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Federal Ministry for Economic Affairs and Climate Action
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IKI INTERNATIONAL CLIMATE INITIATIVE

Policy instruments for facilitating rooftop solar PV investments: Thailand and international cases

16 August 2024

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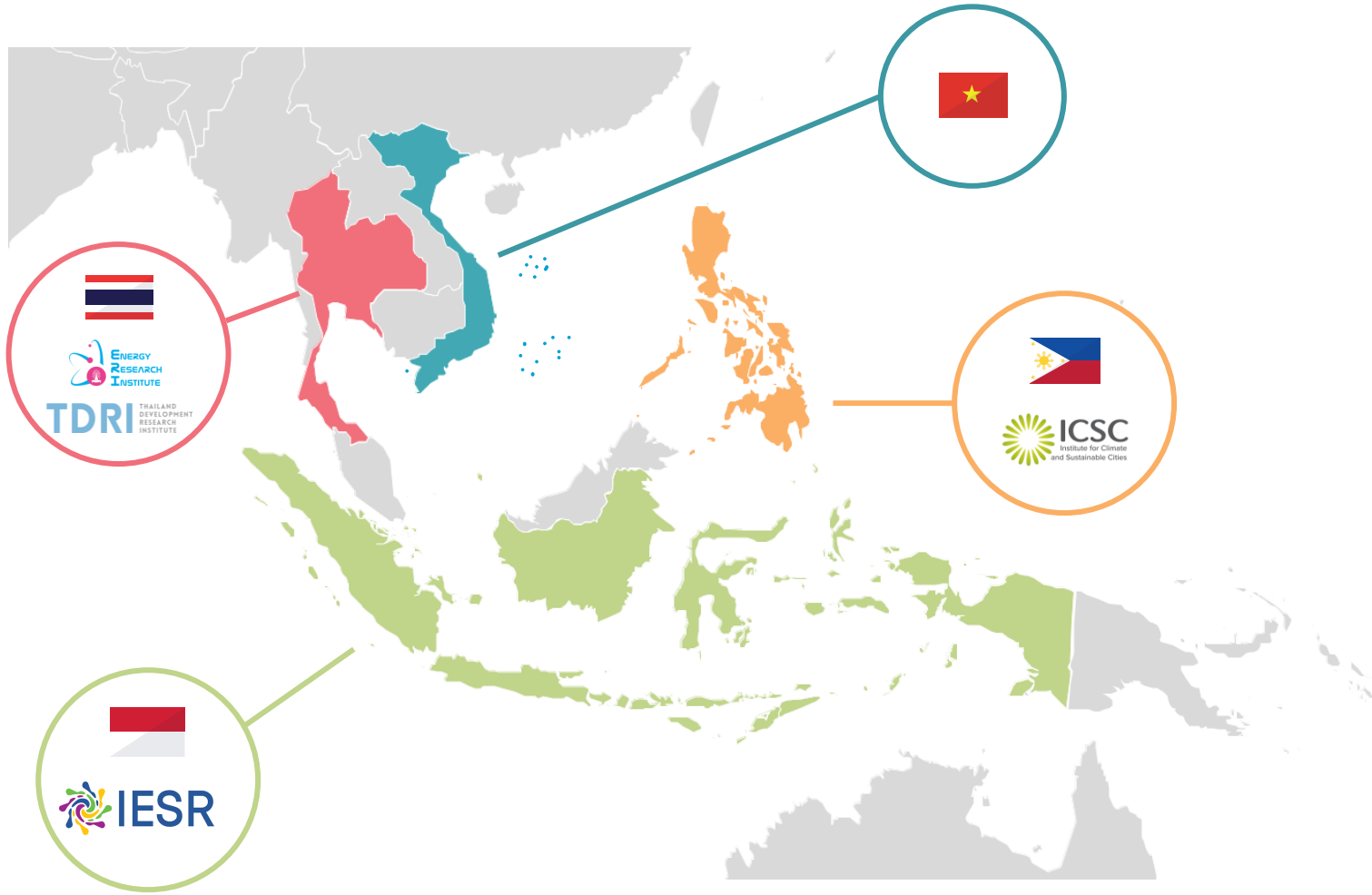
on behalf of Clean, Affordable and Secure Energy (CASE) for Southeast Asia

CASE Overview

CASE for Southeast Asia



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on the basis of a decision by the German Bundestag

Duration: March 2020 – February 2027

Focused **activities** in:

- Indonesia
- Philippines
- Thailand
- Viet Nam

Coordinator:

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

International Expert Organisations:

Agora Energiewende

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A CASE Project Overview:

Unlocking Rooftop Solar PV Investments in Thailand: Facilitating Policy and Financial Instruments

Objectives of the study

- To systematically identify the main risks and underlying barriers that lead to increased financing costs for solar rooftop projects in Thailand
- Increase knowledge and awareness of key stakeholders on how financial and policy de-risking instruments could mitigate the risks.
- To promote de-risking instruments for the country, leveraging international experience.

Part 1: Risk environment analysis	Part 2: Review existing de-risking policy and financial instruments	Part 3: Recommendations for policy and financial de-risking instruments
• What are the risks for investment in rooftop solar and the underlying barriers? • What are the impacts of these risks on financial costs? • Which risks should be prioritized for the de-risking instruments?	• What are existing de-risking policy and financial instruments in Thailand? • What are the lessons learned from existing de-risking instruments in other countries?	• Which de-risking instruments should be prioritized and could be developed in Thailand based on experience in other countries?

(Report launch expected in August 2024)

Currently, Thailand has a net-billing program for rooftop solar PV installations only for residential consumers

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Rooftop solar PV programs in Thailand

Year implemented (status)	Program	Customer target group	Achieved (MW)
2013–2015 (completed)	FiT	Residential Commercial & Industrial	130
2017 (completed)	Self-Consumption only (Pilot Project)	Residential Commercial & Industrial	5.63
2018 (ongoing)	Self-Consumption only (No export)	Residential, Commercial & Industrial	1,673
2019–2020 (completed)	Net-billing with buyback rate of 1.68 THB/kWh	Residential (≤ 10 kW)	5.42
2021–2022 (ongoing)	Net-billing with buyback rate of 2.2 THB/kWh	Residential (≤ 10 kW)	25.43

Source: CASE (2024, forthcoming) with data collected from various sources

Policy instruments mitigating administrative and permitting, power market, developer and financial risks should be put as priorities in reducing financial costs of rooftop PV investments in Thailand

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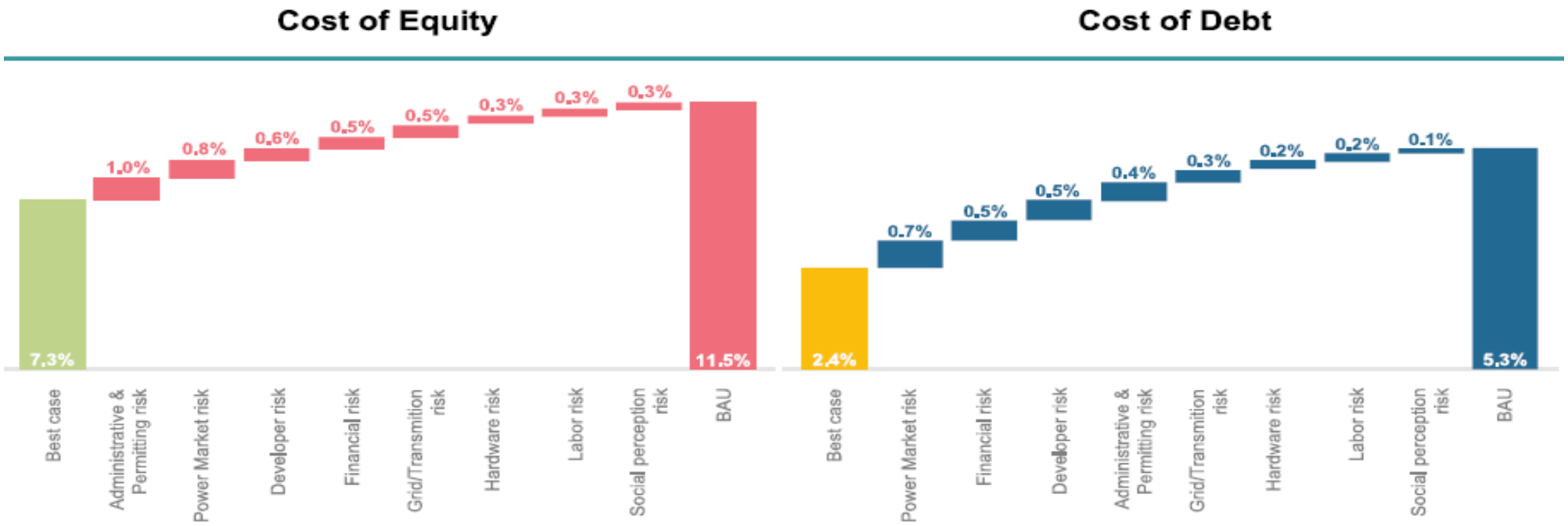
Risk waterfall for cost of equity and cost of debt for rooftop PV investments in Thailand



Top 3 risks

1. Administrative and permitting risk
2. Power market risk
3. Developer risk

Increase the cost of equity by 2.4% points

These top 3 risks account for 57% of risk premium.

Top 3 risks

1. Power market risk
2. Developer risk
3. Financial risk

Increase the cost of debt by 1.7% points

These top 3 risks account for 58% of risk premium.

Source: CASE (2024, forthcoming)

Policy de-risking instruments for rooftop solar PV investments

CASE for Southeast Asia

Power market risks	1	Setting long-term rooftop solar targets and well-designed rooftop solar programs
Administrative and permit risks	2	One-stop shop portal for rooftop solar that streamlines permitting process
		Equipment standards/vendor registration
Grid/transmission risks		Hosting capacity
		Grid code modifications

Key policy recommendations

CASE for Southeast Asia

1 Setting long-term rooftop solar targets and well-designed rooftop solar programs

- **Long-term targets** provides signals for investments and directions for policy support on rooftop solar projects
- **Well-designed rooftop solar programs** improve the investment environment for rooftop solar deployment and help the government meet other policy objectives such as

Ensure electricity supply with increased demand	Avoid the risks of electricity shortages	Reduce adverse impacts on grids	Ensure fair distribution of electricity fixed costs

Source: and CASE (2024, forthcoming)

The design choice of the program depends on policy objectives, for example:

- DPV as **sources of power supply and grid services** → allows for export of excess generation
- **Manage duck curve** → change the compensation mechanisms to incentivize export to the grid during the peak hours, for example, Smart Export Program in Hawaii
- **Promote self-consumption with battery storage** → reward consumers for each kWh of electricity discharged at times needed by the system (peak hours)

Source: USAID Clean Power Asia (2017)

Examples of rooftop solar poicy changes designed to meet different objectives

State	Policy changes	Objectives
California (U.S.)	NEM (2013) NEM 2.0 (2016) NEM 3.0 (2022)	Minimize grid challenges and cost shifting concerns (between Net Energy Metering (NEM) and non-NEM customers) **The NEM 2.0**: • Introduced a one-time **interconnection fees** • Imposed **non-bypassable charges (**a part of tariff) • Mandated TOU rates for NEM participants to reflect the actual cost of electricity during peak and off-peak times for program participation **The NEM 3.0 or the new net-billing tariff (NBT)** • **Reduce export rates** by about 75% and enact instantaneous **netting (real-time** instead of hourly) to reflect the value of generation to the grid • Incentivize **battery storage** with solar installations (e.g., exporting energy back to the grid during peak hours) and **encourage charging** for EVs and appliances **during off-peak hours**
Nevada (U.S.)	NEM to NB, then back to NEM	Overcome cost-shifting concerns by changing from **NEM to net billion (NB)**. However, as the transition to NB had a negative impact on PV market growth, as a result, they reverted back to **NEM** (allowing the offset in energy unit equivalent to retail rates)
New York (U.S.)	NEM to NB	Address concerns over the impact of distributed solar on distribution utilities by shifting from NEM to NB with **compensation for excess generation reflecting avoided costs.**

Source: CASE (2024, forthcoming) and USAID Clean Power Asia (2017)

Long-term rooftop solar targets and programs: India case

CASE for Southeast Asia

Targets

India 40 GW by 2026

Objectives of the program:

- To promote grid connected RTS
- To **bring DISCOMs** (as the nodal points for implementation and **as key drivers** for rapid development of RTS
- To **create awareness**, capacity building and HR development, etc.
- To promote sustainable business models
- **To add 38 GW by 2022 (4G in residential with CFA and 34 GW in other sectors)**
- To promote domestic manufacturing of solar cells and module

Solar Rooftop Program

Grid Connected Rooftop Solar Program Phase II (2019-2026)

- **Component A**: a **subsidy to the residential sector** for 4.2 GW (40% Central Financial Assistance or CFA for up to 3 kW capacity and 20% for 3-10 kW capacity)
- **Component B**: **Incentives to DISCOMs** based on achievement towards initial 18GW capacity (e.g., 5% of applicable cost for capacity achieved above 10% of the installed base capacity within a financial year

Note: Phase I (2015-2019) approved for installation of 4.2 GW RTS by 2019-2020 (2.1 GW through CFA) – implemented by State Nodal Agencies (SNA's), Solar Energy Corporation of India (SECI), Public Sector Undertakings (PSUs) and other government agencies

Source: https://solarrooftop.gov.in/notification/145_notification.pdf

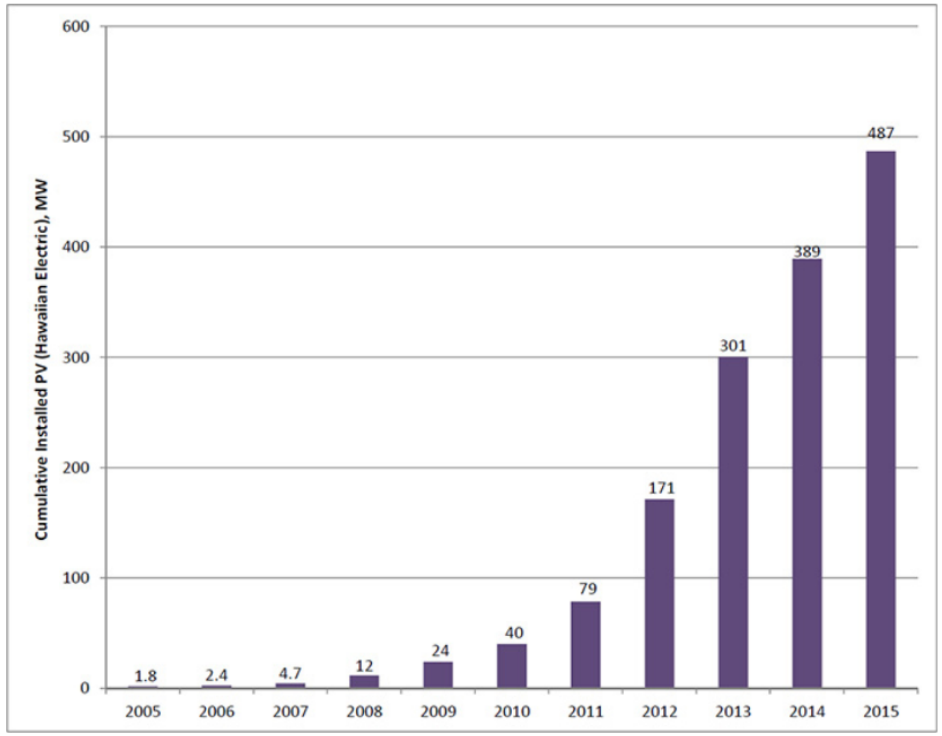
Long-term rooftop solar targets and programs: Hawaii case

CASE for Southeast Asia

Targets

Hawaii Add nearly 50,000 rooftop solar systems across the islands by 2030

Installed PV growth under NEM program



Solar Rooftop Program

Evolution of rooftop solar programs

The Net Energy Metering (**NEM**) program is no longer available since 2015, however, it was a huge success program resulting in early achievement of adding over 60,000 customers installed systems. The rooftop solar PV programs in Hawaii evolved from full incentives provided under the NEM towards the following **program characteristics**

- A lower compensation rate for excess electricity generation
- Restrictions on export to the grid during certain times
- Incentives provided for battery storage installations to ensure grid reliability and stability with higher levels of rooftop solar PV penetration.

"Demand flexibility (e.g., EV chargers) and batteries help increase on-site consumption of rooftop PV energy, avoiding consumption of utility-purchased energy and enabling substantial customer bill savings."

Note: Net Energy Metering Plus **(NEM Plus)** is available only to current NEM customers. Customers may install new panels, battery storage or a combination of both under this program. The output from the NEM Plus system is used solely on-site and is not allowed to export to the grid.

Source: https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/rooftop-solar

Long-term rooftop solar targets and programs: Hawaii case

CASE for Southeast Asia

Targets

Hawaii

Add nearly 50,000 rooftop solar systems across the islands by 2030

"Hawaiian Electric, the islands' main electric utility, has set a goal of cutting carbon emissions from power generation by 70% by 2030, and will not only shutter the state's last coal plant in 2022 but will aim to add nearly 50,000 rooftop solar systems across the islands."

Source: https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/rooftop-solar

Solar Rooftop Program

Examples of rooftop solar programs in Hawaii

- **Customer Grid-Supply Plus (CGS Plus)** allows customers to install private rooftop solar or other renewables that export energy to the electric grid throughout the day. This also requires the use of equipment that allows the utility to manage output to maintain safe, reliable grid operation**.** Customers receive a monthly bill credit for energy delivered to the grid, for example of **CGS Plus Credit Rate**: Oahu - 10.08 cents/kWh, Lanai - 20.80 cents/kWh, Molokai - 16.77 cents/kWh
- **Smart Export** allows customers with a renewable system and battery energy storage system to export energy to the grid from 4 p.m. – 9 a.m. and get compensated at lower rate. Systems must include grid support technology to manage grid reliability and system performance.
- **Customer Self-Supply (CSS)** is intended only for private rooftop solar installations that are designed to not export any electricity to the grid. Customers are not compensated for any export of energy. PV customers with energy storage are eligible for an expedited review and approval of their systems in areas of high PV penetration.

Note: These programs were closed to new customers on March 31, 2024

Emerging trends for rooftop solar programs

CASE for Southeast Asia

Examples in Hawaii

- A new program called **"Smart DER"** in April 2024 with a participant requirement of advanced meter and '**shift and save rate**' (incentives to shift energy consumption for higher savings e.g., high rates during overnight peak).
- In addition, **Bring Your Own Device (BYOD)**, a successor program to Battery Bonus program that ended in December 2023, aims to provide a ***one-time incentive*** of $850 for every kW committed from a ***new energy storage*** to an existing or new rooftop solar system and a$5 monthly bill credit for every kW committed for the 10 year-duration of the program. The BYOD is scheduled to launch on March 1, 2024.

Source: Hawaiian Electric (2024)

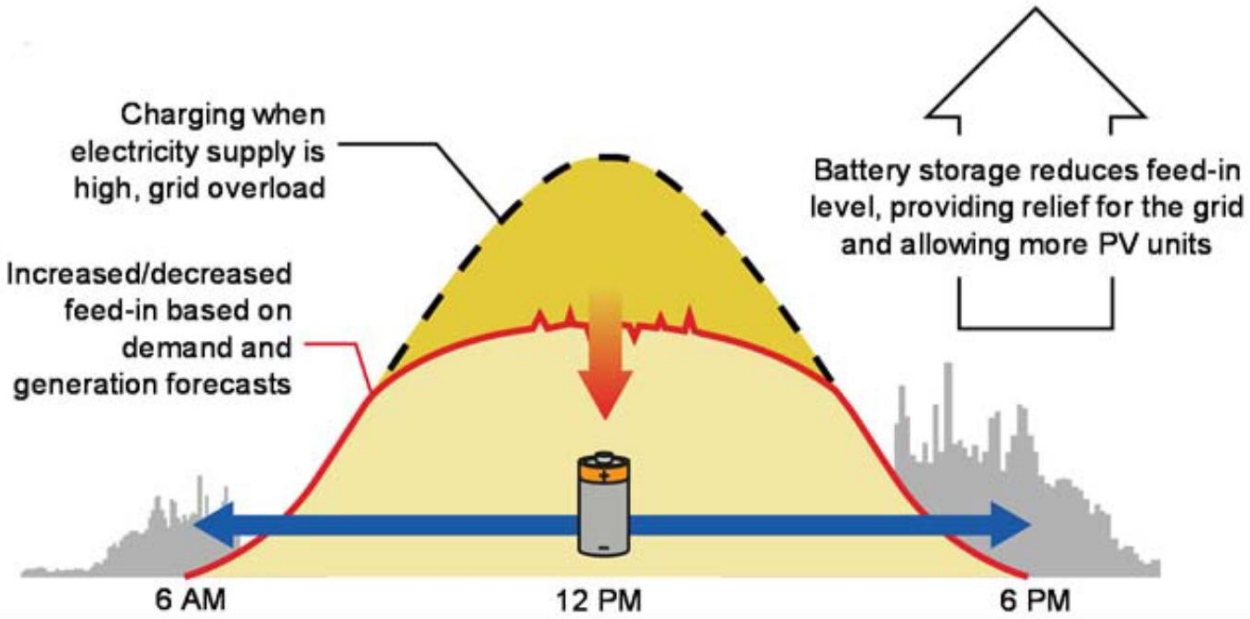
Examples in India

- the **adoption of battery storage** in rooftop solar (driven by increasing diesel cost, falling battery price, restrictive net metering policies, higher grid tariffs for C&I consumers, adoption of time-of-day tariff structure expected in 2024)
- the **adoption of peer-to-peer (P2P) trading** mechanism (driven by benefits to prosumers – such as freedom to choose an energy supplier, determined tariffs more attractive than net or gross metering – and to DISCOMs such as – reduction in distribution loss, rapid adoption of smart meters, stabilization of voltage and reverse flow issues and balancing local generation and demand, etc.)

Source: https://solarrooftop.gov.in/notification/145_notification.pdf

Residential batteries and demand-side responses can incentivize load shifting and minimize system costs: Germany case

Illustration of system-friendly storage operation (not only optimized for self-consumption)



adapted from Sterner et al. (2015)

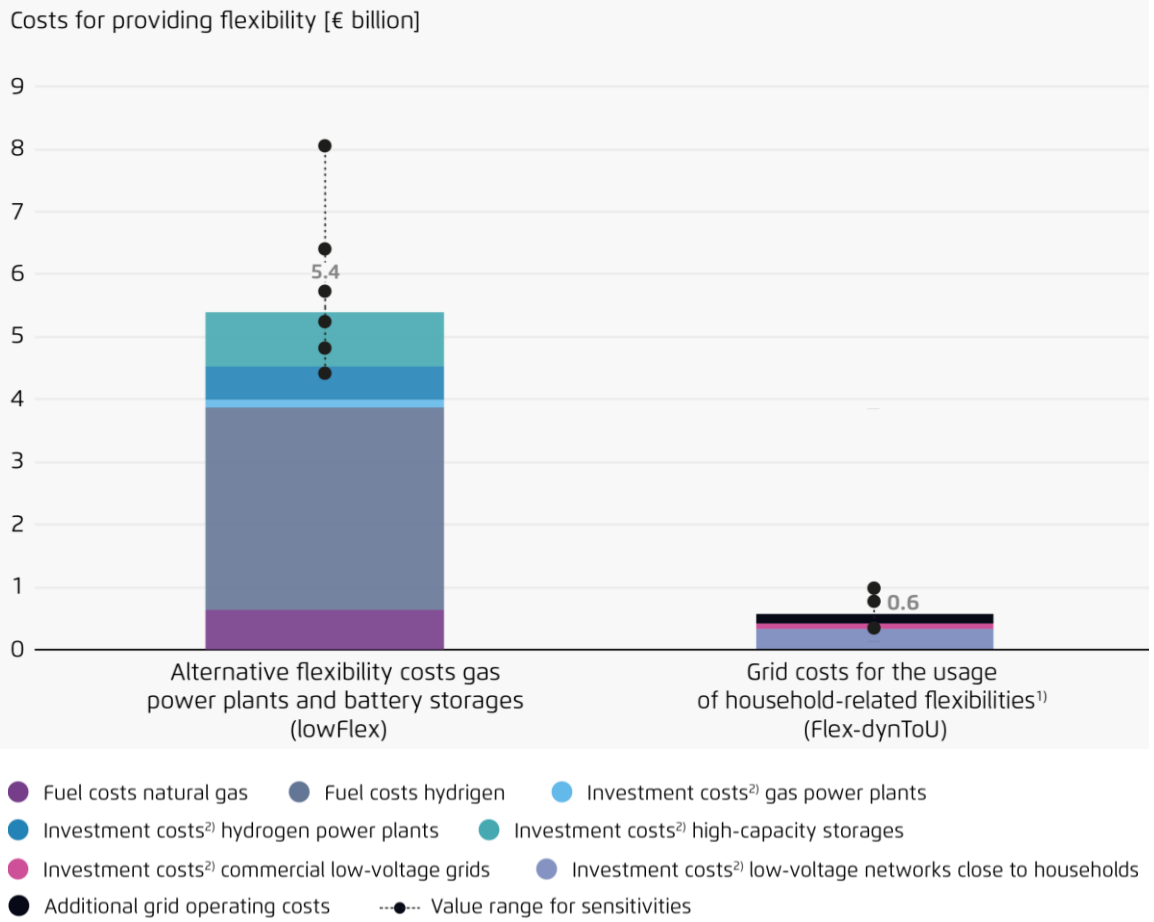
- **Favourable charging strategies** for household battery (e,g. prevents steep PV feed-in and provides balancing energy and voltage control)
- PV electricity is fed into the grid when it **contributes to system needs**; later it is used to charge the battery, thereby diminishing noon feed-in peaks
- A system-friendly operation of battery is technically feasible (e.g. ICT-based forecasts charging) and **incentivized through appropriate regulations** (dynamic electricity tariffs and grid fees).
- The **system costs** strongly depend on financial incentives (e.g. dynamic wholesale market tariffs they can incentivize grid-friendly consumption while also maximizing the use of RES generation).
- This leads to slightly increased grid expansion costs, but **significantly decreased back-up capacity costs**.

Source: Agora Energiewende (2024)

Residential batteries and demand-side responses can incentivize load shifting and minimize system costs: Germany case

CASE for Southeast Asia

Annual cost comparison of flexibility options



Flexibility from the demand side + residential batteries can provide cheaper flexibility than dispatchable generation + large-scale batteries

- Solely minimizing grid expansion leads to high costs for back-up capacity.
- Optimizing both, grid expansion and back-up capacity by incentivizing load shifting minimizes system costs:
  - Less curtailment: 20 TWh/year
  - Reduced need for back-up capacity, infrastructure and fuel
- Annual cost savings of 4.8 billion euros.

Savings of dynamic load-shifting incentives exceed additional grid expansion costs in the long term.

Source: Agora Energiewende (2023). Note: Annuity investment costs, real values.
1) Heat pumps, electric vehicles and battery home storage in household and commercial low-voltage grids. 2) Annuity-based approach.

Key policy recommendations

2

One-stop shop portal for rooftop solar that streamlines permitting process

A dedicated **one-stop shop portal for rooftop solar** is necessary to facilitate the installations of rooftop solar, removing main implementation barriers, by providing:

- streamline permitting process
- a single source of related information about regulations, standards
- list of reliable vendors and availability of financial sources.

This one-stop shop portal could help **alleviate administrative and permit risks** for rooftop solar investments particularly in the residential sector, improving consumer awareness on solar schemes and reducing complex responses to applications on various queries (that may involve several authorities.

National Portal for Rooftop Solar: India case

One-stop shop for permits - collaboration cross ministries

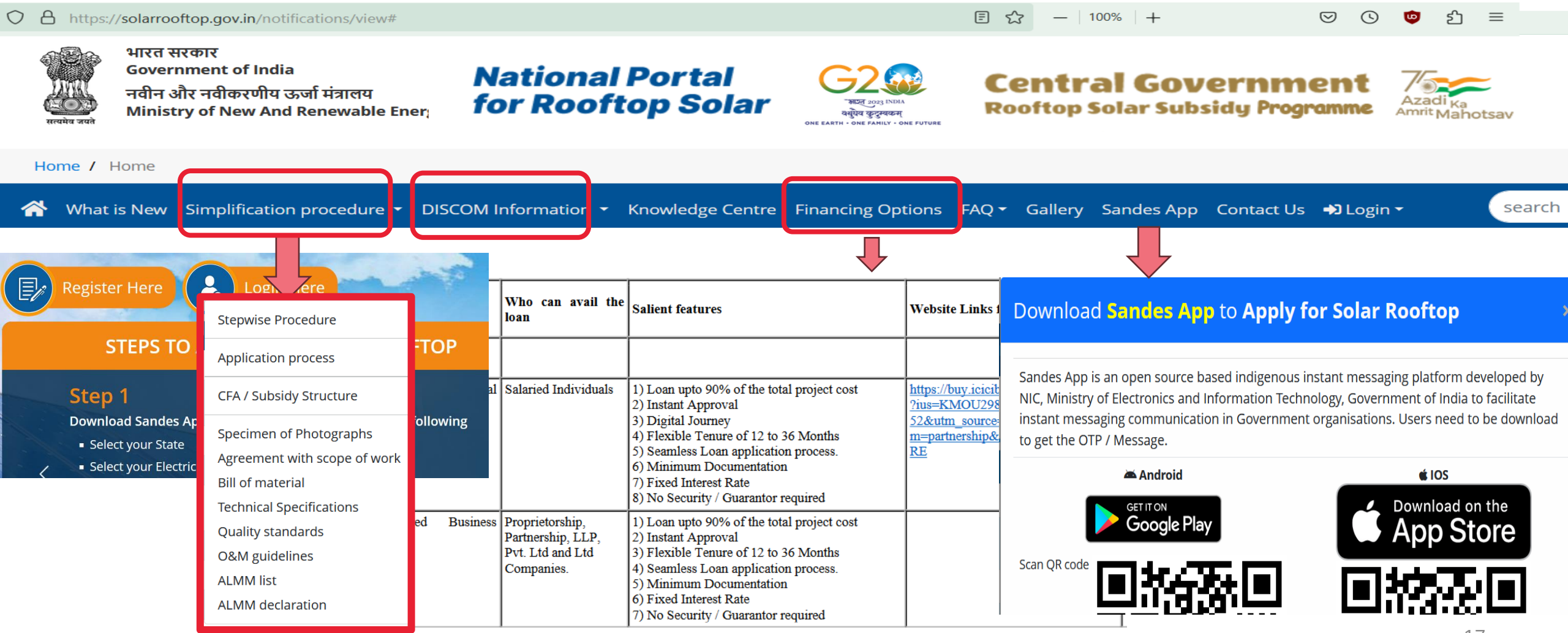
- **Online Application**
- **Utility information**
- **Vendor Registration**

Features of National Portal for Rooftop Solar in India

Single source for RTS installation facilitation	Ease of sharing information and processing application	Single infrastructure enabling time saving for all stakeholders
Enhanced consumers'flexibility and choice for RTS installation	Smooth tracking and monitoring of applications	Notification mechanism to provide real time updates

Source: https://solarrooftop.gov.in/

National Portal for Rooftop Solar: India case



Source: https://solarrooftop.gov.in/

National Portal for Rooftop Solar: India case

F. No. 283/54/2018-GRID SOLAR-Part(1)
भारत सरकार / Government of India
नवीन और नवीकरणीय ऊर्जा मंत्रालय / Ministry of New & Renewable Energy
ग्रिड सौर ऊर्जा प्रभाग / Grid Solar Power Division

In India, there are about 60 manufacturers in the list

Sub: Updation of List I (Manufacturers and Models of Solar PV Modules) of ALMM Order, 2019 – Reg.

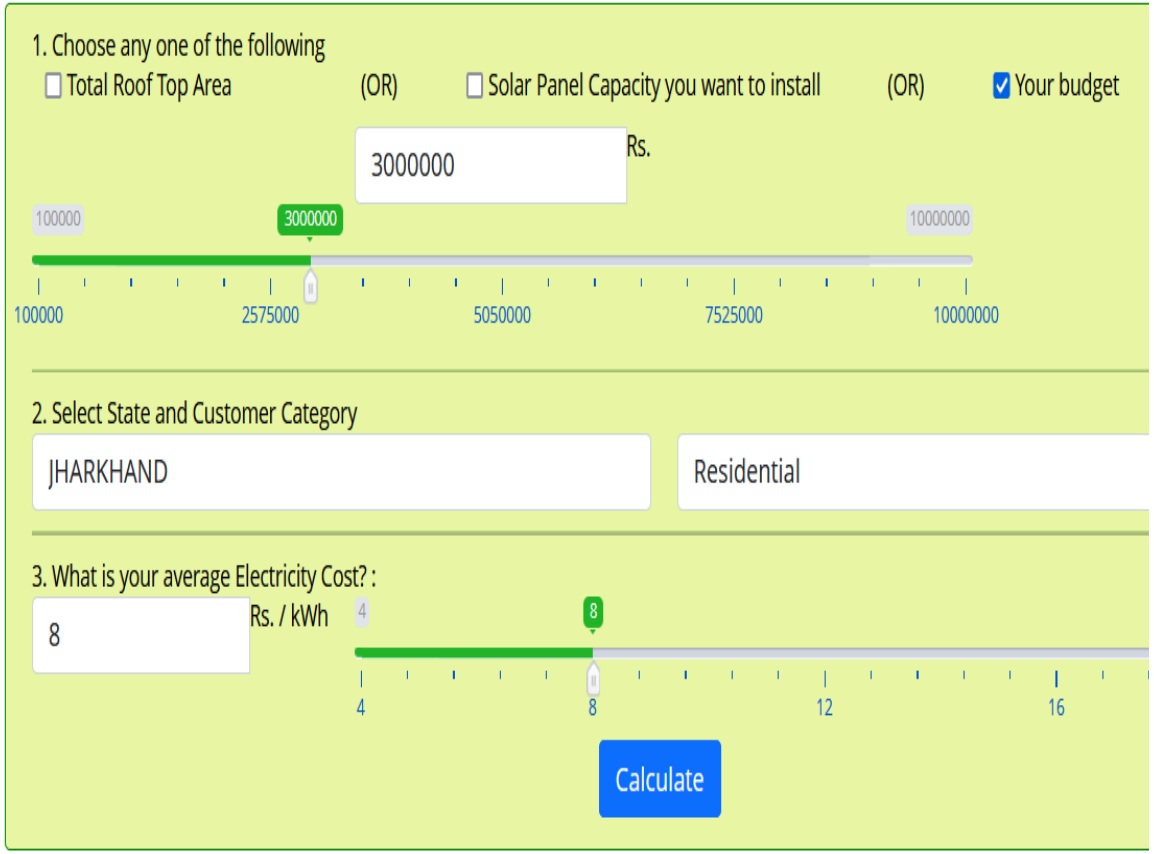
Detailed List of Manufacturers and Models of Solar PV Modules Recommended under ALMM Order (As on 05.04.2022)

S. No.	Name of the Manufacturer	Location of Manufacturing Facility	Enlisted Capacity (MWs / Year)	S. No.	Type of Module	Applied Model	Enlisted Models	No. of Cells in Module	System Voltage (in Volt)	Validity	
										From	To
1	Mundra Solar PV Ltd.	Tunda, Mundra SEZ, Mundra, Gujarat, India	1100	i	Multi C-Si Modules	ENCORE Series, ASP-7-335 (335 Wp)	ASP-7-325	72 (Full Cells)	1500	10.03.2021	09.03.2023
							ASP-7-330				
							ASP-7-335				
							ASP-7-340				
							ASP-7-345				
							ASP-7-350				
				ii	Mono C-Si PERC Modules	ETERNAL Series, ASM-7-PERC-375 (375 Wp)	ASM-7-PERC-360	72 (Full Cells)	1500	10.03.2021	09.03.2023
							ASM-7-PERC-365				
							ASM-7-PERC-370				
							ASM-7-PERC-375				
							ASM-7-PERC-380				
							ASM-7-PERC-385				
							ASM-7-PERC-390				
2	Vikram Solar Ltd.	Falta SEZ, South 24 Parganas, West Bengal, India	1050	i	Multi Crystalline Silicon Module	Eldora VSP.72.330.05 (330 Wp)	VSP.72.320.05	72 (Full Cells)	1500	10.03.2021	09.03.2023
							VSP.72.325.05				
							VSP.72.330.05				
							VSP.72.335.05				

Source: https://solarrooftop.gov.in/

National Portal for Rooftop Solar: India case

Solar Rooftop Calculator



Source: https://solarrooftop.gov.in/rooftop_calculator

Average solar irradiation in JHARKHAND state is 1156.39 W / sq.m

1kWp solar rooftop plant will generate on an average over the year 4.6 kWh of electricity per day (considering 5.5 sunshine hours)

1. Size of Power Plant	
Feasible Plant size as per your Budget :	78kW
2. Cost of the Plant :	
MNRE current Benchmark Cost (without GST) :	Rs. 38236 Rs. / kW
View Benchmark Cost List	
Without subsidy (Based on current MNRE benchmark without GST) :	Rs. 2982408 (near to your budget)
With subsidy 40% upto 3kW & 20% above 3kW upto 10kW (Based on current MNRE benchmark without GST) :	Rs. 2882995
3. Total Electricity Generation from Solar Plant :	
Annual :	107640kWh
Life-Time (25 years):	2691000kWh
4) Financial Savings :	
a) Tariff @ Rs.8/ kWh (for top slab of traffic) - No increase assumed over 25 years :	
Monthly :	Rs. 71760
Annually :	Rs. 861120
Life-Time (25 years) :	Rs. 21528000

Carbon dioxide emissions mitigated is	2207 tonnes.
This installation will be equivalent to planting	3531 Teak trees over the life time. (Data from IISc)

Disclaimer: The calculation is indicative in nature. Generation may vary from location to location.

Key recommendations for Thailand

- Policy and financial instruments for addressing **administrative and permitting, power market, developer, and financial risks** should be prioritised to reduce the financial costs of rooftop PV investments
- Setting **proactive long-term rooftop solar PV targets and well-designed supporting programs aligned with grid planning** can mitigate power market risks and unlock flexible system services through demand response from distributed energy resources including energy storage systems. The design of rooftop solar PV programs could be tailored to meet several policy objectives while offering attractive benefits to all consumers, for example,
  - Capital subsidies for low-income households or for low installation capacity
  - Incentivize battery energy storage installations with capital subsidies and rate incentives to shift away from peak demand periods
  - Set programs for commercial and industrial consumers to unlock demand responses and for better grid planning
- Developing **a one-stop shop or centralized platform** that simplifies permitting, streamlines equipment registration, and offers an online application process, could significantly boost rooftop solar PV deployment by reducing administrative and permitting costs, improving forecasting accuracy, and easing processes for all stakeholders.

Implemented by

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