

# Thailand's Feed-in Tariffs for Solar Power: Calculation, Impacts, and Future Directions

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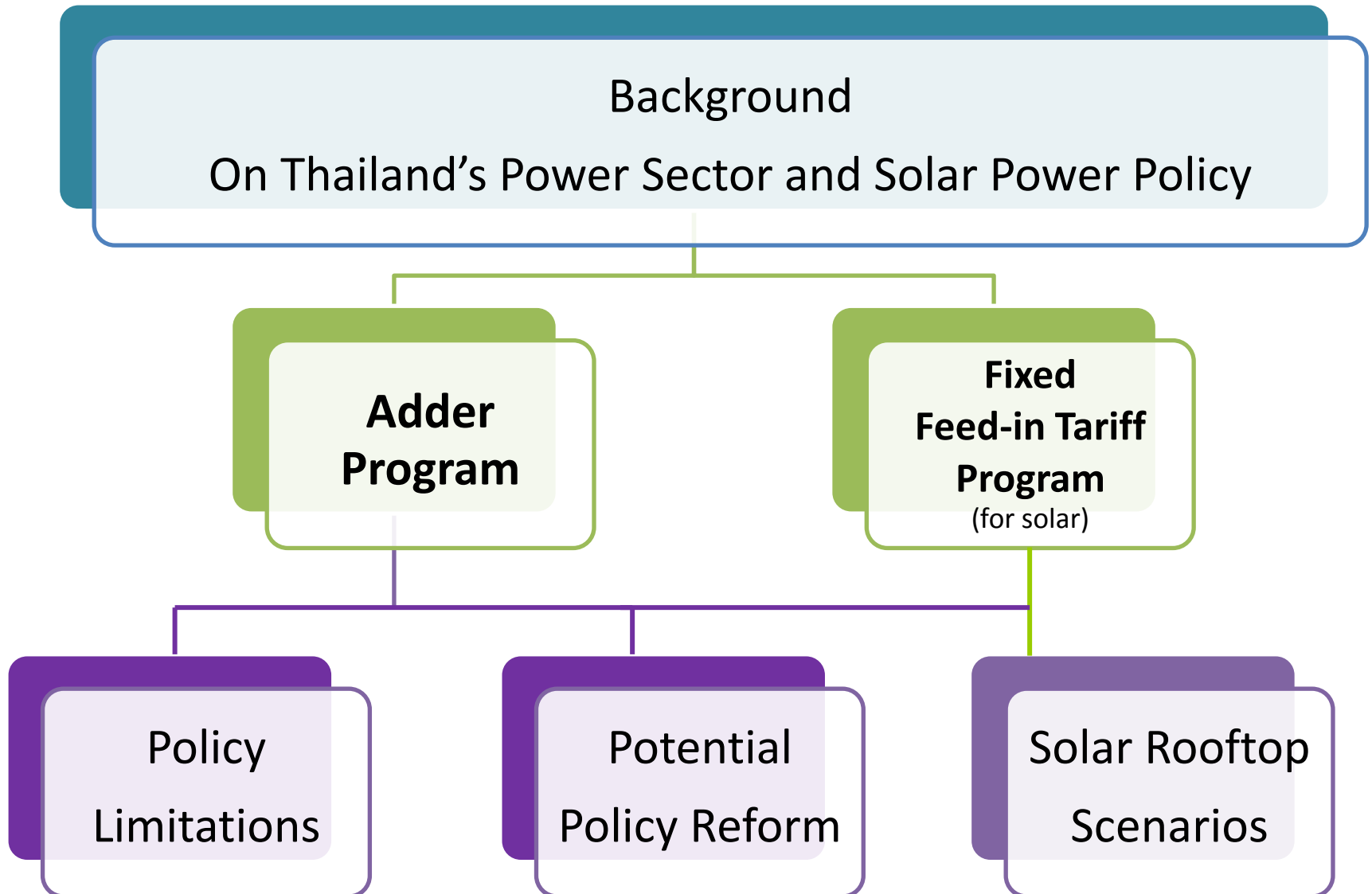
Energy Research Institute, Chulalongkorn University

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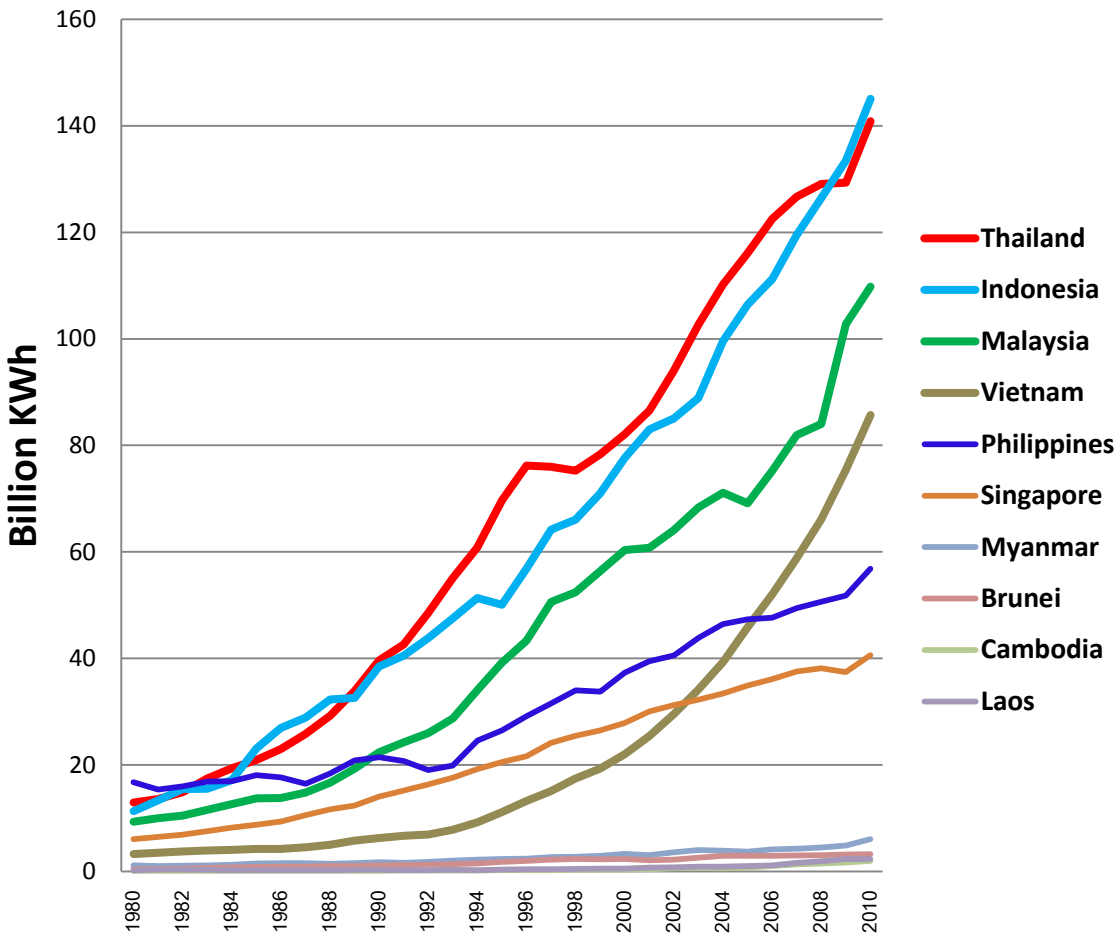
# Overview



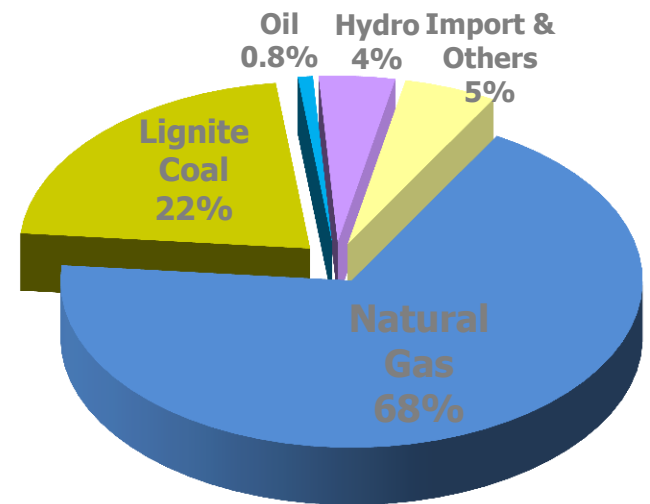
# Thailand's Power Sector

High Growth in Power Consumption; Limited Resources

**Total Electricity Net Consumption  
(Billion Kilowatt-Hours)**



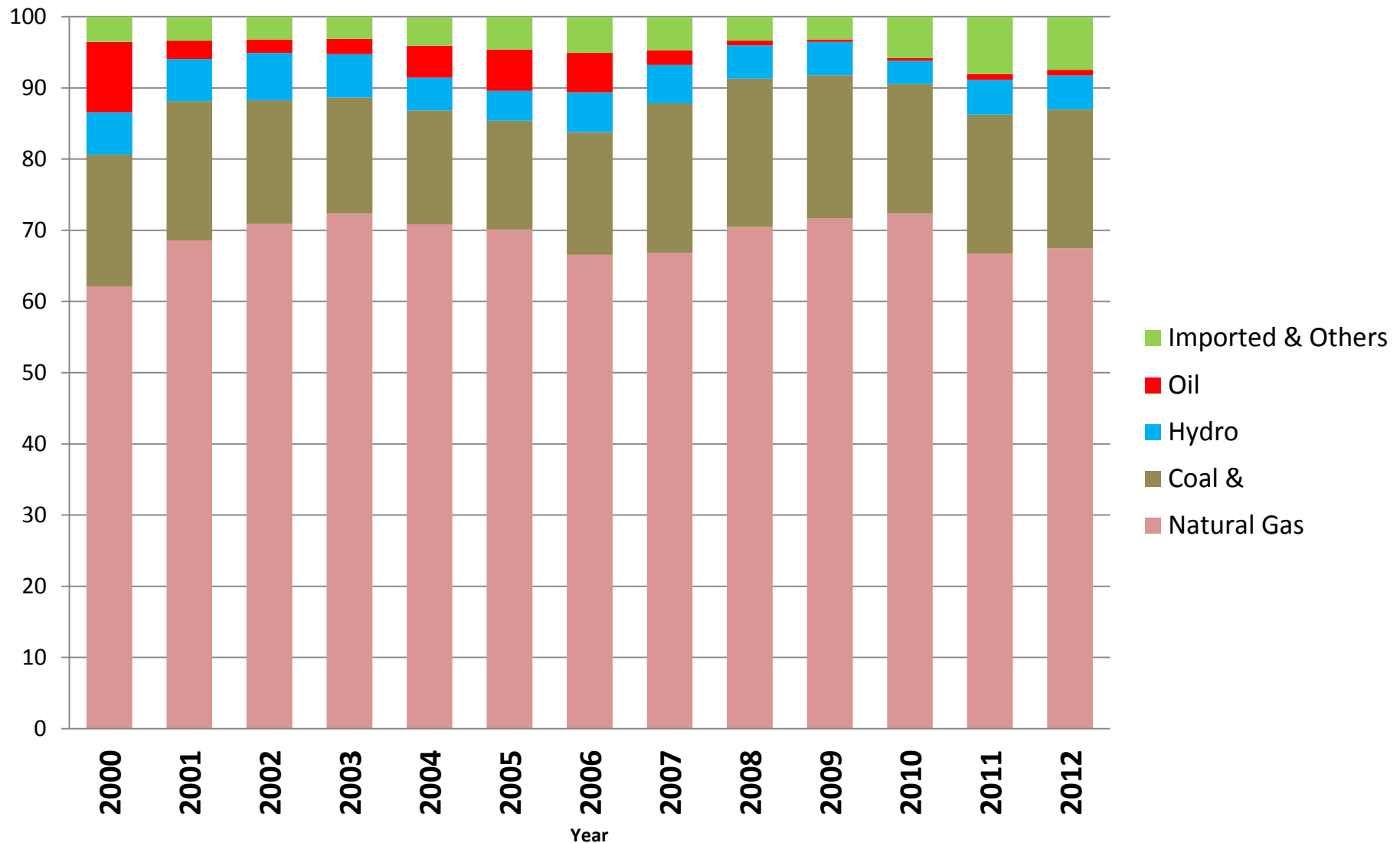
Source: EIA (2013)



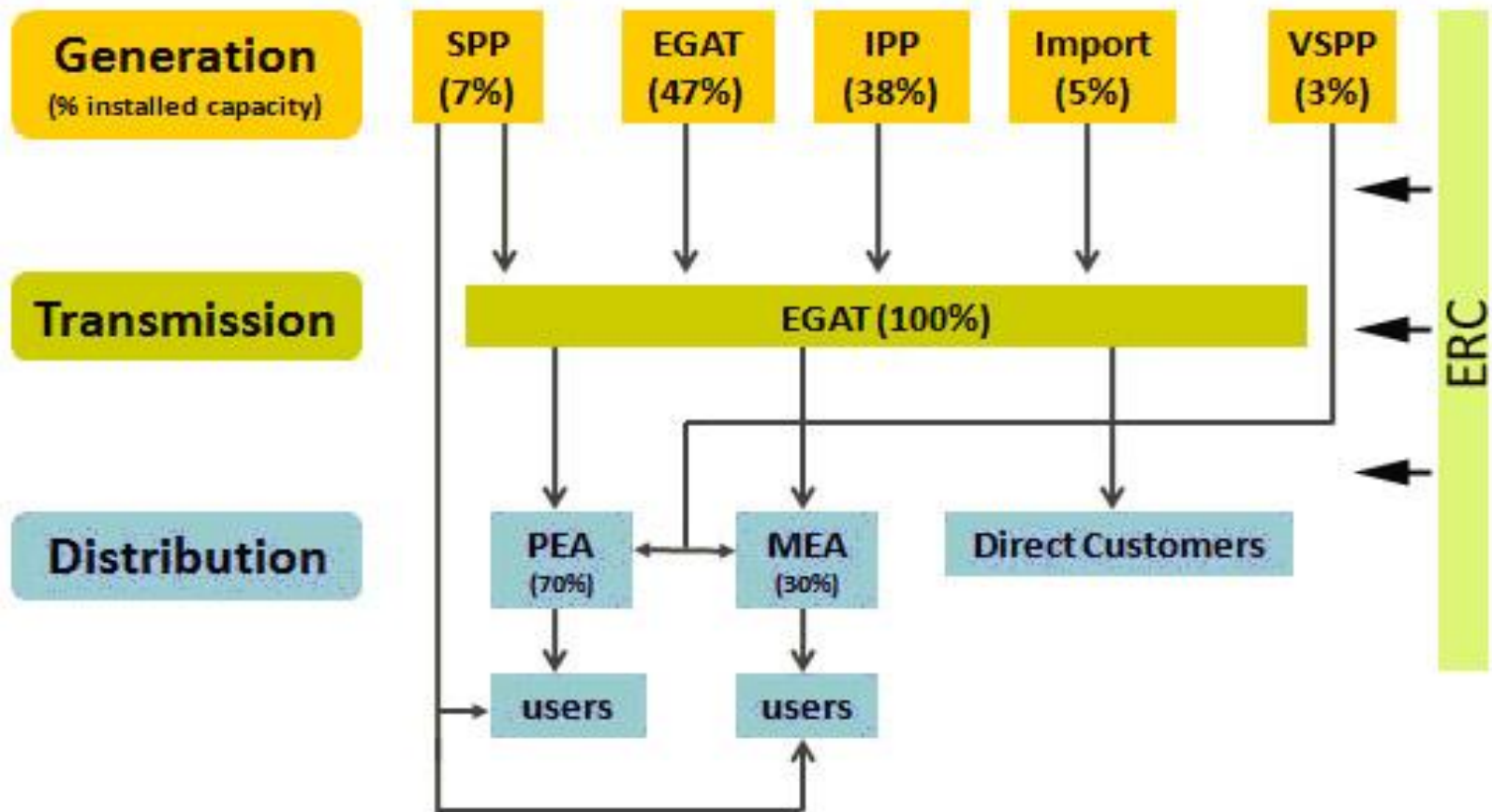
Source: EPPO (2013)  
based on Jan-Feb 2013 generation data

# Fuel Share in Thailand's Power Production(2000-2012)

(percent)



# Thailand Power Industry Structure

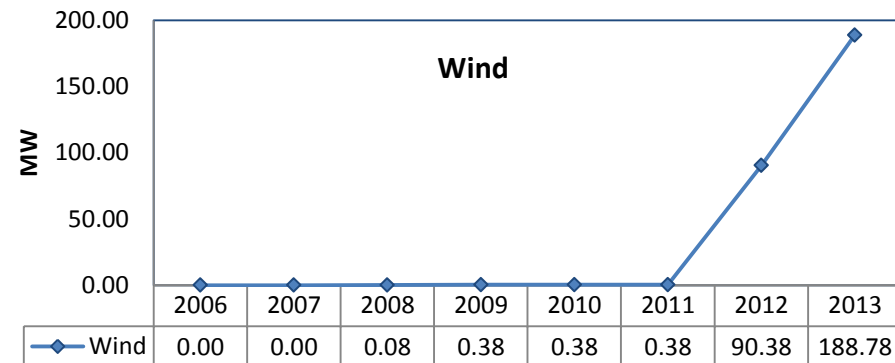
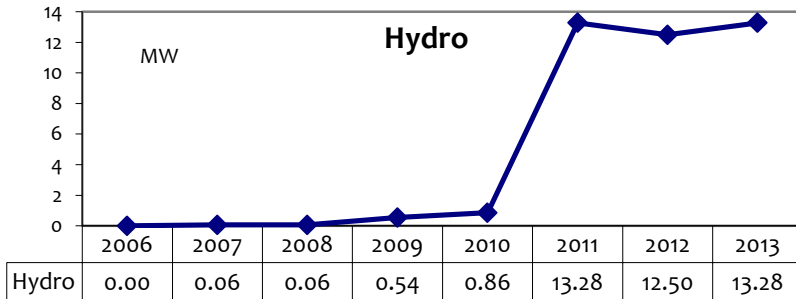
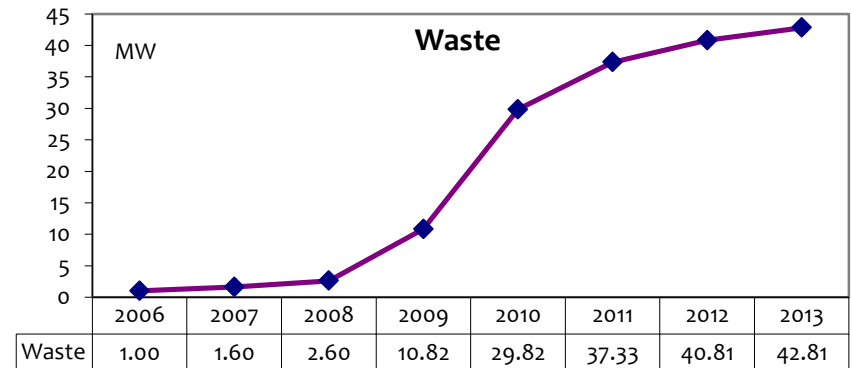
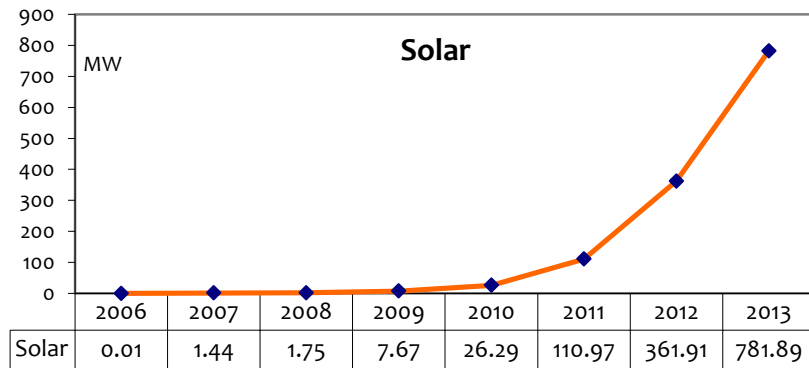
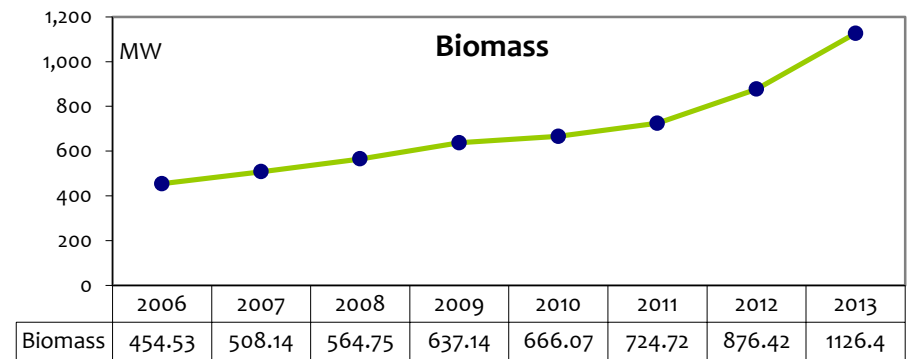
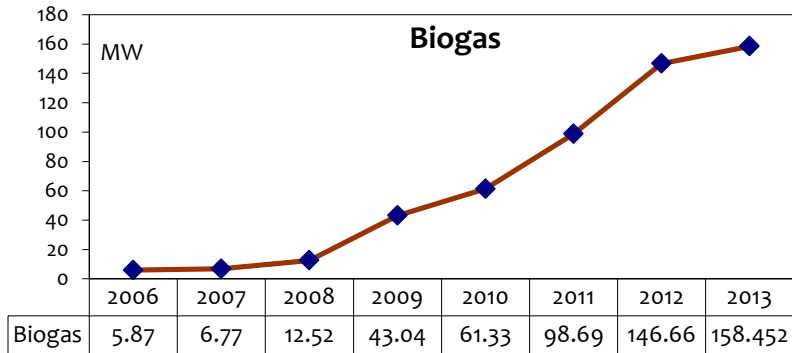


Source: Tongsopit and Greacen (2013)

# Thailand's Alternative Energy Development Plan (AEDP 2012-2021)

Type of RE	REDP (2008-2022) (MW)	AEDP (2012-2021) Targets (MW)	AEDP updated targets (MW)
<b>Solar</b>	500	2,000	3,000
<b>Wind</b>	800	1,200	1,800
<b>Hydro</b>	324	1,608	324
<b>Biomass</b>	3,700	3,630	4,800
<b>Biogas</b>	120	600	3,600
<b>MSW</b>	160	160	400
<b>Hydrogen</b>	3.5	0	1
<b>Geothermal</b>	-	1	1
<b>Tidal</b>	-	2	1
<b>Total</b>	5,608	9,201	13,927

# Trends in RE Power Growth: before & after ADDER

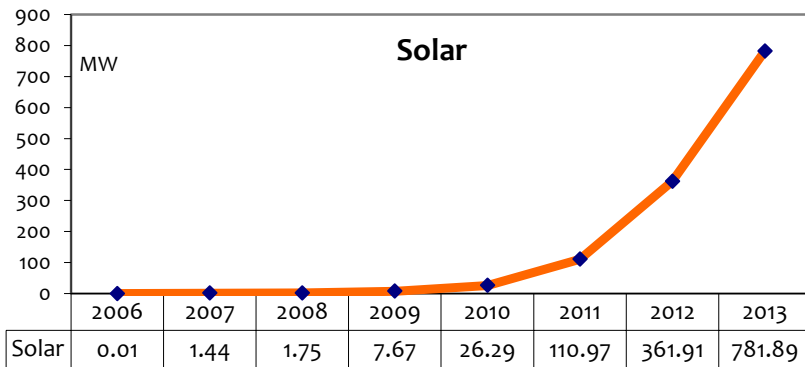


# THAILAND'S ADDER RATES

Type of RE	Unit: US Dollars per kWh					Years Supported
	2007 Adder Rate	2009 Adder Rate	2010 Adder Rate	Special Adder for Diesel Replacem ent	Special Adder for Three Southern most Provinces	
Biomass						
Installed Capacity ≤ 1 MW	0.010	0.017	0.017	0.033	0.033	7
Installed Capacity > 1 MW	0.010	0.010	0.010	0.033	0.033	7
Biogas						
Installed Capacity ≤ 1 MW	0.010	0.017	0.017	0.033	0.033	7
Installed Capacity > 1 MW	0.010	0.010	0.010	0.033	0.033	7
Waste						
Landfill and Digestor	0.083	0.083	0.083	0.033	0.033	7
Thermal Process	0.083	0.117	0.117	0.033	0.033	7
Wind						
Installed Capacity ≤ 50 kW	0.117	0.150	0.150	0.050	0.050	10
Installed Capacity > 50 kW	0.117	0.117	0.117	0.050	0.050	10
Small/Micro Hydro						
50 kW <Installed Capacity < 200 kW	0.013	0.027	0.027	0.033	0.033	7
Installed Capacity ≤ 50 kW	0.027	0.050	0.050	0.033	0.033	7
Solar	0.267	0.267	0.217*	0.050	0.050	10

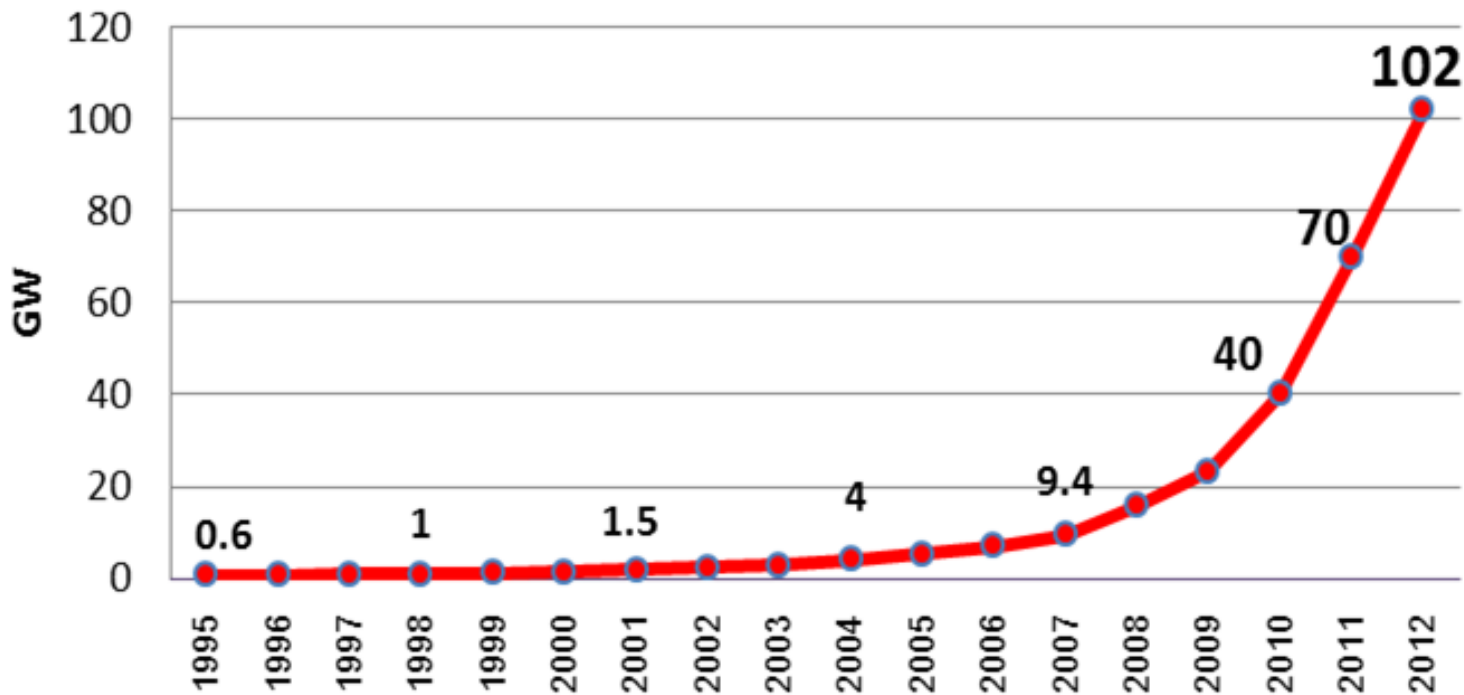


## Thailand's Solar PV Installed Capacity (2006-2013), MW



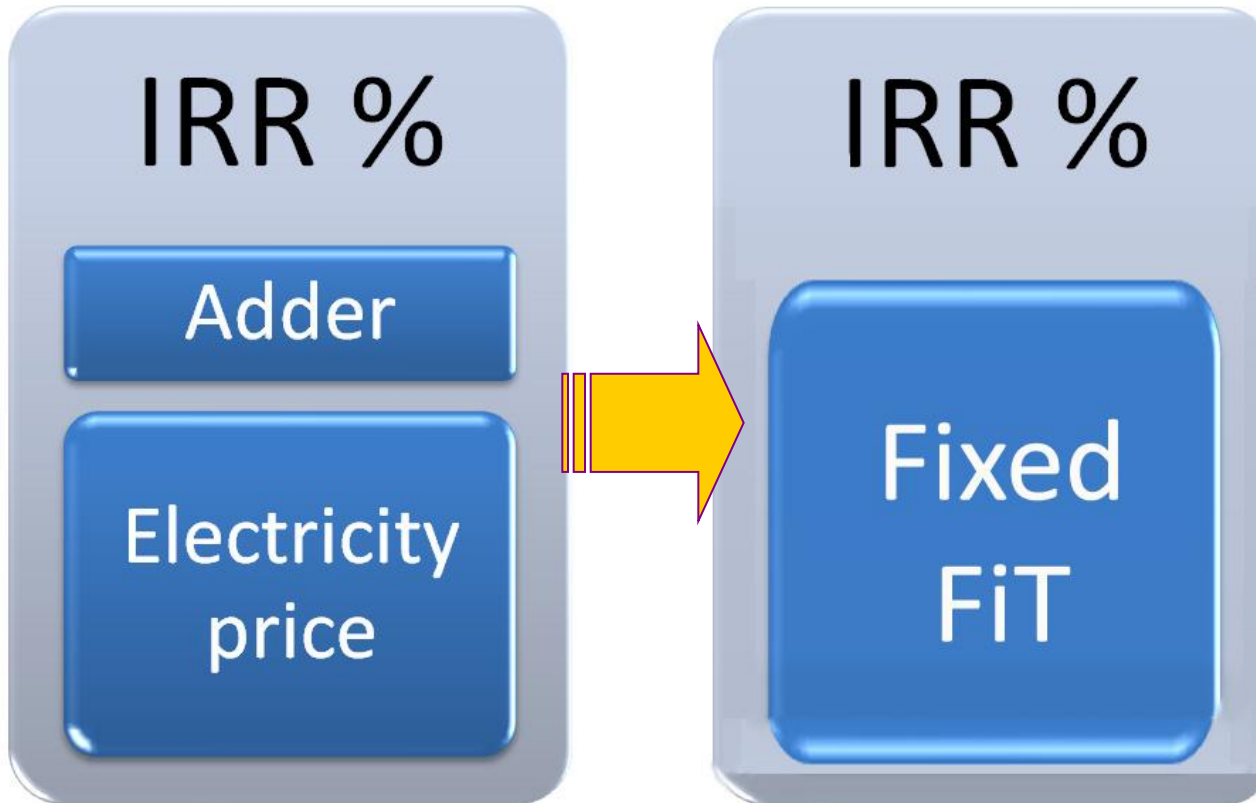
Source: SPP and VSPP database (2013)

## Global Solar PV Installed Capacity (1995-2013), GW



Source: REN21 (2012) for 1995-2011 data and Shahan (2013) for 2012 data

There are two types of feed-in tariffs in Thailand,  
distinguished by the rate structure



**Premium-price FiT:**

- \*Total tariff rate varies with Ft+base tariff
- \*increases over time
- \*As of 2014, available for 5 types of RE:  
*biomass, biogas, waste, wind, small/microhydro*

**Fixed-price FiT:**

- \*Tariff rate independent of wholesale/retail grid tariffs
- \*Constant over a fixed period of time
- \*Policy framework approved in June 2010
- \*July 2013: First Fixed FiT rates for Solar

## *Thailand's Solar Adder Program*

*Thailand was one of the first Asian countries to implement a feed-in tariff (FiTs) program*

- Streamlined interconnection regulations and avoided-cost tariffs adopted by the Thai Cabinet in 2002.
- Technology-specific renewable energy premium tariffs in 2006.
- **Adder** is additional payment to RE generators on top of the normal prices that power producers would receive when selling electricity to the power utilities.

# Thailand's Adder program

## *Basic Features of Thailand's Adder Program*

○ Eligibility	<ul style="list-style-type: none"><li>➤ VSPP (0-10 MW)</li><li>➤ SPP (10-90 MW)</li></ul>
○ Rate Structure	Premium-price FiT (paid on top of wholesale cost)
○ Rates	<ul style="list-style-type: none"><li>➤ Differ by technology &amp; scale</li><li>➤ No depression</li></ul>
○ Cost control mechanism: Cap and Deadline	<ul style="list-style-type: none"><li>➤ 2008 Deadline lifted in March 2009</li><li>➤ Except for solar, all other types of RE are accepted until an acceptable level of rate impact is reached.</li></ul>
○ Approval Process and Criteria	<ul style="list-style-type: none"><li>➤ Screened by utilities and approved by Management Committee</li><li>➤ Approval Criteria: feeder MW cap</li></ul>
○ Contract Term	➤ 5 years with automatic renewal
○ Support Period	<ul style="list-style-type: none"><li>➤ 10 years for solar and wind;</li><li>➤ 7 years for biomass, biogas, MSW, small/micro hydro</li></ul>
○ Financing Mechanism	➤ Pass-through to ratepayers
○ Program Review	➤ Subject to ad hoc approval by NEPC

# Thailand's Adder program

## *How Adder Rates are Determined (1):*

Four fundamental approaches for determining FiT rates, based on:

- Actual levelized cost of electricity generation;
- The “value” of renewable energy generation, either to society or to the utility (the avoided cost of utility);
- Fixed price incentives that are unrelated to the actual levelized cost of electricity generation or the value of renewable energy generation; and
- the result of an auction or bidding process.

Thailand has used a combination of these approaches in determining the Adder rates.

# Thailand's Adder program

## *How Adder Rates are Determined (2):*

### Plant-specific Assumptions

Capacity	MW
Useful life	Years
Project Cost <ul style="list-style-type: none"><li>• machine &amp; equipment</li><li>• construction</li></ul>	\$
Construction Period	Years
Operating Hours <ul style="list-style-type: none"><li>• Peak period</li><li>• Off-peak period</li></ul>	% of total
Capacity Factor	%
O&M Cost <ul style="list-style-type: none"><li>• operating cost per year</li><li>• part replacement</li></ul>	\$/year \$
Other technology-specific assumptions (e.g., degrade factor for solar; cost of fuel supply per year for biomass, degression rate, etc.)	

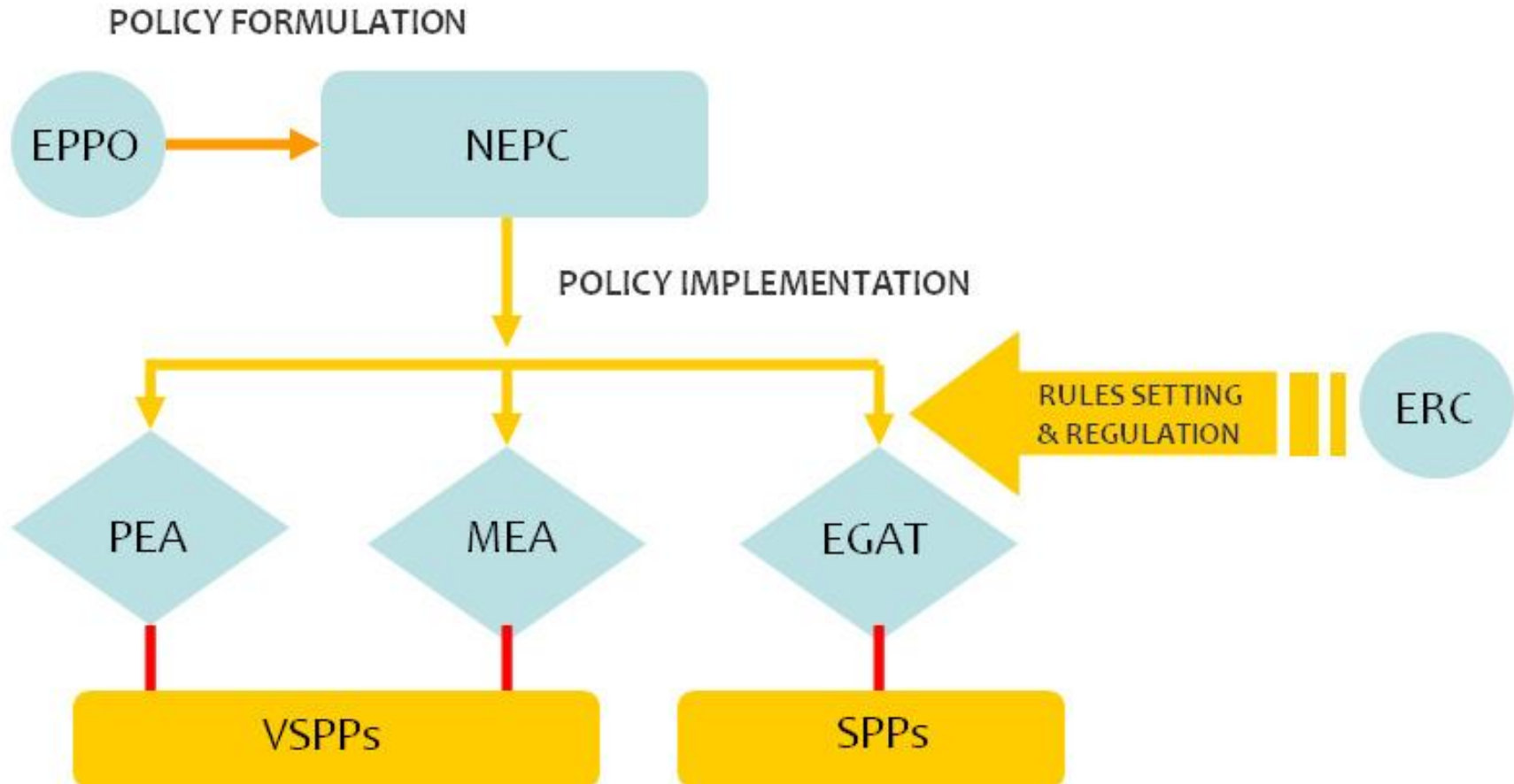
### Financial Assumptions

Interest Rate	%
Exchange Rate	%
Debt Leverage	%
Loan payback	Years
Tax privilege	details
CDM income	\$/year


### Reasonable IRRs

# Adder (FiT) Policy Process

## *Policy, Implementation, and Rules Setting*



# *The Evolution of Thailand's Adder Program (1)*

1992-2009:  laying the foundation for the ADDER

**1992**

- Regulations for Power Purchase from SPPs (10-90 MW) approved → EGAT was allowed to purchase power from SPPs using non-conventional energy (RE & Cogeneration) as fuel.

**2002**

- VSPP Regulations drafted, based on net-metering regulation in the U.S., approved by Cabinet, **applicable to generation sized <1MW.**
- Applicable to renewable and co-generation facilities
- up to 1 MW** contracted capacity
- Tariffs set at avoided cost (wholesale or retail tariff + Ft)

**2006**

- contracted capacity of VSPP extended from 1 MW to 10 MW
- Feed-inTariffs ("ADDER") program approved by Cabinet

**2007**


- ADDER program implemented by utilities
- ADDER rate bidding for biomass SPPs, 7 biomass projects chosen
- ADDER rates for wind power projects increased and support period for wind & solar projects extended from 7 to 10 years
- ADDER rates for three southernmost provinces introduced

**2009**

- ADDER rates adjusted to encourage smaller-scale installations and diesel offsets
- Some rules and regulations adjusted (bid bond, dispatch, and rooftop solar)



## *The Evolution of Thailand's Adder Program (2)*

- 2010-2012:**  ADDER Program Reviewed and Revised
- Solar application acceptance temporarily closed
  - Policy to focus solar FiTs on rooftop systems only
  - Post-approval regulations become more stringent for all technologies
- 2010**
- Rate structure to be changed from adder to fixed feed-in-tariff
  - “Managing Committee” established to coordinate, regulate the program and approve projects
- 

- 2011-2012**
- The study of fixed feed-in tariffs for all technologies in process

## *The Evolution of Thailand's Adder Program (3)*

### **2013:** **Brief Market Opening for Rooftop Solar, Community Solar**

- Additional targets for solar power = 1,000 MW

  - (200 MW rooftop solar + 800 MW community solar)

**2013**

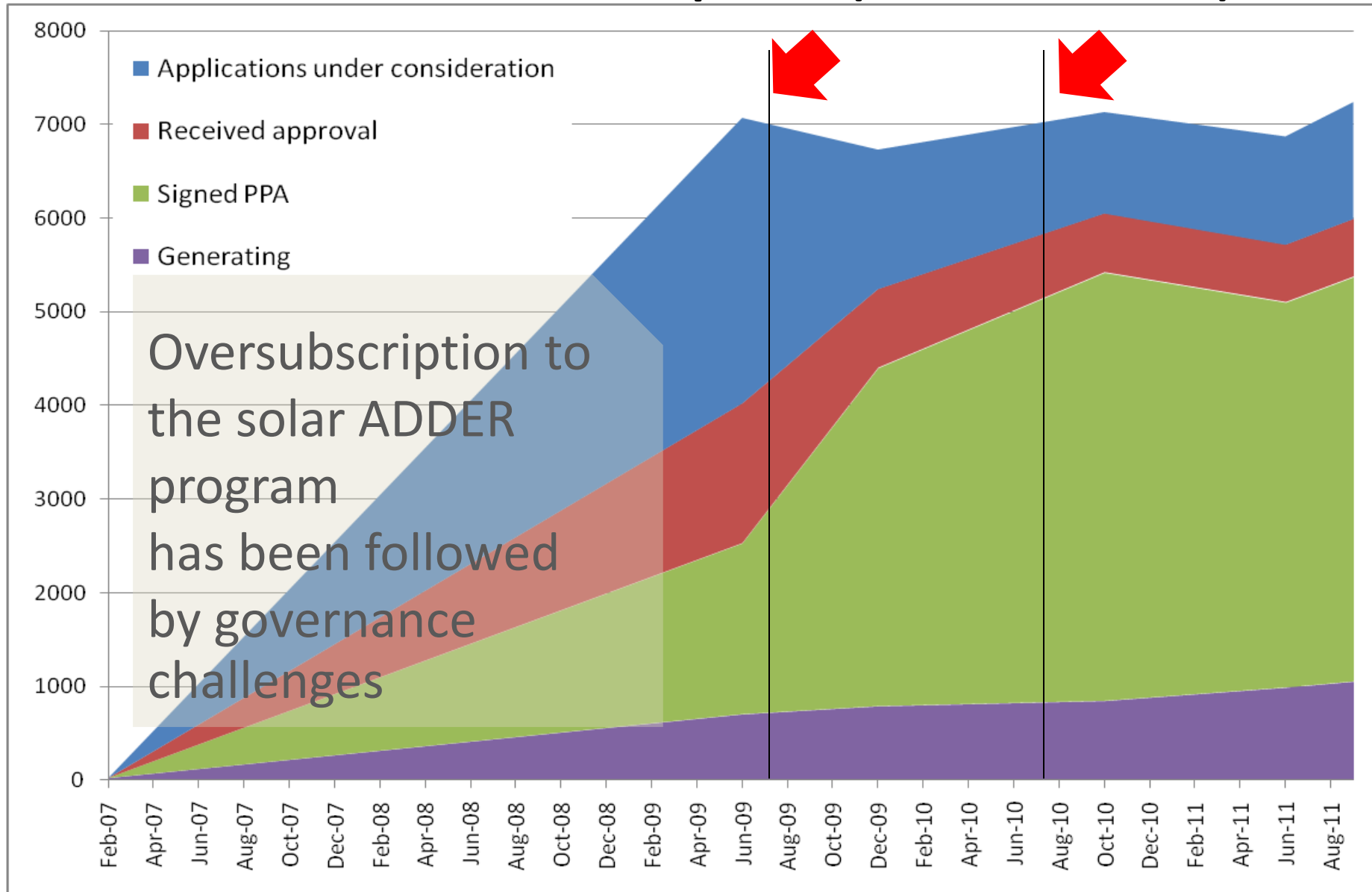
- New FiT Rates released for rooftop & community solar

- Application process was opened briefly between Oct-Nov 2013 for rooftop solar FiT

- More stringent regulation reflects learning past lessons

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# Trend of MW in the Pipeline (All Renewables)



“Healthy Pipeline?”

# Thailand's Solar Adder program: Strengths

## Attractive Rates

- High enough to attract investment
- However, no depreciation led to windfall profits

## Rate Structure

- Simple and easy for investors to integrate into investment plans.
- Special rates for the three southernmost provinces and remote areas with diesel generation

## Enforceable Contracts

- guaranteed payment period for 10 years
- Utilities have good track record of honoring contracts

## Uniform Interconnection Standards

- Standardized interconnection through grid code

# Thailand's Solar Adder program: Challenges

## Lack of a Unified Energy Plan

- Major energy policies are not integrated into a coherent framework
- Solar support faces high policy uncertainty:
  - interruption of support between 2010-2013
  - Brief market opening between Oct-Nov 2013

## Weak Regulatory Framework

- 2007-2010 Frequent rule changing in response to problems as they arise; rule changing and implementation were ad hoc and non-transparent
- 2013 improved rooftop solar regulation BUT still complicated permitting process
- Lack of effective monitoring and evaluation

## Economic/Financial

- Thai solar market is directly shaped by global market forces, including surplus inventories from manufacturing countries
- A need to study the value added to the Thai economy

## Social and Environmental

- Justification of the adder cost to ratepayers
- Potential environmental impacts of modules disposal
- Land Use

# Recent Development for Thailand's Solar Power Policy:

## *July 2013's FiT for Solar Power*

*July 16, 2013: NEPC approved two policy packages, which reopens support of solar power in Thailand and increased the total government target from 2,000 to 3,000 MW.*

### 1) Rooftop solar FiT for three scales of installations:

Scale	FiT Rate (Baht/kWh)	Quota
0-10kW	6.96	100 MW
>10-250 kW	6.55	100 MW
>250 kW-1 MW	6.16	

The total quota: **200 MW**. All projects must be installed by **December 2013**.

The system owners will get paid for 25 years.

The administrator of the program will be the Energy Regulatory Commission (ERC)

### 2) FiT for Community ground-mounted solar (1 Tambon, 1 Megawatt).

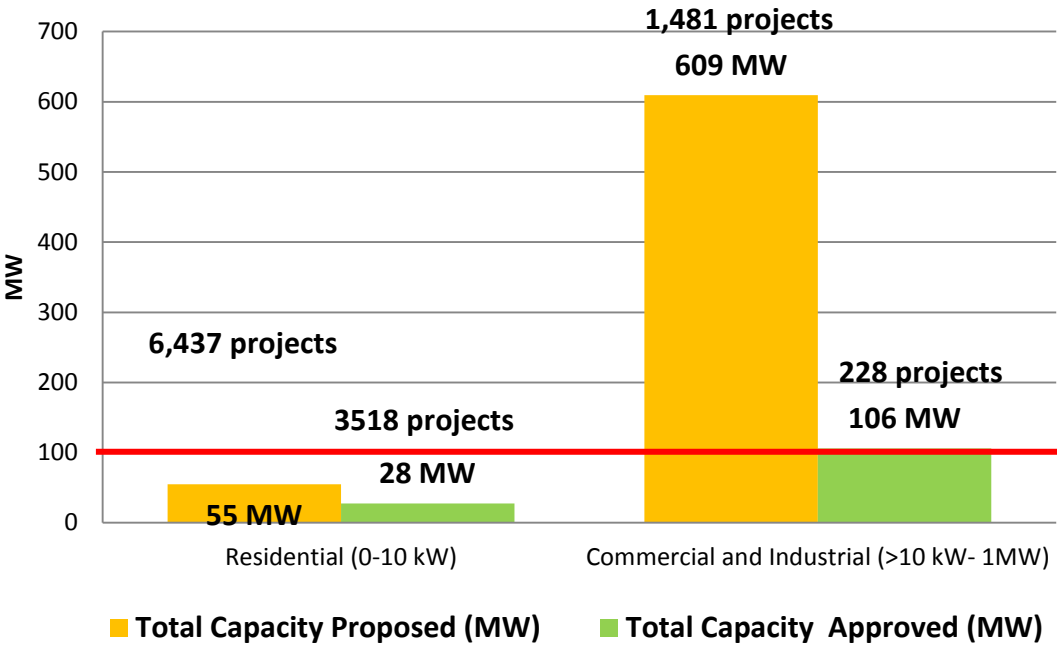
Year	FiT Rate (Baht/kWh)
1-3	9.75
4-10	6.50
11-25	4.50

Total quota: **800 MW**. All projects must be installed by **December 2014**.

The administrator will be **Thailand's Village Fund** and the Ministry of Energy.

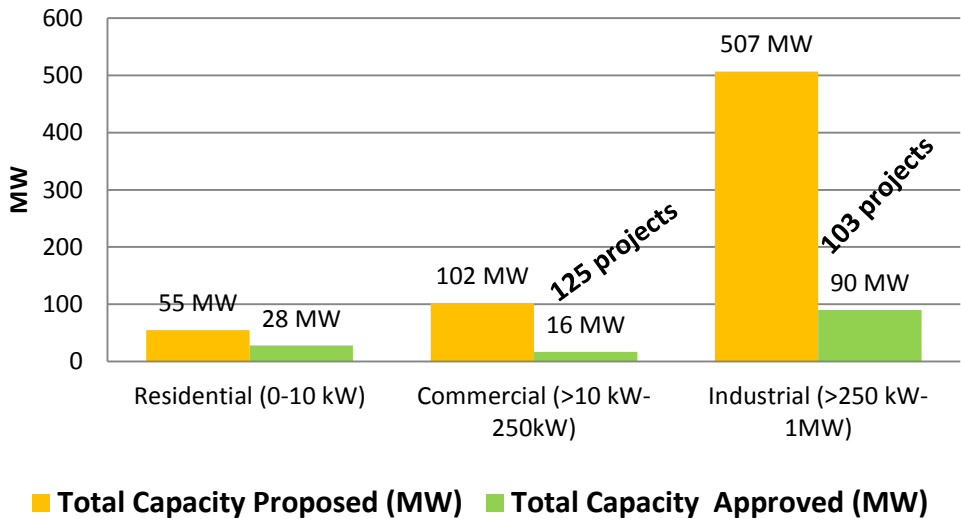
# FiT for Rooftop Solar PV (2013)

## Proposed and Approved Status vs. Targets



Targets = 100 MW + 100 MW

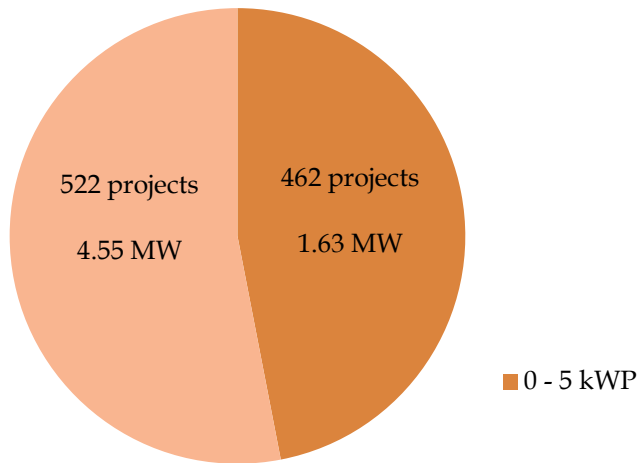
Approval Status of Feed-in-Tariff for Rooftop Solar PV (2013)



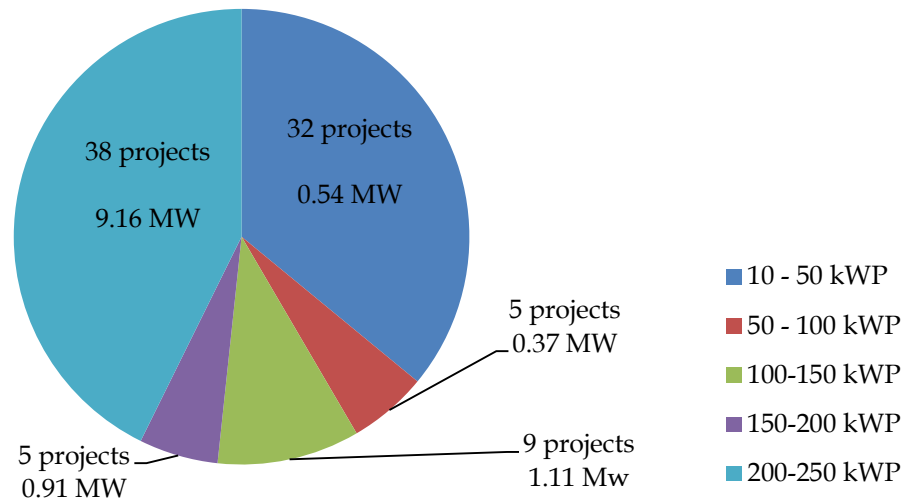
# FiT Approval Status for Rooftop Solar – MEA

(Total Installed Capacity = 54.69 MW)

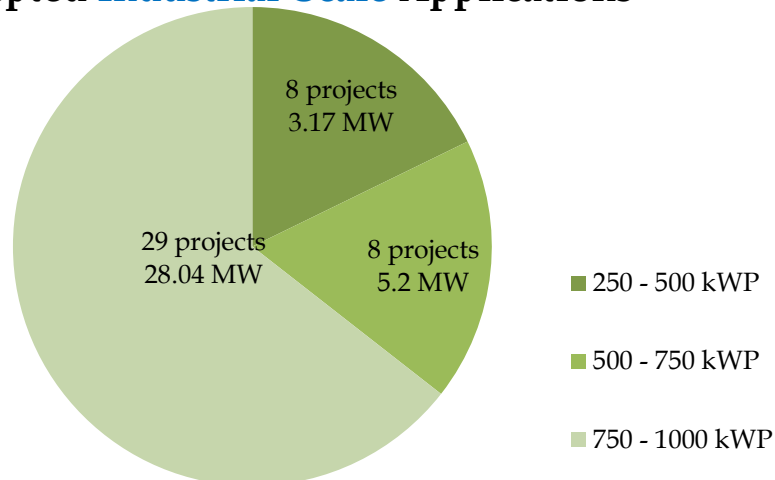
**MEA**  
Accepted **Residential-Scale** Applications



**MEA**  
Accepted **Commercial-Scale** Applications



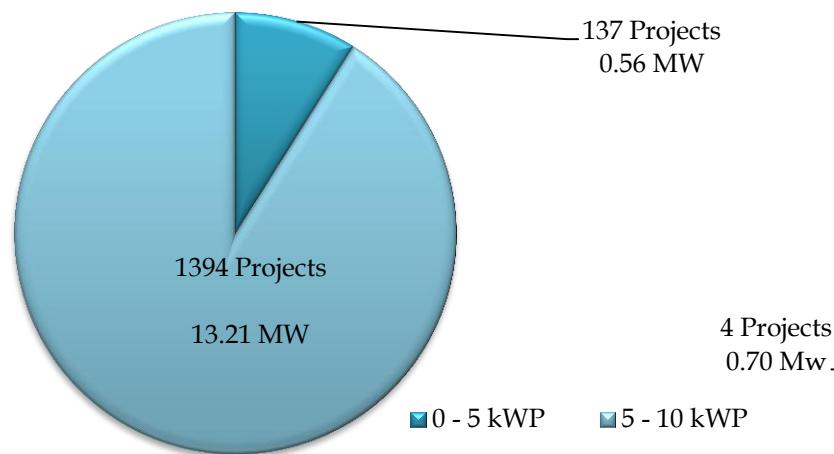
**MEA**  
Accepted **Industrial-Scale** Applications



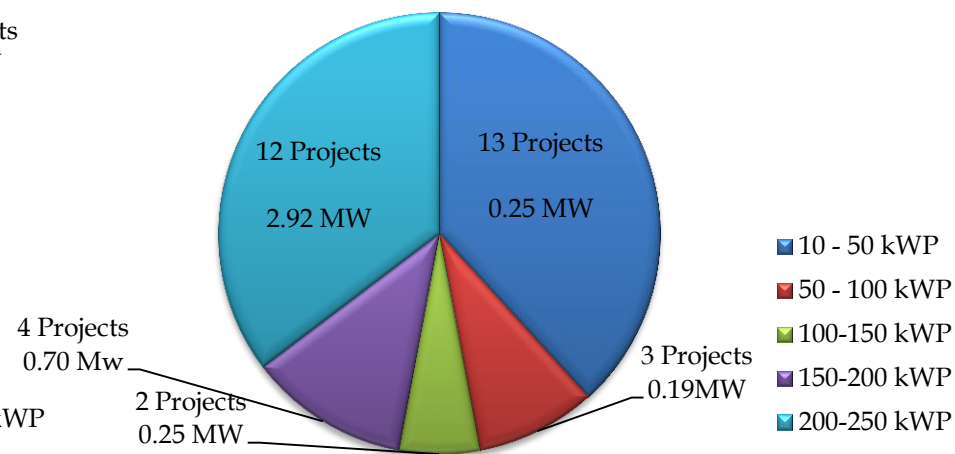


# FiT Approval Status for Rooftop Solar – PEA

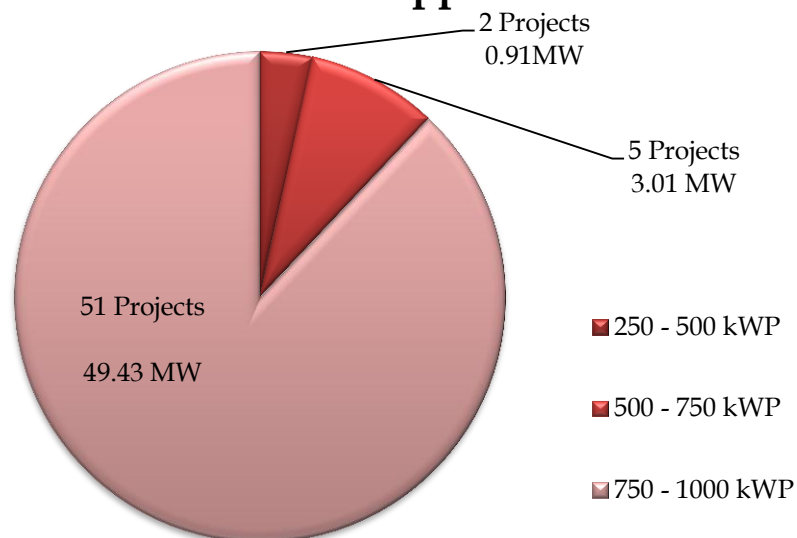
PEA  
Accepted **Residential-Scale** Applications



PEA  
Accepted **Commercial-Scale** Applications



PEA  
Accepted **Industrial-Scale** Applications



# Lessons from 2013 Rooftop Solar FiT program

## Strengths:

- Megawatt cap to prevent oversubscription and high impact on ratepayers
- Strict COD deadline as a condition for receiving FiT – to prevent speculators from selling PPAs

## Challenges

- **Residential market is still developing and unheard of to many.**
- **Complex Permitting Process:** Even though the new rooftop solar regulation was well-designed and effectively implemented, complicated permitting process remains due to other related regulations to which PV systems must comply.
  - Building Permits
  - Factory Permits
  - Inverter Certification: Type-testing vs. Single inverter test
- **Uncertainty over future policy:**
  - Continuous support is needed to earn the benefits of a sustainable market (e.g., job creation and innovation)
  - To address the concerns on ratepayers' impact, depression rates should be applied; depression rates can be tied to volume as in Germany.

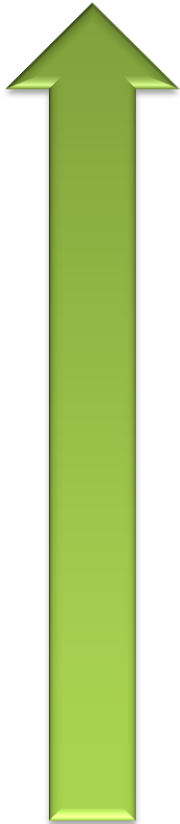
# Model Analysis

- The purpose of this analysis is to determine the feasibility of residential rooftop solar projects in Thailand under three scenarios:
  - NEPC assumptions
  - Current market
  - Market Stimulation

# Characteristics of the Three Scenarios

Scenario	Description
1. NEPC assumptions	<ul style="list-style-type: none"><li>➤ assumptions used to craft the 2013 rooftop FiT policy</li></ul>
2. Current market	<ul style="list-style-type: none"><li>➤ system prices are based on a survey from 10 system integrators available in Bangkok during Oct-Nov 2013</li><li>➤ Financial assumptions remain the same and reflect available financing options for residential consumers</li><li>➤ Income tax is included</li></ul>
3. Subsidized market	<ul style="list-style-type: none"><li>➤ system prices are based on a survey from 10 system integrators available in Bangkok during Oct-Nov 2013</li><li>➤ A 20% tax incentive is provided in addition to the FiT</li></ul>

# 2013 Residential Rooftop Solar Price Survey



Solar Power Roof Co., Ltd	<b>100.3 THB/W</b>
Thai Solar Future	<b>96.3 THB/W</b>
Bangkok Solar Co., Ltd.	<b>95.2 THB/W</b>
DNA Power Co., Ltd.	<b>89.34 THB/W</b>
TSUS Excellent Engineering Co., Ltd.	<b>87.2 THB/W</b>
Solar d Simply Clean Energy	<b>82.14 THB/W</b>
Grenzone (Thailand) Co., Ltd.	<b>82 THB/W</b>
Renewable Energy for Thai People Co.,Ltd.	<b>80.25 THB/W</b>
Polytechnology Co., Ltd.	<b>80 THB/W</b>

**National Energy Policy Commission (NEPC)**  
**(Base case)**



ERC Brochure	<b>60 THB/W</b>
Smart Solar Cell	<b>62.25 THB/W</b>

Assumptions – <i>System Characteristics</i>	NEPC	CURRENT MARKET	MARKET STIMULATION
1. System Size	3.73 kW	3.73 kW	3.73 kW
2. System Cost	2.12 USD/W (63.7 THB/W)	2.96 USD/W (88.8 THB/W)	2.96 USD/W (88.8 THB/W)
3. O&M Cost (% of investment cost pa.)	0.68%	0.68%	0.68%
4. Capacity Factor	14.84%	14.84%	14.84%
5. Degradation Rate (% per year)	1%	1%	1%
6.System Lifetime	25 years	25 years	25 years

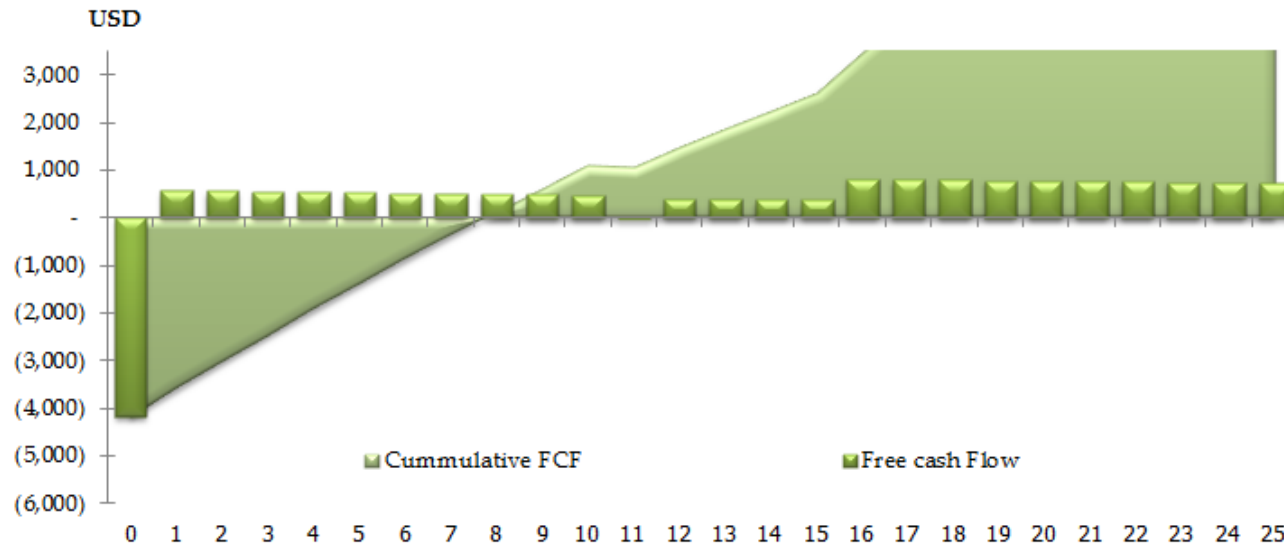
Assumptions – <i>Financial Parameters</i>	NEPC	CURRENT MARKET	MARKET STIMULATION
1. D/E ratio	1:1	1:1	1:1
2. Interest Rate	7%	7%	7%
3. Loan term	15 years	15 years	15 years
4. Income tax	0%	10%	10%
5. Income tax incentive	None	None	20% of investment cost
5. FiT rate	6.96	6.96	6.96
6. FiT term	25 years	25 years	25 years

# Model Results of 3 Scenarios

SCENARIOS	NEPC	CURRENT MARKET	MARKET STIMULATION
Project IRR	10.25%	4.76%	7.06%
Equity IRR	12.03%	2.78%	6.36%
NPV	<b>3,016 USD</b> (90,493 THB)	<b>1,707 USD</b> (51,209 THB)	<b>467 USD</b> (14,014 THB)
Payback Period	7.72 years	20.08 years	16.64 years
Energy Produced	103,355 kWh	103,355 kWh	103,355 kWh
Total Subsidy	<b>23,978 USD</b> (719,352 THB)	<b>23,978 USD</b> (719,352 THB)	<b>26,270 USD</b> (788,097 THB)

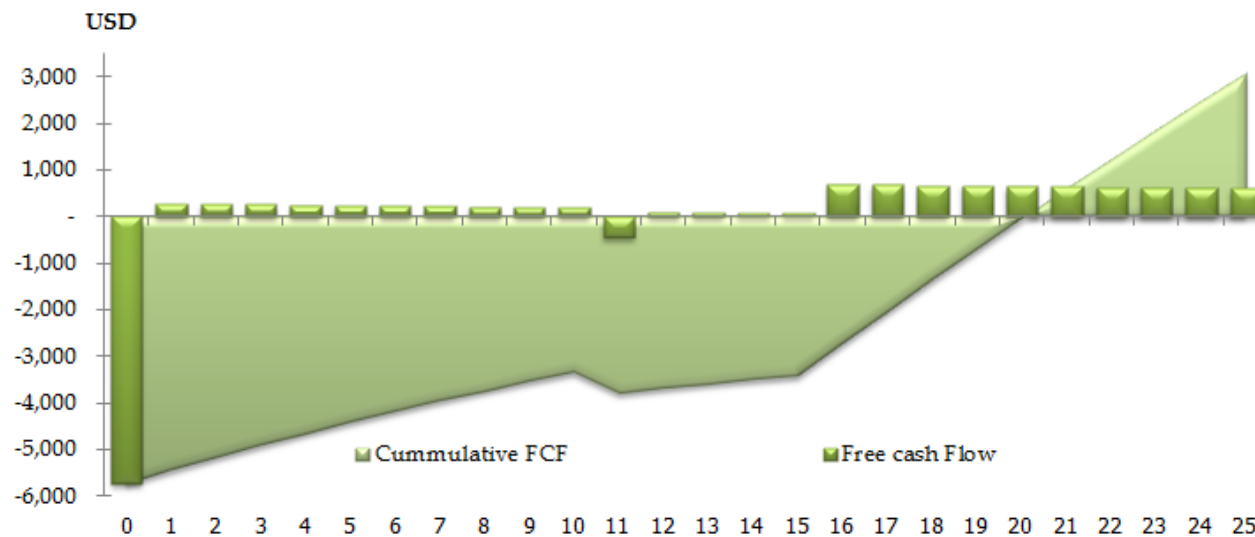
## Scenario 1: NEPC Assumptions

### Cash Flow to Site Host



## Scenario 2: Current Market

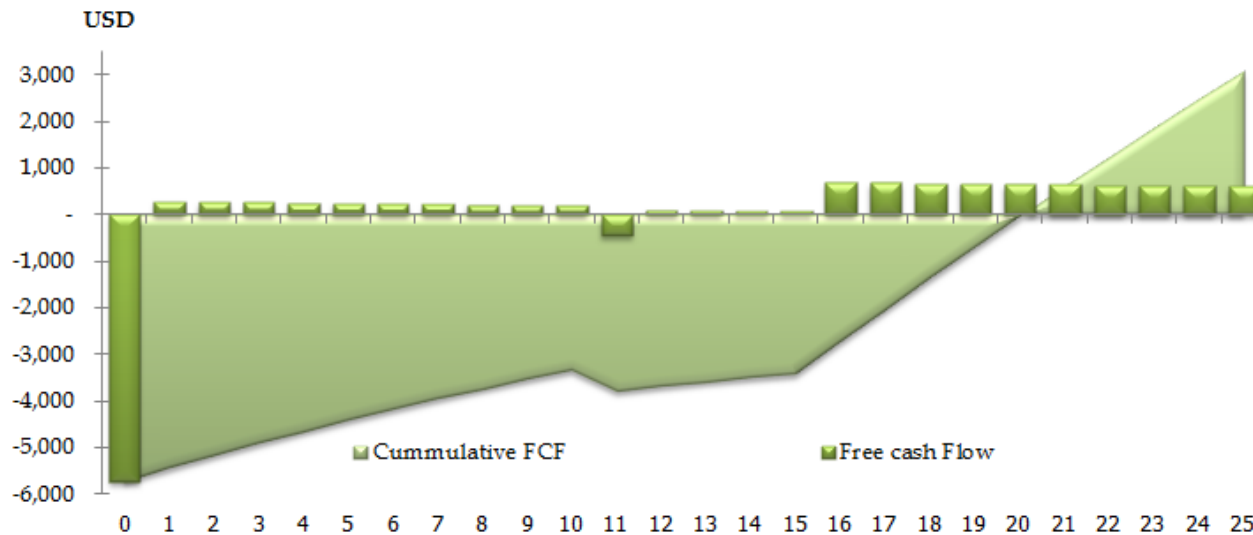
### Cash Flow to Site Host





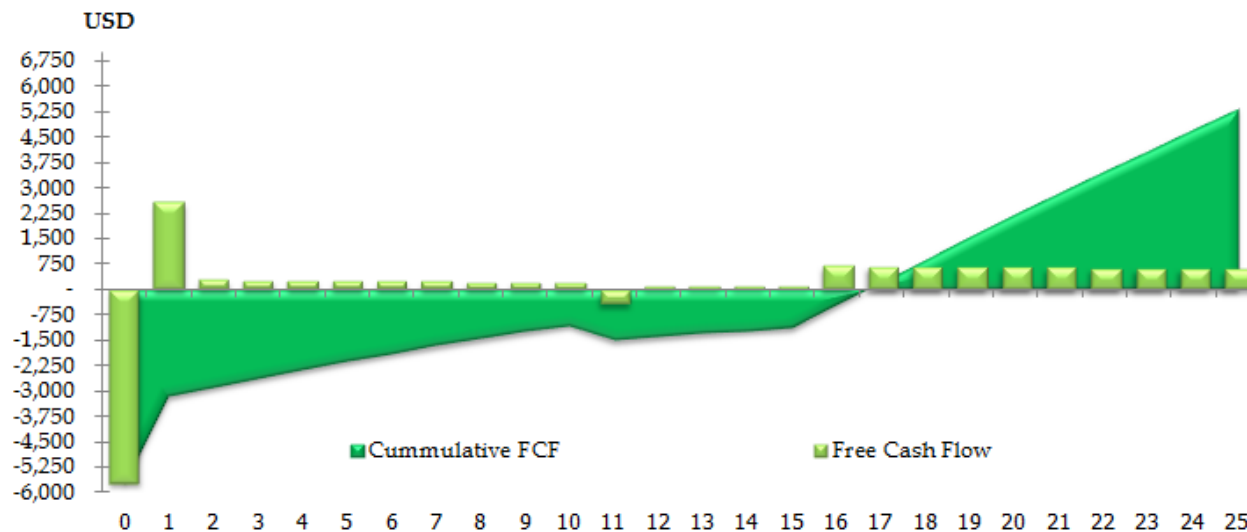
## Scenario 2: Current Market

Cash Flow to Site Host



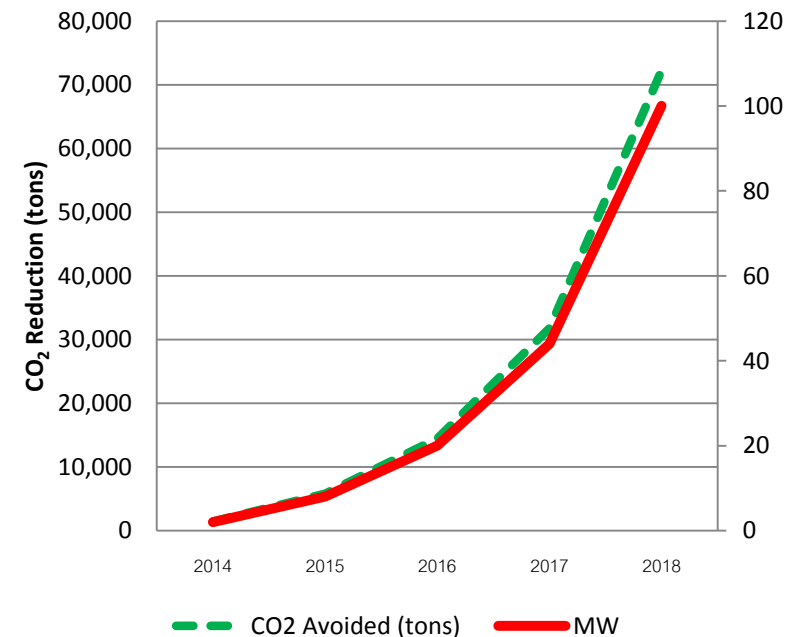
## Scenario 3: Subsidized Market

Cash Flow to Site Host with Incentive - Tax Credit 20%



# Further refinement of the model

- ***Mature Market Scenario***: taking into account of meeting some load in the post-FiT era:
  - Electricity tariff forecast
  - Increased targets to correspond to future demand
  - Exploration of various financing options
  - Current target of 100 MW Rooftop solar results in modest environmental benefits.



# Policy Lessons and Proposed Reform

- Residential rooftop solar market in Thailand is a nascent market and will need more campaign and stimulus.
- Solar power support needs “transparency, longevity, and certainty” for the investors (Fulton and Auer, 2012) in order to obtain the benefits of clean energy growth.
- Benefits and costs need to be quantified and communicated in order to shape the vision & strategies for supporting solar PV.
- Tax revenues and rate-payer pass-through costs of supporting solar (which is the most expensive type of RE) must be justified on the grounds that solar power will eventually deliver the benefits that policies promise at competitive prices.