ENERGY
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Theme Guide: Off-Grid Regulations & Standards

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Off-grid renewable energy solutions will be instrumental in achieving SDG7 on universal access to energy. In the last couple years, stand-alone and mini grid solutions have seen a steep reduction in costs combined with an increasing reliability. According to the IEA, off-grid solutions are estimated to supply nearly 60% of the additional generation needed to achieve universal access, with mini grids accounting for the bulk of this.

Based on a growing track record in the sector, private sector developers will be able to accelerate growth in off-grid electricity supply. Combining technology with new business and financing models, the private sector is deploying off-grid solutions by utilising diverse financing options.

Governments in Asia and Africa, most of which have set targets for national universal access, can greatly benefit from facilitating private sector participation. By developing regulations with private sector involvement in mind, the journey towards universal access can be a joint public and private sector exercise.

Private sector players in the off-grid electrification field can enhance the trust in their technology and financial models by adhering to and/or aligning with international standards - not only pure technical standards for the diverse technical components of their energy delivery infrastructure, but also on common indicators that can facilitate investors in the sector to compare off-grid companies to each other.

Policy developments

As part of efforts to provide access to modern energy for rural populations, an increasing number of countries are turning their attention to distributed renewable energy technologies, and are introducing specific policy measures to promote them.

One of the more common types of policy measures is to include off-grid electrification in national strategies and commitments. In 2018, several countries integrated off-grid electrification into their rural electrification strategies and plans. For example, Togo's new electrification strategy aims to provide electricity access to 3 million people by 2030 by installing 300 solar PV mini grids and providing solar kits to some 550,000 households, among other efforts. Kenya plans to provide universal energy access by 2022 through the use of off-grid systems such as mini grids and stand-alone solar systems, alongside grid extension efforts.

An emerging trend in electrification planning is the use of geospatial least-cost models, which help electrification planners choose among the different electrification solutions for specific locations and sequence the implementation of electrification projects. Nigeria, Tanzania and Zambia are among the countries that have benefited recently from the use of such tools.

Governments are extending policy measures to implement off-grid electrification projects through specific delivery instruments. For example, Kenya launched a tendering process in early 2019 for the construction of 1.4 MW of solar PV plants with associated power distribution networks, as part of its plan to increase rural electricity access through mini grids. In the Philippines, the government approved a new competitive process for selecting power supply providers in off-grid areas.

Some countries also focused on developing specific regulatory support and rules for off-grid electrification systems. For example, Sierra Leone's Electricity and Water Regulatory Commission drafted comprehensive mini grid regulations that were set to be adopted in 2019. Such steps are in line with similar developments in previous years in countries like Tanzania and Nigeria, which adopted detailed mini grid regulations addressing challenging issues such as the tariffs that operators are allowed to charge, or the arrangements around the interconnection of mini grids in the case of grid arrival.

Some countries adopted specific incentives to create a more supportive enabling environment for off-grid electrification. The DRC issued an import tax exemption on solar equipment, and India approved Phase III of its Off-grid and Decentralised Solar PV Applications Programme, which targets an additional 118 MW of off-grid solar PV capacity by 2020.

To leverage the benefits of these innovations, it is crucial to ensure that the systems deliver the expected services and benefits over the long term.

Quality infrastructure for off-grid technologies reduces technical risk, leading in turn to better financial opportunities, improved operation and maintenance, and assured performance across the technology's lifespan. Quality infrastructure comprises the entire institutional network and legal framework necessary to formulate and implement standards and regulations for products and services. It extends to evidence of the fulfilment of those standards and regulations through testing, certification and accreditation.

The adoption of international technical specifications for rural electrification – notably a methodology for the implementation and management of systems – will be essential in ensuring and sustaining quality. However, with rapid innovations in off-grid solutions, new quality gaps are arising. As shown in Figure 1 for renewable energy mini grids, most of the emerging needs relate to the use of digital technologies and interoperability of components, including frameworks for big data management, interconnection to the main grid, elaboration of DC mini grid standards and comprehensive standards for the internet of things.

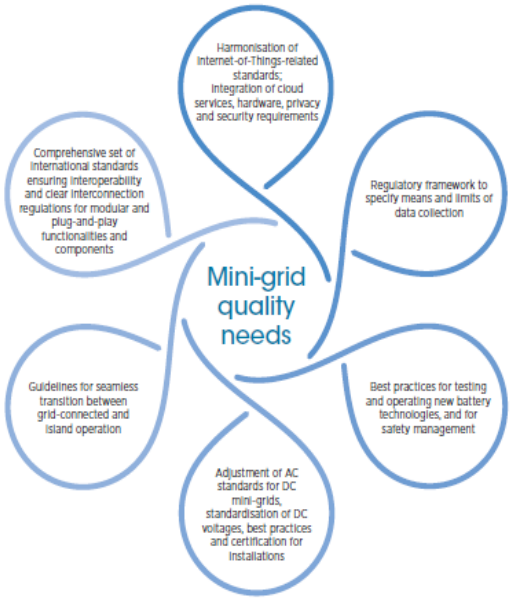

Figure 1 Mini grid quality needs, Source: IRENA, 2018.

Some countries, such as India and Tanzania, have begun to address these gaps. The Tanzania Energy and Water Utilities Regulatory Agency has developed "Guidelines for Grid Interconnection of Small Power Projects", which includes standards and engineering recommendations to be considered when designing a system capable of being connected to the grid.

In the following section, the key components of a regulatory framework for the off-grid sector will be discussed. These are an integral part of the overall support framework for off-grid energy projects. Please refer to Figure 2 for the full picture.

As every country has its own regulations and requirements, only a general overview is provided here. When considering starting an off-grid electrification business in a country, it is advisable to ensure access to the latest

policy developments. In most cases, the easiest way to do this is to team up with a local company or hire local staff/consultants who are up to date with both policy developments and the expected direction of upcoming regulations.

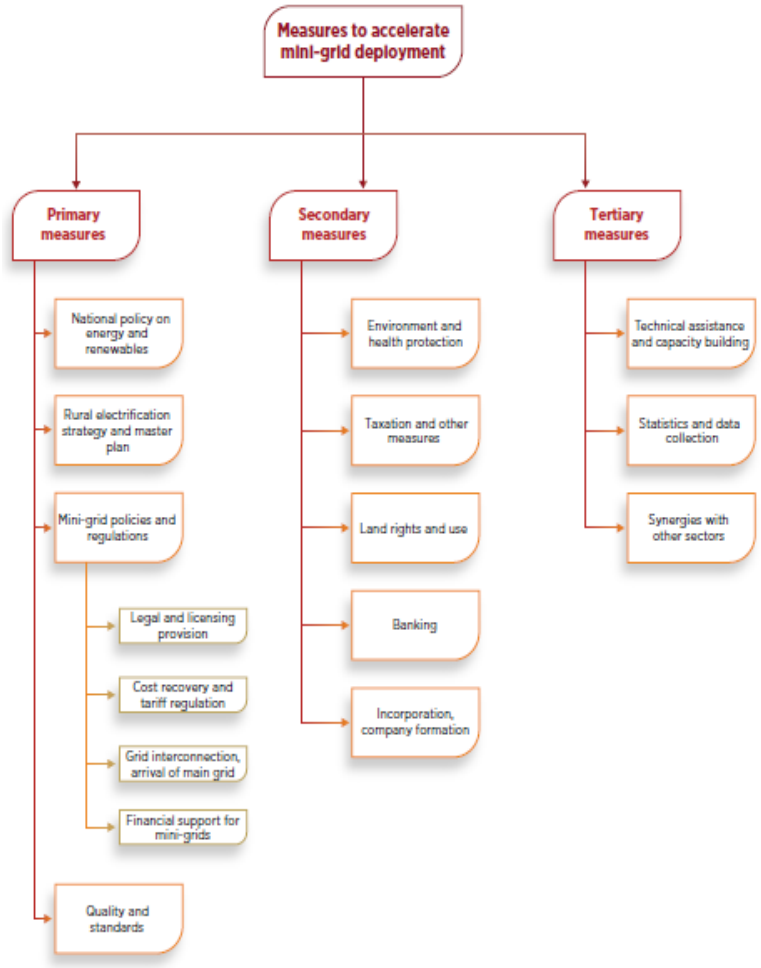

Figure 2 Measures to accelerate mini grid deployment, Source: IRENA, 2018.

Legal and licensing provisions

As a first principle, the private sector must have the legal right to generate, distribute and sell electricity to consumers. A common approach to facilitate mini grid licensing and other regulatory requirements is to establish a single-window clearance facility hosted at a rural electrification agency or similar body.

A considerable number of countries facilitate small scale off-grid electrification projects by either relaxing requirements or waiving certain licencing requirements for installation below a certain threshold. In Tanzania, for example, mini grids with a capacity of less than 1 MW need not apply for a generation license. Other countries provide for standardised agreements and environmental assessments.

In some countries, it is possible to apply for provisional licenses and concessions. This can mitigate project-development risks, as it helps avoid two or more developers carrying out preparatory activities on the same site.

Cost-recovery and tariff regulation

Tariff regulation has a strong influence on the viability and sustainability of off-grid electrification projects, notably by affecting the operators' ability to set end-user tariffs.

A balance needs to be struck between the political wish to have uniform national electricity tariffs and the fact that, even with current cost reductions in renewable energy technologies, a cost-reflective tariff for an off-grid mini grid will be higher than the often-subsidised main grid tariff. Luckily, more and more countries are realising that a cost-reflective tariff is a key requirement for the private sector to start off-grid electrification businesses. The Southern Africa Electricity Regulators Association, for example, emphasises that mini-grid tariffs be high enough to cover costs (thus invariably higher than main grids), and structured to reflect current spending on energy. It recommends that authorities provide provisions for communities to appeal, without directly regulating tariffs. This process can be facilitated by exempting small scale systems from tariff approvals.

Main grid encroachment

The unexpected arrival of a main grid is a major risk faced by off-grid electrification operators. Encroachment of the main grid can siphon off customers and strand investments. The absence of, or lack

of adherence to, grid-extension plans make it difficult to internalise the risk in the preparatory and project-development phase of off-grid projects.

National policy on grid extension should be readily available as should the process to follow if the grid reaches an area with a previously isolated mini grid. Either the mini grid may be connected to the main grid (subject to technical compatibility) and continue to operate as an IPP to the grid, or the operator should be compensated.

Facilitate access to finance

Assisted by international finance institutions, a number of countries have opted to facilitate private sector involvement in the off-grid market by providing funds to national governments to prepare (pre)feasibility studies for, e.g., mini grids. In 2015, Rwanda was awarded a USD $840 000 grant by the Sustainable Energy Fund for Africa to co-finance feasibility studies of 20 micro-hydro sites, as well as rollout and implementation plans that include tariff and business models for mini grids.

Making subsidies available to private sector developers, either in the form of reduced taxes, CAPEX subsidies or OPEX support, can assist in mobilising the private sector. In Uganda, for example, the government will finance the local distribution network of mini grids, while Nepal's Renewable Energy Subsidy Policy is designed to cover approximately 40% of CAPEX.

Quality standards

As mentioned under policy development, developing off-grid electrification projects and programmes according to international standards will ensure quality infrastructure that is able to deliver the required service over time.

Adherence to international quality standards is also important when making use of funding or services from international funders. For example, Figure 3 outlines the international and European norms and standards to be adhered to when procurement is subject to the German KfW procurement guidelines.

Technical Committee 82 of the International Electrotechnical Commission (IEC), for example, is responsible for the preparation of international standards for systems of photovoltaic conversion of solar energy into electrical energy, and for all the

Photovoltaics	International and European standards	Field of application/explanation
System components		
Modules	IEC 61730	Security
Wechselrichter	IEC 61683	Efficiency
	IEC 62109 Part 1 and 2	Security
	EN 50530	Efficiency
	EN 61000	Electromagnetic compatibility (EMC)-Safety
Junction Boxes	EN 5054	Design Qualification, Safety
Connectors (Plugs)	EN 50521	Security
Batteries	EN 50727	Safety requirements for batteries and battery systems
	UN Manual "Test and Criteria" III, 38.3 Rev.5 (Transport)	UN regulation on transport, contains a safety test for lithium and lithium-ion batteries: altitude, thermal, vibration, shock, external short circuit, overload and forced discharge test, impact test.
Installation of PV systems		
Electricity generation systems	IEC 60364	Security, general
	IEC 62124	PV stand-alone systems
Operation of electricity generation systems	EN 50110	Operation of electrical installations, including safety rules when working on electrical installations
Lightning protection	EN 62305 esp. EN 62305-3 supplement 5	Planning and installation of lightning and overvoltage protection, EN62305-3 supplement 5 deals with PV installations
Safety	IEC 61173 (Overvoltage protection)	Overvoltage protection for PV installations
	DIN EN 61008-1 (Circuit-breaker)	Fault current/residual current circuit breaker without incorporated overvoltage protection (RCCBs) for domestic installations and for similar applications.

Figure 3 Product standards for photovoltaic systems, Source: KfW Toolbox Sustainable Procurement, 2014.

elements in the entire photovoltaic energy system. In this context, the concept "photovoltaic energy system" includes the entire field from light input to a photovoltaic cell to and including the interface with the electrical system(s) to which energy is supplied.

Specifically for Africa, the African Electrotechnical Standardisation Commission (AFSEC) has published overviews of the applicable norms and standards for rural electrification projects (see sections on Further Reading and Useful Addresses).

Earlier led by PV GAP, but now by Lighting Global, international quality standards have been developed for affordable solar-powered devices and solar home systems. These are part of a larger support programme that includes advice to manufacturers on quality standards. Two comprehensive standards have been developed by Lighting Global: One for Pico PV and one for Solar Home Systems (see Further Reading section for more details).

Project developers do need to take in consideration that countries might have their own quality standards for products and installations, sometime complemented by local content requirements. In Indonesia, for example, approx. 45% of the components need to be locally manufactured (depending on technology and application used).

Common indicators

Given the capital-intensive nature of their business models, PAYG companies require a significant amount of working capital to support their growth. The sector was initially financed through grants, as well as other types of concessional financing provided by impact investors and various development finance institutions. Today, however, the demand for working capital and commercial investment in the PAYG industry clearly outweighs its supply. One of the main underlying issues that continues to block effective investments in the sector is investors' mismatched expectations and lack of familiarity with the nuances of the different PAYG business models.

To increase awareness of the different operational and business model performance levels of PAYG companies, a joint World Bank-IFC team, together with the Global Off-Grid Lighting Association (GOGLA), have developed a KPI framework for the sector. In addition to increasing transparency, the framework seeks to expand market data availability and reliability, and ultimately enable a more robust understanding of the sector by using data analytics.

Three key factors underpinned the necessity to establish the KPI Framework:

1. The PAYG industry is a growing sector in need of higher levels of commercial capital
2. The lack of industry data and reporting standards is keeping investors from entering the sector
3. Investors want a standardised due diligence process, and companies are willing to provide the data

While investors will – and should – continue to perform their in-house investment assessments, the KPI Framework will help to improve information flow between investors and companies in the PAYG industry by establishing standardised definitions and reporting standards. Given the continuously changing business models of PAYG companies, the KPI framework is not meant to be a scorecard of a company's operational performance, but rather a more structured mechanism to periodically assess the portfolio health of a company and its customer base, taking into consideration the many business models deployed. Each of the KPIs is defined across a portfolio of PAYG solar assets, generally a cohort in time, contained within a single country or region. Indicators are defined at a point in time, and measuring the KPIs on a periodic basis (monthly or quarterly) helps monitor performance over time.

Table 1 Overview of the Key Performance Indicators to assess a PAYG company	
Key Performance Indicator	**Definition**
Average Monthly Revenue per User (ARPU)	Total payments (including interest) received over the last 30 days divided by portfolio size
Average Unit Cost	Mean of the cost of active units, inclusive of hardware, international and in-country transportation and installation, import taxes and stock insurance, but exclusive of customer acquisition and maintenance
Average Credit Period	Average nominal number of months between system acquisition and expected final payment
Average Customer Deposit as a Proportion of Unit Cost	Average of the customer deposit as a fraction of total unit cost
Portfolio At Risk (PAR)	Total amount owed on units with any balance billed in the last 90 days that is overdue by 30 or more days, divided by total amount owed by customers (inclusive of interest and exclusive of any potential late payments)
Portfolio Size	Total number of customers in portfolio
Churn	Fraction of units that have gone inactive over the previous 90 days
Standard Deviation of Amount Ahead/Behind on Payments	Total revenue received minus total amount expected up to present date, in local currency, divided by number of active units
Average Total Expected Revenue	Mean total anticipated payments, including deposit but excluding unscheduled maintenance and late fees, in local currency
EBITDA Breakeven	EBITDA breakeven yes/no for the company as a whole
Average Maintenance Cost	Total payments received in local currency for scheduled and unscheduled maintenance, over the last 30 days
Standards Compliance	Percentage of systems complying with Lighting Global quality standards
FX Exposure: Net Open Position as a Percentage of Equity	Net open position divided by equity, calculate on absolute value basis

Table 2 Overview of support programmes on standards

Programme	Description
Lighting Global	Lighting Global – managed by IFC and the World Bank – works with manufacturers, distributors, governments, and other development partners to build and grow the modern off-grid solar energy market. Lighting Global's work with the off-grid lighting industry began in 2008 with the launch of the first Lighting Africa pilot in Kenya. Since then they have expanded across the African continent and into Asia and the Pacific under the Lighting Asia programme. The programme toolkit includes: • Quality Assurance: creating an international quality standard for affordable solar-powered devices and solar home systems, and advising manufacturers on these quality standards. • Market Intelligence: providing market intelligence that lowers the cost and risk for first movers entering frontier markets. • Access to Finance: facilitating access to finance for manufacturers, distributors, retailers and consumers. • Business Development: addressing impediments to the market's development, and working with individual firms to scale their businesses, providing on-the-ground business-to-business support and linkages to build the last mile supply chain. • Consumer Awareness: raising consumer awareness about emerging solar products in nascent markets. • Policy and Partnering with Government: working with governments on their quality standards.
PAYGo PERFORM	The PAYGo Performance, Reporting, and Measurement (PERFORM) initiative comprises investors (private and debt investors, local and international banks, and development finance institutions), PAYGo executives, and experts in energy and financial inclusion from around the world. Together, they are working to develop a reporting framework and set of key performance indicators for the PAYGo solar industry, building on previous work to this end by Lighting Global and GOGLA. The PAYGo PERFORM initiative is an open, transparent industry process that seeks the active involvement of stakeholders.

References and further reading

IRENA policies and regulations for renewable energy mini grids
https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Oct/IRENA_mini-grid_policies_2018.pdf

USAID Practical guide to the regulatory treatment of mini grids
https://pubs.naruc.org/pub/E1A6363A-A51D-0046-C341-DADE9EBAA6E3

IEC – Technical Committee 82 on solar PV https://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1276

Guide for application of standards for rural electrification in Africa
http://www.afsec-africa.org/Portals/15/AFSEC_Guide2018_Rural_Electrification_Africa_WEB.pdf

Key Performance Indicator Technical Guide for the Off-Grid Pay-As-You-Go Sector
https://www.gogla.org/sites/default/files/resource_docs/wbg_kpi_011818_yp_v20interactive-comp.pdf

Lighting Global Pico-PV Quality Standards
https://www.lightingglobal.org/resource/lighting-global-quality-standards/

Lighting Global Solar Home System Kit Quality Standards https://www.lightingglobal.org/resource/solar-home-system-kit-quality-standards/

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