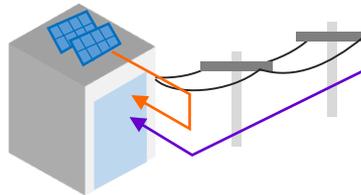
Solar PV Rooftop



Off-grid



Grid-connected

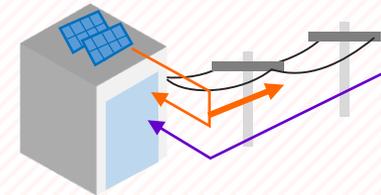


Self-consumption

### Excluded



Ground-mounted system

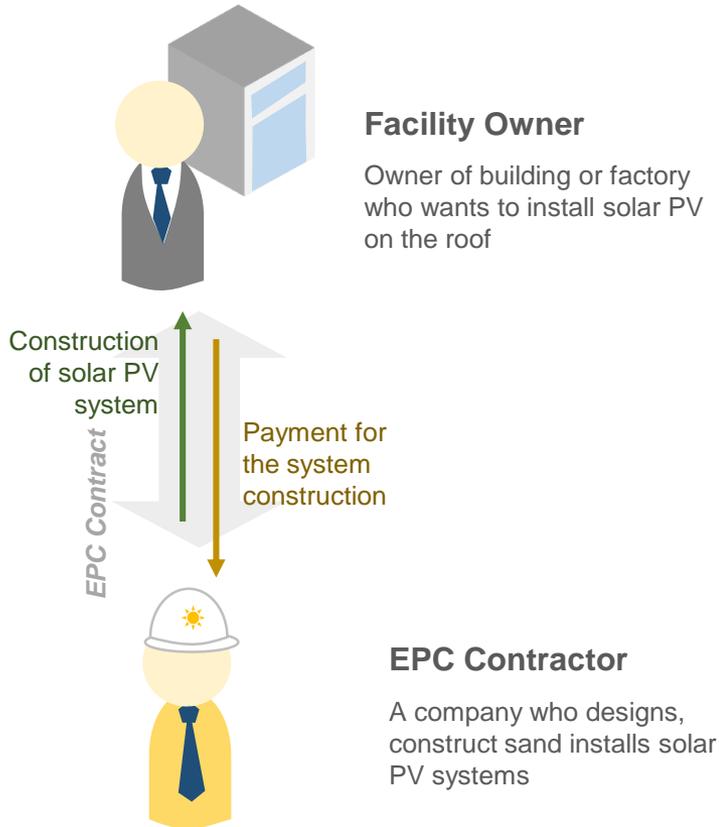


Feed electricity back to the grid

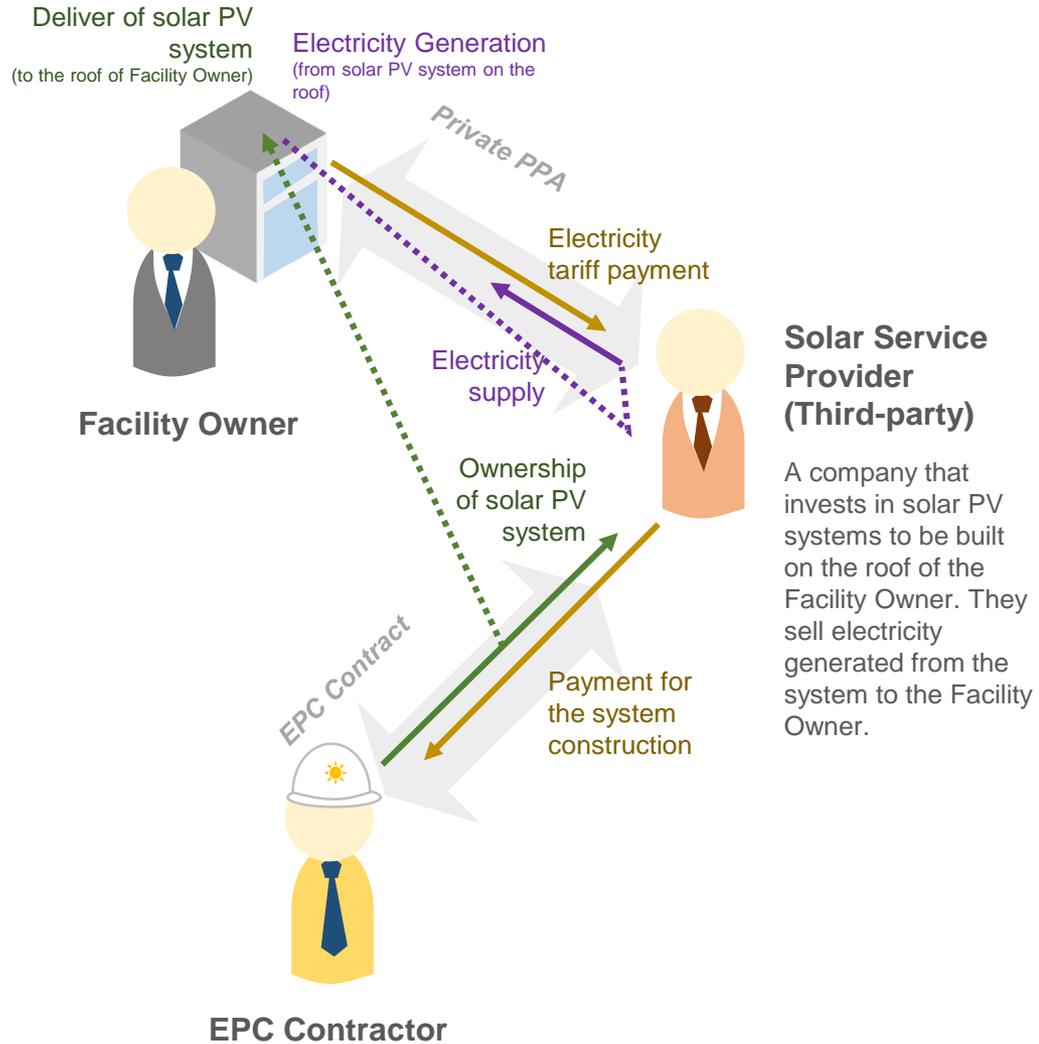
- Covers all installed capacity
- Business model: Self-financed project & Third-party Ownership

# About this E-Guidelines

Terms used in the Guidelines



**Self-financed model**

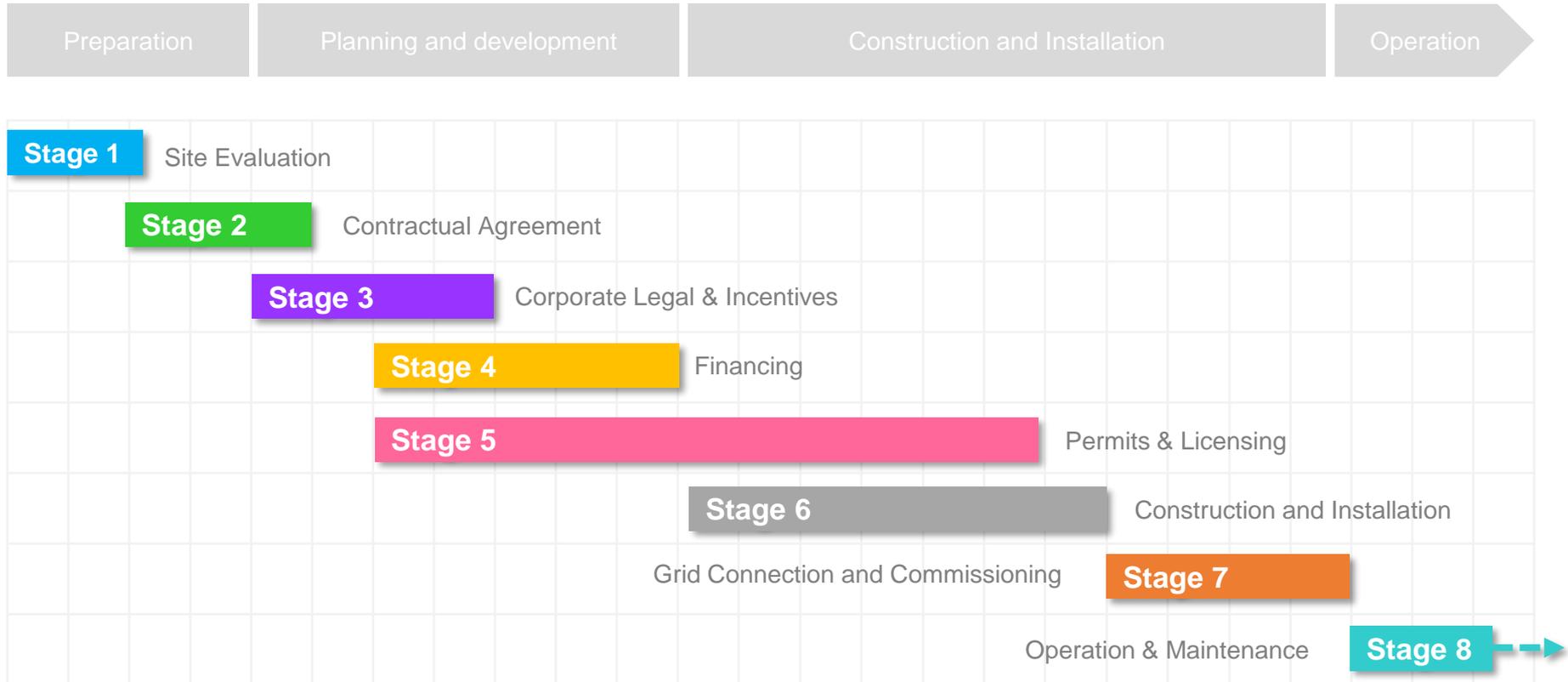


**Third-party Ownership model**



# Procedures: Step-by-Step

Development of Solar PV rooftop in Thailand (Gantt's Chart)



*Note: The bar length on the Gantt's chart is not to scale. It should be used for qualitative comparison only.*



# Procedures: Step-by-Step

*Development of Solar PV rooftop in Thailand (Flow Chart)*

Preparation

Planning and Development

Construction and Installation

Operation

## Stage 1

Site Evaluation

## Stage 2

Contractual Agreement

## Stage 3

Corporate Legal & Incentive

## Stage 4

Financing

## Stage 6

Construction and Installation

## Stage 7

Grid Connection & Commissioning

## Stage 8

Operation and Maintenance

## Stage 5

Permits & Licensing



# Procedures: Step-by-Step

*Development of Solar PV rooftop in Thailand*

• Page 1/3

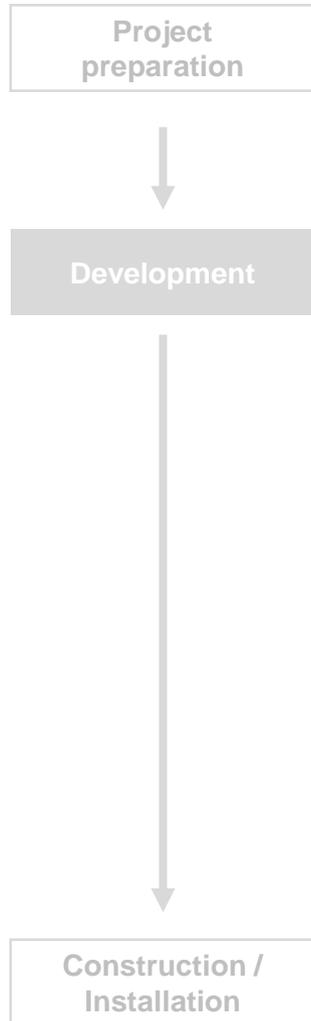
The process for the development of rooftop PV projects in Thailand can be divided into four phases. They are: (1) Project Preparation, (2) Planning and Development, (3) Construction and Installation, (4) Operation. The interfaces between these phases are marked by three major milestones of project development.



# Procedures: Step-by-Step

Development of Solar PV rooftop in Thailand

• Page 2/3



**Development Phase** describes the process after the contract with implementing party is signed and before the actual construction begins. It covers securing necessary financing, obtaining applicable incentives and supporting mechanisms, and applying for necessary licenses or permits.

This phase consists of 3 stages:

Corporate Legal & Incentive

**Corporate Legal & Incentive (Stage 3):** Some incentives or supporting schemes are available for the development of RE projects in Thailand (i.e. BOI). In this stage, the project developer will apply for those incentives / schemes.

Financing

**Financing (Stage 4):** In this stage, the project developer will secure necessary financing for procurement and installation of the system.

Permits & Licensing

**Permits & Licensing (Stage 5):** Several licenses or permits are necessary for solar PV rooftop projects (depending on the installed capacity). The project developer must secure all relevant licenses during this stage.



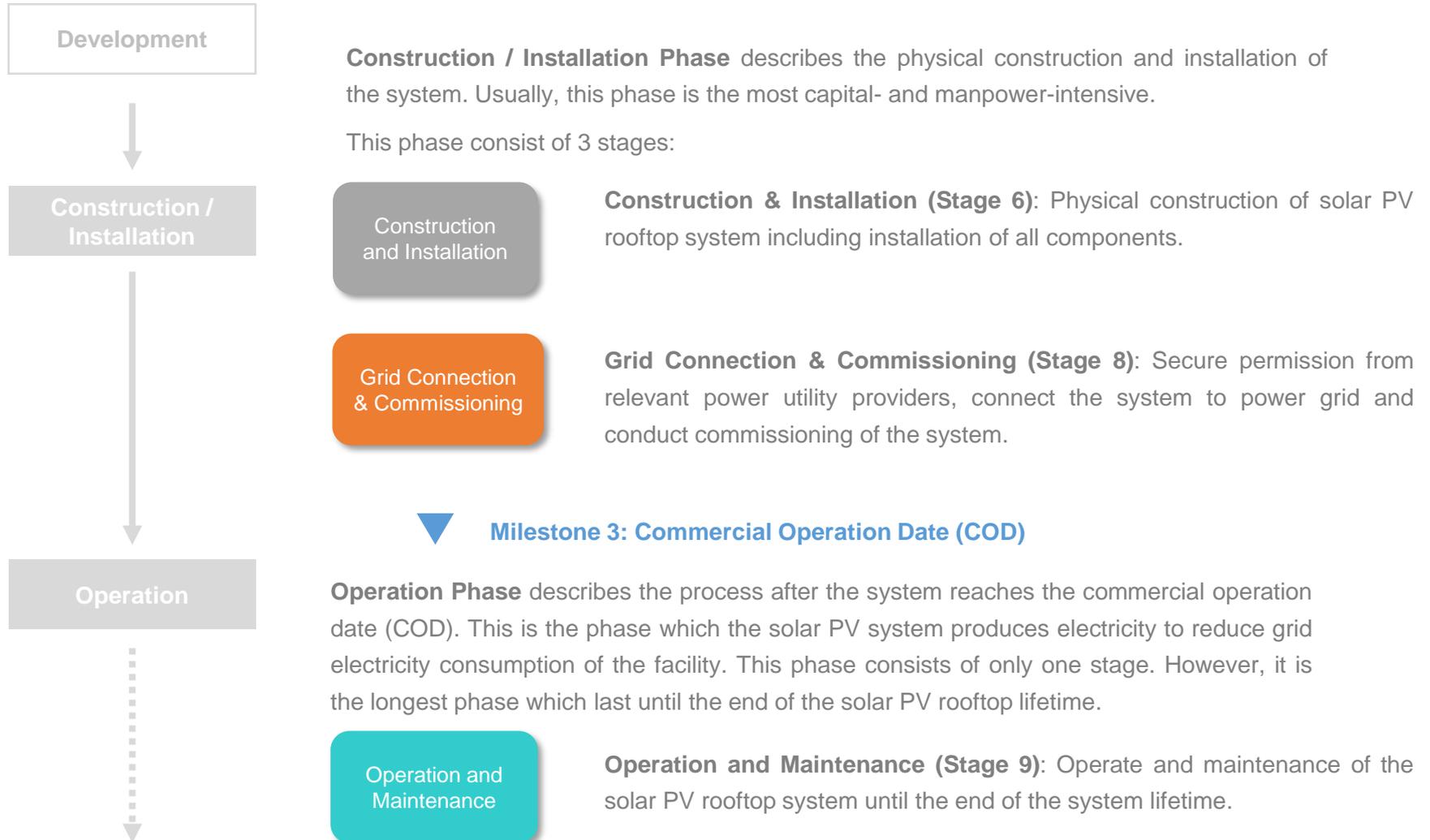
**Milestone 2: Financial close / Pre-construction licenses obtained**



# Procedures: Step-by-Step

Development of Solar PV rooftop in Thailand

• Page 3/3



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

# 1 | Site Evaluation

**Step 1.1**

Decision Making Flow Chart

**Step 1.2**

Business Model Selection

**Step 1.3**

Information Checklist

**Step 1.4**

Send Request for Proposal to EPC/Developer

**Step 1.5**

Site Survey

**Step 1.6**

Technical Design & Financial Offer

**Step 1.7**

Investment Feasibility

**Step 1.8**

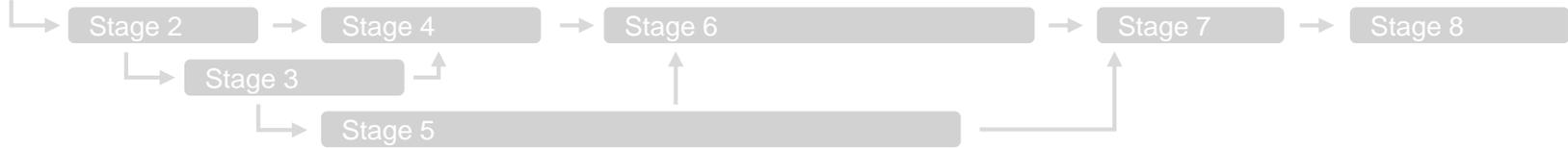
Selection of EPC/Developer

Step by Facility Owner

Step by EPC/Developer

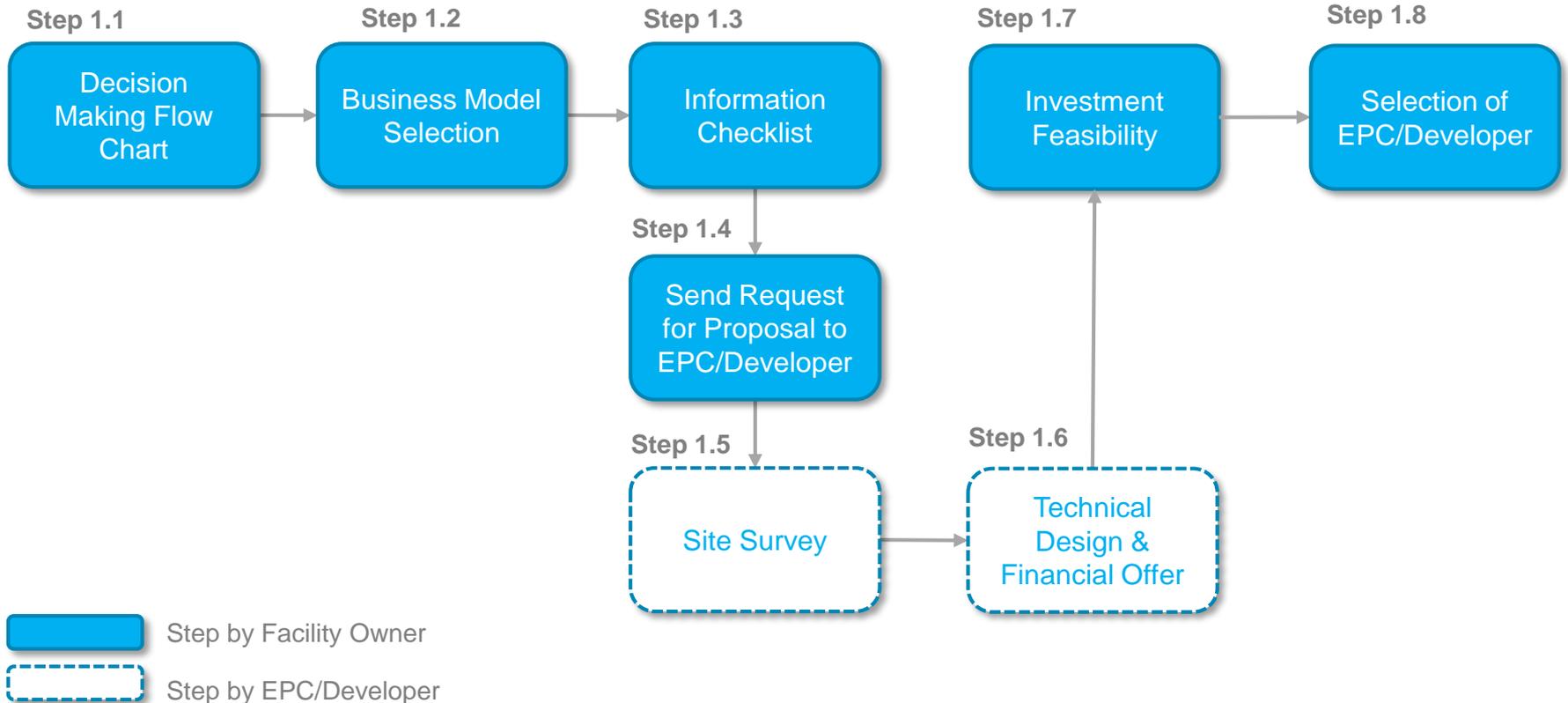


Stage 1



[See Stage Details >](#)

# 1 | Site Evaluation



# 1 | Site Evaluation

## Stage Description

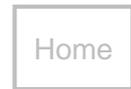
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**Site Evaluation stage** aims to assess whether a facility (i.e. commercial building, factory, etc.) is technically and financially feasible for solar PV rooftop system development. Throughout this stage, the Facility Owner is in the decision-making position. Therefore, several tools are provided as parts of this guidelines to assist them in making effective decision-making on the project.

First, the Facility Owner shall go through the **decision-making flowchart** ([Step 1.1](#)) to get an initial assessment whether it is suitable for them to install the system. The flowchart will assist the Facility Owner in determining a suitable business model, taking into consideration their investment capability and their needs / requirements. Two business models are provided in this Guidelines (i.e. Self-financed & Third-party Ownership model). The Facility Owner shall select the **business model** ([Step 1.2](#)) which is suitable for them. Each business model will lead to different pathways on the project development.

The Facility Owner shall use the **Information Checklist** ([Step 1.3](#)) to self collect all required information / data. Then, they shall reach out to potential EPC Contractors or Solar Service Providers and **call for their interest** ([Step 1.4](#)). Interested EPC Contractors / Solar Service Providers are invited to conduct **site visits** ([Step 1.5](#)). This allows them to further collect necessary information / data in more detail, which is crucial for drafting **technical and financial offer** ([Step 1.6](#)) to submit to the Facility Owner for consideration.

With the offers at hand, the Facility Owner performs financial assessments using a **financial model** ([Step 1.7](#)) provided in this Guidelines to check their project's financial feasibility (i.e. return on investment, payback period, etc.). Based on the result of the financial analysis in combination with other selection criteria, the Facility Owner **determines the most suitable EPC Contractor / Solar Service Provider** ([Step 1.8](#)) to further develop the project. This is the last step of the Site Evaluation stage.



# Decision Making Flow Chart

Details

Tool

## DETAILS

Many building or factory owners want to install a solar PV rooftop system at their facility. One main barrier is the lack of information. They may not know where to start or unsure if their roof is suitable for installing solar PV systems from a technical and financial perspective.

Therefore, as the first step, the Guidelines provide a decision-making flow chart for the Facility Owner. They can go through the flow chart by themselves to gain greater understanding on key considerations of developing a solar PV rooftop project. At the end, they will know if installing a solar PV rooftop system is still to be considered as an option. If yes, they will need to consider the possible business models to adopt.

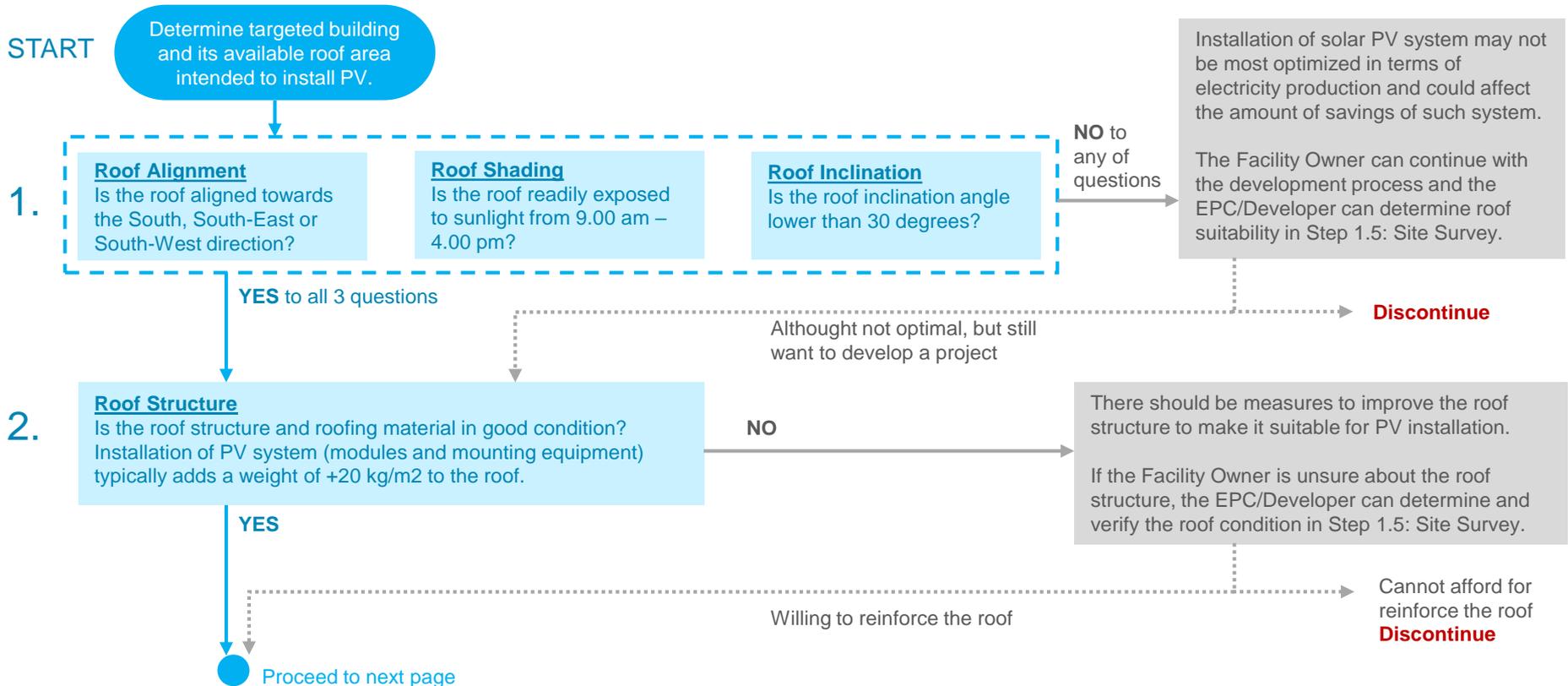


# Decision Making Flow Chart

Details **Tool**

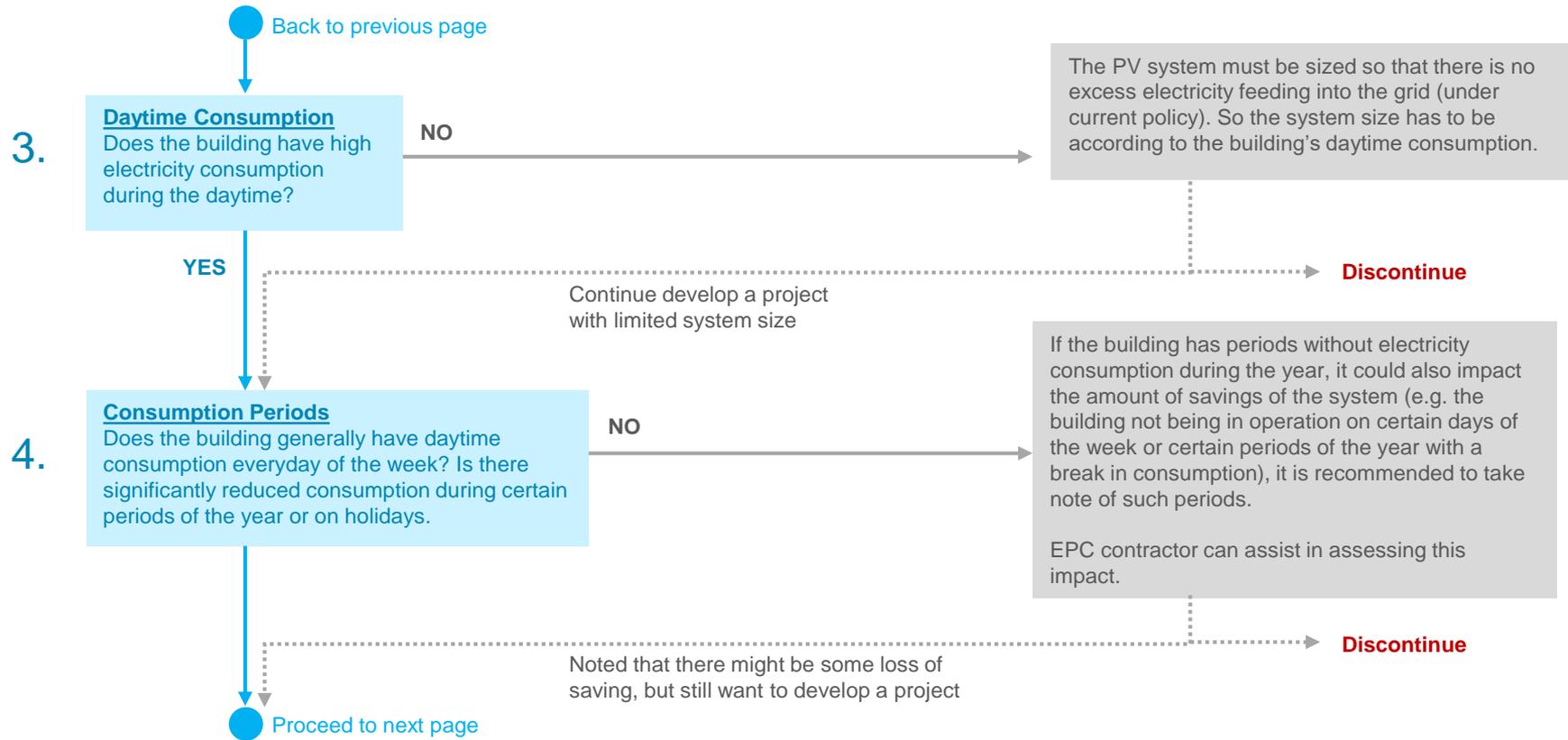
## TOOL: Decision Making Flow Chart

Decision Making Flow Chart Tool: asking general questions to determine basic technical suitability of the site



# Decision Making Flow Chart

## TOOL: Decision Making Flow Chart

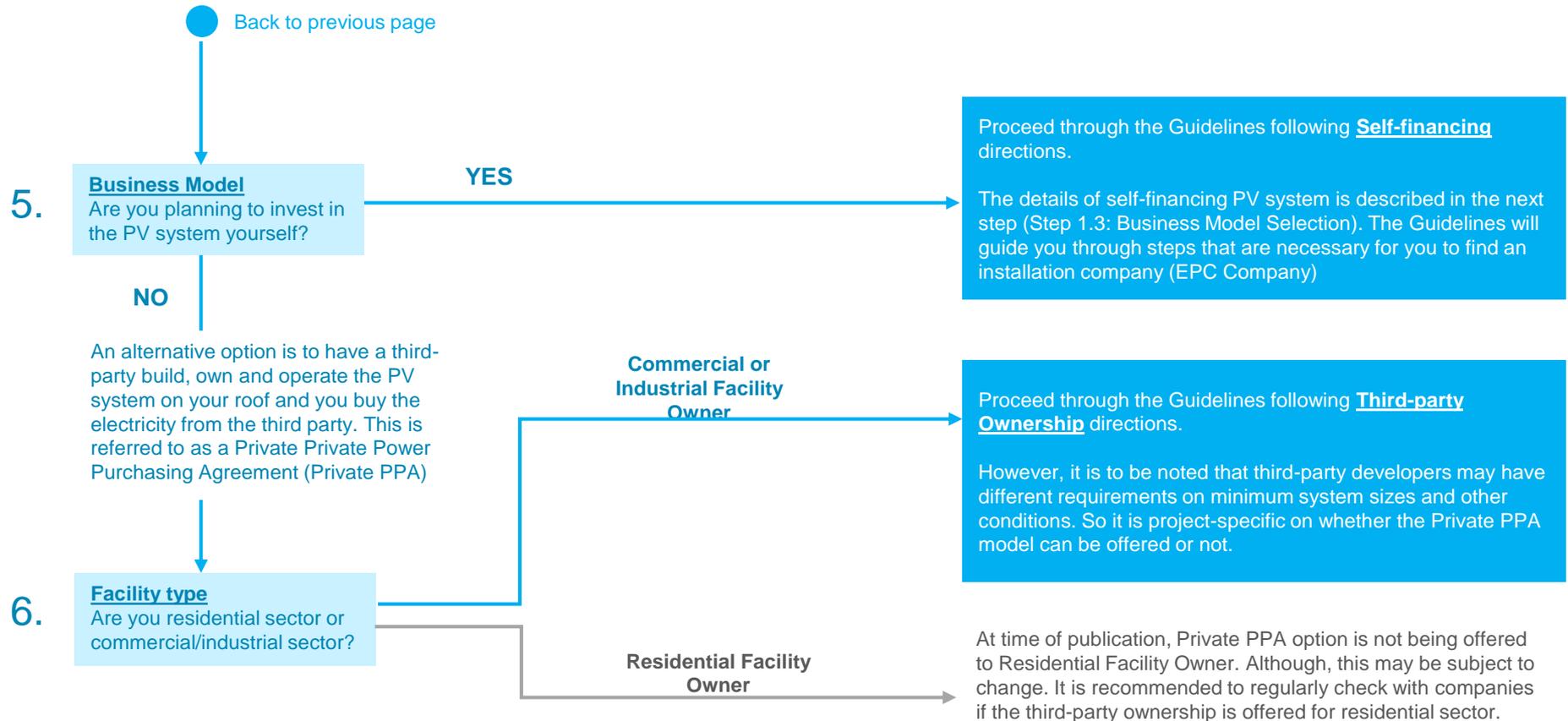


# Decision Making Flow Chart

Details

Tool

## TOOL: Decision Making Flow Chart



# Business Model Selection

Details

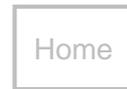
Self-Financed

Third-Party

## DETAILS

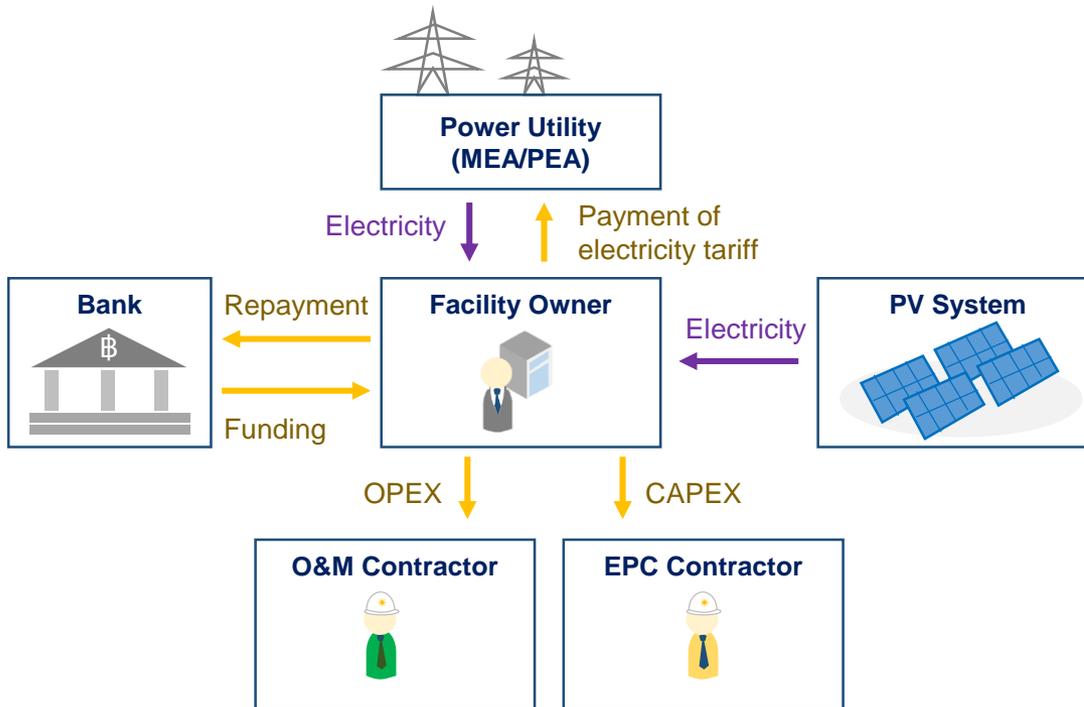
By using the decision making flow chart (see [Step 1.1](#)), the Facility Owner will have a good idea on the suitability of their roof for solar PV system installation. The flow chart also provides recommendations on which business model the Facility Owner should use for the project implementation. These Guidelines cover the two most prominent business models (i.e. Self-financing, Third-party Ownership) that are currently offered in the Thai market.

	Self-Financed Model	Third-party Ownership Model
<b>Description</b>	The Facility Owner buys the system. Full investment cost upfront is to be paid to the EPC Contractor once the system is completely installed (Year 0).	The Solar Service Provider developer builds, owns, operates (BOO) the PV system and sells electricity to the Facility Owner at a discounted price for contract duration (20-25 years)
<b>Investment Cost</b>	Depends on system size	None
<b>Electricity Savings</b>	Full electricity cost savings is obtained by the Facility Owner	Part of the savings is obtained by the Facility Owner (depending on the discount rate agreed upon with the Solar Service Provider)
<b>Ownership</b>	The Facility Owner	The Solar Service Provider
<b>O&amp;M</b>	By the Facility Owner. However, the EPC Contractors are typically offering free O&M for the first 2 years.	By Developer for the contract duration
<b>Benefits</b>	<ul style="list-style-type: none"> <li>- Receive full electricity savings</li> <li>- Lock in electricity rate for 25 years</li> <li>- Fully in control of the system</li> <li>- No long term contract</li> </ul>	<ul style="list-style-type: none"> <li>- Limited Investment cost &amp; O&amp;M cost</li> <li>- Guaranteed savings for 25 years</li> <li>- Have a buy-back option to switch to self-finance model</li> </ul>



# Business Model Selection

## SELF-FINANCED MODEL



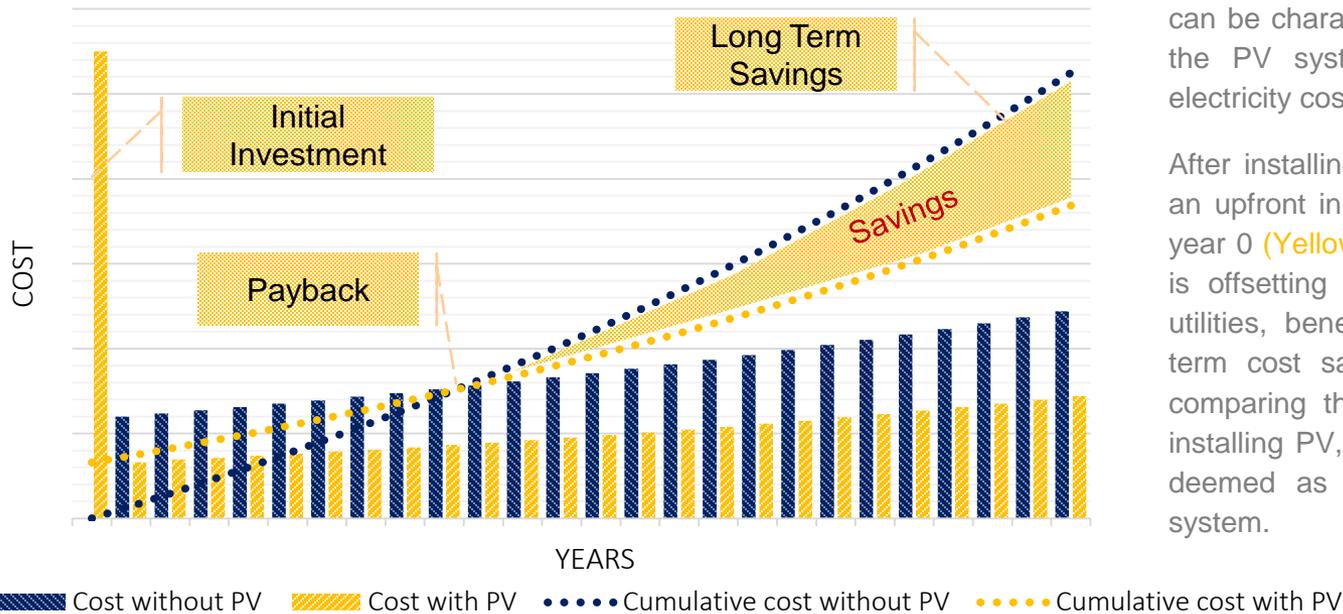
In the Self-financed model, the Facility Owner purchases the system through their own financing. This can be either through equity financing or debt financing (or combination of both). The Facility Owner contracts an EPC Contractor to design and construct the PV system. The ownership of this system is with the Facility Owner.

Stage 4 covers some of the possible financing options for Facility Owner that are buying the PV system.

# Business Model Selection

- Details
- Self-Financed**
- Third-Party

## SELF-FINANCED MODEL



Electricity savings for self-financing the PV system can be characterized by the graph below. Without the PV system, the Facility Owner is paying electricity cost to power utilities (Blue bars).

After installing PV, the Facility Owner has to pay an upfront initial investment for the PV system in year 0 (Yellow Bars). Electricity produced from PV is offsetting the amount being bought from the utilities, benefiting the Facility Owner from long term cost savings (for the next 25 years). By comparing the cumulative cost before and after installing PV, the intersection of both lines can be deemed as the simple payback period of the system.

# Business Model Selection



Details

Self-Financed

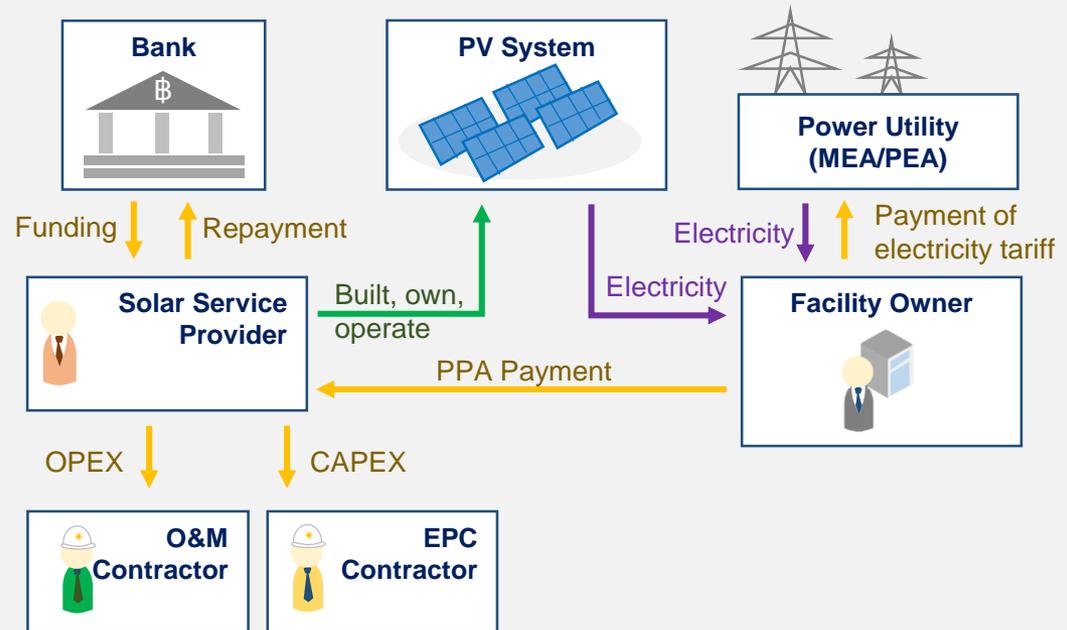
Third-Party

## THIRD-PARTY OWNERSHIP (TPO)

A third-party (or so-called “**Solar Service Provider**”) invests and installs a solar PV system on the Facility Owner’s roof. As all investment is done by the Solar Service Provider, this model eliminates an upfront investment from the Facility Owner’s end. There are many project settings which can be categorized under the TPO model. The prominent one that is covered in these Guidelines is the “Private-to-Private Power Purchasing Agreement (‘**Private PPA**’)”.

### Private PPA

A **Private PPA** is a contractual arrangement of purchasing and selling power between a private Solar Service Provider and a Facility Owner. The Solar Service Provider invests and installs a solar PV system on the Facility Owner’s roof. The Solar Service Provider does not sell the system itself to the Facility Owner. Instead, the Solar Service Provider builds, owns and operates the system (BOO) for the Facility Owner. The Solar Service Provider receives revenues from selling electricity generated to the Facility Owner at an agreed rate, typically lower than the local utility rate, but covering the cost of electricity produced by the solar PV system.



# Business Model Selection

Details

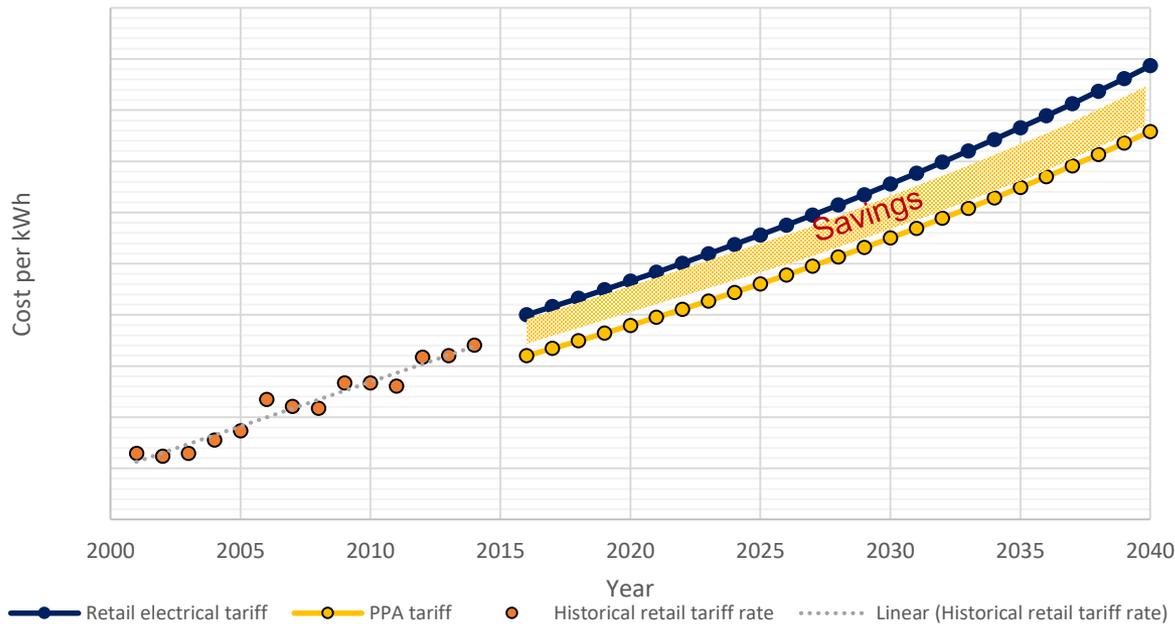
Self-Financed

Third-Party

## THIRD-PARTY OWNERSHIP (TPO)

From the Facility Owner's perspective, they benefit from buying electricity from the TPO at a cheaper (discounted price) rate than the typical retail electricity tariff they normally pay to the power utility.

The savings of the Facility Owner under this TPO model can be characterized by the graph below:



# Information Checklist



Details

Tool

## DETAILS

Once the business model is decided (see [Step 1.2](#)), the Facility Owner shall collect several key information that is necessary for the solar PV project development. These collected data / information can facilitate effective discussion and exchange with potential EPC Contractors or Solar Service Providers (depending on the chosen model) in the [Step 1.4](#).

These Guidelines provide an information checklist tool ([Tool: Information Checklist](#)). Although the information suggested in the checklist will not be sufficient for EPC Contractors / Solar Service Providers to immediately come up with technical designs, they should be sufficient for the EPC Contractors / the Solar Service Providers to pre-determine roof suitability and system size. It is also designed to be simple for Facility Owner who may not be familiar with solar PV technology.



# Information Checklist



Details

Tool

## TOOL: Information Checklist

The checklist below outline the information that the Facility Owner should collect (if possible)

<input type="checkbox"/> <b>Site Location</b> Address and GPS Coordinates	Use of google map, HERE map or other available map application
<input type="checkbox"/> <b>Building Plans</b> <ul style="list-style-type: none"> <li>▪ Floor Plan</li> <li>▪ Roof Plan</li> <li>▪ Roof Usable Area (in square meters)</li> <li>▪ Building Electrical Plan (single line diagram)</li> </ul>	These information can be obtained from engineering documents of the facility construction. Please consult with relevant person from engineering/building department
<input type="checkbox"/> <b>Electricity Consumption and Cost</b> Monthly electricity consumption (kWh), customer type, monthly electricity cost (THB)	Copies of electricity bills from the utilities (past 6-12 months) that is showing consumption and cost
<input type="checkbox"/> <b>Load Profiles</b> Commercial/Industrial Facility Owners may have their own load profile data or those with AMR can check with the utility (at least 1 full week).	<ul style="list-style-type: none"> <li>▪ PEA customers can typically access the load profile via <a href="http://www.amr.pea.co.th/">www.amr.pea.co.th/</a></li> <li>▪ MEA customer have to request for the load profiles at their relevant MEA office</li> <li>▪ (Residential Facility Owners may not have the load profile available)</li> </ul>
<input type="checkbox"/> <b>Photos of Site and Targeted Roof Area</b> For preliminary assessment of the roof construction, surrounding obstacle, etc.	If safe access to the roof is possible, go to the roof and take pictures in all direction. If not, try to take photo of the roof from nearby building or use a drone.



# Send Request for Proposal to EPC/Developer



Details

Tool

## DETAILS

The Facility Owner reaches out to renewable energy / solar companies (For the Self-financed model: EPC Contractors; For the Third-party Ownership model: Solar Service Providers).

To facilitate effective communication and to ensure that the companies receive an accurate understanding of the project from the beginning, it is recommended that the Facility Owner summarizes all information collected in [Step 1.3](#) and submits them to the EPC Contractors / the Solar Service Providers. At this step, the Facility Owner can arrange for a site visit, allowing the EPC Contractors / the Solar Service Providers to get more detailed understanding on the project.

For the Third-party Ownership model, these Guidelines provide the Private PPA Term sheet template. As a private PPA signed by the Facility Owner and a Solar Service Provider will play a crucial role for the project lifetime, it is important that terms and conditions contained therein are appropriate and fair for both parties. The template provides some typical conditions that should be part of the PPA for the Facility Owner to use as a reference.



## Send Request for Proposal to EPC/Developer



Details

Tool

### TOOL: PPA Term Sheet Template

*This step is for Third-Party Ownership model*

This Term Sheet template is developed as part of the Solar PV Implementation Guidelines to help the Facility Owner set the right private PPA with Solar Service Providers in the beginning. When sending request for proposals to TPO companies, the Facility Owner can attach this template to state their position and requirements on the private PPA to be drafted (i.e. preferred terms and conditions, etc.)

Please note that all terms stated in the template are only suggestions based on common practices. The Facility Owner can use them as references and may adjust them according to their own requirements.

[\(English Version\)](#)

#### Private PPA Term Sheet Template

This Term Sheet template has been developed as part of the Solar PV Implementation Guideline to facilitate the consumer when sending request for proposals to Private PPA Developers. The template is outlining the consumer's general requirements for a Private PPA offer. Please note that all the terms stated below are suggestions and may be redefined as per the consumer's requirements.

<b>Contract type</b>	Power Purchase Agreement (PPA) with Take-and-Pay basis	
<b>Buyer</b>		
<b>Seller</b>		
<b>Project</b>		
<b>System</b>	Solar PV Rooftop System including Solar PV panels and the balance of system, which includes all components of a PV system such as wiring, switches, a mounting system, one or many solar inverters and control & monitoring system	
<b>Location</b>		
<b>Guaranteed Electricity Delivery</b>	Seller shall deliver at minimum the Guaranteed Electricity Delivery Unit to Buyer (per year)	
<b>Energy Price (PPA Price)</b>	(Energy Price offered by the Developer)	
<b>Energy Price Calculation</b>	(Energy Charge Calculation Formula)	
<b>Demand Charge</b>	Buyer shall benefit any reduction of Demand Charge	
<b>Retail Electricity Tariff</b>	means the tariff that applies to Buyer's purchase of electricity from the Electricity Authority at that time (including Base Tariff and FT)	
<b>Expected Electricity Delivery Unit (kWh) and Guaranteed Electricity Delivery Unit (kWh)</b>	<b>Year</b>	<b>Expected Electricity Delivery Unit (kWh)</b>
	1	Guaranteed Electricity Delivery Unit (kWh)
	2	
	3	
	4	
	5	
	6	
	7	



# Site Survey



## Details

### DETAILS

The site survey will be conducted by EPC Contractors / Solar Service Providers invited by the Facility Owner. There are several key pieces of information that need to be collected during the visit in order to design the system.

- Roof Direction & Inclination Angle
- Roofing material
- Roof structural condition
- Roof Shading
- Location of Main Distribution Board (MDB) or DB
- Inverter housing location
- Cable Routing
- (Other necessary information for design)

From the Facility Owner's perspective, they must ensure that site surveys are effectively conducted, which will eventually lead to proposals from EPC Contractors / Solar Service Providers which is to-the-point and meets the Facility Owner's requirements. Therefore, the Facility Owner should make sure that the person-in-charge of the facility's electrical system are present during the visit.



# Technical Design & Financial Offer



Details

Reg. / Doc.

## DETAILS

After the site survey ([Step 1.5](#)), the EPC Contractors / the Solar Service Providers should possess sufficient information for preliminary sizing of the system. They will prepare and submit a technical design and proposal to the Facility Owner for consideration. There are several key components that the system designer should acknowledge when designing the system.

### Relevant Technical Design Standards:

- [ERC Mini Code of Practice \(Mini-CoP\)](#):

There are several equipment and design standards that are specified by ERC in order to fulfill their code of practice. The standards are outlined in [Step 5.2: Mini-CoP](#).

- [PEA & MEA Grid Connection Code](#):

The system design should take into account the requirements that are specified in PEA/MEA grid connection code. The requirements are outline in Step 8.2: Request for Grid Connection.

- [EIT Rooftop PV Installation Standards \(optional\)](#)

The Engineering Institute of Thailand (EIT) has published a standard on Thailand Electrical Installation Standard: Solar Rooftop Power Supply Installations ([EIT 022013-16](#)). Although it should be noted that the standard is optional.



# Technical Design & Financial Offer

[Details](#)[Reg. / Doc.](#)

## REGULATIONS

1. ERC Announcement on COP Regulation for PV Systems with Power Generation License, 15 September B.E. 2557 ([Thai](#))
2. ERC Announcement on COP Regulation for PV System Exempted from Power Generation License, 15 September B.E. 2557 ([Thai](#))
3. EIT Standard 022013-16, Thailand Electrical Installation Standard: Solar Rooftop Power Supply Installations, November 2016 ([Thai](#))
4. MEA Grid Interconnection Code 2015 ([Thai](#))
5. PEA Grid Interconnection Code 2016 ([Thai](#) / [English](#))

## RELEVANT DOCUMENTS

1. DEDE Solar PV Rooftop Safety Guidelines, December 2014 ([Link](#))



# Investment Feasibility



Details

Tool

## DETAILS

### Self-Financed model

After the Facility Owner receives proposals and offers from EPCs, the Facility Owner will have sufficient information to assess the investment feasibility of installing the PV system. The Guidelines provided in the [Tool: Financial Model Template](#) can be easily used by the Facility Owner to evaluate the project feasibility. The template already provides basic assumptions that are generally used, other project specific inputs are needed to be input by the Facility Owner. These input include: site location, CAPEX, Yield, etc.

### Third-party Ownership model

After the Facility Owner receives Private PPA proposals from the Developers, the Facility Owner can assess the investment feasibility by using the [Tool: Financial Model Template](#). The template provides basic assumptions that are generally used, other project specific inputs are needed to be input by the Facility Owner. These input include: PPA electricity price, yield, contract duration, etc.



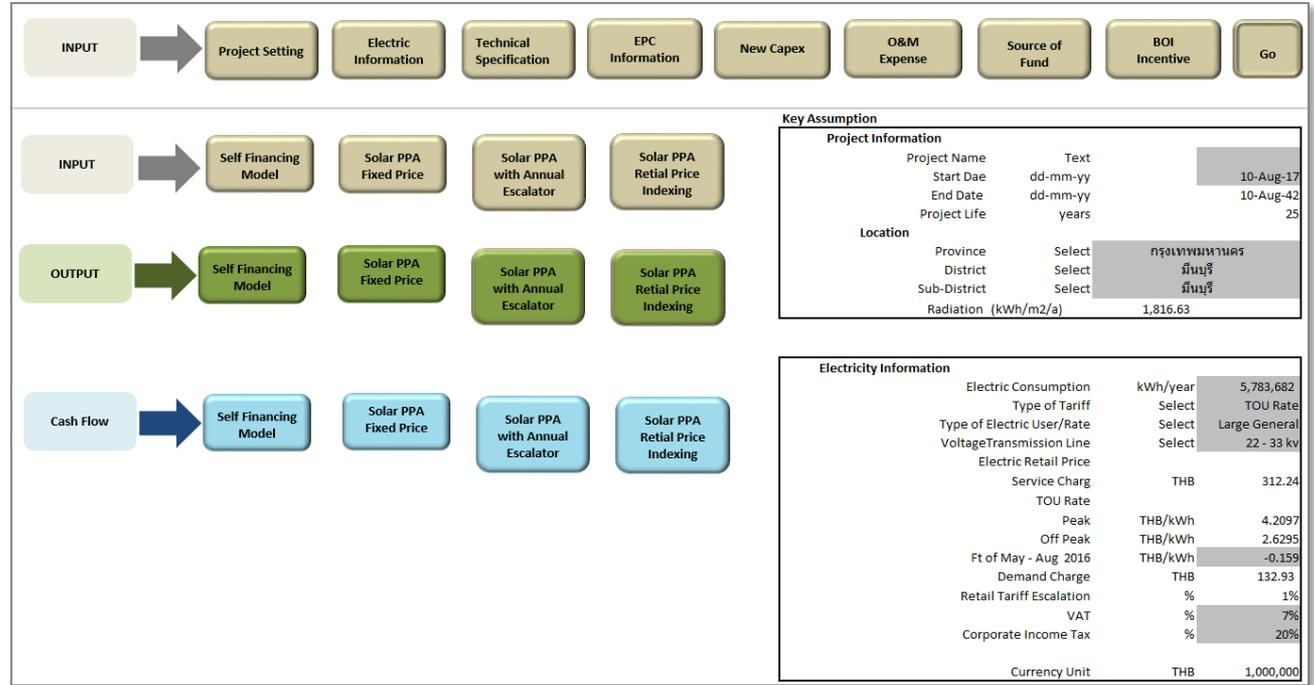
## Investment Feasibility

Details **Tool**

### TOOL: Financial Model Template

The Financial Model Template can be used to assess both Self-financing and Private PPA models in one Excel document. The Template was developed by the USAID Clean Power Asia to facilitate investment in distributed electricity generation systems from solar PV in Thailand.

[English Version](#)



# Selection of EPC/Developer



Details

## DETAILS

Based on the results of the investment feasibility ([Step 1.7](#)), the Facility Owner decides on the EPC Contractor or the Solar Service Provider (depending on selected business model) who will further develop the project. This selection will set the project to the next stage ([Contractual Agreement, Stage 2](#))

Although the result of investment feasibility is important, the Facility Owner should consider other aspects as well:

Self-financed model (EPC Contractor)	Third-party Ownership model (Solar Service Provider)
<ul style="list-style-type: none"> <li>▪ Technical offer (e.g. completeness of details, etc.)</li> <li>▪ Track Record / credibility of the EPC Contractor (e.g. past experience, etc.)</li> <li>▪ Price of the system offer</li> <li>▪ Electricity yield (the higher, the better)</li> <li>▪ Yield guarantee (e.g. coverage, etc.)</li> </ul>	<ul style="list-style-type: none"> <li>▪ Track record of the company (e.g. past experience, etc.)</li> <li>▪ Electricity tariff offer</li> <li>▪ Contract duration</li> <li>▪ O&amp;M services</li> <li>▪ Insurance policy (e.g. coverage, duration, etc.)</li> <li>▪ Yield guarantee (e.g. coverage, etc.)</li> </ul>



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

## 2 | Contractual Agreement

Construction and Installation

### SELF-FINANCED

Step 2.1

EPC Contract

O&M Contract

Step 2.2

### THIRD-PARTY OWNERSHIP

Step 2.3

Private PPA Contract

Step 2.1

EPC Contract

Step 2.2

O&M Contract

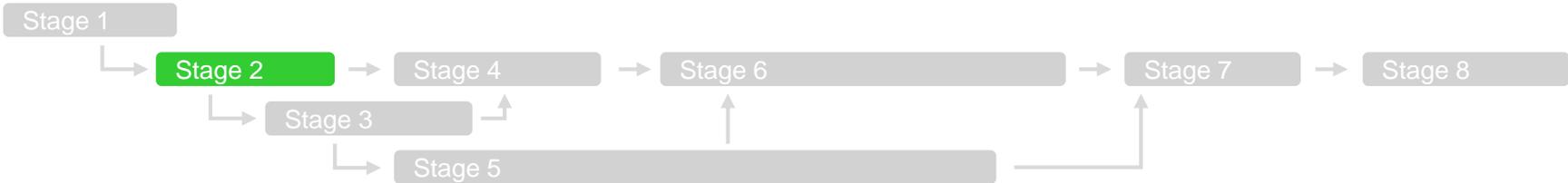
Step 2.4

Insurance Contract

 Step by Facility Owner and EPC Contractor / Solar Service Provider

 Step by EPC/Developer

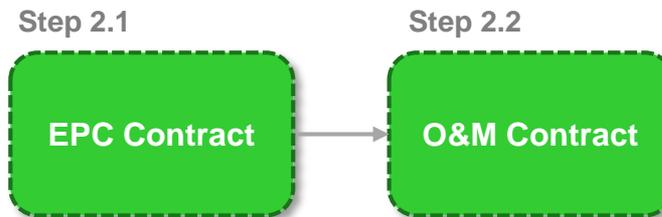




[See Stage Details >](#)

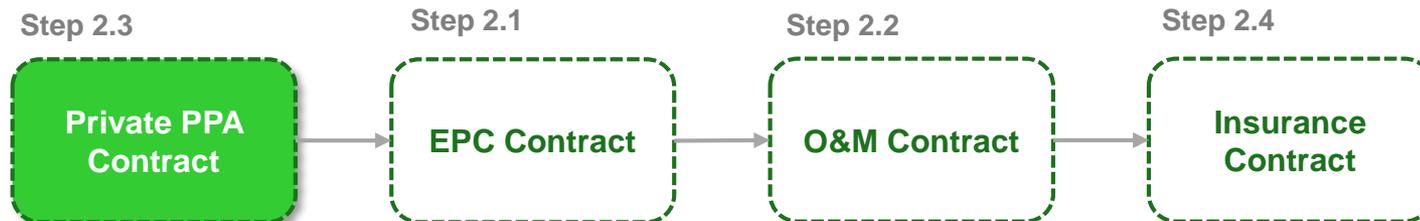
## 2 | Contractual Agreement

### SELF-FINANCED



- Step by Facility Owner and EPC Contractor / Solar Service Provider
- Step by EPC/Developer

### THIRD-PARTY OWNERSHIP



# 2 | Contractual Agreement

## Stage Description

---

In Site Evaluation Stage, the Facility Owner has decided on which type of business model is considered for the project development (Self-financed model or Third-party Ownership model). This leads to different contractual implications and therefore has to be negotiated differently between the concerned parties.

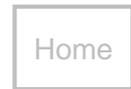
### Self-Financed Model

For the Self-financed model, the Facility Owner contracts the EPC Contractor to provide turnkey service in installing a solar PV system. There are two contracts that are crucial for this model. First, the Facility Owner and the EPC Contractor must agree on terms and conditions of the **EPC contract** ([Step 2.1](#)). Usually, the EPC Contractor provide operation & maintenance (O&M) services for a certain duration of time after completion of the system installation. After that point, the Facility Owner must be responsible on all O&M activities. Some Facility Owners use their own personnel to handle all O&M activities. However, mostly, the Facility Owner contracts an external party to take care of O&M activities through **O&M contract** ([Step 2.2](#)).

### Third-party Ownership Model

For the Third-party Ownership model, a long-term **private PPA contract** is made between a Solar Service Provider and the Facility Owner ([Step 2.3](#)). The private PPA contract stipulates terms and conditions of which the Facility Owner buys electricity from the Solar Service Provider. As this contract is long-term (can be up to 20-25 years), it is important that the private PPA is comprehensive and covers all conditions. The Guidelines are providing a tool: Private PPA Template that has standardized terms & conditions for a project developed under the Third-party Ownership model. The template can be used by both the Facility Owner and the Solar Service Provider.

As the Solar Service Provider is responsible for construction, operation, and maintenance of the system, the Solar Service Provider must take care of **EPC Contract** ([Step 2.1](#)), **O&M Contract** ([Step 2.2](#)) and **Insurance Contract** ([Step 2.4](#)).



## EPC Contract

Details

Checklist

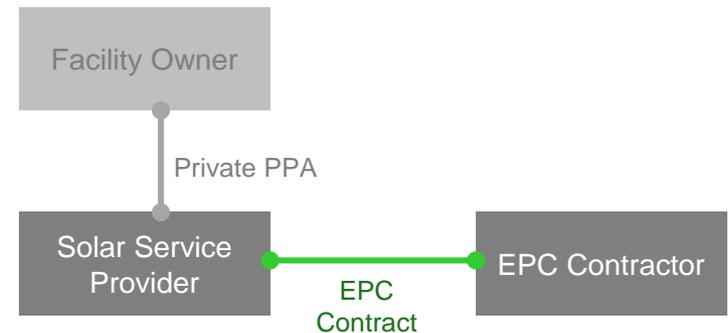
### DETAILS

An EPC contract is a contract that govern two parties on design, engineering, procurement, construction, and installation of solar PV rooftop systems. The EPC contract is the same regardless of development model chosen (i.e. Self-financed mode or Third-party Ownership model). Only difference is that they are concluded by different player.

#### Self-financed Model



#### Third-party Ownership Model



## EPC Contract



Details

T&amp;C

## TERMS &amp; CONDITIONS

## Payment Conditions

## Cost of EPC

The EPC contract must clearly indicate the turnkey cost of the project which is all inclusive. Covering the scope of engineering, procurement and construction. The Facility Owner should check if the price is inclusive or exclusive of VAT (7%).

## Payment Schedule

A typical payment schedule for a PV installation is divided into 3 payments (note that this is highly depends on agreement with EPC). The first schedule is typically paid after agreement has been reached for a portion (10-30%) of total EPC cost. The second schedule is paid after construction and installation of the system is complete for a larger portion (50-60%). The last schedule is paid after the successful grid connection and commission of system for the remaining portion (10-20%).

## Warranty

## Equipment Warranty

The equipment warranty (mainly PV modules and inverters) are covered by the equipment supplier. A typical warranty periods are as the following:

- **PV Module Performance warranty:** Performance is not lower than 80%, 25-30 years. The Facility Owner should also take note whether it is step or linear warranty.
- **PV Module Workmanship:** 10 years
- **Inverter Warranty:** 5 years (with options to buy extension of warranty)



## EPC Contract

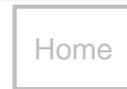
Details

T&amp;C

## TERMS &amp; CONDITIONS

## Warranty

<p><b>System Performance Ratio Guarantee</b></p>	<p>To ensure a certain level of system yield, the EPC companies may also give a system performance guarantee. This is typically verified against the simulated performance ratio (PR ratio) that the real system performance should not be lower than a certain PR ratio.</p> <p>Verification of real system PR ratio requires certain equipment to measure solar irradiation. This can be too costly for smaller scale systems.</p>
<p><b>System Yield Guarantee</b></p>	<p>Another alternative to ensure a certain level of system yield is that EPC companies give a yield guarantee which is stating annual electricity generation (in kWh) from the solar PV system. Verification of the system performance can be completed easily by checking if the actual electricity generation meets the guaranteed figure over the year.</p>
<p><b>EPC Workmanship Warranty</b></p>	<p>This workmanship warranty covers the system installation. The scope and duration of which this covers is depending on the EPC Contractor.</p>
<p><b>O&amp;M Period</b></p>	<p>It is also typical that in the contract states that a period for which the EPC will provide Operation &amp; Maintenance service free-of-charge for a certain duration (typically 2 years).</p> <p>After that, the Facility Owner may contract other external party to do all O&amp;M activities or self-operate the system</p>



## O&M Contract

Details

Scope

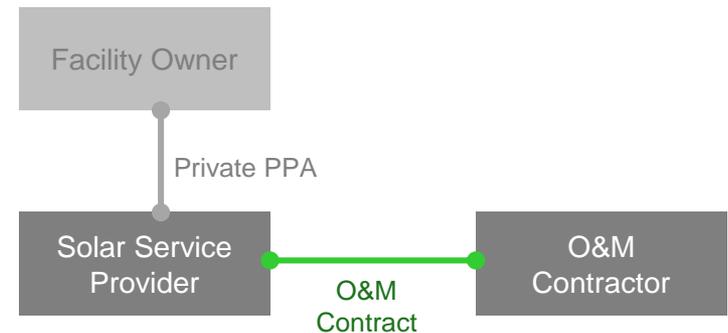
### DETAILS

An operation & maintenance (O&M) contract is a contractual document governing all operation & maintenance activities on the installed solar PV rooftop system. Details of this step are the same regardless the chosen business model (i.e. Self-financed model or Third-party Ownership model). The difference is only in players that are involved in the O&M contract.

#### Self-financed Model



#### Third-party Ownership Model



Usually, the EPC Contractor who constructs and installs the system covers all O&M activities for the few years after commissioning. After that point, it is necessary for the Facility Owner or the Solar Service Provider (depending on type of business model) to make an O&M contract with an external solar PV company or they can decide to do self O&M. Most EPC Contractors offer O&M services.

## O&amp;M Contract



Details

Scope

## GENERAL SCOPE OF O&amp;M CONTRACT

## Scope of PV Operation &amp; Maintenance

<b>Monitoring &amp; Reporting</b>	<ul style="list-style-type: none"> <li>Remote monitoring (alarms)</li> <li>Daily/Monthly/Yearly reports</li> <li>Routine inspection reports</li> </ul>
<b>Preventive Maintenance</b>	<ul style="list-style-type: none"> <li>Weekly: Cleaning of PV modules, Inspection of: roof condition, PV modules, mounting structures, combiner boxes, protection equipment, etc.</li> <li>Quarterly: Inverter preventive maintenance</li> <li>6 months: Inspection and testing of system</li> <li>Annually: meter calibration</li> </ul>
<b>Corrective Maintenance</b>	<ul style="list-style-type: none"> <li>Error diagnosis</li> <li>Handling equipment &amp; product warranty claim for the Facility Owner</li> <li>Repair work</li> <li>Stocking of Modules and Inverter spare parts (optional)</li> </ul>



# Private PPA Contract



Details

Tool

## DETAILS

### *This step is for Third-party Ownership model*

The Facility Owner must conclude a private PPA with a Solar Service Provider. Key terms and conditions that should be considered / be part of the private PPA are summarized in the following table:

Terms	Description
<b>Contract term</b>	(Typically) 15 to 25 years
<b>Private PPA Price Structure</b>	Several PPA price structures are possible and can be offered: <ul style="list-style-type: none"> <li>▪ A fixed-price (per kWh) or</li> <li>▪ Price with fixed annual escalation (per kWh)</li> <li>▪ Retail tariff indexed-linked price to prevailing tariff rates (per kWh)</li> </ul>
<b>Investment and Financing</b>	Covered by the Solar Service Provider
<b>Yield Guarantee</b>	Will the Private PPA Developer guarantee yield performance of solar rooftop system?
<b>Transfer of Ownership</b>	<ul style="list-style-type: none"> <li>▪ Is the owner system transferred to the Facility Owner at the end of the contract? Are there any payments on the Facility Owner's end for the transfer?</li> <li>▪ Is there a buyback option for the Facility Owner to buy the system before the end of the PPA contract?</li> </ul>
<b>Emission Reduction</b>	<ul style="list-style-type: none"> <li>▪ Will future emission reduction certificate belong to the Solar Service Provider or the Facility Owner?</li> </ul>



# Private PPA Contract

Details

Tool

## TOOL: Private PPA Template

A private PPA template was developed by the USAID Clean Power Asia program to facilitate investment in distributed electricity generation systems from solar PV in Thailand. USAID Clean Power Asia encourages the use of this document by all interested parties. This is a standardized agreement aiming to support market players by providing neutral clauses as a starting point for a negotiation between the Seller and the Purchaser of solar PV system. It is expected that this agreement can help to reduce soft costs and negotiating time for all interested parties.

[English Version](#) / Thai Version



# Insurance Contract

Detail

## DETAILS

### *This step is for Third-party Ownership model*

For the Third-party Ownership model, the Solar Service Provider has certain risks, as the solar PV system which is an asset of the Solar Service Provider is located on the Facility Owner's roof. Therefore, the Solar Service Provider may seek for an insurance contract to cover such risks. It should be ensured that the insurance cover all risks deemed necessary from the Solar Service Provider's perspective. Insurance cost varies depend on its coverage, but usually 0.5 – 1.0% of total CAPEX per year can be expected.



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

## 3 | Corporate Legal & Incentive

### SELF-FINANCED

Step 3.1

BOI Incentives

*(The Facility Owner gets the incentive)*

### THIRD-PARTY OWNERSHIP

Step 3.1

BOI Incentives

*(The Solar Service Provider gets the incentive)*

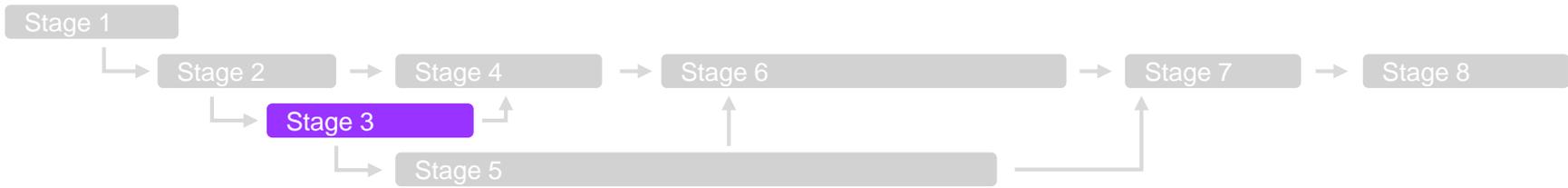
 Step by Facility Owner and EPC Contractor / Solar Service Provider

 Step by EPC Contractor / Solar Service Provider

*Abbreviation:*

*BOI: The Board of Investment of Thailand*





[See Stage Details >](#)

# 3 | Corporate Legal & Incentive

## SELF-FINANCE

 Step by Facility Owner and EPC Contractor / Solar Service Provider

 Step by EPC Contractor / Solar Service Provider

Step 3.1

**BOI Incentives**

*(The Facility Owner gets the incentive)*

## PRIVATE PPA MODEL

Step 3.1

**BOI Incentives**

*(The Solar Service Provider gets the incentive)*

# 3 | Corporate Legal & Incentive

## Stage Description

---

Corporate Legal & Incentive Stage describes the process to secure corporate incentives from investing in solar PV projects. Currently, an incentive is given by Thailand's Board of Investment (BOI). BOI normally gives tax incentives to an investment in sectors that are promoted in Thailand. The Facility Owner can benefit from the BOI if they are eligible for it.

The details are described in [step 3.1](#)



# BOI Incentives

Details

Regulations

Self-financed

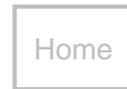
Third-party

## DETAILS

Currently, there are two BOI incentives for an investment in a solar PV project. A solar PV rooftop project development under both self-financed model and third-party ownership model can benefit from these BOI incentives.

- For the Self-financed model, the Facility Owner is eligible for “Measure to promote improvement of production efficiency”.
- For the Third-party Ownership model, the Solar Service Provider is eligible for “Activity-based incentives”.

Unfortunately, the BOI incentives are valid until the end of 2017 only. At the time of Guidelines publication (October 2017), there is no clear sign if the BOI incentives will be extended. Therefore, the Facility Owner / the Solar Service Provider should apply for this incentive as soon as possible. This must be no later than 31 December 2017.



# BOI Incentives

Details

Regulations

Self-financed

Third-party

## REGULATIONS

1. Announcement of the Board of Investment No.1/2557 Measure to Promote Improvement of Production Efficiency ([Thai](#) / [English](#))
2. Announcement of the Board of Investment No. 2/2557 Policies and Criteria for Investment Promotion is eligible for activity base incentive ([Thai](#) / [English](#))
3. BOI List of Activities Eligible for Promotion ([Thai](#) / [English](#))



# BOI Incentives

[Details](#)[Regulations](#)[Self-financed](#)[Third-party](#)

## SELF-FINANCED MODEL

### 1. Measure to Promote Improvement of Production Efficiency

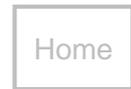
Solar rooftop installations can receive tax incentives from the Board of Investment (BOI) under announcement No.1/2557 as a “Measure to Promote Improvement of Production Efficiency”. Investments on solar PV project fits under the Measure 1: “Upgrading technology or machinery for energy conservation, alternative energy utilization or reduction of environmental impact”

#### Incentives:

1. Import duty waiver
2. 3-year corporate income tax exemption. Tax exemption shall not exceed 50% of the investment under this measure (excluding cost of land and working capital)
3. Corporate income tax exemption period shall start from the date of revenue derivation after promotion certificate issuance.

#### Eligibility:

To be applicable, the Facility Owner’s business/activity must be an activity supported by BOI. List of such activities can be found at [\(Link\)](#)



# BOI Incentives

Details

Regulations

Self-financed

Third-party

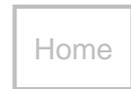
## THIRD-PARTY OWNERSHIP

### 2. Activity-Based Incentive

Business activity relating to the production of electricity from solar energy falls under Activity 7.1.1.2 of the “Announcement of the Board of Investment No. 2 /2557 Policies and Criteria for Investment Promotion is eligible for activity base incentive”.

#### Incentives:

- 8-year corporate income tax exemption, accounting for 100% of investment (excluding cost of land and working capital)
- Exemption of import duty on machinery
- Exemption of import duty on raw or essential materials used in manufacturing export products for 1 year, which can be extended as deemed appropriate by the Board
- Other non-tax incentives



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

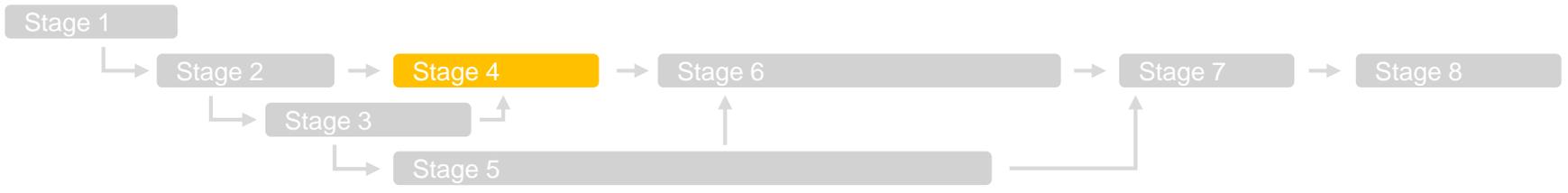
## 4 | Financing

### SELF-FINANCE

Step 4.1

Bank Financing





[See Stage Details >](#)

# 4 | Financing

## SELF-FINANCE

Step 4.1

Bank Financing



## Stage Description

### *This stage is for Self-financed model*

In the **Financing stage**, the Facility Owner that is self-financing their system may decide to utilize bank financing to partially or fully finance their PV system. Currently, several banks are offering solar-specific loan schemes to Facility Owners. The terms and conditions of such schemes are highly dependable on the banks and the Facility Owner's creditworthiness. Therefore, the Guidelines recommend that a Facility Owner directly contact banks to check for these schemes.



# Bank Loan

## Details

### DETAILS

#### *This step is for Self-financed model*

For the self-financing model, the facility owner is the one who pays for upfront investment of a solar PV rooftop system. Despite the declining cost of PV systems, the upfront investment of solar PV system can still be considerable. When 100% equity investment in solar PV rooftop projects is not practical, the facility owner must secure a bank loan.

Different banks have different criteria in evaluating solar PV rooftop projects. However, when applying for a loan, the facility owner may have to show that they can channel some of their own equity for the project (usually at least 30% equity). Some commercial banks in Thailand are already progressive in the renewable energy sector and offer financial instruments tailored specifically for renewable energy or green energy project.

Most of the renewable energy projects financing in Thailand is still done through corporate loans, meaning that the company's financial status and credit is crucial. As this could significantly impact interest rates and loan tenures, depending on risks perceived by the bank.

The Facility Owner must contact potential banks to learn more about the evaluation criteria and requirements. The Facility Owner must also ensure the project proposal contains sufficient information that is “bankable”.



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

# 5 | Permits & Licensing

**SYSTEM SIZE: <200 kW**

Construction and Installation

**Step 5.1** Building Modification Permit or Notification

**Step 5.2** Mini-CoP Checklist

**Step 5.5** Notification for Exemption of Power Generation License

**SYSTEM SIZE: 200 kW – 1,000 kW**

**Step 5.1** Building Modification Permit (Aor. 1)

**Step 5.2** Mini-CoP Checklist

Regulated Energy Production License **Step 5.3**

**Step 5.5** Notification for Exemption of Power Generation License

 Step by Facility Owner & EPC/Developer

 Step by EPC/Developer



Home



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

# 5 | Permits & Licensing

**SYSTEM SIZE: > 1,000 kW**

Construction and Installation

**Step 5.1**

Building Modification Permit (Aor. 1)

**Step 5.2**

Mini-CoP Checklist

Regulated Energy  
Production License

**Step 5.3**

**Step 5.4**

Factory Operation License

**Step 5.6**

Power Generation License

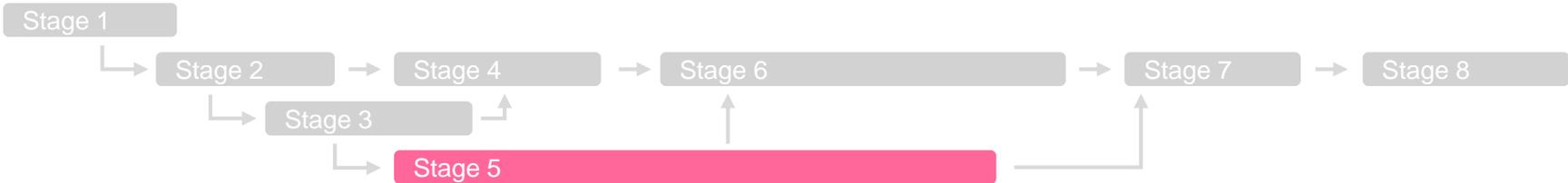
 Step by Facility Owner & EPC/Developer

 Step by EPC/Developer



Home





[See Stage Details >](#)

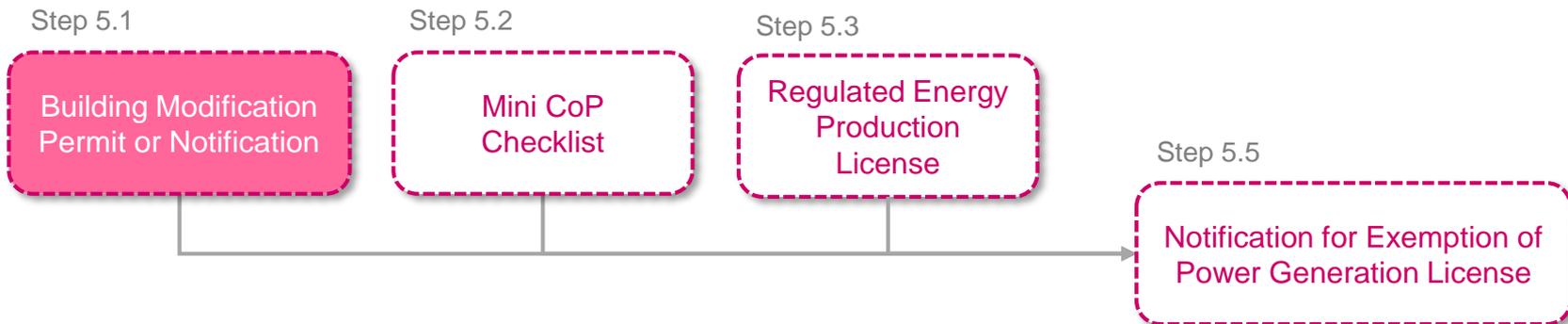
# 5 | Permits & Licensing

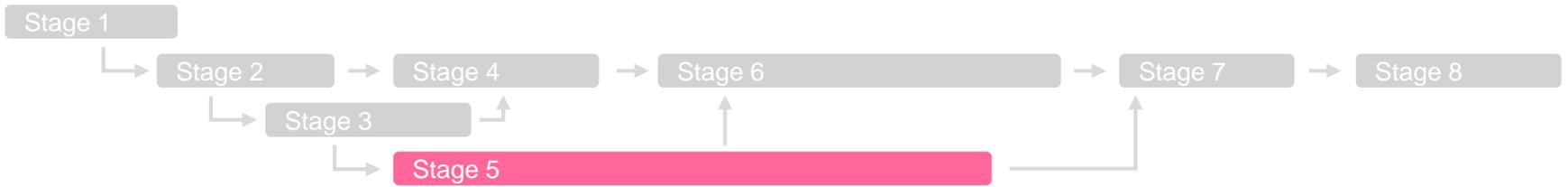
## SYSTEM SIZE: <200 kW

- Step by Facility Owner & EPC/Developer
- Step by EPC/Developer



## SYSTEM SIZE: 200 kW – 1,000 kW

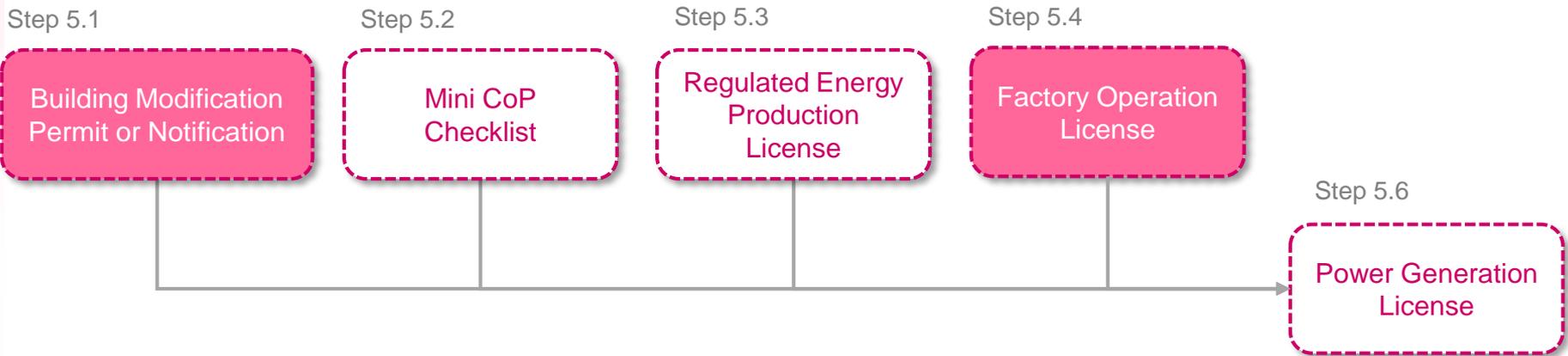




[See Stage Details >](#)

# 5 | Permits & Licensing

**SYSTEM SIZE: > 1,000 kW**



- Step by Facility Owner & EPC/Developer
- Step by EPC/Developer

## Stage Description

**Permits and Licensing Stage** outlines key permits and licenses which are required for solar PV rooftop projects. Different permits and licenses are required depending on the installed capacity of the system (DC capacity). Of which it can be divided into three classes, systems that are; under 200 kWp (<200 kWp), 200 kWp – 1000 kWp and over 1000 kWp (>1000 kWp).

Logically, the larger the system size the more permits and licenses are required. Below table summarize the required permits / licenses for each project size range.

Step	License/Permit	< 200 kWp	200 – 1,000 kWp	> 1,000 kWp
<a href="#">5.1</a>	Building Modification Permit / Building Modification Notification (Aor 1)	●	●	●
<a href="#">5.2</a>	Mini Code of Practice (Mini CoP) checklist	●	●	●
<a href="#">5.3</a>	Regulated Energy Production License (Por Kor 2)		●	●
<a href="#">5.4</a>	Factory Operation License (Ror Ngor 4)		●	●
<a href="#">5.5</a>	Notify for Exemption of Power Generation License	●	●	●
<a href="#">5.6</a>	Power Generation License			●

# Building Modification Permit or Notification

Details

Application

Regulation

## DETAILS

The installation of solar PV systems on rooftops may be considered as making a modification to the building itself. Before construction of the system, it must be checked with the Building Control Act if the building modification permit or notification is required for the solar PV system.

### Installation of solar PV on building located in building controlled zone

For installation of PV on buildings that are located in the building control zones (this zone is defined differently in each province), a Building Modification Permit prior to the installation is mandatory, unless:

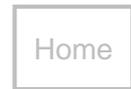
- PV is installed on a reinforced concrete roof
- Total installation area is no larger than 160 m<sup>2</sup> and has a total weight of less than 20 kg per m<sup>2</sup> (Inclusive of panels and mounting structure weight).

In exemption cases, an official letter shall be sent to inform the relevant agency of the PV installation, without the need to apply for the Building Modification Permit.

### Installation of solar PV on building located outside building controlled zone

In this case, installation of PV on the facility roof do not need a Building Modification Permit. Except if the building has an area of >10,000 m<sup>2</sup> or is higher than 23 meters. These buildings have to apply for the Building Modification Permit.

After completing all the procedures, the Facility Owner will obtain a permit called the Building Modification Permit (Aor. 1)



# Building Modification Permit or Notification



Details

Application

Regulation

## REQUIRED DOCUMENTS

The following documents must be prepared and submitted for the building modification permit

- Request for Building Modification Form (Kor. 1)
- Building & Roof Blueprint
- Structural Calculation
- Certification letter by engineer for system designer and structural calculation
- Building Survey form

Forms can be downloaded from:

<http://www.erc.or.th/ERCWeb2/Front/StaticPage/StaticPage.aspx?p=185>

## SUBMISSION PROCEDURE

- 1) Determine whether the building permit modification permit is needed. List of provinces with building control zones can be found at [\(link\)](#)
- 2) Preparation of all documents
- 3) Submit documents to the respective office
- 4) Review/evaluate the submitted documents
- 5) Approval from relevant authority

## AUTHORITIES

- District Office or Sub-District Administration Office (SAO)
- ERC

## FEES

- The license fee is 10 THB.
- Fee for review of floor plan ranges from 0.5 – 4 THB/m<sup>2</sup>



# Building Modification Permit or Notification



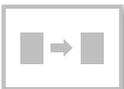
Details

Application

Regulation

## REGULATIONS

1. Building Control Act B.E. 2522 ([Thai](#))
2. Ministerial rules no. 65 (B.E. 2558) Building Control Act B.E. 2522 on PV rooftop ([Thai](#))
3. MoU between ERC and Ministry of Interior on permitting process of buildings, 5 September B.E. 2555 ([Thai](#))



# Mini-CoP


[Details](#)
[Document](#)
[Regulation](#)

## DETAILS

PV projects must comply with the **Code of Practice (CoP)** stipulated by the ERC. Its purpose is to alleviate rooftop PV from other waste and environmental protection regulations (i.e. EIA). Ones who implement the project must submit proof that the project complies with the CoP measures when applying for licenses with ERC.

Rooftop PV projects are subject to a lighter version Code of Practice measures which is called the Mini-CoP Checklist. The Mini-CoP version concerns two main measures 1) Equipment and Design measures 2) Waste Management measures

### [Equipment and Component Measures](#)

Equipment and component must follow the following standards:

<b>1. Modules</b>	Crystalline Modules: IEC 61215 or Mor.Aor.Kor. 1843 Thin Film Modules: IEC 61646 or Mor.Aor.Kor. 2210 Safety standards: IEC 61730 or Mor.Aor.Kor. 2580
<b>2. Balance-of-System Components (BOS)</b>	IEC 62093
<b>3. Installation</b>	IEC 60364-7-712 or Mor.Aor.Kor 2572-2555
<b>4. Grid Connection</b>	Following grid connection code or IEEE 1547 and UL1741 or IEC 61727 and IEC 62116



# Mini-CoP

[Details](#)[Document](#)[Regulation](#)

## DETAILS

### System Design Measures

- Plant capacity factor must >15% and the performance ratio >75%.
- Design must be able to withstand wind load of at least 30 m/s

### Waste Management Measures

It must be clearly stated on how the PV modules will be disposed at the end of its life. Either by means of recycling or disposal in secure landfill domestically or internationally.

[Home](#)

# Mini-CoP

- Details
- Application
- Regulation

## DOCUMENTS

- ERC Mini-CoP Checklist ([Word](#) / [PDF](#))
- Attachments:
  - Component (PV module, balance of system) datasheets showing that the required standards have been met
  - Single line diagram (with endorsement by a licensed engineer)
  - Yield simulation
  - ...(other relevant documents)

ปรับปรุงครั้งล่าสุดเมื่อวันที่ 3 มีนาคม 2558		สกพ-CoP-PV	
		<b>สำนักงานคณะกรรมการกำกับกิจการพลังงาน</b> <b>Office of the Energy Regulatory Commission</b>	
<b>รายการตรวจสอบมาตรฐานการออกแบบติดตั้งตามประมวลหลักการปฏิบัติ (Code of Practice)</b>			
- ผู้ผลิตไฟฟ้าพลังงานแสงอาทิตย์จากเทคโนโลยีแผงโฟโตโวลเทอิก -			
คำแนะนำในการกรอก: ให้ทำเครื่องหมาย ✓ ลงใน <input type="checkbox"/> หรือ <input type="radio"/> ที่ตรงกับความเป็นจริง และเติมข้อความอธิบายเพิ่มเติมในช่องว่าง			
<b>ประกอบการยื่น:</b>			
<input type="checkbox"/>	คำขอรับใบอนุญาตประกอบกิจการผลิตไฟฟ้า	เลขที่ สกพ-น .....	วันที่ยื่น .....
<input type="checkbox"/>	แบบแจ้งการประกอบกิจการพลังงานที่ได้รับการขออนุญาต	เลขที่ สกพ-ย .....	วันที่ยื่น .....
<b>ส่วนที่ 1: ข้อมูลการประกอบกิจการ</b>			
<b>1. ชื่อผู้ขอรับใบอนุญาต/ผู้แจ้ง</b>			
<b>2. การติดตั้ง</b> <input type="checkbox"/> บนพื้น (Ground Mounted) <input type="checkbox"/> บนหลังคา (Rooftop)			
<b>3. ระบบติดตามแสงอาทิตย์</b> <input type="checkbox"/> มี (Solar Trackers) <input type="checkbox"/> ไม่มี (Fixed Racks)			
<b>ส่วนที่ 2: มาตรฐานอุปกรณ์ การติดตั้ง การเชื่อมต่อกับระบบโครงข่ายไฟฟ้า และความปลอดภัย</b>			
<b>4. แผงโฟโตโวลเทอิก:</b> ผ่านการทดสอบและรับรองตามมาตรฐาน ดังต่อไปนี้			
<input type="checkbox"/>	IEC 61215	<input type="checkbox"/> มอก. 1843 (Crystalline Silicon Performance)	
<input type="checkbox"/>	IEC 61646	<input type="checkbox"/> มอก. 2210 (Thin Film Performance)	
<input type="checkbox"/>	IEC 61730 (Safety)	<input type="checkbox"/> อื่นๆ (โปรดระบุ)	

<b>5. อุปกรณ์ประกอบ (Balance of System Components):</b> ผ่านการทดสอบและรับรองตามมาตรฐาน ดังต่อไปนี้		
<input type="checkbox"/>	IEC 62093	<input type="checkbox"/> อื่นๆ (โปรดระบุ)
การทดสอบคุณสมบัติด้านการเชื่อมต่ออุปกรณ์ตามมาตรฐาน เช่น สายไฟฟ้า, ท่อร้อยสายไฟฟ้า, Battery		
<b>6. การติดตั้งและระบบจ่ายกำลังไฟฟ้า:</b> เป็นไปตามมาตรฐาน ดังต่อไปนี้		
<input type="checkbox"/>	IEC 60364-7-712	<input type="checkbox"/> มอก. 2572-2555 <input type="checkbox"/> อื่นๆ (โปรดระบุ)
ระบบจ่ายแรงดันไฟฟ้าพลังงานแสงอาทิตย์ตามมาตรฐาน ระบบที่ทำหน้าที่เชื่อมโยงระหว่างระบบส่งกำลังไฟฟ้ากับโหนดผู้ใช้ไฟฟ้า เช่น Power Distribution System, หม้อแปลงไฟฟ้า, Switch Gear, Solar Charge Controller หรือ แบบ Single Line Diagram แสดงการติดตั้งตามมาตรฐาน พร้อมวิศวกรเซ็นรับรอง		
<b>7. การเชื่อมต่อระบบผลิตไฟฟ้ากับระบบโครงข่ายไฟฟ้า:</b> เป็นไปตามมาตรฐานของกริดฟาย์เวย์จำหน่าย ดังต่อไปนี้		
<input type="checkbox"/>	IEC 61727	<input type="checkbox"/> IEC 62116
<input type="checkbox"/>	IEEE 1547	<input type="checkbox"/> UL 1741 <input type="checkbox"/> อื่นๆ (โปรดระบุ)
การทดสอบคุณสมบัติการเชื่อมต่อระบบผลิตไฟฟ้ากับระบบโครงข่ายไฟฟ้า เช่น Inverter เปลี่ยนกระแสไฟฟ้า DC เป็น AC		
<b>ส่วนที่ 3: การออกแบบ</b>		แบบเอกสาร พิจารณาแล้ว (เจ้าหน้าที่)
<b>8. อัตราส่วนของพลังงานไฟฟ้าที่ผลิตได้ต่อปีต่อขนาดกำลังการผลิตติดตั้งสูงสุดของแผง (Plant Capacity Factor)</b>		
$\frac{[\text{Annual Energy Yield} / (\text{Capacity} \times \text{Operating Hours})] \times 100}{[(\text{MWh}_{\text{DC}}/\text{year}) / (\text{MW}_{\text{DC}} \times 24 \times 365.25)] \times 100} = \text{ \%}$		
<b>ส่วนที่ 4: การกำจัดแผงโฟโตโวลเทอิก อุปกรณ์ไฟฟ้า และอุปกรณ์อิเล็กทรอนิกส์ที่เกี่ยวข้อง</b>		แบบเอกสาร พิจารณาแล้ว (เจ้าหน้าที่)
<b>9. วิธีการกำจัดแผงพลังงานแสงอาทิตย์และขยะอิเล็กทรอนิกส์</b>		
<input type="checkbox"/>	Recycling Method	<input type="radio"/> ภายในประเทศ <input type="radio"/> ภายนอกประเทศ
<input type="checkbox"/>	นำไปกำจัด	
<input type="checkbox"/> วิธีการอื่น (โปรดระบุรายละเอียด)		

# Mini-CoP



Details

Document

Regulation

## REGULATIONS

1. ERC Announcement on COP Regulation, 27 November B.E. 2555 ([Link](#))
2. ERC Announcement on COP Regulation for PV Systems with Power Generation License, 15 September B.E. 2557 ([Link](#))
3. ERC Announcement on COP Regulation for PV System Exempted from Power Generation License, 15 September B.E. 2557 ([Link](#))

## RELEVANT DOCUMENTS

1. PV Code of Practice Handbook by ERC ([Link](#))



# Regulated Energy Production License

Details

Application

Regulations

## DETAILS

Solar PV systems that are larger than 200 kVA are required by the government to obtain a **Regulated Energy Production License (Por Kor 2)**. To apply for this license, the Facility Owner / Solar Service Provider must prepare several forms and technical documents. The documents must be submitted before construction of the system.

Once most of the system components have been installed (90% completed), the Facility Owner / the Solar Service Provider shall notify DEDE or ERC to send officials to inspect the system. Once, the system is approved by the officials, a license will be granted.

The regulated energy production license has a duration of four years. It must be renewed by the Facility Owner / the Solar Service Provider . There is no license fee.

แบบ พค.2

(ตราครุฑ)  
กรมพัฒนาและส่งเสริมพลังงาน  
ใบอนุญาตให้ผลิตพลังงานควบคุม

ที่ ..... / .....

ใบอนุญาตนี้ให้ไว้แก่

เพื่อแสดงว่าเป็นผู้ได้รับอนุญาตให้  ผลิต  ขายการผลิต พลังงานควบคุมตาม  
มาตรา 25 แห่งพระราชบัญญัติการพัฒนาระบบส่งเสริมพลังงาน พ.ศ. 2535 ณ สถานที่ทำการผลิตพลังงานควบคุม

ชื่อ .....

ตั้งอยู่เลขที่ ..... ตระกูลซอย ..... ถนน ..... หมู่ที่ .....

ตำบลแขวง ..... อำเภอเขต ..... จังหวัด .....

รหัสไปรษณีย์ ..... โทรศัพท์ ..... โทรสาร .....

เพื่อประกอบกิจการ ..... โดยมีรายละเอียด ดังนี้

ใบอนุญาตฉบับนี้ให้ใช้ได้ตั้งแต่วันที่ ..... เดือน ..... พ.ศ. ....  
ออกให้ ณ วันที่ ..... เดือน ..... พ.ศ. ....

(ลายมือชื่อ) .....

ตำแหน่ง .....

ผู้อนุญาต



# Regulated Energy Production License



Details

Application

Regulations

## REQUIRED DOCUMENTS

- Request for Regulated Energy Production License Form (Por. Kor. 1) ([Word](#) / [PDF](#))
- Single Line Diagram
- PV Panel + Inverter Specification
- Certification letter by professional electrical engineer (Power)
- License for professional practice of electrical engineer
- Building Floor Plan
- ...Other administrative documents (See [Checklist](#))

## PROCEDURES

- Check if the system requires a Regulated Energy Production License
- Submit request form to DEDE. Either in person or via online portal ([Link to Online Portal](#))
- Document is checked by DEDE (for missing and additional documents)
- Receive memo of request
- Construction of system
- Inspection of System
- Approval of License

For more detailed, please refer to the process work flow ([Thai](#))

The expected duration of approval process is within 90 days. Although this is depending on the duration of construction.



# Regulated Energy Production License

Details

Application

Regulations

## REGULATIONS

1. Royal Decree on Regulated Energy Production License B.E. 2536 ([Thai](#))



# Factory Operation License

Details

Application

Regulations

## DETAILS

*This step is for solar PV rooftop systems of 1,000 kWp and larger*

Thailand Factory Act considers PV systems as a power plant which is classified as Type 3 Factory, meaning that a **Factory Operation License (Ror Ngor 4)** is required before commencement of construction.

Fortunately, solar PV rooftop system with an installed capacity of less than 1000 kWp are not considered as a factory and are not subject to this license.

พ.ร.บ.  
ลำดับที่ 1

**ใบอนุญาตประกอบกิจการโรงงาน**  
กระทรวงอุตสาหกรรม

ที่.....

วันที่..... เดือน..... พ.ศ.....

อนุญาตให้..... จังหวัด.....

อยู่บ้าน/สำนักงานเลขที่..... ซอย/ซอย..... ถนน.....

หมู่ที่..... ตำบล/แขวง..... อำเภอ/เขต..... จังหวัด.....

ชื่อโรงงาน.....

ประเภทหรือชนิดของโรงงานลำดับที่.....

ประเภทกิจการ.....

กำลังเครื่องจักร..... แรงม้า จำนวนคนงาน..... คน

สิ่งปลูกสร้างเลขที่..... ซอย..... ถนน.....

หมู่ที่..... ตำบล..... อำเภอ..... จังหวัด.....

อำนาจ/เขต..... จังหวัด.....

ประเภทกิจการใดโดยไม่มีระบบขออนุญาตโรงงานภายในกำแพง..... วัน.....

ซึ่งไม่มีรายการรายละเอียดอื่นใด

(1) เป็นใบขออนุญาตไม่ประกอบกิจการโรงงาน และการเปลี่ยนแปลงสิ่งปลูก	แสดงไว้ในลำดับที่ 3
(2) การเริ่มประกอบกิจการโรงงาน กำหนดสิ่งปลูกใบอนุญาต และกำหนดขออนุญาต	แสดงไว้ในลำดับที่ 3
(3) ใบอนุญาตขออนุญาตโรงงาน	แสดงไว้ในลำดับที่ 4
(4) เป็นใบขออนุญาตใช้ชื่อโรงงาน และการเปลี่ยนแปลงสิ่งปลูก	แสดงไว้ในลำดับที่ 5
(5) การเริ่มประกอบกิจการโรงงานในส่วนที่ขาด	แสดงไว้ในลำดับที่ 5
(6) บันทึกการเปลี่ยนแปลงต่างๆ	แสดงไว้ในลำดับที่ 7
(7) การขออนุญาตในการประกอบกิจการโรงงาน	แสดงไว้ในลำดับที่ 8
(8) บันทึกการชำระค่าธรรมเนียมรายปี	แสดงไว้ในลำดับที่ 8
(9) ลำดับและจำนวนของเอกสาร	แสดงไว้ในลำดับที่ 10

# Factory Operation License



Details

Application

Regulations

## REQUIRED DOCUMENTS

- Request From (Ror. Ngor. 3) ([TH](#))
- Land ownership documents
- Building blueprint
- Single line diagram
- Waste management plan
- Other administrative documents (See [ERC Checklist](#))

## PROCEDURES

- Check if the system requires a Factory Operation License
- Submit documents to ERC (At ERC office or online via ERC E-licensing portal)
- Site Inspection
- ERC Approval
- Licensing Fee Payment
- Approval and Granting of License

For more detailed procedure, please refer to Work Flow Schedule ([Link](#))



# Factory Operation License

Details

Application

Regulations

## REGULATIONS

- Factory Act B.E.2535 ([Thai](#))
- Ministry of Industry Regulation No. 23 / B.E. 2557 (Thai)



# Notification for Exemption of Power Generation License

Details

Document

Procedures

Fee/Duration

Regulation

## DETAILS

***This step is for solar PV rooftop systems smaller than 1,000 kVA***

PV systems that are less than 1,000 kVA are exempted from the Power Generation License.

Nevertheless, the Facility Owner / Solar Service Provider must submit a notification for exemption to ERC. This can be submitted online or at ERC office.



# Notification for Exemption of Power Generation License



Details

Document

Procedures

Fee/Duration

Regulation

## REQUIRED DOCUMENTS

- Request From
- Building Modification Permit or Notification
- Mini-CoP
- Certification letter by engineer for system designer and structural calculation
- Single Line Diagram
- Pictures of system e.g. PV modules, Inverter
- Other administrative documents (See Checklist)



# Notification for Exemption of Power Generation License

[Details](#)[Document](#)[Procedures](#)[Fee/Duration](#)[Regulation](#)

## PROCEDURES

- Submit documents to ERC, at ERC office or via ERC E-licensing portal ([Link](#))  
*Online registration is possible. However, a hard copy must be submitted as well.*
- ERC Check Documents
- ERC office issues letter of notification for exemption of Power Generation License

[Home](#)

# Power Generation License

Details

Document

Procedures

Fee/Duration

Regulation

## DETAILS

PV systems with an installed capacity of  $\geq 1,000$  kVA must apply for a Power Generation License with ERC. System sizes  $< 1,000$  kVA are exempted from these licenses.

ERC will consider that the project complies with all other relevant laws/regulations. Applicable laws include; Mini-CoP, Factory Operation License, Building Modification Permit, Regulated Energy Production License.



# Power Generation License

[Details](#)[Document](#)[Procedures](#)[Fee/Duration](#)[Regulation](#)

## REQUIRED DOCUMENTS

- License Request Form
- Power Generation Diagram
- Risk Assessment
- Documents regarding to relevant licenses: Mini-CoP, Factory Operation License
- ...Other administrative documents (See Checklist)

## CHECKLIST

- ERC License Request Form and Checklist of Required Documents ( [Word](#) / [PDF](#) )

[Home](#)

# Power Generation License

Details

Document

Procedures

Fee/Duration

Regulation

## PROCEDURES

- Notify ERC
- Check and submit all required documents; Full-CoP/Mini-CoP, Factory Operation License, Building Modification Permit
- ERC Check Documents
- Fee Payment
- ERC office issues letter of notification for exemption of Power Generation License

Detailed procedures can be found in Page 22 of ERC's Licensing Guidelines ([Link](#))



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

## 6 | Procurement and Construction

**Step 6.1**

Site Preparation

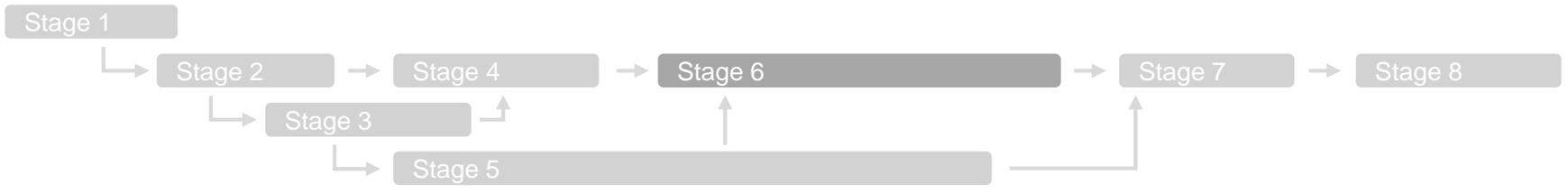
**Step 6.1**

Construction & Installation



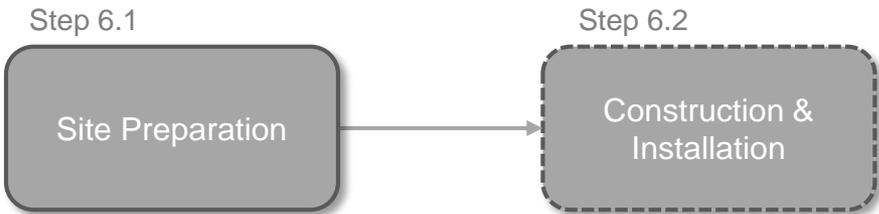
Home





[See Stage Details >](#)

# 6 | Procurement and Construction



## Stage Description

---

The **Procurement and Construction Stage (PCN)** describes the process of equipment/system procurements, site preparation and arrangement, construction and installation of PV rooftops. Most tasks are to be done by EPC contractor. However, project owners shall oversee the overall development to ensure quality of deliverables. This stage consists of two steps: Site Preparation and Construction and Installation.

**Site Preparation (Step 6.1)** is a task to be done by the Facility Owner. Before the actual construction and installation, access to the site must be granted. Use of necessary facilities/utilities must be provided (e.g. water, electricity, etc.) After all arrangements are done, EPC contractor or subcontractor will access the site to **construct and install the system (Step 6.2)**. During the latter step, project owners must oversee the overall work to check progress and ensure quality of workmanship.



# Site Preparation

## DETAILS

EPC contractors or subcontractors are the ones who are responsible for construction and installation of the system. Project Owners do not have much of a role during the procurement and construction stage. However, before the EPC constructors come to the site, the Project Owner must ensure that EPC contractors are granted with access and are allowed to use utilities (e.g. electricity, water, etc.) as agreed in advanced. The Project Owner must ensure that all obstacles at the installation site are clear before the EPC contractor arrives.

Key items that must be communicated / clearly agreed with the EPC contractor are:

- Access to the site (i.e. roof): Security procedure (e.g. submission of ID cards of all personnel, advanced registration at check point), allowed operation time (when EPC contractor can access to the site, when EPC must leave the site, nightshift?, etc.)
- Use of electricity at site for system installation: Limitation of use (kWh/month, maximum current), connection point, etc.
- Use of water at site: Limitation (liters/month), connection point, etc.
- Use of other facilities: Loading/unloading areas, temporary office space, location for storage etc.
- Procedure to connect / disconnect relevant electricity circuit breaker: Who to notify?, When to notify?
- Safety requirement / measures of the facility: use of personal protection equipment (e.g. glass, helmet, sling, safety shoes, etc.)
- Environmental requirement / measures of the facility: discharge of waste water, measure to mitigate noise / dust, etc.



# Construction and Installation

## DETAILS

For the self-financing model, the EPC contractor is the one who is responsible for procurement of all components, construction and installation of the solar PV rooftop system. When possible, it is recommended that the facility owner contracts a third-party consultant to act as an owner engineer (OE) to oversee and supervise the construction. This is to ensure that all procured components meet with technical requirement and comply with standard or good engineering practices. This can also ensure that the system is properly installed.

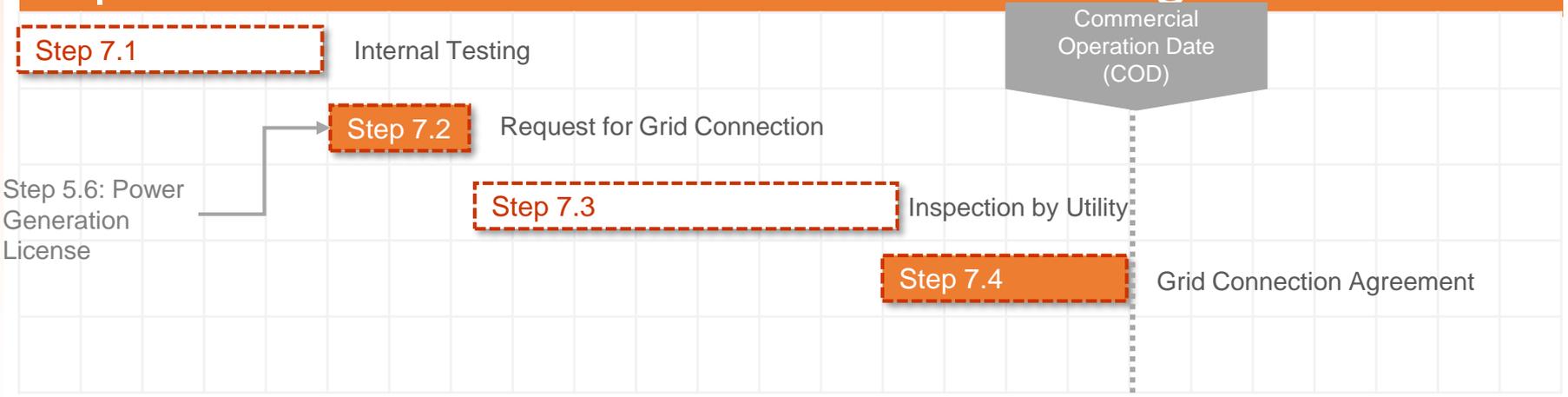
For the Third-party Ownership model, the Developer Company is the one who is responsible for procurement of all components, construction, and installation of the solar PV rooftop system. Usually, they contract an EPC contractor to do these activities. Therefore, the facility owner does not have to actively engage or supervise the construction works.



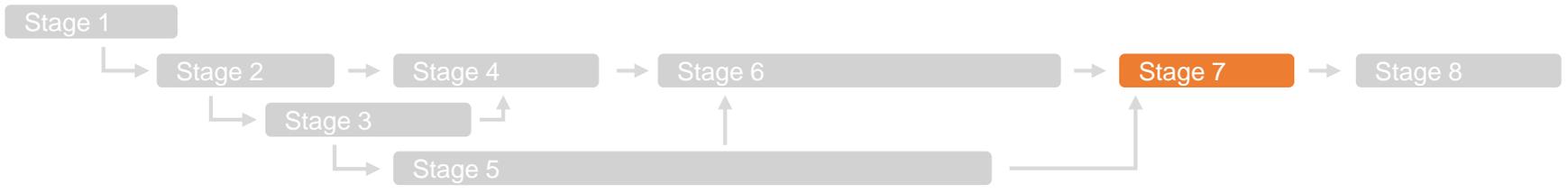


[See Stage Details >](#)

# 7 | Grid Connection and Commissioning



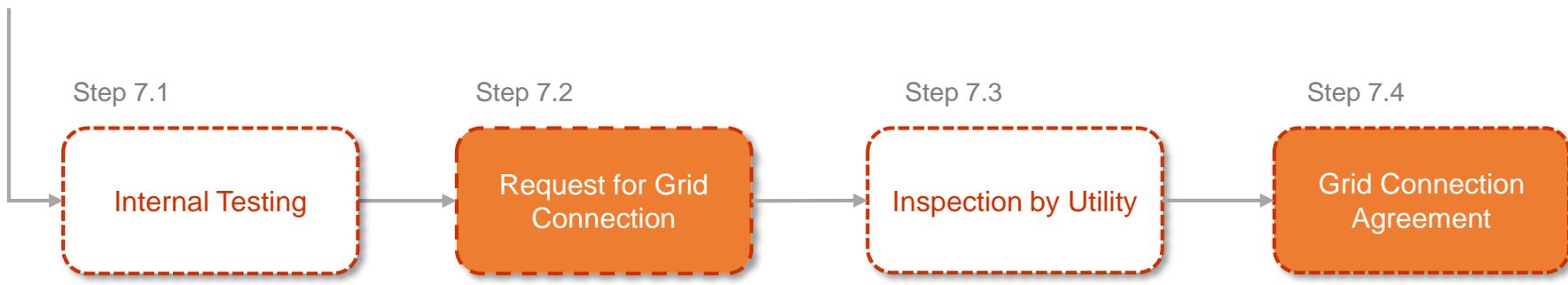
-  Step by Facility Owner & EPC/Developer
-  Step by EPC/Developer



[Step Details >](#)  
[See Stage Details >](#)

# 7 | Grid Connection and Commissioning

Step 5.6: Power Generation License



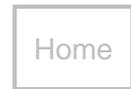
- Step by Facility Owner & EPC/Developer
- Step by EPC/Developer

## Stage Description

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After completion of installation, there are several steps to commission and connect the system to the grid. Even though, the system is not feeding electricity into the grid, they are subject to grid connection requirements.

First, the EPC Contractor or an external party shall conduct **an internal testing** ([Step 7.1](#)) on the solar PV system. This is to ensure that all components and the system can be operated properly. It is also to ensure that all construction / installation is properly done. Then, the Facility Owner submits a **request for grid connection** ([Step 7.2](#)) to relevant power utilities (i.e. MEA / PEA). Power utilities shall review all submitted documents and conduct an **on-site inspection** ([Step 7.3](#)). If everything is according to the requirements, the Facility Owner can sign a **grid connection agreement** ([Step 7.4](#)) with the power utility.



# Internal Testing

## Details

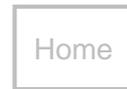
### DETAILS

Upon completion of construction, internal testing must be conducted to ensure that all systems and components are properly installed. They must comply with relevant standards. Usually, conduction of internal testing should be part of the deliverable of the EPC contractor who installs the system.

Usually, testing should include:

- Functional test on component / equipment
- System operation
- Testing of safety device
- Standard of equipment
- Installation and construction workmanship
- Etc.

Some Facility Owner may contract an external party who has expertise to support in the internal testing to ensure that the work delivered by the EPC Contractor is in good quality.



# Request for Grid Connection

Details

MEA

PEA

## DETAILS

After the Facility Owner is confident that the installed solar PV system can be operated properly, a request for grid connection shall be submitted to relevant power utilities. If the project is in Bangkok, Nonthaburi, and Samut Prakarn, the request must be submitted to Metropolitan Electricity Authority (MEA). If the project is in other provinces, the request is to be submitted to Provincial Electricity Authority (PEA).

Certain requirements, forms and list of required documents are different between areas in PEA and areas in MEA when requesting for grid connection. The connection of PV systems to the grid shall follow requirements for grid connection as outlined in the PEA Grid Interconnection Code 2016 ([Thai](#) / [English](#)) and MEA Grid Interconnection Code 2015 ([Thai](#)).



# Request for Grid Connection

Details

MEA

PEA

## MEA Key Requirements

▪ <b>Inverter used must be on MEA's approved list</b>	The list of approved inverters can be found at ( <a href="#">Link</a> ).
▪ <b>Comply with Power Capacity requirements</b>	<u>Low Voltage (230/400V)</u> : Total capacity on each transformer must not exceed 15% of the transformer capacity <u>Medium Voltage (12 kV/24kV)</u> : Total capacity on each circuit must not exceed 20% of the circuit capacity.
▪ <b>Comply with interconnection scheme</b>	See Interconnection scheme Single Line Diagram
▪ <b>Comply with Protection Equipment</b>	Reverse Power Relay



# Request for Grid Connection

Details

MEA

PEA

## PEA Key Requirements

▪ <b>Inverter used must be on PEA's approved list</b>	The list of approved inverters can be found at ( <a href="#">Link</a> ).
▪ <b>Comply with Power Capacity requirements</b>	Low Voltage (380/220V) : Total capacity on each transformer must not exceed 15% of the transformer capacity Medium Voltage (22 kV/33kV): Total capacity on each circuit must not exceed 75% of the circuit capacity.
▪ <b>Comply with interconnection scheme</b>	See Interconnection scheme Single Line Diagram
▪ <b>Comply with Protection Equipment</b>	Reverse Power Relay



# Inspection by Utility

## Details

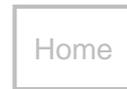
### DETAILS

After receiving a grid connection request, relevant power utilities (PEA, MEA) will screen the completeness of submitted documents. Then, they perform technical evaluation on the documents. If everything is satisfactory, the next step is to do inspection at the facility.

The utilities will send their personnel to the facility to check crucial installation and wiring as per relevant standard and grid connection code. Usually, the EPC contractor who installs the system facilitates the inspection by the utility personnel. It must be ensured that all documents are available during the inspection (i.e. single line diagram, wiring diagram, equipment data sheet, etc.)

After the inspection, the power utility informs the result of the inspection to the Facility Owner. The list of items that do not pass the inspection shall be provided (if any). The EPC contractor must take care of those items on the list before inform the power utility to do an inspection again.

If everything is satisfactory, the power utilities will provide a document indicating that inspection had been conducted and everything met the requirements without any further modification/adjustment. This will be a basis for physical connection to come.



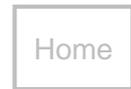
# Grid Connection Agreement

Details

## DETAILS

Typically, the Facility Owner already has an agreement regarding grid connection with the power utility. This agreement allows the Facility Owner to be supplied with electricity from relevant power utilities. However, with an installation of a solar PV rooftop system, a new grid connection agreement dedicated for solar PV system must be obtained.

After the on-site inspection by power utility's personnel, if all components, systems including their installation meet with applicable standards / requirement, the Facility Owner can sign a grid connection agreement with power utility. This officially allows the solar PV rooftop system to be connected to the grid.



Step 1

Step 2

Step 3

Step 4

Step 5

Step 6

Step 7

Step 8

[See Stage Details >](#)

# 8 | Operation and Maintenance

Step 9.1

Training

## SELF-FINANCE

Step 9.2

O&M Scope

## PRIVATE PPA

Step 9.3

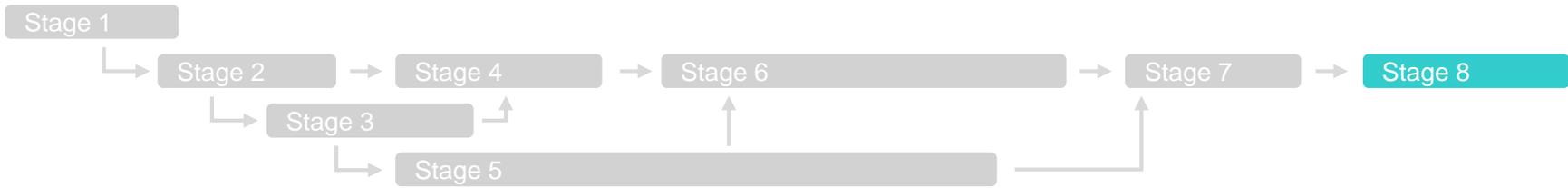
Energy Verification & Payment

Transfer Ownership

Step 9.4

- Step by Facility Owner
- Step by Facility Owner & EPC/Developer
- Step by EPC/Developer

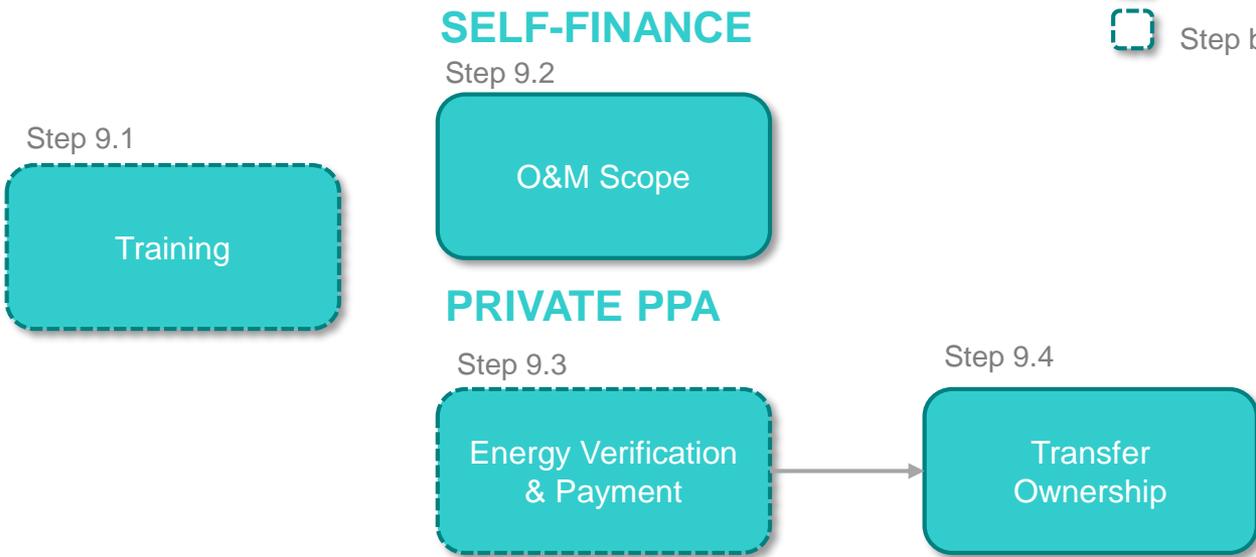




[See Stage Details >](#)

# 8 | Operation and Maintenance

- Step by Facility Owner
- Step by Facility Owner & EPC/Developer
- Step by EPC/Developer

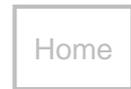


## Stage Description

Operation and Maintenance Stage is when solar PV systems have been completely installed and commissioned. This stage is the longest in terms of duration. This stage lasts until the end of the systems lifetime which is normally 25-30 years.

First, **training** shall be conducted ([Step 8.1](#)) for those who operate and is responsible for the maintenance of the system. For the self-financing model, the EPC Contractor typically provides operation and maintenance (O&M) service for 2-3 years after the commissioning of the system. After that, the Facility Owner must plan for **O&M scope** and activities after that point ([Step 8.2](#))

For the third-party ownership model, the Facility Owner pays a monthly electricity bill to the Solar Service Provider. Therefore, the Facility Owner must have some measure to perform **energy verification** before payment ([Step 8.3](#)). This is to ensure that actual electricity generation is matching to that indicated in the bill. The third-party ownership usually involves handing over of the system to the Facility Owner after some years. Therefore, the Facility Owner must prepare for the **transfer of ownership** ([Step 8.4](#)) in advance. Several aspects must be considered and checked before the transfer (e.g. system status & condition, documentation etc.) This is to ensure smooth operation after the change of ownership.



# Training



## Details

## DETAILS

To ensure sustainable operation of the system, it is crucial that operator has a good understanding of the system. This is especially important for the self-finance model when the PV rooftop system is owned and maintained by the project owner (unless the system owner make an O&M contract with an external party, see [Step 2.2](#)). If the project owner uses their own personnel to do operation and maintenance, they should nominate a person-in-charge of the PV rooftop system in the beginning and ensure that the person possesses the appropriate skills and capability. Training of this person should be within the scope of the EPC contractor.

### What system operator should know?

- Fundamentals of solar PV system
- Overview of the system (i.e. component, rated capacity, and other parameters, review of single line diagram, etc.)
- Safety consideration once working with PV system (i.e. risk associated with PV system operator, etc.)
- Routine inspection / performance monitoring (i.e. understand system parameters, etc.)
- Use of measurement devices (e.g. clamp meter, etc.) or monitoring system Preliminary troubleshooting
- Cleaning of system components
- Warranty period, point of contact
- Etc.

In the case of third party ownership (TPO) model, the solar PV rooftop system is owned and operated by the developer company. Therefore, the owner of the facility does not have a direct responsibility on maintenance of the system. However, basic knowledge on solar PV technology is still beneficial for facilitate communication with the developer company.



# O&M Scope



Details

## DETAILS

### *This step is for Self-financing model*

Usually, the EPC contractor will offer O&M service as part of the contract for certain years after the system commissioning. Therefore, the facility owner can rely on the EPC contractor during this period for agreed O&M activities. The facility owner must be aware of the scope of O&M that the EPC contractor must deliver and ensure that the EPC contractor fulfill this responsibility.

After the EPC contract reaches an end, the facility owner must plan ahead on who will be the one conducting O&M after. If it is decided that the external party will conduct O&M activities, then a new O&M contract must be made (see [Step 2.2](#)). If it is decided that the facility owner will use their own personnel to oversee O&M activities, then proper capacity building (i.e. training) must be conducted (see [Step 9.1](#))



# Energy Verification & Payment



## Details

### DETAILS

#### ***This step is for Third-party Ownership model***

In the Third-party Ownership model, the Developer Company sells electricity generated by the solar PV rooftop system to the facility owner. The process of electricity cost payment shall be transparent for both parties. The Developer Company will submit electricity bills to the facility owner on an agreed date every month. The facility owner should verify if the electricity generation is consistent with the electricity cost billed.

Depending on the level of trust between the facility owner and the developer company, several method can be used to verify electricity generation in the bill:

- Cross-checking with power meter at the output of the PV system (installed by the Developer Company) or from monitoring system
- Cross-checking with power meter installed independently by the facility owner at the input to main distribution board (please note that the value will not be exact as the power meter installed at the output of the PV system as there might be some line loss. However, value reading from the dedicated meter should be in the same level as the value stated in the bill)
- Comparing with electricity generation from past months (taking into consideration weather condition, operation hours of the facility, etc.) – This can give only a brief comparison that the level of electricity that should be more or less than previous month
- Etc.

Once the electricity generation stated in the bill is verified, the facility owner pay the respective electricity cost to the Developer Company.



# Transfer Ownership

## Details

### DETAILS

#### *This step is for Third-party Ownership model*

The transfer of ownership must be clearly indicated in the contract made between the facility owner and the Developer Company ([Step 2.3](#)). The facility owner must be aware of the timeframe for the ownership transfer and prepare for it in advanced.

Before the system is transferred, the following aspect should be considered in advance:

- **Who will be the system operator?** – After the system is transferred to become an asset of the facility owner, all O&M activities will be on the facility owner side. It must be decided if an O&M contract is to be made with external party or the facility owner will nominate their own personnel to conduct this tasks.
- **System condition prior to the transfer** – It is recommended that an inspection of component performance shall be conducted in advanced prior to the transfer. This can give a good overview on the systems condition & performance at that time. It also helps the facility owner to plan for procurement or replacement of certain component in advance.
- **Effect to accounting** – After the transfer, the PV rooftop system is an asset of the facility owner. This must be taken into consideration in the accounting system.
- **Monitoring system** – Apart from transfer of hardware, it is important that the monitoring system is properly transferred as well (including username and password for access, right of access, right of update, etc.)
- **Recent engineering document** – Maintenance and equipment replacement are regularly done by the Developer Company before the transfer. Therefore, actual systems may not be exactly the same as mentioned in the engineering document during the system commissioning. It is recommended that the facility owner asks the Developer Company to update all engineering documents (i.e. single line diagram, equipment datasheet, etc.) to reflect the system on the date of transfer.



**Solar PV Rooftop Implementation Guidelines**  
**THAILAND**