# MINI-GRIDS

## A JUST AND CLEAN ENERGY TRANSITION

## THE GLOBAL SOUTH: A SCOPING STUDY

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# MINI-GRIDS: THE GLOBAL SOUTH

**THE TECHNOLOGICAL LANDSCAPE IS CHANGING IN FAVOUR OF MORE DECENTRALISATION AS THE COSTS OF PV AND BATTERY ENERGY STORAGE CONTINUE TO FALL SHARPLY AND AS ENERGY EFFICIENCY, REMOTE CONNECTIVITY AND DATA ANALYSIS HELP TO REDUCE OPERATING COSTS AND IMPROVE EFFICIENCY**

Power systems first started almost 150 years ago as a decentralised architecture, but were later consolidated into a much more centralised structure, with large generation plants benefitting from economies of scale, and transmission and distribution networks relaying the electricity generated to the consumer. Governments in emerging countries have, in the past, tried to use similar, centralised approaches to improve access to electricity, but this has now started to change. The areas that can easily be reached by the main grid are diminishing, and the marginal costs of extending the grid to reach more remote and rural customers are becoming prohibitive. This has led some governments to deploy decentralised forms of energy that benefit from rapid declines in the costs of modular, distributed clean energy generation and storage technologies.

## A DECENTRALISED APPROACH

In some communities, where the main grid is not nearby or is insufficiently reliable, off-grid generators have been deployed. The technological landscape is changing in favour of more decentralisation as the costs of PV and battery energy storage continue to fall sharply and as energy efficiency, remote connectivity and data analysis help to reduce operating costs and improve efficiency. Renewable hybrid mini-grids as well as household-sized solar home systems can complement and compete with the grid in terms of the costs of electricity, speed of deployment and profitability.

## COST-EFFICIENT TECHNOLOGY TO DELIVER ELECTRICITY

The most cost-effective method of delivering power is determined by both the distance from the nearest grid line and the amount of energy utilised. The cost of a grid expansion amortised over 20 years can add US $0.10-0.50/kWh to low-income consumers with annual energy usage of 70-200 kWh per home, easily tripling retail rates and increasing the maximum range of the cost as high as US $1/kWh (see Graph 1). Despite the substantially greater cost of generating electricity in a kW-scale installation, this additional cost makes mini-grids viable in many regions.

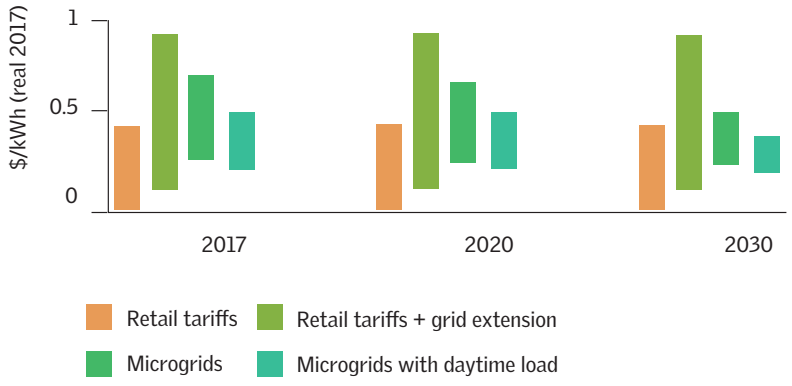
For houses with an annual energy usage of 1,000 kWh or more, the cost of power provided by grid extension is much lower (see Graph 2). The cost of expanding the grid is soon recouped, as it amounts to just US $0.03-0.11/kWh. The grid is, therefore, likely to remain the major alternative in more easily accessible areas or where demand growth is expected to be fair. Solar household systems are already affordable enough to compete with mini-grids in areas where access is difficult or grid electricity is costly. If the system is actively managed to boost demand during the daytime, through new business and operating models, electricity provided by mini-grids will become cheaper.

## TRENDS IN ELECTRICITY ACCESS

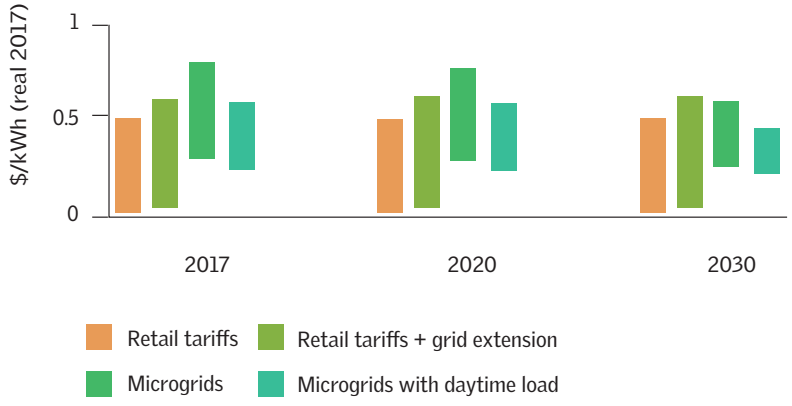
Globally, the anticipated number of people without access to electricity had declined to around 771 million by the end of 2019, down from 1.4 billion in 2010. This amazing improvement, particularly in Asia, was aided by grid extension and the quick

IF THE SYSTEM IS ACTIVELY MANAGED TO BOOST DEMAND DURING THE DAYTIME, THROUGH NEW BUSINESS AND OPERATING MODELS, ELECTRICITY PROVIDED BY MINI-GRIDS WILL BECOME CHEAPER

**Graph 1: Cost of delivered energy for low-income consumers (200 kWh per year)**




**Graph 2: Cost of delivered energy for medium-income consumers (1,000 kWh per year)**




Note: Low-income customers are assumed to use 200 kWh per year. Medium-income customers are assumed to consume 1,000 kWh/year. The average grid extension cost per household was derived from past project examples. A mini-grid with daytime load produces additional electricity for non-residential activities. Retail tariffs refer to national utility tariffs.

deployment of off-grid solar kits. Electrification, on the other hand, varies greatly between Sub-Saharan African nations, with the number of people without electricity relatively stable in recent years at little over 600 million. Without the rapid deployment of new energy access technologies, such as mini-grids,

achieving universal power access by 2030 seems improbable.

Between 2010 and 2016, the worldwide electrification rate increased somewhat, going from 0.77 per cent per year (127 million people per year) to 0.83 per cent per year (136 million people per year) between 2016 and 2019. These figures, however, fall short of the advances required to meet the 2030 target of universal access to energy.

According to existing and planned policies prior to the onset of the COVID-19 crisis, some 620 million people will still be without access in 2030, with 85 per cent of them living in Sub-Saharan Africa[1].

Since 2010, there has been a global gain in access to energy, although growth has been uneven among areas. By 2021, Latin America and the Caribbean, Eastern Asia, and South-east Asia will have achieved universal access to electricity, with 98 per cent of the people having access to power. By 2019, more than 90 per cent of the people in Central and Southern Asia had obtained access to electricity. Access to information is becoming increasingly concentrated in Sub-Saharan Africa.

**SINCE 2010, THERE HAS BEEN A GLOBAL GAIN IN ACCESS TO ENERGY, ALTHOUGH GROWTH HAS BEEN UNEVEN AMONG AREAS**

In 2019, the 20 nations with the worst access gaps accounted for 78 per cent of the global population without access to electricity (see Table 1). The three countries with the biggest deficits were Nigeria, the Democratic Republic of Congo (DRC) and Ethiopia, with 89 million, 70 million, and 58 million people, respectively. Bangladesh, Kenya and Uganda have

**Table 1: The 20 countries with the largest access deficit**

| Sl. no. | Countries | Access to electricity (% of population) | Population without electricity | Ease of Doing Business Ranking out of 190 countries 20202 "Getting Electricity and Electricity Access" | Per capita electricity consumption (kWh) |
|---|---|---|---|---|---|
| 1 | Nigeria | 55.40 | 8,96,29,766 | 169 | 145 |
| 2 | DR Congo | 19.10 | 7,02,13,571 | 177 | 109 |
| 3 | Ethiopia | 48.30 | 5,79,44,703 | 137 | 69 |
| 4 | Pakistan | 73.90 | 5,65,23,549 | 123 | 448 |
| 5 | India | 97.20 | 3,82,59,697 | 22 | 805 |
| 6 | Tanzania | 37.70 | 3,61,37,402 | 85 | 104 |
| 7 | Uganda | 41.30 | 2,59,86,249 | 168 | NA |
| 8 | Mozambique | 29.60 | 2,13,77,692 | 103 | 479 |
| 9 | Sudan | 53.80 | 1,97,79,717 | 162 | 257 |
| 10 | Madagascar | 26.90 | 1,97,14,566 | 186 | NA |
| 11 | Niger | 18.80 | 1,89,28,305 | 159 | 51 |
| 12 | Angola | 45.70 | 1,72,81,132 | 156 | 312 |
| 13 | Myanmar | 68.40 | 1,70,78,353 | 148 | 215 |
| 14 | Burkina Faso | 18.40 | 1,65,82,246 | 183 | NA |
| 15 | Malawi | 11.20 | 1,65,42,330 | 171 | NA |
| 16 | Kenya | 69.70 | 1,59,29,913 | 70 | 164 |
| 17 | Chad | 8.40 | 1,46,07,342 | 180 | NA |
| 18 | North Korea | 49.40 | 1,29,87,077 | NA | 602 |
| 19 | Bangladesh | 92.20 | 1,27,17,600 | 176 | 320 |
| 20 | Mali | 48.00 | 1,02,22,176 | 161 | NA |

Countries in African region  Countries in Asian region

improved the most among the 20 nations that had the highest access deficits since 2010.

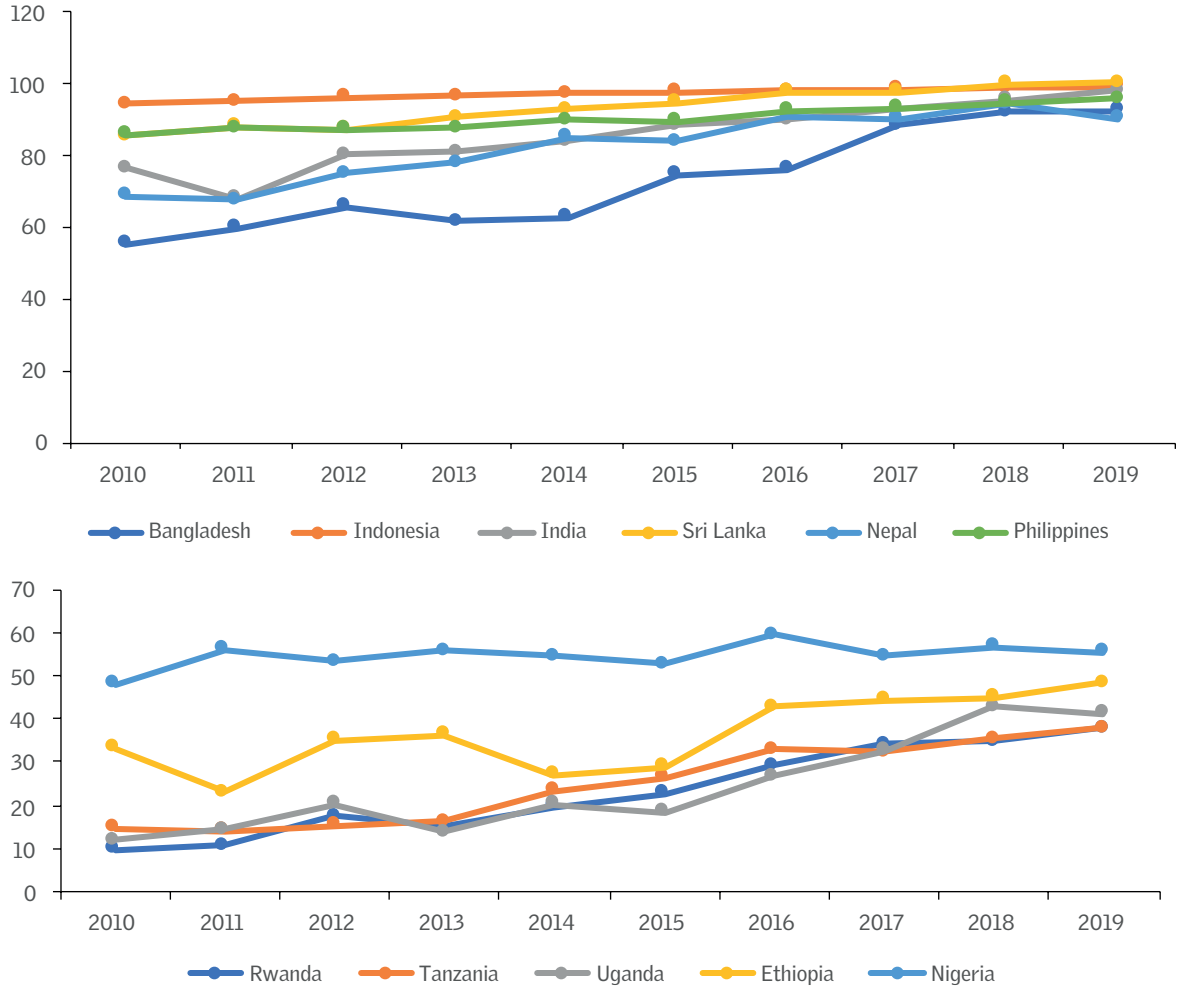
## PROGRESS: NOT UNIFORMLY DISTRIBUTED

Even within the same region, progress in gaining access to electricity differs greatly among countries. These disparities imply that progress can be hastened if governments commit to aggressive electrification programmes.

In Asia, the Philippines and Indonesia have made

steady progress in recent years, with electrification rates of 96 per cent and 99 per cent, respectively, by the end of 2019. However, growth beyond this may be slower, and on distant islands where grid extension is not economically feasible, local energy systems may be required. Between 2010 and 2019, Bangladesh's electricity rate increased from 55 to 92 per cent, thanks to a surge in the off-grid solar sector and concessional financing from the Infrastructure Development Company Limited (IDCOL).

**Graphs 3-4: Historical electrification rates of (a) select Asian countries and (b) select Sub-Saharan African countries**



**A SURVEY OF 10,000 RURAL CONSUMERS AND COMPANIES IN FOUR STATES IN INDIA SHOWS THAT DESPITE BEING WITHIN 50 METRES OF AN ELECTRICITY POLE, MANY RESPONDENTS DID NOT UTILISE ENERGY FROM THE GRID**

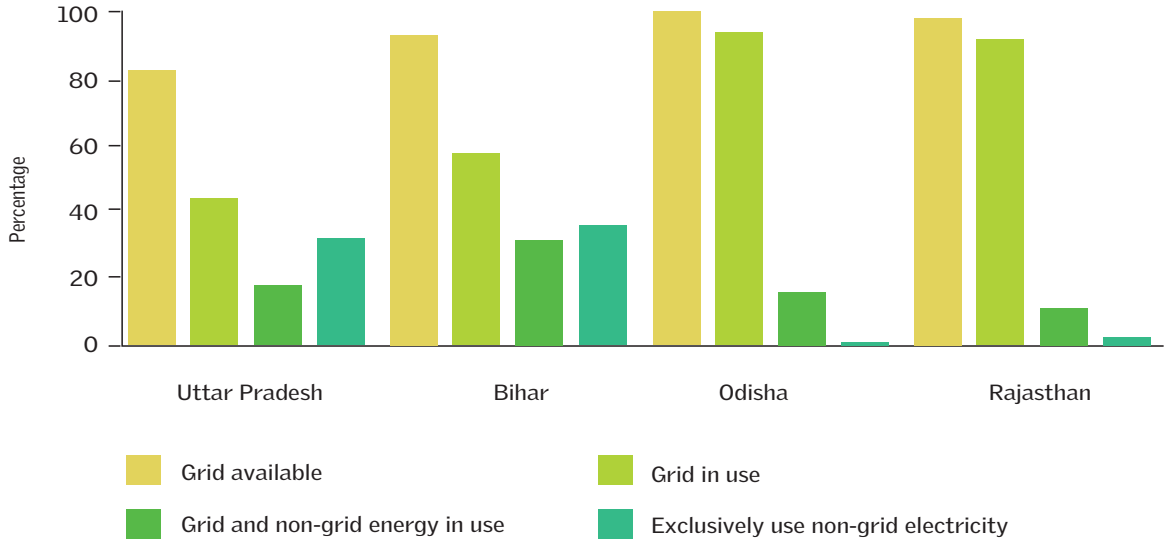
Off-grid solar kits have aided growth in East African countries in Sub-Saharan Africa. Rwanda's electricity rate increased from 10 per cent in 2015 to 38 per cent by the end of 2019, with off-grid solar accounting for a third of the increase. Between 2010 and 2019, Tanzania's electricity rate increased from 15 to 38 per cent, mainly due to both grid extension and off-grid solar. Nigeria, on the other hand, had a reduction in access from 60 per cent to 55 per cent between 2016 and 2019, as population growth exceeded the number of individuals who gained access.

## RELIABILITY CHALLENGES

Even if a consumer has grid connection, the supply of power is not always consistent (i.e., electricity is supplied intermittently). In March 2019, the Indian government declared "100 per cent energy availability" at the home level. However, a survey of 10,000 rural consumers and companies in four states commissioned by the Rockefeller Foundation's Smart Power India Initiative revealed that, despite being within 50 metres of an electricity pole, many respondents did not utilise energy from the grid.

Solar, mini-grids, lead-acid batteries, and diesel generators were utilised solely by 32 per cent and 36 per cent of small enterprises in Uttar Pradesh and Bihar, respectively (see Graph 5). An additional 18 per cent and 32 per cent, respectively, utilised such technologies in combination with the grid, presumably to cover the nine-12 hours per day when the grid is not supplying energy. Such trends imply that distributed energy solutions aren't merely considered as a last resort for locations without power lines, but may also

**Graph 5: Available electricity options among small rural enterprises in India**




be perceived as a supplement to or replacement for the grid, providing extra services to consumers.

## WILL UNIVERSAL ACCESS BE ACHIEVED BY 2030?

The quick answer is no, not according to present patterns. According to Climatescope 2019, 65 nations in Africa, Asia, and Latin America have established medium or long-term power access goals. Kenya's universal energy access objective is set for 2020, Ethiopia's is set for 2025, while Haiti and Myanmar's targets are set for 2030. The deadlines aren't going to be met. Even if we take such announcements at face value, the global financial gap is enormous, and the world is presently not on track to meet the 2030 target of universal power access: 620 million people will still be without power in 2030 if progress on energy access continues at its current rate and policies are implemented as intended.

This equates to around 8 per cent of the global population, with nine out of 10 individuals residing in Sub-Saharan Africa. This highlights the urgent need to speed electrification programmes and investment in order to develop and scale up low-cost power access solutions.

## BEYOND ELECTRICITY ACCESS

Attaining universal energy access goals does not guarantee that everyone will have dependable electricity at all times. Most emerging-market governments assess energy access only on the basis of whether customers have access to power at all, regardless of its availability, dependability, or quality. In 2015, the World Bank Energy Sector Management Assistance Program (ESMAP) and Sustainable Energy for All (SEforALL) recommended Multi-Tier Frameworks (MTFs) since this method does not provide a comprehensive picture of access quality. MTFs can assist better capture the multiple components of energy access, such as electricity and cooking, as well as the many technologies and sources that can supply energy access, while accounting for individual differences in experience.

**MOST EMERGING-MARKET GOVERNMENTS ASSESS ENERGY ACCESS ONLY ON THE BASIS OF WHETHER CUSTOMERS HAVE ACCESS TO POWER AT ALL, REGARDLESS OF ITS AVAILABILITY, DEPENDABILITY, OR QUALITY**

Figure 1 depicts indicators used to assess residential power supply within MTFs. The frameworks, for example, allow us to determine whether families utilise basic solar lamps or grid electricity, as well as how many hours each day on average they can use grid electricity. Even if grid energy is available, if availability is less than eight hours a day, residences fall into Tier 3 or lower. Tier 3 and above households mostly utilise grid electricity.

**Figure I: Multi-tier frameworks to measure access to household electricity supply**

| | | Tier 0 | Tier 1 | Tier 2 | Tier 3 | Tier 4 | Tier 5 |
|---|---|---|---|---|---|---|---|
| | 1. Peak capacity | <3W (<12Wh) | Min 3W (Min 12Wh) | Min 50W (Min 200Wh) | Min 200W (Min 1kWh) | Min 800W (Min 3.4kWh) | Min 2kW (Min 8.2kWh) |
| | 2. Availability (hours per day/evening) | <4hrs/1hr | Min 4hrs/1hr | Min 4hrs/2hrs | Min 8hrs/3hrs | Min 16hrs/4hrs | Min 23hrs/4hrs |
| | 3. Reliability | More than 14 disnuptions per week | | | Al most 14 discruptions per week at most 3 discruptions per week with total duration of 2hrs+ | Max 14 discruptions per week | Max 3 discruptions per week of total duration <2 hrs |
| Electricity supply | 4. Quality | Household experiences voltage problems that damage appliances | | | | Voltage problems do not affect the use of desired appliances | |
| | 5 . Affordability | Cost of a standard consumption package of 365 kWh/year is more than 5 per cent of household income | | | Cost of a standard consumption package of 365 kWh/year is more than <5 per cent of household income | | |
| | 6. Legality | No bill payments made for the use of electricity | | | | Bill is paid to the utility, prepaid card selier, or authorized representative | |
| | 7. Healtyh & safety | Serious or fatal accidents due to electricity connection | | | | Absence of past accidents and perception of high risk in the future | |
| Electricity services | | | Task lighting and phone charging | General lighting, phone charging, television and fan (if Needed) | Ter 2 and any medium-power appliances | Ter 3 and any high-power appliances | Ter 4 and any very high-power appliances |

Tier 2 and lower often employ decentralised energy solutions such as off-grid solar and mini-grids, while Tier 0 residents have little or no access to power. The majority of homes in Sub-Saharan Africa do not have access to electricity or employ basic lighting equipment, with more than 55 million people in Ethiopia belonging to Tier 0. More homes in Asia

**THERE ARE 5,544 DEPLOYED MINI-GRIDS WORLDWIDE, WITH 60 PER CENT AND 39 PER CENT IN ASIA AND SUB-SAHARAN AFRICA, RESPECTIVELY. DIESEL OR HYDROPOWER ARE USED IN AROUND 31 PER CENT OF EXISTING MII-GRIDS**

have access to grid power in some manner, although dependability may be improved further.

## MINI-GRID MARKET TRENDS

This study has identified 10 countries in Sub-Saharan Africa, South Asia, and Southeast Asia with best practises for mini-grid installation (see Annexure 1). Large corporations have been more involved in the mini-grid market, exploring investments, mergers and acquisitions (M&A), and partnerships. As developers must adjust their techniques to the regulatory environment, no one business model has triumphed.

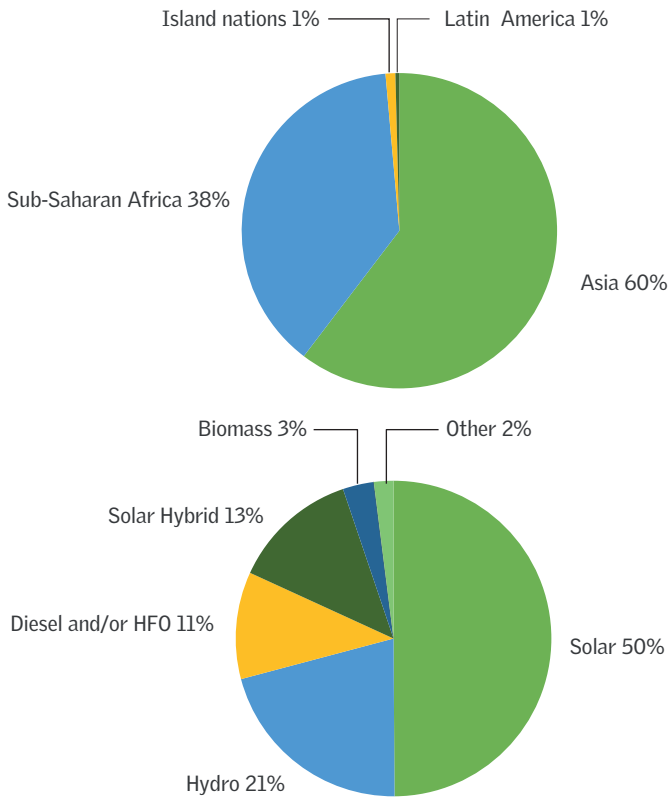
Remote mini-grids are not a new concept, but the technology behind them has evolved significantly since 2012. The majority of older mini-grids rely on a single fuel source, such as fossil fuels, hydropower, or biomass. According to SEforALL's study, there are 5,544 deployed mini-grids worldwide, with 60 per cent and 39 per cent in Asia and Sub-Saharan Africa, respectively. Diesel or hydropower are used in around 31 per cent of existing mini-grids.

Mini-grids installed in the last five years tend to contain PV and battery storage with diesel generators for backup, as technology costs have decreased and control technologies have advanced to integrate multiple distributed energy resources (DER) and optimise their operations. PV is also modular and extremely simple to set up in distant locations. Solar hybrid mini-grids are the most common type of contemporary mini-grids erected today, and many government-led mini-grid initiatives are aimed at

promoting them. Where resources are available, hydro mini-grids are still widespread (e.g., in parts of Tanzania and Nepal).

A strong legislative framework in Sub-Saharan Africa, Rwanda and Tanzania, has resulted in a rural electrification programme that has attracted private investors and boosted the solar hybrid mini-grid sector. India tops Asia with 1,792 mini-grids, followed by Indonesia with 1,061 and the Philippines with 326. Thousands of islands in the latter two nations lack main grid connections and are either dependant on mini-grids or have no access to energy.

**Graphs 6-7: Installed mini-grids by (a) region and (b) technology**



MINI-GRIDS FOR RURAL ELECTRIFICATION INCLUDE A VARIETY OF BUSINESS MODELS, WITH VARIOUS COMBINATIONS AND APPROACHES TO OWNERSHIP AND OPERATION, TECHNOLOGY, CONSUMERS, SERVICE DELIVERY, AND INVOICING

## OPERATIONAL MODELS

Mini-grids for rural electrification include a variety of business models, with various combinations and approaches to ownership and operation, technology, consumers, service delivery, and invoicing. Because developers must adjust to the legal environment as well as other local circumstances such as geography, terrain, culture, and population, there is no proven business model that works everywhere, although certain tendencies may be detected.

Ownership and operation of mini-grid assets, such as generating and distribution assets, affects mini-grid operating models. The legislative environment in which projects are built has an impact on these factors, deciding which operational models are most likely to succeed.

The national utility owns and operates the mini-grids in a utility operator model. Kenya Electricity Generating Company (KenGen) owns and manages two mini-grids in the country. Users pay the same rates as grid power customers, with payments collected from grid electricity customers subsidised. In the Philippines, the National Power Corporation Small Power Utilities Group (NPC-SPUG) established the bulk of known mini-grids, which are owned and run by local electric cooperatives. The cooperatives are in charge of power distribution and are owned by local communities, albeit the latter has little influence; in actuality, this is similar to a utility model.

Different groups are in control of ownership, generation, and distribution under a hybrid paradigm.

Many of the projects created under this paradigm are public-private partnerships, in which the government finances and controls the mini-grid while a private corporation runs it. Kenya's Rural Electrification and Renewable Energy Corporation (REREC) has 19 mini-grids that are managed by Kenya Power, a retail utility.

A private developer creates, owns, and runs the mini-grids in a private operator model. The developer may sell power to the grid operator if the mini-grids are connected to the main grid and if rules allow it. This is comparable to the structure of independent power producers (IPPs), who sell electricity to the grid from bulk generating power plants. Clean Power Indonesia, for example, sells power generated by its biomass mini-grids to the state-owned utility. To operate, most developers require a special licence. Private businesses in the Philippines must get a Qualified Third Party (QTP) licence in order to own and manage a mini-grid system in a defined region under the country's electrification programme.

The community operator model refers to a mini-grid that is owned and operated by the local community. This covers situations in which the developer provides assets to the community after the installation is completed. Local communities in Indonesia own and run mini-grids, following this paradigm. In Indonesia, certain mini-grid assets are passed to cooperatives, which may not necessarily have the competence to manage the systems.

THE COMMUNITY OPERATOR MODEL REFERS TO A MINI-GRID THAT IS OWNED AND OPERATED BY THE LOCAL COMMUNITY. THIS COVERS SITUATIONS IN WHICH THE DEVELOPER PROVIDES ASSETS TO THE COMMUNITY AFTER THE INSTALLATION IS COMPLETED

**Figure 2: Mini-grid business models – elements and options**

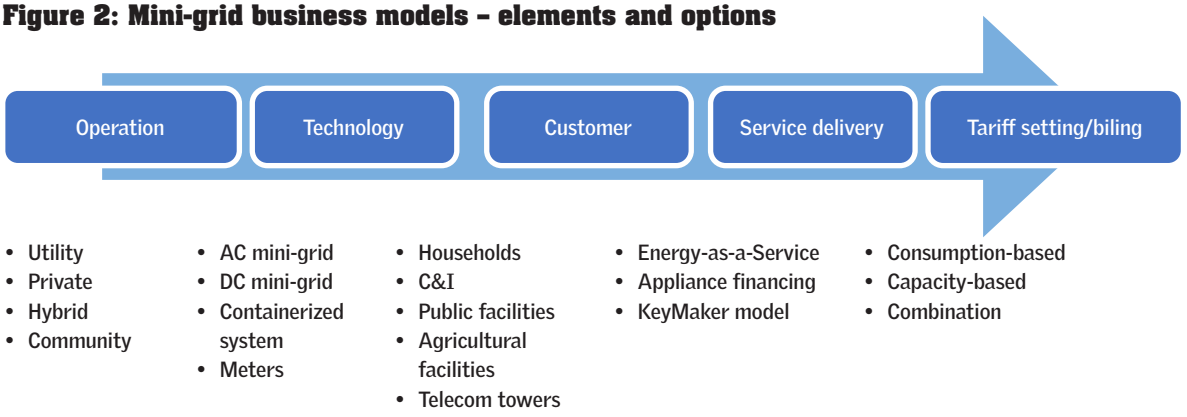



**Table 2: Examples of mini-grid operator models**

| Operator model | Owner | Operator | Examples |
|---|---|---|---|
| Utility | Utility | Utility | KenGen, NPC-SPUG in the Philippines, PLN in Indonesia |
| Hybrid | Government | Developer | Powerhive, GVE |
| | Government | Utility | REREC-Kenya Power |
| Private | Developer | Developer | Powerhive, PowerGen |
| Community | Community | Community | Cooperatives in Indonesia |

# UGANDA

Uganda has currently installed 34 mini-grids. For developers, government approval processes and tariffs that restrict their ability to recover costs without subsidies pose the greatest obstacles to further rollouts. To scale up the mini-grids in the country, in 2017 the government identified sites using least-cost electrification methods and introduced the bundled tender scheme.

At the end of 2019, only 41 per cent of Uganda's urban population had access to electricity; in rural areas, the number was a mere one in 10 accessing electricity. While the government has a stated goal

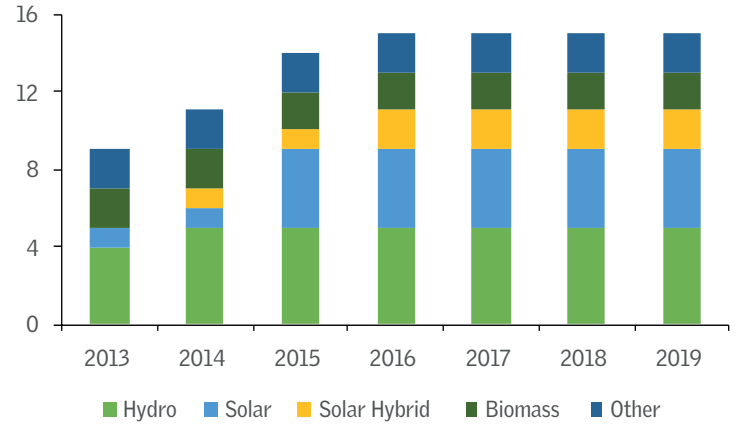
of achieving 26 per cent rural electrification by 2022, this appears quite unlikely unless the decentralised energy technology market scales up rapidly in the country.

Today, the combined total installed capacity of Uganda's 34 projects is 56.8 MW, representing 6 per cent of the country's total capacity of 940 MW[3].

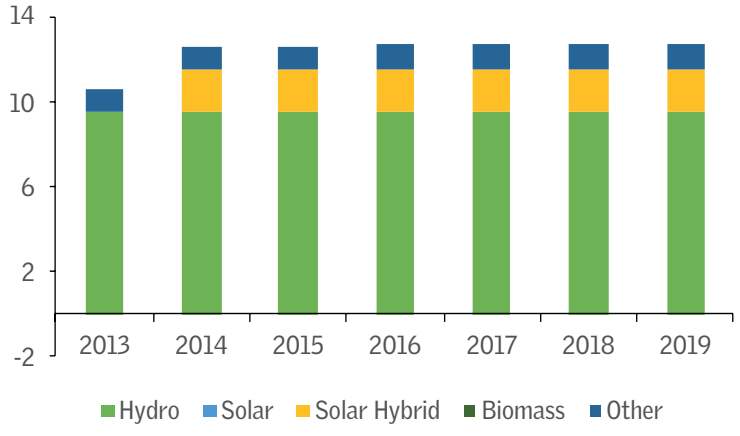
Uganda's Rural Electrification Agency (REA) has undertaken a master planning exercise and identified opportunities to build mini-grids providing power to 62,000 households across 10 service territories by 2029 (Uganda Off-grid Market Accelerator, 2019)[4]. Potential sites were selected based on the criteria of having more than 50 households clustered in one particular area and having expected grid extension costs not exceeding US $2,000 per customer.

Despite the opportunity for further mini-grid development in Uganda, the market has been slow to take off, largely due to a fragmented regulatory environment. Among other issues, the country's current policies fail to explicitly set an energy access target to be met through mini-grids. In addition, the current licensing process lacks transparency, and rules around main-grid arrival at installed mini-grid sites are unclear. In 2017, as part of the efforts to achieve the 2022 target, the Ugandan government, with support from the German Agency for International Development (GIZ), launched a bundled tender mechanism with a goal of installing 40 solar mini-grids, 25 in northern and 15 in southern Uganda.[5]

**Graph 7: Uganda's installed mini-grids, by projects**




**Graph 8: Uganda's installed mini-grids, by capacity (MW)**




## DISTRIBUTED POWER MARKET STRUCTURE

In 2001, the Uganda Electricity Board (UEB) was unbundled into three parastatal entities: the Uganda Electricity Generation Company Limited (UEGCL), the Uganda Electricity Transmission Company Limited (UETCL) and the Uganda Electricity Distribution Company Limited (UEDCL).

Under a sublease agreement with Eskom, UEGCL undertook to sublet its generation operations in 2003.

Similarly, in 2005, the Ugandan energy distributor Umeme was awarded a 20-year concession for the distribution and retail of electricity by UEDCL. Umeme provides 98 per cent of all grid electricity consumed in Uganda. The government owns assets that are operated by private distribution companies outside Umeme's control area.

Utility companies, private companies, community groups, or some combination of these operate mini-grids in Uganda. Generally, a private company develops and operates the mini-grid, owning the generating asset and paying for its construction.

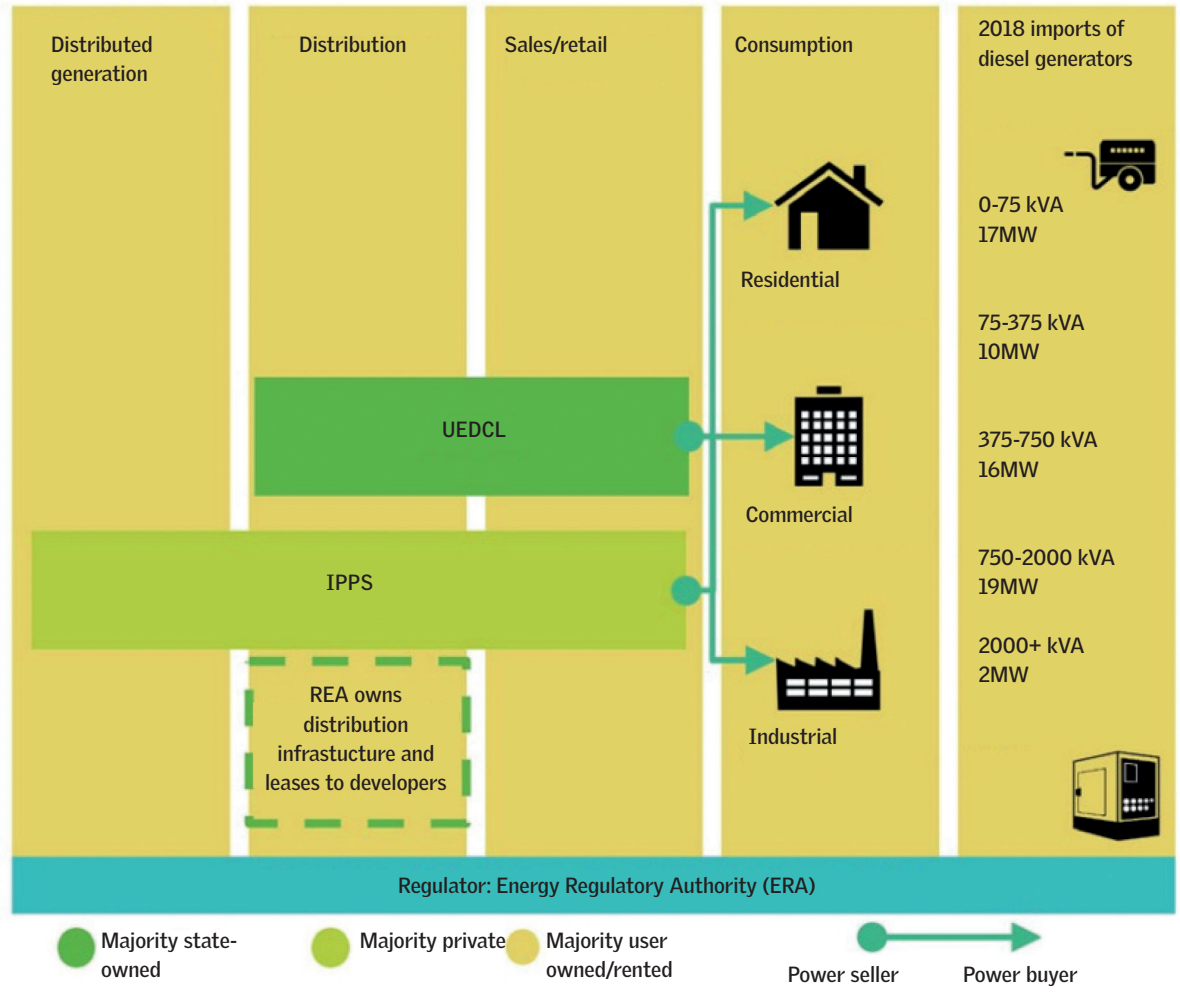
The Electricity Regulatory Authority (ERA) is responsible for approving licenses, establishing tariffs and maintaining technical standards. There is no direct regulation of mini-grids by the REA, but the ERA consults with the REA for review and approval. As part of its Rural Electrification Fund (REF), REA finances and owns the distribution infrastructure of mini-grids.

## CURRENT MARKET STATUS

Uganda's renewable-hybrid mini-grid market is less developed than those in neighbouring Kenya and Tanzania as measured by completed projects and number of players.

In Uganda, solar and hydro represent 40 per cent and 34 per cent of the total energy production. About 70 per cent of the projects are privately owned, while over a quarter are owned, operated, and managed by local communities.

**Figure 2: Uganda's distributed power market structure**




There are a number of private developers operating in Uganda's mini-grid market or planning to enter soon. Uganda lacks adequate regulations and experienced local workers. They also lamented the difficulty of acquiring land rights. Yet, they are also exploring opportunities in the country's most remote areas, such as the islands in Lake Victoria. Already, Bugala Island has a 1.6 MW solar hybrid mini-grid that serves its 30,000 inhabitants. The project is operated by Kalangala Infrastructure Services (KIS), a

public-private partnership between the government of Uganda, InfraCo Africa, and privately owned EleQtra.

**Graphs 9-10: Uganda's installed mini-grids by (a) technology and (b) ownership**

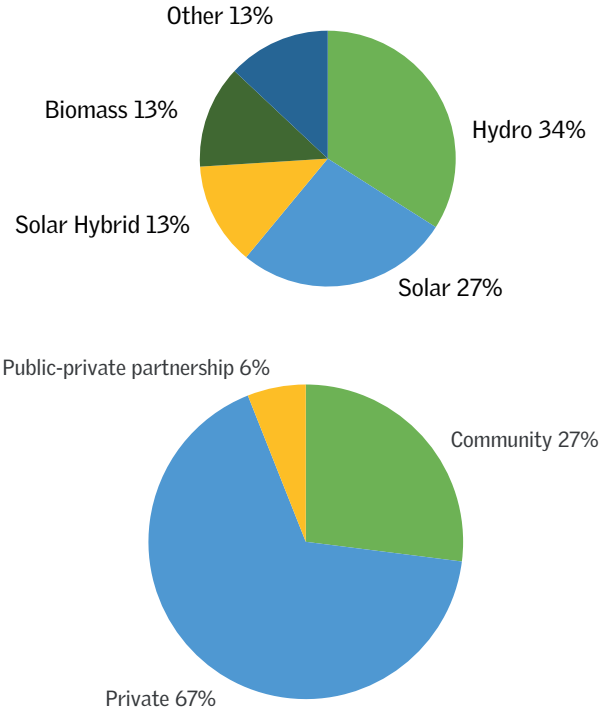



**Table 4: Mini-grid developer landscape in Uganda**

| Financier | Developer |
|---|---|
| Energising Development (EnDev) | Pamoja Cleantech |
| Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH | Absolute Energy |
| Swedish International Development Cooperation Agency | Remergy Energy Solutions |
| Sweden Sverige | Kirchner Solar Group GmbH |
| German Society for International Cooperation | Kalangala Infrastructure Services Ltd |
| InfraCo Africa Limited | GRS Commodities Ltd |
| Royal Norwegian Ministry of Foreign Affairs, Kingdom of Norway | Mantrac Group |
| Swiss Agency for Development and Cooperation, Federal Department of Foreign Affairs, Swiss Confederation | Winch Energy Group |
| Ministry of Foreign Affairs, Kingdom of the Netherlands | Equatorial Power |
| UK Aid Direct | |

Most of the financial support for projects operating in Uganda today is provided by development financing institutions (DFIs) and donor agencies. Developers have yet to access commercial loans since their business models do not meet the seven-10-year tenors of traditional lenders. Most of the funding has come from grants, with a small proportion coming from equity investments.

The REA mini-grid tender launched in 2017 had the potential to revolutionize the local market for hybrid solar power projects. The scheme has been shortlisted and will be implemented by Winch Energy and WeLight Africa.

## POLICY AND REGULATIONS

The Ugandan government has traditionally prioritized grid extension over distributed energy in its long-term electrification policies. The government released its Rural Electrification Strategy and Plan (RESP) in 2013, which aimed to electrify 26 per cent of the rural population by 2022. Additionally, REA announced it would extend the grid to connect an additional 1.28 million households. Meanwhile, 8,500 households would get service from mini-grids, with 130,000 solar home systems also being installed to meet the goal. RESP's on-grid electrification efforts accounted for 91 per cent of the total budget of US $952 million. Only 6 per cent of the budget was allocated to off-grid energy technologies.

Despite this shift in thinking, the government continues to emphasise grid-based infrastructure, despite acknowledging that this leaves the majority

of rural populations without access to electricity. In 2018, the Electricity Connections Policy was released, which sought to address low connection rates that had not been improved by earlier policies. The study recognized that high connection costs, high wiring costs, and a lack of incentives for households to gain access to electricity under a plan that focused primarily on grid expansion. Additionally, the new policy aligns targets in earlier policies, aiming to achieve 30 per cent electrification by 2020, 60 per cent by 2027, and 80 per cent by 2040 (Ministry of Energy and Mineral Development, 2018).

With just 10 per cent of Uganda's rural population having access to electricity at the end of 2018, we expect that meeting the 2027 target will be difficult without further scaling of decentralized energy technologies.

## MINI-GRID REGULATIONS

By undermining investor confidence, insufficient regulations represent the biggest bottleneck to mini-grid development in Uganda.

Accordingly, the government is working closely with the German government on developing an enabling environment for mini-grids, such as the previously mentioned tender scheme.

**Licensing:** Licensing is one of the biggest hurdles to mini-grid development in Uganda. According to the Electricity Order (ERA, 2007), off-grid mini-grids smaller than 2 MW are exempt from any licensing requirements. In reality, however, a certificate of

exemption for each project from the ERA is still required. Securing such an exemption can be a lengthy process taking a year or longer.

Developers must complete feasibility studies and acquire approvals from the National Environmental Management Authority (NEMA) for any site. They must submit environmental reports to NEMA for review with ERA having no role in that part of the process. After submitting these reports, developers can apply for a licence exemption that costs US $3,500. Only those granted exemptions then have exclusive rights to generate, distribute and sell electricity in the given area[6].

Above 2 MW, developers of stand-alone and grid-connected mini-grids must obtain licences for generating, distributing and selling electricity. This licensing process is unpredictable, opaque and time-consuming, according to market participants. Developers say there is lack of clarity on documents required and on how the licence approval process actually works. Developers receive no provisional development rights during the review, adding further uncertainty.

**Mini-grid tariffs:** Mini-grid developers can propose tariffs higher than on-grid alternatives to the ERA for review. However, in response, the ERA can amend the proposed tariffs to come closer to matching prices paid on the grid of approximately US $0.20/kWh. This may be particularly challenging for developers who find that the revised tariffs render their projects unworkable without subsidies. The

REA funds distribution infrastructure via REF, and this covers both connection and house wiring costs. This serves to reduce project capex.

**Arrival of the main-grid:** There are no clear rules in Uganda for how a mini-grid is to interact with the central grid in the future when the main-grid gets built out to where a mini-grid is located. However, developers recognize that the grid is unlikely ever to get connected to where they have been operating on Lake Victoria. According to the Ugandan government, there are more than 100 inhabitable islands on the lake with 300-600 households each, and all will gain electricity access by mini-grids.

**Tenders:** The Uganda Ministry of Energy & Mineral Development (MEMD) leads the Promotion of Mini-Grids for Rural Electrification (Pro Mini-Grids) initiative with support from the German Federal Ministry for Economic Cooperation & Development (BMZ), the German Climate Technology Initiative (DKTI), the European Union and (GIZ). The initiative started in 2016 and is due to conclude in 2020. GIZ aims to spur private investment through assisting government and the private sector in four areas: policy and steering, regulatory instruments, technology and design, and productive use.

The Pro Mini-Grids initiative also includes a tender process launched in September 2017 that aims to ensure long-term quality of supply and accelerate private investment. Within the initiative, the tender mechanism is a government-led approach that bundles sites that developers can bid to serve. A

simplified licensing procedure cut the time in half, to three months from the standard six. Using a least-cost electrification planning model developed by the Massachusetts Institute of Technology, the tender sought to estimate grid-extension costs versus mini-grid costs.

The pilot phase aims to use this mechanism to provide power to up to 15 villages in the south of the country and 25 in the north. The winning bidders, Winch Energy and WeLight Africa, are eligible to receive a subsidy of up to 70 per cent of the low-voltage distribution capex with the 10-year concession. Given that low-voltage distribution is typically 20-40 per cent of the overall capex, the subsidy equates to a sizeable 14-28 per cent of the overall capex. Interestingly, GIZ has stated that successful developers have been able to access debt financing due to the increased economies of scale and lower perceived risk.

**Table 5: Approval and licensing requirements**

| Generation capacity (kW) | Generation licence required? | Tariff approval required? |
|---|---|---|
| <100 | No | Yes |
| 100-2,000 | No | Yes |
| 2,000+ | Yes | Yes |

Source: Uganda Electricity Order 2007, Electricity (Application for Permit. Licence and Tariff Review) Regulations, 2007.

# TANZANIA

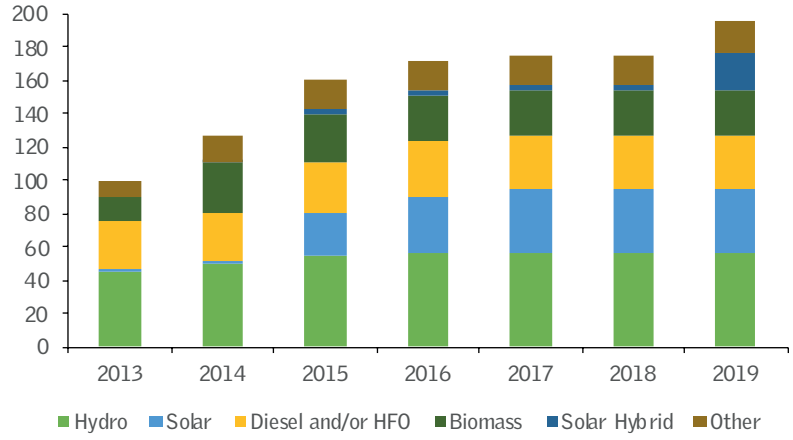
Tanzania's renewable hybrid mini-grid market had taken off in the 2010s, earlier than elsewhere in Sub-Saharan Africa, thanks primarily to robust regulations and international assistance. However, weak implementation of policies, frequent changes in rules and ambiguity about the role mini-grids should play within the larger goal of improving energy access are making developers uncertain about the market's future.

Tanzania has one of the lowest electrification rates in East Africa. At the end of 2019, one-third of the general population -- and less than 20 per cent of the rural population -- had access to power. Today, Tanzania has 209 known installed mini-grids. With an aggregate capacity of 231.7 MW, these projects account for about 15 per cent of the country's total capacity of 1,461 MW. Of these projects, almost one-third are either solar or solar hybrid mini-grids. On a per-MW basis, renewable mini-grids are dwarfed by older hydro and diesel projects.

Market growth has slowed, however. Weak enforcement of existing regulations plus rule changes have made players wary of developing new projects. Mixed signals from the government are partly to blame. The Ministry of Energy and Minerals' latest (2016) long-range electrification strategy emphasises grid expansion and large generation capacity building, but leaves the role of mini-grids somewhat ambiguous. These factors

might have contributed to the slowdown in project development over the past few years.

**Graphs 11-12: Tanzania's installed mini-grids by (a) projects and (b) capacity**




## MARKET STRUCTURE OF DISTRIBUTED POWER

Tanzania's mainland power sector is dominated by the state-owned vertically integrated utility Tanzania Electric Supply Company (TANESCO). TANESCO owns most of the country's bulk generation directly. In the distributed segment of the power-generation market, however, private companies hold sway.

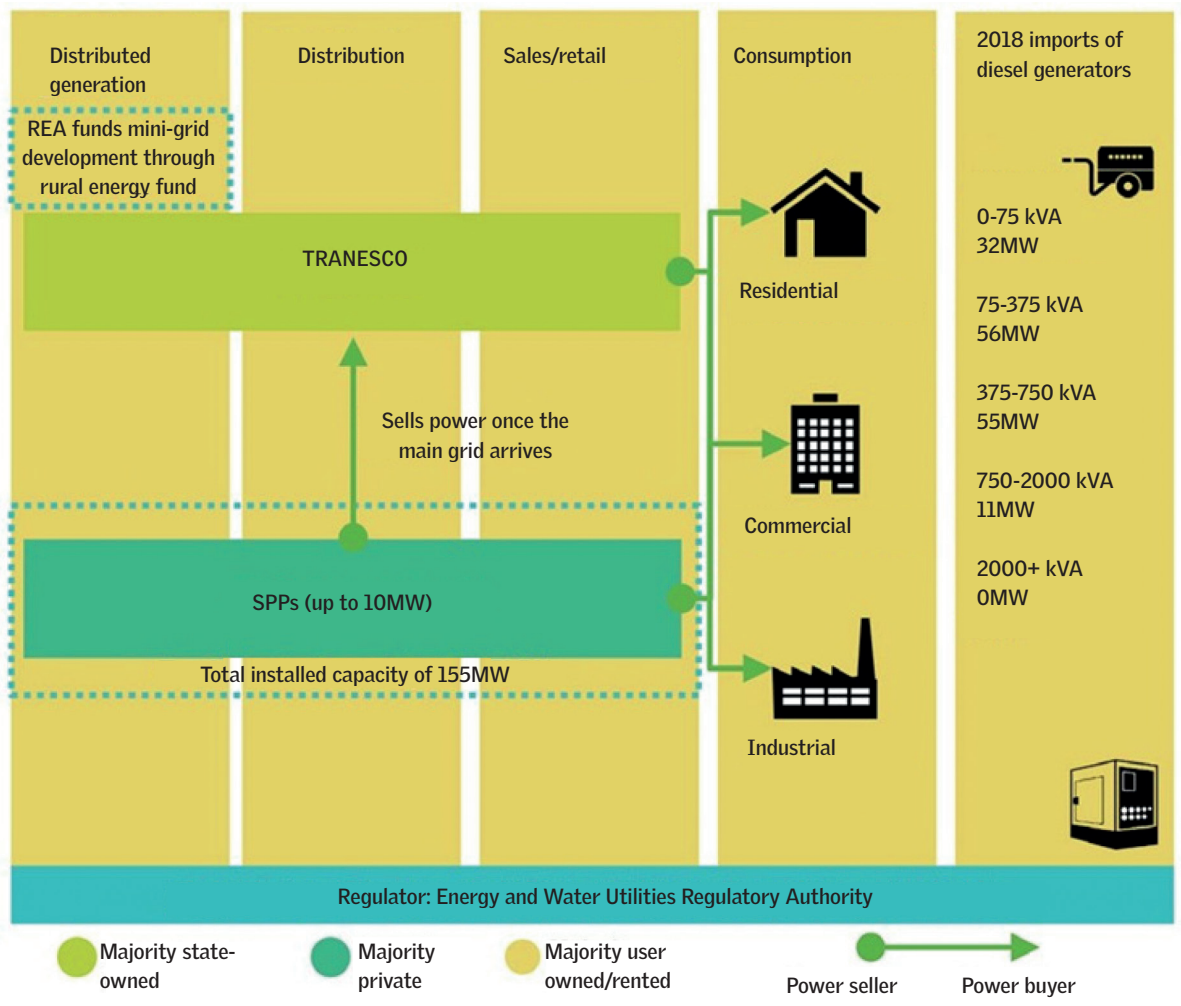
Tanzania's Small Power Producers Framework policy defines any project 10 MW or smaller in size as a small power producer (SPP). The framework allows electricity from mini-grids to be sold directly to consumers, or to TANESCO if the central grid expands to where a mini-grid is operating. As of the

end of 2018, there were nine registered SPPs serving off-grid communities.

The Energy and Water Utilities Regulatory Authority (EWURA) oversees technical and economic regulations in the power sector. It sets grid electricity tariffs and fixed tariffs paid to SPPs, develops guidelines and oversees licensing. Tanzania's Rural Energy Agency (REA) is the government's dedicated agency for electricity access and manages the Rural Energy Fund (REF). The REF is funded by international donor agencies, DFIs and the government via the annual budget and from commercial generation levies. It also provides financing to fund rural energy projects in the form of:

- Grants for feasibility studies up to US $100,000 or 80 per cent of the study cost
- Grants of US $500 per household connection to distribution grids or mini-grids, or a maximum of 80 per cent of the project's transmission and distribution costs
- Construction loans up to 85 per cent for <3 MW generation projects (70 per cent for projects greater than 3 MW).

**Figure 3: Tanzania's distributed power market structure**




## THE MARKET TODAY

Urged on by favourable regulations and rural electrification programmes that attracted many developers, the mini-grid market in Tanzania had taken off earlier than in neighbouring countries. There are nine developers active in the market with Jumeme and PowerGen as the two largest in terms of the number of mini-grids installed.

After successfully developing projects in Kenya and Zambia, PowerGen began installing mini-grids in Tanzania in 2015. The organisation will expand its portfolio further with a project financing deal it secured with CrossBoundary Energy Access (CBEA) and other financiers in July 2019. CBEA has an agreement with the Renewable Energy Performance Platform (REPP), managed by Camco Clean Energy, to finance an initial debt investment of US $5.5 million to build 60 mini-grids in Tanzania[1]. In August 2019, PowerGen also acquired EON subsidiary Rafiki Power, which has built eight mini-grids ranging from capacities of 5-kW to 50-kW for customers in Tanzania.

Co-funded by the EU, solar hybrid mini-grid operator Jumeme aims to build 300 systems and serve one million people by 2022. In March 2019, it announced it was constructing 11 more mini-grids to serve more than 80,000 Tanzanians. These were commissioned in June 2019.

Devergy, a Tanzanian social energy utility, was founded in 2010 and began operating its first mini-grid two years later. The company installed an adaptive DC mini-grid system to supply 60 to 400 households with electricity. It sets up local kiosks where customers pay for use of electricity at daily, weekly or monthly rates via mobile money. As a complementary revenue stream and a way to boost household consumption, customers can also purchase DC-compatible and energy efficient appliances from the kiosks. Devergy communicates with its mini-grids through wireless Internet

communication systems that enable remote monitoring and control down to the individual household and meter level.

Recently, the government has chosen to step back on encouraging mini-grids, and appears to be prioritising grid expansion for electricity access. This has led to uncertainty among developers. The government's perception of the role of mini-grids in its rural electrification strategy can hinder growth and may lead to stagnation in coming years.

**Table 5: The mini-grid developer landscape in Tanzania**

| Financier | Developer |
|---|---|
| CrossBoundary Energy Access (CBEA) | Rift Valley Energy (RVE) |
| Camco Clean Energy | PowerGen Renewable Energy |
| EDFI ElectriFI | DEVERGY |
| Department for International Development, The United Kingdom | JUMEME |
| Swedish International Development Cooperation Agency (SIDA) | Ensol (T) Limited |
| | REDAVIA |
| | Virunga Power |
| | PowerCorner Tanzania LTD |
| | Husk Power Systems |
| | CEFA Onlus Via Lame \| CEFA Il seme della solidarietà |
| | ACRA Foundation |

## CASE STUDY
# LAKE VICTORIA, TANZANIA

On the islands of Lake Victoria in Tanzania, an ambitious effort is underway to build mini-grids for more than 160,000 off-grid residents. In one of its island villages, the project has been successful, especially in terms of people making constructive use of mini-grid energy to enhance their lives and livelihoods.

The overall aims of the project are to develop solar mini-grids in islands in Lake Victoria that are more economically viable; improve energy access in target communities in order to promote economic development; use energy in a productive manner to empower women economically; and explore options for including women in KeyMaker's value chains with a gendered approach to the model.

Through the installation of 11 solar hybrid mini-grids, the first phase of the 'Micro Power Economy Roll-Out Project' was planned to electrify 20 communities by the end of 2018. The expected investment cost was roughly US $5.7 million, with funding from the European Union through the ACP-EU Energy Facility and other sources such as the African Development Bank's Sustainable Energy Fund for Africa and GIZ. With a total expenditure of US $8.4 million, the EU is the project's biggest backer.

This initial phase of the project decided to link 5,000 houses, businesses and public facilities such as schools and health centres that were previously reliant on hazardous and expensive energy sources such as kerosene and diesel or had no access to power at all. The developer planned to expand its mini-grids to the mainland in the second phase, bringing the total number of connections to 13,000. By 2022, the initiative aims to reach a total of 300 systems, delivering power to one million people in Tanzania's rural areas.

The developer of the mini-grid offers a variety of services to the local population, promoting economic growth. Even big mill motors, irrigation pumps, workshop equipment, and pastry ovens may be powered by its solar hybrid systems. To combat overfishing in Lake Victoria and contribute to the future stability of fishing income, it has even planned to develop fish farming activity.

A 95-kW solar hybrid power plant was erected for the pilot project in the village of Bwisya on the island of Ukara, which currently provides electricity to over 1,000 people. The initiative has resulted in expansion of current enterprises as well as establishment of new ones, and economic empowerment of women.

Customers on Lake Victoria's mini-grid are mostly individuals and small enterprises. The bulk of energy consumption is accounted for by a few key commercial-industrial users, such as mills, workshops and telecom towers. Consumption differs depending on the consumer. Mills and telecom towers consume 10-50 kWh each day, whereas families only use 1-5 kWh per month.

Each mini-grid is tailored to the needs of the community, and the developer has trialled a pay-as-you-go method that enables customers to top-up their metres with any amount at any time using their cell phones. To balance demand and supply, the system employs time-of-use tariffs and activates pumping loads during periods of high solar output.

## POLICIES AND REGULATIONS

At the end of 2019, Tanzania's national electrification rate was 38 per cent. In rural areas, where less than (or more than?) two-thirds of the population resides, the rate was considerably lower at 19 per cent, according to a World Bank estimation done in…. The Tanzanian government aims to have all the 12,268 villages in mainland Tanzania electrified through grid expansions or off-grid renewable energy by 2022. This means that all public buildings, including schools, clinics and churches, will have access to electricity when the target is met -- but not necessarily households. Overall, Tanzania has established robust regulations for mini-grids compared to other countries in Sub-Saharan Africa. However, recent actions have called the government's commitment into question with developers complaining of weak enforcement.

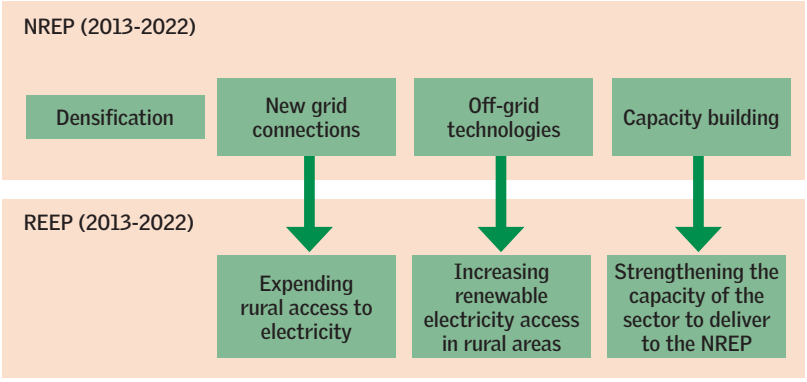
## RURAL ELECTRIFICATION IN TANZANIA

The government designed its national electrification policy with international interventions in mind. Specifically, it developed the National Rural Electrification Programme (NREP) to precede the country's participation in the Scaling-Up Renewable Energy Programme in Low Income Countries (SREP), administered by Climate Investment Funds (CIF).

In 2016, the International Development Association (IDA), CIF and other development partners combined to provide US $467 million in loans, grants and direct aid to implement the Rural Electrification Expansion Programme (REEP). The programme addresses three of the four electrification goals outlined in the NREP, and aims to connect 2.5 million rural households.

REEP applied a programme-for-results mechanism that links the disbursement of funds directly to the delivery of defined results.

**How Tanzania's Rural Electrification Expansion Programme (REEP) takes off from the National Rural Electrification Programme (NREP)**




## RESULTS-BASED FINANCING PROGRAMMES

The REA has established a number of results-based financing (RBF) programmes to assist mini-grids. In its first such programme, it disbursed US $500 and US $600 grants per new connection for a hydro mini-grid and a solar hybrid mini-grid, respectively, under the Tanzania Energy Development and Access Expansion Project (TEDAP); this project was administered by the World Bank in FY 2014-15. As a result, US $2.3 million was awarded to three hydro mini-grids connecting over 4,600 customers.

In 2016, the UK's Department for International Development (DFID) and the Swedish International Development Cooperation Agency (SIDA) funded a new RBF programme. In its first call, REA dispersed

grants for new connections of mini-grids based on the level of electricity service provided, with US $600 per Tier 5 connection for grid-connected mini-grids, and US $500 per Tier 4 connection as well as US $300 per Tier 3 connection for isolated mini-grids (REA, 2016). In November 2019, the REA announced the second call for applications to disburse grants for only Tier 4 and 5 connections (REA, 2019). In this call, SIDA was the only international donor agency that participated.

## MINI-GRID REGULATIONS

Tanzanian regulator EWURA has set relatively clear regulations around mini-grids. Through its Mini-Grids Information Portal, it provides regulatory information such as on licensing requirements and the process to obtain financial support. However, mini-grid developers reported that regulations are not always enforced as promised, leading to confusion in recent years. In addition, recent regulatory changes have raised the hurdle for sub-100 kW mini-grids, which now for the first time must receive tariff approval from EWURA. These elements could be part of the reason why market growth has remained stagnant in the last few years.

## SMALL POWER PRODUCER FRAMEWORK

Tanzania defines an SPP as a generation facility below 10 MW that produces power from renewable or fossil sources, or has cogeneration, or is a hybrid system. SPPs can sell power to TANESCO's main-grid or its isolated mini-grids. They can also sign Standardised Small Power Purchase Agreements (SPPA) directly with wholesale or retail customers[2].

Under this framework, projects receive a fixed tariff for the lifetime of the SPPA. Payments are invoiced in US dollars and may be adjusted to another hard currency subject to the mutual agreement of the parties to the SPPA. Tariff rules and licensing requirements are established based on project size.

## TARIFFS

Developers can propose to EWURA a specific retail tariff structure (such as a flat tariff, time-adjusted tariff, or a combination of the two) for mini-grid projects below 100 kW (Very Small Power Producers or VSPPs). However, if 15 per cent of the households served by the mini-grid petition EWURA, the regulator undertakes a tariff review. EWURA then has the power to adjust the tariff for VSPPs if it deems it to exceed relevant cost-recovery levels. While this has the potential to worry developers, EWURA has reviewed few projects to date and has never adjusted tariffs.

100 kW-1 MW mini-grids (SPPs) receive fixed tariffs for electricity, regardless of whether they sell to TANESCO's isolated grid or to the main grid. The tariffs are specified by technology and are cost-reflective on paper as they are examined based on operating expenditures, capital depreciation,

**Table 6: Tariff licences and approvals**

| Generation capacity (kW) | Generation licence required? | Tariff approval required? | Tariff structure flexibility? |
|---|---|---|---|
| <100 | Yes | Yes | Yes |
| 100-1,000 | Yes | Yes | No (fixed tariffs) |
| 1,000+ | Yes | Yes | No (fixed tariffs) |

Source: Energy and Water Utilities Regulatory Authority (EWURA), year?

interest expenses, and cash reserves for emergency maintenance and taxes.

## LICENSING

Prior to the 2018 rule change, any project below 1 MW in size was exempt from licensing and only required registration with EWURA upon commissioning. Since the change, developers have been required to obtain licences for all projects. They have also had to demonstrate proof of government support, proof of an agreement with an off-taker to buy their power and obtain a number of other project development certificates. Developers regard this licensing procedure as cumbersome; it generally takes over a year to complete.

## GRID ARRIVAL RULES

By law, when the main grid expands sufficiently to arrive at a mini-grid, a VSPP, SPP or small power distributor (SPD) owner becomes eligible to receive compensation depending on how long the mini-grid has been operating, so long as specified conditions are met. An SPP developer is also eligible to sell electricity to the main grid. The applicable tariff for the connected mini-grid varies depending on whether the project's SPPA was executed before or after August 2015. If the execution is after, the technology-specific tariff is applied.

Developers say that grid arrival rules are not always enforced as promised. Negotiations are difficult with the state utility, which seeks to lower the tariff as much as possible. This perhaps reflects the fact that TANESCO is cash-strapped, partly due to the

## CASE STUDY
# MWENGA HYDRO AND RURAL ELECTRIFICATION PROJECT

Before 2012, households and businesses near Njombe in southern Tanzania lacked access to a reliable supply of electricity. The Mufindi Tea and Coffee Company factory received electricity only intermittently from the national grid, relying on diesel generators during outages. Most households in the area were beyond the reach of the grid's power lines, so they had no electricity at all. The Mufindi factory and plantation relied on local labour, but workers were leaving to seek employment in urban areas where they could live in electrified homes.

The Rift Valley Corporation -- through its subsidiary Rift Valley Energy, Ltd -- decided to install the Mwenga Hydro and Rural Electrification Project, a 4-MW hydropower mini-grid, to:

- provide a reliable supply of electricity to the Mufindi factory and plantation
- provide access to affordable electricity in surrounding villages, where plantation workers live
- sell excess electricity to Tanzania Electric Supply Company Limited (TANESCO), the national utility, under Tanzania's new small power producer (SPP) programme

Rift Valley Energy, Ltd identified a potential hydropower site on land it owned, about 50 km from the tea and coffee factory. Plans showed that the transmission line from the hydropower site to the factory would pass 17 unelectrified villages, many of whose residents worked at the plantations.

In 2017, the project was delivering a total of 21.5 GWh of reliable electricity to more than 2,200 rural customers, small businesses, the Mufindi factory, the tea/coffee plantation's irrigation pumping stations and the national grid. Next year, Rift Valley Energy, Ltd had expanded the project into the nearby Kihansi Basin. The project has ultimately supplied electricity to more than 6,000 rural customers in 30 villages across 200 km of distribution line.

The Rural Power Development Company receives grants from the ACP-EU Energy Facility and Tanzania's Rural Energy Agency to subsidise the distribution costs. Rift Valley Energy, Ltd began making a profit once it reached 2,300 customers. The project also benefits the village residents, the Mufindi Tea and Coffee Company and the national utility. Reliable electricity makes the factory more efficient, and electrifying villages encourages plantation workers to stay in the region. Selling excess electricity to TANESCO, the national utility, helps subsidise low residential tariffs. TANESCO, in turn, can purchase wholesale electricity, as needed, from the mini-grid instead of investing in new capacity.

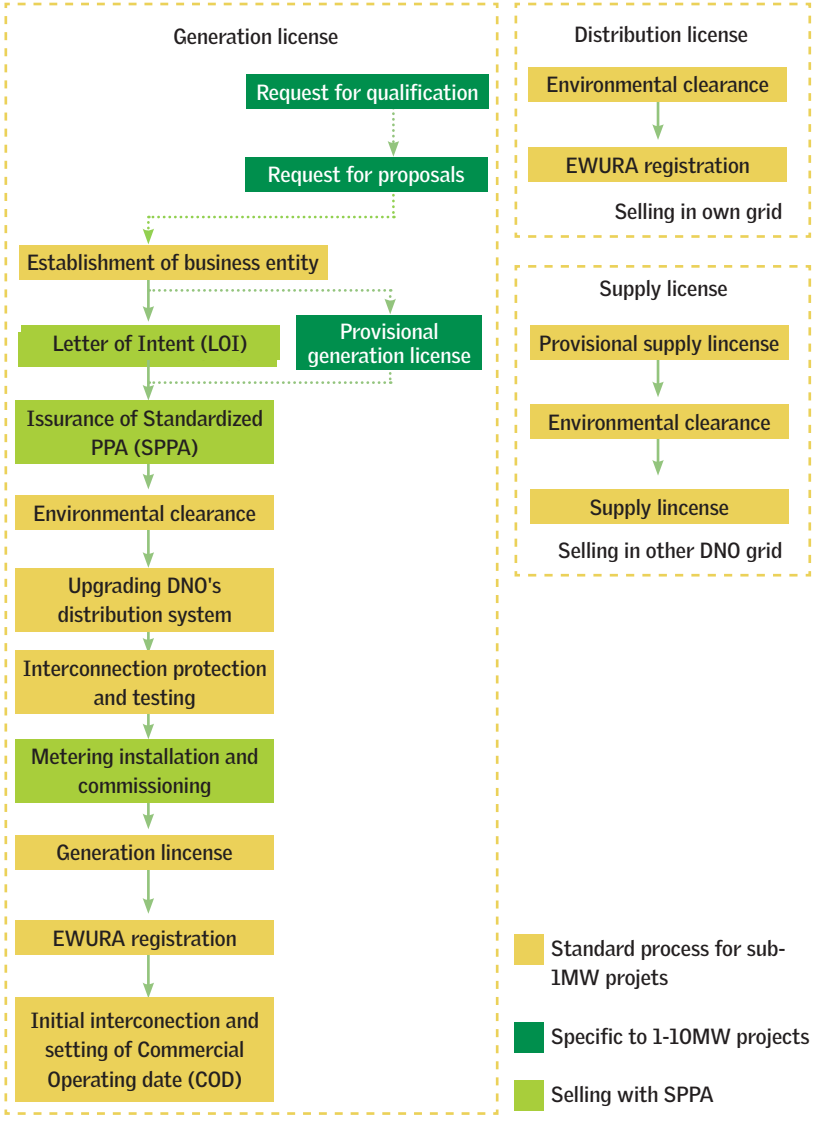
Through grants and subsidies, the project keeps costs affordable for rural households. The average cost of a new connection to the mini-grid is US $920, but support from the ACP-EU Energy Facility and Rural Energy Agency allows Rift Valley Energy, Ltd to charge only US $70 per connection. As a way to reduce household wiring costs, the project subsidises the cost of ready-boards, which are prefabricated wiring systems that include lights, switches, and several outlets. Rift Valley purchases ready-boards for US $45 each and sells them to consumers for US $14. Household meters are also affordable. Prepaid D1 (single-phase) meters cost about US $55, while T1 (three-phase) meters cost about US $130.

Customers who consume very little energy pay a low subsidised tariff. Rural customers who use less than 50 kWh of electricity per month pay US $0.03 per kWh (D1 tariff). More than 80 per cent of Mwenga Hydro, Ltd's customers use less than 50 kWh per month; they account for 20 per cent of the retail power sold. Households using more than 50 kWh per month pay the unsubsidised T1 tariff of US $0.13 per kWh. T1 customers use an average of 135 kWh per month, while D1 customers use an average of only 16 kWh. Blending the two rates yields a unit price close to the wholesale price paid by TANESCO.

1 http://www.ewura.go.tz/wp-content/uploads/2018/06/The-Electricity-Development-of-Small-Power-Projects-Rules-2018.pdf

low grid tariffs it receives. Given the potential risk of being insufficiently compensated by TANESCO, some developers say they are specifically avoiding building mini-grids within seven-10 km radius of the main grid.

**Figure 7: Tanzania's mini-grid licensing processes**



# NIGERIA

The Nigerian mini-grid market has, in recent years, generated growing interest from developers not just because of the size of its growth opportunities but because of its robust regulatory environment. A recently introduced results-based financing (RBF) mechanism showcased how governments elsewhere can potentially assist with bulk scaling and financing of mini-grids. The mechanism is straightforward, transparent and partially mitigates currency risk.

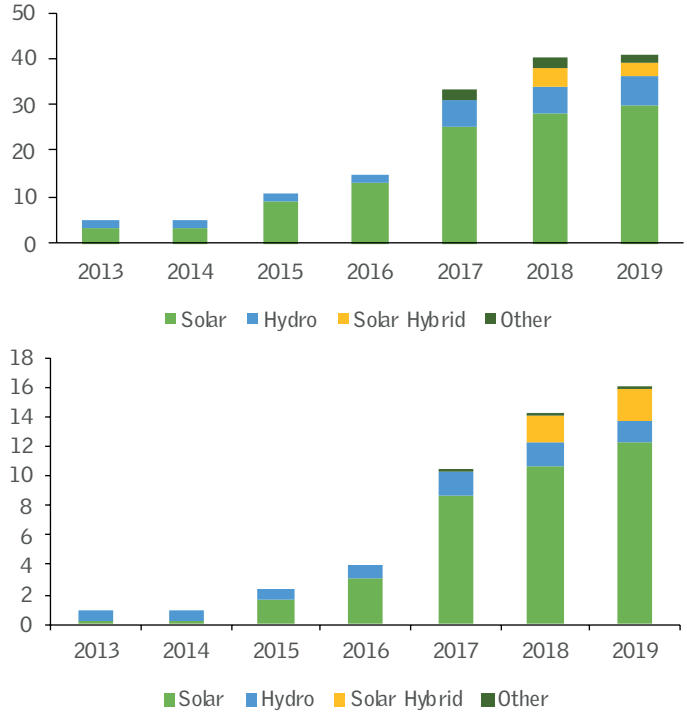
Nigeria has the largest population (206 million) and economy (US $432 billion) in Africa. Only 26 per cent of the rural population had access to electricity in 2019; nation-wide, the figure was 55 per cent. Where the grid is available, consumers experience frequent power cuts ranging from four to 15 hours a day. Very few believe that expansion of the central grid planned for the next five years will dramatically improve the situation. Hence, consumers seeking uninterrupted service are compelled to take matters into their own hands with distributed energy systems.

At the end of 2019, Nigeria's estimated installed mini-grid capacity was about 2.8 MW, with 59 projects serving rural consumers. These are mostly residential-based mini-grids with some developed for specific productive uses. If fully commercial-served mini-grids are included, the number is expected to be significantly higher. Separately, Nigerians spent US $16 billion in 2016 alone to fuel

privately-owned diesel/petrol generators to meet the shortfall in demand.

Nigeria's failure to provide stable grid power has created favourable conditions for strong off-grid development. In 2017, the country introduced a mini-grid regulation managed by the Nigerian Electricity Regulatory Commission (NERC) supporting isolated and grid-connected mini-grids between 100 kW and 1 MW in size. To operate, these must obtain mini-grid permits from the NERC. Mini-grids below 100 kW must register with the NERC, but obtaining the permit is optional. If Nigeria's central grid is later extended to the site of the mini-grids, developers

**Graphs 13-14: Nigeria's installed mini-grids by (a) projects and (b) capacity**



are to be paid for their depreciated assets plus any operating revenue generated over the prior 12 months.

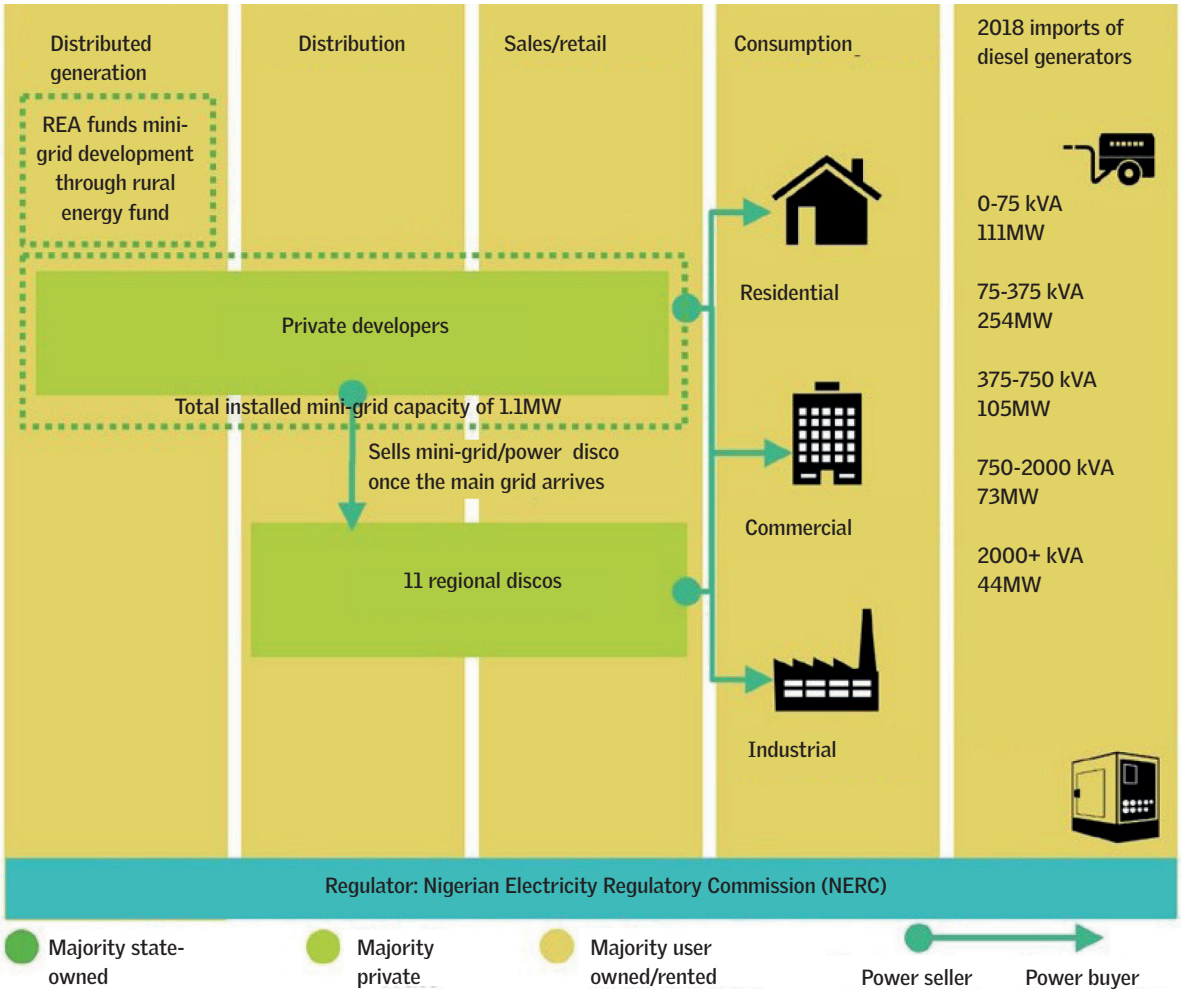
These regulations are regarded as robust and have signalled the government's commitment to distributed energy systems. Developers have responded but most have pursued smaller projects because building projects above 1 MW often requires time-consuming approvals (such as a generating company licence).

## DISTRIBUTED POWER MARKET STRUCTURE

In Nigeria, private companies have installed and are operating the majority of mini-grids under public-private partnership models (see Figure 6). They usually own the generation equipment and bear the capex, meaning they develop the project with their own (or shareholder) capital and agree an off-take agreement with the government or a community. Developers can establish isolated mini-grids and set their own tariffs so long as they hold mini-grid permits; in this process, the tariff must be approved by the NERC.

Nigeria has 11 distribution companies (discoms) with load allocated by region. Each owns and operates distribution grid assets that include transmission lines (mostly 11 kV/33 kV cables), substations, meters and other distribution equipment. While the regional discoms are privately owned and managed, only one is permitted to operate per region.

**Figure 6: Nigeria's distributed power market structure**




The NERC issues and monitors generation, transmission and distribution licences. It also issues mini-grid permits, and sets and reviews retail electricity tariffs based on the Multi-Year Tariff Order (MYTO) policy. The Nigerian Electricity Management Services Agency (NEMSA) is charged with inspections and certifications of mini-grids, and inspections must take place in order for the NERC to approve the mini-grid permit. Nigerian developer

GVE's mini-grids were the first to be inspected by NEMSA, and its projects were benchmarked against the grid code.

## CURRENT MARKET STATUS

In Nigeria, private-sector players primarily develop solar hybrid mini-grids with financial backing from DFIs and donor agencies. The mini-grid development sector is more crowded in Nigeria than elsewhere, reflecting the fact that the market has significant potential to provide electricity access and displace existing diesel generators, with 587 MW of diesel generators imported into the country in 2018 alone.

The World Bank, the African Development Bank and Nigeria's Rural Electrification Authority (REA) have recently made major commitments to the country's mini-grids with a US $550 million fund for the Nigeria Electrification Project (NEP), of which US $220 million is dedicated to implementing an RBF programme through a performance-based grant (PBG) and minimum subsidy tender mechanism to help developers finance solar hybrid mini-grids.

The minimum subsidy tender process is part of the NEP, which aims to provide power to 300,000 homes and 30,000 local businesses in 250 locations across four states (Niger, Ogun, Sokoto and Cross-River states). The goal is to scale mini-grid adoption at the least cost (see the 'Policies and regulations' section for more details). The World Bank and REA will select developers with the experience and capability to install mini-grids at lowest cost. Developers will then build a portfolio of projects at designated

sites. The winning bidders will gain access to the technical information of the sites through the REA and will be able to build up their mini-grid portfolio, which will help them secure financing for future projects.

The PBG programme selects developers who submit mini-grid proposals on a first-come, first-served basis and provides a fixed grant of US $350 per new connection for their mini-grid (where each mini-grid may contain about 29 or more connections)[3]. In December 2019, PowerGen Renewable Energy Nigeria, a subsidiary of PowerGen, commissioned a solar hybrid mini-grid including a 64 kW PV with 360 kWh batteries in Rokota community, Niger state, reaching 3,000 people. This is the first project to be commissioned under the NEP. PowerGen Nigeria plans to develop nine more projects under the NEP programme.

GVE, Nigeria's largest mini-grid developer that is also taking part in the NEP, already has a portfolio of 14 mini-grids in operation with a combined installed capacity of 589 kW of PV and 4,200 kWh of lead-acid batteries. It has 395 kW of PV with 670 kWh of lithium-ion batteries currently under construction. GVE invested some US $4 million in mini-grids in Nigeria between 2013 and 2019. As part of the Energizing Economies programme, GVE has recently signed a deal to develop a 1 MW commercial renewable hybrid mini-grid project to provide power to Wuse market in Abuja.

A few private financiers are active in Nigeria

today. NEoT Offgrid Africa, an investment platform launched by France-based NEoT Capital and EDF in 2017, aims to invest hundreds of millions of dollars in distributed renewable energy projects in Africa through late 2021 (NEoT Capital, 2017). NEoT Offgrid Africa invested an undisclosed amount in Rensource's special purpose vehicle, Sabon Gari Energy Solutions. The investment was used to develop a mini-grid project consisting of 1.3 MW of PV to supply reliable electricity to 12,000 shops in the Sabon Gari Market in Kano, the second-largest city in the country.[4]

In the commercial mini-grid segment, Rensource, a three-year-old off-grid solar energy firm, has raised US $20 million in a 'Series A' round equity funding jointly led by African venture capital fund CRE Venture Capital and impact investor the Omidyar Network in December 2019. The round also saw participation from Inspired Evolution, Proparco, EDPR, I&P, Sin Capital, and Yuzura Honda. Rensource's funding round follows sustained investor interest in Africa-focused off-grid and renewable energy start-ups seeking to plug electricity gaps. In June 2019, Arnergy, another solar mini-grid company, had raised US $9 million in its 'Series A' round equity funding.

Commercial banks have thus far been largely absent from Nigeria's mini-grid market. Developers regard commercial bank debt as too costly and too inflexible, with interest rates offered of reportedly over 25 per cent and tenors lasting just two years, at best. There is no project financing product available

**Table 7: Mini-grid developer landscape in Nigeria**

| Financier | Developer |
|---|---|
| The International Bank for Reconstruction and Development (World Bank) | Green Village Electricity Projects Limited (GVE) |
| European Union (EU) | Havenhill Synergy |
| Bank of Industry Limited | Arnergy Solar Limited |
| Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) \| German Society for International Cooperation GmbH | Rubitec Nigeria Limited |
| All On Partnerships for Energy Access | Ajima Farms and General Enterprises Nigeria Limited |
| Électricité de France S.A (EDF) | ACOB Lighting Technology Limited |
| NEoT Capital (New Energy of Things) | A4&T Power Solutions |
| Meridiam | EM-ONE Energy Solutions |
| | Nayo Tropical Technology Limited |
| | Rensource Energy |
| | Solad Integrated Power Solutions Limited |
| | Powergen Renewable Energy |
| | Darway Coast Nig. Ltd |
| | Community Research and Development Centre (CREDC) |
| | GoSolarAfrica |
| | SOSAI Renewable Energies Company |

in Nigeria allowing vendors to borrow solely against predictable cash flows, which is why it is good to see PowerGen Nigeria in the picture, since it managed to secure project finance debt in Tanzania. Instead, local banks require developers to provide physical assets as collateral. Even then, lenders tend not to accept solar equipment as collateral but instead require that borrowers own real estate that can be used for that purpose.

As a result of all of the above, developers have mostly financed projects off their own balance sheets, either in US dollars for multinational corporations

or in Nigerian Naira in the case of local developers. The Nigerian Bank of Industry (BOI) is the only institution able to provide Naira-denominated financing for mini-grid developers under its '6 billion Naira' solar fund.

## POLICIES AND REGULATIONS

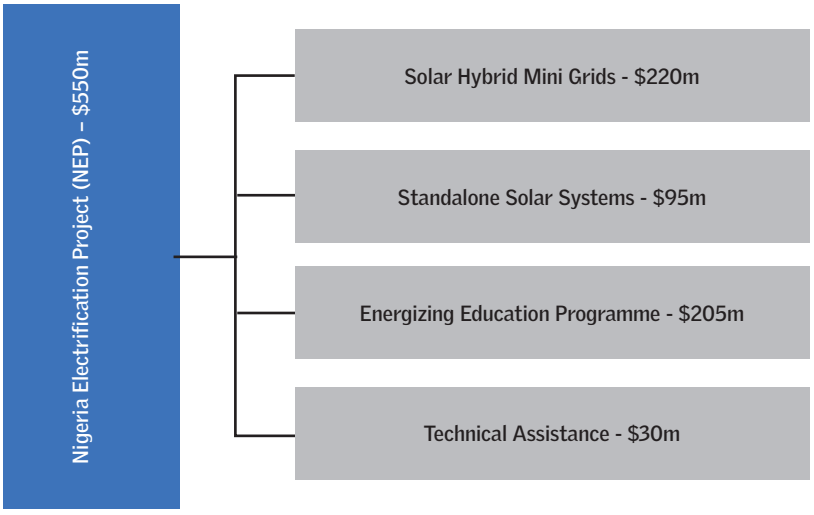
A turning point for Nigeria's mini-grid sector came with the ratification of a key regulation for mini-grids in May 2017. The new rule issued under Section 70 (8) of the Electric Power Sector Reform Act (EPSRA) sought explicitly to enhance private-sector electricity access activities.

At the end of 2019, NERC developed a web-based tool to streamline the mini-grid registration process for developers and released a downloadable simplified MYTO Excel-based model to help developers determine what cost-reflective tariffs to charge end-users[5]. While many developers have in-house tools to make these calculations, they still found it reassuring to see the regulator take such a modern approach. Moreover, the downloadable mini-grid MYTO model allows developers to verify their own tariffs. This increases transparency and the chance that a proposed tariff will receive approval. Typically, the tariff a developer submits to the NERC must be in line with the mini-grid MYTO tariff calculator. If it is not in line with the NERC tool, developers must provide a valid reason for the difference when seeking mini-grid permit approval.

The World Bank issued a US $350 million loan to the Federal Ministry of Finance to implement the five-

year programme known as the Nigeria Electrification Project (World Bank, 2018). The programme consists of four components; its goal is to increase access to electricity services for households, public educational institutions and micro, small and medium enterprises throughout Nigeria.

**Figure 6: Nigeria Electrification Project (NEP)**




Source: The Rural Electrification Agency

In March 2020, the African Development Bank (AfDB) and Africa Growing Together Fund (AGTF) agreed to jointly provide US $200 million for the NEP (AfDB, 2020). The fund focuses on helping the REA achieve its 100 per cent electrification (or universal energy access) target by 2030 and help de-risk and scale-up private sector investment. The fund is focused on both mini-grid and other off-grid solutions. Combining this with the US $350 million commitment from the World Bank brings the total commitment to US $550 million for the NEP.

## RESULTS-BASED FINANCING

### PERFORMANCE-BASED GRANT (PBG) PROGRAMME

Nigeria achieved another important milestone when it launched an RBF mechanism for financing new solar hybrid mini-grid projects in 2018 within the NEP. The PBG programme aims to close the viability gap for mini-grids developed on a spontaneous basis. Grants of US $350 per new connection are available on a first-come first-served basis, with a minimum total grant request of US $10,000 per mini-grid (with about 29 connections per mini-grid at minimum). Isolated solar hybrid mini-grids are eligible for the grants, but grid-connected projects are not.

Developers need to carry out geospatial studies, energy audits and community surveys to select their proposed viable sites. The grants are available for qualified projects on a rolling basis until the funds are exhausted.

The PBG programme aims to help developers raise other sources of financing over the capital markets. Given these grants are denominated in US dollars, this also enables developers to source for US dollar-denominated financing as this partially mitigates risk for the lender, be it debt or equity. As a potential financing strategy, more risk-averse lenders can even cap the percentage of the construction capex they are willing to finance at the timing of post-construction pay-out of the grant as a percentage of the overall capex.

If successful, the programme has the potential to be

a game changer and similar mechanisms could be rolled out across Sub-Saharan Africa.

### MINIMUM SUBSIDY TENDER PROGRAMME

Separately, the World Bank and the REA are planning to implement minimum tenders to install 250 new mini-grids at least cost. The REA initially screened 2,000 sites, then narrowed them to 250, filtering projects out by choosing sites with a larger number of inhabitants, more economic activity and nearby infrastructure. The programme has two phases:

- Tender for 57 sites across four states: Niger, Sokoto, Ogun and Cross River
- Scale-up to complete construction of the 250 sites across these four states, potentially adding more states in this phase.

Winning bidders of the minimum subsidy tender programme can potentially claim grants of more than the fixed US $350 per connection that the PBG programme offers. However, the tender aims to drive this figure lower, if at all possible, although it may be higher depending on competition.

As of October 2019, the original list of 64 developers had been culled down to 16. Five or six who can build mini-grids at the pre-selected sites at lowest grant cost per new connection will be awarded contracts. Each winning bidder will have access to a database that includes technical information about each of the 250 sites to help them develop site-specific business models. These developers will need to develop multiple mini-grids (potentially 40-50 per developer)

and will still need to raise capital from the financial markets, be it debt or equity.

As with the PBG programme, once developers have built their mini-grids and connected their customers, the grants will be disbursed upon verification that customers have been connected to the network and have been provided satisfactory service.

## COMPARING THE PBG AND THE MINIMUM SUBSIDY TENDER PROGRAMME

While developers will always receive a fixed US $350 per new connection in the PBG programme, the amount of the grant can be above or below US $350 per new connection under the minimum subsidy programme. For example, if all bidders bid US $500 per connection, the REA would need to increase the subsidy by US $150 per connection above the PBG level. If the winning bid prices are below US $350 per connection, the REA would successfully minimise the cost to install mini-grids.

In both cases, the grant typically is to be paid out three months after the project is commissioned and developers can prove to the REA that the end-users are receiving reliable power from their mini-grids.

Nigerian developers informed that they prefer the minimum subsidy tender since the 250 sites are already defined for them, reducing upfront project development costs. All the developers need to do is to validate the information that the REA has given them regarding the pre-determined mini-grid sites. All project technical data for the REA's pre-

determined sites are available on NEP platform[6].

**Table 8: PBG versus minimum subsidy tenders**

| Key criteria | Performance-based grants (PBG) | Minimum subsidy tenders |
|---|---|---|
| Budget | $80m | $140m |
| Location | All 36 states, developer to submit proposed sites. | 250 sites in five states designated by REA. |
| Subsidy per connection | Fixed at $350 per new connection. | More or less than $350 per new connection. Developers submit their bids to meet their hurdle IRRs. |
| Mini-grid development experience | Proof of designing and building at least one mini-grid of 10kW or larger within the past five years that is still operational. | Proof of two mini-grids of 10kW or larger. |
| Mini-grid operation experience | Proof of operating one mini-grid of 10kW or larger within the past five years, not necessarily continuously. The mini-grid needs to be still operational. | Proof of two mini-grids of 10kW or larger. |
| Experience in raising debt/ equity financing | Experience of securing finance of amount of $100,000 or larger, or naira equivalent, in equity, debt or both, for at least one infrastructure project in the past five years. | Proof of minimum $5m is required for at least two infrastructure projects. |
| Liquid assets | Total assets must exceed liabilities for past two years. | Minimum of $1m or its naira equivalent in liquid assets in financial statements. |
| Nigerian-registered business | Registered with the Corporate Affairs Commission and must have a certificate of incorporation in Nigeria. These need to be done prior to signing a grant agreement. | Same as PBG. |
| Registered taxpayer | Registered with the Federal Inland Revenue Service (FIRS) with a valid Tax Identification Number (TIN) through which deductible taxes shall be remitted to the Federal Government of Nigeria. | Same as PBG. |
| Qualified staff | Demonstrate a qualified team (with CVs) dedicated to environmental and social risk management. | Same as PBG. |

Source: The Rural Electrification Agency

## CASE STUDY
# ROKOTA, NIGER STATE

The Nigerian Rural Electrification Agency (REA) facilitated the completion of its first mini-grid site, which was financed by the World Bank-assisted Nigeria Electrification Project's Performance-Based Grant programme, on December 7, 2019. PowerGen Renewable Energy Nigeria Limited created the project, 64-kWp solar hybrid small grid in Rokota Community, Edati Local Government Area, Niger State.

Rokota is an agricultural hamlet in Niger State's Edati Local Government Area, whose economic interests include shea butter and palm fruit production. Under the Nigeria Electrification Project Mini-Grids component, the community is the first to benefit from renewable off-grid power. Around one-fourth of families in Rokota were already using stand-alone diesel generators to generate energy. This current demand piqued interest of the developer since it proved that the community was already aware of and valued power. Rokota's other features make the site much more enticing. Because the houses were near enough, the developer was able to connect over 300 families to the mini-grid at a low cost. The mini-grid now provides a reliable supply of power to 3,500 people.

REA uses first-cut prioritisation with existing data and has identified 200+ sites with at least 100-kW demand. REA teams prioritised sites by 'sufficient load/density, productive-use, daytime, and flexible loads, supportive local and state government, community engagement, and accessibility.

REA is in charge of electrifying villages that are currently unserved or neglected. In conjunction with the World Bank (US $350 million) and the African Development Bank (US $200 million), the Nigeria Electrification Project (NEP) aims to catalyse off-grid development in Nigeria through grant money, precise market data, and technical support. Solar Hybrid Mini-Grids, Solar Home Systems (SHS), and the Energizing Education Programme (EEP) are the three components of the NEP.

While the minimum subsidy tenders cover only four states (Sokoto, Ogun, Niger and Cross River), the PBG does not specify locations, hence, diversifying risk. This may even suit the developers' current business operations/plan. It is possible for developers to submit applications for both the PBG and the minimum subsidy tender programmes at the same time, which may increase their chances of receiving subsidies.

## MINI-GRID ACCELERATION SCHEMES

### MINI-GRID ACCELERATION SCHEME (MAS) – ISOLATED PROJECTS

The REA announced the results of a separate mini-grid acceleration scheme (MAS) on October 2, 2019[7]. The government agency stated that: "MAS is a nationwide, non-site-specific, open competitive tender designed to select mini-grid companies." It also noted that: "The winners of the tender will be supported in deploying their proposed mini-grid projects with an in-kind partial capital grant – in the form of distribution and metering equipment – and technical assistance." The successful bidders were Nayo Tropical Technology, Havenhill Synergy Ltd, GVE Projects Ltd and ACOB Lighting Technology Ltd.

The scheme is implemented by the REA, championed by the Federal Ministry of Power (FMP) and supported with EU funds plus backing from the German government via its Nigerian Energy Support Programme (NESP), implemented by the German Agency for International Development (GIZ). The REA did not state how many mini-grids will be developed by the winning bidders but the call for the tender concerned construction of "isolated mini-grids up to 1 MW" in generation capacity.

Once built, the mini-grids supported by the programme will be operated on a commercial, public-private partnership basis. By the end of 2020 some of Nigeria's remote rural and underserved communities will have access to reliable, clean electricity at an affordable tariff that, according to the REA, would

have been economically unviable without the scheme.

## INTERCONNECTED MINI-GRID ACCELERATION SCHEME (IMAS) – GRID-CONNECTED PROJECTS

The interconnected mini-grid acceleration scheme (IMAS) proposal call went out in May 2019 and applications were accepted up until 14 August 2019, the deadline set by the REA. Similar to the MAS (above), the IMAS is a nationwide non-site-specific open competitive tender and targets developers who can build a sustainable business model to provide stable electricity to grid-connected but poorly-served communities in Nigeria (a minimum of 15,000 customers), where such projects would have been unfeasible without the IMAS.

The difference between the two schemes is that in the IMAS, developers were invited to submit proposals to design, construct, commission and operate an interconnected solar-based mini-grid of up to 1 MW on a commercial public-private partnership, partnering directly with the interested distribution company. The winners of the tender will be supported in deploying their proposed interconnected mini-grid projects with a partial capital grant (in the form of procured distribution and metering infrastructure equipment) and technical assistance.

In 2019, as proof of concept, the Nigerian government partnered with the Kaduna discom and Torankawa community in Sokoto state to build a 60 kW PV hybrid mini-grid with 216 kWh batteries and a

100 kVA diesel generator. The project consisted of four kilometres of local distribution wires and 335 smart meters and was designed to operate as a grid-connected or isolated mini-grid, serving some 350 households and 20 small businesses. This was a government-funded project that was able to provide uninterrupted power with 0 per cent collection loss using pre-paid meters.

For its first commercial interconnected mini-grid, the private company Nayo Tropical Technology has partnered with the Ibadan discom in Mokoloki, Ogun state to develop a 180 kW PV hybrid mini-grid containing 144 kWh of lead-acid batteries and a 62 kW backup diesel generator. It is designed to serve up to 200 households, 28 small businesses and eight public institutions with a peak demand of 55 kW. The project will be the first commercial tripartite contract where the mini-grid operator will pay a distribution usage fee to the discom.

On April 3, 2020, the REA announced the results of its IMAS tender and bidders (developers) were selected to partner with the seven discoms listed. The REA aimed to get these projects online by the end of September 2020, providing end-users with affordable electricity tariffs – however, the COVID 19 pandemic created a hurdle.

## LICENSING

Nigeria allows private companies to build projects and sell electricity to customers. Its regulations define mini-grids as being 1 MW or smaller and either isolated or connected to the main-grid. For

an independent power producer (IPP) to supply electricity to two or more neighbouring businesses/ households using a mini-grid 100 kW to 1 MW in size, it must secure a mini-grid distribution permit from the NERC regardless of grid-connection status. For sub-100 kW projects, a permit is optional. Steps required for permits vary slightly according to the size of the mini-grid and whether it is connected to the main-grid or isolated.

**Table 9: Steps required for permits for <1 MW mini-grids in Nigeria**

| How to get a Nigerian mini-grid permit? | Inter-connected | Mini-grids | Mini-grids |
|---|---|---|---|
| Intended mini-grid capacity | ≥ 100 kW | ≥ 100 kW | < 100 kW |
| Is a permit required? | Yes | Yes | No |
| Identify eligibility of unserved area | 1 | 1 | 1 |
| Contact community for operating agreement | 2a | | |
| Contact discom for operating agreement | 2b | | |
| Sign exclusivity period agreement with community | 3a | 2 | 2 |
| Sign exclusivity period agreement with discom | 3b | | |
| Sign and register tripartite contract | 4 | | |
| System design (i.e., mini-grid specs) | 5 | 3 | 3 |
| Sign commercial agreement with community | 6a | 4 | 4 |
| Sign commercial agreement with discom | 6b | | |
| Acquire land and necessary building approvals | 7 | 5 | 5 |
| Apply to NERC for operating permit for intended area | 8 | 6 | |
| Construct, test then commission mini-grid | 9 | 7 | 6 |
| Register mini-grid with NERC | | | 7 |
| Submit two copies of supporting documents to NERC | | 8 | |
| Number of key steps | 12 | 8 | 7 |

## ISOLATED MINI-GRIDS

Isolated or off-grid mini-grids have been defined by Nigerian regulators as falling into two specific size categories: sub-100 kW and 100 kW-1 MW. A sub-100

kW mini-grid can opt for either a registration with NERC or for a mini-grid permit. A permit is generally more desirable than a registration certificate as it confers on the operator the right to compensation when the main-grid arrives at the site (i.e., there is no compensation if the project is just registered). To qualify, however, the project must adhere to minimum network technical and safety standards defined by the NEMSA. If the main-grid gets built out by the regional discom to reach the mini-grid site, the operator can either:

- Convert the project into an interconnected mini-grid, or
- Transfer the asset to the discom and get paid in return.

These options mitigate the risk for developers.

Projects of 100 kW-1 MW are legally required to have mini-grid permits from the NERC before starting operations. Without an approved mini-grid permit, projects have no guaranteed protections should the central grid expand into their territory.

## INTERCONNECTED MINI-GRIDS

While some mini-grids are built in remote areas lacking central grid access and then encompassed by the central grid when it is expanded outward, others are built from day one adjacent to the central grid. These interconnected mini-grids are linked to the regional discom but deliver power to areas where power delivery is particularly challenging. In these cases, developers must enter tripartite contracts with the local community to be served and the discom.

The tripartite contract must then be approved by the NERC to be official. Developers must also secure mini-grid permits.

Interconnected mini-grids are targeted at communities classified as 'under-grid', that is, grid-connected but with frequent/lengthy outages and usually relying on expensive diesel/gasoline gensets to meet demand during outages. The proven ability to pay for expensive fuel to meet demand is what really differentiates them from the isolated mini-grids where residents may not necessarily need or be able to pay for power.

## ABOVE 1 MW PROJECTS

If the mini-grid exceeds 1 MW in generating capacity, the developer must secure an Independent Electricity Distribution Networks (IEDN) licence. Mini-grid developers in Nigeria with projects whose capacities exceed 1 MW must hold NERC generation

**Table 10: Nigeria's mini-grid policies**

| Policy | Description |
|---|---|
| Mini-Grid Regulation, 2016<br>100 kW to 1 MW | Isolated mini-grids require signed agreements between mini-grid operators and the communities they serve. If such projects have mini-grid permits from the NERC, the discom must pay off the mini-grid owner with 100 per cent of the depreciated asset value (capex) plus one year of revenue. While the NERC has determined a depreciation schedule, it has not yet been published. Interconnected mini-grids require an agreement among the mini-grid operator, the community and the discom |
| Independent Electricity Distribution Networks (IEDN) Regulation, 2012 1 MW+ | For any power project planning to distribute power above the 1 MW threshold of the mini-grid regulation, the GENCO must hold an IEDN licence from the NERC. |
| Application for Licences (Generation, Transmission, System Operations, Distribution & Trading), 2010<br>1 MW+ | For any 1 MW+ project to transmit, distribute or generate power for sale (i.e., when a PPA is involved), the developer must apply for a generation licence at a cost of US $10,000 for projects of 1-10 MW. The licence and operating fees regulation details fees involved with obtaining this generation licence. The application process timeline should not exceed six months, according to the NERC. |

Note: Renewal is guaranteed if the renewal fees are paid and all requirements met. Once a licence is granted, renewal is pretty much guaranteed
Source: Nigerian Electricity Regulatory Commission

company licences. The mini-grid regulation does not protect these projects.

## TARIFFS

Before the mini-grid regulation was ratified, the mini-grid tariff structure was unregulated, allowing mini-grid developers to charge whatever the customer was willing to pay for the power.

NERC developed a downloadable Excel-based tool to help developers and communities agree on reasonable cost-reflective tariff rates mini-grid developers should be charging end-users. The downloadable mini-grid MYTO tariff calculator allows developers to input all their cost assumptions, customer load, grants etc into the model and get a tariff that they should be charging. If for some reason the developer's internal (proprietary) mini-grid tariff model is not in line with this (above the MYTO tariff calculator), they need to provide a clear justification for why the tariff is different to NERC before submitting the application. Typically, if 60 per cent of the potential customers in a community agree to a tariff proposed by the developer, NERC will approve this tariff.

# RWANDA

Rwanda is a small landlocked country in East Africa, bordered by the Democratic Republic of Congo, Tanzania, Uganda and Burundi. Rwanda's population is 13 million, of which more than 50 per cent are women. It has also one of the highest population densities in Africa, at an estimated 525 people per square km. Rwanda has maintained political stability since the genocide and civil strife in the early 1990s. Subsistence farming dominates the economy, employing 90 per cent of the people and contributing over 30 per cent of the GDP. The services sector contributes over 50 per cent of the GDP. The share of the population living below the national poverty line has been falling from 57 per cent in 2005 to 45 per cent in 2011. Rwanda has one of the fastest growing economies in Africa, with GDP growth averaging 5.75 per cent in the period 2000-2015.

**Table 11: Rwanda's installed mini-grids, by capacity**

| Company | Technology | Location | Size | Households connected |
|---|---|---|---|---|
| Neseltec | Solar | Kirehe district | 30kW | 183 |
| ECOS | Hydro | Muhanga district | 11kW | 303 |
| RENERG | Solar | Nyamasheke | 30kW | 121 |
| MeshPower | Solar | Multiple in Bugesera and Ngoma districts | 1kW each, 57 sites | 2,048 |
| MeshPower | Solar | Bugesera district | 4kW AC/DC | 78 |
| Absolute Energy | Solar | Gasibo district | 50kW | 506 |

Source: Energising Development (EnDev), 2019

## CURRENT MARKET STATUS

**Table 12: Mini-grid developer landscape in Rwanda**

| Financier | Developers |
|---|---|
| UK government | Trama TecnoAmbiental S.L.x |
| African Development Bank (AfDB) | CET and R Consortium |
| Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) | Norinco International Cooperation Ltd. |
| Inter-American Development Bank (IDB) | Guodian Nanjing Automation Co. Ltd |
| US Agency for International Development (USAID) | Neseltec |
| | ECOS |
| | RENERG |
| | MeshPower |
| | Absolute Energy |

The solar mini-grid subsector is at a very early stage of development. Currently, 84 mini-grids (78 DC and 6 AC) have been installed in Rwanda with a total capacity of around 250 kW. These solar and solar hybrid mini-grids may be DC, AC, or a combination thereof. While most minigrids are AC, rural communities with low power demands may be suited to DC. DC systems, such as those developed and operated by MeshPower, tend to have a lower capex per watt as they require fewer components and do not require expensive inverters. DC mini-grids also have the added benefit of being directly compatible with DC appliances, which tend to be more energy efficient. This ultimately allows mini-grid operators to set lower tariffs. On the other hand, AC minigrids are more expensive, while allowing for the use of higher-voltage appliances. They also allow for easier connection to the main grid, if it arrives.

Rwanda mini-grid developers are ready to scale up, but they are limited by access to concessional capital. Even with access to loan guarantees, high interest rates, large upfront capital and collateral requirements remain considerable hurdles for potential developers.

## POLICIES AND REGULATIONS

The Government of Rwanda recognises the vital role that electricity access plays in accelerating economic development, and has set targets of 70 per cent electrification by 2017/18 and 100 per cent by 2020. The Government has provided significant financing to achieve the current 24 per cent level of household connections, and recognises that in many cases, the most cost-effective means for increasing access to electricity is through off-grid solutions.

A good enabling environment for GMGs has been established in Rwanda through a number of related policies. These include the National Energy Policy and National Energy Strategy (2008-2012), the Electricity Law (2011), an updated Energy Policy (2015), and more recently, a regulation regarding licensing for rural electrification. This Regulation Governing the Simplified Licensing Framework for Rural Electrification was approved in 2015, subsequent to the updated Energy Policy, with the intention of expediting licensing for rural electrification projects. The regulation does not apply to isolated grids of greater than 1 MW, and GMGs of less than 50 kW are exempted from the need for a licence, although developers are still required to notify the Rwanda Utilities Regulatory

Authority (RURA) of any related activity prior to its commencement.

In June 2016, building on these earlier measures, the Government adopted a rural electrification strategy that aims to ensure that Rwandan households have access to electricity through the most cost-effective means. The strategy gives priority to increasing private sector participation in electrification, with more competition to reduce costs and improve the choice of technologies, and with a risk mitigation facility to support private investors. The strategy also demonstrates integrated energy planning, as it sets broad objectives for grid extension, mini-grids and solar home systems, as well as for use of the SEforALL Multi-Tier Framework to define five levels of access.[8]

The Rwandan rural electrification strategy prioritises the use of "mechanisms that will increase the development of mini-grids in suitable locations." However, it also asserts that mini-grids should only be used in specific circumstances, where: (i) given the distance or other geographic constraints, they are cheaper than connecting to the national network; and (ii) there is sufficient demand to justify the investment. The strategy identifies areas that could be suitable sites for mini-grid development, and commits to feasibility assessments to determine sites with potential hydro generation resources and sufficient demand. There is also acknowledgement that GMGs present a number of risks (finance, demand, operations) that need to be shared between government and private developers.

Finally, the strategy includes cross-cutting principles for the different rural electrification options. These include educating consumers about the most cost-effective solutions; encouraging private sector competition; highlighting the need for standards and consumer protection; and developing "local capacity and enterprise." Potential institutional roles and responsibilities include setting up hubs for technical, financial and policy co-ordination, and monitoring and evaluating local implementation.

## LICENSING

In Rwanda, mini-grid developers can apply for licenses to develop mini-grids with a capacity of up to 1 MW and small power generation projects of up to 5 MW. A mini-grid license provides exclusive rights to distribute and sell energy on a retail basis for five to 25 years within a determined geographical area. The retail tariff may be set by the developer at a level allowing cost recovery and a reasonable rate of return, and the tariff may be reviewed at any time by RURA.[9]

Mini-grids of less than 50 kW are exempt from the licensing procedure but must notify authorities of their operations. In the case of the main grid arriving within connecting distance of a minigrid, the license holder must choose one of three options: (i) switch the license to that of a small power distribution and generation licenses, which would be valid for the remainder of the original license period (thereby splitting its business into a generator that sells to the grid that can qualify for feed-in tariffs and an electricity retailer that buys from it; (ii) enter into

negotiations with the national utility for acquisition of the project; and (iii) relocate the assets, and where possible, and in exchange for a relocation fee, operate for the remainder of the license period. In exceptional case were connecting to the main grid would not benefit the local population, the regulator may decide to withhold the license conversion.

## SUBSIDIES

Several subsidy schemes are in place. Since 2006, EnDev has supported private sector participation in micro-hydro power development through financial and technical assistance. In this programme, private project developers are invited to participate in a tender set up by REG and EnDev. EnDev supports the companies with business plan development and provides viability gap funding. There are currently three plants in operation (Murunda 95 kW, Musarara 430 kW, and Mazimeru 500 kW), and two more are at an advanced stage of development. In the ongoing phase, six new plants are expected to be implemented with the support of the GIZ-managed EnDev programme. The Global Village Energy Partnership (GVEP) has a similar programme, financed by the World Bank, in place. The Government of Rwanda has recently approved the leasing of 15 publicly owned micro-hydro plants, and will progressively use the PPP approach for developing new micro-hydro plants.

## TARIFFS

In their original business plans the companies agreed on two principles:

(i) Pre-payment meters are necessary (in Rwanda this is now standard mode of operation for all grid customers; at the time of planning for the PSP hydro projects, this was not yet the case).

(ii) Clients need to pay less than what EWSA clients pay. The EWSA end-user tariff was RWF 112/kWh (+ 18 per cent VAT) or about US $0.24/kWh, while the tariffs proposed by the micro utilities were around 100 RWF (+ VAT).

All new household clients, as well as institutional and industrial clients, have a pre-payment meter. The system is automated, and clients can purchase units in retail shops and offices. Detailed statistics are kept on the purchase details

# ETHIOPIA

Located in the Horn of Africa, Ethiopia is the second most populous country in Sub-Saharan Africa. It occupies a territory of 1.1 million square km and is home to over 100 million people. Its largest city, Addis Ababa, boasts a population of 3.4 million people. Over 80 per cent of Ethiopia's population lives in rural areas, with agriculture functioning as the backbone of the country's economy.

Although Ethiopia is unique in that almost 100 per cent of its power generation coming from low carbon energy resources (mainly hydropower),[10] further diversification of the energy mix will be key to providing electricity to rural communities and ensuring adequate energy supply. Approximately 58 million Ethiopians currently lack access to the electrical grid, and there is also great disparity between rural and urban access (25 per cent in rural areas to 83+ per cent in urban areas).[11]

To address this, the Government of Ethiopia launched the National Electrification Program (NEP) in 2017, which serves as an action plan for achieving universal electricity access nationwide by 2025.[12] It is envisioned that 65 per cent of electricity access will be provided by grid solutions, while the remaining 35 per cent will come from off-grid technologies such as mini-grids.[13] Mini-grids are installations disconnected from a larger power grid, and involve small-scale electricity generation that is well-suited to smaller, more remote communities.

As they can generate electricity from fossil fuels or from renewable energy resources such as solar, wind, hydropower, and biomass (making them 'green' mini-grids), they can significantly enhance energy security and reliability. Mini-grids are also an especially promising solution for increasing electrification in Ethiopia, as the country's varied topography creates natural barriers to grid expansion and low rural population density results in high connection costs.

As stated in the National Association of Regulatory Utility Commissioners (NARUC) Practical Guide to the Regulatory Treatment of Minigrids[14], there can be some significant barriers to their development, including uncertainty regarding mini-grid investment decisions. A strong investment climate arises when investors have confidence in the ability of the utility to provide safe, reliable, and affordable service to customers, thus ensuring they can preserve and enhance the value of their invested capital. In the case of Ethiopia, the energy regulator is striving to minimize investment risk by demonstrating that mini-grids can be operated efficiently and sustainably in the country.

## CURRENT MARKET STATUS

The adoption of a mini-grid program is part of the government's approach towards integrated planning, as mini-grids and solar home systems, as well as grid connectivity, are technologies that complement each other, supporting different levels of current and potential demand and reflecting a different time frame for access provision. Consistent with the green

growth objectives of the government, only hybrid or renewable mini-grids will be developed in Ethiopia.

Presently, Ethiopia Electric Utility Company (EEU) operates several isolated diesel generation distribution systems, where grid power is not yet available. Out of the 31 mini-grids constructed, five have been successfully connected to the grid.

About 35 per cent of the mini-grids have an installed capacity of 100 kW, with one site at 520 kW and the remainder between 150 kW and 360 kW. About 8,000 connections are estimated to be currently provided through these existing installations. The government is also collaborating with the development partners for piloting the mini-grids powered by renewable energy sources. USAID is conducting a feasibility analysis for the conversion of EEU's diesel mini-grids to renewable energy power. Five new hydroelectric sites have been identified by Water Works Enterprise and several clusters of unelectrified villages to evaluate mini-grid solutions for access provision. The European Union is financing five new hydro mini-grids implemented by GIZ, testing a model for renewable energy–distributed generation that is currently based on Cooperatives but is aimed at scaling up the market for private or public agencies, as well as a combination of both.

Recently, the Ministry of Water, Irrigation and Electricity (MoWIE) and EEU have identified over 250 villages throughout the country that are far from on-grid substations and need to be connected via

solar photovoltaic mini-grids. Before scaling up solar mini-grid projects, MoWIE and EEU want to launch pilot projects in different regions and demographics of the country to determine the technical, financial and operational feasibility of mini grids.

## POLICIES AND REGULATIONS

Developing a mini-grid regulatory framework is integral to boosting investor confidence, and requires comprehensive stakeholder engagement to establish effective policy, planning, and regulations. As many aspects of mini-grid regulation are heavily context dependent, stakeholder perspectives – including those of policy makers, mini-grid developers and operators, customers, and the local community – are important to take into account in order to ensure regulatory decisions reflect balanced goals and interests. With this in mind, the EEA has made great progress by passing the Mini-Grid Directive and developing its accompanying resources, which will help to create an enabling business environment and engage stakeholders in order to meet electrification needs.

The five implementation guides that the EEA and NARUC developed to accompany the Mini-Grid Directive cover a variety of topics related to the regulation of mini-grid development, including:

- Implementing the mini-grid framework
- Designing and improving standards for electric service quality
- Conducting feasibility studies as a means of proving that green mini-grids can provide or improve electricity access in a given location

- Sharing international best practices on regulatory approach, tariff setting, exclusivity, and resolving disputes between stakeholders
- Conducting future periodic reviews to evaluate the efficiency of mini-grid projects and explore their impacts

In Ethiopia, the energy sector is the responsibility of MoWIE. Under MoWIE, there are three central implementation bodies: Ethiopian Electric Power (EEP), Ethiopian Electric Utility (EEU) and the Ethiopian Energy Authority (EEA) that have specific roles in the Ethiopian energy sector. EEP is responsible for generation and transmission (132 kV and above), EEU is responsible for distribution and the Universal Energy Access Program (UEAP), and EEA is the regulatory body for the energy sector.

Besides, there are two relevant directorates under MoWIE: the Energy Study and Development Follow-Up Directorate (ESD); and the Alternative Energy Technology Development and Promotion Directorate (AETDPD). The ESD is a directorate for strategy and coordination within the energy sector. The AETDPD was originally an implementing agent, coordinating the Rural Energy Fund, but is now being developed into a strategy and dissemination institution along with the ESD. MoWIE does planning centrally, in partnership with regional energy agencies.

These agencies coordinate energy activities within their regions, suggest priority settlements for electrification to MoWIE and are responsible for promoting and facilitating regional dissemination of

modern energy technologies. The planning process is not done on a purely economic basis but involves balancing social development factors as well.

## LICENSING

Notably, one of the guides focuses on enabling mini-grid developers to complete the licensing process more efficiently. Mini-grid licensing pertains to the process private developers undergo in order to obtain licenses for the generation, distribution, and sale of energy through mini-grids. For regulators, the licensing process provides an opportunity to review and approve a proposed project, and allows an element of control and oversight over developers.

The mini-grid Licensing Guidelines summarise the new licensing processes that accompany the Mini-Grid Directive[15], outline license requirements, and list authorities that are involved. The document also provides an overview of Ethiopia's Energy Proclamation and Energy Regulation in mini-grid licensing as of December 2020[16], and is meant to be updated by the EEA on an as-needed basis to ensure the most current practices are in place.

As the EEA is charged with regulating mini-grids through a licensing regime, the Licensing Guidelines[17] will serve as a key resource for it to help mini-grid developers navigate the project approval process and better comply with the existing regulatory framework. By providing potential investors with access to transparent regulation, the EEA can effectively decrease any existing uncertainties or confusion around regulatory

requirements or commercial viability.

Since issuing the Mini-Grid Directive, Ethiopia has seen an increase in applications for licenses. There are several international investors who want to join this sector as soon as possible, and they will likely be among the first licensees under the new Directive. In order to better understand the licensees' experience with the process upon its completion, NARUC is in coordination with the Energy & Investment Law Firm that represents them. NARUC will support the EEA in making updates to the Licensing Guidelines accordingly.

The passing of the Mini-Grid Directive is the first step of many towards improving the livelihoods of Ethiopia's citizens, encouraging private sector development, and implementing off-grid electrification. Moving forward, NARUC will continue to support the EEA as it works to meet national development goals and strengthen its regulatory frameworks to establish a more reliable grid, add new power connections, and create an enabling environment for private sector investment in Ethiopia.

All projects except those run by cooperatives require a licence. The duration, renewal, amendment, replacement, transfer and termination of licences are covered in Article 11 of the Energy Regulations. Transmission licences are limited to 30 years, hydro and geothermal generation licences to 25 years, and all other licences to 20 years. Subsequent renewals of licences are limited to half these initial periods.

Article 19 of the Energy Regulations specifies license fees. A Certificate of Competency is required for any electrical work, conditions for which are set out in Article 10. Excepting cooperative projects, which are covered by the Cooperative Law, there are three main stages of project regulation through EEA:

- Initial feasibility and pre-feasibility studies, requiring an investment permit, governed by the investment proclamation (769/2012)
- Investment incentives are covered under regulation (270/2012)
- Following the feasibility study a detailed plan needs to be submitted to EEA in order to obtain an operational licence (15-25 years), which is covered by operational regulation (49/1999). A new operation regulation relating to the already ratified new energy law is under ratification by the Council of Ministers currently

## SUBSIDIES

Ethiopia has a highly subsidised national flat-rate tariff of under 3c$/kWh, against a long run marginal cost to grid supply of 7cUS$/kWh.[18] This tariff rate has been in place since 2006 as part of a national strategy to drive consumption, but is currently being reviewed by EEU and EEP. The current tariff schedule extends to some parties who could pay a much higher tariff, such as industrial customers, although export prices are higher (from 7cUS$/kWh). This subsidisation is not extended to off-grid programs or projects.

A credit subsidy for low carbon technologies is available through the Rural Electrification Fund

Credit Line. Administered by the Development Bank of Ethiopia and funded by the World Bank (through an US $40 million initial funding round), it provides a credit line to micro-finance institutions to support household spending on renewable energy and energy efficiency products. This credit line is forming an integral part of the World Bank's future engagement in Ethiopia, alongside two other credit lines tackling women's entrepreneurship and SME development.

General investment incentives are available, such as the duty-free import of machinery and equipment. An investor is exempted from taxes and duty for machinery and equipment intended for the project and 15 per cent of spare parts. With respect to batteries, they must be imported with solar equipment to be eligible for customs duties exceptions, as batteries could be used for other purposes. There are no VAT exemptions. Challenges arising from the import of solar products currently exist due to the lack of capacity at the Conformity Assessment Enterprise, which is responsible for testing of imported products. Given their speed of testing, many products are stranded in customs for long periods of time, leading to additional substantial storage costs.

## TARIFFS

The EEA reviews, recommends and approves tariffs for grid and off-grid projects. Currently the off-grid tariff rate does not allow full cost recovery. The general principles guiding the review of grid-related tariffs and approval of off-grid tariffs are

listed in Article 28 of the Energy Regulations. The Energy Regulations detail requirements such as the production of a general tariff study every four years and the need for a uniform system of accounts and annual audited reporting. The pricing procedure for small mini-grids is outlined in the Pricing Procedure for Small and Very Small Self-Contained System (SCS) No. 2/2005. This covers small (100 to 500 KVA peak demand) and very-small (less than 100 KVA peak demand) self-contained systems (SCSs). Price structures for SCSs are submitted every four years, based on marginal and average costs. Price structures are reviewed by the EEA before being submitted to the ministry for approval.

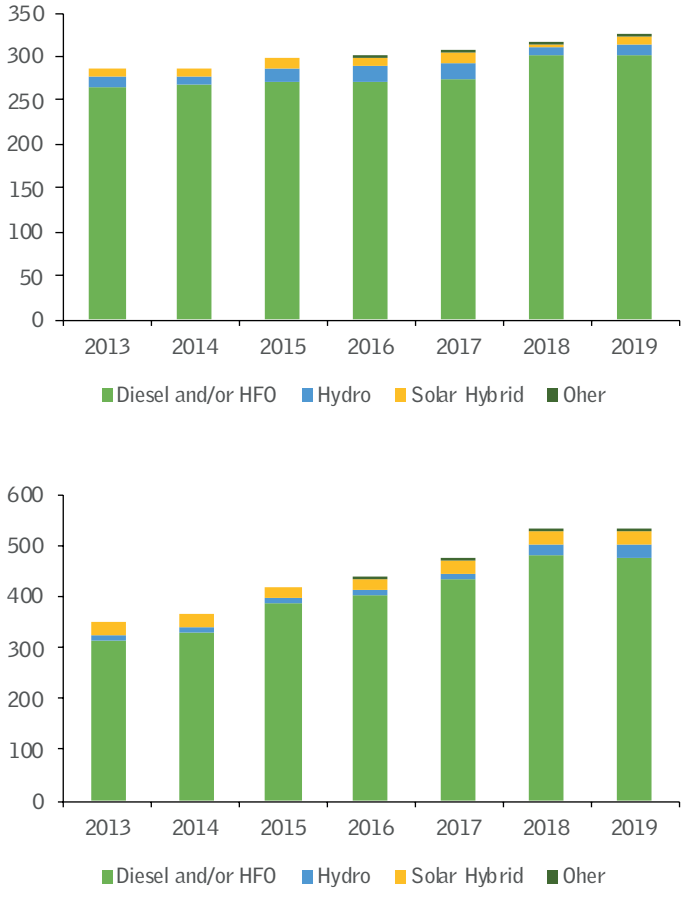
A review of the national tariff structure is proposed under the National Electrification Strategy, in order to seek full cost recovery to better promote electrification reach and service quality. The Strategy also addresses the issue of clarity of tariff setting principles for off-grid projects, highlighted within the broader issue of limited regulatory powers provided to EEA. As cost recovery is not typically achieved by off-grid projects, legislation is needed either to develop a specific (cost-recovering) decentralised tariff (i.e., technology-specific feed-in-tariff), increase the ability to set project tariffs or to provide subsidies for off-grid generators to cover tariff-cost deficits.

## THE PHILIPPINES

Communities on remote islands in the Philippines typically rely on fossil fuel-based mini-grids. The majority were built under the government's electrification mechanism, but many of them do not supply reliable electricity, partly due to the very high cost of electricity generation and growing power demand. Transporting fuel to remote islands can add 20 per cent to the average cost per litre of fuel. Legislation may assist solar hybrid mini-grids for unserved and underserved communities, if enacted.

The Philippines consists of 7,641 islands, of which about 2,000 are inhabited. The country achieved an electrification rate of 95 per cent by the end of 2019, up from 85 per cent in 2010. The majority of the population resides on the large islands of Luzon, Mindanao and Visayas. An estimated five million people still live without access to electricity, most of them on remote islands where there is no grid. The government aims to reach 100 per cent electricity access for targeted households identified in the 2015 census by 2022, and universal access by 2040 that includes households beyond the census (Department of Energy, 2016). It recognises that these targets are unlikely to be met without decentralized energy technologies such as mini-grids.

**Graphs 15-16: Philippines' installed mini-grids by (a) projects and (b) capacity**




Source: BloombergNEF, Department of Energy, the Philippines, National Power Corporation

According to the Department of Energy, 326 mini-grids with a total capacity of 530 MW were installed as of February 2020. The majority of these were built within the missionary electrification framework and run-on fossil fuels. There are many (but unquantifiable) power supply networks on very small islands that are organised informally (Paul Bertheau, 2018). In July 2019, Senator Win Gatchalian, chair of the Senate Committee on Energy, filed

Senate Bill 175[19] to promote renewable hybrid mini-grids for unserved and underserved areas to achieve the electrification target in a more cost-efficient manner. The bill is being implemented to resolve some existing regulatory hurdles for mini-grids.

## DISTRIBUTED POWER MARKET STRUCTURE

The Philippines has 150 franchise areas and each has electricity supplied by a distribution utility that may be an electric cooperative or a local government or private investor-owned utility (e.g., Meralco).

Off-grid electricity is mostly supplied by the Small Power Utilities Group (SPUG) under the National Power Corporation (NPC). Some electricity is supplied by New Power Providers (NPPs), qualified third parties (QTPs), distribution utilities or independent power providers (Department of Energy, 2016). The NPC-SPUG is a state-owned entity that pursues the government's missionary electrification plan initiated in 2001 (Department of Energy, 2001) to install decentralised electricity for consumers in remote communities. NPPs are private entities that took over existing assets from the NPC-SPUG either by outright purchase or lease or by installation of new facilities. They are in charge of power generation. QTPs are private entities that generate and distribute electricity in remote villages in areas where the franchised utility is not able to provide service. The government introduced the NPP and QTP schemes to facilitate private investment in the mini-grid sector.

There are a few examples of private entities that have developed mini-grids outside these three forms. Meralco, the largest private distribution company that covers metropolitan Manila, has installed mini-grids supplying electricity to villages (called barangays) on Cagbalete Island and Verde Island. One developer formed a joint venture with an electric cooperative, installed a mini-grid then transferred the asset to the cooperative.

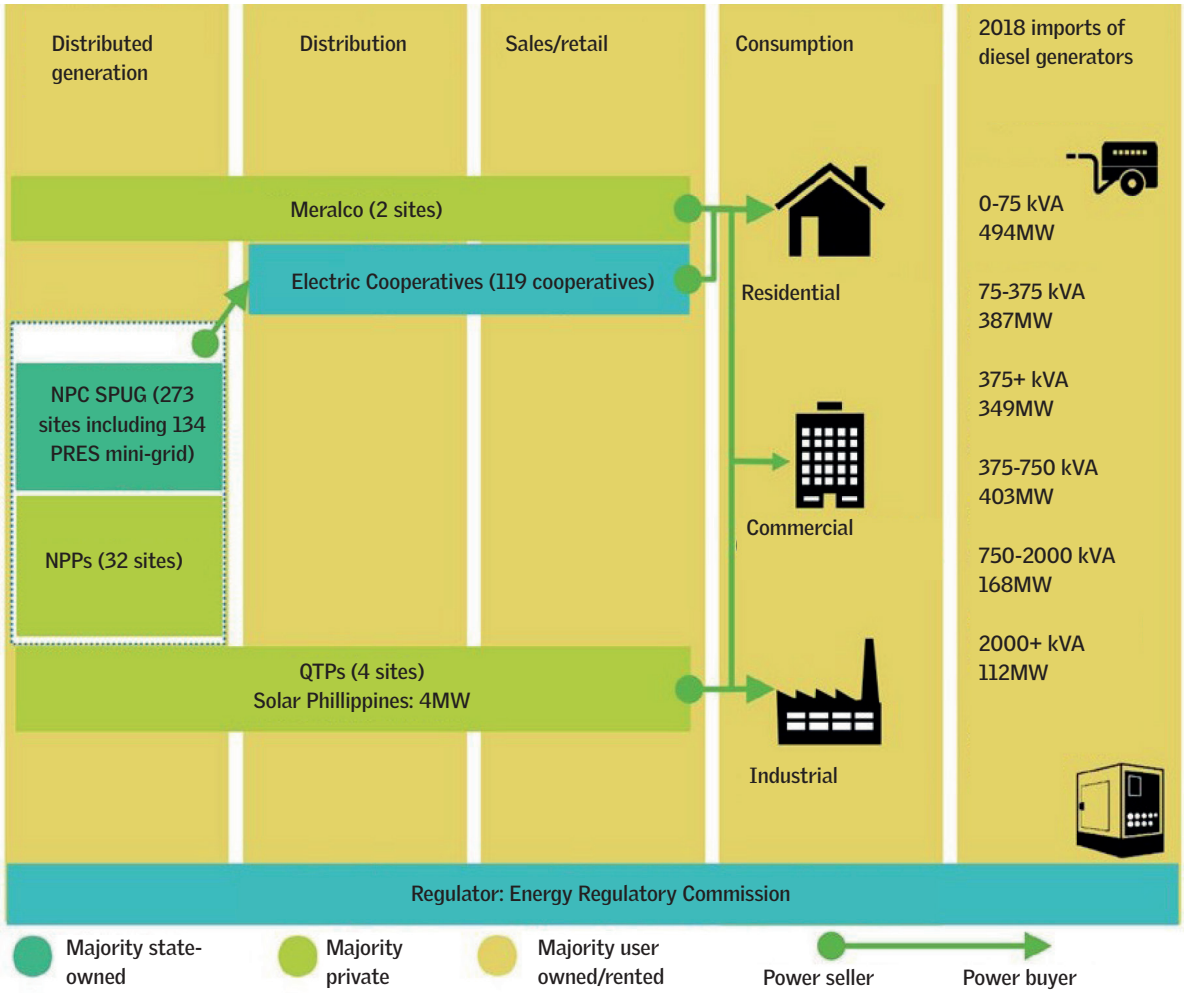
## MARKET STATUS

Mini-grids are predominantly NPC-owned or under public-private partnership. NPC-run SPUG operates 273 mini-grids of which 134 were installed in mainland Masbate and on Ticao Island under the Philippine Rural Electrification System (PRES)[20]. Private developers need to be approved as NPPs or QTPs or else collaborate with an electric cooperative to develop mini-grids. New solar hybrid mini-grid projects would mostly take one of these forms. QTPs need to build their own distribution system in unserved areas.

Most of the SPUG mini-grids use either diesel or heavy fuel oil (HFO) to generate electricity. This is costly because delivered diesel fuel costs can be up to 20 per cent more expensive than the national average pump price of US $1.4/litre in 2018.

The solar hybrid mini-grid market has just started maturing with only seven mini-grids installed at the end of 2019. These were generally retrofits of existing diesel generators. The National Electrification Administration (NEA), the Asian

**Figure: The Philippines' distributed power market structure**




Development Bank (ADB) and foreign governments financed the work. There is a mixture of domestic and international players in the market, including both large corporates and start-ups. Most developers are working on one or two mini-grids. The growing participation of mini-grid developers suggests their recognition of the market's growth potential to substitute the use of fossil fuel or to develop green field projects. Still, the market is at a very early stage.

**Table: The players in Philippines**

| Financer | Developer |
|---|---|
| Development Bank of the Philippines | AC Energy |
| Ministry of Trade, Industry and Energy, the Republic of Korea (ROK). | Autarsys GmbH |
| Asian Development Bank (ADB) | Manila Electric Company |
| InfraCo Asia Development Pte Ltd (InfraCo Asia) | Solar Para Sa Bayan Corporation |
| TEPCO Power Grid, Incorporated (TEPCO Power Grid) | PetroEnergy Resources Corporation (PERC) |
| Development Bank of the Philippines | One Renewable Energy Enterprise, Inc. |
| | Infunde Development Pte. Ltd. |
| | Kennedy Energy and Development Corporation |
| | Okra Solar Pty Ltd. |
| | WEnergy Global Pte Ltd |

## POLICIES AND REGULATIONS

### MISSIONARY ELECTRIFICATION

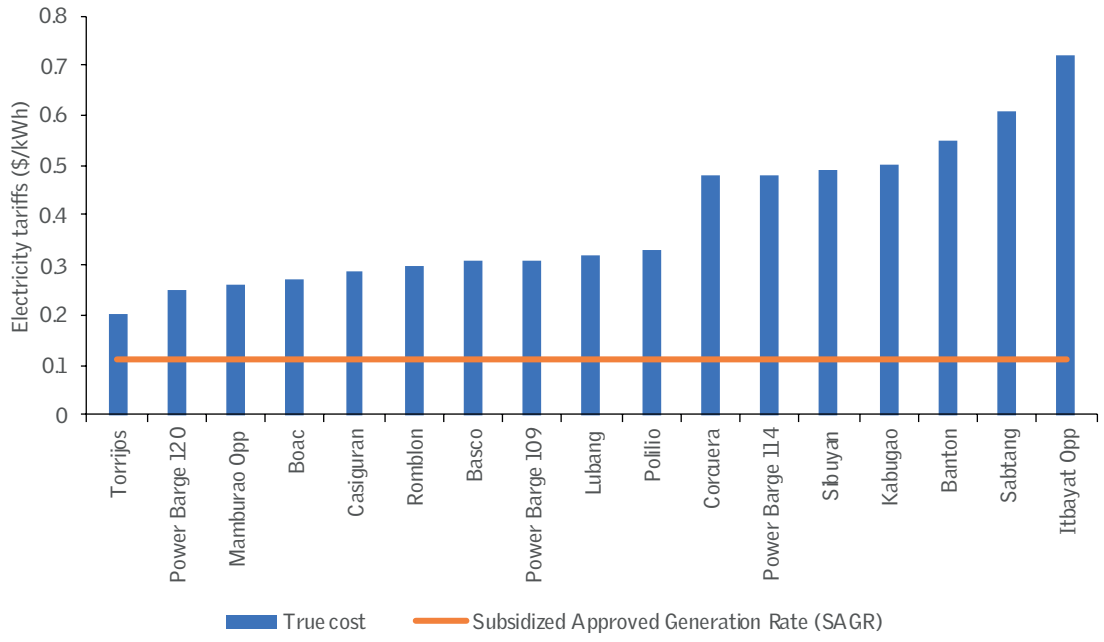
The core of the rural electrification framework in the Philippines is missionary electrification. According to Republic Act 9136, which came into force in 2001, the National Power Corporation performs "the missionary electrification function through the Small Power Utilities Group (SPUG) and shall be responsible for providing power generation and its associated power delivery systems in areas that are not connected to the transmission system." Missionary areas refer to designated off-grid, unviable, and underserved areas. SPUG serves 242 missionary areas[21].

The electrification scheme is funded by two revenue sources: electricity sales in the missionary areas and universal charges for missionary electrification

(UCME) collected from all rate payers in the country as determined by the Energy Regulatory Commission (ERC). The UCME covers the gap between the true cost of the mini-grids operated by SPUG and the subsidized approved generation rate (SAGR) that is determined by the ERC. In the Philippines, the true cost of these generation plants on remote islands is US $0.20-0.72/kWh according to the NPC, as most of the assets burn expensive diesel or HFO. This is well above the tariffs of US $0.11-0.12/ kWh charged to grid consumers.

The country's electricity access rate improved from 76 per cent to 95 per cent between 2001 and 2019. While the missionary electrification programme has supported rural electrification to some extent, it has

**Graph: Gap between true costs and SAGR in the Philippines**




Source: Compiled from National Power Corporation, Philippines

also increased the cost of electrification, due to high generation costs coupled with the increase in mini-grid installations, as well as population and power demand growth in the missionary areas.

Another issue is the relatively low reliability of mini-grids. More than 55 per cent of the country's mini-grids supplied electricity for less than eight hours a day as of December 2019, according to the Department of Energy (DOE). The 134 PRES mini-grids installed in mainland Masbate and on Ticao Island supplied electricity for five hours per day. This is due to several factors including the high cost of generation, the timings of fuel delivery to the islands and unreliable payment of UCME by the government.

On December 16, 2018, the DOE announced that the country plans to phase out the UCME gradually, depending on economic conditions in the remote areas. It said that if such a fund is needed, it should be charged to the government, not grid ratepayers.

## MINI-GRID REGULATIONS

For developers, becoming an NPP or QTP is a bottleneck as the process to obtain a permit is cumbersome and lengthy and makes it difficult for them to secure financing for mini-grid projects. New legislation however intends to address this challenge.

## LICENSING

No explicit licensing process for mini-grids exists in the Philippines, making the application process at least as long and costly as that for utility-scale

projects. Even small projects need to go through the cumbersome licensing process, which disadvantages smaller developers that lack the overhead resources of large developers.

In March 2019, President Duterte signed the Energy Virtual One-Stop Shop (EVOSS) Act that aims to streamline the process of permits for power generation, transmission and distribution in the country.[22] The EVOSS is an online portal that allows energy developers to apply for permits or licences, submit all the required documents and monitor the approval process. The law also requires all the government bodies involved to follow a strict timeline. Their failure to act within the timeframe results in the automatic approval of an application and a potential penalty against public officers.

As of March 2022, EVOSS had yet to include NPP and QTP licensing processes, but it should cover them once the software work has been completed.

As part of the implementation of Senate Bill 175, the DOE and the ERC aim to establish a streamlined process to approve the licence for a micro-grid system provider.

### GRID CONNECTION RULES

Developers initially pay the costs of grid connection, but this is paid back to them over time by the ERC.

### NET METERING

A net metering programme was launched in 2014 to allow end users to produce power at facilities 100

kW or smaller and export excess energy to the grid. Exported energy is paid at rates corresponding to the blended generation charge of the distribution utilities (DUs). Like the feed-in tariff mechanism, surplus electricity generated under net metering agreements has priority of dispatch ahead of other forms of generation.

## MICROGRID SYSTEMS ACT

Senate Bill 175 (the Microgrid Systems Act)[23] have set-up a new policy framework to promote renewable hybrid mini-grids to provide reliable electricity to communities on remote islands. At the end of 2020, the bill substituted by SBN-1928 under committee report no. 145, and on January 2022 it became Republic Act no. 11646.[24]

The bill targets unserved and underserved areas nationwide, thus, any areas without access to reliable electricity are within the scope including those designated under the missionary electrification policy. However, there can be changes to this depending on the results of the discussion in the Technical Working Group meetings in the Senate. According to the DOE, approximately 900 areas are currently unserved in the Philippines.

## INDONESIA

As an archipelago, Indonesia is unlikely to be completely electrified through the main-grid. There is therefore the potential for mini-grids to support Indonesians in otherwise hard-to-reach regions. If the private sector is to be involved in installations, cooperation with the government and the state-owned utility, Perusahaan Listrik Negara (PLN) is vital.

Indonesia includes more than 17,500 islands, of which around 1,000 are inhabited (NREL, 2016). Over 98 per cent of Indonesians had access to electricity at the end of 2019. The rural access rate of 97 per cent equates to approximately 4 million people without access to electricity in these areas. Generally, islands in the eastern region tend to have lower electricity access rates.

Grid extensions are often not feasible in island nations. Rural Indonesians rely almost exclusively on tens of thousands of diesel generators serving villages or hamlets. The state-owned utility PLN operated some 3.1 GW of diesel generators and 600 mini-grids (BloombergNEF, 2018). In 2018 alone, the country imported over 23,000 diesel generators. This suggests a huge potential for substituting diesel with renewables.

Indonesia has installed a total of 1,061 mini-grids, mostly led by the national government with support from international donor agencies. Although not reflected in the database, a further 655 mini-grids

have been installed by provincial governments[25]. Thanks to their efforts, electricity access has improved steadily in the last several years. However, participating in the mini-grid market is quite difficult for private entities, particularly non-Indonesian companies. Despite the PLN not having exclusive powers over the transmission, distribution and sale of electricity, it still dominates the power market, making it difficult for other entities to obtain business licences. Limits on foreign ownership of businesses operating in the country presents an additional barrier.

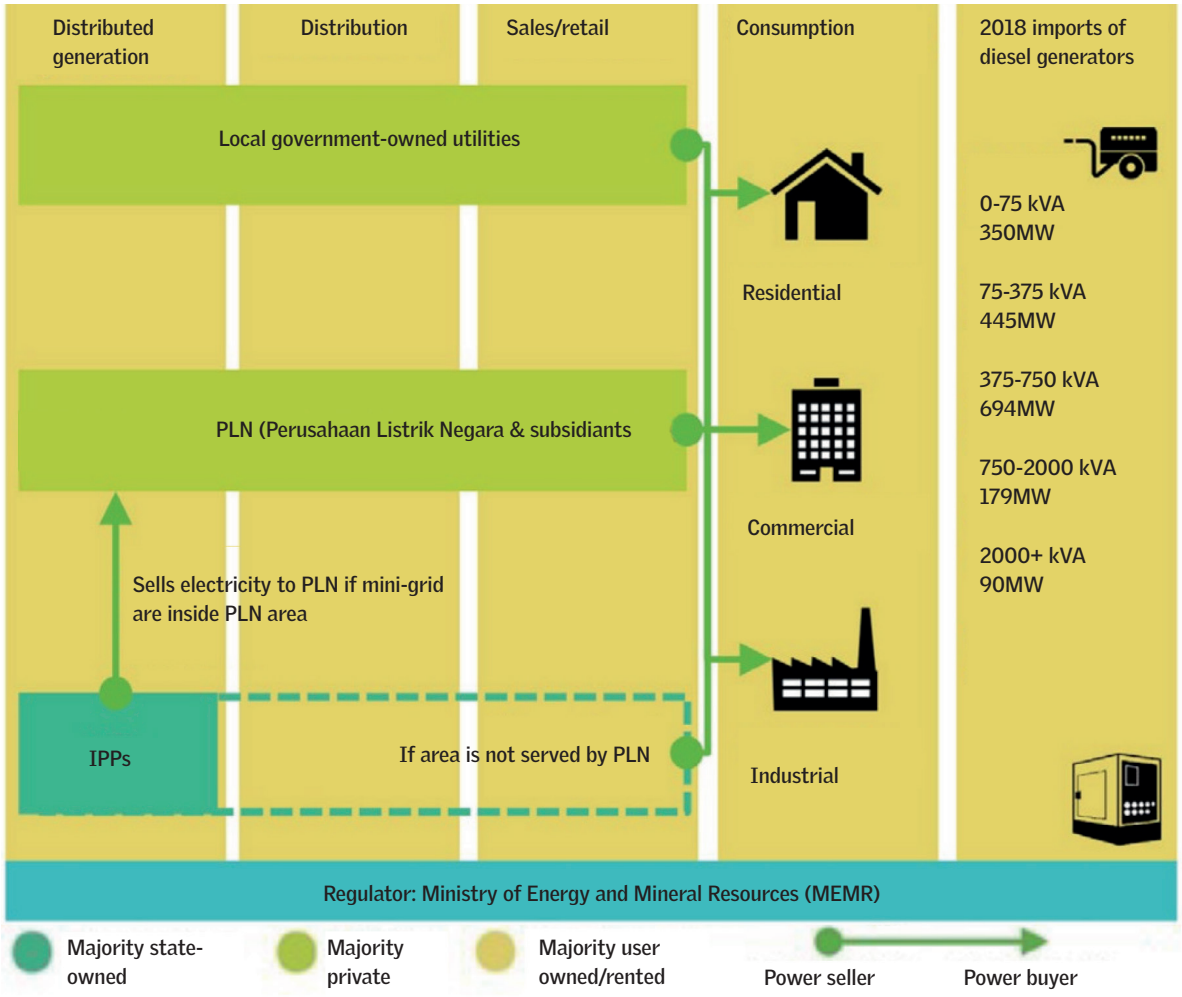
## DISTRIBUTED POWER MARKET STRUCTURE

The PLN dominates the power market in Indonesia, covering generation, transmission and retailing. However, it does not cover all areas of the island nation; remote islands, and some concentrated industrial areas in particular, leave some room for other entities to participate in the distributed power market.

Independent Power Producers (IPPs) holding generation licences may build plants up to 50 MW and sell power directly to consumers in non-PLN service areas. They may also build mini-grids and sell electricity to the PLN in its service areas, which requires negotiation and close cooperation with the utility.

The Ministry of Energy and Mineral Resources (Kementerian Energi dan Sumber Daya Mineral Republik, or ESDM) oversees the energy sector. The

**Figure: Indonesia's distributed power market structure**




Directorate General of Electricity creates the national electrification plan, issues generation licences to IPPs and approves tariffs in cooperation with the PLN. The Directorate General of New, Renewable Energy and Energy Conservation (EBTKE) is in charge of planning, regulations and of the mini-grid programme (IRENA, 2018).

## CURRENT MARKET STATUS

A total of 1,061 identified mini-grids are installed in Indonesia, including almost 630 solar or solar hybrid, some 422 hydro, and a handful of biomass and wind-based systems. The total generation capacity is 38 MW. Since the 1990s, a large number of hydro mini-grids have been developed with support from the government and international agencies. GIZ, for example, supported NGOs and local turbine manufacturers to deploy micro-hydro projects.

Most projects were built with direct and indirect technical support from the Energising Development (EnDev) programme, which has promoted access to affordable and sustainable energy since 2005. As many as 72 projects were installed by IBEKA, an Indonesia-based social enterprise that builds mini-grids for off-grid communities. Various government ministries such as the Ministry of Cooperatives and SMEs and the Ministry of Villages, Development of Disadvantaged Regions and Transmigration, and local governments financed construction of these projects.

Mini-grids are usually handed over to local governments after installation, but three types of entities continue to operate and maintain the mini-grids: co-operatives, village-owned enterprises and communities. The co-operative ownership model used to be common, but the national government is now more supportive of the village-owned enterprise model.

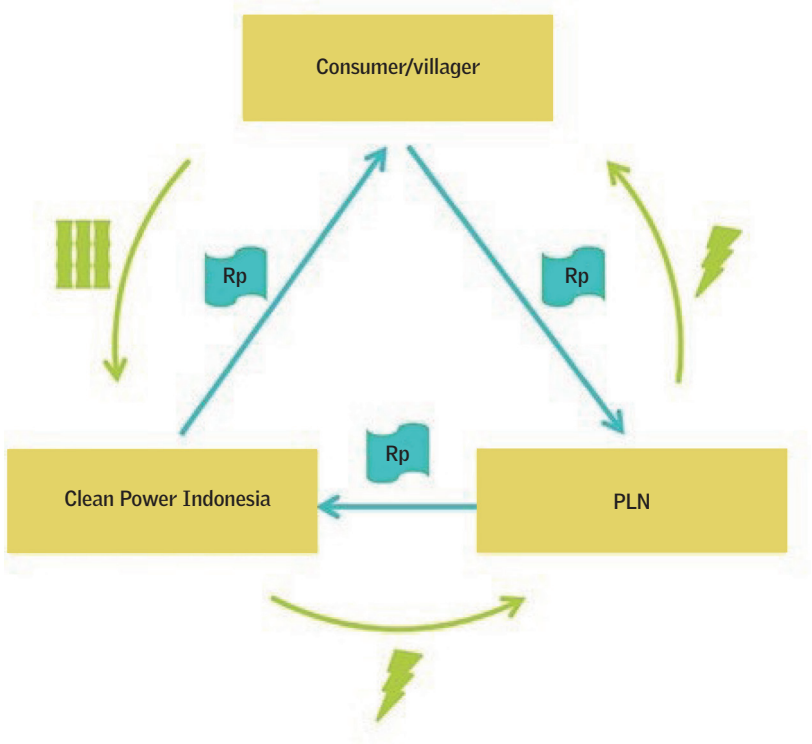
There are very few private entities in the mini-grid sector in Indonesia. Private-sector participation has

been in engineering, procurement and construction (EPC). One active developer is Clean Power Indonesia, which has developed biomass mini-grids that use bamboo and other forest-based biomass as feedstock in rural communities in the PLN service areas. Singapore-based developer Canopy Power has not completed any mini-grids for rural electrification but has installed three mini-grids for private resort islands since September 2019. The company not only sells mini-grids but offers energy-as-a-service to customers.

**Table: The players in Indonesia**

| Financers | Developers |
|---|---|
| Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) \| German Society for International Cooperation GmbH | Institut Bisnis dan Ekonomi Kerakyatan (IBEKA) |
| The International Bank for Reconstruction and Development (World Bank) | Hivos |
| New Zealand Agency for International Development (NZAID) | Akuo Energy |
| Millenium Challenge Account, Indonesia | Perusahaan Listrik Negara |
| Endev: Energising Change | Clean Power Indonesia (CPI) |
| Sweden Sverige | WEnergy Global Pte Ltd |
| Swiss Agency for Development and Cooperation, Federal Department of Foreign Affairs, Swiss Confederation | |
| UK Aid Direct | |
| Ministry of Foreign Affairs, Kingdom of the Netherlands | |
| Royal Norwegian Ministry of Foreign Affairs, Kingdom of Norway | |

**Figure: Business model of Clean Power Indonesia**




## POLICIES AND REGULATIONS

Indonesian law allows only one entity to distribute and sell electricity in any area. The PLN has the right of first refusal before the government may offer the opportunity to other entities. Permits can be granted if the area is not already covered by an Electricity Supply Business permit holder or if a permit holder is not able to provide reliable electricity access.

To obtain the rights to a business area, IPPs need to make a request to the Ministry of Energy and Mineral Resources (ESDM) through the Directorate General of Electricity (DGE). The application must be supported by an analysis of the electricity needs and business plans for the requested business area and a recommendation from the governor or other official from the provincial government. The DGE will assign

a technical team to assess the feasibility of the request to determine whether the requested permit in the business area will be granted.
Organizations interviewed with highlighted the fact that the licensing procedure is complicated. To date, no non-PLN entity has obtained a licence to sell electricity to end-users in a PLN business area.

## OUTSIDE THE PLN AREAS

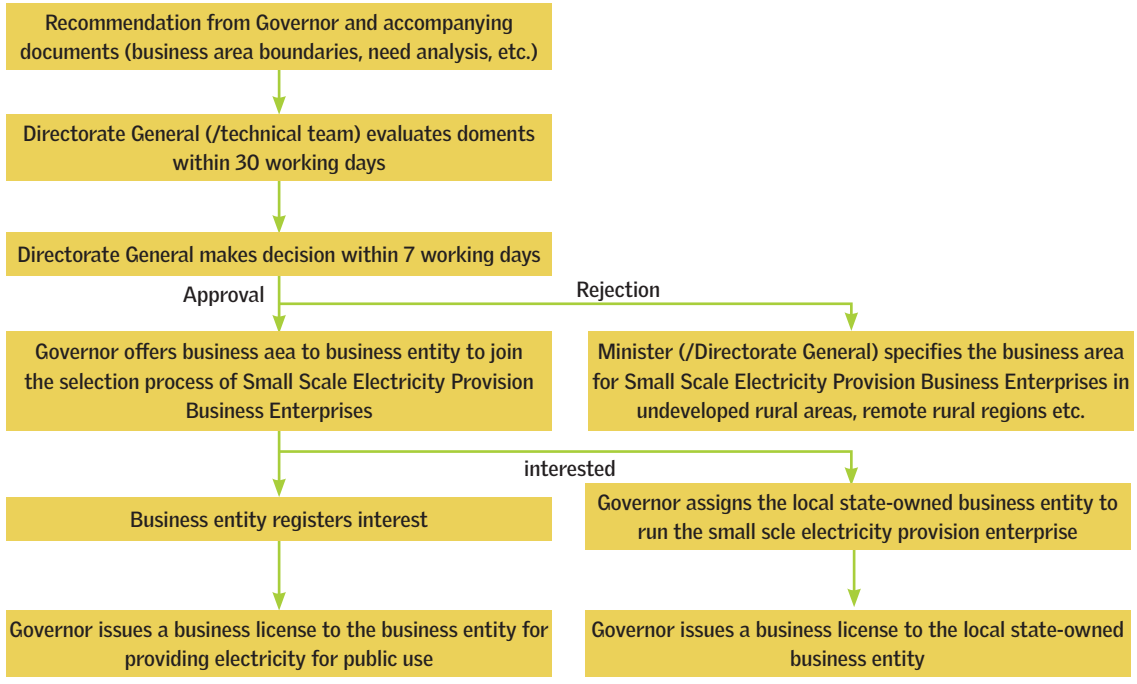
In 2016, the ESDM issued a regulation that sought to accelerate electrification in rural areas (Minister of Energy and Mineral Resources, 2016). The minister determines a business area, consisting of multiple villages not served by the PLN. Developers can apply to serve the area. If successful, they may generate up to 50 MW and sell electricity directly. If no private companies register an interest in serving the business area defined by the local government, then the local state-owned business is assigned to run the service.

## FOREIGN COMPANY OWNERSHIP

The Indonesian government limits foreign ownership of businesses that build or operate generation plants of any size. Power plants up to 1 MW in size must be owned by domestic investors while power plants 1-10 MW are open to foreign investment of up to 49 per cent. Projects larger than 10 MW may have foreign investment of up to 95 per cent (or 100 per cent under a public-private partnership arrangement). This bars any direct foreign ownership in mini-grids, which would typically have a capacity of less than 1 MW.

There are also local content requirements that may further deter investors, even though it is unclear how the share of locally-manufactured content is measured or how effectively this will stop developers from importing foreign materials. The regulations are especially unclear for hybrid-generation projects such as solar-diesel, as there are different local content requirements for each generation source.

**Figure: Indonesia's business licence application procedure**




Source: The Ministry of Energy and Mineral Resources, 2016.

## TARIFFS

### GRID CONNECTED MINI-GRIDS

In PLN areas, developers are required to charge a regulated tariff. For developers receiving a subsidy

from the national government, the PLN's subsidized tariff of US $0.03/kWh must be charged to residential consumers and a subsidy (that considers operational expenditure, losses, generation cost and expansion plans) is provided. If developers don't receive a subsidy, the minister or governor decides the tariff. However, it is unlikely that rural consumers would be willing or able to pay a cost-reflective tariff.

### OFF-GRID MINI-GRIDS

Where the PLN is not present, tariffs are unregulated. The most common tariff structure is a flat rate, the level of which is agreed between the villagers and developer, typically ranging from US $0.73-3.91 per kWh. This wide range likely reflects the operation and maintenance, and transmission and distribution costs associated with complex geographies on remote islands. This might include the cost of transporting equipment to these remote locations that can take several weeks.

### ARRIVAL OF THE MAIN-GRID

The PLN is obliged to purchase electricity generated from an IPP's mini-grid if the main-grid arrives at the site, through a 20-year PPA. The PLN must purchase power in Indonesian rupiah, and can pay in US dollars only if an exemption is obtained from Bank Indonesia[26]. The mini-grid is transferred to the PLN once the 20-year term is over.

The PLN is required to purchase electricity from renewable energy power plants of less than 10 MW, which include renewable mini-grids. The tariff is set under two different scenarios:

- 85 per cent of the regional cost of electricity generation if the regional cost of power exceeds the national average
- A negotiated rate if the regional cost is equal to or less than the national average.

**Table: Outcomes of mini-grids in Indonesia upon arrival of the main grid**

| Outcome | Reason (s) | Number of projects |
|---|---|---|
| Mini-grid abandoned | Tariff higher than that of PLN Poor management of the system | 140 |
| Mini-grid operating in parallel to the main grid | Tariff cheaper than that of PLN Better quality service | 50 |
| All electricity sold to PLN | | 5 |
| Excess electricity sold to PLN | | 4 |

Source: World Bank ; Note: Highlights favourable outcome

# BANGLADESH

Since 2010, Bangladesh's energy business has performed impressively, thanks to progressive policies, partnerships with developing countries, and the execution of good projects by both public and private developers. The rise in capacity expansion has been considerable, from around 4.5 GW in 2008 to 25.5 GW in 2022. The private sector owns over 60 per cent of the total installed capacity in the electricity industry.

But despite the growth in electrification, Bangladesh's rural regions remain inadequately linked to the grid. The entire electrification rate has grown from 14 per cent in 1990 to 32 per cent in 2000 and 92 per cent in 2019. Number of electricity connections, on the other hand, differs substantially between rural and urban locations. In 2019, 62 per cent of the country's population lived in rural regions, where 88 per cent of the dwellings were electrified; in the same year, 38 per cent people lived in cities, where 98 per cent of households were electrified.

Grid expansion, mini-grids, and freestanding systems were all parts of the government's plan to supply energy to everyone by 2021. The Power Sector Master Plan (PSMP) 2010 outlined the government's aim for developing the generation, transmission, and related infrastructure needed to achieve country-wide electrification by 2021. The government knows that public sector investment alone will not be

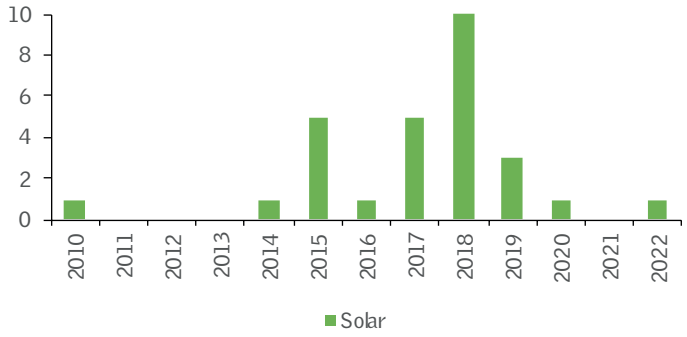
enough to meet its goal, and thus seeks to mobilise private sector resources.

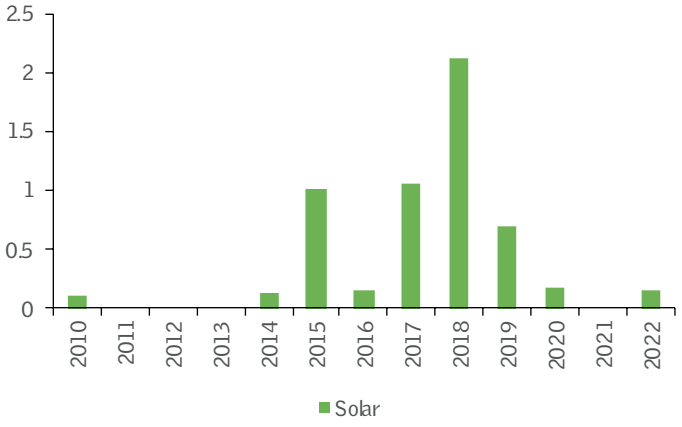
Infrastructure Development Company Limited (IDCOL), a 100 per cent government-owned finance entity, aims to accelerate and encourage private sector engagement in renewable energy projects. IDCOL collaborates with the Ministry of Power, Energy, and Mineral Resources (MPEMR) to identify locations where grid development is unlikely in the near future, as well as to attract commercial small grid developers.

Mini-grid operators have a limited but expanding market in Bangladesh; as of early 2022, the country had 28 mini-grids with a total capacity of 5.8 MW. The island of Sandwip became home to Bangladesh's first commercial solar mini-grid in 2010, delivering energy to 201 customers using a 100-kW solar PV system that was combined with a 40-kW diesel generator and battery storage system. The project is up and running, with clients paying Bangladesh Taka (BDT) 32 per kWh.

Independent mini-grid developers work in a regulated environment governed by contracts. IDCOL sets rates and tight requirements to incentivise the quality of service that is superior to that provided by the main grid. Licenses are not required. Mini-grid providers charge 30 BDT per kWh (about US $0.38), a heavily subsidised rate.

**Graphs: Bangladesh's installed mini-grids by (a) projects and (b) capacity (MW)**



| Sl. | Project | Capacity | Location | Finance | Completion date |
|---|---|---|---|---|---|
| 1 | ava-148.5-kwp-solar-minigrid-godagari-rajshahi-10 | 148.5 kWp | Godagari, Rajshahi | Self | 2022-03-09 |
| 2 | BREL Solar Mini-Grid Project | 170 kWp | Sonargaon Upazila, Narayanganj | IDCOL | 2020-01-22 |
| 3 | Impressive Greentech Ltd. Mini-Grid Project | 250 kWp | Harirampur Upazila, Manikganj | IDCOL | 2019-12-31 |
| 4 | Western Renewable Energy Ltd. Minigrid Project-01 | 218 kWp | Bhola Sadar Upazila, Bhola | IDCOL | 2019-11-23 |
| 5 | UDDIPAN -1 Mini-Grid Project 1 | 220 kWp | Belkuchi Upazila, Sirajgonj | IDCOL | 2019-03-25 |
| 6 | Connectia Limited Mini-Grid Project | 220 kWp | Rajarhat, Kurigram | IDCOL | 2018-12-27 |
| 7 | GHEL Solar Mini-Grid Project 02(Char Kajal) | 100 kWp | Galachipa Upazila, Patuakhali | IDCOL | 2018-11-24 |
| 8 | Western Renewable Energy Ltd. Minigrid Project-01- | 280 kWp | Bhola Sadar Upazila, Bhola | IDCOL | 2018-10-31 |
| 9 | GHEL Solar Mini-Grid Project 03(Char Biswas) | 100 kWp | Galachipa Upazila, Patuakhali | IDCOL | 2018-10-26 |
| 10 | Blue Marine Energy Limited Mini-Grid Project | 250 kWp | Teknaf Upazila, Cox's Bazar | IDCOL | 2018-09-30 |
| 11 | Eastec Ltd. Mini-Grid Project | 250 kWp | Shibganj Upazila, Chapainawabganj | IDCOL | 2018-04-20 |
| 12 | Envis Energy Limited Mini-Grid Project | 250 kWp | Kazipur Upazila, Sirajgonj | IDCOL | 2018-04-13 |
| 13 | Brit Bangla Trade Initiatives Ltd. Mini-Grid Project | 250 kWp | Fulchhari, Gaibandha | IDCOL | 2018-03-18 |
| 14 | UDDIPAN -2 Mini-Grid Project 2 | 160 kWp | Alfadanga Upazila, Faridpur | IDCOL | 2018-03-10 |
| 15 | Solar Electro Bangladesh Ltd.-Mini-Grid Project 3 | 250 kWp | Bhedarganj Upazila, Shariatpur | IDCOL | 2018-01-06 |
| 16 | Vincen G-Tech Ltd. Mini-Grid Project | 250 kWp | Islampur Upazila, Jamalpur | IDCOL | 2017-12-30 |
| 17 | Solar Electro Bangladesh Ltd.-Mini-Grid Project 2 | 250 kWp | Bhedarganj Upazila, Shariatpur | IDCOL | 2017-12-14 |
| 18 | Solargao Solar Mini-Grid Project | 130 kWp | Sirajganj Sadar Upazila, Sirajgonj | IDCOL | 2017-02-28 |
| 19 | PEL Solar Mini-Grid Project | 210 kWp | Daulatpur, Kushtia | IDCOL | 2017-02-15 |
| 20 | Super Star Solar Mini-Grid Project | 228 kWp | Daulatpur Upazila, Manikganj | IDCOL | 2017-01-28 |
| 21 | AVA Solar Mini-Grid Project | 150 kWp | Godagari, Rajshahi | IDCOL | 2016-11-16 |

| Sl. | Project | Capacity | Location | Finance | Completion date |
|---|---|---|---|---|---|
| 22 | Solar Minigrid Pilot Project at remote haor areas of Sullah, Sunamganj | 650 kWp | Sullah, Sunamganj | CCTF | 2015-12-31 |
| 23 | GEAL Solar Mini-Grid Project | 160 kWp | Nageshwari, Kurigram | IDCOL | 2015-11-14 |
| 24 | SEBL Solar Mini-Grid Project | 180 kWp | Manpura Upazila, Bhola | IDCOL | 2015-10-20 |
| 25 | HBPL Solar Mini-Grid Project | 140 kWp | Bagha, Rajshahi | IDCOL | 2015-03-09 |
| 26 | GHEL Solar Mini-Grid Project 01 | 100 kWp | Kutubdia Upazila, Cox's Bazar | IDCOL | 2015-01-15 |
| 27 | Shouro Bangla Solar Mini-Grid Project | 140 kWp | Raipura Upazila, Narsingdi, Narsingdi | IDCOL | 2014-12-12 |
| 28 | PGEL Solar Mini-Grid Project | 100 kWp | Sandwip Upazila, Chittagong | IDCOL | 2010-10-01 |

## DISTRIBUTED POWER MARKET STRUCTURE

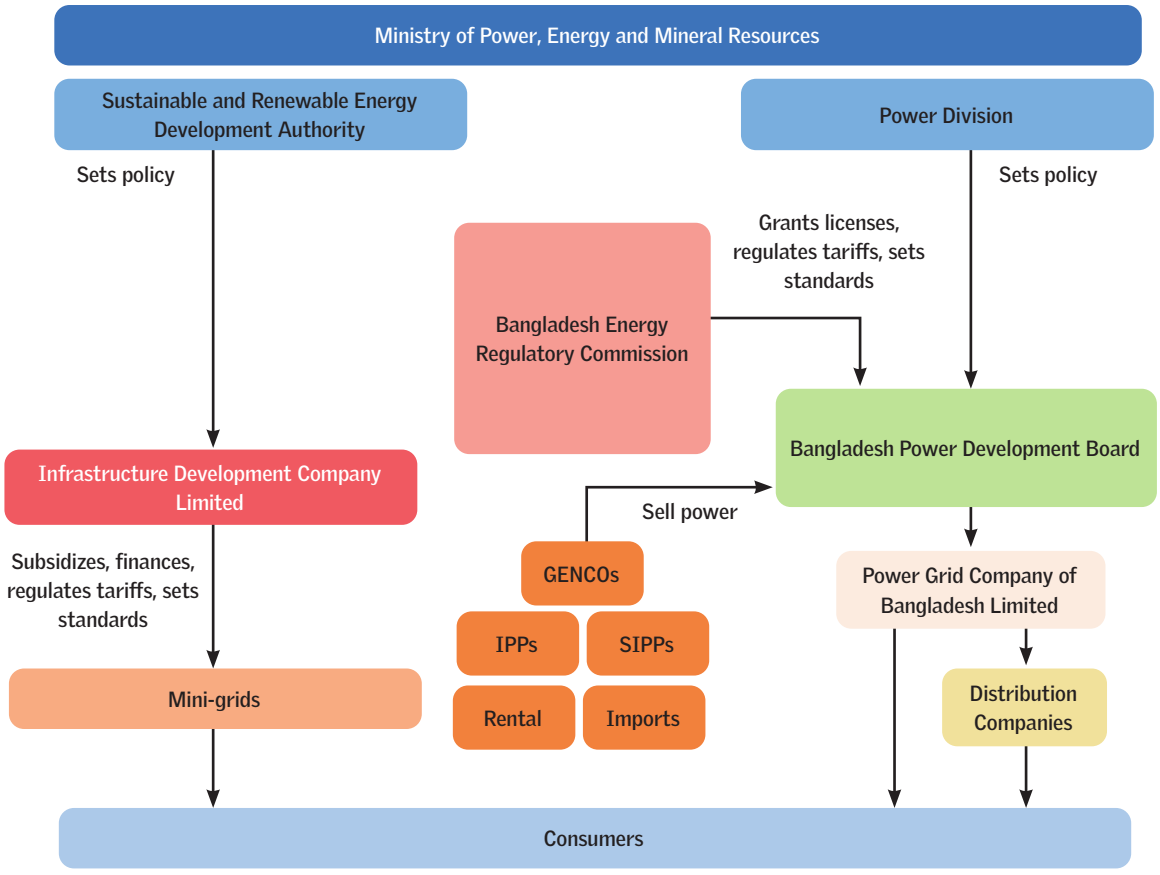
In Bangladesh, access to electricity has risen dramatically over the last decade, yet load-shedding affects 79 per cent of the grid-connected population, and low-voltage supply affects 60 per cent.

Around 70 per cent of Bangladeshi houses are linked to the main grid, while another 20 per cent have access to off-grid power (including home lighting systems). In 2019, there were 24.8 million persons linked to the main grid, with around 17 million of them being residential users

.

The Bangladesh Power Development Board (BPDB), BERC, IDCOL, Power Grid Company of Bangladesh (PGCB), MPEMR, and the Rural Electrification Board are all power sector actors in the country.

**Figure: Bangladesh Power Sector Structure**




## BANGLADESH POWER DEVELOPMENT BOARD (BPDB)

The BPDB is a partially integrated public utility that produces, trades, and distributes electricity. After Bangladesh gained independence in 1972, BPDB was established to improve the country's electricity industry. BPDB is also in charge of planning and implementing the sector's expansion strategy, as well as constructing the majority of the sector's infrastructure.

## BANGLADESH ENERGY REGULATORY COMMISSION (BERC)

The Bangladesh Energy Regulatory Commission (BERC) is in charge of overseeing the power industry in a completely independent and unbiased manner. The agency is in charge of determining electricity generation and transmission prices, as well as licencing, disputes, and quality of service requirements, as well as monitoring the sector as required by law. The President picks the Chairman and four other members of the BERC on the ministry's recommendation.

## INFRASTRUCTURE DEVELOPMENT COMPANY LIMITED (IDCOL)

IDCOL provides grants and loans to private renewable energy projects. The World Bank, Asian Development Bank, Islamic Development Bank, and KfW are among the entities that sponsor IDCOL. It is in charge of developing medium and large-scale renewable energy and infrastructure projects in Bangladesh, as well as overseeing tariffs and standards compliance.

## POWER GRID COMPANY OF BANGLADESH LTD (PGCB)

The PGCB is in charge of the country's transmission system. PGCB was established as the national grid operator in 1996, when the power sector was restructured. Grid connections, grid renovations, and the growth and operation of the national grid are among its tasks.

## GENERATION COMPANIES (GENCOS)

GENCOs, a state-owned company, generate nearly a quarter of Bangladesh's power. GENCO has established five subsidiaries during the 1990s, as the electrical industry has become more vertically integrated. Ashuganj Power Station Company (APSCL), Bangladesh Electricity Generation Company (EGCB), North West Power Generation Company (NWPGCL), Coal Power Generation Company (CPGCBL), and Rural Power Company Ltd are among them (RPCL).

## DISTRIBUTION COMPANIES (DISCOMS)

Besides BPDB, Dhaka Power Distribution Company (DPDC), Dhaka Electric Supply Company Ltd (DESCO), West Zone Power Distribution Company (WZPDC) and Northern Electricity Supply Co Ltd. are the DISCOMs responsible for distributing power in Dhaka and other parts of the nation.

## POLICIES AND REGULATIONS

In Bangladesh, there is no adequate legal framework for small grids. The government of Bangladesh has taken a contract-based strategy to regulating the small grid industry, with IDCOL acting as the de facto regulator. The MPEMR policy guidelines are followed by IDCOL.

## A REGULATION BY CONTRACT APPROACH

The Implementation Agreement with IDCOL governs private developers that are building small grids in Bangladesh. Mini-grids are one of the five sectors targeted by the government as part of the Solar Power Development Program to generate solar

energy (along with utility-scale, rooftop, irrigation, and social infrastructure). Mini-grids providing power up to 5 MW were exempted from having a license in 2013. The government de facto delegated most of the regulatory powers to IDCOL by exempting small grid companies from seeking BERC licences.

IDCOL manages small grid tariffs through the Implementation Agreement. IDCOL also outlines the systems' equipment and performance requirements. By licencing possible small grid locations through SREDA, the government has maintained some sort of control.

## POLICY APPROACH TO NATIONAL TARIFF

In Bangladesh, there is no national tariff policy; mini-grids have a different tariff than main grids. But all mini-grids must charge the same rate. The major grid rates are differentiated by customer type, with incremental block pricing for home users and a single rate for agricultural pumps and public lights. Off-peak and peak tariffs are the same for small industry and commercial customers.

Bangladesh's government massively subsidises power costs on the national grid. According to the BERC Act, BPDB should sell energy at a price that covers its costs of generating and acquiring power from independent sources. BPDB, on the other hand, sells power to distribution firms at a lower cost than what it pays to generate. The gap between the generation cost and the supply tariff is subsidised by the government through a loan to BPDB at a lower-than-market interest rate. BPDB received US $800

million in government subsidies in 2014, up from US $584 million the year before. Distribution businesses pay PGCB at a defined price set by BERC.

The tariffs for all mini-grids are nearly the same. IDCOL established a pricing ceiling of BDT32 per kWh (US$ 0.40) for solar mini-grids in their Implementation Agreement. Most mini-grids price BDT30 per kWh (US $0.38) in actuality, with just one of the seven active mini-grids charging more at BDT32 per kWh. Tariffs are heavily subsidised, much like main grid power.

## EXPANSION PLANNING

Bangladesh's growth of electricity availability is guided by a strategy devised by the REB. The REB has identified regions where grid extension is technologically and economically advantageous, as well as areas where mini-grids will be used. It has identified 1,027 sites where mini-grids are technologically and economically ideal, where the grid cannot be expanded, or where the number of consumers with the ability to pay is insufficient to support grid expansion.

Although the development of mini-grids in Bangladesh is not officially controlled, IDCOL and SREDA assist developers with guidelines. Developers requesting IDCOL financing must submit a proposal, and if the proposed location is not one of the 1,027 SREDA-identified sites, IDCOL validates when the grid is projected to reach there. If the grid is not expected within four to five years, IDCOL has the option to approve the project. Only developers aiming

for isolated rural regions, however, are eligible for assistance.

## LICENSING

In Bangladesh, it is illegal to engage in electricity generation, transmission, or distribution without a license, unless the BERC has granted an exception. The BERC was founded in 2003 as the only agency responsible for awarding licenses and exemptions. BERC has the authority to exclude particular individuals for a set length of time. The BERC License Regulations 2006 established requirements for obtaining a licence or an exemption from a licence. The Act also empowers the BERC to regulate licensee rates.

Solar mini-grid system operators with a capacity of less than 5 MW are exempted from obtaining a power generation license under Bangladesh's Renewable Energy Policy of 2008. Two kinds of mini-grids are defined in the "Guidelines for the Implementation of the Solar Power Development Program":

I. Solar mini-grid systems with capacity up to 250 kW must simply inform the BERC with a letter.
II. Solar mini-grid systems with capacity between 250 kW and 5 MW must obtain a waiver certificate from BERC.

The Renewable Energy Policy, on the other hand, does not appear to have been enacted into law, meaning that mini-grids operate in violation of the BERC Act of 2003 and the License Regulations that followed in 2006. The BERC stated that it has

not established a special framework for tiny grids; yet, mini-grids were still required to seek a licence, notwithstanding the government's position. It does not, however, have enforcement authority. Regarding mini-grid licencing exemptions, IDCOL stated that it has reached an agreement with the MPEMR's Power Division. While mini-grid system operators are not required to have a license, BERC demands that they follow the same rules as a licensee: they must generate, transmit, and supply electricity effectively.

The Department of Environment has also modified the categorisation of solar mini-grid systems from 'Red' to 'Orange A,' which is the category for electricity projects. This reclassification eliminates the need for small grid developers to complete an Environmental Impact Assessment in order to get their required Environmental Clearance Certificate.

## TARIFFS

The tariffs that mini-grids can charge their customers are regulated by IDCOL. This tariff regulation is part of the Implementation Agreement that developers must sign in order to get IDCOL's basic financing package. Suppliers having a system capacity of less than 5 MW are not subject to BERC intervention in tariff fixing.

The power rate for the initial years of operation is set between BDT30 and BDT32 per kWh, according to the Implementation Agreement between IDCOL and private developers. The Implementation Agreement calls for a rate rise, which must be approved by IDCOL. Most mini-grids can seek a tariff rise every

five years, while others can request one every two years. Till the time of going to press, no small grids have raised their prices, and several have even reduced their pricing in order to encourage demand.

Although IDCOL has computed the tariff to allow a return on equity of 13 to 15 per cent, the tariff level may not allow mini-grids to generate a profit. This is due to the fact that the tariff is computed ex ante, leaving little possibility for adjustment once the project is completed.

# NEPAL

In 2019, electricity was used as the major source of illumination in over 90 per cent of residences in Nepal -- with 94 per cent of the urban households and 88 per cent of the rural households utilising power. But with 79 per cent of the population living in rural areas, 2.9 million still people do not have access to even the most basic forms of electricity. Even when access is available, low system capacity limits electricity use to lighting and other low-power activities.

Despite having a considerable hydropower potential of almost 42,000 MW, Nepal has one of the lowest per capita energy consumption rates in the world, with an annual average of 171 kWh in 2019. It is widely known that a shortage of power and frequent power outages have impeded the country's economic growth.

Despite significant renewable energy potential, traditional biomass (firewood and charcoal) still accounts for 85 per cent of the total energy use. Expanding the national grid to include disconnected areas is not practicable because of difficult terrain and high costs.

The Alternative Energy Promotion Centre (AEPC) was founded in 2016 with the goal of providing universal access to renewable energy options that are clean, dependable, and affordable in Nepal by 2030. The organisation supports programmes

that assist communities in gaining access to low-cost, high-quality power. In 2012, AEPC launched a subsidy programme to promote the use of mini-grids for rural electrification. AEPC previously only gave subsidies to community and cooperative-owned hydroelectric mini-grids; but, starting in 2017, privately-owned projects are now eligible as well.

## DISTRIBUTED POWER MARKET STRUCTURE

The Alternative Energy Promotion Centre (AEPC), which is part of the Ministry of Environment, Science, and Technology, is the country's main off-grid renewable energy institution. ADB, Danida, DFID, the EU, KfW, the Norwegian Ministry of Foreign Affairs, SNV, UNDP, and the World Bank are among the bilateral and multilateral development partners that have helped AEPC construct renewable energy projects.

Most off-grid renewable energy installations in Nepal have been established with government and/or development partner subsidies. Currently, the AEPC, with the help of different donors, subsidises these projects to the tune of roughly 40 per cent of their expenses. The developer (through loan and equity finance) and community/rural electric cooperatives (who often offer part of their equity contribution in-kind through labour) typically supply the remaining 60 per cent of the funding. Even at this amount of subsidies, however, the industry has yet to expand at the rate that AEPC has set for it.

Micro Hydro Projects (MHPs) were first launched

in Nepal in the 1960s and have since given energy to the country's rural off-grid residents. Nepal had manufactured approximately 3,000 MHPs with a total generating capacity of 35 MW by the end of 2018. As of 2019, Nepal's rural population is served by roughly 10 per cent of the country's mini-grids. In remote hilly locations, the Nepal Energy Authority (NEA grid) costs roughly NPR (Nepalese Rupee) 17-25/kWh to distribute energy (depending on distance), whereas a 50-100 kW MHP connected to the grid costs around NPR 9-15/kWh. As a consequence, linking Nepal's existing MHPs to the grid offers a more cost-effective solution to the country's energy problems.

In terms of fixing Nepal's energy problem, the MHP interconnection offers a lot of promise. It is, however, costly, necessitating further government subsidies. Collaboration is also required among a number of stakeholders, including the NEA, the Alternative Renewable Energy Center (AEPC), and the target communities.

Many remote communities in Nepal have both the potential and the need for off-grid and especially mini-grid electricity, and Nepal has one of the finest hydro mini-grid development records in the world. Despite this, progress has lagged behind expectations, and it is clear that more work is needed if these prospects are to be realised on a big scale.

## POLICIES AND REGULATIONS

In 2019, almost 90 per cent of the population of Nepal had access to electricity. This was a substantial

improvement – in 2007, just 60 per cent had access. The government is on pace to achieve its 2030 goal of universal electrification.

The extension of the national grid to rural regions has long been impeded by unequal rural settlement distribution, expensive power infrastructure development costs, and the 2015 national fuel crisis caused by intermittent hydropower.

The promotion of rural electrification projects via mainstreaming RE sources and introducing distributed generation (DG) as a core option of national energy strategy contributed significantly to this excellent outcome. For example, the Government of Nepal's Rural Electricity Policy of 2006 helped to rural poverty reduction and environmental protection by ensuring rural communities have access to clean, dependable, and suitable energy.

The AEPC launched the National Rural and Renewable Energy Program (NRREP) in 2012 for a five-year period with the goal of improving the living standards of rural women and men, increasing employment and productivity, reducing reliance on traditional energy, and achieving sustainable development by integrating alternative energy with the socioeconomic activities of rural women and men. The National Renewable Energy Program (NRRP) proposes to establish the Central Renewable Energy Fund (CREF) as the central financial entity in charge of delivering subsidies and credit assistance to the renewable energy industry.

The Renewable Energy Subsidy Policies of 2013 and 2016, as well as the Renewable Energy Subsidy Delivery Mechanisms of 2013, have aimed to support off-grid electricity provision through funding mechanisms with private sector participation to develop solar PV, micro- and mini-hydropower, wind energy, and biomass energy technologies. According to the policy, solar or solar/wind hybrid mini-grid projects will be eligible for a subsidy if the location is not connected to the national grid and there are no other options for electricity. Solar or solar/wind hybrid mini-grid systems with installed capacity of 5 kW to 100 kW are eligible for an upfront capital subsidy. The upfront capital subsidy ranges from NRs 150,000 to 175,000 per kW for generating and NRs 28,000 to 32,000 per home for distribution, with a total of NRs 430,000 to NRs 495,000 per kW depending on the project's remoteness.

Nepal's current energy policies are dispersed among a number of papers and executive orders. It is critical to have an integrated energy strategy that covers all types of energy resources, including mini grids. The kind and type of energy resource, the legal foundation of the energy organisation, and the magnitude of energy generation all influence the current institutional arrangement in the energy sector. As a result, Nepal's energy industry has a number of institutions. AEPC, which is part of the MoEWRI, is in charge of planning, managing, and facilitating microscale electricity and other alternative energy.

## LESSONS FROM SUBSIDIES FOR MICRO-HYDRO MINI-GRIDS

Nepal's subsidy delivery model for micro-hydro minigrids traditionally involves community members coming together as a group and applying to AEPC for a subsidy. They then work through AEPC to contract a private company to build and service the micro-hydro mini-grid. The community contributes a mixture of sweat equity and cash, and may also seek grants from the local government or NGOs. While this model has contributed to significant growth of micro-hydro mini-grids in Nepal, it has faced many complications. Where the community provided sweat equity by contributing to civil construction of micro-hydro schemes, poor construction often led to the user groups and cooperatives not being able to achieve the targeted power generation — thus impacting subsidy payments from AEPC. An over-reliance on grants for financial closure delayed projects. In addition, donor funding for technical assistance to support project due diligence and processing declined from 2017 onwards resulting in many micro-hydro companies struggling to remain in the market. This has been exacerbated by other issues, such as the shrinking market as electricity access inches towards 100% through national grid extension and community rural electrification programmes. In addition, public procurement guidelines are complex leaving some companies unable to bid, and with limited public funds for technical assistance, there is an insufficient pipeline of projects.

Another failure of this model was lack of sustainability: there were no incentives for the private sector to support communities to ensure the systems were delivered and maintained. Many communities were left to manage the system without the required technical knowledge and skills, which resulted in many schemes deteriorating. Communities also tended to set impossibly low tariffs, which resulted in communities not being able to pay back their loans, undermining the confidence of commercial banks to lend to the sector. A lack of focus on productive use of energy also meant that the mini-grids were heavily under-utilised, reducing the systems' sustainability even further. In addition, enterprise development suffered from the funders' focus on monitoring the impact through the number of households electrified and kilowatts generated.

To address these challenges, the community-owned model has evolved since the NRREP programme. In subsequent programmes such as the ADB-funded South Asia Subregional Economic Cooperation (SASEC) programme, the total project financing (subsidy, loans and equity) is provided prior to starting construction of mini-grids, and the construction is carried out by the energy company, with AEPC having the responsibility to monitor and supervise. In addition, the SASEC programme is collaborating with the RERL project (focused on technical assistance) to conduct post-installation support, community mobilisation, tariff, management, etc. In the MGEAP (initiated in 2019 and currently under project development phase), companies are allowed to function as an Energy Services Company (ESCO), where the model is shifting from a pure demand-side subsidy to a supply-side subsidy. The MGEAP financing model includes 60% subsidy and 30% concessionary loan to the minigrid developer, which can be a private company, local government or a community-led cooperative, and 10% as equity from the mini-grid developer.

# SRI LANKA

Only 38 per cent of the population in Sri Lanka had access to the grid during the civil war in 1994, and the figure was significantly lower in rural regions. Sri Lanka's government stated in 2019 that all of the country's households have been linked to the national grid.

Much of the electricity expansion over the previous 20 years has been fuelled by the construction of the central grid. Many Sri Lankans, on the other hand, were served by small hydropower facilities.

Over the last two decades, two types of organisations have emerged to develop these sites: electricity consumer societies (ECSs) and small power producers (SPPs), each servicing a distinct market. Individual, run-of-the-river pico and micro-hydropower projects were built, owned, operated, and managed by ECSs to provide energy to rural residents in communities that had not yet been linked to the national utility's main grid (the Ceylon Electricity Board) (CEB).

Between 1997 and 2012, the government and the World Bank supported the establishment of more than 250 isolated community-owned micro-hydropower plants in Sri Lanka. The program's purpose was to create village-level mini-grids that would be owned and managed by community-based organisations called Electricity Consumer Societies (ECSs).

These projects, which had a median size of 27 users, have used average installed capacity of 7.5 kW. At their peak, the ECSs had a total installed capacity of roughly 4 MW, supporting about 10,000 rural residents.

More than 100 of the isolated micro grids were abandoned when the national utility's main grid reached these villages. The bulk of ECS members are currently served by the Ceylon Electricity Board (CEB). Private consultants aided the ECSs, and they were granted project preparation grant payments for each mini-grid they assisted in the construction of that was still working six months later. The consultants were paid to help discover potential hydropower locations and then persuade local residents to participate in the project. After the projects were done, the consultants continued to work with the ECS to verify that they were working well (at least for the first six months).

The Energy Forum, a non-profit organisation based in Sri Lanka, was instrumental in supporting the conversion of the three ECSs. More than half of the ownership shares in the new limited liability firms are held by it and another NGO, the Federation of Electricity Consumer Societies. According to the Energy Forum, more than 50 more abandoned mini-grids held by ECSs might be converted to SPPs if funding could be found. However, conversion would need an agreement between the Energy Forum, the Federation of Electricity Consumer Societies, and individual ECSs on how the post-conversion equity would be shared among the three.

Three community-owned microgrids were successful in converting to grid-connected small power producers (SPPs). The switch to an SPP required the acquisition of connecting equipment as well as regulatory clearance costs. The ECSs, which were consumer welfare organisations, had to be rebuilt as limited liability firms in order to sign the standardised power purchase agreement with the CEB, and the three microgrids no longer offer retail services to their members as a result of the shift. Their only source of income is bulk power sales to the CEB.

In Sri Lanka, legal obstacles have slowed the development of national grid connectivity. These impediments are difficult to overcome, especially if they are enshrined in national law. The projects had an average capacity of 7.5 kW. In most circumstances, the profits from large-scale projects are insufficient to cover the whole cost of operation.

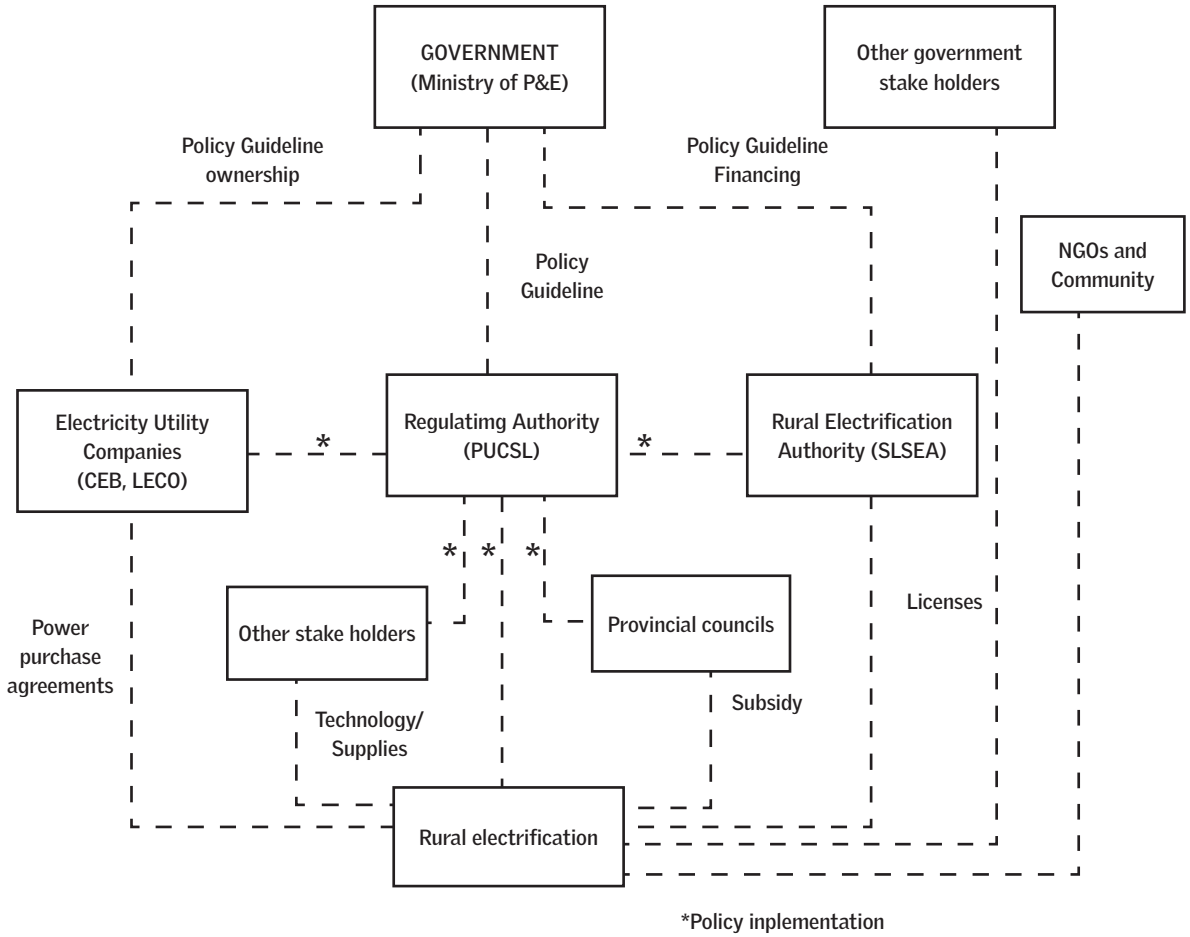
## DISTRIBUTED POWER MARKET STRUCTURE

The Ministry of Power and Energy, as well as the Public Utilities Commission of Sri Lanka (PUCSL), are responsible for electrifying homes. The Ministry of Power and Energy is in charge of developing a long-term electrification strategy that will be revised on an annual basis. With the help of electrical utilities, the Sri Lanka Sustainable Energy Authority (SLSEA), provincial councils, and other stakeholders, PUCSL will execute it. It will also develop strategies for providing targeted subsidies and carry them out. The Ceylon Electricity Board is the country's primary

electricity utility, which is overseen by the Ministry of Power and Energy.

Figure ... shows the elements of the institutional model that is in practice for RE in Sri Lanka. Following due process, grid-connected RE producers enter into power purchase agreements with CEB. The SLSEA will be in charge of providing permits for both grid-connected and off-grid RE initiatives.

**Figure: Elements of the institutional model for RE in Sri Lanka**



Government rules and PUCSL standards control the power purchase agreements (PPAs) between CEB and producers. In addition to federal subsidies like as import discounts, gasoline pricing, and fiscal incentives, provincial councils oversee subsidies. Other government stakeholders include ministries and departments, whose permissions and clearances are critical to the project's success.

## POLICIES AND THE INSTITUTIONAL FRAMEWORK

The first National Energy Policy of Sri Lanka was prepared in 1997 by the National Energy Policy Committee (NEPC), which was constituted under the Ministry of Power and Energy, but it was never formalised. Nonetheless, it had established the country's future blueprint for the industry. For the first time in the country's history of energy policymaking, the policy emphasised the relevance of energy for the country's economic growth. The draught policy paper prioritised universal access to energy and the development of the country's renewable energy resources. It emphasised the need of off-grid initiatives in communities without access to grid-based electricity.

The SLESA Act has clear provisions related to renewable based off-grid electricity generation, supply and distribution, and demarcation of geographical areas to be electrified through off-grid systems. It had laid down a clear roadmap for off-grid energy projects by stating that national grid can be extended to cover 97 % of the population, and the remaining 3 % is covered by off-grid systems. Accordingly, Ceylon Electricity Board (CEB) also had come up with the list of villages for off-grid projects.

The Ministry of Power and Energy of Sri Lanka enacted National Energy Policy and Strategies (NEPS) in 2005, which was the first formalised energy policy declaration of the Government of Sri Lanka. Implementation techniques, particular energy objectives, and strategies for reaching millennium development goals (MDGs) were all prioritised in the policy. The strategy prioritised boosting home electricity, particularly in rural regions, as well as meeting everyone's fundamental energy needs, increasing energy security, and improving the quality of energy services. The programme, in particular, had entrusted Provincial Councils with the task of developing off-grid electrification as an alternate method of electricity throughout the country. By 2016, the initiative aimed to electrify 98% of houses in Sri Lanka, using both grid-based and off-grid methods. The establishment of the Sri Lanka Sustainable Energy Authority (SLSEA) in 2007, under the SLSEA Act, was the next significant step, with the primary goal of increasing the country's renewable energy potential.

The Government of Sri Lanka's most recent energy policy announcement was the Sri Lanka Electricity Act 2009. One of the Act's most important aspects concerns the connecting of off-grid initiatives with the grid. The Act contains specific requirements for technical, tariff, and ownership issues relating to off-grid systems' grid-interconnection mechanisms. Only community-based village micro-hydro projects are eligible for these connectivity provisions. It appears that some type of incremental policy learning has occurred in the creation of energy

policies in Sri Lanka during the last few decades, based on various measures announced from time to time.

It appears that the lessons learned from previous policies have fed into the design of the 2009 Act; one can see how the scope of various policies announced from time to time has gradually widened, and how policies have been designed to address the sector's current challenges at the time of their declaration. For example, the most recent policy, the Sri Lanka Electricity Act 2009, has a strong emphasis on grid-interconnection difficulties, which is one of the most pressing concerns in the globe when it comes to off-grid energy growth.

## FINANCING

Grants were used to support the first village hydropower plants (prior to the Energy Services Delivery initiative). Projects finally received money from a consortium of about ten local commercial and regional development banks that had access to a World Bank credit line, allowing them to provide better terms. Commercial banks believed the projects were financially viable for the term of the loan, as evidenced by the credit line; future projects were often funded as follows:

| | |
|---|---|
| Commercial bank loan | 35% |
| Cofinancing grant from the Global Environmental Fund | 29% |
| Equity from ECS members | 18% |
| Provincial council grant | 18% |

The conditions of commercial bank loans are not disclosed to the general public since they are backed by private loan agreements. However, one knowledgeable observer claims that the typical loan in 2010 had a 16% interest rate and a four to five-year repayment period. This was a far lower rate than the estimated 48% charged by non-bank lenders in the area at the time. In certain situations, commercial bank loans were provided to the ECS, while others were made to individual ECS members.

Cross guarantees were a one-of-a-kind feature of the ECS loans. Each family was responsible for a part of a debt and guaranteed the payments of the others.

Four programme features are significantly responsible for the ECS's success:

- Local private consultants who were compensated for their work provided targeted and timely technical help.
- Commercial bank funding was made possible thanks to a World Bank credit facility.
- Grants of US $400 per kW of installed micro-hydropower capacity, up to a total payment of US $20,000, dependent on performance.
- The approval of initiatives by provincial councils, as well as the allocation of additional money by the councils, boosted their legitimacy.

They have supported projects that were produced as part of a well-designed and well-implemented government programme on which the Sri Lankan government and donors worked together.

## LICENSING

The approach is quite easy in the case of privately held projects, and a common practise has been established. Before signing a power purchase agreement (PPA) with the CEB, a project developer must first obtain a 'Energy Permit' from SLSEA and a 'Generation License' from PUCSL. In the case of community-based initiatives, however, the process is more complicated and entails resolving a wide range of technical, social, administrative, and financial concerns. The key technological problem is building an adequate control panel. Furthermore, adapting current distribution systems to meet CEB requirements is both technically and financially challenging. Converting freely operated ECSs into commercial legal companies is a time-consuming process on the social front. Grid connectivity of these off-grid ventures necessitates a slew of administrative permissions. Other permissions, such as authorization from provincial authorities, are also necessary for operationalizing the grid connections procedure, in addition to SLSEA energy permits, PUCSL generating licences, and CEB power purchase agreements (Subasinghe, 2017)[1]. In terms of financing, community-based enterprises have a hard time raising the funds needed to turn their efforts into economic endeavours.

This is due to the fact that communities lack the appropriate collateral to obtain the necessary financing from banks. As a result, the tiny size of these enterprises makes commercial viability problematic (ESMAP, 2018)[2]. The pilot results from

two independent initiatives imply that CEB and SLSEA's interconnection costs are excessively expensive and need to be decreased in order for interconnection to be successful.

However, the country's current feed-in-tariff method is deeply entwined with these connectivity difficulties. Though a feed-in-tariff (FiT) was created in Sri Lanka to promote renewable energy technologies for power plants with a capacity of less than 10 MW, many of these small-scale projects are not covered by the present FiT system[3]. FiT was first established on the basis of 'avoided cost,' which is the cost the utility would have paid if the same quantity of energy had been obtained via traditional fuel sources. This was updated in 2007 to include a cost-based tariff computation based on technology. However, it appears that the current FiT regulation does not take minor initiatives into account (ADB and UNDP, 2017)[4]. Smaller renewable energy projects, it is proposed, should be permitted to charge higher rates than bigger renewable energy projects, which is not provided for in the current FiT programme. This would have aided in the resolution of the connectivity problems.

## TARIFFS

Many ECSs were functioning long before the Public Utilities Commission of Sri Lanka (PUCSL), Sri Lanka's electricity regulator, was founded in 2003. The PUCSL had no authority over the retail pricing that the ECS charged its members even after it was founded.

PUCSL's lack of pricing control over the ECSs has been explained in two ways. The first is that ECSs were classified as captive generation (i.e., self-supply), which meant they were usually immune from tariff regulation. Members' monthly contributions to the ECS were classified as membership dues rather than tariff payments, which is the second problem. This position is supported by the fact that the ECS's "customers" are also its "owners," implying that members would have no incentive to overpay for the power provided by the ECS. As a result, the government's electrical regulator was relieved of its responsibility to protect ECS members from increased costs. In fact, the opposite criticism has been levelled: the ECS membership fees are excessively cheap. Fees covered operational expenses and loan repayments because there was no provision for depreciation or a return on invested capital (during the loan duration).

Tariffs set at absurdly low levels are not unique to Sri Lankan ECSs. Pico, micro, and mini-grids controlled by communities appear to be the standard across the world. These community-owned firms' tariffs are frequently too low to sustain financially successful operations in the long run. Excessively cheap tariffs are not a severe issue if the community-owned system's distribution assets are replaced with new distribution facilities paid for by a bigger national or regional utility when the main grid reaches the village. They are, however, a severe concern if the system is projected to function for a lengthy period of time. In this case, the system will need to set

aside money for depreciation to cover future asset replacements.

Between 1997 and 2012, ECSs grew in popularity. Many of them went out of business when the main CEB grid extended fast into communities supplied by them, and many of their members became CEB customers.

According to a study conducted by the Energy Forum in 2014, more than 100 ECS vanished once the CEB grid was installed. When the CEB grid reached a village that had previously been serviced by an ECS, roughly 60 per cent of the ECS's members generally became CEB customers—usually houses closest to the village's centre and those who could pay the US $50 connection fee. The ECS households, which accounted about 40 per cent of the total, were often located further away from the town centre. Because they couldn't pay the higher connection fees required to extend CEB distribution lines to their more remote locations, they continued to be supplied by the ECS. For some years after the CEB grid was installed, the hamlet had two electrical distribution networks.

Most ECSs are anticipated to go out of business as viable retail power providers in the near future. They will be pushed into a financial death spiral since the total income they will collect from a declining number of families will not be enough to cover their operating expenditures, let alone any substantial repairs.

There are two compelling financial reasons for ECS

members to move to the CEB. The CEB, for starters, provided a substantially reduced per-kWh rate. As soon as a hamlet is connected, residents may take advantage of the CEB's heavily subsidised national lifeline pricing[5], which costs US $0.017-0.067 per kWh[6] for homes using 90 kWh or fewer per month. Villagers, on the other hand, pay roughly US $0.25 per kWh if they continue to use the ECS.

The CEB, on the other hand, provided a greater degree of service. It was able to deliver power 24 hours a day, seven days a week, with no constraints on the kind of domestic equipment that could be attached. ECS members, on the other hand, were frequently prohibited from using irons or rice cookers during peak hours in the evening or morning. They were also forbidden from connecting refrigerators, which, if widely utilised during peak hours, would put a pressure on the system's full capacity, resulting in brownouts or blackouts. Connecting to CEB distribution lines allowed homes to use more appliances for longer periods of time with no constraints on how long they could use them. The average residential use in one typical system increased from roughly 50 kWh per month before connectivity to 90 kWh after linkage. Given these distinctions, it's hardly unexpected that the ECSs ceased to exist.

# RECOMMENDATIONS

# RECOMMENDATIONS

## FOR GOVERNMENTS

It is policy that determines whether a country can cultivate an enabling environment for mini-grid developers to flourish, and for private financing to flow. In countries with poor energy access services or highly unreliable power grids, it is particularly essential for governments to support mini-grids through legislation and regulations so that they can grow and become economically viable for meeting the needs of the poorest.

It is likely that the grid will remain the primary choice for electrification where it is easily accessible or there is a reasonable expectation of demand growth, however, mini-grids can often be cheaper where access is difficult or grid power is expensive, provided power demands can be managed. In addition, the area that can be easily reached by the grid is diminishing, so extending it to reach more remote and rural customers becomes prohibitively expensive. It is for this reason that governments should focus on mini-grids in their electrification efforts. This report recommends governments provide direct financial support for renewable hybrid mini-grids for improved access to clean, reliable, and affordable electricity. Grants through results-based financing (RBF) and tenders are considered direct financial support. Governments with real financial constraints may need help from DFIs and other governments.

## TAKE A LEAST-COST APPROACH

For rural electrification to improve, it is imperative that governments pursue least-cost approaches. This term refers to the least cost necessary to deliver

electricity to the end users. In many countries, that means prioritizing mini-grids over expanding existing hub-and-spoke power lines. There are two fundamental reasons why mini-grids are better than traditional power lines: cost and speed. Rural households are generally located in sparsely populated areas, which means they incur high transmission and distribution costs. They also consume relatively little power per capita, which in turn means the cost of building transmission and distribution lines is high.

Given these two factors, the true cost of electricity delivered to remote households is relatively high. Meanwhile, state-backed utilities charged with grid expansion are often burdened with substantial debt. For some of these entities, securing additional loans to finance build-outs can be extremely expensive or impossible. All of these factors result in grid extension simply being prohibitively expensive. In addition, grid expansions involve a variety of practical issues. Such projects typically require a lot of investment and planning time. Construction can take many years. A few initiatives have been undertaken to develop geospatial modelling tools that compare the costs of mini-grids versus grid extensions, allowing governments to prioritize technologies according to location.

## SET ELECTRICITY ACCESS TARGETS AND ROADMAPS BY TECHNOLOGY

Most governments have set national targets for electricity access, but few have been explicit about how they intend to increase off-grid access in rural

areas to achieve those targets. This is crucial for the development of comprehensive policy frameworks. Even though setting targets, and then creating roadmaps for each technology type is a detailed process, it can send a clear message to stakeholders about what technologies will be deployed and supported. Creating roadmaps that merely satisfy short-term political goals is unlikely to succeed.

## OUTLINE CLEAR GRID ARRIVAL RULES TO PROTECT VALUE OF MINI-GRIDS, ATTRACT INVESTORS

The building out of the central grid into a remote region after a mini-grid has been built and is operating can pose an existential risk to the financial health of that mini-grid. In particular, developers (and, their financial backers) are concerned that their projects will be engulfed by the grid and expropriated by the government-backed utility without adequate compensation. In order to protect the value of isolated mini-grids, governments can establish clear grid arrival rules. Nigeria is an example of good practice, which provides three options if the main grid reaches isolated mini-grids:

1. The regional distribution company, referred to as the discom, buys any excess electricity generated from the mini-grid beyond what is needed to serve its existing customers.
2. The discom buys all the mini-grid's generated electricity and regards it as part of the main grid system.
3. The discom compensates the developer for the loss of any revenue.

Concerning feed-in-tariffs, the national utility of Indonesia is obligated to purchase electricity from renewable energy power plants under 10 MW, which includes renewable mini-grids. The tariff is set under two different scenarios:

1. 85 per cent of the regional cost of electricity generation if the regional cost of power exceeds the national average
2. A negotiated rate if the regional cost is equal to or less than the national average

For the utility, such rules allow mini-grids to be integrated directly into the main grid and allow it to save capital. For the mini-grid owner and investors, it protects the value of the asset after the main grid arrives.

## ESTABLISH FAST ADMINISTRATIVE PROCESSES

A streamlined licensing procedure could reduce administrative time and cost, easing the burden on governments, as many countries will need hundreds and often thousands of mini-grids. Small-scale projects could have different requirements than utility-scale ones, and developers could be granted a single licence to develop multiple projects. It can be challenging and time-consuming for minigrid operators to obtain a generation and retail licence in some countries, thereby increasing development costs. Creating one-stop shops where all applicable permits can be obtained can also drive down development costs. Such organizations can handle administrative procedures at every stage of a project. By streamlining the process, governments are

relieved of the burden of duplication of work. For example, like in Philippines Energy Virtual One-Stop Shop Act that aims to streamline the process of permits for power generation, transmission and distribution in the country. Tanzania allows developers to obtain a single licence for several distinct sites.

## IDENTIFY AND DISCLOSE POTENTIAL SITES FOR MINI-GRID DEVELOPMENT

In an effort to keep private sector costs down, governments can identify and disclose locations where they will support mini-grid development. As a result, developers can better determine where and how many mini-grids to install and save both time and money identifying project sites. A comprehensive list of sites could also help developers plan clusters of mini-grids, which would increase operating efficiency and maintenance, for example Tanzania and Nigeria had comprehensive lists aligning to their national electrification goals.

## BE TRANSPARENT

Energy access issues in emerging countries are frequently misunderstood by governments as well as the regulations they have developed to address them. It is important to be able to offer such information to companies and investors who need it to make important decisions. This problem could be addressed effectively by disclosing data, starting with clear definitions, identifying places that require better access, and providing information on local policies that assist stakeholders in assessing local enabling environments.

For example, some governments disclose village-level electricity access data without defining how electrification is defined. Under the Indonesian government's definition, an electrified village does not have all its households connected. It may mislead stakeholders to believe the country is closer to universal electricity when it is actually far from it, and potentially affect investments in the country. In Kenya, data on electrification differ between the Energy Ministry, the National Bureau of Statistics, and utilities. Electricity access in Tanzania refers to the total population near a locality that benefits collectively from electricity, regardless of the number of households hooked up to the grid. The government should also disclose results of policy interventions such as mini-grid tenders and RBF programmes. This has not always been the case in the past. It's vital to publish this information on public web sites that are easy to navigate and understand.

## DEVELOPMENT FINANCE INSTITUTIONS AND DONOR AGENCIES

Donor agencies and development finance institutions are crucial to providing governments with financial and technical assistance to install mini-grids. The organizations could, however, focus their efforts more strategically on certain types of interventions in order to allocate their resources most efficiently.

## ESTABLISH AND SUPPORT RBF PROGRAMMES TO SCALE MINI-GRIDS

Developers receive RBF funding once the mini-grids are installed. Several RBF programs for mini-grids

have been implemented in Nigeria and Tanzania, among others. RBF programmes can be very useful to governments in exerting greater control over how mini-grids are developed in their jurisdictions because they are clear and easy to implement. Developers and investors generally find them straightforward to use because they are clear and efficient to implement. In its white paper, the African Minigrid Developer Association (AMDA), which has more than 30 members, also recommends the use of RBF programmes[27]. There are relatively few existing RBF programmes today. For instance, in Nigeria, the continent's most populous nation, the Performance Based Grant (PBG) programme has only made USD 150 million available to date. In addition to providing more financial support to existing RBF programs, DFIs can work with governments to seed new ones.

## PROVIDE PARTIAL-RISK GUARANTEES TO FINANCIERS

State-run utilities and the governments behind them can pose major risks to minigrid developers. Deeply indebted utilities and governments have in the past failed to honor payment obligations. As a result, the creditworthiness of governments directly impacts the viability of a mini-grid project and its developer's ability to access capital. There are also legal and political risks associated with such contracts. The provision of partial-risk guarantees (PRG) that insure against non-payment by utilities or governments would be useful for DFIs.[28] Typically, such PRGs bind DFIs to pay back private commercial lenders or even shareholders. They cover both principal and interest on a loan, covering both local and foreign currency

debt. In Nigeria, utility-scale power generation projects have adopted PRGs in collaboration with the World Bank. According to the agreement, the Bank will compensate the loan provider any unpaid debt. Mini-grid PRGs could protect commercial lenders in the mini-grid sector in case a utility or government cannot meet its contractual obligations.

### CONSIDER CROSS-SECTORAL COLLABORATION

Rural electrification aims to do more than supply rural communities with energy. It aims to improve their social, economic, and environmental conditions as well. It may boost agricultural productivity, allow for longer study hours, improve healthcare services, and broaden internet access. This suggests that commitments to mini-grids should not merely be made by government energy departments, DFIs, or donor agencies but also by others. Energy, agriculture, and health-related groups should work together to design and implement effective programmes.

## FINANCIERS

Up until recently, mini-grids have been financed primarily by governments, development finance institutions, donor agencies, and foundations. Commercial financiers, strategic investors, and corporate investors have recently provided some private capital. However, there is a much greater opportunity here for these players, especially if the minigrid sector is to achieve real scale.

### FINANCE MINI-GRID PORTFOLIOS

Investing in aggregated portfolios of projects from a single developer would benefit both investors and

developers. Due to the fact that most mini-grids are smaller than 100kW, a single project may not be as attractive as a large-scale renewable project. The bundling of small projects into a single portfolio can not only increase potential economic return, but also spread operational and regulatory risks across the portfolio. Furthermore, developers would save on transaction costs if a given number of projects is concentrated in a single or very small number of jurisdictions, rather than being spread out. Financing multiple projects would also enable a developer to procure equipment in bulk at a lower cost.

### EMPLOY ADVANCED IMPACT ASSESSMENT METRICS TO EVALUATE RESULTS

By evaluating a mini-grid's success solely by whether it provides comprehensive electricity access to rural communities, one can miss out on important social, economic, and environmental effects and other co-benefits that mini-grid projects can provide. To add further nuance, organizations like the Global Off-Grid Lighting Association (GOGLA) and Acumen have developed advanced metrics to collect data and assess impact. Financial institutions, including DFIs and donor agencies, could mandate that their recipients collect data using these advanced metrics, use the data to evaluate whether their investments were successful, and share the results with the poorest populations. Financial institutions can look for mini-grid developers with business models that focus on creating impact using impact metrics (e.g., The KeyMaker model promotes rural manufacturing by enabling developers to procure raw materials from local communities, process them in deep rural

areas using electricity from their mini-grids, and sell the products to customers in competitive urban or international market).

## DEVELOPERS

As evidenced by the development of some mini-grids to date, developers can generally improve the efficiency of their processes, reduce costs, and create benefits for customers while generating sufficient revenues. These were some of the lessons learned during research for this project:

### APPLY DATA ANALYTICS SOLUTIONS THROUGHOUT VARIOUS STAGES OF A PROJECT'S LIFETIME

Several technology start-ups exist today that provide innovative data analytics tools that can assist with mini-grid project development at various stages. These can be used to screen out unsuitable sites, simulate potential demand, and optimize system sizes and tariffs. Electricity consumption data from smart meters can also be analyzed to assess operational performance, and remote monitoring technology can minimize the time engineers spend reporting, troubleshooting, and visiting remote areas. Using these tools can improve efficiency of project development and operation and minimize costs throughout the value chain of a project.

### FOCUS ON MINIMIZING OPERATING EXPENSES AND STIMULATING POWER DEMAND

In order to improve project economics, developers can minimize operating expenses (opex) and stimulate customers' demand for power. Although

capex reductions are more affected by external factors such as regulations and technology costs, developers can minimize opex by design with minimal diesel fuel use and employing soft services that support efficient mini-grid operations and customer management. They can train local technicians, operate multiple sites close to each other, and use remote monitoring and control technologies. A business model that focuses on the use of electricity is essential to improve average revenue per user (ARPU) by including large power users as mini-grid customers (i.e., anchor loads) and/or stimulating productive use of electricity (e.g., financing appliances). A higher ARPU can be achieved using solar hybrid mini-grids.

Adopting the KeyMaker model is another way to stimulate power demand. Rural consumers have low power demands and the demand profile may not align with the generation profile. This model has the advantage that developers can take part in controlling how electricity is used, since they use minigrid power to process raw materials (e.g., freezing and milling) sourced locally. As a result, developers will be able to improve the economic performance of the mini-grids while improving the ability of local communities to generate income.

### CONSIDER BUNDLING ELECTRICITY WITH APPLIANCES VIA PAY-AS-YOU-GO MODELS

One way to stimulate the demand for power among mini-grid customers is to offer their customers appliances. The pay-as-you-go model lowers the barrier to rural residents using appliances as they

don’t have to pay for them in advance. Offering appliances can increase demand and encourage small businesses, resulting in more predictable loads, greater economic growth in rural areas, and a reduction of storage costs.

# ANNEXURES

# ANNEXURES

## Annex I: Key study findings (presented in a tabular form)

| Countries | Multi & Bilateral funding agencies | Does the electrification plan include off-grid solutions (minigrids and standalone systems)? | Does the government have a dedicated funding line or budget for electrification? | Does an official renewable energy target exist? | Is the target legally binding? | Is the RE target linked to international commitments (eg. NDC or regional commitment)? | Is there a renewable energy action plan or strategy to attain the target? | Are there programs which aim to develop minigrid systems or support the development of minigrids systems? | Do the regulations clarify what will occur when the interconnected grid reaches a minigrid? | Are minigrids legally allowed to operate in the country? |
|---|---|---|---|---|---|---|---|---|---|---|
| Nigeria | REA, AFDB, World Bank, GIZ | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |
| Ethiopia | USAID, EU DELEGATION, UNDP, KOREA INTERNATIONAL COOPERATION AGENCY (KOICA), EIB, AFDB, GIZ | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes |
| Tanzania | Sida, USAID, Energizing Development (EnDev) , DFID | Yes | Yes | Yes | Yes | Yes | Yes | Yes | yes | Yes |
| Rwanda | AfDB, GIZ, IDB, USAID | Yes | Yes | Yes | Yes | Yes | Yes | Yes | yes | yes |
| Uganda | EnDev, GIZ, SIDA, UKAID | Yes | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |
| Bangladesh | Asian Development Bank, EDCF, IDA, KfW, WB, JICA | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Nepal | World Bank, ADB | No | Yes | Yes | No | Yes | Yes | Yes | Yes | Yes |
| Sri Lanka | Asian DEVELOPMENT BANK, AfDB, IFC, WB, EU | N/A | N/A | Yes | No | Yes | Yes | N/A | N/A | N/A |
| India | ADB, DFID, GiZ, IFC, KfW, WB, EIB | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Indonesia | GIZ, NZAID, Endev, SIDA, FDFA, UKAID | Yes | Yes | Yes | Yes | No | Yes | Yes | No | Yes |
| Philippines | GIZ, Endev, SIDA, FDFA, UKAID | Yes | Yes | Yes | No | Yes | Yes | Yes | No | Yes |

| s<br>o<br>n<br>y? | Can minigrids be owned and operated by private operators? | Are there clear licensing proce-dures for minigrid operators and consu-mers? | Do the regula-tions differ by size of minigrids? | Are minigrid operators legally allowed to charge a cost-reflective tariff, even if it is different from the national tariff? | Are there duty exemptions and/or capital subsidies for minigrid systems and/ or individual components? | Are there specific financing facilities (access to credit etc.) available to support operators? | Are there technical standards detailing the requirements for minigrids to connect the grid? | Are technical standards made publicly available? | Are there safety standards for minigrids (e.g. overcurrent protection, system control etc.)? | Are these safety standards made publicly available? |
|---|---|---|---|---|---|---|---|---|---|---|
| | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | Yes | No | No | Yes | Yes | Yes | No | No | No | No |
| | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| | Yes | Yes | No | Yes | Yes | No | No | No | Yes | Yes |
| | Yes | No | Yes | Yes | Yes | Yes | Yes | No | Yes | No |
| | Yes | Yes | No | Yes | Yes | Yes | No | No | No | No |
| | N/A | | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| | Yes | No | No | Yes | Yes | No | Yes | Yes | Yes | Yes |
| | Yes | No | No | Yes | Yes | No | No | No | No | No |
| | Yes | Yes | No | Yes | Yes | No | Yes | Yes | Yes | Yes |

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