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Lessons learned from various approaches in scaling up solar rooftop

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June 7, 2017

Prepared for the Asia Clean Energy Forum (ACEF) 2017, ADB Headquarters, Manila, Philippines

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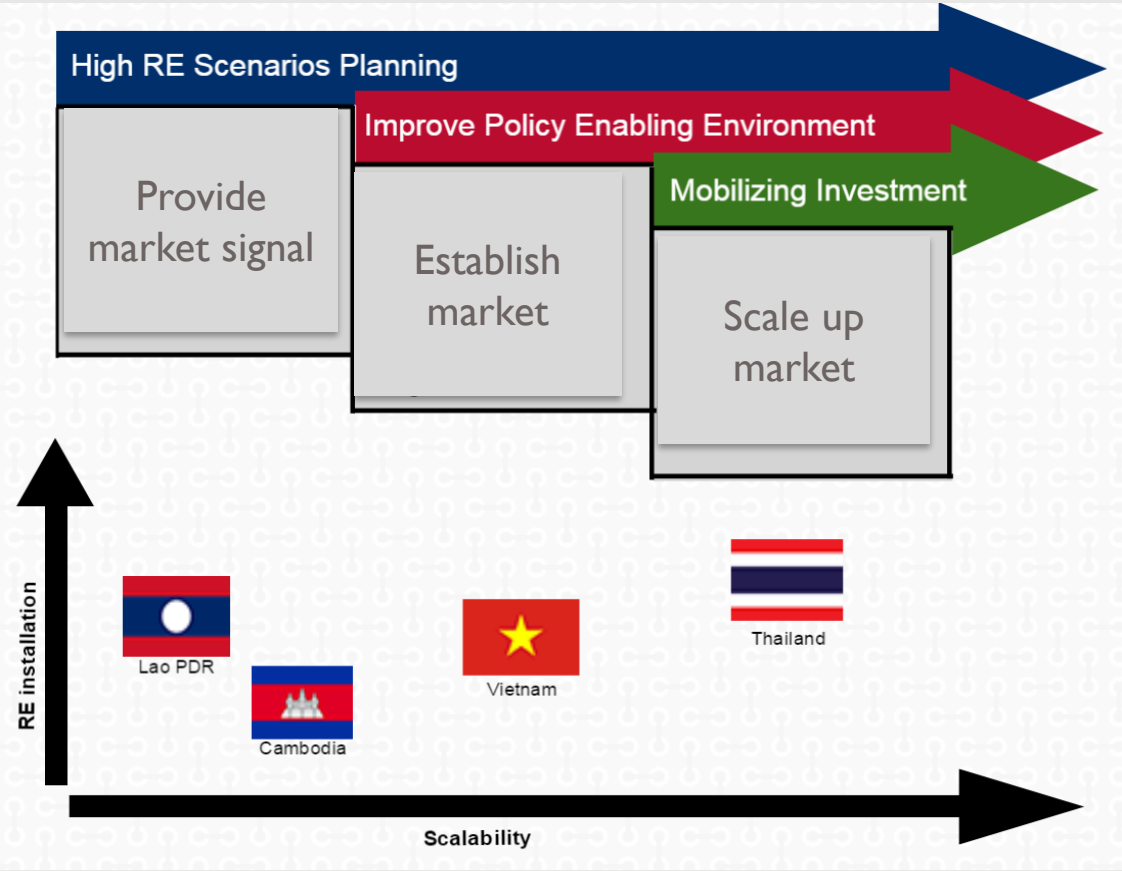
Lessons learned from various approaches in scaling up solar rooftop

- Overview of solar rooftop market and incentives
- Thailand experiences
- USA experiences

USAID Clean Power Asia aims to increase deployment in 'grid-connected' renewable energy in Asia

- 5 years: June 2016 – June 2021
- Regional clean energy program
- Focus on Cambodia, Lao PDR, Thailand, and Vietnam
- Goals:
  - 15 laws/policies/regulations
  - $750 M USD investment mobilization
  - 500 MW of installed RE
  - 3.5 M tCO2e reduction
- Implemented by Abt Associates and partners
- Funded by USAID (United States Agency for International Development)



Introduction

- Distributed PV systems (DPV), defined as small-scale solar PV systems located at or near the point of consumption, are becoming an increasingly popular mode of power production due to supportive policies and declining system prices.
- Many countries across the world have made a transition (Germany and Italy) or are making a transition from feed-in tariffs (FIT) to self-consumption schemes (Thailand, Malaysia, and Australia)
- Some countries are in the beginning stage of designing a DPV policy, and details of the design will have a strong impact on customers' economics.

Building Blocks for DPV Policy Deployment

Building Block 1: Articulate DPV role & desired market elements

Building Block 2: Legal and institutional considerations

Building Block 3: Establish interconnection standards and process

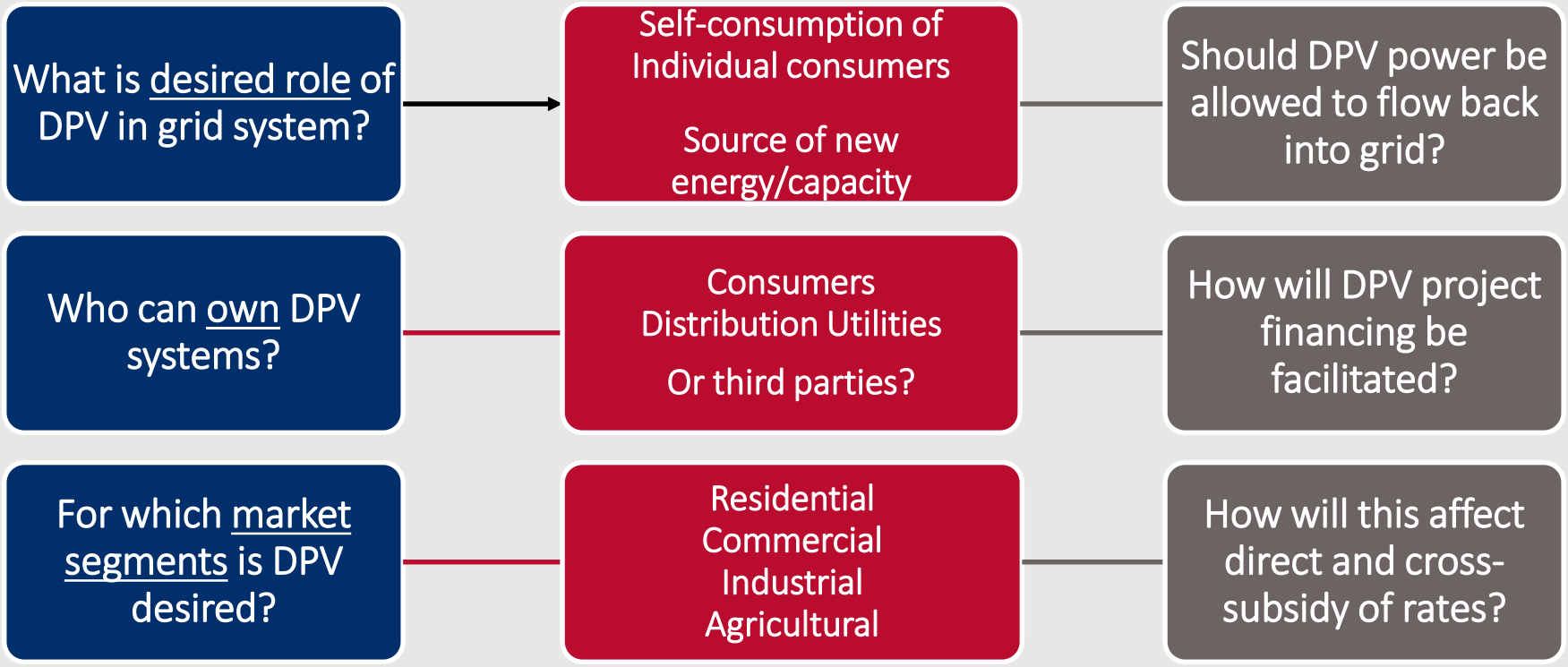
Building Block 4: Establish compensation mechanism for DPV generation

Building Block 5: Establish metering arrangements

Building Block 6: Establish additional support

Source: Zinaman (2016). NREL

Articulate DPV role & desired market elements



Note: Most options are not mutually exclusive

Establish compensation mechanism for DPV generation

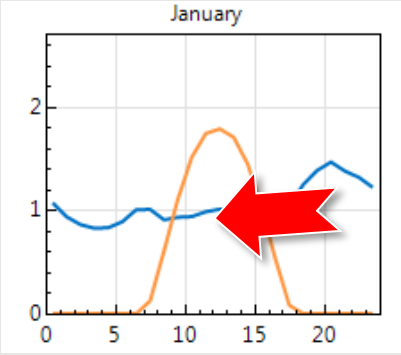
Three categories of compensation mechanisms: net metering, net billing, FIT

FIT
(Export 100%)

Self-consumption
with net metering
or net billing

Self-consumption
with no export

What does a compensation mechanism do?

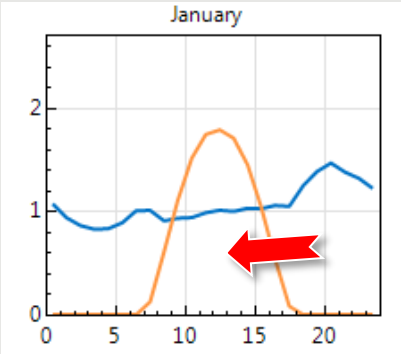


Treat all PV electricity produced:

All PV electricity produced:

- Pay for all PV electricity produced
- At a rate: typically higher than retail but doesn't have to be.

FiT

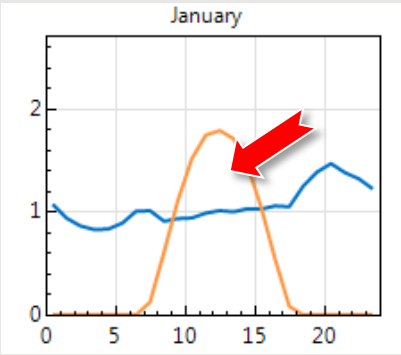


Treat the self-consumed part vs. excess separately:

Self Consumptio Schemes

Self-consumed part of PV electricity:

- Typically is valued at the tariff rate to which the customer subscribes
- Bonus on top of this is possible but rare.



Excess PV electricity:

- How frequently it is read
- Whether it is accounted as kWh or as $
- How frequently it is used to offset the kWh that consumers buy from the grid→ integration interval

A look at what's happening across the world

Compensation schemes	Self-consumed electricity	Rolling credit timeframe	Buyback rate	Banking Period	Meter	Countries	Sources
Real-time	√	Hourly	Wholesale	×	2	Sweden	IEA,PVPS (2016)
	√	Hourly	Wholesale	×	2	Denmark	RES Legal, 2017
Simple Net Metering	√	×	×	Billing period (monthly)	1	Spain	
	√	×	×	Billing period (monthly)	I	Thailand's rooftop PV pilot project,	(GIZ, 2017)
	√	×	×	Billing period (monthly)	I	Belgium (Flanders)	(RES, Legal, 2017)
Net metering with rolling credit (no buy-back)	√	Yearly	Retail	Yearly	I	USA (Columbia, Illinois, Pennsylvania, Louisiana, Arizona, Maryland	(DSIRE, 2017)
	√	Yearly	Retail	Yearly	I	Greece	(RES, Legal, 2017)
Net metering with rolling credit and buy-back	√	Yearly	retail rate	Yearly	I	USA (New York, New Jersey, Nevada ,Columbia)	Originenergy, 2017
Simple Net Billing	√	No	N/A	No	2		
Net billing with rolling credit (no buy-back)	√	Yearly	No	Yes	2	USA (Rhode Island)	(DSIRE, 2017)
Net billing with rolling credit and buyback	√	Yearly	Average wholesale	Yes	2	Italy	(RES, Legal, 2017)

A look at what's happening across SE-Asia

Malaysia

- **Self-consumption only scheme:** for PV rooftop, no size limit
- **Net metering program:** Started in Nov 2016
  - Limit of 100 MW/year during 2016-2020
  - Rooftop PV (residential < 72 kWp, commercial/industrial < 1 MWp)
  - Sell excess electricity at rate = displaced cost

Singapore

- **Self-consumption plus selling excess electricity scheme:**
  - Started in 2011, rooftop PV with no size limit (res. & commercial)
  - Sell excess electricity at market retail rate minus grid charge

Philippines

- **Net metering scheme:**
  - Started in 2013, rooftop PV, not >100 kW (res.& commercial)
  - Excess electricity rate= blended generation cost (half of retail rate)

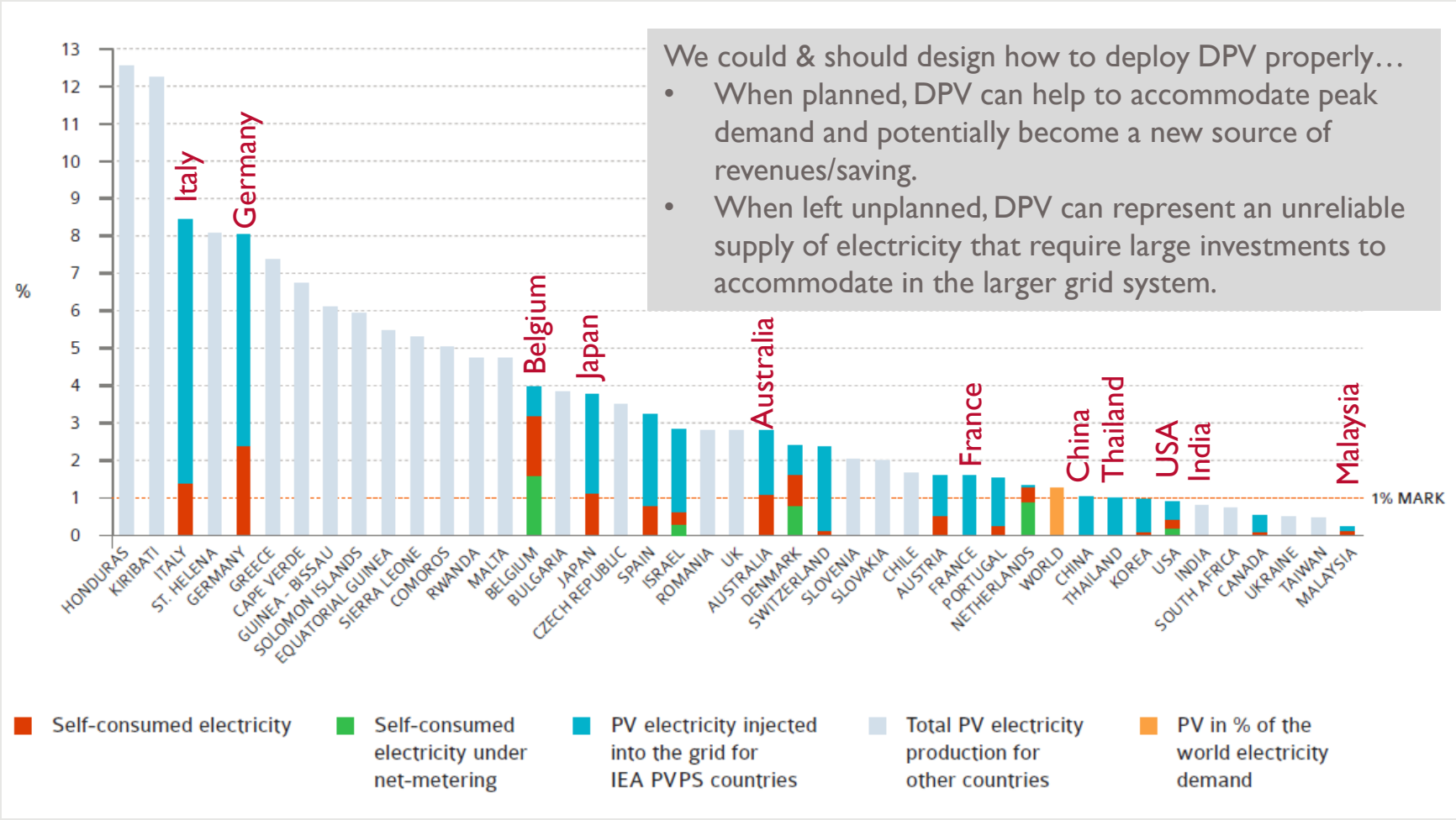
Thailand

- **Self-consumption only scheme** (100 MW pilot started in 2016)
- Only rooftop PV (0-10 kW for residential, 1MW limit for commercial/industrial)

Vietnam

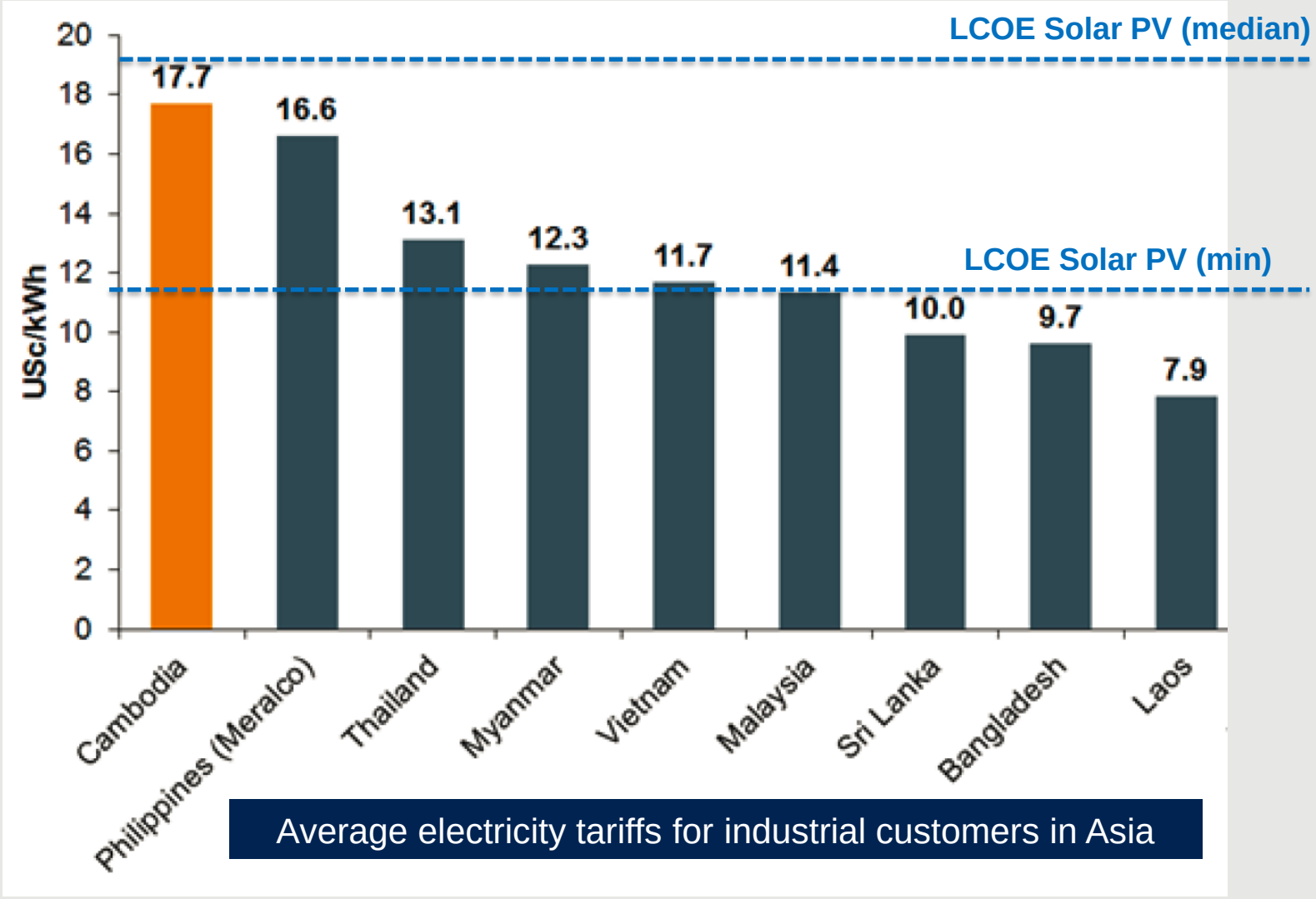
- **Net metering scheme** (Pilot in Ho Chi Minh started in 2015)
  - Only rooftop PV (residential, commercial, & govt. building)

PV penetration rate across the world



Source: IEA PVPS

Cost of solar power becoming more competitive to industrial electricity tariff



Source: Cambodia-In depth Study on Electricity cost and supplies (2015), LCOE of selected renewable technologies in the ASEAN Member states (2016) and team analysis

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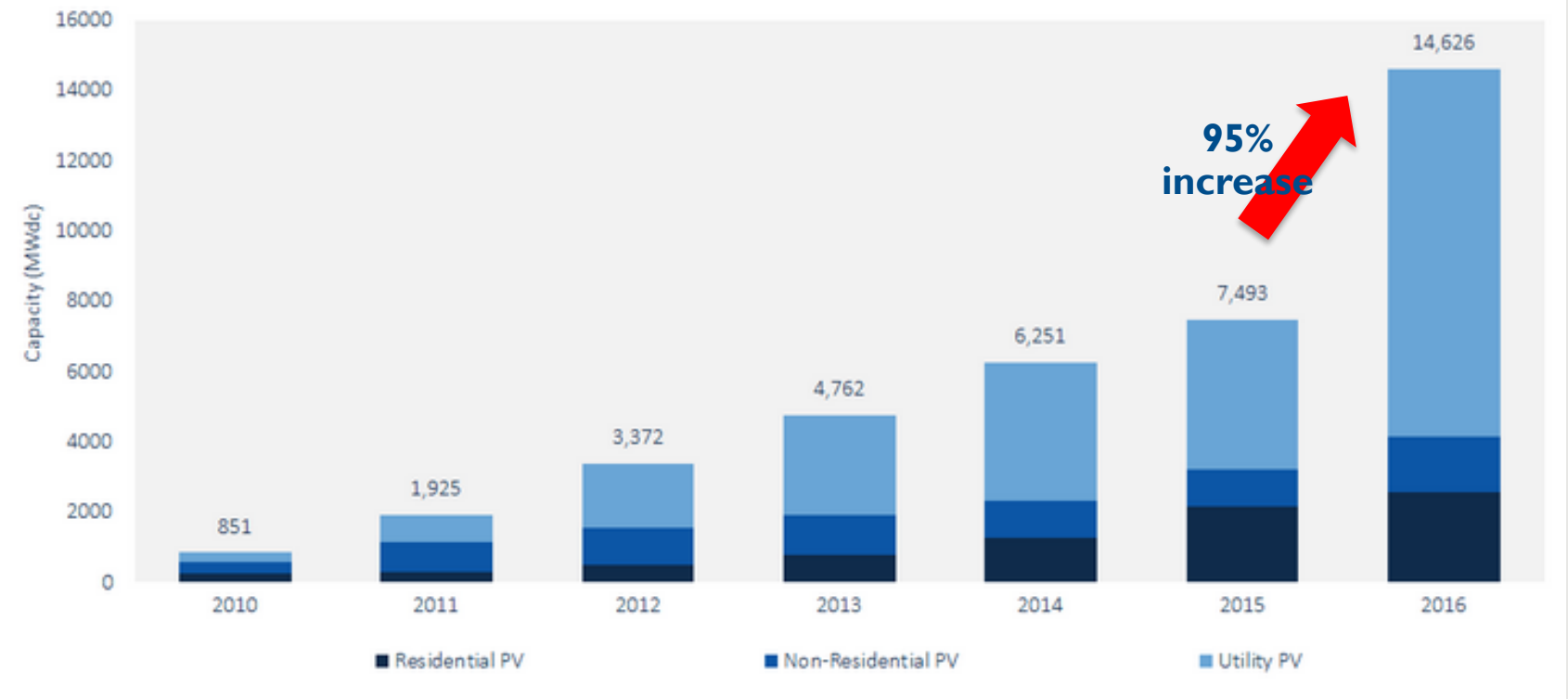
U.S. Experience

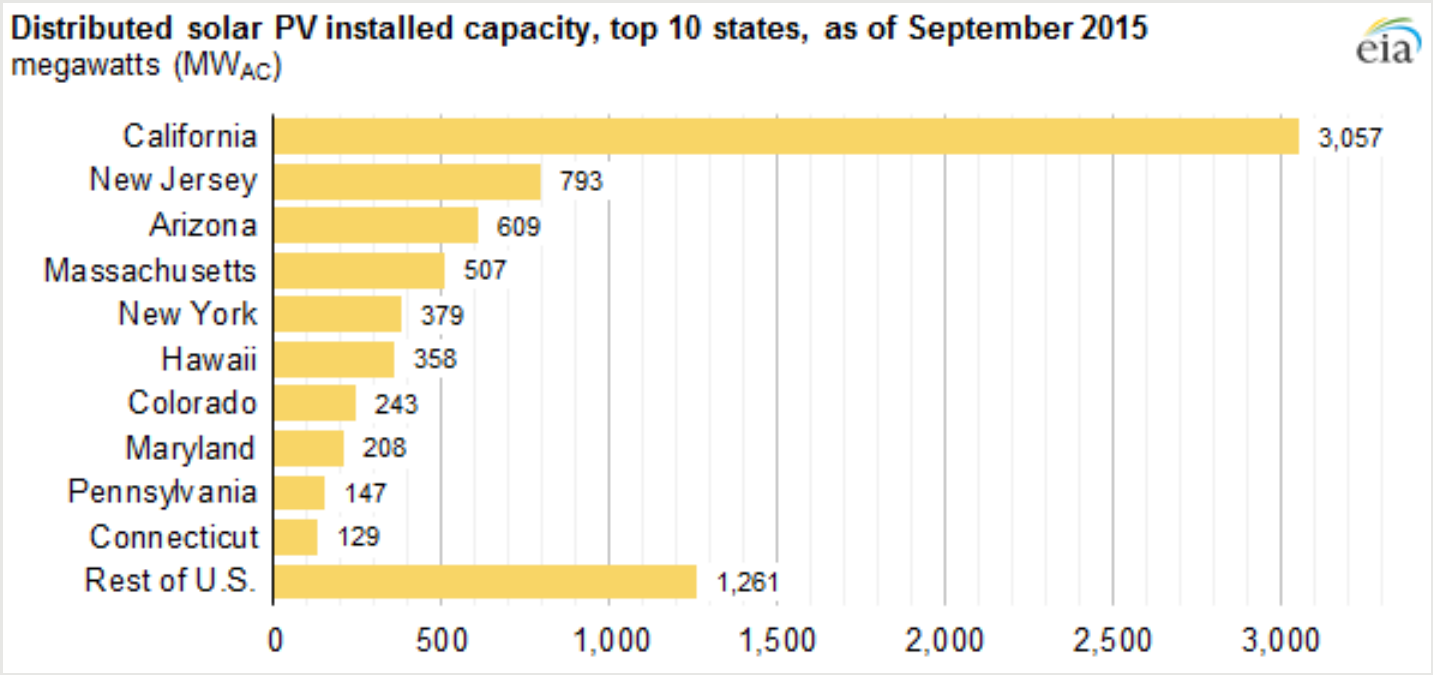
U.S. Annual Solar PV installations by market segment



- 2016 was a historic year :
  - ✓ The U.S. nearly doubled their annual solar installed capacity by adding 14,626 MW of solar
  - ✓ For the first time ever, solar electricity was the No. 1 source of new electric generating capacity additions on an annual basis

Source: GTM Research & SEIA. "U.S. Solar Market Insight:." March 2017

U.S. Distributed Solar PV Installed Capacity



Source: EIA (2015)

- In 2016, California had over 500,000 rooftop solar arrays, representing nearly half of the distributed PV solar capacity in the U.S
- Note: Definition of distributed PV in the U.S. < 1 MW (EIA, 2015)

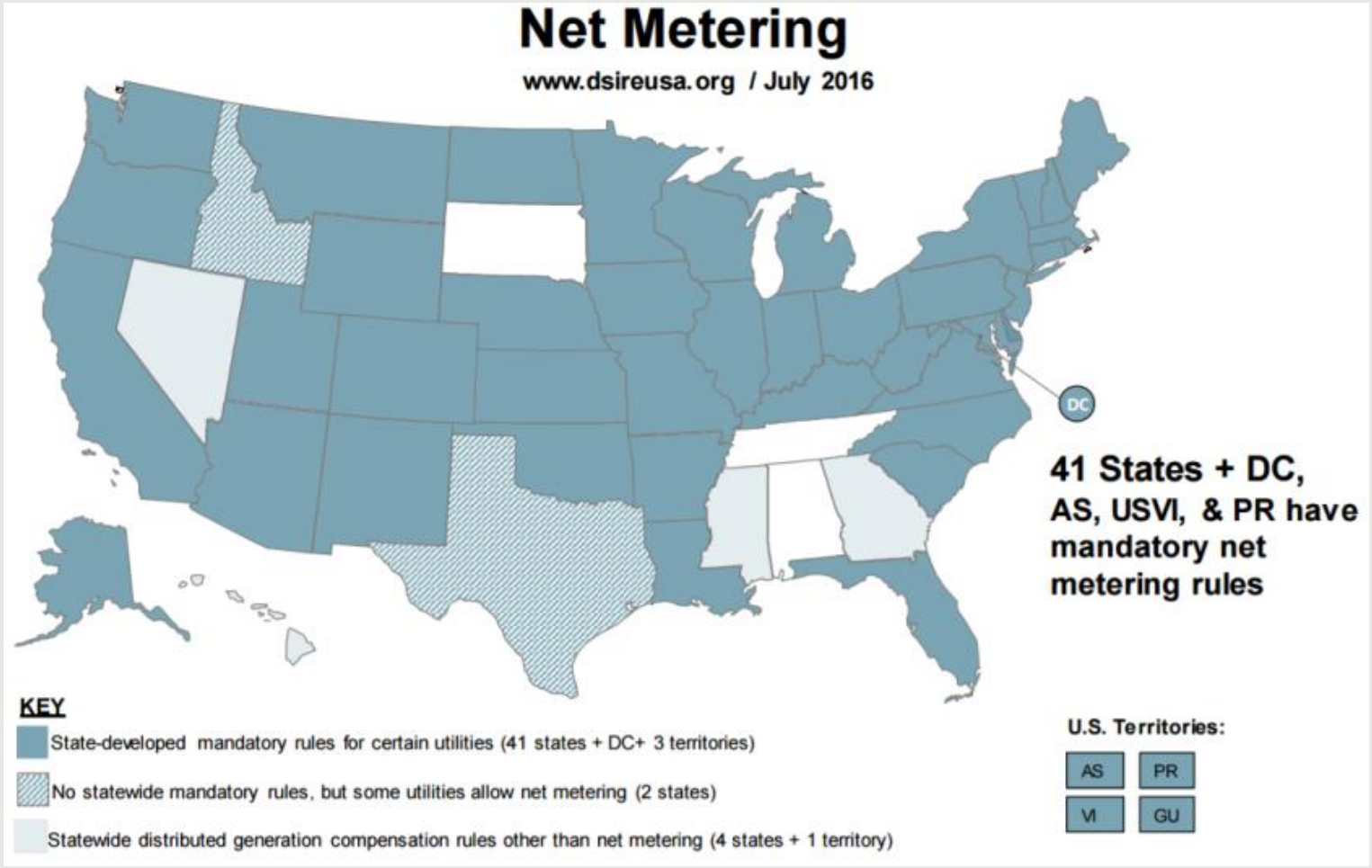
Source: http://www.nrel.gov/docs/fy15osti/62371.pdf

What drives U.S. solar market growth?

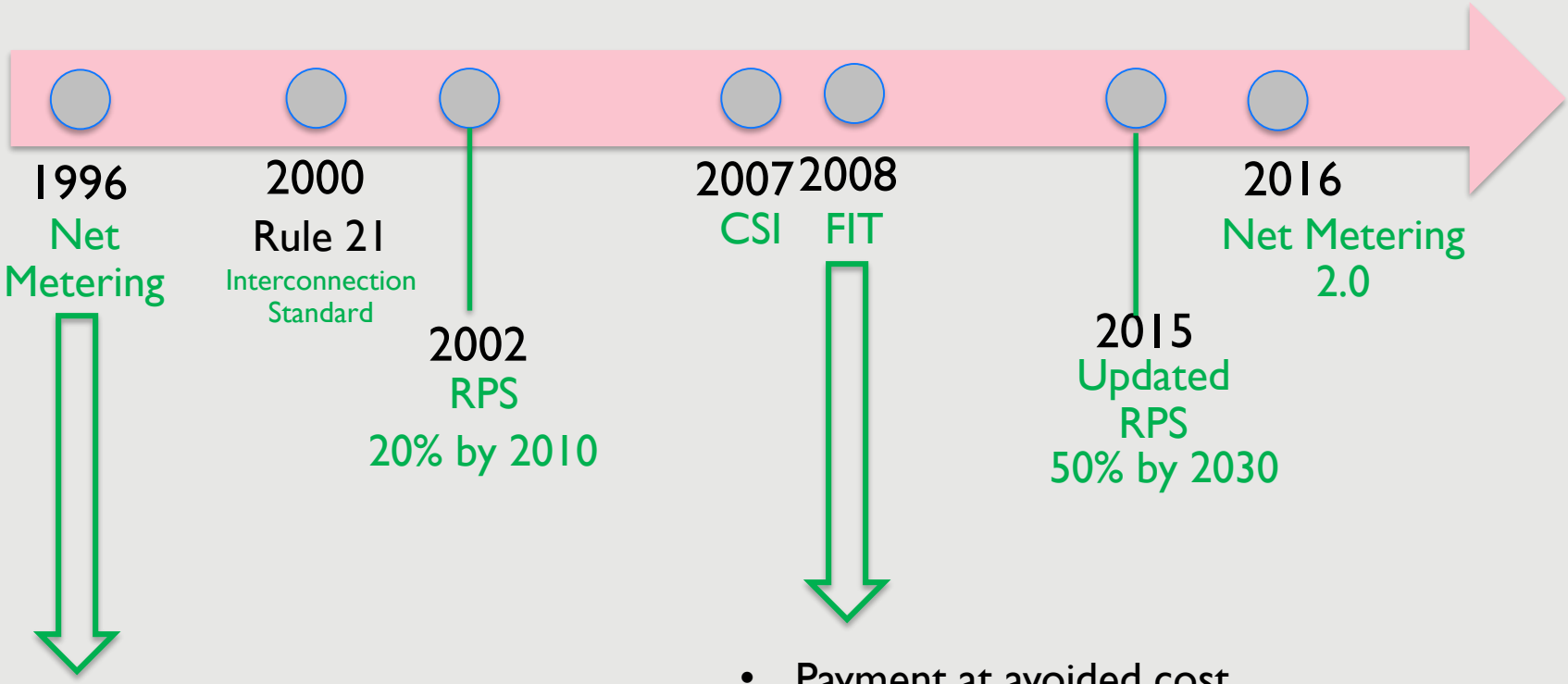
- Presence of federal and state support policies.
  - Federal: Production tax credit, investment tax credit
  - State: net metering, rebates, interconnection standards
- Renewables Portfolio Standards: require suppliers to acquire a share of their power from RE, including solar power (distributed and utility-scale solar)
- High electricity prices in some states (Hawaii, New York)
- Third-party ownership model:
  - Solar leasing
  - Solar PPA

U.S. state-level distributed solar polices: Net metering

Net metering has been the primary distributed solar compensation mechanism used in the United States



California's Policy Related to Distributed PV



- System sized up to 1 MW
- Credits excess PV electricity at full retail rate by allowing rolling credits
- At the end of 12-month banking period, payment

- Payment at avoided cost
- 10, 15, or 20 yrs contract
- Sized up to 1.5 MW (later increased to 3 MW)

California: Lessons Learned on Net-Metering

- **Net Metering (NEM) and Interconnection**

What works:

- An enabling law
- Uniform interconnection procedures reduce ambiguity and uncertainty
- High electricity prices for upper tier customers combined with net metering created potent DG adoption driver
- NEM enabled later DG specific-incentive programs like the California Solar Initiative

What didn't work:

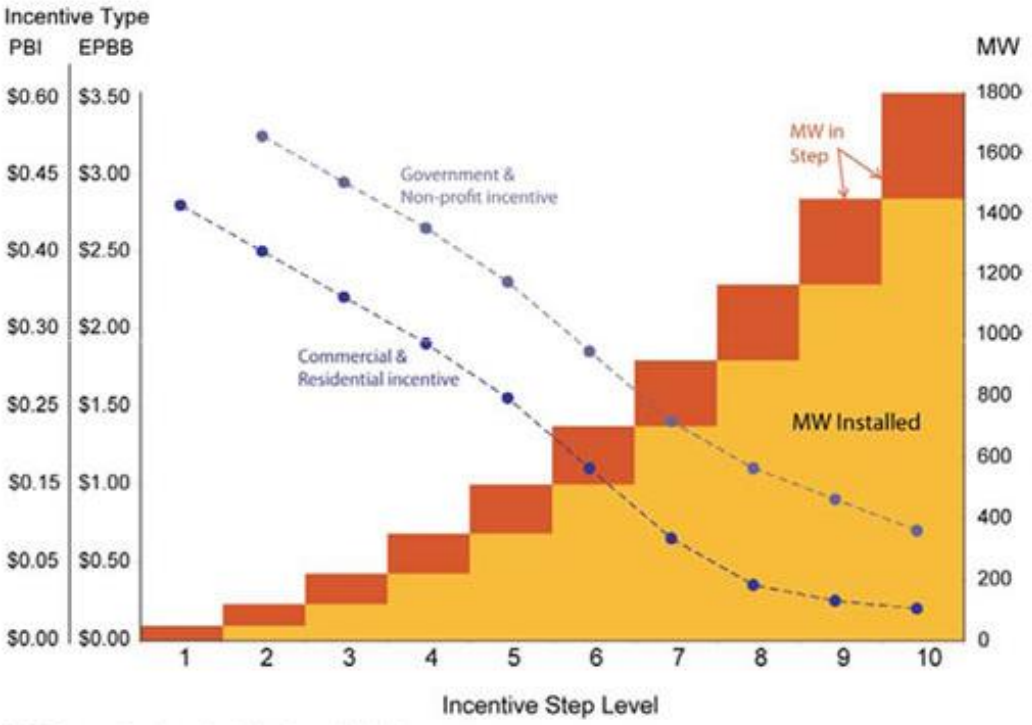
- Lack of monitoring in the early stages

- Increasing concerns on cross-subsidization
- Rate reform toward Net Metering 2.0

California: Lessons learned on CSI

What works:

1) Up-front commitment to fully fund the ten-year effort @ $3.35 billion for 10 years
2) Structured incentive decline over time provided clear market signal to reduce costs
3) Rebate ($/W) is based on performance of system, as opposed to nameplate capacity



Source: Go Solar California (2017)

California: Lessons Learned on Feed-in Tariff

What has not work:

- The price is not right: as of July 2016, only 6 US cents/kWh for solar
  - Based on the costs of building and operating a combined-cycle natural gas power plant
  - must be high enough to drive deployment
  - should be based on cost of generation+profit
- FIT program cap and system size should be high enough to take advantage of economies of scale

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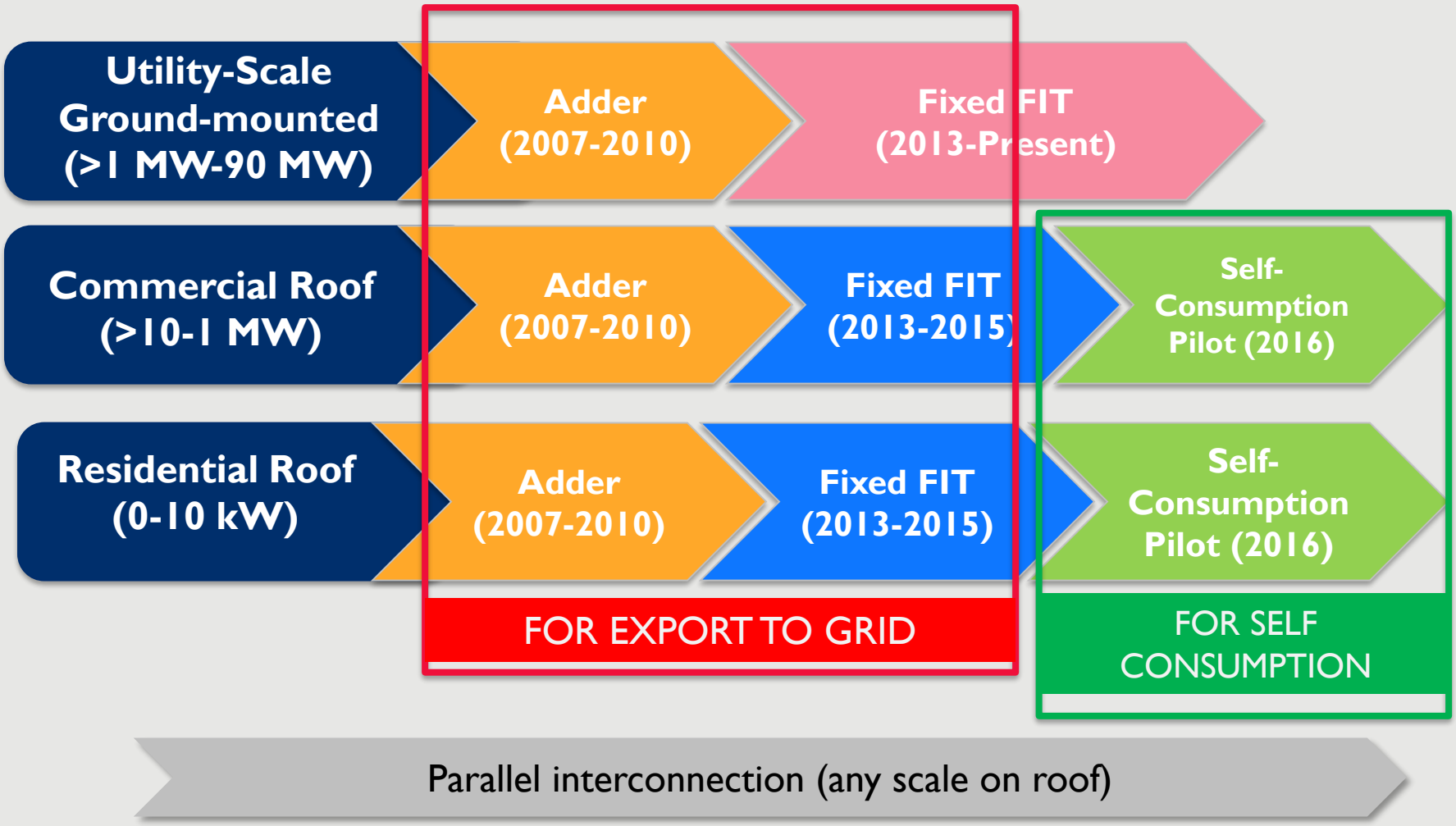
Thailand Experience

Thailand: Market segments for solar PV



Note: Adder is a premium rate paid on top of electricity users' wholesale electricity rate for electricity power generated from renewable energy resources. Fixed FIT is a fixed rate paid for each kWh of RE electricity generated.

Thailand: Market segments for solar PV

330 KW solar farm and roof at TESCO, Chonburi, 2011
(Credit: Thai Solar Future)

7.5 MW solar farm at Nakon Pathom, 2012
(Credit: Sonnedix)

Credit: Solar D, 2015

15 MW (total), Thammasat Univ.
(Credit: Solartron, 2016)

Compensation mechanism: How it evolved

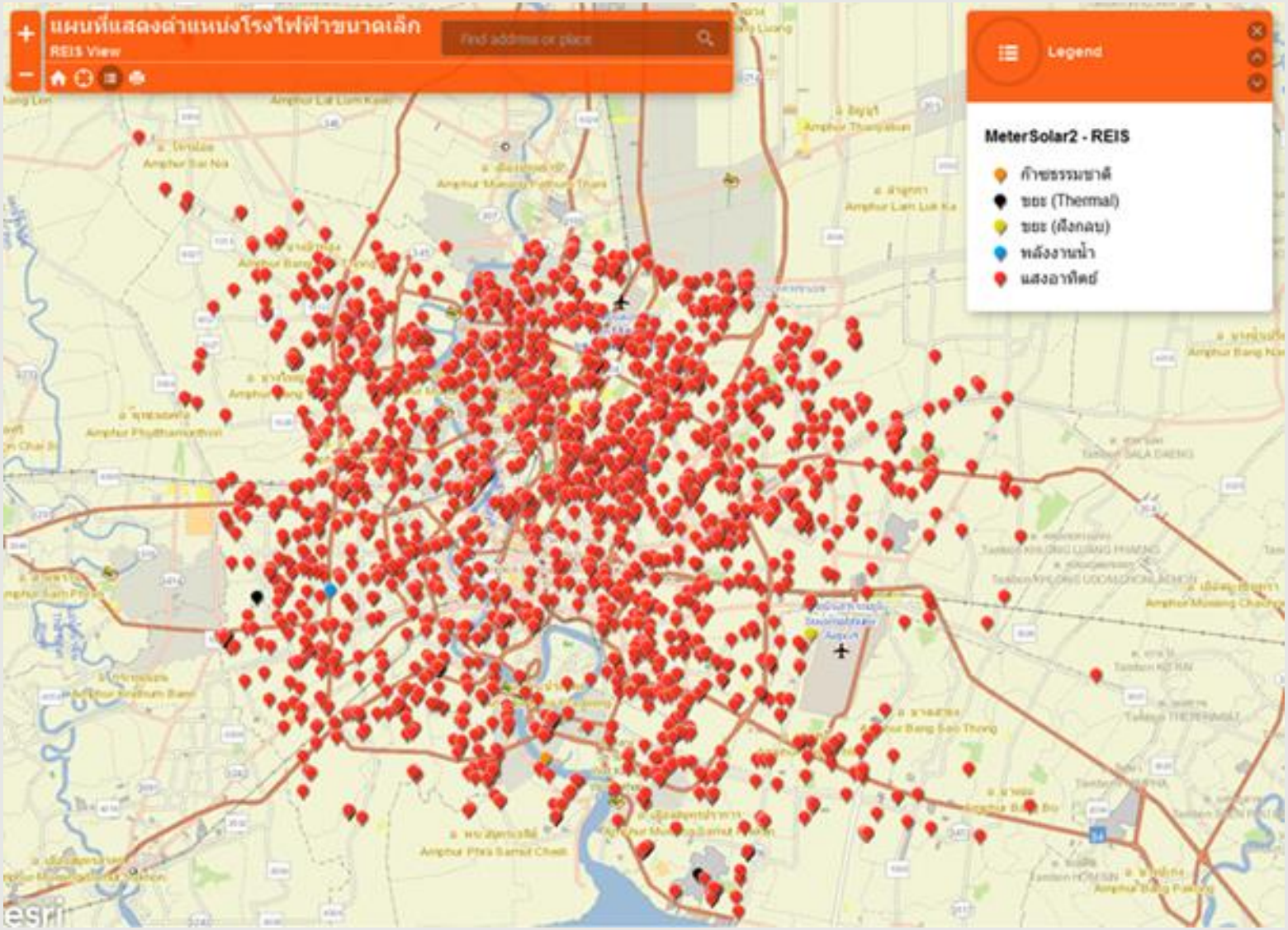
ROOFTOP FIT

- FIT program for rooftop PV launched in 2013 (Phase 1) and 2015 (Phase 2). Program assigned FIT rates for three scales of installations, as shown in this table:

Installed Capacity	Phase 1 FiT (THB/kWh)	Phase 2 FiT (THB/kWh)
Residential rooftop (0-10 kW)	6.96 THB/kWh (0.198 $USD/kWh)	6.85 THB/kWh (0.195 $USD/kWh)
Commercial rooftop (10-250 kW)	6.55 THB/kWh (0.187 $USD/kWh)	6.40 THB/kWh (0.183 $USD/kWh)
Commercial rooftop (250-1000 kW)	6.16 THB/kWh) (0.176 $USD/kWh)	6.01 THB/kWh (0.171 $USD/kWh)

- For each project, rooftop PV FIT rate would be applied for 25 years.
- PV electricity under this program was for export only.
- Rooftop PV FIT program resulted in 130 MW of rooftop PV systems, out of the 200 MW target.
- Program now closed. Due to retail grid parity, government now prefers to support rooftop PV for self-consumption only and not for export.

Results of rooftop FIT (2013-2015)

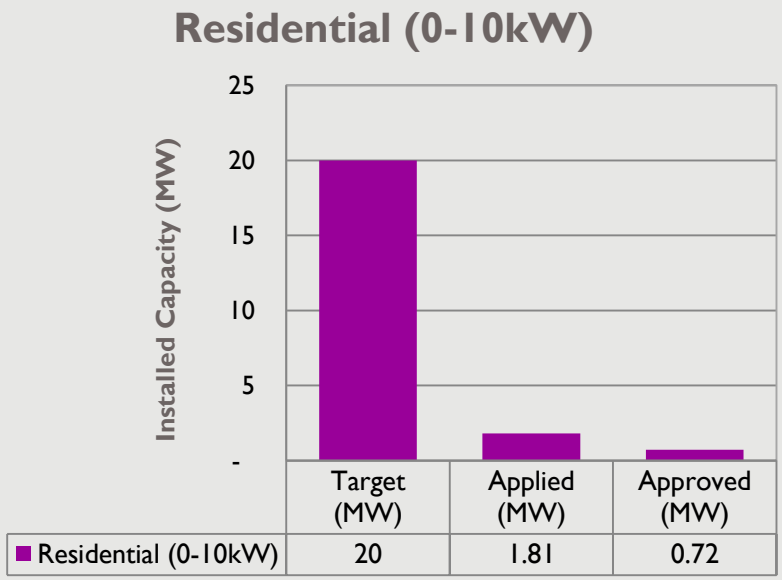


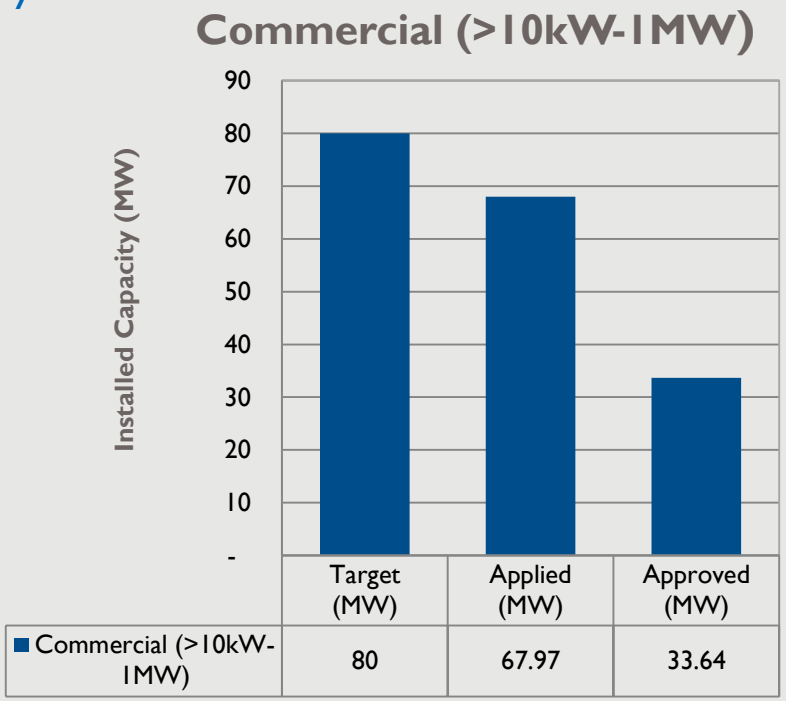
Rooftop PV (2,160 projects, 51 MW) in Bangkok and neighboring provinces (MEA service area)

Compensation mechanism: How it evolved

Rooftop PV Pilot for Self-Consumption

- Rooftop PV pilot launched in September 2016 for total quota of 100 MW.
- PV electricity serves load onsite first; excess electricity will flow to grid without compensation.
  - Each project under this pilot signs a 5-year contract with the utility, subject to renewal after the utility approves technical audit at the end of the 5th year.
  - The application process for the pilot is now closed. The government is considering a compensation scheme for excess electricity for 2017.





Thailand: Comparison of DPV support schemes

	Fixed FIT	Projects Parallel to Distribution System	Self-Consumption Rooftop Solar PILOT	Future Self-Consumption Scheme for Rooftop Solar
System wide quota	200 MW	None	100 MW	TBD
Contract period	25 years	5 years with audit before renewal	5 years with audit before renewal	TBD
Compensation scheme	THB/kWh for all PV electricity	None	None	TBD
Allow reverse power flow to the grid?	Yes	No	Yes	Yes
Individual system cap	Yes	No cap	Yes	TBD
Transformer cap	Yes	No cap	Yes	TBD

Future outlook for defining PV self-consumption schemes

			Being Considered in Thailand?
PV self-consumption	1	Right to self-consume	Yes (in draft RE law)
	2	Revenues from self-consumed PV	Yes (in savings)
	3	Charges to finance T&D	No
Excess PV electricity	4	Revenues from excess electricity	Yes
	5	Maximum timeframe for compensation	Yes
	6	Geographical compensation	Yes
Other system characteristics	7	Regulatory scheme duration	Yes
	8	Third party ownership accepted	Being proposed
	9	Grid codes and additional taxes/fees	Yes
	10	Other enablers of self-consumption	Yes (tax incentives, loans, leasing)
	11	PV Systems Size Limitations	Yes (in grid code)
	12	Electricity System Limitations	Yes (in quota and grid code)
	13	Additional features	

Source: Framework adapted from IEA (2016)

Thailand: Lessons learned

ROOFTOP FIT

WHAT WORKED:

- Different FIT rates for different scales of installations
- FIT rates were set based on cost of generation+ reasonable return
- Program quota stimulated quick subscription
- Standardized grid code

ROOFTOP FIT

WHAT DID NOT WORK:

- Lack of policy revision timeline
- Complicated permitting process in the beginning (but later resolved)

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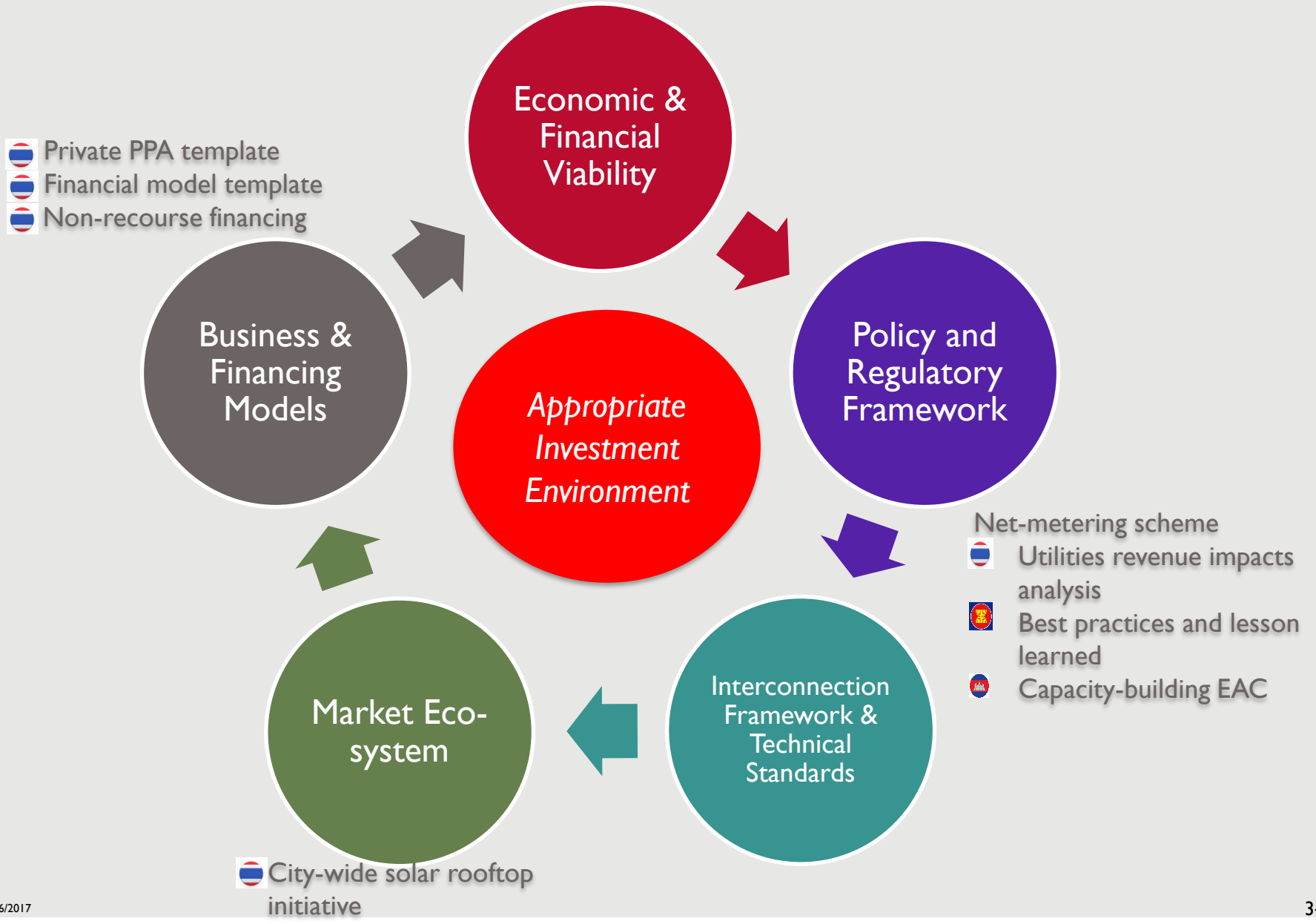
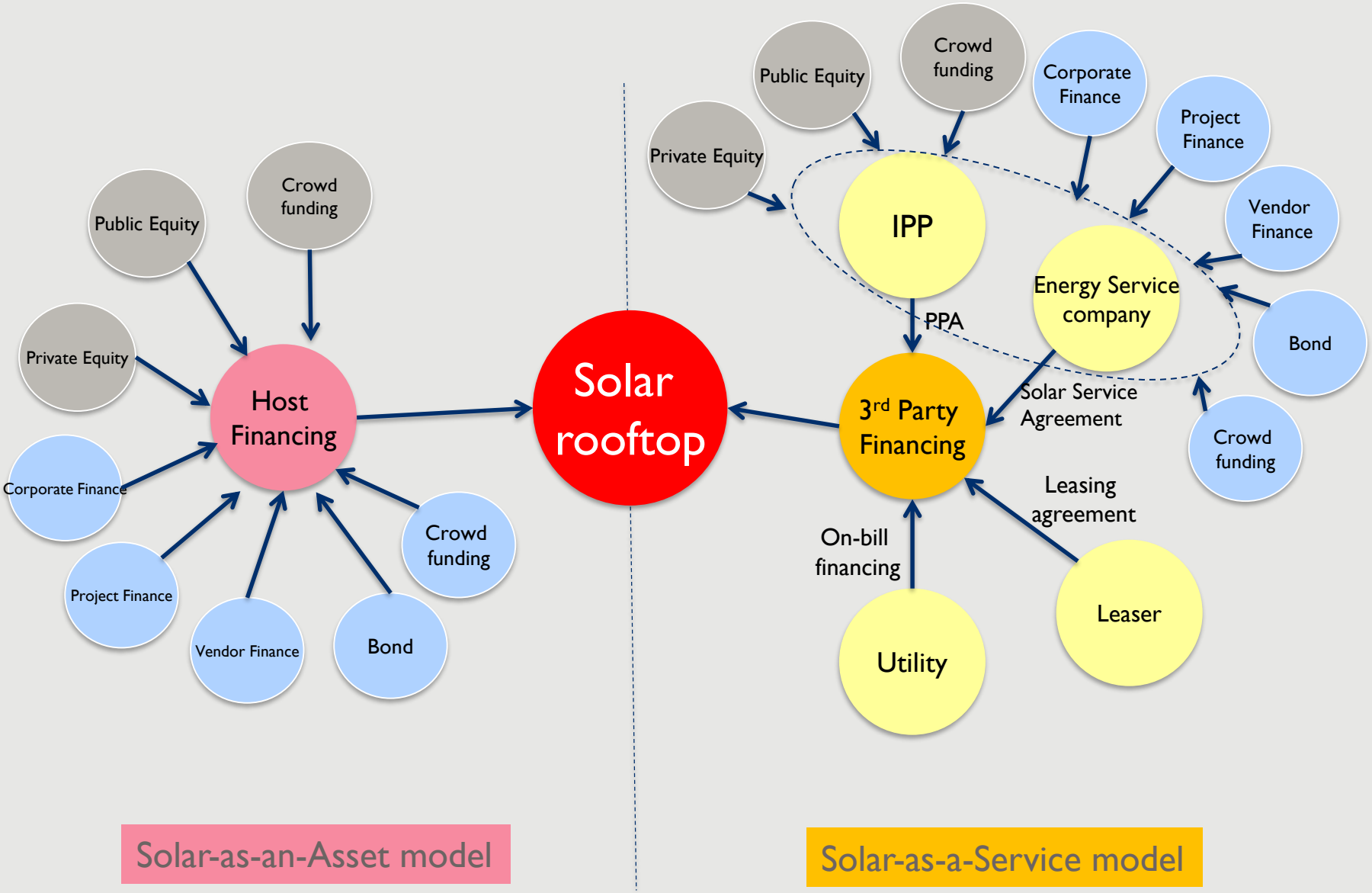
USAID Clean Power Asia work on DPV deployment

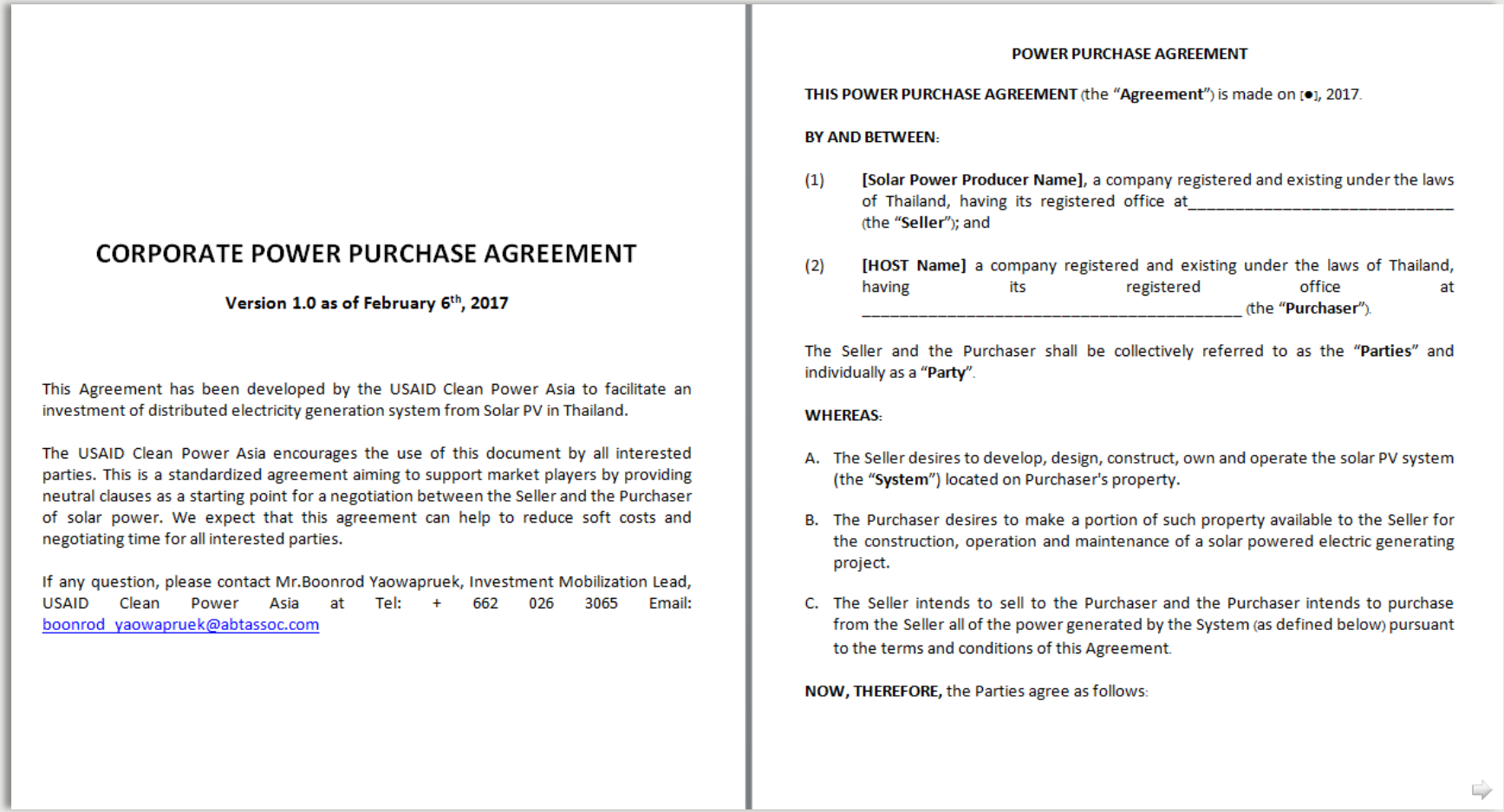
Scaling up solar rooftop deployment



Landscape of solar PV rooftop financing



Corporate Power Purchase Agreement*



CORPORATE POWER PURCHASE AGREEMENT

Version 1.0 as of February 6th, 2017

This Agreement has been developed by the USAID Clean Power Asia to facilitate an investment of distributed electricity generation system from Solar PV in Thailand.

The 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 power. We expect that this agreement can help to reduce soft costs and negotiating time for all interested parties.

If any question, please contact Mr.Boonrod Yaowapruek, Investment Mobilization Lead, USAID Clean Power Asia at Tel: + 662 026 3065 Email: boonrod_yaowapruek@abtassoc.com

POWER PURCHASE AGREEMENT

THIS POWER PURCHASE AGREEMENT (the "**Agreement**") is made on [●], 2017.

BY AND BETWEEN:

(1) **[Solar Power Producer Name]**, a company registered and existing under the laws of Thailand, having its registered office at_____ (the "**Seller**"); and

(2) **[HOST Name]** a company registered and existing under the laws of Thailand, having its registered office at _____ (the "**Purchaser**").

The Seller and the Purchaser shall be collectively referred to as the "**Parties**" and individually as a "**Party**".

WHEREAS:

A. The Seller desires to develop, design, construct, own and operate the solar PV system (the "**System**") located on Purchaser's property.

B. The Purchaser desires to make a portion of such property available to the Seller for the construction, operation and maintenance of a solar powered electric generating project.

C. The Seller intends to sell to the Purchaser and the Purchaser intends to purchase from the Seller all of the power generated by the System (as defined below) pursuant to the terms and conditions of this Agreement.

NOW, THEREFORE, the Parties agree as follows:

The quality of power purchase agreement (PPA) / leasing agreement / service agreement is crucial. Risks shall be allocated properly among all parties to create bankable contract.

*USAID Clean Power Asia is developing a standard template for corporate power purchase agreement (cPPA). Interested parties can contact us for more info and receive the template (boonrod_yaowapruek@abtassoc.com).

Facilitate city-wide initiative for solar rooftop deployment

Regulations

- **Introduce regulations based on legal attributions of cities** via building codes, permitting procedures, solar ordinances, grid connection regulations, technical standards, public housing, local taxation, etc.
- **Enable households and businesses to purchase solar power** through obligations on energy suppliers, or by aggregating electricity demand

Financing

- **Facilitate low-interest and long-term loans**
- **Provide flexible financing solutions** to repay investments (e.g. through energy bills)
- **Leverage financial resources** through mechanisms to de-risk investment
- **Issue municipal green bonds** and create funds to support municipal solar PV investments

Advocacy and facilitation

- Influence the behavioral choices of citizens by **raising awareness** about benefits of solar PV through public information and education campaigns, stakeholder consultations, demonstration projects, voluntary agreements, etc.
- **Disseminate relevant information** to individuals and companies such as potential mapping, open data portals, etc.
- **Promote knowledge sharing** among various stakeholders, and strengthen local capacities and skills through dedicated training programs on solar PV.

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