3 Unlocking finance and investment for small-scale renewable power in Thailand

This chapter provides an overview of policies promoting investment in small-scale renewable power in Thailand. It examines the main financing, policy, regulatory and governance challenges as well as market development barriers. It also presents the main business models for rooftop solar PV that have emerged in Thailand. Based on a set of case studies of financing instruments deployed in other countries, the chapter also presents a series of potential financing models that could be explored in Thailand to de-risk small-scale renewable projects, such as credit guarantee schemes, aggregation and securitisation mechanisms and pay-as-you-go models. To support the Government of Thailand and key Thai stakeholders to promote and de-risk small-scale renewable power investment, the chapter ends with recommendations across three key pillars: (i) financial support; (ii) policy, regulation and governance; and (iii) capacity building, data collection and awareness-raising.

In the last two decades, Thailand achieved significant progress in the development of utility-scale renewable energy projects (APEC, 2012[1]). However, the development of small-scale renewable energy remains a major outstanding challenge for Thailand's achievement of its energy plans. For example, over 90% of solar installations are large-scale solar farms rather than rooftop solar projects (USAID, forthcoming[2]). Deploying small-scale renewable energy in Thailand can provide considerable benefits in terms of development and energy access, especially to rural and remote areas across the country. Small-scale installations bear significant advantages over large-scale projects. For example, rooftop solar projects are simpler to develop, build and operate than ground-mounted PV projects, they use space that would not be used otherwise and often protect roofing material. However, expanding small-scale renewables still faces several market and financing challenges, further outlined below.

Overview of policies promoting investment in small-scale renewable power

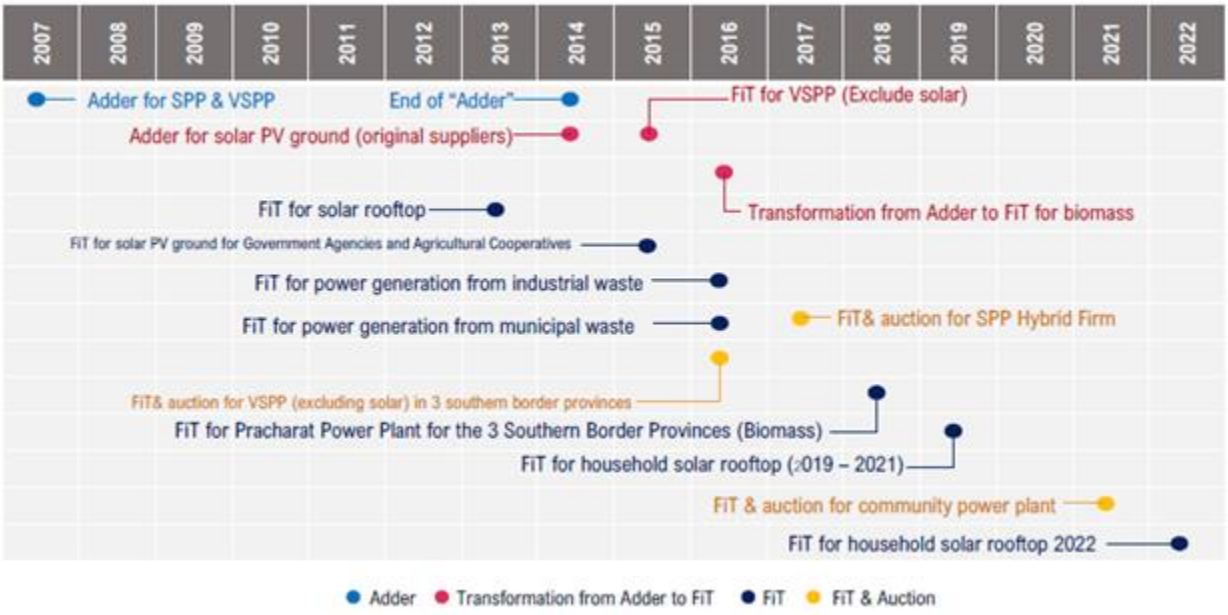
As discussed in Chapter 1, since 2006, Thailand put in place a suite of feed-in-tariff (FiT) schemes to boost the development of renewable energy in Thailand's electricity sector, including that of small-scale sources (see Figure 3.1 below for an overview and timeline of the different FiT schemes for grid-connected renewables).

The first incentive scheme was called the **"adder", a feed-in premium**, implemented by way of an additional compensation, variable by technology and installed capacity, on top of the normal wholesale tariff. The adder rates varied depending on the installed capacity of the SPPs or VSPPs and the type of renewable power plant. For ground-mounted solar (solar farm) projects, the incentive was at around 8 Thai Bht (THB) per kWh in 2007 and it was subsequently revised to 6.5 THB/kWh in 2010.

The adder scheme led to oversubscription with many solar PV systems installed capacities (almost 2 000 MW) and caused stakeholders' concerns on the impacts of this policy support for consumers. As a result, the adder was replaced by a **Feed-in Tariff (FiT)** which is the traditional policy instrument providing a guaranteed purchase rate for each unit of electricity generated from renewable energy resources. The FiT scheme was launched in 2013 to support solar PV rooftops at around 6-7 THB/kWh with a quota of 200 MW. While the quota of commercial and industrial scale (100 MW) was filled quickly, residential-scale projects achieved only around 30 MW in the first round. The FiT scheme was extended to cover ground mounted solar PV systems for government agencies, agricultural co-operatives, and other energy technologies such as for electricity generation from municipal/industrial waste resources. During 2016-2017, a joint "FiT and auction" scheme was introduced for VSPPs (biomass) in three southern border provinces and for SPPs hybrid firms. In 2021, the FiT and auction scheme was extended to support solar community power plants.

In 2022, Thailand introduced a new quota of 5 GW under the FiT scheme for the period covering between 2022 and 2030. This quota is exclusively for ground-mounted solar, wind power, ground-mounted solar and battery storage, and biogas from wastewater and waste (Watson Farley & Williams, 2022[3]).

Figure 3.1. Adder and Feed-in Tariff systems for grid-connected renewable energy systems



Source: EPPO, 2023

At present, rooftop solar PV installations for self-consumption are permitted for all electricity users. However, any excess electricity generated by the PV systems cannot be fed back into the power grid, with the exception of the residential solar buyback programme (CASE for Southeast Asia, 2022[4]).

Following the FiT scheme, in 2017, a pilot project for self-consumption scheme was launched with a quota of 100 MW of solar rooftop PV. This pilot scheme only encouraged self-consumption, without any incentives to generate and utilise surplus power. This pilot project was unsuccessful, as only around 6 MW was achieved. In 2019, the government started a net billing residential solar programme, allowing households with solar rooftop systems to sell surplus power to the grid, but at a lower price than they buy it for. In the case of Thailand, a rate of around 2 THB/kWh was provided for surplus power which is lower than the previous FiT and Thailand's average wholesale rate. As a result, turnout in installed capacity by residential investors was low. Table 3.1 summarises the suite of solar rooftop PV policies in Thailand (Junlakarn et al., 2021[5]).

Table 3.1. Timeline of solar rooftop PV policies in Thailand

DPV programme	Quota of customer target group	Achieved (MW)	Year implemented (status)
Feed in Tariff	Residential: 100 MW Commercial & Industrial: 100 MW	130	2013-2015 (completed)
Self-consumption only (pilot project)	Residential: 20 MW Commercial & Industrial: 80 MW	5.63	2017 (completed)
Self-consumption only (no export)	No quota, depending on grid availability	1 673	2018 (ongoing)
Net billing with buyback rate of 1.68 THB/kWh	Residential (≤ 10 kW)	5.42	2019-2020 (completed)
Net billing with buyback rate of 2.2 THB/kWh as of January 2021	Residential (≤ 10 kW)	25.43	2021 – 2022 (ongoing)

Source: Adapted from Junlakarn et al (2021[5]), A cross-country comparison of compensation mechanisms for distributed photovoltaics in the Philippines, Thailand, and Vietnam, 10.1016/j.rser.2021.110820 and CASE for Southeast Asia (forthcoming[6]), Unlocking Rooftop Solar Investment in Thailand: Facilitating Policy and Financial De-risking Instruments

The Government of Thailand has considered switching from net billing to net metering, which can significantly incentivise the installation of solar rooftop PVs as the household's sell and buy electricity price would be the same. Recently, the government commissioned a study to evaluate the feasibility for net metering, which concluded that the country is not yet ready for it due to technical and regulatory issues related to the fiscal treatment of the scheme and the grid balance. In 2023, the government thus put plans to initiate the net metering scheme on hold (The Nation, 2023[7]).

According to a recent assessment of the Clean, Affordable and Secure Energy (CASE) for Southeast Asia, the levelised cost of electricity (LCOE) of residential, commercial, and industrial rooftop solar PV in Thailand is grid parity as of 2023, ranging between 3.6 and 5 THB/kWh (approximately United States Dollars (USD) 0.10) (CASE for Southeast Asia, forthcoming[6]).

Thailand is also exploring peer-to-peer (P2P) electricity trading, which would enable consumers to trade electricity directly with one another without the state utilities as an intermediary (USAID, 2020[8]). As a first step, in 2022 EGAT introduced a peer-to-peer energy trading platform connecting producers and consumers that have installed solar rooftops for the first time in Thailand (EGAT, 2022[9]).

Challenges and market development barriers

Unlocking finance and investment for small-scale renewable power in Thailand faces outstanding barriers, linked to:

- financing challenges, including access to financing for Micro, Small and Medium Enterprises (MSMEs), unfavourable conditions for existing renewable loan programmes for MSMEs, limited access to funding and expertise for micro-grids in remote, off-grid island-communities, rising supply chain costs
- policy and regulatory challenges, including cumbersome and costly licensing and permitting procedures, inconsistent and challenging grid codes and regulations, lack of skilled staff and low enrolment in net-billing schemes
- governance challenges, including lack of cross-ministerial co-ordination, overlapping responsibilities, and capacity and information gaps amongst MSMEs.

Financing challenges

MSMEs have limited access to finance for renewable energy

While large companies can invest in renewable energy projects relatively easily, especially if they are listed companies, it is much more difficult for smaller companies. This is mainly due to their low (perceived) credit worthiness as a result of low or unstable revenue streams. MSMEs also often lack collateral as well as repayment track record. Moreover, unlisted MSMEs and small-scale renewable projects are typically too small to match the ticket size required by institutional investors to invest at scale in debt instruments such as project finance loans or green bonds.

Unfavourable conditions of existing loan programmes for renewable energy

Current loan programmes for renewable energy available for MSMEs are not easily accessible due to unfavourable conditions, such as short tenor periods, high interest rates and requirements for large amounts of collateral. Moreover, most existing loan programmes in Thailand focus on solar PV and available lending options for other forms of energy remain limited.

Limited access to funding and expertise for micro-grids in remote, off-grid island-communities

While Thailand achieved full electrification, about 180 islands in the Gulf of Thailand and the Andaman Sea still face limited, intermittent, expensive and environmentally harmful access to electricity (GIZ, 2017[10]). They mainly rely on electricity generated by highly polluting diesel engines, either on household level or supplied by a private operator selling power to the community. Diesel generators typically operate only 4-6 hours a day. The average cost of electricity per unit in these islands is estimated to be six times higher than prices of electricity from the national grid.

Electrification of remote areas and off-grid islands in Thailand was mainly funded by the government, through grants for hybrid micro-grids or for the installation of solar home systems (SHS). However, such projects often failed to achieve scale due to lack of local expertise for repairs and expensive maintenance of equipment and replacements. The sections below discuss the potential of using pay-as-you-go (PAYG) models to make solar home systems and community-owned mini-grids accessible to off-grid communities at an affordable cost, based on two case studies in Jik Island and Bulon Don Island.

Increasing clean energy equipment costs, especially for off-grid solutions and vulnerability to exchange rate fluctuations

In 2021 and 2022, prices of clean energy equipment rose significantly globally, mainly due to soaring costs of inputs, such as critical minerals, supply shortages, as well as trade and shipment delays. The IEA estimated that prices for solar PV modules were 30% higher in mid-2022 compared to 2020 (IEA, 2023[11]). Off-grid access solutions in developing countries faced even higher price fluctuations, with inflation hitting consumer demand and local currencies depreciating against the dollar. Moreover, since Thailand imports most solar equipment and panels from other countries, it is vulnerable to exchange rate fluctuations.

High cost of debt for rooftop solar and other clean energy projects

The high cost of debt of clean energy projects in emerging markets and developing economies (EMDEs) is a major barrier to attract investment for the clean energy transition. Results of a survey conducted by the IEA suggest that cost of capital for utility-scale solar photovoltaic (PV) projects in EMDEs is well over twice as high as it is in advanced economies (IEA, 2024[12]). According to CASE for Southeast Asia, the cost of debt associated with rooftop solar PV investment in Thailand, which amounts on average to 5.3%,

could be reduced by 1.7% by mitigating power market risk, developer risk and financial risk (forthcoming[6]). Cost of capital and risk perceptions of nascent or unproven clean energy technology (e.g. green hydrogen) is even higher than that of established technologies such as solar PV.

Policy and regulatory challenges

Renewable energy licensing and permitting pose severe burdens to businesses

Business players are burdened with cumbersome licensing and permitting requirements for renewables projects, which create high transaction costs and are time-consuming. For example, processes for rooftop system owners to request building modification permissions are often lengthy. To overcome this, the ERC office is in the process of developing a digital platform to streamline and expedite permitting process for commercial solar power plants (CASE for Southeast Asia, forthcoming[6]).

Grid codes and regulations remain challenging and inconsistent

Different electricity authorities in Thailand (namely EGAT, PEA and MEA) have slightly different grid connection codes.[1] For example, different grid codes have different requirements on equipment for solar installation systems.

Solar PV technicians and contractors often lack adequate skills

The skills of solar PV technicians and contractors vary significantly. Rooftop solar professionals do not have a specific certification to attest their adherence to quality standards for rooftop solar installations (CASE for Southeast Asia, forthcoming[6]). Some companies offer on-the-job training to increase skillsets. Moreover, as supply of solar installations is now increasing and developers are increasingly competing to offer low-cost solar installations, safety issues might be overlooked.

Low enrolment in net-billing schemes

The existing net-billing scheme for residential rooftop solar PV had relatively low enrolment due to a cap on eligible capacity and a significantly lower net-billing tariff rate for surplus electricity production, compared to residential power prices. Moreover, grid connection fees also hindered take-up.

Lack of cross-ministerial co-ordination

Roles and responsibilities overlap between different government agencies and ministries, which hinders and slows down processes for licensing and permits.

Innovative business models and financing opportunities for small-scale renewables

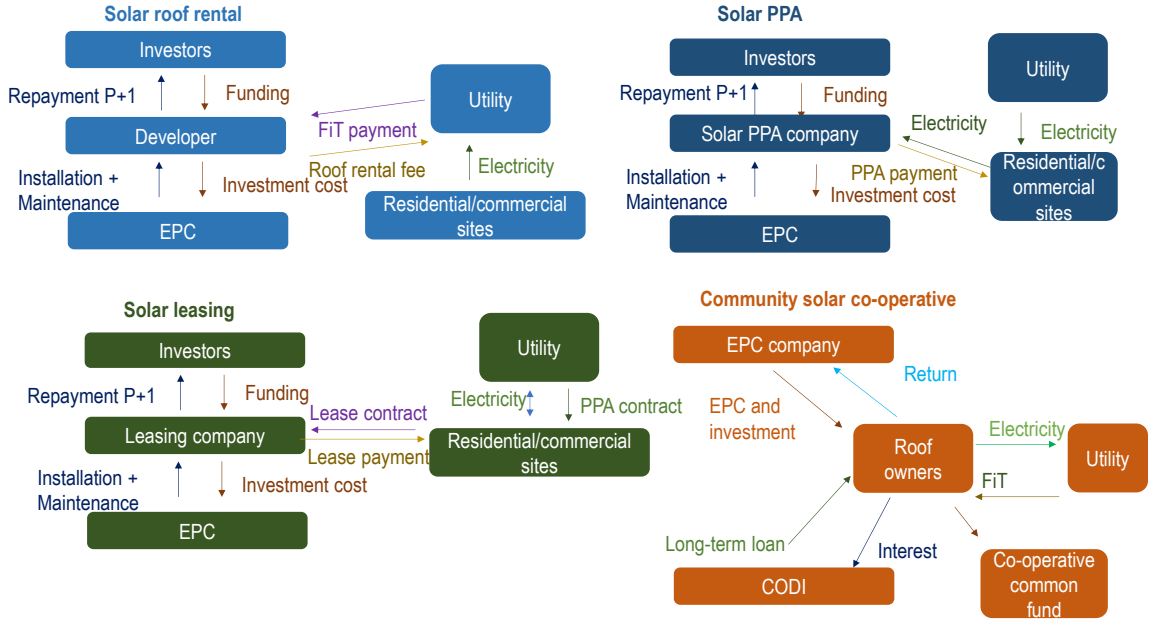
Business models for small-scale renewable power

During the time the feed-in tariff (FiT) was available, four main business models for rooftop solar emerged in Thailand, as discussed in (Tongsopit et al., 2016[13])(Table 3.2 below):

- Solar roof rental
- Solar power purchase agreement (PPA)
- Solar leasing[2]
- Community solar.

Since these business models are still relatively recent and given the discontinued FiT support, it is unclear which models will dominate the solar energy market in Thailand. Some of the business models, such as solar leasing and solar PPA, could further develop even without public support. In contrast, solar roof rental and community solar may require significant public support (such as through a FiT). For the development of the solar leasing market, setting up a dedicated third-party registration system for solar system components (modules and inverters) would be necessary. Such a system would create an active secondary market for solar systems, which is currently missing in Thailand. Figure 3.2 below outlines the different solar PV business models emerging in Thailand and Table 3.2 below summarises the main characteristics, drivers, barriers and risks.

Figure 3.2. Solar PV business models emerging in Thailand



Source: Tongsopit et al (2016[13]), Business models and financing options for a rapid scale-up of rooftop solar power systems in Thailand, https://doi.org/10.1016/j.enpol.2016.01.023.

Table 3.2. Business models for small-scale solar power in Thailand: drivers, barriers and risks

Business model	Business structure	Driver	Barrier	Risk
Solar roof rental	**Scale**: Commercial **Ownership**: Developer **Customer benefit**: Rental fee **Customer cost**: None	- Roof owners benefit from rental fee and reduced heat absorption, leading to decreased power consumption - Housing developers can increase revenues and value of their houses.	Limited PPA quota programmess from the government.	- Risk of roof damage (for building owners) - Building use changes risks (for developers)
Solar PPA (or solar shared savings)	**Scale**: Commercial **Ownership**: Developer **Customer benefit**: Bill savings **Customer cost**: PPA electricity price < grid price	- Model shielded from policy support and uncertainty - Economic attractiveness and bill savings from buying solar electricity instead of grid electricity. - The developer would cover O&M costs.	- Limited applicability in residential sector due to high investment costs.	- Risk of increase in electricity price. - Load pattern may change, affecting the amount of PPA electricity needed (risk for building owners)
Solar leasing	**Scale**: All **Ownership**: Customer **Customer benefit**: Sale of electricity to the grid or bill savings **Customer cost**: Lease payment	- Interest from financial institutions with existing leasing products. - Avoidance of high upfront costs of solar systems for customers.	- Limited feasibility for small-scale systems. - Lack of a third-party registration system for solar system components (modules and inverters).	- Risk of non-payment from the lessee (lessor risk). - Uncertain yield/performance from the solar system (lessee risk)
Community solar	**Scale**: Residential **Ownership**: Customer **Customer benefit**: Sale of electricity to the grid **Customer cost**: Principal and interest	- Strong neighbor networks. - Peer effects of adopting solar technology.	- Limited financing options for community residential customers.	- FiT sharing agreement deviations. - Unexpected yield/performance from the solar system. - High community co-ordination costs.

Source: Tongsopit et al (2016[13]), Business models and financing options for a rapid scale-up of rooftop solar power systems in Thailand, https://doi.org/10.1016/j.enpol.2016.01.023.

Financing mechanisms for small-scale renewable power

The following section presents a series of potential financing models that could be explored in Thailand to de-risk small-scale renewable projects and attracting finance and investment towards them:

- credit guarantee schemes targeted at MSMEs and small-scale renewable energy projects
- aggregation and securitisation models for small-scale renewables
- pay-as-you-go and community-owned models to make renewable energy accessible to off-grid islands at affordable costs.

The OECD and the Creagy developed a series of five case studies on financing mechanisms for small-scale renewable power and energy efficiency projects in Thailand. The choice of the case studies was based on consultations and interviews with a wide range of stakeholders on challenges and barriers for

attracting financing in the two sectors in Thailand. Further details on each of the five case studies can be found in Annex B.

Credit guarantee schemes targeted at MSMEs and small-scale renewable energy projects

Credit guarantee schemes can help MSMEs access finance by transferring all or part of the borrower's credit and default risks, thus alleviating factors such as limited collateral and track record of MSMEs. Thanks to guarantees, in case of a borrower default, the lender can resort to a full or partial repayment from a third-party guarantor. Guarantees can cover either individual loans of individual borrowers, or a portfolio of loans, for example made by commercial banks to intermediary financial institutions (Alliance for Financial Inclusion, 2022[14]). Green credit guarantee schemes also contribute to improving the ability of banks to price MSME risks and to evaluate green projects.

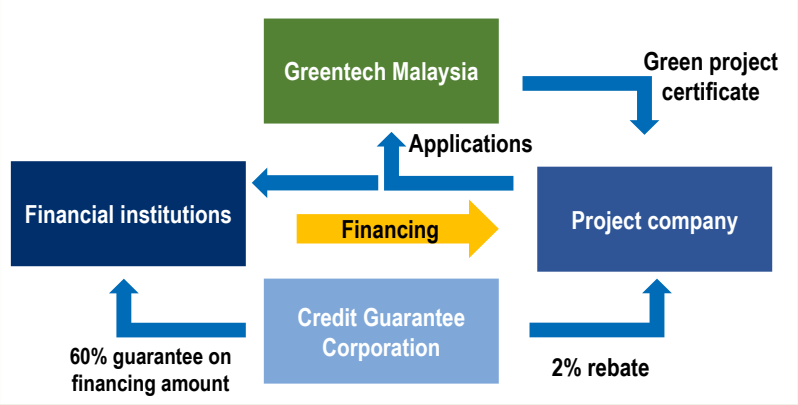
Governments and public financial institutions can play a key role in de-risking small-scale renewable projects through funding or supporting green guarantee schemes. For example, Malaysia's Green Technology Financing Scheme (GTFS) is a government support programme offering a 2% interest subsidy and a government guarantee covering up to 60% of loans for green projects (Malaysian Sustainable Finance Initiative, 2023[15]) – see Box 3.1 below. Several other emerging markets and developing economies (EMDEs) have sector-neutral credit guarantee schemes (i.e. not specifically targeted at green projects). For example, India's Credit Guarantee Fund Trust for Micro and Small Enterprises (CGTMSE) facilitates access to collateral-free credit for MSMEs by providing a credit guarantee cover of up to 85% on loans up to INR 200 (USD 256 thousand) (OECD, 2022[16]).

Box 3.1. Malaysia's Green Technology Financing Scheme (GTFS)

In 2010 the Government of Malaysia established the Green Technology Financing Scheme (GTFS), with initial funding of RM 1.5 billion (USD 470 million). The scheme was extended in the following years and in 2023 the government allocated RB 1 billion to the GTFS, until 2025. The scheme continues to support six sectors, including energy, manufacturing, transport, buildings, waste and water.

The scheme offers a 2% interest subsidy and a government guarantee covering up to 60% of loans for green projects. It targets Malaysian-registered companies with a minimum of 60% Malaysian ownership, focusing on both producers and users of green technologies, including ESCOs. The Malaysian Green Technology and Climate Change Corporation and Credit Guarantee Corporation Malaysia Berhad are the agencies tasked with administering the GTFS. The former is responsible for the promotion, assessment, certification and monitoring of participants, while the latter is responsible for offering and extending guarantees (Figure 3.3 below).

Figure 3.3. Key players of Malaysia's GTFS



Source: Ministry of Natural Resources and Environment Malaysia (2014[17]), Green Technology Financing Scheme (GTFS), https://unfccc.int/files/focus/mitigation/application/pdf/malaysia_presentation.pdf.

As of 2018, the GTFS resulted in the participation of 28 financial institutions, which extended loans for 319 projects worth approximately USD 875 million (World Bank, 2020[18]). Most of the funding was allocated to solar power projects (Tu, Fan, 2016[19]). A recent study analysing the impact of the GTFS on the business performance of renewable energy producers shows that the scheme improves the financial and non-financial performance of participating companies (Adebiyi et al., 2020[20]).

Annex B provides further information on this scheme.

Extensive stakeholder consultations conducted to develop this Roadmap concluded that Thailand could consider setting up a credit guarantee scheme to reduce risk perceptions of small-scale projects, for both renewable energy and energy efficiency. A potential credit guarantee programme would incentivise small-sized ESCOs and MSMEs with limited track record and collateral to obtain credit to finance their green projects.

Table 3.3 below outlines potential actors involved in the implementation of a risk guarantee scheme in Thailand and the challenges they may encounter. Key actors that would need to be involved in exploring options to pilot a credit guarantee scheme include: the government (especially DEDE and the Ministry of Energy more broadly), the Thai Credit Guarantee Corporation (TCG), the ESCO Association, Thai commercial banks, academic institutions, as well as international partners.

Lack of experience and expertise of credit guarantee institutions and commercial banks in assessing and managing the risks of energy efficiency projects as well as high transaction costs relative to the small ticket size of such projects stand out as key challenges. Moreover, conducting due diligence and processing the guarantee could pose significant administrative burdens, which can be eased using a single digital platform and standardised due diligence checklists. It is also important that the guarantee fees and administrative processes are not prohibitively high for small-sized ESCOs.

Table 3.3. Key players and potential challenges of implementation of a credit risk guarantee scheme in Thailand

Key players	Potential Thai actors	Challenges
Funding agencies	**Domestic public funds:** e.g. the Energy Conservation Promotion Fund (ENCON Fund) & Power Development Fund	• Eligibility criteria of the fund • Political priorities
	Multilateral development banks: e.g. World Bank, Asian Development Bank (ADB), etc.	• Stringent eligibility criteria • Complex application process • Currency and repayment risks • Competitive funding environment
Technical support agencies	**Department of Alternative Energy Development and Efficiency (DEDE)**, Ministry of Energy	Limited resources
	Academic and research institutions, e.g. Joint Graduate School of Energy and Environment, Chulalongkorn University	
	International agencies, e.g. GIZ, UNDP	
Financial Institutions	**Commercial banks in Thailand**	• Limited technical capacity to offer financing for small-scale renewable energy projects • Lack of proven track records of MSMEs • Stringent eligibility criteria
Credit guarantee corporations	**Thai Credit Guarantee Corporation (TCG)**	• Lack of experience and expertise in assessing and managing the risks of energy efficiency projects • High transaction costs and administrative burdens for applying and processing the guarantee • Limited availability and accessibility of donor funds to subsidise the guarantee fee and cover the potential losses • Low awareness and understanding of the benefits and requirements of the guarantee mechanism among potential borrowers and lenders

Source: Authors

One option for Thailand is to design a green credit guarantee scheme through the Thai Credit Guarantee Corporation (TCG), a state-owned specialised financial institution that already has a legal mandate to be able to extend guarantees. Concessional financing will be required, especially at the onset of the programme, to ensure that the guarantee is accessible by MSMEs, e.g. concessional resources from the government and support by donors and DFIs to fund a reduced uniform guarantee fee for lending for small-scale renewable projects.

Table 3.4 below proposes a roadmap of key activities to be undertaken by responsible organisations and a timeline for implementation for each of the potential responsible agencies. As a first step, a programme feasibility study could be conducted, assessing the market offer and challenges of green financing products for small-scale renewables, readiness of the TCG, potential guarantee take-up challenges faced by ESCOs and MSMEs (e.g. through a market survey) as well as the degree of awareness of financial institutions on the Thai green taxonomy. Since the pre-requisite of providing green credit guarantees is the provision of green loan products, it is important that participating financial institutions have a common understanding on how to apply the recently developed Thai taxonomy, e.g. to assess and classify the "greenness" of activities of their lending portfolios.

The feasibility study could inform decisions on key design elements, namely: (i) the choice between the individual and portfolio guarantee approach; (ii) the coverage ratio (i.e. what portion of a loan can be covered by a guarantee); (iii) the pricing structure for the guarantee fees; (iv) the process for handling defaults and guarantee payouts; and (v) the exit strategy.

The feasibility study could build on the work being conducted by the Carbon Trust on the design of a credit guarantee scheme in Thailand, as part of the ASEAN Low Carbon Energy Programme, which has already developed a financial model to cost the guarantee scheme, quantify the potential lending mobilised and test the sensitivity of market assumptions (e.g. default rates) and design decisions (Carbon Trust, 2023[21]).

It is worth noting that a credit guarantee scheme alone will not be able to bridge the lack of technical capacity of a lender or borrower to assess renewable energy projects, so the guarantee scheme needs to be accompanied by tailored capacity-building programmes, for example on the Thai taxonomy energy criteria and on technical risk assessments for small-scale projects.

Aggregation and securitisation models for small-scale renewables

Aggregation models can help tackle some of the barriers that small-scale and off-grid renewable projects face. Different types of aggregation exist and can be used to lower transaction costs and risks of projects (IIED, 2017[22]):

- **Financial aggregation**: bundling financial assets or investments into a bigger, individual portfolio or vehicle
- **Demand aggregation**: aggregating demand (e.g. of energy and equipment) of different households or communities
- **Aggregation of companies or projects**: creating a portfolio of companies or projects
- **Information aggregation**: creating platforms to ease and standardise access to information.

Through financial aggregation and securitisation, projects can be bundled to reach a scale and risk profile that is attractive to investors. For example, small loans for renewable energy projects can be pooled and then sold to a separate legal entity, such as special purpose vehicle (SPV), to protect the assets from any insolvency of the sponsoring entity or seller. The SPV can then issue marketable securities, typically in tranches with different risk profiles, to attract different types of investors (Coalition for Green Capital, 2019[23]). Securitisation also allows companies and lenders to recycle capital and free up financial capacity for more business or investment.

As an example, in 2023 Sun King, a Kenyan off-grid solar energy company, closed a securitisation transaction raising USD 130 million from DFIs and commercial investors, backed by future PAYG cash receivables. Earlier in 2022, King Sun also received USD 17 million through the proceeds of two green bonds issued by Symbiotics Investments, an impact asset manager focused on EMDEs. The French DFI Proparco invested in one of the two green bonds for an amount of USD 10 million (see Box 3.2 below).

In addition, the Pro Mini-Grids programme launched in Uganda in 2017 is another example of a pilot aggregation of small-scale renewables. The programme, funded by the Government of Uganda with support from the German Federal Ministry for Cooperation and Economic Development and the European Union, supported the Government of Uganda in bundling multiple mini-grid sites into single tenders to create a larger ticket size for investors to pursue. The bundled tenders were won by an energy developer, Winch Energy, which succeeded in raising approximately USD 20 million from a wide range of investors and DFIs. The OECD Blended Finance Guidance for Clean Energy includes a case study with further information on this programme (OECD, 2022[24]).

Box 3.2. Sun King: the case of a local currency securitisation and green bonds for off-grid solar projects in Kenya

In 2023, Sun King, a Kenyan off-grid solar energy company, and Citi established a Kenyan-Shilling-denominated USD 130 million green securitisation transaction. The company's current and future payments from off-grid solar products were securitised and financed by investors. The transaction was arranged by Citi and supported by commercial lenders as well as development finance institutions, including ABSA Kenya, British International Investment, Citi, FMO, Norfund, Standard Bank Kenya and the Trade and Development Bank.

Sun King's customers can purchase products using the company's pay-as-you-go financing service, which splits payments into regular and affordable instalments. These payments can be made via mobile money or cash for as little as USD 0.15 a day. The funds raised through the securitisation will finance further growth and expansion of the company.

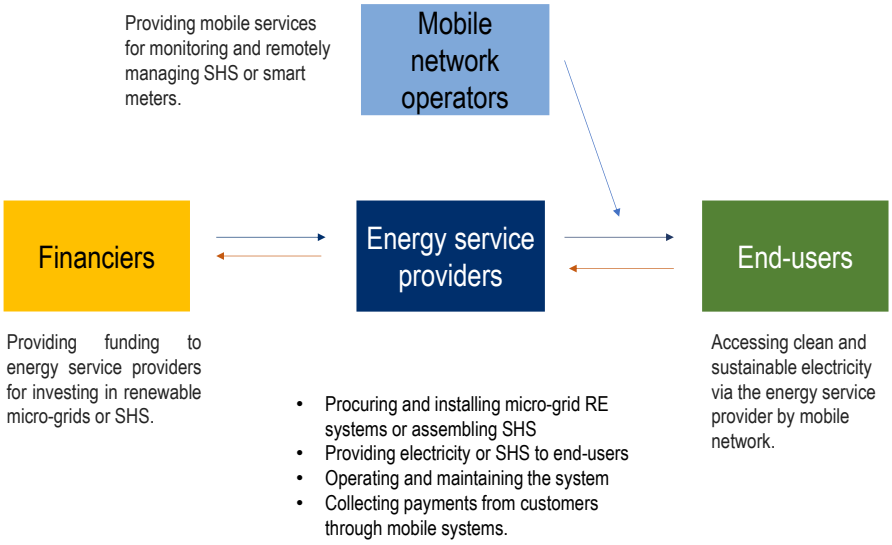
In addition, in 2022, Sun King received USD 17 million through the proceeds of two green bonds issued by Symbiotics Investments, an impact asset manager. Symbiotics originates, structures and manages impact investments on behalf of companies in EMDEs. The French DFI Proparco invested in one of the two green bonds for an amount of USD 10 million. The proceeds of the bonds will finance Sun King's activities to ease access to solar energy for off-grid costumers in underserved African markets, mainly though SHS and PAYG. The bonds have been issued by the innovative MSME Bonds SA platform.

A further example of an aggregation model in an emerging market is the Green Receivables Fund in Brazil (Davies and Saygin, 2023[25]). This fund is designed as a securitisation instrument to address the lack of long-term finance for clean energy projects in the Brazilian market, as well as to overcome barriers such as illiquidity of assets. Through a special purpose vehicle (SPV), receivables for contractual debt can be pooled, and financial securities backed by income-generating assets can then be sold to investors.

Pay-as-you-go and community-owned models to make renewable energy accessible to off-grid islands at affordable costs

Pay-as-you-go (PAYG) models can ease access to clean energy to off-grid communities, using mobile payment technologies to facilitate payment by instalments. PAYG models usually involve home solar systems that customers pay for using mobile payment technologies and mobile phone credit (IRENA, 2020[26]). There are four key players in the PAYG model: an energy service provider, mobile network operators, financiers and end-users. Each player has a unique role to play, as illustrated in Figure 3.4 below.

Figure 3.4. Key actors in PAYG models



Source: Authors.

PAYG models can be implemented at both household and community level. PAYG systems can also be implemented as a micro-grid solution, where a solar PV system with battery storage is used to provide electricity services to a community (IRENA, 2020[26]). PAYG schemes are often implemented in the context of community-ownership models, which refer to the collective ownership and management of energy-related assets. Through cost-sharing, community-ownership models enable individual participants to own assets with lower levels of investment requirements (IRENA, 2020[27]).

In Thailand, a pilot community-owned PAYG model was launched in 2017 through a collaborative effort between the Ministry of Energy, GIZ Thailand and the social enterprise ReCharge Energy, aiming to develop sustainable electrification using solar home systems (SHS). The targeted areas include two off-grid islands in the Gulf of Thailand and the Andaman Sea, which currently rely on electricity generated by diesel engines: Bulon Don Island and Jik Island.

On the island of Bulon Don, the programme provided three different packages of solar home systems, operationalised and maintained by a local community enterprise through a revolving fund. A PAYG model was set up as a digital pre-payment scheme consisting of monthly instalments. On Jik Island, a private, community-owned hybrid renewable energy mini-grid was upgraded thanks to private equity investments, grants and technical assistance by development partners and the government (International Solar Alliance, 2023[28]). See Box 3.3 below and Annex B for further details on the case studies on the two islands.

In both cases, grant resources and TA provided by the government and development partners have been crucial to the project's kick-off and mobilisation of private investors. This shows that financing at favourable terms from governments or development agencies is often required at the early stage of innovative PAYG models, to cover upfront investment and business planning costs.

Box 3.3. PAYG and community-owned models in Thailand: The cases of Jik Island and Bulon Don Island

The Case of Jik Island: microgrid upgrade and prepaid system

Jik Island, located in the Chantaburi province in the Gulf of Thailand, is home to nearly 150 households, mainly dependent on fishing for their livelihoods. Since 2014, Jik Island went through an electrification process mainly funded by the government, which developed a hybrid microgrid system. The system was managed and maintained by the company Koh Jik established by the community itself. Due to the limited capacity of the solar PV system and the expensive maintenance of wind turbines, the community enterprise soon opted to use diesel generators for electrifying the island, incurring substantial expenses. Over time, the ESCO faced increasing challenges in securing funds for replacements of renewable energy equipment such as batteries.

In response, GIZ Thailand, the Ministry of Energy of Thailand and ReCharge Energy, a social enterprise with a mission to develop high impact community energy projects, collaborated to enhance the community's management and technical skills, preparing them to independently own, operate, and maintain the system, thereby attracting private investors. In 2020, a joint venture between private Blue Solar and Symbior Solar provided an equity investment amounting to USD 172 000 for the installation of a 72 kilowatt peak (kWp) solar PV system, batteries with total capacity of 266 kWh and a 60 kW backup diesel generator. A development co-operation agency provided a grant for the installation of 100 smart prepaid meters while Allotrope Partners, which has a network of investors in renewable energy, has entered into a 20-year agreement to purchase Renewable Energy Credits from the Koh Jik renewable electricity project, contributing USD 50 000. This fund has been used to lower the electricity fees charged to the end-users.

The Case of Bulon Don Island: A digital prepaid method for solar home systems

Bulon Don Island, located in Satun province in the Andaman Sea, is home to 79 households. Bulon Don Island was the first community in Thailand using PAYG for Solar Home Systems (SHS). Until 2019, households on the island had limited access to electricity, mainly provided by central diesel generators. In 2019, ReCharge Energy received a grant from a development co-operation agency to pioneer a sustainable electrification initiative using SHS, in a joint effort with GIZ Thailand, the Ministry of Energy and the island's community enterprise. The SHS offered three different packages for consumers, at different prices depending on the electricity needed. For operation and maintenance, a revolving fund was established and managed by the island's community enterprise. Prepaid fees collected digitally from users are allocated to the fund to cover the operational and maintenance costs of the systems.

Further details on these two case studies, lessons learnt and roadmap for implementation in Thailand are available in Annex B.

The two case studies identified several potential challenges and potential solutions for the implementation of PAYG for renewable energy electrification on other off-grid islands in Thailand:

- **Technical durability**: The coastal environment can hasten the degradation of solar equipment. Frequent maintenance or replacement, particularly of sensitive components like batteries and inverters, is necessary.
- **Financial feasibility**: The substantial upfront investment and ongoing maintenance costs of the microgrid require financial support, often from government or donor resources, to be viable. Public funding could be used effectively to mobilise private investors from the onset of the project.

- **Consumption management**: Controlling the community's electricity usage is a complex task. As electricity becomes more available, consumption typically rises, potentially overwhelming the supply. A prepaid electricity model has been introduced to help manage this.
- **Supply reliability**: Solar energy's intermittent nature poses a challenge for consistent power delivery, especially during periods of reduced sunlight, requiring back-up solutions.
- **Affordability**: The cost of solar systems, both initial and recurring, may be prohibitive for some households, particularly where income is inconsistent due to reliance on seasonal revenues.
- **Service and repairs**: Remote islands often lack skilled maintenance personnel, complicating the prompt repair and servicing of solar systems. Expanding the PAYG model in remote islands would require significant training to ensure the communities have the necessary technical skills.
- **Community engagement**: Effective implementation depends on the community's understanding and engagement with the solar systems. This requires comprehensive awareness-raising.

The primary targets for replicating both models include off-grid communities within national reserve parks, where constructing distribution systems is prohibited, and over 100 islands in the Gulf of Thailand and the Andaman Sea, where extending the grid is not economically viable.

Though initially developed for electrification in off-grid areas, the models are also applicable to on-grid communities seeking low-carbon solutions. By incorporating the PAYG model, on-grid communities can move towards greater energy independence, making them more resilient to grid outages and fluctuations in energy prices and allowing communities to transition towards greener, low-carbon energy sources, thus reducing their environmental impact.

Recommendations

Meeting Thailand’s renewable energy goal will require targeted action and tailored solutions to increase small-scale renewable power, through co-ordinated efforts across a wide range of stakeholders, including MSMEs, industry, the government, financial institutions and international partners. Public-private collaboration can provide solutions to unlock the finance needed to harness small-scale renewable energy potential and scale up decentralised community-based financing solutions.

Innovative business models will be critical to help remote communities access renewable energy at lower costs and achieve the replacement of existing diesel generation. Community-owned renewable energy models can be key enablers of a just energy transition by allowing households to acquire greater control and ownership over their energy resources. They can also be a vehicle to challenge norms and perceptions of gender roles by enabling women to fully benefit from clean energy opportunities and jobs.

To support the Government of Thailand and key Thai stakeholders to promote and de-risk small-scale renewable power investment, the Roadmap proposes recommendations across three key pillars: (i) financial support; (ii) policy, regulation and governance; and (iii) capacity building, data collection and awareness-raising.

Financial support

Reviewing and strengthening existing public financial incentives to prioritise the acceleration of small-scale and community-based renewable energy models

Thailand experienced fast growth of installed capacity of solar PV since the introduction of the FiT policy, especially large, utility-scale projects. However, this has not been the case for small-scale and community-owned or community-led projects, which are instrumental to decentralise energy production and ensure energy supply, provide clean electricity access to off-grid areas and spur local socio-economic

development. The Government of Thailand could consider reviewing and strengthening its existing financial incentives to accelerate the installation of small-scale distributed renewable energy projects (e.g. residential rooftop solar PV), which lags behind utility-scale capacity.

Thai energy policymakers and regulators (e.g. the Ministry of Energy and the Energy Regulatory Commission) could regularly monitor the up-take of the ongoing feed-in-tariff scheme, review and adjust FiT tariff rates to encourage small-scale and community-based renewable energy projects if their uptake is low. It is important to ensure that tariffs are calculated to cover investment costs rather than avoided generation cost to kick-start small-scale renewable energy sector. Moreover, the FiT policy can facilitate the development of small-scale solar, for example by developing and disseminating template contracts for solar PPA, solar roof rental and community-ownership models. Such templates could support market players by providing standardised clauses. Furthermore, the FiT policy should also be accompanied by other incentives, such as the ones outlined below, to ease access to finance for small producers, for whom upfront investment costs of solar systems are still significant.

De-risking and improving conditions of green loan programmes for MSMEs

The government, through the Ministry of Energy and Ministry of Finance, could consider continuing incentives or subsidies to encourage banks to offer green loans to MSMEs at more favourable terms. This could take the form of tax incentives, subsidies for interest rate differentials, or credit guarantees to mitigate banks' risks associated with green lending (see recommendation below on the credit guarantee scheme).

Implementing risk mitigation measures, for example through credit guarantees, can help lower the risk of small-scale projects and MSMEs, increase the confidence of lenders, which can, in turn, improve terms and conditions of existing green loan programmes for small-scale renewable energy projects and MSMEs (e.g. through favourable interest rates, lower collateral requirements, longer tenures and flexible repayment schedules).

Terms and conditions of existing green loan programmes for small-scale renewable energy projects and MSMEs could be improved (e.g. favourable interest rates, lower collateral requirements, longer tenures and flexible repayment schedules). Within the loan origination process, financial institutions could apply adequate and proportionate reporting and verification standards for MSME green loans.

Simplifying and streamlining application and approval processes for green MSME loans could also help to ease MSMEs access to financing for renewable energy projects. Expediting approval timelines and providing online application options can help lower barriers to entry for MSMEs seeking green financing. Access to information and capacity-building activities for both financial institutions and MSMEs could be increased – see a dedicated action plan on this below.

Piloting a green credit guarantee scheme for small-scale RE projects

The government could consider supporting the pilot of a green credit guarantee scheme to de-risk small-scale renewable projects, designing it to cover grid connected solar rooftops and other renewable energy technologies as well as off-grid renewable energy solutions. A green credit guarantee would incentivise small-sized ESCOs with limited track record and collateral to obtain financing. Such a guarantee scheme could also accelerate the uptake of a net-billing policy offering high enough tariffs.

The Thai Credit Guarantee Corporation (TCG) could act as guarantor, given its mandate and ability to extend and process guarantees. While designing the pilot guarantee scheme, it is important to ensure that guarantee fees and administrative processes do not disproportionately add to the final cost of finance for MSME and ESCO borrowers. Concessional financing from the government and support by donors and DFIs might be required to partially offset guarantee fees and service costs, especially at the onset of the programme, to lower the guarantee fee for MSMEs and small-scale renewable projects as well as to mobilise commercial banks.

As a first step, a programme feasibility study could be conducted, assessing the market offer and challenges of green financing products for small-scale renewables, readiness of the TCG, potential guarantee take-up challenges faced by ESCOs and MSMEs (e.g. through a market survey) as well as the degree of awareness of financial institutions on the Thai green taxonomy. The feasibility study could inform decisions on key design elements, namely: (i) the choice between the individual and portfolio guarantee approach; (ii) the coverage ratio (i.e. what portion of a loan can be covered by a guarantee); (iii) the pricing structure for the guarantee fees; (iv) the process for handling defaults and guarantee payouts; and (v) the exit strategy.

A credit guarantee scheme alone will not be able to bridge the lack of technical capacity of a lender or borrower to assess renewable energy projects, so the guarantee scheme needs to be accompanied by tailored capacity-building programmes, for example on the Thai taxonomy energy criteria and on technical risk assessments for small-scale projects. The full roadmap and timeline for piloting a credit guarantee scheme for small-scale renewable projects in Thailand can be found in Table 3.4 below.

Table 3.4. Roadmap for a green credit guarantee implementation in Thailand

Key areas	Activities	Responsible agency	Year 1-2: Preparation		Year 3-5: Pilot			Year 6 onwards: Scale-up
Program feasibility	1.1. Market and analysis and feasibility study	DEDE	X					
	1.2. Regulatory review and policy development	DEDE	X					
	1.3. Financial modelling and risk assessment	DEDE	X					
Program design	2.1. Identify the type and structure of the guarantee scheme that best suits the local context and needs of MSMEs (individual vs portfolio guarantee)	DEDE engaged with all key stakeholders		X				
	2.2. Design the scheme with appropriate risk sharing, fees, types of loans, defaults and risk management mechanisms to ensure financial sustainability and additionality.	DEDE and TCG		X				
	2.3. Involve donors, the public sector and the private sector in funding, regulating and operating the scheme, and balance their roles and interests	DEDE, TCG and funding agencies		X				
	2.4. Create a conducive regulatory and institutional framework that supports the creation and growth of the scheme and promotes its use among the financial sector and the general public	DEDE		X				
Pilot project	3.1. Marketing and outreach	TCG			X	X	X	
	3.2. Training and capacity building	Technical support agencies			X	X	X	
	3.3. Financing setup	TCG, funding agencies and commercial banks			X			
	3.4. Installation of clean energy technologies	Project developers				X	X	
	3.5. Monitoring and data collection	TCG and commercial banks				X	X	
	3.6. Evaluation and adjustment	TCG					X	
Scale-Up	4.1. Program revision and finalisation	DEDE and TCG						X
	4.2. Capacity building and marketing	DEDE and TCG						X
	4.3. Continuous monitoring and evaluation	DEDE and TCG						X

Source: Authors

Providing financial support to Pay-As-You-Go (PAYG) models to expand off-grid, community-based RE

The primary targets for replicating PAYG models include off-grid communities, especially in remote islands, where extending the grid is not economically viable. Financing at favourable terms from the government, donors, multilateral development banks (MDBs) and development finance institutions (DFIs) is necessary at the early stage of innovative PAYG models, to cover upfront investment and business planning costs. Sufficient funding is also necessary for frequent maintenance and/or replacements, particularly of sensitive components like batteries and inverters. Public funding could be used effectively to mobilise private investors from the onset of the project.

Replicating and expanding the PAYG model in remote islands would require significant training to ensure the communities have the necessary technical skills. Effective implementation significantly depends on the community's understanding and engagement with the solar systems. This requires comprehensive awareness raising and capacity-building. The full roadmap and timeline for the PAYG model implementation in Thailand is included in Table 3.5 below.

Though initially developed for clean electrification of off-grid areas, PAYG models are also applicable to on-grid communities seeking clean energy solutions. Through the PAYG model, on-grid communities can move towards greater energy independence, making them more resilient to grid outages and fluctuations in energy prices and allowing communities to transition towards cleaner energy sources.

Table 3.5. Roadmap for PAYG implementation in Thailand

Key areas	Activities	Responsible agency	Year 1: Preparation	Year 2-3: Pilot expansion	Year 4 onwards: Scale-up
Stakeholder engagement and policy support	1.1 Establish a task force with representatives from the Ministry of Energy, private investors, international aid organisations, and community leaders.	MOEN & ReCharge Energy	X		
	1.2 Advocate for policy reforms that support microgrid developments in off-grid and on-grid areas.	MOEN & ReCharge Energy	X		
	1.3 Engage local communities throughout the project development process	Task Force		X	X
	1.4 Foster public-private partnerships to enhance investment and technology innovation.	Task Force		X	X
Technical and need assessment	2.1 Identify potential off-grid and on-grid communities that can benefit from PAYG.	MOEN & ReCharge Energy	X		
	2.2 Evaluate current technologies and identify the need for technical upgrades or adaptations to suit local conditions.	MOEN & ReCharge Energy	X		
Financing	3.1 Create a financial strategy suitable for scaling, including identifying sources for funding and investment.	MOEN & ReCharge Energy	X		
	3.2 Secure financing sources for project investment	Investors, Banks		X	X
Expansion	4.1 Deploy PAYG systems in selected off-grid / on-grid communities.	MOEN & ReCharge Energy		X	X
Capacity building and training	5.1 Develop local capacity in technical, managerial, and financial aspects of PAYG systems.	MOEN & ReCharge Energy		X	X
	5.2 Implement comprehensive education programs for end-users to ensure proper use and maintenance.			X	X
Monitoring and evaluation	6.1 Set up systems to monitor usage, payments, and operational metrics.		X		
	6.2 Regularly monitor and evaluate projects as per the set-up systems			X	X

Source: Authors

Developing aggregation and securitisation models for small-scale renewable energy projects

Blended finance can be used to support bundling and aggregation of multiple small-scale projects or assets into larger and rateable financial products or vehicles that are more attractive to large institutional investors. With the aggregated portfolio acting as an entry point for investors, transaction costs are reduced as compared to investing in small-scale projects individually. Moreover, financial aggregation and securitisation provide a means of managing portfolio risk as the operational risks of individual assets are diluted within the portfolio.

Through securitisation, projects can be bundled to reach a scale and risk profile that is attractive to investors. For example, small loans for renewable energy projects can be pooled and then sold to a separate legal entity, such as special purpose vehicle (SPV), to protect the assets from any insolvency of the sponsoring entity or seller. The SPV can then issue marketable securities, typically in tranches with different credit risk. Different layers of risk exposure can facilitate the participation of different types of investors and risk-return profiles. Within such structures, donors, DFIs, MDBs and/or the government can

provide first loss tranches as credit enhancement to comfort senior tranche investors. Private investors and commercial banks can act either as originators (to reduce credit risks and free up capital for new lending) or as risk buyers (e.g. to get increased exposure in renewable energy portfolios).

This type of financing model has been successfully employed in other emerging and developing economies. Examples include Brazil's Green Receivables Fund, a securitisation instrument to address the lack of long-term finance for clean energy projects, as well as clean energy securitisation transactions in Kenya. Lessons learnt from previous experience with these transactions point to the need for grants and technical assistance to develop large and bankable pipelines of small-scale renewables projects as well as to gather and standardise risk and performance data from small entities. Sharing legal services and technical advice and standardising common documentation can reduce transaction costs associated with structuring, underwriting and due diligence of individual companies or projects.

Policy, regulation and governance

Strengthening policy planning and setting region-specific targets on small-scale renewable energy over the near- and long-term

To meet distributed renewable ambitions, a clear strategy with near- and long-term targets for small-scale renewable power installed capacity (including a specific target on rooftop solar PV) could help to provide policy direction, clarify long-term opportunities for developers and foster the development of a local industry ecosystem. Such strategy and targets can also help strategically target public and development funds to where they can have the most impact in mobilising private investment to meet sustainable energy needs. While the national energy plan sets out high-level ambitions, developing clear technology- and region-specific targets will be necessary if the aim is to ensure that all communities have access to reliable, clean and affordable electricity.

Encouraging financial institutions to assess and disclose taxonomy alignment of their portfolios

The first phase of Thailand Taxonomy, launched in 2023 by the Bank of Thailand and the Securities and Exchange Commission, as co-leads of the Thailand Taxonomy Board, was a key step to provide clarity and harmonisation on technical screening criteria and thresholds of green and transition activities in the energy and transport sector. The taxonomy can also stimulate the growth of small-scale renewable energy projects by providing harmonisation of green criteria as well as bring clarity and certainty to investors, who will be able to better assess and compare the environmental benefits of renewable energy projects and thus avoid greenwashing risks.

The next phase of the taxonomy will focus on developing quantitative criteria for additional sectors. Beyond expanding the sectoral coverage of the taxonomy, it is important to encourage and support actual implementation of the taxonomy by financial institutions, for example, by setting requirements for financial institutions to assess and disclose the extent of alignment of their portfolios with the taxonomy. Such regulatory measures shall clarify the taxonomy alignment reporting requirements and timelines for both financial and non-financial entities. Regulatory provisions could also mandate or encourage that the taxonomy is used to identify eligibility criteria of green financial products (e.g. green bonds and loans). On the supply side, developers of small-scale projects would need to incorporate green taxonomy criteria into project design and implementation, which would provide assurance of the mitigation and other environmental benefits, thereby facilitating access to sustainable finance sources. Standardised taxonomy-alignment assessments can also facilitate smaller projects to be pooled together as assets are more readily compared.

Internal capacity of financial institutions to conduct technical assessments of the alignment of financed activities with taxonomy criteria needs to be developed, through appropriate trainings and capacity building. Taxonomy-alignment disclosure requirements to financial institutions and listed companies would indirectly affect their clients and suppliers, regardless of their size. For this reason, it is important to anticipate that MSMEs will need significant support to build the internal capacity and infrastructure to be able to gather climate and environmental risks and performance data, incorporate green criteria and conduct assessments of taxonomy alignment.

Strengthening the regulatory environment for financial securitisation of renewable energy assets

Developing the green securitisation market in Thailand in a prudent way requires establishing a favourable local regulatory environment by the Thai financial regulator and supervisor (the Bank of Thailand). Such regulation could address the risks inherent to securitisation transactions, for instance by setting strict risk retention requirements, improving transparency and risk management processes, and enhancing underwriting policies (EBA, 2022[29]). Moreover, facilitating the standardisation of contracts and enabling access to issuers' performance data of the underlying assets are key to facilitate due diligence and provide transparency to investors.

The regulatory framework would also clarify eligibility criteria for renewable energy assets to be securitised, e.g. related to the project size, technology type, track record and revenue generation stability. Moreover, the assessment and rating of renewable energy securitisation transactions by independent credit rating agencies would need to be facilitated. To do so, the financial regulator could collaborate with rating agencies and industry associations to develop rigorous methodologies for assessing the creditworthiness of this type of transactions.

Technical assistance and capacity building on securitisation and risk transfer, learning from international experience (e.g. on green securitisation regulation in the United States, European Union and China), can be beneficial for both supervisors and financial institutions.

Simplifying renewable energy licensing and permitting processes and requirements

Processes and requirements for renewable energy licensing and permitting could be simplified, including building modification permissions for smaller projects. The creation of a single-window service licensing portal (such as an online platform or one-stop service) could significantly reduce administrative barriers and streamline application procedures, especially for small players. To be effective and such one-stop-shop could be adequately staffed and have a digital platform for online monitoring. Such a platform could also provide information about all related regulations, equipment standards as well as available products. Moreover, the governance of the one-stop shop, including management and oversight responsibilities and inter-agency co-ordination for licensing processes, will need to be defined and agreed upon early on to avoid potential operationalisation delays. Additional ways to facilitate small-scale renewable energy development include streamlining permitting requirements for small or community-owned installations (e.g. construction permits, grid connection authorisations, etc.). This can help reduce costs and shorten timelines for obtaining relevant technical and environmental approvals for the project, thereby reducing risks of project development at the pre-feasibility and feasibility stages.

Improving consistency and harmonisation of grid connection codes

Thailand currently has several different grid connection codes for the power system, defined by the Electricity Generating Authority of Thailand (EGAT) and its two distribution utilities Provincial Electricity Authority (PEA) and Metropolitan Electricity Authority (MEA). For example, EGAT, PEA and MEA have slightly different requirements on equipment for solar systems and this creates complexity and uncertainty.

Grid codes could be harmonised and streamlined across the three agencies, to ensure consistency to accommodate for future increase in variable renewable energy. They could also be reviewed to accommodate for distributed clean energy resources. When revising the codes, it is important to ensure the technical capabilities needed to efficiently operate the system and provide supply security while avoiding excessive requirements that may be a barrier to deployment. Grid codes could be technology neutral to avoid putting up barriers to any new technologies such as distributed resources (IEA, 2023[30]).

The regulator (ERC) can play a key role in improving the consistency of grid codes between EGAT, MEA and PEA and ensuring that stakeholders comply with the grid codes. Effective co-ordination among EGAT, MEA and PEA agencies is necessary to streamline requirements.

Capacity building, data collection and awareness

Building capacity of MSMEs, financial institutions and technicians and developing training programmes

With grants, technical assistance and support of international development partners, access to information and capacity-building activities for both financial institutions and MSMEs could be increased, in particular by focusing on the following priorities:

- enhancing financial institution capacity on conducting climate-related disclosures, applying green standards for their lending and investment products, assessing portfolio alignment with the Thai taxonomy criteria as well as on assessing small-scale renewable energy business models
- increasing MSMEs awareness and knowledge on the latest renewable energy opportunities as well as to improve their financial literacy
- increasing developers knowledge on designing renewable energy products that are in line with the Thai taxonomy criteria
- developing financial institution and regulators knowledge on securitisation and risk transfer for renewable energy assets, learning from international experience (e.g. on green securitisation regulation in the United States, European Union and China)
- providing adequate training to solar PV technicians and contractors for them to acquire adequate skills and updated knowledge on latest innovations as well as safety standards.

Furthermore, given the rapidly evolving nature of distributed renewable energy technologies, continuous learning and monitoring of technology developments is essential to ensure that technology-selection decisions continue to be well suited to the market's particular stage of development.

Implementing consumer awareness and education campaigns and fostering community engagement

With support from international development partners, awareness campaigns on small-scale, distributed and off-grid renewable technologies can address different target groups ranging from policy makers, project developers and industry professionals, as well as financial institutions, commercial end-users and civil society. Awareness campaigns could focus not only on spreading knowledge on the latest technologies and regulatory changes and standards, but also on the latest developments in terms of financial instruments, both public and private.

Fostering community engagement and raising community awareness about the benefits of PAYG-enabled renewable energy model are necessary to encourage the up-take of these solutions. Empowering local communities to take ownership of decision-making process, addressing their energy needs and preferences, and demonstrating the socio-economic and environmental benefits of PAYG models can help

generate demand and acceptance for these initiatives. Education campaigns on community-based renewable energy models and PAYG solutions in schools can also promote youth engagement.

Furthermore, the local and decentralised nature of community-based renewable energy projects can facilitate the creation of green job opportunities and skill development for women and youth. Community ownership structures can encourage women and youth to participate in decision-making processes, take leadership roles and get involved in project development. Moreover, the provision of cleaner energy opportunities will benefit women who often bear most of the consequences of the use of polluting sources of energy and fuel. Community engagement activities could therefore promote outreach and participation of women and youth.

Fostering data collection on small-scale renewable capacity and financing

Increasing the availability of data on the expansion of small-scale energy capacity across different types of renewable energy would be beneficial. Financial institutions and investors would benefit from better access to risk and performance data of small-scale renewable projects (e.g. recovery rates, default risks), which would facilitate their aggregation for securitised products as well as more generally increase investors' knowledge and confidence in investing in these models.

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Notes

[1] These grid codes can be categorised according to transmission and distribution levels and by the types of generators (IPP, SPP and VSPP) as follows: EGAT (connection and operation codes for IPP, EGAT power plants, SPP, IPS, MEA and PEA; service code); MEA (VSPP connection code, VSPP operation code, VSPP service code); and PEA (VSPP connection code, VSPP operation code, VSPP service code) (OECD/IEA, 2018[31]).

[2] Solar leasing is considered both a business and a financing model. It can be considered a business model as it is structured to enable enterprise and customer value creation, but it is also a financing model, as it provides the capital needed for consumers to own a solar system (Tongsopit et al., 2016[13]).