EXPLORING AFRICA'S MINI-GRID TARIFF METHODOLOGIES

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1.0 Introduction

In October of 2019, under funding from the Energy Division of the United States Agency for International Development (USAID), the National Association of Regulatory Utility Commissioners (NARUC) provided support to the African Union Commission (AUC) at a workshop hosted by AUC's 'Unlocking Africa's Mini-Grids Market' project as part of USAID's Power Africa's Scaling up Renewable Energy (SURE) project.

The overall objective of the workshop was to provide policymakers and regulators from African Union Member States with guidelines for interconnection terms, compensation mechanisms for mini-grids, business and financing models, and tariff tools that will form part of country-specific mini-grid policy in Africa.

NARUC delivered an examination of the various mini-grid tariff methodologies being used across the continent to identify best practices and trends and summarize similarities, differences, strengths, and weaknesses across these different methods. The objective of this work is to provide recommendations to inform the development of future methodologies within Africa.

This report summarizes NARUC's research to analyze mini-grid tariff setting in African countries.

1.1 Overview of Research Objectives

The specific objectives of this research include:

- Identifying **themes, similarities, and differences** in current African mini-grid tariff setting approaches;
- Identifying tariff-setting **best practices** in Africa and around the world that could be leveraged and implemented within African markets in AUC member states;
- Providing **alternative regulatory pathways** for African countries to consider when approaching market challenges; and
- Providing **recommendations for additional tariff-setting tools** that could provide benefit to the African market.

2.0 Methodology

This project entailed predominantly desk-based research. After conducting an initial survey of countries, a rubric was developed for classifying each of the approaches to tariff-setting. This rubric was based in part on the approach taken by the World Bank Energy Sector Management Assistance Program (ESMAP), with sub-distinctions added to surface variations in approaches to individualized cost-based tariffs. This rubric is reflected in the Tariff Assessment Matrix which accompanies this report, and sets out the key findings, sources, and assumptions.

Countries were selected following a discussion between project sponsors and their respective advisors. Because tariff-setting is a highly technical aspect of mini-grid regulation, countries with more developed and publicly available tariff-setting approaches were prioritized for in-depth review. Countries were also selected to reflect a spread of approaches employed across the continent. It was decided that case studies be added to this report in order to surface some of the broader contextual issues that might impact upon tariff setting methodology, such as state capacity, market maturity, and capital subsidies. Cambodia was chosen as a primary case study country because the country's tariff setting methodology has evolved over time in response to changing market conditions and to achieve different regulator objectives. Thus,

Cambodia provides an instructive lesson for how African countries might revise regulations at different stages of market development. Nigeria was also added as a case study after workshop participants expressed interest in learning about Nigeria's Multi-Year Tariff Order (MYTO) tool, and how the country's tariff setting methodology interacts with other aspects of its regulatory approach, including licensing and grid arrival.

In accordance with the rubric, each country was analyzed, initial findings were presented to the AUC in October 2019. The preliminary findings were presented during a short 1.5-hour session as part of USAID's Unlocking Africa's Micro-/Mini-Grid Market workshop held in Arusha, Tanzania on October 17-18, 2019. Feedback from participants has also been incorporated in the findings set out in this report.

Table 1 below summarizes the approach for different components of the research.

Table 1. Summary of Research Methodology

Research Component	Description
Countries Reviewed	• **Africa:** Ethiopia, Kenya, Rwanda, Tanzania, Uganda, Zambia, Nigeria, Ghana • **Asia:** Cambodia
Information Gathered	• **Tariff Setting Methodology.** Type of tariff-setting methodology employed by country regulators, along with specifics related to that tariff methodology • **Outcomes Assessment.** Average cost of electricity and trends in access to electricity across country • **Context Assessment.** A variety of additional criteria that included three institutional factors, five policy factors and goals, and five market factors
Information Sources	• **Country regulations, plans, and strategies.** Publicly available documents created by national government to explain their market context, goals, and current tariff-setting approach for mini-grids. For some countries, this also included detailed tariff-setting Excel models. • **Third-party resources.** Publicly available reports on mini-grid regulation developed by the World Bank, the International Renewable Energy Agency, World Resources Institute, and the International Finance Corporation, among others
Case Studies Developed	• **Cambodia** • **Nigeria**

3.0 Results

3.1 Tariff-Setting Approach

The analysis categorized the tariff-setting approaches employed within African countries into the following five high-level methodologies based on World Bank Energy Sector Management Assistance Program (ESMAP)[1]:

- **Uniform National Tariff.** Regulator sets standard national tariff for all mini-grids that is equivalent to the main grid tariff
- **Efficient New Entrant:** Regulator sets single benchmark tariff for all mini-grids, estimated as the cost of service for an efficient new market entrant
- **Bid Tariff.** Tariff set at the lowest price bid by mini-grid developers in a competitive process
- **Individualized Cost-Based Tariff:** Regulator develops tariff limits for each mini-grid individually based on the estimated cost recovery tariff for that mini-grid (standard tariff for all customers/households served by that mini-grid)
- **Willing Buyer/Willing Seller:** Tariff price set through an agreement with the mini-grid developer and customer (either individual customers or a community of customers)

The tariff-setting approaches deployed in each country are summarized in Table 2 below. As demonstrated in the table, hybrid approaches that span multiple methodologies are feasible.

Table 2. Summary of Tariff-Setting Approaches by Country Researched[2]

	Uniform Tariff	Efficient New Entrant	Bid Tariff	Individualized Cost-Based Tariff	Willing Buyer/Willing Seller
Ethiopia					
Ghana					
Kenya					
Nigeria					
Rwanda					
Tanzania					
Zambia					
Uganda					

Primary Methodology: employed broadly for all projects meeting certain criteria

Split Categorization: primary methodology has elements of multiple approaches

Secondary Methodology: employed currently or in past for specific projects

[1] Note that ESMAP has released an executive summary of the report, available here, which does not include the tariff methodology framework. The Project Team had the opportunity to review the forthcoming full report's tariff framework to ensure alignment of resources.
[2] See accompanying Tariff Assessment Matrix for detailed sources.

The analysis revealed four key findings:

- **Countries in the region primarily use the Willing Buyer/Willing Seller and Individualized Cost Based Tariff methodologies for mini-grid tariff setting.** With few exceptions, African countries are employing Willing Buyer/Willing Seller and/or Individualized Cost Based Tariff to set mini-grid tariffs. Rwanda and Uganda employ methodologies that have characteristics of both approaches, in which a tariff is locally approved but the regulator can provide oversight to ensure its fairness. These methodologies are generally used because they enable project-specific tariffs, which are useful because the cost structure of mini-grids varies significantly from project to project.

- **Uniform tariffs have been deployed in two countries, but only in specific circumstances.** None of the reviewed countries have implemented uniform national tariffs as the primary tariff setting model. Kenya has implemented uniform national tariffs for projects owned by the Kenya Power and Lighting Company (KPLC), which owns and operates a large portion of the main utility grid.[3] Ghana is in the process of pursuing a pilot uniform national tariff model.[4] In most cases, in order to adopt uniform national tariffs significant subsidies are needed, making it challenging for most countries to employ this approach. Uniform tariffs are primarily planned and implemented in countries with relatively high electrification rates, which makes the required mini-grid subsidy for this approach relatively limited.

Example of a Tiered Regulatory Framework: Zambia

In Zambia, mini-grids are divided into three categories, which are each subject to different approaches to tariff-setting:

- Mini-grids less than 100 kW are exempt from formal tariff regulation.
- Mini-grids between 100 kw and 1 MW must submit a proposed tariff to the Energy Regulation Board (ERB) for five years. The proposal is assessed for "reasonableness."
- Mini-grids over 1 MW are subject to a formula set by the ERB and are regulated in a similar manner to on-grid.

This practice ensures the optimal use of administrative capacity by reducing oversight on smaller projects, keeping a moderate level of oversight on mid-sized projects, and the most oversight on large projects. It also primes larger projects for grid arrival by creating a smoother transition process.

Source: Zambia Energy Regulation Board, *Summary of Approved Regulatory Framework for Mini-Grids in Zambia* (2018)

- **The bid tariff methodology has only been used in one country, Uganda, under unique circumstances.** Uganda implemented the bid tariff approach for a set of projects supported by Gesellschaft für Internationale Zusammenarbeit (GIZ). The tender was released for competitive bids for the entire project region of up to 25 villages. Bids were evaluated based on lowest weighted tariff offering.[5] Broadly speaking, regulators may not be employing the bid tariff model due to lack of established competition within the market, as countries primarily have nascent mini-grid markets based on research conducted into market factors. The bid tariff approach may become more relevant—and prevalent—as market participation grows.

[3] "Kenya National Electrification Strategy: Key Highlights." *Kenya National Electrification Strategy: Key Highlights*. Kenya Ministry of Energy, 2018. http://pubdocs.worldbank.org/en/413001554284496731/Kenya-National-Electrification-Strategy-KNES-Key-Highlights-2018.

[4] "Mini Grids for Timely and Low Cost Electrification in Ghana: Exploring Regulatory and Business Models for Electrifying the Lake Volta Region." Mini Grids for Timely and Low Cost Electrification in Ghana: Exploring Regulatory and Business Models for Electrifying the Lake Volta Region. World Bank & ESMAP, November 2017. http://documents.worldbank.org/curated/en/576111512382257544/pdf/121824-ESM-GhanaESMAPGhanaTechnicalReportDECclean-PUBLIC.pdf.

[5] GIZ's engagement provided the financial and technical support required to implement a tender approach. A brief summary of GiZ's support is available here: "Pro Mini-Grids—Clean Electricity in Rural Uganda. GiZ, European Union, Republic of Rwanda. https://www.giz.de/en/downloads/giz2018-Pro-Mini-Grids-Factsheet.pdf

- **Multiple countries have employed a tiered approach to mini-grid regulation.** Three of the eight reviewed countries have implemented a tariff-setting approach that employs different methodologies depending upon the size of the project. For example, in Tanzania terms and tariffs for projects under 100kW are set using a Willing Buyer/Willing Seller model (with regulatory oversight), while projects above 100kW are regulated using an Individualized Cost Based Tariff approach. Regulators have implemented this methodology to relieve administrative capacity, enabling them to focus their time and bandwidth only on the largest mini-grid projects.

3.2 Individualized Cost-Based Tariff Analysis

The Individualized Cost-Based Tariff methodology is employed by many African countries and therefore it was deemed appropriate to conduct a more detailed assessment of the approaches to individualized tariff setting in the study countries.

If employed effectively, the Individualized Cost-Based Tariff model is an attractive methodology because it enables regulators to ensure cost recovery for mini-grid developers/operators, which incentivizes private sector investment. Additionally, the methodology enables regulators to set project-specific tariffs that account for variability in mini-grid costs from one project to the next. When employed with sufficient regulatory oversight, the Individualized Cost-Based Tariff methodology also ensures that communities are paying truly cost reflective tariffs and not unfairly high rates set by developers. However, the individually set tariffs are almost certain to result in different rates for mini-grid customers throughout the country and rates that are much higher than the national main grid tariff, which could create political challenges within the country. Additionally, the Individualized Cost-Based Tariff methodology can be administratively burdensome, which could pose challenges with limited administrative capacity.

Because most African countries employ some version of the Individualized Cost-Based Tariff methodology, the analysis reviewed different countries' approach to administering this tariff setting methodology. This analysis explored the following elements of the Individualized Cost-Based Tariff methodology.

- **Regulatory Asset Base:** Guidelines for assessing the value of regulated assets on which the mini-grid developer is allowed to earn a return
- **Allowed Rate of Return:** Guidelines for the rate of return allowed for mini-grid developers on their capital investment
- **Depreciation:** Guidelines for calculating depreciation of assets
- **Treatment of Capital Subsidies:** Guidelines for how capital subsidies provided by the country or other grant sources should be incorporated within the asset base and depreciation of assets

The different approaches that countries take for each of these components of the Individualized Cost Based Tariff methodology are summarized below. Note that some of these components are relevant for other tariff-setting methodologies, particularly depreciation and treatment of capital subsidies.

3.2.2 Regulatory Asset Base

The Regulatory Asset Base (RAB) refers to physical components of the mini-grid development that are accounted for when calculating a cost-based tariff. RAB is described in varying levels of detail by countries throughout Africa. The primary approaches include:

- **Providing detailed tools that have pre-set categories for asset base inputs**. Nigeria, Tanzania, and Kenya all have detailed Excel-based tools that offer categories that are allowed within the RAB. For example, in Nigeria's tool there are entries available for both generation assets (solar panel, solar cables, battery bank, solar inverter, battery inverter, sub-distribution infrastructures,

generation house, PH costs) and distribution assets (poles, grid low voltage, grid connections, customer connections, smart meters).[6] It is unclear whether mini-grid developers can enter in categories within the RAB that are outside the pre-set inputs. In these tools, there are no parameters guiding the costs of specific components of the RAB.

- **Defining broadly as with catch-all terminology.** Several countries define the RAB with terminology such as "the sum of all assets used and useful in providing regulated services" (Zambia).[7] This approach gives the regulator the discretion to determine the reasonableness of entries on a case-by-case basis.

- **Leaving types of costs included within RAB unspecified in regulation.** Several countries do not specify what is included within the regulated asset base in their regulations. It is presumed in these countries, that it is left to regulatory discretion to assess the types of assets that can be claimed by developers for return.

Allowed Rate of Return

Similar to the RAB, there are different approaches to defining the allowed rate of return within African country regulations. The primary methodologies include:

- **Calculating "allowable rate of return" based on the weighted average cost of capital (WACC).** Both Ethiopia and Zambia track the allowed rate of return to the developer's WACC, which is determined by the cost of debt and cost of equity. This can be calculated on this individual developer-level or by using industry benchmark figures. Regulations can also require a target debt to equity ratio.

- **Identifying or capping at a specified rate of return.** Several countries set a maximum rate of return that the developers can earn on their regulatory asset base. For example, Kenya caps the developer's internal rate of return at 18% for mini-grid projects.[8] Similarly, Cambodia caps the rate of turn at 10%.[9] In a related approach, Nigeria capped the rate of return at a specific number but pegged it to the non-recourse commercial debt interest rate plus six percent.[10] In calculating the rate of return, it is normally the developer that bears the risk of foreign exchange, which increases developer risk.

Depreciation

Countries within Africa specify approaches to depreciation in varying levels of detail within regulations. While some countries do not specify an approach for depreciation, those that do include depreciation within the calculation of the regulated asset base. The two primary approaches observed within regulations include:

- **Straight-line depreciation.** Regulators that referenced depreciation cited a straight-line depreciation approach applied either over the "asset's useful lifetime" or for a pre-set number of years (e.g. 20 years). Some counties, for example Zambia, set the straight-line approach as the default methodology but allowed for an exemption based on individual project needs.[11]

- **Depreciation referenced but precise methodology unspecified.** Other countries referenced depreciation as part of the calculation of the regulated asset base and ongoing costs of the mini-grid

[6] Nigerian Electricity Regulatory Commission; Multi-Year Tariff Order [MYTO] Tool (2015)
[7] Electricity Regulatory Board; Summary of Approved Regulatory Framework for Mini-Grids in Zambia (2018)
[8] World Bank, Climate Investment Fund, Energy Sector Management Assistance Program; "Mini Grids in Kenya: A Case Study of a Market at a Turning Point" (2017)
[9] World Bank, Climate Investment Fund, Energy Sector Management Assistance Program; "Mini Grids in Cambodia" (2017)
[10] Nigerian Electricity Regulatory Commission; Multi-Year Tariff Order [MYTO] Tool (2015)
[11] Electricity Regulatory Board; Summary of Approved Regulatory Framework for Mini-Grids in Zambia (2018)

project but did not specify a methodology for calculating asset depreciation.

Treatment of Subsidies

African countries that define an approach for treating capital subsidies in tariff setting employ a similar methodology. All countries that specify treatment of capital subsidies **exclude these subsidies from the regulatory asset base calculation**. For example, Tanzania's regulation states, "For purposes of calculating a reasonable return on capital, the regulatory asset base should not include any grants received from the Rural Energy Agency, Government, or donors for the purpose of lowering tariff levels." Several reviewed regulations did not define an approach for treating capital subsidies.

3.3 Alternative Regulatory Approaches: Service-Based Regulatory Structures

While most regulatory approaches employ a per-kilowatt hour (kWh) tariff, several participants sought ideas on alternative financing structures for mini-grids during USAID's Unlocking Africa's Micro-/Mini-Grid Market Workshop held in Arusha, Tanzania on October 17-18, 2019. In response, a high-level analysis of alternative service-based regulatory models was conducted to identify approaches that might be applicable in contexts where it is difficult to bridge the gap between a politically-feasible tariff and one that allows for cost recovery.

Service-based regulations charge electricity consumers a fixed monthly payment based on a given level of service. Under this approach, customers pay a set price over a given period (either per day, per week, or per month) for a defined energy allowance, which is typically metered in kWh.[12] If the customer uses up the entire allowance before the end of the period, electricity service is shut off and resumes at the beginning of the following payment period, or when additional payment is received, whichever is first.

The service-based approaches can offer certain benefits and challenges to various mini-grid stakeholders, including investors, developers, national politicians, and consumers. However, these approaches also come with potential drawbacks for regulators and customers. Benefits of service-based approaches include:

- **Service-based approaches enable developers to create innovative packages that enable cost recovery.** One of the persistent challenges of per-kWh based pricing for mini-grids is that the resultant tariff is too high for customers in rural communities to pay. A service-based methodology enables mini-grid developers to create packages—potentially including appliances such as phone chargers, televisions, radios, or other low-electricity consumption goods—that enable developers to recover their costs. Providers can also earn a portion of their returns via a mark-up on the appliances sold, reducing the need to recover all mini-grid costs via rates.

- **They can be more politically-feasible than per-kWh tariffs.** Per-kWh tariffs are easily compared to the main utility tariff, making the difference in main grid and mini-grid electricity prices stark for community members and elected officials alike. In some of the countries reviewed, this difference in cost creates political challenges, as rural customers are upset by paying significantly more than those connected to the main grid. Service-based packages make direct comparisons less relevant and less possible, as mini-grid developers are creating packages that are based on service rather than hourly electricity consumption.

- **They can create more certainty for developers, investors, and consumers.** Because service-based approaches cap consumption at certain daily or monthly amounts, it is easier for mini-grid operators to predict mini-grid electricity consumption and revenue and therefore, to dimension mini-grid assets accordingly. Relatedly, this creates more certainty for investors supporting mini-grid development. Monthly caps can also make it is easier for customers to plan around their regular payments. Per-kWh based pricing encourages rationing, while pricing based on a given level of service

[12] Economic Consulting Associates, Trama TechnoAmbiental; "Project Design Study on the Renewable Energy Development for Off-Grid Power Supply in Rural Regions of Kenya: Final Report" (2014)

provides customers with valuable cost certainty (particularly valuable for those unfamiliar with the electricity consumption of particular appliances).

- **They leverage customer familiarity with prepaid package-style services.** Many customers are already familiar with service-based models through the implementation of prepaid approaches in other examples (for example, the telecom sector). This familiarity can make it easier to implement a service-based tariff approach for electricity consumption.

On the other hand, serviced-based approaches present several risks and drawbacks that regulators need to be mindful of.

- **Service-based approaches can create challenges and capacity burden for regulators.** Service-based approaches can be more difficult for regulators to comprehensively review because the structure of the packages can vary significantly by developer. This can add to the existing capacity constraints of regulatory agencies. On the other hand, in most cases in the mini-grid sector, such service-based pricing structures are not directly controlled by regulators, reducing the administrative burden. In most cases, government involvement is more limited, and focused on putting a service in place (e.g. a hotline) to receive and process customer complaints.

Example of a Service-Based Approach: Akkan, Morocco

In Akkan, Morocco, the Spanish Cooperation Agency funded a mini-grid project to electrify 31 households, 4 community facilities including a school and a mosque, and some public lighting using solar and battery storage.

The estimated annual power consumption of each household was 465 kWh. The residents paid a flat monthly rate for a capped amount of per-day electricity and were offered two-tiers of service levels.

The project is community-owned, and the operation and maintenance of the mini-grid is managed by a local entity that is also responsible for fee collection.

Source: E3 Analytics (note that full case study is not publicly available)

- **They can increase risk of unfair pricing.** Because the service-based packages are more difficult to review by regulators, it creates the risk that mini-grid developers exploit their monopolistic position and earn an unfair return on investment. While competitive pressures may ensure that mini-grid developers price their services fairly, it is a risk that must be considered and mitigated when employing a service-based approach.

- **They are relatively untested at large scales.** To-date, service-based regulatory approaches have been employed either for small, standalone projects and/or in a more pilot capacity. Regulators would need to further analyze and vet this approach to deploy the methodology at scale in the mini-grid sector.

Service-based regulatory approaches offer just one of many examples of alternative to tariff-setting for regulators, policymakers and mini-grid developers. It is important to remain aware of these alternative approaches, especially in jurisdictions that are finding it difficult to attract private investment in mini-grids due to local financing constraints.

4.0 Conclusion and Recommendations

Many African countries have successfully employed tariff setting approaches and are beginning to see their mini-grid markets develop. However, numerous countries are encountering challenges as they work to create the structure in which their mini-grid markets can attract private investment and scale.

In particular, they are facing challenges related to the high expense of electrifying rural communities, the difficulties inherent in having different tariff levels throughout the country, and the administrative challenges of regulating an increasing number of mini-grids. Additionally, they are struggling to regulate mini-grids as infrastructure, which requires long time horizons for payback, when there is so much uncertainty within the market related to grid arrival, growth in electricity consumption, and other factors.

4.1 Conclusions on Further Research and Tools

This research has brought to light a variety of follow-on work that could be done to further support regulators in developing their tariff setting policies and tools. These include:

- **Developing a robust decision-making tool to identify the tariff-setting methodology that is most appropriate given local context.** This tool would enable regulators to assess broad features, including market maturity, administrative capacity, and willingness to subsidize in order to determine the feasible policy options that the regulator can adopt when regulating tariffs.

- **Conducting a broader study of mini-grid subsidization levels and approaches across the globe.** During the Arusha Workshop, several participants voiced a need to conduct a global assessment of the levels of subsidization for mini-grids in order to assist them with benchmarking their own subsidization policies. The different models of subsidization, including results-based approaches, should also be explored as part of this research so that the regulators are aware of the options that are available for designing a subsidization program.

- **Developing a database of reasonable cost ranges for the regulatory asset base**. This could be a shared platform where developers can input data on costs that have been claimed in mini-grid projects in order to benchmark the reasonableness of their approach to regulatory asset base. This would facilitate cross-sharing of data and reduce administrative burdens associated with tracking market costs of assets.

- **Creating a customizable tool to calculate an individualized cost-based tariff**. This tool would offer options to regulators on what to include and exclude in an individualized cost-based tariff calculation and allow regulators to develop a customized tool based on their chosen policy approach. Accompanying the tool would be a guide that would benchmark each of the components included in a tariff setting model in order to assist the regulator in understanding the reasonableness of their approach.

4.2 Recommendations

Research conducted for this report yielded the following high-level recommendations for regulators to consider for their work.

- **Countries should ensure that their chosen tariff methodology aligns with other regulatory and market factors that govern mini-grids.** There are a variety of factors that guide the selection of the appropriate mini-grid tariff setting methodology. These factors include internal regulatory factors (e.g. administrative capacity, technical expertise), market factors (e.g. market maturity and competition, availability of market data, national electrification rate), and broader regulatory considerations (e.g. "soft costs" from permitting, risks from grid arrival, tendering and conducting feasibility assessments). The selection of the appropriate tariff methodology is

nuanced and context-specific, but regulators should ensure that they are selecting their approach based on their individual market and regulatory factors and not assuming regulations employed in another country are necessarily appropriate.

- **Regulators should balance responding to changing market factors with ensuing long-term regulatory certainty.** Given that the market factors guiding the most appropriate tariff setting methodology are subject to change, regulators need to balance adjusting their tariff-setting methodology with ensuring regulatory certainty. Changing the regulatory approach can cause uncertainty within the market and create a difficult environment for developers and investors. However, changing regulatory approach is often necessary in order to respond to changing market conditions. Countries, such as Cambodia, that have adjusted their tariff setting methodology and level of oversight as the market develops, have done so in a gradual and predictable manner.[13] If adjusting the regulatory approach is necessary, regulators should seek to ensure that changes are measured and planned in order to maintain market certainty.

- **Standardized methodologies and/or tools for setting individualized cost-based tariff approaches should be made publicly available.** Developers evaluating potential mini-grid projects require certainty regarding how the tariff is calculated so that they can estimate the costs that they will be able to recover from ratepayers. Opaque regulations and/or lack of publicly available tools make it difficult for developers to understand what types of costs they will or will not be able to claim. Therefore, regulators should seek to ensure transparency in their regulatory approach. Publicly available tools, such as Nigeria's Multi-Year Tariff Order (MYTO) tool, that enable mini-grid developers to input data and receive pricing estimates are effective ways to increase tariff setting transparency.

- **Employing a tiered approach to mini-grid regulation is an effective way to relieve administrative capacity constraints.** Several African countries are already employing tiered approaches to tariff setting to relieve administrative capacity. This approach enables regulators to focus time on larger projects and allow smaller projects to operate as Willing Buyer/Willing Seller, ideally with the opportunity for review. Other regulatory agencies throughout the region should consider this approach within their contexts and ensure that, if implemented, consumer interests are protected on smaller projects that are not reviewed in as much detail.

- **Service-based regulatory approaches may be appropriate in certain circumstances.** Service-based approaches can be used to increase the economic viability of mini-grid projects for developers, while providing greater cost certainty for customers. Such approaches can also help circumvent direct comparisons with highly subsidized national tariffs, making it easier to sustain mini-grid electrification business models from a political standpoint. Service-based approaches also leverage some of the strengths of the PAYGO sector, scaling them up for use in mini-grids. However, these models have yet to be applied at scale in the mini-grids sector specifically, and warrant further testing and evaluation.

As regulators throughout the region confront the next generation of tariff setting challenges, they require support to develop appropriate tariff setting methodologies. Additionally, and equally important, they require support for interfacing with the variety of stakeholders within their markets—developers, investors, communities, elected officials, national governments, aid organizations—to create a cohesive vision and framework for deploying mini-grids rapidly to boost national electrification efforts.

[13] See accompanying case study on Cambodia's mini-grid tariff regulation approach.

ANNEX 1

CASE STUDY: CAMBODIA

Introduction

In the late 1980s, following civil war, the electrification rate in Cambodia neared zero percent. By 2017, that number neared 90%.[14] This dramatic improvement occurred despite significant challenges presented by a post-war setting.

The evolution of Cambodia's mini-grid sector provides one example of a roadmap for the development of mini-grid regulation in dynamic and challenging contexts. This roadmap includes three phases: Laissez-Faire, Introduction of Regulation, and Uniform Tariff. Cambodia's experience offers insights for countries seeking to attract private investment in order to harness capital for national electrification.

This Case Study aims to:

- Offer an example of how countries can harness private sector investment in order to support national and rural electrification through mini-grids
- Provide insight into how countries must develop policy that responds to changing market conditions
- Provide insight into the difficulties associated with achieving and maintaining a national uniform tariff

Phase I: Laissez-Faire

The Laissez-Faire phase of the development of Cambodia's mini-grid regulatory framework began in the 1990s, when unregulated mini-grids began to pop up throughout the country to address the widespread lack of access to electricity.

The Cambodian civil war left the country ravaged, and the electric grid was not spared. In the late 1980s, electricity was almost completely unavailable throughout the country. The situation was compounded by two critical challenges: a lack of regulatory capacity within the government and a very weak economy. [15]

These challenges, in fact, proved to be key strengths in allowing the mini-grid market to grow. In order to provide electricity in their communities, unregulated diesel mini-grids began to appear throughout the country. Mini-grids flourished, unhindered by regulatory approval and oversight, and market factors, such as customers' willingness and ability to pay for electricity, regulated the price and location of mini-grids. This environment set the stage for a successful mini-grid adoption campaign for a simple reason: In the absence of regulation, the market was free to develop in whatever way it required to meet growing demand.

The de facto Laissez-Faire philosophy was not without flaw. Tariffs were very high on average during this phase. Service quality was inconsistent and tended to be poor. There was no plan for grid arrival, which created concerns for potential investors. Despite these concerns, however, this period allowed mini-grids in Cambodia an opportunity to become entrenched in the national energy landscape. By 2001, there were an estimated 150-300 mini-grids in operation.

[14] "Access to Electricity (% of Population) - Cambodia." Data. Accessed November 13, 2019. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?end=2017&locations=KH&start=1992&view=chart; "Mini Grids in Cambodia: A Case Study of a Success Story." Mini Grids in Cambodia: A Case Study of a Success Story. ESMAP, 2017.
[15] "Mini Grids in Cambodia: A Case Study of a Success Story." Mini Grids in Cambodia: A Case Study of a Success Story. ESMAP, 2017.

Phase II: Introduction of Regulation

High tariffs eventually propelled the Cambodian government towards regulatory action for mini-grids in the late 1990s and early 2000s. In order to increase electrification, improve quality of service, and lower tariffs, the government took on a more active role, which began with the Electricity Law, drafted in 1998 and implemented in 2001.

One of the primary changes brought about by the Electricity Law of 2001 was the formation of the Electricity Authority of Cambodia (EAC), the nation's regulatory authority. The EAC immediately began to enact changes to bring order to the country's rapidly growing mini-grid industry. The first major change was the institution of a coherent policy requiring all mini-grids (new and existing) to be licensed by the EAC. By 2005, the EAC had licensed all existing mini-grids.

In 2004, the Cambodian government and the World Bank launched the Rural Electrification Fund (REF), which is used to fund subsidies for mini-grids. The REF was co-capitalized by the government from 2004 until 2012, at which point the EAC took over responsibility for managing the fund.

Finally, the law gave the EAC power to review and approve end-user tariffs based on the mini-grid operator's costs. In this way, the EAC was able to begin to rein in excessively priced tariffs and develop an understanding of issues facing mini-grid operators in their quest to be profitable.

During these early stages of regulated tariffs, the oversight was geared toward supporting operators and gently encouraging expansion and improvements to electricity service. There were no formal calculations or formulae; tariff prices were set by a review of operator costs and reflected the wide regional variance in cost of providing electricity. [16]

Phase III: Uniform National Tariff

In the final phase of regulatory development, Cambodia's focus shifted to implementing a uniform national tariff to make electrification more equitable. At this point, the government of Cambodia took advantage of the foundations it had laid in earlier mini-grid regulatory policy development phases to continue to attract investment, while also closing the gap in tariffs between rural customers (who were generally poorer with higher electricity tariffs) and their urban counterparts.

In Phase III, Cambodia leveraged the REF to implement subsidies that enabled the creation of a uniform national tariff. These subsidies continue to be used to compensate certain mini-grid operators. Under this scheme, the EAC utilizes a set methodology to calculate costs for the mini-grid operator (including the allowable asset base, an allowable rate of return, straight-line depreciation, and other costs deemed reasonable by the EAC) and applies a tariff-based subsidy to make up any difference in generation cost and the uniform national tariff.

Cambodia incorporated three additional regulatory improvements to encourage expansion of mini-grids and improvement of service. First, they offered subsidies for high performance, and levied penalties against mini-grids that performed poorly. Second, they formalized a scheme for grid arrival, in which mini-grid operators sell their generation assets and become independent power distributors—which offers increased potential for profits due to the inexpensive energy offered to those distributors through the national grid. Finally, they balanced their mandate for mini-grid operators to connect every single potential customer in the service area with an offer of continued exclusivity for power production and distribution.

This system went into effect in 2016. One important caveat is that uniform tariff only applies to mini-grids

[16] "Mini Grids in Cambodia: A Case Study of a Success Story." Mini Grids in Cambodia: A Case Study of a Success Story. ESMAP, 2017.

that have been connected to the main grid. Isolated mini-grids, mini-grids that import their electricity over medium voltage lines, and residential customers consuming more than 50kWh per month are not subject to the national uniform tariff. Despite their commitment to providing a uniform tariff in as much of the country as possible, the government has recognized that in certain situations, they cannot sustainably subsidize the gap between the costs of generating electricity and the uniform national tariff. In these situations, the EAC has allowed mini-grid operators to charge customers what they must in order to turn a reasonable profit. These exceptions highlight the pragmatism that continues to underlie Cambodia's successful mini-grid program, wherein achieving a national uniform outcome is considered a long-term policy objective, not an immediate outcome.

Conclusion

In instances in which a country seeks to close an electrification gap via mini-grids, there is always the question of how best to balance need to create an enabling environment for private sector investment, and the need to cater to equity concerns and political feasibility. Simply put, it tends to be more costly to provide electricity in remote communities and at the same time, these communities tend to be home to people with lower incomes than urban on-grid areas. It can be difficult for a government to justify requiring poorer people to pay higher tariffs for the same resource that generally wealthier people receive for less.

As the Cambodia study illustrates, contextual features play an integral role in informing tariff-setting policies for mini-grids. Issues such as electricity demand, market maturity and the ability to subsidize mini-grids will play a key role in informing what a viable tariff-setting policy looks like for each specific context. Regulators need to be mindful of context considerations when setting out and revising their tariff-setting policies, always balancing the need for regulatory stability with the need to react to changing conditions.

ANNEX 11

CASE STUDY: NIGERIA

Overview

Nigeria is a West African country with a population of roughly 196 million people, approximately 97 million of whom live in rural areas. In 2017, the overall electrification rate for the country was 54.5% and the rural electrification rate was 22.6%. [17] To close the electrification gap, Nigeria has increasingly turned to renewable energy powered mini-grids.

Since 2005, a host of regulations and policies have been introduced in an effort to attract investors to bring electricity to Nigerians, particularly those in isolated rural areas. Some of the most important of these policies are:

- Electric Power Sector Reform Act (EPSRA) of 2005
- Nigerian Renewable Energy and Energy Efficiency Policy (NREEEP) of 2015
- Rural Electrification Strategy and Implementation Plan (RESIP) of 2016
- Nigerian Electricity Regulatory Commission Mini-grid Regulation of 2017
- Rural Electrification Fund Operational Guidelines (REFOG) of 2017. [18]

This case study explores the tariff approaches for mini-grids in Nigeria, which are defined as systems less than 1MW. Mini-grids are further stratified by size, with slightly different registration and permitting regimes applying to mini-grids of <100kW installed capacity and mini-grids of 100kW-1MW installed capacity. Systems above 1 MW are treated as Independent Power Producers.

Registered Mini-Grids (0-100 kW)

For mini-grids of <100kW capacity, the Nigerian tariff regulation system makes application for a permit optional, however all such systems are required to register with the Nigerian Electricity Regulatory Commission (**NERC**). Developers are incentivized to seek a permit for such systems by a set of clearly defined options for the sale or use of mini-grid assets in the case of grid arrival.

Registered mini-grids enjoy greater flexibility over permitted mini-grids in two areas: site selection and tariff-setting methodology. Unlike registered mini-grids, permitted mini-grids must develop their assets in a specified area described further **below**. In addition, registered mini-grids are free to set a cost-recovery tariff; whereas permitted mini-grids are required to use NERC's Multi-Year Tariff Order (**MYTO**) tariff calculation tool.

Regardless of permitting or registration, all mini-grid operators must sign an agreement with the community they intend to serve.

[17] "Access to Electricity (% of Population) - Nigeria." World Bank World Development Indicators. Accessed November 14, 2019. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=NG.
[18] "Minigrid Investment Report: Scaling the Nigerian Market." Minigrid Investment Report: Scaling the Nigerian Market. Rocky Mountain Institute, 2018.

Permitted Mini-grids (100kW-1MW)

All mini-grids between 100kW and 1MW must be permitted. Permitted mini-grids develop their assets in either an unserved area (isolated system) or an underserved area (interconnected system). In addition, they must set their tariff according to the MYTO tool, and NERC must approve it.

Should the grid arrive in the service area of an isolated permitted mini-grid, the asset owners have two options: to convert into an interconnected mini-grid, or to sell the assets to the government at their depreciated price plus 12 months of revenue. Registered mini-grids do not receive any assurances on purchase prices for assets in this scenario. [20]

The Multi-Year Tariff Order (MYTO) Tool

The MYTO Tool is NERC's methodology for setting fair and transparent retail tariffs. NERC has adapted the MYTO tool specifically for mini-grids and made it available to the public on their website. [3] The methodology is based around allowances for three specific costs:

- allowed return on capital;
- depreciation; and
- efficient operating costs and overhead

The MYTO tool is intended to incentivize efficiency in operation and quality of service and foster trust between mini-grid operators and retail customers through transparency.

Interconnected Mini-grids

Interconnected mini-grids have a slightly different tariff setting process. Regardless of their size, interconnected mini-grids must sign a Tripartite Contract with the community and the local Distribution Company (DisCo). After reaching agreeable terms with all parties, the agreement must be approved by NERC. Each of these contracts must include the tariff for electricity generated by the mini-grid and distributed over the DisCo network (if applicable), the community's commitment to purchase electricity from the mini-grid, and the right for the mini-grid to use the DisCo's network infrastructure. [21]

Conclusion

Nigeria's mini-grid program is an example of the ways in which regulators can innovate to provide sensible tariff options to mini-grid developers, and pair these options with associated levels of regulation and incentives. It illustrates how tariff-setting policy needs to interface with other aspects of mini-grid regulation including licensing and grid arrival.

[19] "MYTO." NERC. Accessed November 21, 2019. https://nerc.gov.ng/index.php/home/myto.
[20] ESMAP, and World Bank. "Mini Grids in Nigeria: A Case Study of a Promising Market." Mini Grids in Nigeria: A Case Study of a Promising Market, 2017.
[21] ESMAP, and World Bank. "Mini Grids in Nigeria: A Case Study of a Promising Market." Mini Grids in Nigeria: A Case Study of a Promising Market, 2017.

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