PRACTICAL GUIDE

TO THE REGULATORY TREATMENT OF MINIGRIDS

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PRACTICAL GUIDE TO THE REGULATORY TREATMENT OF MINI-GRIDS

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Abbreviations

AC	Alternating Current
CAIDI	Customer Average Interruption Duration Index
CRDB	Centenary Rural Development Bank
DC	Direct Current
DWRM	Directorate of Water Resource Management (Uganda)
EAC	Electricity Authority of Cambodia
EDT	Electricity Disputes Tribunal (Uganda)
EIA	Environmental Impact Assessment
EIR	Environmental Impact Review
EIS	Environmental Impact Study
EPQ	Electric Power Quality
ERA	Electricity Regulatory Authority (Uganda)
ERC	Energy Regulatory Commission (Philippines)
EWURA	Energy and Water Utilities Regulatory Authority (Tanzania)
FIT	Feed-in Tariff
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GTF	Global Tracking Framework
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IFC	International Finance Corporation
KIS	Kalanga Infrastructure Services
KfW	Kreditanstalt für Wiederaufbau
kW	Kilowatt
kWh	Kilowatt-hour
LED	Light-emitting Diode
MEMD	Ministry of Energy and Mineral Development (Uganda)
MNRE	Ministry of New and Renewable Energy (India)
MTF	Multi-tier Framework
MW	Megawatt
NEMA	National Environmental Management Authority (Uganda)
NGO	Nongovernmental Organization
NREL	National Renewable Energy Laboratory
ORIO	Netherlands Facility for Infrastructure Development
OSINERGMIN	Organismo Supervisor de la Inversión en Energía y Minería
PIDG	Private Infrastructure Development Group
PPA	Power Purchase Agreement
PV	Photovoltaic
REA	Rural Electrification Agency (Uganda)

REB	Rural Electrification Board (Uganda)
REF	Rural Electrification Fund (Uganda)
RESP	Rural Electrification Strategy and Plan
ROI	Return on Investment
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SGIP	Smart Grid Interoperability Panel
TOR	Terms of Reference
UECCC	Uganda Energy Credit Capitalization Company
UETCL	Uganda Electricity Transmission Company Limited
UIA	Uganda Investment Authority
UNBS	Uganda National Bureau of Standards
WENRECO	West Nile Rural Electrification Company (Uganda)

EXECUTIVE SUMMARY

The *Practical Guide to the Regulatory Treatment of Mini-grids* provides regulators with clear guidance and tools for developing an enabling regulatory framework for mini-grid development.[1] Three pillars of regulation are identified for consideration when developing a regulatory regime for mini-grids: (1) policy and planning, (2) retail service regulation, and (3) technical standards (including interconnection, technology, power quality and service quality standards). For each pillar, the guide identifies:

- A series of regulatory decisions and their associated options;
- Questions regulators should ask for each regulatory decision;
- Benefits and drawbacks of each option, including the tradeoffs between a more light-handed and comprehensive approach;
- Next steps associated with each option; and
- References to other publications for more information.

The guide is a flexible, modular tool that users can consult in its entirety or review a specific section to work through one regulatory issue. Particular issues are heavily context dependent, therefore the guide does not prescribe a single solution for developing a mini-grid regulatory regime. Instead, regulatory decisions are divided into low, medium, and high priority decisions based on different stakeholder's perspectives including regulators, policy makers, and mini-grid developers and operators (Table 1). The guide aims to support policy makers and regulators in meeting rural electrification goals and expanding access to clean, sustainable, affordable, and reliable electricity.

WHAT IS A MINI-GRID AND WHY ARE THEY IMPORTANT?

Many countries across the globe are working to expand electricity access to all citizens. There are three main approaches countries can take to provide electricity access: extending the national grid, developing grid-connected or off-grid mini-grids, and deploying stand-alone systems such as solar home or pico-photovoltaic (PV) systems.

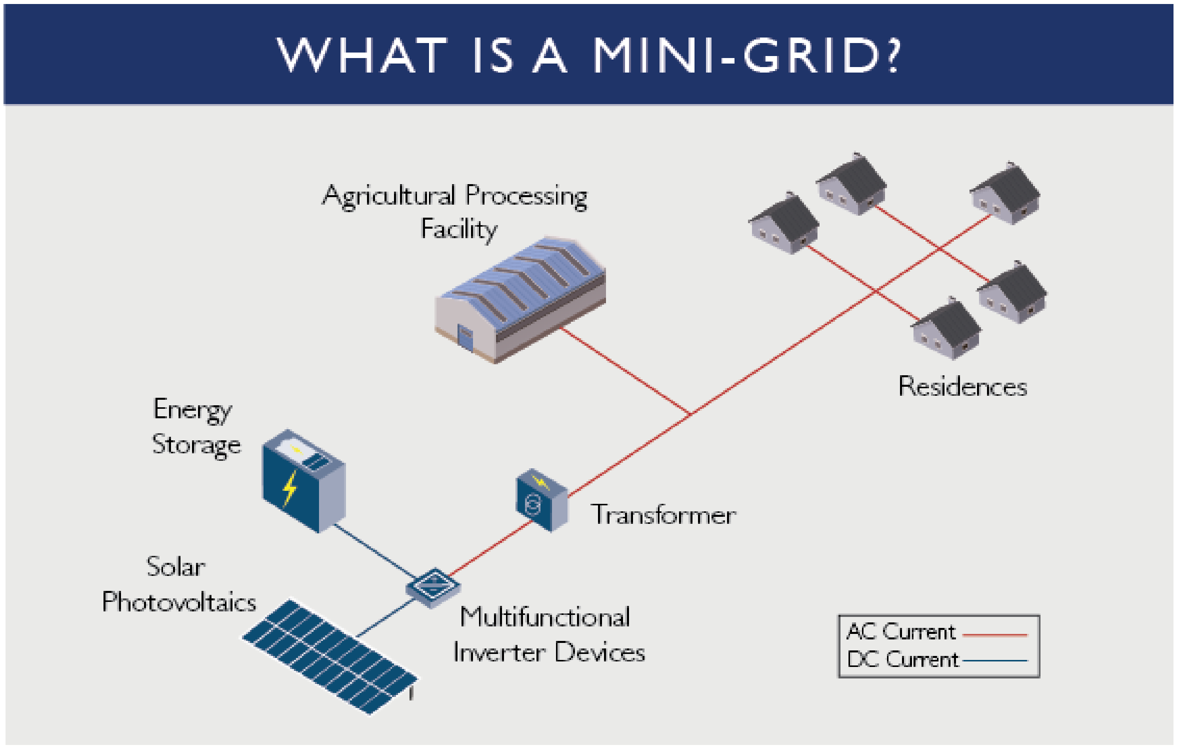
According to the International Energy Agency *Energy for All* report, 70% of the world's rural population that is without access to electricity would be best served by either mini-grids (52.5%) or stand-alone systems (17.5%)(IEA, 2011; EUEI PDF, 2014). Given these figures, countries are increasingly interested in the promise of mini-grid systems as a means of meeting national electrification needs, especially in rural areas.

[1] The authors relied heavily on the following resources in developing this guide:

Tenenbaum, T., Greacen, C., Siyambalapitiya, T. & Knuckles, J. (2014). *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa*. Washington, D.C.: World Bank;

Franz, M., Peterschmidt, N., Rohrer, M., & Kondev, B. (2014). *Mini-Grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-grid Roll-outs*. Eschborn. European Union Energy Initiative Partnership Dialogue Facility.

Figure 1. Schematic of a Typical Mini-Grid System



BARRIERS TO MINI-GRIDS

Experience with mini-grid development is quite varied: some countries have effectively deployed mini-grids at the national level, while others have little to no mini-grid penetration. In general, the lack of an enabling regulatory regime is one of the main roadblocks to mini-grid development. Some of the main challenges include:

- A lack of rural electrification planning and strategy;
- Political and legal uncertainty regarding mini-grid investment decisions;
- Unclear or complicated regulatory processes and approvals;
- Lack of retail regulations; and
- Lack of technical standards.

OVERCOMING BARRIERS TO MINI-GRIDS

Barriers to mini-grid development may be overcome by establishing clear regulatory rules that govern the mini-grid sector. In developing a regulatory regime, regulators and policy makers must decide the degree of regulation to impose on the development of mini-grid projects. There are two competing philosophies on mini-grid regulation: (1) government regulation should be light-handed, in order to minimize barriers to the sector's development, (2) Government regulation should be comprehensive, in order to ensure that mini-grid projects are deployed systematically, are responsive to rural energy needs, protect consumers, and provide electricity service that is in line with the performance and technical standards of the national grid.

In practice, the choice between light-handed regulation and comprehensive regulation is not always clear; instead, regulators and policy makers must choose a point somewhere between the two. In general, mini-grid regulation should aim to establish an enabling framework for the mini-grid sector and a clear, streamlined, and efficient process for mini-grid development. Regulation should:[2]

- Minimize the additional workload of regulatory staff.
- Limit the amount of information a regulator requires.
- Minimize the number of separate regulatory processes and decisions.
- Use standardized documents or similar documents created by other agencies, and make documents available on the internet.
- Use applicable rules and decisions made by related government or community bodies, when possible.

ABOUT THIS GUIDE

The guidance provided is geared toward clean-energy-based mini-grids that are independent of the national grid (referred to as autonomous mini-grids throughout this guide) with a load output of 10 MW_{ac} or below. Note that the 10 MW_{ac} load limit could refer to, for example, a 10MW average continuous load to power a large town (i.e. 100,000 inhabitants of 20,000 – 25,000 customers with consumption of 8-10kWh/day/household). The guide also:

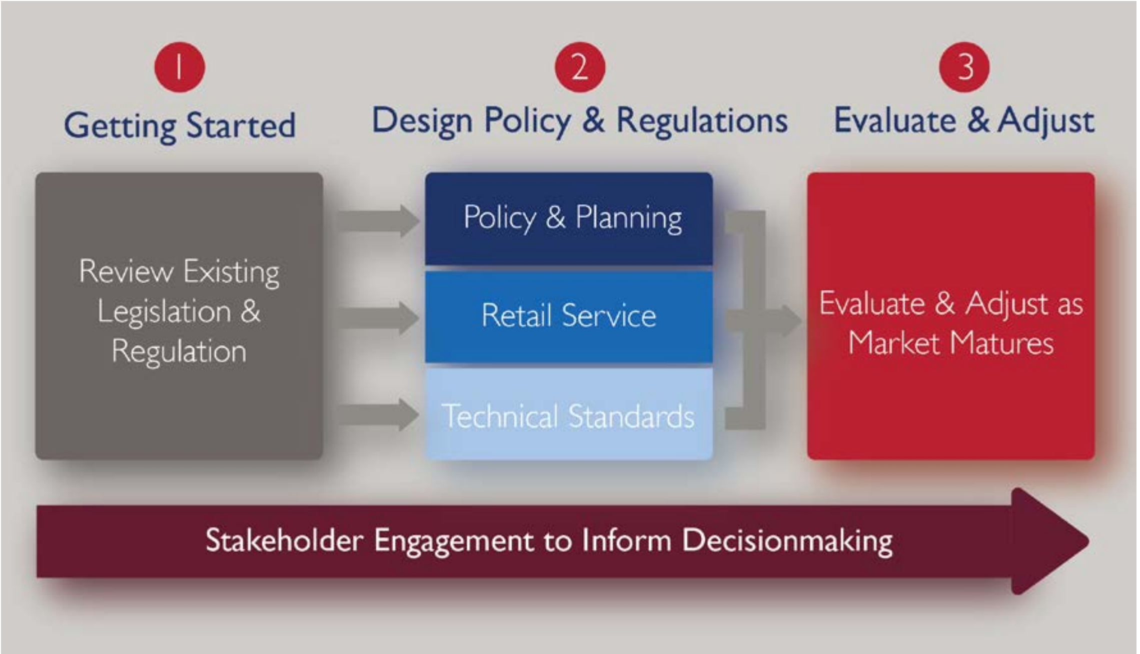
- Features the country of Uganda as a case study of how one country has made decisions about mini-grid regulation (Appendix I);
- Features other countries experiences to highlight different approaches to the same regulatory decisions; and
- Includes a decision-making tool summarizing the high priority regulatory decisions (Appendix II).

The intended audience for the guide includes anyone involved in the mini-grid regulatory process—including regulators, policy makers, mini-grid owners, developers and operators, utilities, and customers. The guide is also useful for development partners such as donors, multilateral agencies, regional or international organizations, nongovernmental organizations (NGOs), and other entities that may be involved in the mini-grid sector. The guide assumes that readers have some background in the regulatory arena and in mini-grids; for those who may lack this background, references are included for other publications that can provide more information.

It should be noted that a country's mini-grid sector will continue to evolve even after the regulatory decisions are made. Regulators should therefore be prepared to revisit the regulations over time, and to make adjustments that reflect the realities of an evolving mini-grid market. Figure 2 outlines the suggested process for incorporating mini-grids into rural electrification plans and using this guide to develop mini-grid regulations.

[2] Tenenbaum et al., 2014

Figure 2. Suggested process for Incorporating Mini-Grids into Rural Electrification Plans and Using the Practical Guide to the Regulatory Treatment of Mini-Grids



The guide is intended as a flexible tool to support regulators and other stakeholders in various stages in developing a mini-grid regulatory framework to understand their options and identify a regulatory approach that is appropriate to their specific context. Ideally the guide will support policy makers and regulators in meeting rural electrification goals and expanding access to sustainable, affordable, and reliable electricity using clean-energy-based mini-grids.

INTRODUCTION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I. ABOUT THIS GUIDE

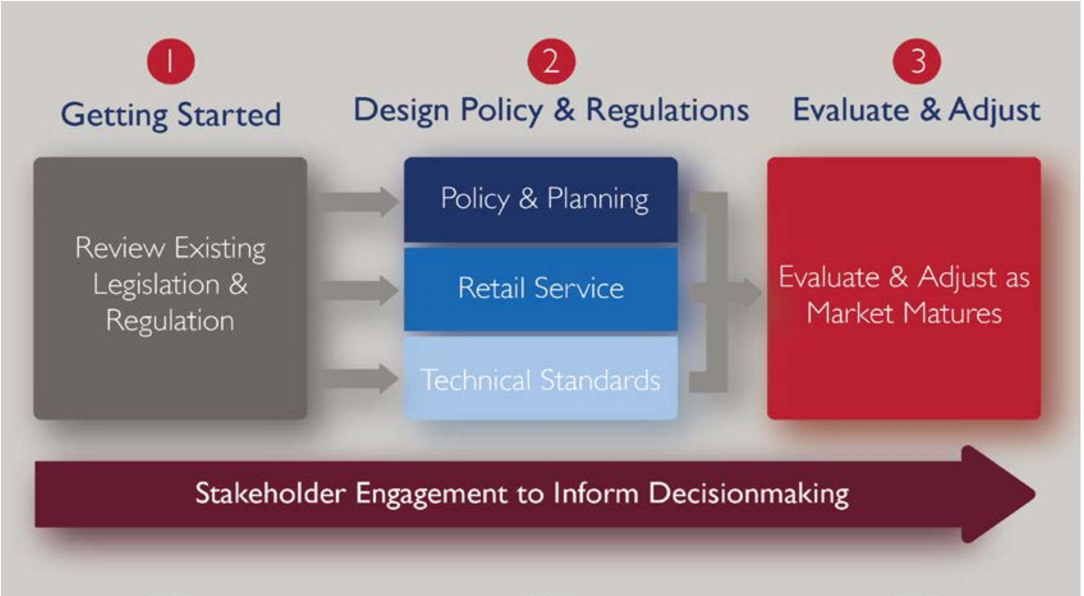
Worldwide, countries are working to expand electricity access to all citizens. There are three main approaches countries can take to provide electricity access: extending the national grid, developing grid-connected or off-grid mini-grids, and deploying stand-alone systems such as solar home or pico-photovoltaic (PV) systems. According to the International Energy Agency *Energy for All* report, 70% of the world's rural population that is without access to electricity would be best served by either mini-grids (52.5%) or stand-alone systems (17.5%), with the remaining 30% well suited for national grid extension (IEA, 2011; EUEI PDF, 2014). Given these figures, countries are increasingly interested in the promise of mini-grid systems as a means of meeting national electrification needs, especially in rural areas.

The purpose of this guide is to provide regulators in emerging economies with concrete guidance and practical tools for developing a clear enabling regulatory regime for mini-grid development. The guidance is geared toward clean-energy-based mini-grids below 10 MW that are independent of the national grid. The guide is intended to be a flexible, modular tool that users could consult in its entirety or could review a specific section to work through one regulatory issue.

Experience with mini-grid development is quite varied: some countries have effectively deployed mini-grids at the national level, while others have little to no mini-grid penetration. In general, the lack of an enabling regulatory regime is one of the main challenges to mini-grid development.

The purpose of this guide is to provide regulators with concrete guidance and practical tools for developing a clear enabling regulatory regime for mini-grid development. The guidance is geared toward clean-energy-based mini-grids that are independent of the national grid (such grids will be referred to as *autonomous mini-grids* throughout this guide). Figure 3 outlines the suggested process for using this guide to develop mini-grid regulations and incorporate mini-grids into rural electrification plans.

Figure 3. Suggested Process for Incorporating Mini-Grids into Rural Electrification Plans and Using the Practical Guide to the Regulatory Treatment of Mini-Grids



The intended audience for the guide includes anyone involved in the mini-grid regulatory process—including regulators, policy makers, mini-grid owners, developers and operators,[3] utilities, and customers. The guide is also useful for development partners such as donors, multilateral agencies, regional or international organizations, nongovernmental organizations (NGOs), and other entities that may be involved in the mini-grid sector. The guide assumes that readers have some background in the regulatory arena and in mini-grids; for those who may lack this background, references are included for other publications that can provide more information.

The guide is meant to support regulators and other stakeholders that are at various stages in developing a mini-grid regulatory framework, and should serve as a resource in identifying the most suitable regulatory approach for expanding electricity access using clean-energy-based mini-grids in rural, non-electrified areas. The guide is intended to be a flexible, modular tool that users could consult in its entirety or could review a specific section to work through one regulatory issue. For example, regulators that have already developed a mini-grid regulatory regime could consult the guide to review and potentially adjust their current framework or one specific regulatory issue. Regulators that have not developed such a regime could use the guide as a starting point, as they consider different decision points and options. Regulators and policy makers could also use the guide as a tool for working with donors and other development partners as they collaborate to develop a country's mini-grid sector.

[3] The mini-grid owner is the entity that owns the project, the developer is the entity that develops the project and the operator is the entity that operates the project once it is constructed. The owner, developer and operator can be the same entity or different entities, depending on the business model.

Other organizations can use the guide to help steer financing and knowledge into a country's mini-grid sector. For example, donor institutions could use the guide to assess a country's mini-grid regulatory framework and decide where to target support. Organizations developing specific projects could use the guide to develop an understanding of the regulatory issues and processes they should consider.

The guide identifies three main pillars of regulation that must be considered when developing a regulatory regime for mini-grids: (1) policy and planning, (2) retail service regulation, and (3) technical standards (including interconnection, technology, power quality and service quality standards). For each pillar, the guide identifies:

- A series of regulatory decisions and their associated options;
- Questions regulators should ask for each regulatory decision;
- Benefits and drawbacks of each option, including the tradeoffs between a more light-handed and comprehensive approach;
- Next steps associated with each option; and
- References to other publications for more information.

The guidance provided is geared toward clean-energy-based mini-grids that are independent of the national grid (referred to as autonomous mini-grids throughout this guide) with a load output of 10 MW_{ac} or below. Note that the 10 MW_{ac} load limit could refer to, for example, a 10MW average continuous load to power a large town (i.e. 100,000 inhabitants of 20,000 – 25,000 customers with consumption of 8-10kWh/day/household). The guide also:

- Features the country of Uganda as a case study of how one country has made decisions about mini-grid regulation (Appendix I);
- Features other countries experiences to highlight different approaches to the same regulatory decisions; and
- Includes a decision-making tool summarizing the high priority regulatory decisions (Appendix II).

This guide draws heavily on prior work conducted in the field.[4] The intention is not to provide a full explanation of each issue involved in mini-grid regulation but to provide basic contextual information for each issue. Each section closes with a list of further reading, so that readers can obtain more in-depth information on particular topics.

As the question of how to approach a specific regulatory issue is heavily context dependent, the guide does not prescribe a single path for countries to follow in developing a mini-grid regulatory regime. Instead, the guide is intended as a flexible tool to support regulators and other stakeholders in many different settings to understand their options and identify an approach that is appropriate to their specific context.

[4] The authors relied heavily on the following resources in developing this guide:

Tenenbaum, T., Greacen, C., Siyambalapitiya, T. & Knuckles, J. (2014). *From the Bottom Up: How Small Power Producers and Mini-Grids Can Deliver Electrification and Renewable Energy in Africa*. Washington, D.C.: World Bank;

Franz, M., Peterschmidt, N., Rohrer, M., & Kondev, B. (2014). *Mini-Grid Policy Toolkit: Policy and Business Frameworks for Successful Mini-grid Roll-outs*. Eschborn. European Union Energy Initiative Partnership Dialogue Facility.

The regulatory decisions are divided into low, medium and high priority decisions based on different stakeholder's perspectives including regulators, policy makers, and mini-grid developers and operators (see Table 1). It is suggested that regulators first tackle high priority decisions before moving to the medium and low priority decisions as the high priority decisions will form the foundation of a country's mini-grid sector, signal the country's overall approach to regulation to mini-grid owners, developers and operators, and influence many of the medium and low priority decisions. As regulators develop their country's mini-grid regulatory framework it is also important to consider the priority regulatory decisions of mini-grid developers and operators.

It should be noted that a country's mini-grid sector will continue to evolve even after the regulatory decisions are made. Regulators should therefore be prepared to revisit the regulations over time, and to make adjustments that reflect the realities of an evolving mini-grid market.

The guide is intended as a flexible tool to support regulators and other stakeholders in various stages in developing a mini-grid regulatory framework to understand their options and identify a regulatory approach that is appropriate to their specific context. Ideally the guide will support policy makers and regulators in meeting rural electrification goals and expanding access to sustainable, affordable and reliable electricity using clean-energy-based mini-grids.

Table 1. Decision Matrix for the Regulatory Treatment of Mini-Grids

LEGEND	
	High priority
	Medium priority
	Low priority

MINI-GRID REGULATORY DECISION MATRIX		Stakeholder		
Section	**Regulatory Decision Description**	**Regulator**	**Policy maker**	**Developer**
1. POLICY AND PLANNING				
1.1 Approach to Mini-Grid Planning	Decide between a decentralized, centralized, or mixed approach to mini-grid planning.			
1.2 Mini-Grid Regulatory Authority	Assign one or more public agencies regulatory authority over mini-grids.			
1.3 Developing a Mini-grid Definition	Define the term mini-grid in a country's relevant laws, plans, policies and regulations.			
1.4 Developing Classes or Categories of Mini-grids	Develop classes or categories of mini-grid projects based on the capacity and/or other factors such as technology, DC vs. AC mini-grids.			
1.5 Ownership Model	Decide which organizations will be legally allowed to own and operate mini-grids.			
1.6 Fiscal Support for Mini-Grids	Design fiscal policies to provide grants and subsidies to encourage mini-grid development.			
1.7 Approval Process and Procedures	Establish a clear and transparent approval process (for entities both within and outside the electricity sector) for mini-grid projects.			
1.8 Licensing	Establish a clear and transparent licensing process for mini-grid projects.			

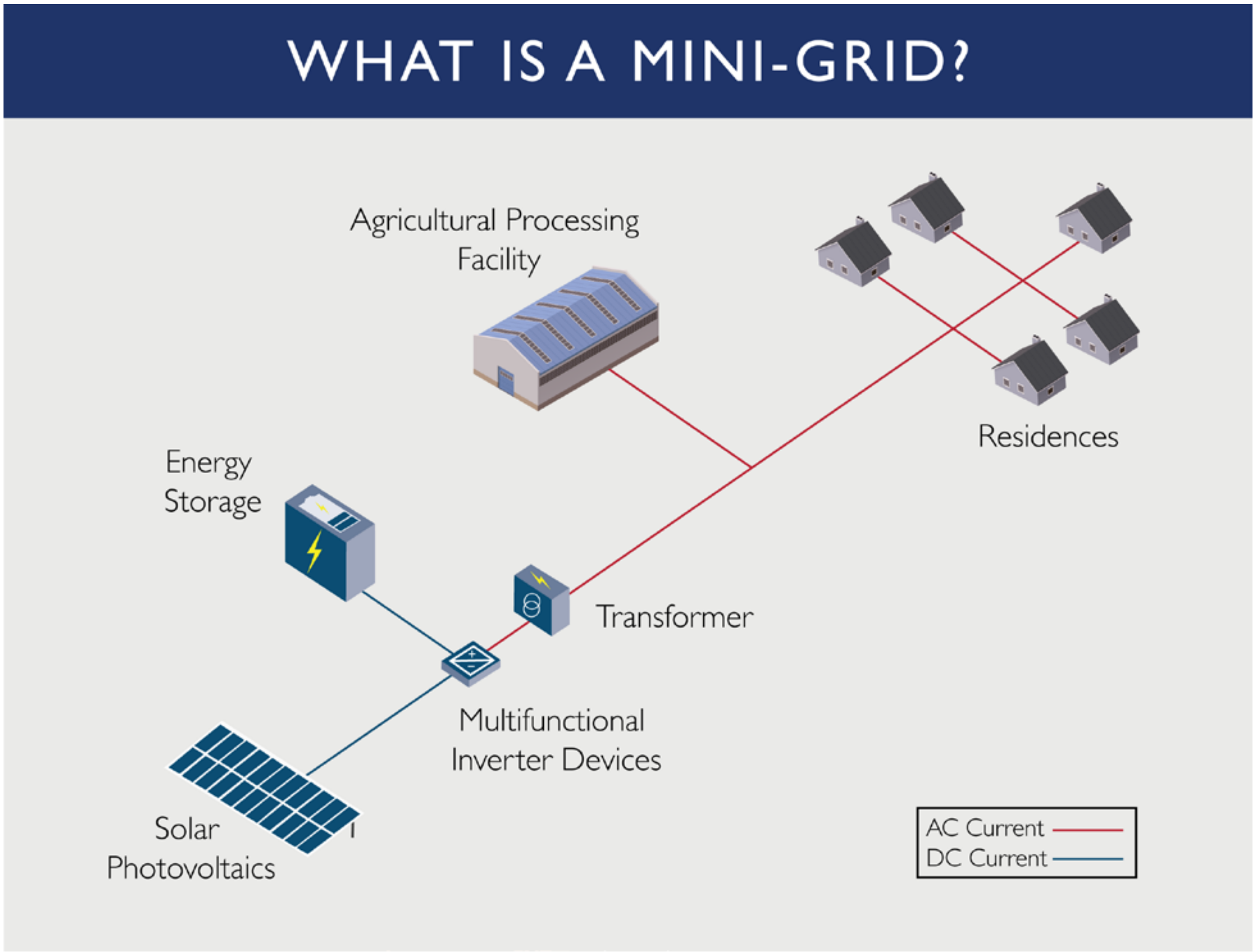
MINI-GRID REGULATORY DECISION MATRIX		Stakeholder		
Section	**Regulatory Decision Description**	**Regulator**	**Policy maker**	**Developer**
1.9 Environmental Regulation	Outline an environmental review process for mini-grid projects.			
1.10 Technology Requirements	Decide whether to require or incentivize certain generation technologies for mini-grids.			
1.11 Reporting and Filing Requirements	Determine whether to require mini-grid operators to submit regular reports on technical and business operations.			
1.12 Ownership Following Connection to the National Grid	Define how mini-grids will be treated in the event of interconnection with the national grid.			
2. RETAIL SERVICE REGULATION				
2.1 Retail Tariff Oversight	Decide whether to regulate retail tariffs and oversee customer retail relationships.			
2.2 Retail Tariff Level	Select an approach to retail rate setting and decide whether to place restrictions on retail rate levels for mini-grids.			
2.3 Consumer Subsidies	Decide whether to establish subsidies designed to lower mini-grid customers' cost of connection and/or retail rate.			
2.4 Retail Tariff Structure	Decide whether to require a specific retail tariff structure and metering systems for mini-grids.			
3. TECHNICAL STANDARDS				
3.1 Interconnection to the National Grid	Determine whether mini-grids must adhere to technical standards that will ease interconnection to the national grid.			
3.2 Technology Standards for Equipment and Functionalities	Determine whether mini-grid equipment will be subject to technology standards.			

MINI-GRID REGULATORY DECISION MATRIX		Stakeholder		
Section	**Regulatory Decision Description**	**Regulator**	**Policy maker**	**Developer**
3.3 Electric Power Quality	Determine whether to require specific grid codes to standardize the technical operation of mini-grids.			
3.4 Service Quality: Availability, Capacity, and Reliability	Decide whether to adopt specific criteria or requirements for quality of service.			

II. WHAT IS A MINI-GRID?

Mini-grids are integrated energy infrastructure involving electricity generation and distribution to customers via a distribution grid (EUEI PDF, 2014). Mini-grids include generators; energy storage devices; power conversion equipment; and control, management, and measurement equipment (IRENA, 2016a). Electricity generation can come mainly from fossil fuels or from renewable energy resources such as solar radiation, wind, hydro, biomass, or a combination of two or more. Mini-grids can vary greatly in generating capacity, ranging from around 1 kilowatt (kW) up to 10 megawatts (MW) (IRENA, 2016b). Mini-grids can be designed to deliver different levels of service, from meeting basic lighting needs to satisfying commercial energy demand. Mini-grids can be connected to the national grid or can operate independently, as autonomous mini-grids. Figure 4 provides an illustration of a solar-PV, battery-based, autonomous mini-grid providing energy services to an agricultural processing facility and residences in a theoretical village.

Figure 4. Schematic of a Typical Mini-Grid System



The information provided in this guide is geared toward autonomous, clean-energy-based mini-grids with capacities below 10 MW.[5,6] Thus, the guidance provided is not fully applicable to interconnected mini-grids. Readers who would like additional information on regulating interconnected mini-grids are advised to consult the lists of further readings that conclude each section of the guide. Table 2 outlines the two main types of mini-grids (autonomous versus interconnected) and provides examples of the level of service provided by each (IRENA 2016a).

Table 2. Types of Mini-Grids and Levels of Service

	Lower Tier of Service	Higher Tier of Service
Autonomous	Autonomous Basic (AB mini-grids) • Generation Sources: PV, hydro and biomass • Tier of service: Less than 24-hour power • End-users: Remote community without major commercial or industrial activity • Added value: Enables enhanced energy access, alternative to grid-extension, improved quality of life, cost savings	Autonomous Full (AF mini-grids) • Generation Sources: PV, hydro and wind • Tier of service: 24/7 power • End-users: Remote communities with major commercial or industrial requirements; industrial sites disconnected from grid • Added value: Alternative to expensive polluting imported fuels, diversification and flexibility of supply, cost savings
Interconnected	Interconnected Community (IC mini-grids) • Generation Sources: PV, wind and biomass/biogas • Tier of service: High, 24/7 power critical/interruptible • End-users: Medium to large grid-connected community, such as university campus • Added value: Community control, improved reliability, response to catastrophic events, cost savings	Interconnected Large Industrial (ILI mini-grids) • Generation Sources: PV, wind and biomass/biogas • Tier of service: Very high, 24/7 power, critical/uninterruptible • End-users: Data centers, industrial processing or other critical uses • Added value: High reliability for critical loads, enhanced environmental performance, resiliency

Source: IRENA, 2016a.

[5] Note that the 10 MW_{ac} load limit could refer to for example a 10MW average continuous load to power a large town (i.e. 100,000 inhabitants of 20,000 – 25,000 customers with consumption of 8-10kWh/day/household).

[6] In many countries, mini-grid developments tend to be much smaller than 10 MW; in Uganda, for example, mini-grids typically refer to projects sized 2 MW or smaller. This guide is designed to be broadly applicable to different national and regulatory settings, and to cover regulatory decisions that would apply both to very small projects (including those of only a few kilowatts in size) as well as much larger systems (up to 10 MW).

Further Reading

Provides an in-depth discussion of mini-grid technologies:

- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. Chapter 2: Annex 1: Mini-Grid Technologies. http://www.minigridpolicytoolkit.euei-pdf.org/
- IRENA. 2016. *Innovation Outlook: Renewable Mini-Grids*. Section 2: Types of Renewables-Based Mini-Grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Innovation_Outlook_Minigrids_2016.pdf
- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-grids*. Chapter 2: The Role of Mini-grids in Rural Electrification. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf
- RECP et al. 2013. *Guidelines on Technology Choice and Technical Regulation*. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

III. KEY ISSUES IN MINI-GRID REGULATION

The current state of mini-grid regulation varies significantly across countries. While mini-grids are a relatively new concept for many countries, some have effectively deployed hundreds of mini-grids at the national level (e.g. Sri Lanka, Cambodia, and Nepal). In general, however, regulatory authorities have struggled to address the multi-stakeholder needs of an expanding mini-grid sector.

Underdeveloped policy and regulatory structures are a high priority challenge facing mini-grid developers, customers, utilities, and other stakeholders. In many instances, governments have not taken steps to clearly define regulatory authority over mini-grids, and to set clear regulations for mini-grid deployment. Regulations developed for large national (and often government-owned) or private utilities are often inappropriate or ill-suited for small, heterogeneous mini-grid developers. Occasionally, the structure of the regulatory authority overseeing the mini-grid sector can lead to lax regulation, resulting in inconsistency and confusion regarding how mini-grid projects are regulated.

A summary of the key policy and regulatory challenges impacting the mini-grid sector is briefly described below in Table 3.

Table 3. Summary of Policy and Regulatory Challenges for Mini-grid Development

Issue	Description
Lack of Rural Electrification Planning or Strategy	Mini-grid development is substantially easier in the context of clear national rural-electrification plans. Among other benefits, such plans lay out a clear approach to conducting rural electrification efforts; specify the role that mini-grids are expected to play; provide crucial data regarding non-electrified populations; provide transparent information on where and when extensions of the national grid are to be expected; and may even designate areas where mini-grid development is favored. A clear rural electrification plan and strategy is a crucial part of creating a favorable environment for mini-grid developers and operators.
Political and Legal Uncertainty	Mini-grid developers and operators often function under an uncertain legal framework regarding their ability to establish projects and offer electrical services to customers. In the absence of well-formed legal and regulatory rules and structures, mini-grid developers and operators face significant risks, including political, investment, construction completion, and operational risk (Manetsgruber et al., 2015). A clear policy and legal framework provides the rules under which a mini-grid developer and operator must function. With greater clarity on the rules of the game, these entities can make informed project development and operational decisions.

Issue	Description
Unclear or Complicated Regulatory Processes and Approvals	An unclear, lengthy, or costly approval process can end up imposing new or additional financial risks on already fragile mini-grid projects and may limit developers' interest in entering a specific market.[7] It is thus critical for regulators to develop a straightforward and efficient approval process for mini-grid projects that can reduce project development costs and risks.
Lack of Retail Regulations	Mini-grid developer and operator decisions often depend on the level of payment expected from customers. Without regulated tariffs, developers face significant uncertainty regarding the economic viability of their business model. Additionally, without clear retail regulations, mini-grid customers may be more vulnerable to price gouging. Setting retail regulations can provide greater certainty and security to mini-grid developers, operators, and customers.
Lack of Technical Standards	Without technical standards, decisions are left to mini-grid developers and operators. Even with good intentions, developers' and operators' decisions may lead to electrical safety issues, suboptimal quality of service, technical standards that do not align with national grid-extension goals, or connection and service costs that are prohibitively high for many potential customers. Laying out transparent regulations on technical standards can improve the quality, consistency, and reliability of mini-grid projects for developers, operators, and customers.

Barriers to mini-grid development may be overcome by establishing clear regulatory rules that govern the sector. The regulatory decisions discussed in this guide can be a tool to support countries in developing mini-grid regulations.

[7] The process can be costly in terms of fees and time. Lengthy or delayed approval processes often equate to additional project costs for the mini-grid developer.

IV. LIGHT-HANDED OR COMPREHENSIVE REGULATION?

The purpose of economic regulation is to protect consumers from monopoly abuse. In the electricity sector, a traditional utility can be a natural monopoly, a legal monopoly, or both. The electricity regulators responsibility is to impose rules to control the entities actions to protect consumers. In the case of mini-grids, the regulator must decide if a mini-grid is considered a monopoly, and what level of regulation is appropriate. In making these decisions, it is important for regulators to consider the purpose of mini-grids in a country's electricity sector and the differences between traditional monopoly utilities and mini-grids (Tenenbaum et al., 2014):

- Mini-grids are often used to provide electricity to areas that remain unserved or underserved by the national utility.
- Mini-grids are much smaller entities than traditional utilities (in terms of capacity, customer-base, and revenues).
- Mini-grids, especially newer private companies, are often operating on very small margins.
- Mini-grids vary greatly in-terms of ownership, size, technology, customer base, tariff design, revenue collection, technical standards and quality of electricity service.
- The mini-grid sector is still developing and evolving.

As regulators consider these issues, a central tension arises: what degree of regulation is appropriate to impose on mini-grids? There are two competing philosophies on mini-grid regulation that are discussed throughout this guide:

- Light-handed Regulation: Government regulation should be light-handed, to minimize barriers to private sector development.
- Comprehensive Regulation: Government regulation should be comprehensive, in order to ensure that mini-grid projects are deployed systematically, are responsive to rural energy needs, protect consumers, and provide electricity service that is in line with the performance and technical standards of the national grid.

In practice, the choice between light-handed regulation and comprehensive regulation is not always clear; instead, regulators and policy makers must choose a point somewhere between the two. In general, mini-grid regulation should aim to:[8]

- Minimize the additional workload of regulatory staff.
- Limit the amount of information a regulator requires.
- Minimize the number of separate regulatory processes and decisions.
- Use standardized documents or similar documents created by other agencies, and make documents available on the internet.
- Use applicable rules and decisions made by related government or community bodies, when possible.

The two philosophies of regulation are further outlined in Table 4.

[8] Tenenbaum et al., 2014

Table 4. Overview of Light-handed and Comprehensive Regulation

Regulation	Description	Benefits	Drawbacks
Light-handed Regulation	**Government regulation should be light-handed, to minimize barriers to private sector development.** • Developers should not be restricted by regulatory requirements but should be given the flexibility to determine their own project locations and business models that are guided by customers' willingness to pay and the cost of alternative energy sources, and minimize capital costs by avoiding technical standards and requirements developed with much larger power systems in mind. • Some oversight is called for (such as electrical safety standards and basic registration and reporting). • Regulators should avoid burdening developers and discouraging private-sector investors with regulations that will complicate the already challenging economics of mini-grid project development.	• Minimizes barriers to private sector development of mini-grid solutions. • Reduces regulator's time and resources dedicated to approving each mini-grid project.	• Projects less standardized. • Regulator has less control over development of the sector. • May result in limited customer protection from issues such as price-gouging or unaffordable electricity rates.

Regulation	Description	Benefits	Drawbacks
Comprehensive Regulation	Government regulation should be comprehensive, in order to ensure that mini-grid projects are deployed systematically, are responsive to rural energy needs, protect consumers, and provide electricity service that is in line with the performance and technical standards of the national grid. • It may be tempting to deploy systems that can provide minimal electricity service in the near term, but rural electrification and economic development goals are better served by targeted mini-grid deployment, either to serve areas that cannot be reached by the national electricity grid, or by undertaking projects that can easily be integrated into grid extension efforts. • Developers should meet the same technical and performance requirements as the national grid to ensure customers receive adequate electricity service and to allow for easy interconnection to the national grid. • Regulators have the same responsibility to customers served by mini-grids as they do to national grid customers.	• Ensures mini-grid projects are developed and deployed systematically and customers are protected.	• Creates barriers to private sector development and may slow down the deployment of mini-grids. • Requires more regulatory resources to review and approve each project.

Countries may choose to be light-handed in some areas and comprehensive in others. For example, regulators could allow developers to negotiate their own retail tariffs with customers but require that generation and distribution equipment meet certain technical standards.

Neither view is necessarily the correct one. However, two "golden rules" of regulation can be helpful as regulators and policy makers design the regulatory system for mini-grids (Reiche et al., 2006):

- **Regulation is a means to an end.** What matters ultimately is the outcome, not the rules. For emerging economies, the desired outcome is often sustainable, reliable, and affordable electricity access for households and businesses.
- **The benefits of regulation should exceed the costs.** If complying with regulatory requirements leads to excessive costs for mini-grid developers, mini-grid development will not take place, and the country will struggle to meet its electrification goals.

Throughout this guide, the tradeoff between light-handed and comprehensive regulation will be highlighted, as will other important tradeoffs to which regulators must attend. In most cases, either approach could be effectively implemented given the right context, but regulators and policy makers must be aware of the benefits and drawbacks of each option in order to make the appropriate choice for their country.

In practice, the choice between light-handed regulation and comprehensive regulation is not always clear; instead, regulators and policy makers must choose a point somewhere between the two. In general, mini-grid regulation should aim to (Tenenbaum et al., 2014):

- *Minimize the additional workload of regulatory staff.*
- *Minimize the amount of information a regulator requires.*
- *Minimize the number of separate regulatory processes and decisions.*
- *Use standardized documents or similar documents created by other agencies, and make documents available on the internet.*
- *Use applicable rules and decisions made by related government or community bodies, when possible.*

Further Reading

Provides an overview of key regulatory issues and approaches to consider when thinking through mini-grid regulation:

- Tenenbaum et al. 2014. *From the Bottom Up*. Chapter 3: The Regulation of Small Power Producers and Mini-grids: An Overview. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?sequence=1&isAllowed=y

Provides an overview of main issues and key concerns related to regulating mini-grids:

- EUEI PDF. 2014. *Mini-grid Policy Toolkit.* Chapter 6: Policy and Regulation of Mini-grids. http://minigridpolicytoolkit.euei-pdf.org/policy-toolkit

- IRENA. 2016. *Policy and Regulations for Private Sector Mini-grids*. Chapters 1 and 3. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf

Provides an in-depth review of the key risks mini-grid developers and investors face in developing mini-grid projects, along with a set of risk mitigation strategies and approaches:

- Manetsgruber et al. 2015. *Risk Management for Mini-grids: A New Approach to Guide Mini-grid Deployment.* https://www.ruralelec.org/sites/default/files/risk_management_for_mini-grids_2015_final_web_0.pdf

Provides an overview of power sector reform and regulation in several African countries:

- Eberhard and Kapika. 2013. *Power-Sector Reform and Regulation in Africa: Lessons from Kenya, Tanzania, Uganda, Zambia, Namibia and Ghana.* Cape Town, South Africa: HSRC Press.

Provides an in-depth review of regulatory issues and principles associated with rural electrification efforts; includes a model rural electrification law:

- Reiche, Tenenbaum, & Torres de Mastle. 2006. *Electrification and Regulation: Principles and a Model Law.* http://siteresources.worldbank.org/EXTENERGY/Resources/336805-1156971270190/EnergyElecRegulationFinal.pdf

V. CASE STUDY BACKGROUND

This guide uses Uganda to examine how one nation has approached the development of mini-grid regulations in practice. Uganda's example is relevant for several reasons:

- Uganda is actively pursuing a national rural electrification plan in order to provide energy access for a substantial non-electrified population.
- In doing so, Uganda has taken the initial planning steps needed to create a regulatory and policy regime supporting rural electrification.
- At the same time, Uganda is in the early stages of considering the appropriate role of mini-grids in national electrification efforts, and the unique regulatory challenges of mini-grid projects.
- Given the current discussion around mini-grids in Uganda, there is an opportunity to explore the status of regulation and uncover insights that could be helpful to Uganda and other emerging economies as they evaluate the role for mini-grids in national electrification efforts and develop a regulatory regime.

Although Uganda is an intriguing lens through which to investigate mini-grid regulation, it is important to note that Uganda is currently updating its Rural Electrification Strategy and Plan (RESP) to better clarify the role of mini-grids in rural electrification. Given the current state of mini-grid policy and planning, much of the mini-grid regulatory regime is still under development. Therefore, Uganda is still in the process of making some of the planning and regulatory decisions discussed in the guide.

To complement Uganda's experience and illustrate how other countries have approached specific policy issues, experiences and initiatives from specific "spotlight" countries are interspersed throughout the guide. Spotlight countries are used either to illustrate a regulatory approach that is counter to or complementary to Uganda's approach, or to demonstrate how a country has approached a regulatory issue on which Uganda has not yet taken firm action.

Appendix I provides a full description of the status of mini-grid regulation and deployment in Uganda. It offers contextual information that is necessary for understanding the specific decisions that Uganda has made concerning mini-grid development.

VI. REGULATION OF MINI-GRIDS

The remaining sections of this guide discuss the regulatory decisions that regulators and policy makers must consider when developing regulations for the mini-grid sector. The decisions have been grouped into three high priority pillars of regulation:

- Policy and planning
- Retail service regulation
- Technical standards and regulations

The discussion of each regulatory decision follows a similar format. First, introductory text provides a synopsis of the regulation. Then, a series of guiding questions are presented for regulators and policy makers to bear in mind as they consider the design and implementation of each regulation.

Next, a number of potential options for addressing the regulation are laid out. Each option is briefly described; the description is followed by a discussion of the benefits and drawbacks of that option, as well as the next steps regulators or policy makers should pursue if the option were to be selected. At the end of the guide, a decision-making tool is provided that summarizes the high priority regulatory decisions in an easy to skim table.

A comprehensive stakeholder engagement strategy is crucial for effective mini-grid policy and planning and the development of sound regulations.

Lastly, throughout the discussion of each regulatory decision, the guide emphasizes the importance of comprehensive stakeholder engagement in developing effective mini-grid policy, plans and regulations. Table 5 outlines the various stakeholders whom regulators and policy makers should consult and offers an overview of the stakeholders' perspectives. Throughout the guide, these stakeholders are referred to when discussing the benefits, drawbacks, and next steps for different regulatory decisions.

Table 5. The Importance of a Comprehensive Stakeholder Engagement Strategy in Mini-Grid Regulation

Stakeholder	Perspective
Mini-Grid Developers and Operators 	Regulators' decisions on policy and planning, retail service regulation, and technical standards will directly impact the viability of mini-grid projects. To function effectively, developers and operators require a predictable and supportive regulatory framework that: minimizes project risks, costs, and market-entry barriers, and provides some guarantee of future stability. Developers require a means of recovering their investment, running a profitable business, and/or ensuring sufficient funds are available to sustain operations. Developers' decisions on business models and system design will often be dictated by regulatory decisions. As they develop and implement a regulatory framework, regulators will need to consider the needs of private or public mini-grid developers and operators.

Stakeholder	Perspective
Mini-Grid Host Community 	Regulators have a role in ensuring that communities are engaged effectively and have a voice in the mini-grid development process. So that mini-grid developers can fully understand the needs and desires of the community and incorporate them into their development plans, community members must be engaged before the project development stage. Community engagement should include discussions and education related to technology, system size, siting, pricing, level of service, operations, and maintenance.
Mini-Grid Customers 	Regulators are responsible for ensuring that customers receive affordable and reliable electricity service under fair and transparent terms. The regulator may also mediate disputes between customers and mini-grid developers and operators. However, the regulator and the customer may at times have conflicting goals. For example, the customer's goal is to ensure that the benefits of the electricity service are greater than those associated with current energy sources (e.g. charcoal, wood, kerosene), and that the costs are equal or lower. The regulator's goal is to ensure that the customer's electricity costs are affordable (national grid tariffs are often used as a benchmark). If mini-grid tariffs are higher, regulators may force mini-grid developers and operators to lower tariffs, even if customers are able and willing to pay. As a result, mini-grid operators may be unable to recover costs, and quality of service may decline. A decline in service, in turn, will prevent customers from meeting their goal (of better electricity service at equal or lower cost) and will return to their previous sources of energy. Thus, regulators need to balance their mandate with the goals and interests of consumers.
Civil Society 	Civil society organizations are usually concerned with protecting the interests of the host community and the public in general. Regulators have a role in ensuring that civil society organizations are effectively engaged and have a voice in the mini-grid development process. This includes consultation related to the development of mini-grid regulations and projects.
Policy makers 	Policy makers and regulators often work hand in hand. The policy makers define the policies and plans that dictate a country's rural electrification strategy and amend the legal and institutional framework to allow for the implementation. The regulator is often the main implementer of the policy makers' policies and plans. As regulators develop rules and regulations to implement policies, they must carefully consider policy makers' original intentions.

Stakeholder	Perspective
Other Regulatory and Governmental Agencies 	Regulators will need to work with other government agencies to meet rural electrification goals; ensure that the deployment of mini-grids is in line with national planning efforts; and develop and implement mini-grid regulations. These agencies may include those with authority over the environment, land, finance, foreign and domestic business, and planning. Regulators may also interact with local or regional agencies.

Further Reading

- EUEI PDF. 2014. Mini-Grid Policy Toolkit. Chapter 5: Stakeholder Interests and Contributions. http://www.euei-pdf.org/en/recp/mini-grid-policy-toolkit
- RECP et al. 2013. Guidelines on Planning & Development Process and Role Clarity. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

I POLICY & PLANNING

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FROM THE AMERICAN PEOPLE

1 POLICY & PLANNING

The first pillar of mini-grid regulation is the creation of a sound policy and planning framework. Policy makers, regulators, and other stakeholders (such as mini-grid developers), will need to be involved in many of the decisions discussed in this section (Table 6). There is no single best practice to developing a policy and planning framework for mini-grids; instead, policy makers and regulators have many options for expressing their regulatory philosophies through their decisions.

However, it is important to note that the policy and planning decisions will form the backbone of a country's mini-grid sector and will influence many of the decisions made under Pillar 2 (retail service regulation) and Pillar 3 (technical standards and regulation). The policy and planning framework will also signal the overall approach to the development of the mini-grid sector, which will likely influence decisions to pursue investments on the part of mini-grid developers and operators. This section discusses twelve decisions related to policy and planning (Table 6).

Table 6. Key Issues in Mini-Grid Policy and Planning

Issue	Description
Approach to Mini-grid Planning	Decide between a decentralized, centralized, or mixed approach to mini-grid planning – ideally, one that is informed by a national electrification and rural electrification plan.
Mini-grid Regulatory Authority	Assign one or more public agencies regulatory authority over mini-grids.
Developing a Mini-grid Definition	Define the term mini-grid in a country's relevant laws, plans, policies and regulations.
Developing Classes or Categories of Mini-grids	Develop classes or categories of mini-grid projects based on the capacity and/or other factors such as technology, DC vs. AC mini-grids.
Ownership model	Decide which organizations will be legally allowed to own and operate mini-grids.
Fiscal Support for Mini-Grid Developers: Direct Grants and Subsidies	Design fiscal policies to provide grants and subsidies to encourage mini-grid development and private or public sector investment in rural electrification.
Approval Processes and Procedures	Establish a clear and transparent approval process (for entities both within and outside the electricity sector) for mini-grid projects, which may include licensing.
Licensing	Establish a clear and transparent licensing process for mini-grid projects.

Environmental Regulation	Outline an environmental review process for mini-grid projects.
Technology Requirements	Decide whether to require or incentivize certain generation technologies for mini-grids.
Reporting and Filing Requirement	Determine whether to require mini-grid operators to submit regular reports on technical and business operations.
Ownership Following Connection to the National Grid	Define how mini-grids will be treated in the event of interconnection with the national grid, including whether the mini-grid operator will maintain ownership and operating rights over any aspect of the mini-grid infrastructure.

1.1. APPROACH TO MINI-GRID PLANNING

A crucial first step in encouraging the growth of mini-grids is to develop the foundational policies and plans that (1) enable the development and regulation of mini-grid projects and (2) clarify the role that mini-grids will play in national electrification efforts. Frequently, national policy makers, rather than regulators, are responsible for making decisions on a country's approach to mini-grid planning. Nevertheless, it is important for policy makers to consult regulators (and other stakeholders) in the course of making those decisions. Ideally, a comprehensive national electrification policy and rural electrification plan should be in place before policy makers consider a mini-grid planning approach. In particular, the rural electrification plan should lay out targets, a timeline, and funding needs; identify the key government agencies that will have responsibility for the effort; and clarify the role that grid extension, mini-grid projects, and/or stand-alone systems will have in meeting the targets. Policy makers should also establish a process for tracking progress toward meeting electricity-access targets (Box 1).

Generally, policy makers can choose to pursue a centralized or decentralized approach to rural electrification planning.[9] In a centralized approach, the government closely plans, regulates, and participates in the expansion of electricity access. In a decentralized approach, the government may have a role in planning and regulating the expansion of electricity access, but the private sector plays a larger role in proposing and implementing electricity projects. Under the decentralized approach, one of the government's main roles is to establish the market signals that will encourage the private sector to pursue electrification efforts.

> ***Decentralized or Centralized?***
>
> *Governments can adopt a mix of centralized and decentralized approaches to mini-grid regulation. Policy makers and regulators should carefully consider whether a centralized, decentralized, or mixed approach will be more effective for their country context.*

Policy makers should also make certain that appropriate energy, electricity, or renewable-energy legislation is in place. The legislation should establish the legal and institutional framework for implementing and enforcing the regulations for rural electrification in general and mini-grids specifically. This usually occurs through an act of parliament or an equivalent legislative authority (EUEI PDF, 2014).

This guide assumes that policy makers have passed the requisite legislation and that the legal framework is in place to regulate the mini-grid sector.

This section discusses the benefits, drawbacks and next steps for:

- Adopting a centralized approach, or
- Adopting a decentralized approach.

[9] The distinction drawn here is based on but different from the discussion in Tenenbaum et al. (2014), which compares centralized approaches to rural electrification (primarily government-controlled expansions of existing electricity grids) to decentralized approaches (which include developer-led mini-grid projects). Here, the comparison focuses on approaches to mini-grid planning and development characterized by varying levels of direct governmental leadership.

Box 1: Assessing Progress Toward Electricity Access Targets

Assessing a country's progress toward electricity access targets is a complex task. In particular, determining the metrics for measuring energy access can be challenging. Several frameworks can support countries in measuring energy access and assessing progress in achieving energy access targets.

The Global Tracking Framework (GTF), developed by the World Bank and the International Energy Agency, is a consensus-based methodology that uses indicators such as percentage of population with an electricity connection and percentage of population with primary reliance on nonsolid fuels (IEA & World Bank, 2015). These indicators have gained attention in the international community and are being used to track countries' progress toward universal access to electricity under the United Nations' Sustainable Energy for All initiative.

Building on the GTF, the World Bank Energy Sector Management Assistance Program (ESMAP), in consultation with development partners, created the Multi-Tier Framework (MTF) for Measuring Energy Access, which replaces the traditional binary measurement (access or no access) with a multidimensional approach that incorporates capacity, duration, reliability, quality, affordability, legality, convenience, and health and safety. Under the MTF, energy access is assigned a tier, from Tier 0 (no access) to Tier 5 (the highest level of access). The framework provides specialized multi-tier frameworks for measuring energy access for households, productive enterprises, and community institutions.

There have also been nongovernmental efforts: the Energy Access Targets Working Group of the Center for Global Development, for example, has developed a set of multidimensional indicators of energy access.

As policy makers, regulators, and other stakeholders develop metrics for assessing progress toward energy access, they can draw on existing frameworks and indicators but should not feel limited to only these resources.

Further Reading

- IEA and World Bank. 2015. Sustainable Energy for All 2015—Progress Towards Sustainable Energy. http://trackingenergy4all.worldbank.org/reports
- Energy Sector Management Assistance Program. 2015. Beyond Connections: Energy Access Redefined. https://www.esmap.org/node/55526
- Energy Access Targets Working Group. 2016. More Than a Lightbulb: Five Recommendations to Make Modern Energy Access Meaningful for People and Prosperity. http://www.cgdev.org/publication/more-than-lightbulb-recommendations-modern-energy-meaningful

Guiding Questions:

- Does the government have a rural electrification plan, including targets for energy access? If so, are mini-grids part of the plan or should they be?
- Are there any policies and regulations in place that establish the legal framework to support the deployment of mini-grids?
- Does the government want to take sole responsibility for implementing the rural electrification plan, or does it want other stakeholders to participate?
- What degree of control and oversight does the government intend to have over mini-grid development?
- Do communities or local jurisdictions have any formal or informal authority over mini-grid development?

Option 1: Adopt a centralized approach

A centralized approach to mini-grid development implies a significant role for government in determining the timing and location of mini-grid projects, and often includes a governmental role in the development and ownership of mini-grid assets. In some cases, centralized mini-grids may be developed and owned directly by government agencies or a national utility. In other cases, mini-grids may be owned by private developers, but with the project development process closely planned and coordinated by governmental authorities.

Benefits	Drawbacks
• Ensures maximum governmental control of the mini-grid development process. • Allows for identification of the most suitable sites for mini-grid development (as opposed to grid extension or stand-alone systems) to be identified, and for mini-grids to be developed in these areas (either by government, public utilities, or private-sector partners) in a tightly controlled manner. • Maintains government control of other aspects of development—including licensing, tariff setting, technical standards, reporting, monitoring, and tracking progress against mini-grid targets or broader energy-access goals.	• Requires significant financial and human resources, as well as coordination on the part of government authorities. • Requires significant capacity to identify and assess sites, develop and manage approval processes, and manage competitive bidding processes, among other responsibilities. • May constrain the ability of entrepreneurs and communities to develop projects in areas not included in centralized plans, thereby hindering experimentation with innovative business models.

Recommended Steps for Policy makers
• Include the identification of preferred mini-grid project sites in rural electrification planning efforts. • Determine whether to pursue mini-grid development directly, through a state or regional agency or national utility, or by offering project sites for private development (discussed further in Section 1.8). • Ensure that the responsible agency has adequate staff capacity and resources to successfully implement a centralized approach.

Option 2: Adopt a decentralized approach

In a decentralized approach, the government relies on nongovernmental parties—private firms, nonprofit organizations, or communities—to identify and propose potential projects. A decentralized approach can be described as an "open door" approach: the government's role is to develop eligibility requirements that mini-grid projects and developers must meet, and to determine, based on these criteria, whether proposed projects can move forward.

Benefits	Drawbacks
• Takes advantage of the varied knowledge and perspectives of diverse nongovernmental actors in determining potential sites for projects, and relies on the efficiency of the market to develop projects. • Can reduce development costs and risks, since mini-grid developers have more influence over the direction of projects. • Allows governments to be flexible and responsive to demand. • Fosters competition and allows progress to move at the pace of the private sector, provided that the government has set up an enabling regulatory environment.	• May lead to confusion and lack of coordination, particularly if multiple developers are interested in pursuing projects in the same area, or if a developer is interested in a site slated for grid extension. • The government has less control over site selection; as a result, projects may not be developed in areas that would provide the greatest public good.

Recommended Steps for Policy makers

- Create a full rural electrification plan that identifies areas well-suited for private development and areas where grid extension is planned: this information will be vital to private sector developers.
- Develop and publish a set of requirements that mini-grid developers and projects must meet; these should be standardized, transparent, and fair.
- Design a project licensing process (Section 1.8) and ensure that the agency responsible for managing this process has adequate staff capacity and resources.

Further Reading

Provides detailed guidance on policy and regulatory decisions associated with the decentralized approach:

- Tenenbaum et al. 2014. From the Bottom Up. Overview and Introduction. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Provides guidelines for policy makers on the assessment of energy needs and demands that can be met using mini-grids:

- RECP et al. 2013. Guidelines on Market Needs and Demand. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Outlines steps that policy makers should follow to guide and inform stakeholders on approval processes for developing mini-grids:

- RECP et al. 2013. Guidelines on Planning & Development Process and Role Clarity. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Box 2: Approach to Mini-Grid Planning in Uganda

While this guide defines mini-grids as 10 MW or less, mini-grid projects in Uganda are more likely to be less than 2 MW. This case study therefore focuses on Uganda's experience regulating mini-grids with a capacity of 2 MW or less.

A number of mini-grid projects are currently in operation or development in Uganda (see Appendix 1). To date, the country has taken a decentralized approach and primarily relies on developers to propose sites. However, the government is beginning to take a more active role in planning for mini-grid development. Uganda's Rural Electrification Strategy and Plan (RESP 2013-2022) outlines a minor role for mini-grids: estimating 8,500 new service connections from mini-grids by 2022, compared with 130,000 new solar home systems and 1,276,500 new connections from grid extensions (REA, 2013).

The Rural Electrification Agency (REA), the government agency responsible for planning and coordinating rural electrification in Uganda, is in the early stages of amending the RESP to better clarify the role of mini-grids and solar home systems in rural electrification. As part of this, REA is undertaking a master-planning process to identify sites that would be good strategic locations for mini-grid development, rather than for grid extension or solar homes systems. REA anticipates running a competitive tender and providing concessions of the identified sites to selected developers, potentially as part of broader concessions to provide distribution service to a region. The Electricity Regulatory Authority (ERA) would oversee the tender and concession process.

This process is designed both to ensure that mini-grid development is included in a comprehensive national plan, and to address a major barrier identified by developers in Uganda—namely, the difficulty and expense of locating and conducting early-stage feasibility studies of potential sites. Ideally, a centralized process will facilitate much of this pre-application work on behalf of developers.

Currently, however, with the exception of the West Nile Rural Electrification Company, each mini-grid project discussed in this guide was initially proposed by a developer and obtained approval from ERA, REA, and other agencies to move forward with project construction (or is in the process of doing so). ERA and REA have stated that even as Uganda develops a master-planning process for rural electrification, the government plans to continue working with mini-grid developers to approve private sector identified projects in specific cases.

1.2. MINI-GRID REGULATORY AUTHORITY

Regardless of the level and type of regulation selected—light-handed or comprehensive, centralized or decentralized—governments should designate one or more public agencies to oversee mini-grid development and operations. Generally, a regulatory authority or institution is defined as an independent "administrative and political [body] through which regulations are made, implemented, and adjudicated" (IFC, 2010).[10]

The designated agency will be tasked with facilitating mini-grid deployment and will be responsible for issuing and monitoring electricity sector regulations on:

- Permitting and licensing;
- Retail tariffs and rate structures; and
- Technical and safety standards.

The regulator may also be given a mandate to make decisions on mini-grid siting based on the national rural-electrification plan. For example, by issuing competitive bids for concessions for mini-grid developers to serve a particular area (discussed further in Sections 1.8.2 and 1.8.3), regulators can dictate where mini-grids will be developed.

In a deregulated market, a government would need a system in place to monitor the progress and development of the electricity sector, along with some form of technical and electrical safety regulations to protect end users. The regulatory authority, at the minimum, could undertake responsibilities such as providing registration platforms for nongovernmental electrical service providers; monitoring the electrical safety of mini-grids; tracking market progress through regular reporting; and potentially receiving stakeholder input.

Public entities that could assume mini-grid regulatory responsibilities include an existing national electricity or energy regulatory agency, a rural electrification agency, a local or regional government body, or a group of village representatives. It is important to keep in mind that the best institutional structure for regulation in one country may not be suitable for another. Countries are advised to closely examine the structure and capacity of existing public agencies to make an informed decision.

In some instances, the entity assigned regulatory authority over the mini-grid sector may also coordinate electricity sector and non-electricity-sector approval processes for mini-grid projects. This may include coordinating stakeholders involved in approval processes; documenting, streamlining, and publishing guidelines on processes and procedures; managing and facilitating approval processes; facilitating and/or administering fiscal support schemes; and identifying and implementing capacity-building programs (RECP, EUEI PDF, & RERA, 2013b). These activities will be discussed further in Section 1.7.

This section discusses the benefits, drawbacks and next steps of adopting a:

- Central approach
- Regional approach, or
- Decentralized approach to designating the mini-grid regulatory authority.

[10] It should be noted that other regulatory agencies will have authority over non-electricity-sector regulations, such as environmental regulation. This section discusses the options for designating regulatory authority for regulations specific to the electricity sector. Section 1.7 will further discuss non-electricity-sector regulations and approval processes and the need for coordination across agencies and sectors.

Guiding Questions:

- What governmental agencies currently have authority over electricity regulation, electrification, and rural development?
- Does any legislation need to be amended to give regulatory authority to the agency or agencies?
- What governmental authorities have a presence in areas that are likely to be subject to mini-grid development?
- What are the roles and responsibilities of the mini-grid regulatory authority?
- Which public institutions have the necessary financial and human resources to develop and implement mini-grid regulations?
- What resources are necessary and available to coordinate regulatory processes and approvals between various government agencies?

Option 1: Assign all primary mini-grid regulatory responsibilities to a single central government entity

Policy makers may choose to assign all electricity-sector mini-grid regulatory responsibilities to a central government entity. It is important to note, however, that other regulatory agencies will be involved in the regulation of mini-grid projects: for example, other agencies will have regulatory authority over non-electricity-sector approvals. However, these other entities are not considered under this option as they do not have authority over electricity-sector regulations.

Benefits	Drawbacks
• Provides a "one-stop-shop" for all stakeholders, including private developers, communities, and end users. • Mini-grid developers could access all the information they need on permitting and licensing, retail tariffs, and technical standards from one place. • Due to minimal cross-agency collaboration, it may enable a streamlined regulatory process.	• Efficient development and implementation of regulations requires significant financial resources. • As development grows, the regulatory authority could experience high volumes of requests pertaining to licensing or technical inspection of generation and distribution facilities, which may be beyond its capacity. • Capacity constraints could be an impediment, as timely responses to applications and inquiries are critical for reducing project development costs. • Regulatory authority may not be physically present in areas where mini-grid deployment is taking place, which makes it less accessible to developers and customers. • Regulatory authority may find it difficult to monitor end-user satisfaction and developers' adherence to regulations due to the inaccessibility of remote areas.

Recommended Steps for Policy makers
• Identify central government entities that could play the role of mini-grid regulator. • Initiate a stakeholder consultation process to collect input from governmental and nongovernmental stakeholders (Table 1Table 5). • Incorporate input from stakeholders and work with relevant government agencies and policy makers to select and designate a regulatory authority. • Assess whether national legislation needs to be amended to move forward with providing regulatory authority. If so, amend the legislation. • Adopt a policy framework that guides and supports the regulatory process. • Empower the governmental entity with the authority, practical tools, and resources to effectively regulate mini-grid development.

Option 2: Assign all regulatory responsibilities to local or regional government bodies

Alternatively, policy makers may wish to assign all regulatory responsibilities to local or regional government bodies. Under this structure, local or regional governments will assume regulatory authority and will be able to adopt and implement regulations tailored to their jurisdictions.

Benefits	Drawbacks
• Useful for countries that have regions with diverse social and economic conditions. • Local public agencies familiar with the socioeconomic and political context of their region may be better suited to regulate mini-grids operating in their area. • May help address the human-and financial-capacity constraints that can arise from having a single, centralized regulatory authority. • May be more likely to be physically present and accessible to developers and customers than a centralized body.	• May result in imbalanced market growth, poor standardization across regions, or both. • May result in a patchwork of regulations that vary across regions and are difficult for mini-grid developers to navigate. • Mini-grid developers may then avoid certain regions, hindering mini-grid development. • Select regional or local regulators may also have fewer financial and human resources to regulate mini-grids within their jurisdictions. • Could prove to be costlier compared to a centralized approach.

Recommended Steps for Policy makers

Central Government Policy makers

- Work with regional and local entities and other stakeholders to identify the local and/or regional regulatory bodies that could have regulatory authority over mini-grids.
- Initiate a stakeholder consultation process to collect input from nongovernmental stakeholders (Table 5).
- Incorporate stakeholder input and designate the appropriate regional and local entities.
- Determine whether national legislation is needed to enable regulatory authority. If so, establish legislation to grant regulatory authority to local or regional government bodies.
- Adopt a policy framework that guides and supports local and regional regulatory processes.
- Empower local or regional entities with the authority, practical tools, and resources to effectively regulate mini-grid development.

Local or Regional Governments

- Work with the central government and other stakeholders to identify the appropriate agency to regulate mini-grid development.
- Support the stakeholder consultation process.
- Incorporate input from the stakeholder consultation process and work with the central government to designate the regulatory authority.
- Assist as needed to ensure that the local or regional entity is granted regulatory authority.
- Provide adequate staff and resources to the local or regional entity.

Option 3: Adopt a decentralized regulatory institutional arrangement

Finally, policy makers may opt for a decentralized institutional arrangement by dividing regulatory responsibilities between various governmental entities, such as rural electrification agencies, regional or local administrative bodies, public utilities, and village representatives.

Benefits	Drawbacks
• Enables institutions participating in the mini-grid regulatory process to contribute some amount of human and financial capacity, ideally relieving the burden on the central government. • A decentralized arrangement allows public institutions that have experience with or capacity for highly technical or specialized regulations to collaborate with other agencies to fulfil regulatory responsibilities.	• A fragmented institutional structure, in which regulatory responsibilities are distributed among several entities, could lead to a disorganized system hindering mini-grid deployment. • Constant cross-agency communication and collaboration are essential if the performance and efficiency of one agency is closely tied to the performance of another. • May require new roles at the national level to oversee, coordinate, and monitor the function and quality of the regulatory process (IFC, 2010).

Recommended Steps for Policy makers
• Assemble a multi-agency group of policy makers who—with input from nongovernmental stakeholders—will map out (1) the electricity-sector regulatory tasks associated with mini-grid development and operations and (2) the governmental bodies best equipped to serve each function. • Designate the selected government bodies. • Determine whether national legislation needs to be amended to move forward with providing regulatory authority. If so, amend the legislation to grant regulatory authority to the designated government bodies. • Identify the method by which the designated entities will collaborate and communicate; if desired or necessary, assign responsibility for coordination to a single entity. • Assemble a special task force that will meet regularly to discuss issues and resolve problems as they arise. The task force should consist of representatives from each agency involved in mini-grid regulation, and should also include a representative from the ministry of energy or equivalent agency. Where applicable, the task force could be organized and led by the mini-grid coordinating agency. • Adopt a policy framework that guides and supports the government bodies in regulating the mini-grid sector. • Empower the government bodies with the authority, practical tools, and resources to effectively regulate mini-grid development.

Further Reading

Discusses the advantages and disadvantages of devolving some regulatory responsibilities to institutions such as rural electrification agencies, community organizations, and village representatives:

- Tenenbaum et al. 2014. From the Bottom Up. An Overview; Chapter 3: The Regulation of Small Power Producers. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Box 3: Mini-Grid Regulatory Authority in Uganda

The Electricity Regulatory Authority (ERA), Uganda's independent energy-regulatory authority, has primary regulatory authority over mini-grid projects—including license approval, retail tariff-setting, and enforcement of technical standards. Although the Rural Electrification Agency (REA) has a broad rural electrification mandate, it does not have regulatory authority over mini-grid projects. Nevertheless, ERA does consult with REA when reviewing and approving projects to ensure that developers are already in discussion with REA regarding issues such as intended project site and funding assistance.

Many project developers expressed that it can be difficult to navigate the mini-grid project development process in Uganda. Although all developers understand that ERA is the regulatory authority in charge of approving projects, many noted that it was not always clear when it was necessary to engage ERA, REA, or both during the various stages of mini-grid development. Project developers suggested that ERA consider establishing a one-stop shop where one ERA staff member would be in charge of coordinating the mini-grid approval process and liaising with mini-grid developers. Developers also suggested having one point of contact at ERA would help streamline the approval process and improve communication during project operation.

Box 4: Country Spotlight: India's Approach to Regulatory Authority at the Regional Level

India's Electricity Regulatory Commissions Act of 1998 codified the establishment of a two-tiered system of independent regulation, at both the national and state levels. Five years later, the Electricity Act of 2003, which brought about extensive electricity sector reforms, set forth new mandates for both the national regulator, the Central Electricity Regulatory Commission (CERC), and India's 29 state-level authorities, the State Electricity Regulatory Commissions (SERCs) (Electricity Act, 2003, Sections 76 and 82).

Among other responsibilities, CERC has the authority to regulate and set tariffs for government-controlled generating companies and interstate electricity transmission; issue licenses for interstate operations; and regulate nongovernmental companies if they generate or sell electricity in more than one state (Electricity Act, 2003, Section 79). CERC also plays an advisory role, developing recommendations and facilitating information sharing with government and among state-level electricity regulators.

The Electricity Act of 2003 gives the SERCs responsibility for state-level regulation—in particular, determining and setting tariffs for intrastate generation, supply, and transmission; issuing licenses; enforcing service quality standards; and wheeling of electricity within each commission's home state (Electricity Act, 2003, Section 86). Furthermore, on matters of interstate electricity transmission and national electricity policy, the central and state regulators work together, along with the Central Electricity Authority, a statutory body that sets national grid codes and formulates plans for the development of the electricity system (Pandey & Morris, 2009).

Kale (2014) notes that the effectiveness of the regional regulators varies substantially, depending on their available resources and level of autonomy. It is important to note that CERC does not have authority over the SERCs and cannot compel states to adopt a given regulation if it does not involve interstate activity. CERC can, however, conduct policy studies and make recommendations to states in order to facilitate coordination. For example, in its advisory role, CERC had developed multiple recommendations on mini-grid regulation, which were promulgated before January 2016. But since mini-grid regulation falls under the jurisdiction of each state-level regulator, the SERCs were not required to implement CERC's proposals (Levi, 2016).

On January 28, 2016, in an attempt to remedy the coordination challenge that would result from trying to encourage every SERC to adopt the recommended mini-grid regulation, India amended the Electricity Act of 2003 to require the SERCs to create mini-grid regulation. Specifically, SERCs are now required to address the substantial risks that mini-grid developers face and to provide incentives for investment, including proposing regulations on mini-grid ownership once interconnection to the national grid occurs (Levi, 2016).

1.3. DEVELOPING A MINI-GRID DEFINITION

It is critical for regulators and government policy makers to define the term mini-grid in a country's relevant laws, plans, policies and regulations. Defining what a mini-grid is provides greater clarity and certainty to mini-grid developers and operators regarding how a given project will be considered, classified, and assessed by the regulator.

Mini-grids can be defined as integrated energy infrastructure involving electricity generation and distribution via a transmission or distribution grid, and can range from around 1 kW up to 10 MW.

Mini-grids can operate independently, as an individual isolated electrification system, can be interconnected to create a collective isolated electrification system, or can be interconnected to the national grid as an individual or collective system.

Mini-grids are most often defined in terms of different characteristics such as:

- By size – generation installed capacity (kW or kVA)
- Capacity to load – a technology-agnostic definition which looks at the maximum power demand side (customer demand) of the mini-grid in kW
- By type – autonomous, interconnected, community, or industrial
- By settlement hierarchy and/or size of population (hamlet, village, town, large town, etc.)
- By energy demand (kWh) served; monthly, quarterly or annually
- By technology – solar PV, micro-hydro, biomass, wind etc.

It is important to note that if defining mini-grids by size, the different technology capacity factors should be considered, so one technology is not favored over another. For example, a MW of hydro will provide different electricity generation output than a MW of solar PV. Since all MWs are not created equal, regulators should bear in mind the differences between technologies, and define them accordingly.

Guiding Questions:

- Is the term mini-grid currently defined in national law, plans, policies or regulations?
- What definition is most appropriate for mini-grids in the specific country context?
- Should mini-grid be defined in terms of size or include other factors such as whether the mini-grid is autonomous or interconnected or based on technology?

Option 1: Define mini-grid in relevant national laws, plans, policies, and regulations

Benefits	Drawbacks
• Provides greater clarity and certainty to mini-grid developers and operators regarding how a given project will be considered, classified, and assessed by the regulator.	• Mini-grid definitions may not keep pace with changes or advancements in mini-grid technologies and their respective efficiencies. • Too narrow of a definition may constrain mini-grid development and advancement. • Too broad of a definition may permit unforeseen or unanticipated types of projects.

Recommended Steps for Policy makers
• Assess national laws, plans, policies and regulations for mini-grid definitions. • Consult with stakeholders to gain different perspectives on mini-grid definitions. • Evaluate different countries mini-grid definitions. • Adopt a definition for mini-grid and include in relevant laws, plans, policies and regulations. • Review definition periodically and update as necessary.

Box 5: Country Spotlight: Tanzania's Mini-grid Definition

Pursuant to Tanzania's Electricity Act Chapter 131, the Ministry of Energy and Minerals (MEM), has established a framework for the development of mini-grid projects. The government has issued rules for the development of mini-grid projects, "The Electricity Act (CAP 131) The Electricity (Development of Small Power Projects) Rules, 2016." Under the rules there are several key definitions related to mini-grids:

> "Mini-Grid" means an electricity transmission and distribution network physically isolated from the Main-Grid;
>
> "Small Power Producer (SPP) means an entity generating electricity in the capacity between 100kW up to 10MW using renewable energy, fossil fuels, a cogeneration technology, or some hybrid system combining fuel sources mentioned above and either sells the generated power at wholesale to a Distribution Network Operators (DNO)[i] or at retail directly to a customer or customers. An SPP may have an installed capacity greater than 10MW but shall only export power at the interconnection point not exceeding 10MW;
>
> SPP developer means a person who promotes and constructs an SPP for the purpose of selling power to a DNO pursuant to an Small Power Purchase Agreement (SPPA) or to any other entity subject to terms and conditions they may agree.
>
> "Very Small Power Project" ("VSPP") means an electricity generator with an installed capacity of one hundred kW or less that either sells power at wholesale to a DNO or at retail directly to a customer or customers."

Tanzania has provided clarity to mini-grid developers and operators on how a mini-grid project is defined and how it will be regulated. Regulators and policy makers can consider Tanzania's and other countries mini-grid definitions as they develop their own definitions.

[i] "Distribution Network Operators' ("DNO") means a distribution network operator responsible for the operation of a distribution network at 33 kV or below.

1.4. DEVELOPING CLASSES OR CATEGORIES OF MINI-GRIDS

In establishing a mini-grid regulatory framework, regulators often develop classes or categories of mini-grid projects based on the capacity or other factors such as DC vs. AC mini-grids (India, Mini-grid Regulations 2016), mini-grids that serve remote rural areas or areas with weak grid supply (Nigeria, Mini-grid Regulations, 2016), or other aspects particular to a country. Developing mini-grid categories ensures the level of regulation matches the scale and technology of the project. For example, a 10 kW project might not require the same level of regulatory oversight as a 1 MW project. Once mini-grid categories are defined, regulations can be structured around the classes or categories of mini-grids (Section 1.3). Table 7 provides examples of different countries mini-grid categorization.

Once mini-grid categories are defined, regulations can be structured around the classes or categories of mini-grids.

As discussed in Section 1.3, when classifying mini-grids and adopting class-based regulations, it is important to consider other project factors outside of capacity such as technology. For instance, a MW of hydropower will provide much different electricity generation output than a MW of solar PV and a hydropower project may have greater local environmental impact and require an environmental impact assessment (EIA) compared to a solar PV project. To reduce the risk of favoring one type of mini-grid project over another, regulators should bear these differences and nuances in mind as they define mini-grids, develop classes or categories, and adopt regulations.

Guiding Questions:

- Do mini-grid categories or classifications already exist?
- What categories or classifications are most appropriate for mini-grids in the specific country context?
- Should mini-grid be categorized in terms of size or include other factors such as whether the mini-grid is autonomous or interconnected or based on technology?

Table 7. Examples of Mini-grid Categories: Summary Tables of Various Regulations (Rodriguez, 2017)

<table>
<tr><th colspan="4">Tanzania</th></tr>
<tr><th>Capacity</th><th>License Requirement</th><th>Tariff Regulation</th><th>Interconnection to Main Grid</th></tr>
<tr><td>< 100 kW</td><td rowspan="2">No, only registration at EWURA
Voluntary licensing procedure</td><td>No</td><td rowspan="3">Interconnection Letter of Intent</td></tr>
<tr><td>> 100 kW up to 1MW</td><td rowspan="2">Yes, approved by EWURA</td></tr>
<tr><td>1-10 MW</td><td>Yes</td></tr>
</table>

<table>
<tr><th colspan="5">Nigeria Mini-Grid Regulations for Autonomous Mini-grids, 2017</th></tr>
<tr><th>Capacity</th><th>License Requirement</th><th>Tariff Regulation</th><th>Interconnection Standards</th><th>National Grid Arrival</th></tr>
<tr><td>< 100 kW</td><td>Registration only
Voluntary licensing procedure</td><td>Site-specific cost-plus approach</td><td>No obligation to build up to national grid standards</td><td rowspan="2">Convert from an isolated mini-grid to an interconnected mini-grid
Transfer all project assets to the national grid operator in return for a financial compensation. In the case asset transfer the financial compensation must be equivalent to the remaining depreciated value of the assets additionally increased by an equivalent of all the revenues gained over 12 months preceding the transfer.</td></tr>
<tr><td>100kW – 1MW</td><td>License required</td><td>Retail tariffs calculated with regulated formula</td><td>Compliant with national standards
Buy-out in case of main grid connection</td></tr>
<tr><td colspan="5">Source: Nigerian Electricity Regulatory Commission. Regulation for Mini-grids 2016. https://www.iea.org/media/pams/nigeria/Nigeria_PAMS_NERCMiniGridRegulation_2016.pdf</td></tr>
</table>

Nepal		
Capacity	**Grid Impact Studies**	**PPA**
< 100 kW	Not required	Pre-defined values for a 30 year PPA: • USD 4.8 cents/kWh for wet season • USD 8.4 cents/kWh for dry season
100kW – 500 kW	Yes	Not pre-defined values

Kenya, Draft Categories for Regulatory Classification (ECA/TTA Study, 2016)				
	A	**B**	**C**	**D**
Capacity to Load	< 50kVA	50-500 kVA	>500 kVA	SDP (10 MVA Max)
Expectation of grid connection (if it arrives)	No (but can be negotiated)	Yes	Yes	n.a.
Technical standards	Light	Light (unless grid connection is anticipated within 8 years	Light (unless grid connection is anticipated within 8 years)	Full grid
Licensing	Light mini-grid	Full mini-grid	Full mini-grid	Full SPD
Tariff	Not reviewed	Cost-reflective	KPLC main grid (uniform tariff)	KPLC main grid (uniform tariff)
Recurrent subsidies available	No	No	Yes	No
Source: Fraatz, Jasmin. GIZ, *Mini-Grid Regulation and Practical Experiences from Kenya:* https://www.giz.de/fachexpertise/downloads/2016-en-kenya-regulation-experiences-jasmin-fraatz.pdf				

Option 1: Develop mini-grid classes or categories and adopt regulation based on classes

Benefits	Drawbacks
• Provides more certainty and predictability to mini-grid developers and operators on how a specific project will be regulated. • Can decrease requirements and regulations for smaller projects with less impact. • Can reduce resources the regulator must dedicate to each mini-grid project.	• Developing categories can be a time-consuming process. • Depending on how categories or classes are structured, they can unintentionally favor specific technologies.

Recommended Steps for Policy makers
• Assess national laws, plans, policies and regulations for mini-grid classifications or categorization. • Evaluate different countries mini-grid classifications. • Develop definitions that are fair, clear, transparent, and understandable, and do not necessarily favor a specific technology (unless it is intended). • Consult mini-grid developers, operators and other stakeholders on proposed categories and segmentation to ensure they align with the private sector's approach to mini-grid development and market needs. • Adopt mini-grid categories and include in relevant laws, plans, policies and regulations. • Review categories periodically and update as necessary.

1.5. OWNERSHIP MODEL

One of the key roles of policy makers is to decide which sorts of organizations should own, develop and operate mini-grid projects—specifically, whether mini-grids are to be owned by governmental bodies, private sector actors,[11] or some hybrid of the two.[12] The decision about an ownership model typically follows from the rural electrification planning process and should be informed by the country's socioeconomic and political context, as well as by the state of electricity sector regulation or deregulation, among other factors.

There are a number of institutional arrangements for mini-grid ownership, development and operation. It is important to keep in mind that mini-grid ownership may not necessarily entail project development or operation and maintenance. Ownership is often associated with the entity that is responsible for financing or financing and developing mini-grid projects, but not operating the project. In cases where the owner is not the developer or the operator they will contract the responsibilities out to one or more entities. Policy makers must think critically about which ownership models to allow, as this decision will greatly impact the development of the mini-grid market.

Guiding Questions:

- Should mini-grid development be a state-run process, or undertaken in partnership with the private sector?
- Does the government have the capacity to quickly and effectively deploy mini-grid projects independently?
- Are there policies in place that support government-approved ownership model?
- Are there policies in place that support private independent power producers and distributors?

[11] Previous authors, such as the European Union Energy Initiative Partnership Dialogue Facility (2014), have further distinguished between private sector and community-based organizations. While there are important practical differences between these two modes of ownership, this guide collapses them into a single, private sector category to highlight the key regulatory decision of whether to allow nongovernmental participation in mini-grid development.

[12] Although this section mentions the option of structuring ownership exclusively through government agencies or utilities, much of the subsequent discussion assumes some degree of private sector participation and investment in mini-grid development.

Option 1: Utility ownership: Designate the national utility as the owner of all mini-grids

Policies that support the utility ownership model afford all mini-grid construction and management responsibilities to the national public utility (alternatively, the responsibilities could be assigned to a rural electrification agency or other public authority). The utility would be in charge of operating and maintaining the generation and distribution systems of the mini-grid and would also manage tariff collection. The utility would receive government funding to pursue mini-grid projects and could also cross-subsidize electricity tariffs from the national grid.[13] This model is best implemented under a centralized planning approach, where the central government works with the national utility to determine the siting of mini-grids.

Benefits	Drawbacks
• Public (or private) utilities have proven technical expertise operating and maintaining the national grid, and greater access to resources compared to private or community owned systems. • Public utilities have better access to government funding for rural electrification, which can be put towards mini-grid development in remote areas. • Tariffs could be more affordable for low-income customers if cross-subsidies are used. • If community members are employed, could lead to job creation and stronger investment in service quality and management.	• May not allow for rapid scale-up of mini-grid deployment, as utilities tend not to invest in mini-grids voluntarily, unless directed by the government. • National utilities risk financial failure due to the high cost of operating mini-grids in remote areas, unless provided with adequate support from the government. • Due to remote locations of mini-grids, national utilities might neglect operation and maintenance responsibilities, potentially raising disputes with community members.

Recommended Steps for Policy Makers
• Provide a clear mandate to the national utility (or other designated public entity) to pursue mini-grid development in tandem with a rural electrification authority or other agency responsible for leading electrification planning. • Identify priority areas for mini-grid development through a master-planning process. • Develop clear schedules for when priority areas and other regions will be subject to mini-grid development and eventual grid expansion. • Provide the necessary capital funding to national utilities to pursue a robust mini-grid development process. • Provide necessary operational funding to operate and maintain the systems over its lifetime.

[13] Under cross-subsidization schemes, certain classes of customers pay higher rates for electricity service than others, thereby subsidizing those who pay lower rates.

Option 2: Private and community ownership: Structure mini-grid ownership solely through private or community actors

Governments that support the private ownership model allow private entities to build, own, and operate electricity generation and distribution systems. Under such an arrangement, private entrepreneurs can invest in mini-grid projects, and governments can offer public grants, subsidies, and loan guarantees to support and encourage development.

Under the community ownership model, community members, usually through cooperatives and local representatives, own and operate mini-grids serving their community. Financing for this model typically comes from public grants and international donor agencies. Policies that support this model enable communities to have formal or informal authority over mini-grid development. Community members are responsible for maintaining the generation and distribution system as well as for tariff collection.

Benefits	Drawbacks
• Combined, private and community ownership models can lead to rapid deployment in previously unserved areas. • Since managers and operators of community owned mini-grids are also the customers, this may lead to stronger investment in service quality and management. • Can generate jobs for local entrepreneurs and community members.	• Rarely commercially viable in rural areas without funding support from the government. • Community ownership model is frequently faced with challenges related to lack of local skills necessary to operate and manage mini-grids. • Private ownership model could lead to inefficiencies in providing electricity service, since operator would benefit from higher sales and may not be interested in energy efficiency. • Requires significant regulatory capacity for a robust policy and regulatory framework.

Recommended Steps for Policy Makers
• Outline clear guiding principles that support and promote private sector and community participation.

Recommended Steps for Regulators
• Develop and implement regulations that create an enabling environment, while also ensuring safe, high-quality electricity service for rural customers. • Adopt (1) common regulations that must be adhered to by all mini-grid developers or (2) regulations that are exclusively applicable to each group or sector (community organizations, cooperatives, and private developers). • To guarantee fair treatment of all stakeholders, make all ownership regulations publicly accessible.

Option 3: Hybrid ownership: Allow private and community actors, as well as public utilities, to develop mini-grids

Under hybrid ownership, public utilities, private enterprises, and communities can develop mini-grids independently or jointly.

Under hybrid ownership, public utilities, private enterprises, and communities can develop mini-grids independently or jointly. In joint ventures, private and public entities can enter into contractual partnerships where each party assumes specific responsibilities during the development and implementation of mini-grid projects. For instance, public agencies can contract with private developers to finance and own the mini-grid generation and distribution facilities, while the private partner operates and maintains the system. An alternative option in this ownership model is a power purchase agreement (PPA), under which the owner of the generation facility sells the electricity produced to another entity that owns the distribution system. Under a PPA, each party is responsible for operating and maintaining its own system.

Benefits	Drawbacks
• Enables governments to mitigate the limitations associated with the first two models by allowing all actors to participate. • Likely to create market competition in mini-grid development, potentially leading to improved quality of electricity services for rural populations. • Encourages the participation of various entities that may not necessarily have the capacity to develop mini-grid projects independently; this can be particularly valuable in remote areas.	• Governments may have conflicting interests or a bias towards protecting state-owned utilities from competitors. • Requires substantial regulatory capacity due to diversity of actors involved. • Could lead to inefficiencies in providing electricity service, since private operator would benefit from higher sales and may not be interested in energy efficiency.

Recommended Steps for Policy Makers

- Adopt mini-grid policies that reflect objectives and priorities under the hybrid ownership model.
- Devise affordable and sustainable fiscal policies to encourage private sector and community participation.

Recommended Steps for Regulators

- Develop and implement regulations that outline the requirements that must be met by each type of mini-grid developer—whether private enterprises, community organizations or cooperatives, or public utilities.
- To guarantee fair treatment of all stakeholders, make all ownership regulations publicly accessible.

Further Reading

Discusses mini-grid operator models and implementation approaches for policy makers:

- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. http://www.minigridpolicytoolkit.euei-pdf.org/

Provides a detailed explanation of ownership models for rural mini-grids and the challenges associated with each model:

- Rolland & Glania. 2011. *Hybrid Mini-Grids for Rural Electrification: Lessons Learned*. Section 4: Business Models for Rural Power Mini-Grids. https://www.ruralelec.org/sites/default/files/hybrid_mini-grids_for_rural_electrification_2014.pdf
- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-Grids*. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf

Box 6: Ownership Model in Uganda

There is no restriction on ownership models for mini-grid projects in Uganda. The majority of mini-grid projects are developed and operated by private sector developers, but are effectively organized as public-private partnerships. Generally, the generation equipment is owned by the private developer, which is also responsible for construction costs. However, the Rural Electrification Agency (REA) typically funds mini-grid distribution infrastructure through the Rural Electrification Fund. REA maintains ownership of mini-grid distribution networks, although they are leased to developers. Thus, the government has no direct role in the operation of mini-grids but provides important financial support to mini-grid projects and ensures that distribution infrastructure is built to national grid standards (Section 3). There are no plans for government agencies to directly and wholly own and operate mini-grid projects in Uganda.

1.6. FISCAL SUPPORT FOR MINI-GRID DEVELOPERS: DIRECT GRANTS AND SUBSIDIES

Mini-grid projects often require some form of funding to be financially self-sustaining. This is particularly true in emerging economies that encourage the use of generation technologies that may have higher capital or levelized costs. To increase the commercial viability of mini-grids and encourage the participation of nongovernmental entities, governments can provide grants and subsidies specifically designed to lower construction, operation, and maintenance costs. At the same time, governments must be conscious of the costs of implementing such financial supports. Overall, grants need to be affordable as well as sustainable, so that governments can support mini-grid deployment beyond a few pilot projects (EUEI PDF, 2014). In addition, governments should consider the phase-out of subsidies and grants and clearly communicate the anticipated end date to mini-grid developers and operators.

Typically, regulators do not have direct decision-making authority over fiscal policies, as this is often the responsibility of policy makers. However, the regulatory authority is responsible for setting retail tariffs at a level that allows developers to recover their costs (see Section 2.2) for a detailed discussion of rate-setting). Therefore, as policy makers determine fiscal supports, it is critical to directly involve regulators or consult them, as the decisions being undertaken will have significant impact on the revenue of developers.

To increase the commercial viability of mini-grids and encourage the participation of nongovernmental entities, governments can provide grants and subsidies specifically designed to lower construction, operation, and maintenance costs. Overall, grants need to be affordable as well as sustainable, so that governments can support mini-grid deployment beyond a few pilot projects (EUEI PDF, 2014). In addition, governments should consider the phase-out of subsidies and grants and clearly communicate when the anticipated end date.

To generate the intended outcomes, subsidies must be designed to achieve specific goals. Subsidies must also be monitored, evaluated, and adjusted as needed to ensure that intended outcomes are being achieved. Public grants and subsidies for mini-grid deployment are generally grouped into two main categories:

- Producer subsidies to reduce the costs and increase the revenue of mini-grid developers; and
- Consumer subsides to lower tariffs and/or connection costs for mini-grid customers (see Sections 2.2 and 0).

Producer subsidies for mini-grid developers can be provided during various project phases, from planning to feasibility assessment, construction, and customer connection. Producer subsidies usually cover a percentage of capital costs and do not cover ongoing (or recurrent) costs, such as maintenance expenses. Subsidies can be offered on a first-come, first-serve basis or on a competitive basis. Subsidies can be disbursed in one up-front payment or can be performance based and dispersed over several payments, once certain project development milestones are reached (RECP et al., 2013). Funds typically come from the central government's rural electrification budget and/or international development agencies.

This guide divides producer subsidies into two categories:

- **Direct grants**, which are direct cash disbursements; and

- **Non-grant subsidies (smart incentives)**, which include tax breaks, accelerated depreciation of assets, and loan guarantees.

The material that follows outlines key options for producer subsidies and their benefits and drawbacks. Although some of the options outlined elsewhere in this guide are mutually exclusive, that is not the case for fiscal support: policy makers can choose one or more options from the list. Regardless of the types of fiscal support selected, policy makers must provide reliable access to incentives and clearly outline the rules for managing and distributing the funds. Regulators must also monitor and periodically inform policy makers about the cost and impact of the subsidies.[14]

Guiding Questions:

- How much funding is the government willing and able to commit to mini-grid deployment?
- How much funding can the government secure from international donors or other partners?
- What priority areas does the government plan to target through producer subsidies?
- What is the estimated duration of the funding?
- What is the government's exit strategy once the funding comes to an end?

[14] Tenenbaum et al., 2014

Option 1: Provide grants for generation and distribution assets

Governments can encourage private sector investment by providing direct grants to offset the cost of generation and distribution assets for mini-grids. The funds are usually provided during the planning, design, and construction phases to reduce capital costs, and can be disbursed once project milestones are accomplished. Regulators may offer a fixed amount or tie grants to generation capacity or number of customers. Such grants can also be tiered (e.g., various amounts may be linked to specific size ranges), or can be made accessible only to mini-grids above a certain size. Policy makers need to develop straightforward and transparent eligibility criteria and requirements for grants.

Benefits	Drawbacks
• Encourage the participation of nongovernmental entities and attract more private investment for rural electrification. • Direct grants enable developers to secure working capital funds and increase the commercial viability of mini-grids. Furthermore, grants targeted at generation assets allow developers to build higher-capacity systems and serve more customers (EUEI PDF, 2014). • Because rural communities lack the financial capacity to cover up-front costs, such grants are also essential for community-owned mini-grids.	• Inefficient management of grants for generation and distribution assets can pose challenges for governments. • Difficult to set the right incentives: lump sum payments encourage purchase of cheapest technologies; size-based grants encourage building larger than necessary mini-grids. • Capital cost grants may not guarantee sustainable and long-term on-going operations. • Requires governments to pick "winners and losers."

Recommended Steps for Policy Makers

- Define eligibility criteria and requirements for the grants.
- Consider how to ensure long-term operation of mini-grids once grant-funding is provided and spent.
- Create a long-term plan to gradually phase out the grants as the mini-grid sector stabilizes and matures.
- Develop transparent and accessible guidelines that clearly outline the purpose of the grants, the application process (including eligibility criteria and requirements), associated timelines, disbursement procedures, and plans for phase out.
- Create a mechanism for communicating the grant information to mini-grid developers.
- Develop a mechanism for monitoring and evaluating the use and impact of the grants.
- Review the grant program after a specified period of time and adjust as needed to ensure the intended outcomes are being achieved.

Recommended Steps for Regulators

- Consult with policy makers to ensure regulatory staff fully understand the terms of the grants.
- Support policy makers in monitoring and evaluating the cost and impact of the grants.
- Support policy makers' efforts to communicate the terms of the grants, including the schedule for gradually phasing out the grants, if applicable.

Option 2: Provide technology-specific grants

Mini-grid developers incur different capital and operation costs, depending on the types of energy resources and technologies used. Accordingly, policy makers can use targeted incentives to create a level playing field or to favor some energy resources or technologies over others (e.g., renewable energy resources over fossil fuels).

Benefits	Drawbacks
• Technology-specific grants can be used to support mini-grid technologies that are relatively costly to implement but have high economic, social, or environmental value. • Emerging economies that have national renewable-energy or emissions-reduction targets can particularly benefit from such grants, which can encourage private sector participation in achieving these targets. • Technology-specific grants can also be used to encourage the shift from diesel mini-grids to renewable energy technologies, either through hybridization of existing systems or the development of new mini-grids.	• Unless allocated and managed efficiently, technology-specific grants can make some energy resources and technologies over dependent on public funding. For instance, renewable energy technologies that receive large amounts of public support may not be self-sustaining once the grants are no longer available. • Policy makers may also face criticism (or accusations of corruption) from developers whose choice of technology renders them ineligible for the grants.

Recommended Steps for Policy Makers

- Identify technologies that will be incentivized based on cost, commercial viability, rural electrification targets, and renewable energy goals.
- Define eligibility criteria and requirements for the grants.
- Create a long-term plan to gradually phase out the grants as the mini-grid sector stabilizes and matures.
- Develop transparent and accessible guidelines that clearly outline the purpose of the grants, the application process (including eligibility criteria and requirements), associated timelines, disbursement procedures, and plans for phase out.
- Create a mechanism for communicating the grant information to mini-grid developers.
- Develop a mechanism for monitoring and evaluating the use and impact of the grants.
- Review the grant program after a specified period of time and adjust as needed to ensure the intended outcomes are being achieved.

Recommended Steps for Regulators

- Consult with policy makers to ensure regulatory staff fully understand the terms of the grants.
- Support policy makers in monitoring and evaluating the cost and impact of the grants.
- Support policy makers' efforts to communicate the terms of the grants, including the schedule for gradually phasing out the grants, if applicable.

Option 3: Provide location-specific grants

The cost of mini-grids can vary with local conditions. Some rural areas may have scattered settlements, be physically inaccessible, or both. In addition, rural populations in emerging economies tend to have disparate economic conditions, with some communities having very low energy demand and/or ability to pay for modern energy services. Such conditions make these areas less financially attractive for developers; hence, policy makers can use location-specific grants to increase the financial viability of mini-grids in these regions.

Benefits	Drawbacks
• Location-specific grants allow policy makers to increase electrification in unserved or underserved areas. These grants incentivize mini-grid developers to expand to locations that might not be considered commercially viable.	• Location-based grants may be seen as the government's way of favoring some communities over others. • And, like technology-specific grants, they may be subject to challenges or accusations of corruption from mini-grid developers and communities that do not qualify for the funds. • As noted earlier, policy makers need to develop transparent and accessible policies for rural electrification that explicitly outline priorities for mini-grid deployment.

Recommended Steps for Policy Makers

- Identify areas that are likely to be underserved by mini-grid developers in the absence of grants, ideally through the rural-electrification planning process (Section 1.1).
- Share the results of the exercise with stakeholders and solicit feedback.
- Incorporate feedback and finalize the areas that would be eligible for grants.
- Define the eligibility criteria and requirements for the grants.
- Create a long-term plan to gradually phase out the grants as the mini-grid sector stabilizes and matures.
- Develop transparent and accessible guidelines that clearly outline the purpose of the grants, the application process (including eligibility criteria and requirements), associated timelines, disbursement procedures, and plans for phase out.
- Create a mechanism for communicating the grant information to mini-grid developers.
- Develop a mechanism for monitoring and evaluating the use and impact of the grants.
- Review the grant program after a specified period of time and adjust as needed to ensure the intended outcomes are being achieved.

Recommended Steps for Regulators

- Consult with policy makers to ensure regulatory staff fully understand the terms of the grants.
- Support policy makers in monitoring and evaluating the cost and impact of the grants.
- Support policy makers' efforts to communicate the terms of the grants, including the schedule for gradually phasing out the grants, if applicable.

Option 4: Provide capacity-building grants

To build the capacity of the rural workforce, policy makers can provide direct grants to support training for mini-grid developers, community representatives, or local organizations. Trainings usually focus on developing bankable business plans, basic technical operation and maintenance, tariff collection, and basic financial accounting (IRENA, 2012).

Benefits	Drawbacks
• Grant-funded trainings can enable local community members to contribute to construction and operation thereby increasing their earning potential. Once community members have received training in day-to-day system operation and tariff collection, public utilities and private developers can enter into a business partnership with them to obtain these services. • Direct grants for capacity building also increase community participation in mini-grid deployment. Because they can help empower rural populations to take charge of providing electricity services for their communities, capacity-building grants are especially valuable for the community ownership model.	• Capacity-building grants can be an expensive undertaking for emerging economies. • Such grants are susceptible to misuse unless the recipients' activities are closely monitored. For instance, private developers that receive grants may use the funds to cover capital costs, instead of providing trainings to community members. Regulators can address this issue by requiring developers to report on fund use and outcomes.

Recommended Steps for Policy Makers

- Conduct a full scan of workforce capacity needs in the mini-grid sector, projecting the number of workers that must learn specific trades in order to meet national rural-electrification targets.
- Consult key stakeholders in government, industry, and education to develop a plan to train the necessary workforce.
- Incorporate feedback and finalize the capacity needs that would be eligible for grants.
- Define the eligibility criteria and requirements for the grants.
- Create a long-term plan to gradually phase out the grants as the mini-grid sector stabilizes and matures.
- Develop transparent and accessible guidelines that clearly outline the purpose of the grants, the application process (including eligibility criteria and requirements), associated timelines, disbursement procedures, and plans for phase out.
- Create a mechanism for communicating the grant information to mini-grid developers.
- Develop a mechanism for monitoring and evaluating the use and impact of the grants.
- Review the grant program after a specified period of time and adjust as needed to ensure the intended outcomes are being achieved.

Recommended Steps for Regulators
• Provide input into the workforce capacity planning efforts, including sharing experiences on the particular weaknesses of the workforce that would potentially be involved in the mini-grid sector. • Consult with policy makers to ensure regulatory staff fully understand the terms of the grants. • Support policy makers in monitoring and evaluating the cost and impact of the grants. • Support policy makers' efforts to communicate the terms of the grants, including the schedule for gradually phasing out the grants, if applicable.

Option 5: Provide non-grant subsidies (Smart Incentives)

In addition to direct grants, policy makers can provide other forms of fiscal support, such as smart incentives, to encourage stakeholder participation in mini-grid deployment. Among the options are the following:

- Tax breaks for mini-grid developers;
- Exemption for all or some portion of import duties and Value-Added Tax (VAT) on generation and distribution equipment;
- Renewable energy premium tariff (RPT) or so-called off-grid feed-in tariff to alleviate/compensate ongoing costs (Moner-Girona et al, 2016);
- Accelerated depreciation of generation and distribution assets; and
- Loan guarantees or low-interest loans.

Benefits	Drawbacks
• Smart incentives can reduce the capital and operational cost of mini-grids, alleviating some of the financial burden for developers. • Tax breaks tied to construction, installation, and/or operational costs can function almost as direct cash transfers for developers. Import-tax waivers reduce capital costs and attract more private investment, and are particularly important in emerging economies, where most-mini-grid developers (except those in China, India, and a few other large economies) have to import generation and distribution equipment. • A premium tariff can support lower customer tariffs, maintain financial sustainability of project operations and provide an incentive for sustaining quality service. • Loan guarantees, low-interest loans, and accelerated tax depreciation can assist developers with the high up-front cost of mini-grid projects. • Does not require picking "winners and losers."	• Like direct grants, smart incentives need to be affordable for governments. Especially as the mini-grid sector grows, emerging economies can incur considerable costs (or loss of revenue) from smart incentives . Policy makers need to design policies that will allow them to spread limited funds across a large number of projects (EUEI PDF, 2014).

Recommended Steps for Policy Makers

- Working with regulators, conduct a survey or consult with mini-grid developers and investors to understand the major financial barriers to mini-grid development.
- Research other countries' experiences with smart incentives.
- On the basis of the consultations and research, adopt a straightforward and accessible fiscal policy that outlines the types of smart incentives available for mini-grid developers and the criteria and requirements for eligibility.
- Create a mechanism for communicating information on smart incentives to mini-grid developers.
- Develop a mechanism for monitoring and evaluating the use and impact of the smart incentives.
- Review the grant program after a specified period of time and adjust as needed to ensure the intended outcomes are being achieved.

Recommended Steps for Regulators

- Provide input to policy makers by sharing experiences on the major financial barriers to mini-grid development.
- Consult with policy makers to ensure that regulatory staff fully understand the terms of the smart incentives.
- Support policy makers in monitoring and evaluating the cost and impact of the smart incentive programs.
- Support policy makers' efforts to communicate the terms of the smart incentives, including the schedule for gradually phasing out the incentives, if applicable.

Further Reading

Provides detailed information on fiscal support mechanisms for mini-grids:

- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. Chapter 4: Mini-grid Economics; Chapter 6: Policy and Regulation for Mini-grids. http://www.minigridpolicytoolkit.euei-pdf.org/
- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-grids.* Chapter 3: Policies and Regulations to Support Private Sector Mini-grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf
- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation*. Chapter 3: Guidelines for Use of Energy Funds for Mini-grid Investment Support. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids
- Tenenbaum et al. 2014. *From the Bottom Up.* Chapter 5: The Regulatory Treatment of Subsidies, Carbon Credits, and Advance Payments. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Box 7: Fiscal Support for Mini-Grid Development in Uganda

Uganda has a Rural Electrification Fund (REF) that is administered by REA. Through REA, the REF provides significant financial support for mini-grid projects, including direct funding for the development of the distribution network for mini-grids. This funding can take several forms: REA may reimburse the developer for distribution costs, or may directly construct distribution infrastructure in coordination with the developer. According to developers, this in-kind support is crucial to the cost-effectiveness of mini-grid projects in Uganda.

Developers are responsible for the capital costs of generation equipment, as well as for planning, operations, and maintenance costs. REA owns the distribution infrastructure, but allows developers to operate the distribution assets for the term of the license or concession.

The Uganda Energy Credit Capitalization Company (UECCC) has also provided financial support and technical assistance mini-grid developers, and is currently working with the ORIO Infrastructure Fund of the government of The Netherlands to support the development of 10 mini-hydro projects ranging from 0.5 and 5 megawatts. It is unclear if UECCC will continue to receive funding to provide financial and technical support to project developers.

1.7. APPROVAL PROCESSES AND PROCEDURES

There are usually a series of approvals that a mini-grid developer must obtain before a project can go forward. The approvals can be broken into electricity-sector approvals and non-electricity-sector approvals. Within the electricity sector, the license (or permit) approval and the tariff approval are among the most important.[15] Non-electricity-sector approvals include the right to operate a business, land and natural resource rights, and environmental approvals. Mini-grid developers may also have to obtain additional, local-level approvals.[16]

Given the many approvals that can be required, it is critical for the approval process to be straightforward and efficient. An unclear, lengthy, or costly approval process can introduce significant project development risk, damage the economic viability of a project, or limit developers' interest in entering a specific market.[17] As general guidance, it is recommended that fees and other development costs amount to no more than 1-2% of total project costs (IRENA 2016b).

A growing trend among countries is to structure approval processes and procedures around classes or categories of mini-grids (as discussed in Section 1.4) and to assign responsibility for overall management of the mini-grid approval process to a single institution. This institution is responsible for coordinating stakeholders, documents and publicizes processes and procedures, delivers capacity building training, and facilitates the delivery and administration of financial incentives. One option is to assign the institution that has mini-grid regulatory authority with responsibility for management and coordination—an approach that can help reduce transaction costs and speed up the approval process (RECP, EUEI PDF, & RERA, 2013a; IRENA, 2016b).[18] It is important to note that establishing and coordinating an approval process requires both financial and human resources. Governments should be prepared to allocate adequate resources to the process and to a coordinating entity.

Box 8 outlines some of the key steps regulators and governments can take to develop a transparent and efficient approval process. For more information on implementing an approval process for mini-grids, including licensing, readers should refer to Section1.8, the country spotlights, and "Further Reading" sections.

Guiding Questions:

- How will electricity sector approvals be coordinated with non-electricity-sector approvals?
- Should the approvals be done in succession or in parallel? If the approvals are done in succession, in what order should they be done?
- If several governmental entities in the electricity sector are included in the approval process, how will these approvals be coordinated?
- Should an agency be designated to coordinate approvals for mini-grid projects?

[15] Some countries refer to a license as a permit. This guide uses the term *license*.
[16] Tenenbaum et al., 2014
[17] Tenenbaum et al., 2014
[18] Bangladesh, Kenya, India, Nepal, and Tanzania have all established mini-grid coordinating agencies.

Option I: Apply the existing approval process for independent power producers (assuming an approval process already exists)

Benefits	Drawbacks
• Relevant government and regulatory agencies do not have to dedicate staff time and resources to develop a new or revised process.	• Approval processes designed for independent power producers may be ill suited for small, autonomous mini-grid projects and may not appropriately address the diversity of mini-grid project sizes, technologies, and business models. • An approval process that is onerous, complicated, lengthy, or costly could lead to higher development costs and risks, and thereby create a major barrier to market entry.

Recommended Steps for Regulators
• As long as a country has an approval process outlined for independent power producers, no next steps are required.

Option 2: Develop a specific approval process for mini-grid projects

Benefits	Drawbacks
• Increases the efficiency and effectiveness of the project approval process. • Improves the experience of government agencies and project developers. • Cuts down mini-grid project development cost. • Mitigates project development risks. • Eliminates barriers to market entry.	• Requires time and resources from the relevant government agencies and other stakeholders that will be involved in the process.

Recommended Steps for Policy Makers

- Designate an agency that will be responsible for reviewing, developing, and enforcing the approval process for mini-grid projects, including licensing and tariff review. The agency could be the entity that has mini-grid regulatory authority or broader authority over rural electrification. Among the agency's responsibilities could be the following: coordinating stakeholders; documenting and publicizing application processes and procedures; managing both electricity sector and non-electricity-sector approvals; delivering capacity-building training; and facilitating the delivery and administration of financial incentives (RECP et al., 2013b).
- Arrange for the designated agency to convene a stakeholder group that includes (1) representatives from the regulatory agencies and other governmental agencies that are responsible for electricity-sector and non-electricity-sector approvals and (2) other key stakeholders, such as mini-grid developers, investors, representatives of civil society, and target beneficiaries.

Recommended Steps for Regulators

- Review the existing approval process; identify ways to make the process clearer, more straightforward, and efficient; develop draft guidelines that define the steps of the revised approval process, including the succession of reviews; validate the draft guidelines with stakeholders; finalize the guidelines on the basis of stakeholder feedback and make them publicly available and easily accessible; update as necessary.

Box 8: Developing a Straightforward and Transparent Approval Process

It is crucial for the approval process to be straightforward and transparent. A transparent process is likely to minimize corruption, allow for more informed decisions, and speed up approvals by reducing the likelihood of incomplete or inaccurate applications.

The following are characteristics of an effective approval process:

- The process is transparent and the decision-making criteria are known to applicants.
- The sequence of general business approvals and electricity sector approvals is clear and logical.
- Final decisions on licensing or tariffs reflect information and decisions from other government bodies.
- The process creates incentives for national and local governmental agencies to make timely decisions and to insulate decisions from political determinations.
- The government or lead agency commits to an external evaluation of the existing review and approval system every two to three years.
- The review and approval process is clearly articulated on the regulatory agency's website.

The regulatory agency develops resources that are available on the Internet such as (1) checklists that outline the actions and documents required during each step of the approval process, (2) template documents to ensure that developers provide the required level of information in a useful format, and (3) a timeline for review and approval.

Source: Tenenbaum et al., 2014.

Further Reading

Provides a detailed review of the approval process for small power projects including an in-depth example of Sri Lanka's approval process:

- Tenenbaum et al. 2014. *From the Bottom Up*. Chapter 4: Regulatory Process and Approvals: Who Approves What, When and How? https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Tools

Provides an extensive checklist of stakeholders and their role in mini-grid development, a mini-grid classification system, and a generic project-approval process that can be tailored to specific country contexts:

- RECP et al. 2013. *Guidelines on Planning and Development Process and Role Clarity*. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Country Examples

Provides easily accessible, publicly available guidelines for the approval process of mini-grid projects in Tanzania:

- Energy and Water Utilities Regulatory Authority. 2011. *Guidelines for Development of Small Power Projects*. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Tanzania_Approved-Small-Power-Projects-Development-Guidelines-March-2011.pdf

An online portal that provides comprehensive information for mini-grid developers and other stakeholders on the approval process for mini-grid projects in Tanzania, including licensing requirements:

- Tanzania Mini-Grid Information Portal. http://www.minigrids.go.tz/en

In the Indian state of Uttar Pradesh, the Mini-Grid Policy of 2016 establishes that the Uttar Pradesh New and Renewable Energy Development Agency that will act as a mini-grid coordinating agency:

- Government of Uttar Pradesh. 2016. *Uttar Pradesh Mini-Grid Policy 2016*. http://upneda.org.in/sites/default/files/all/section/Mini%20Grid%20Policy%202016.pdf

1.8. LICENSING

The license approval process is one of the key approval processes the regulatory institution must outline and mini-grid developers must undertake. For the developer, a license grants the legal right to develop projects and generate, distribute, and sell electricity. For regulators, the licensing process provides a formal opportunity to review and approve a proposed project.

The review process may differ across countries, but often includes evaluating the feasibility of the proposed project and project site, reviewing the developer's business plan and timeline for operations, assessing the developer's technical and financial capacity, reviewing the proposed retail tariff, and evaluating the developer's approach to customer management and community engagement.[19] After review, the regulator has the authority to either approve or reject the license. Thus, the process affords the regulator an element of control and oversight over developers.

As noted in Section 1.7, straightforward and efficient approval processes are critical to the success of a mini-grid sector, particularly developing a clear licensing procedure. A lengthy or unclear licensing process can add to project costs: it has been reported that licensing approval processes in some countries have exceeded 10% of a project's capital cost (ESMAP, 2016; IRENA 2016b).

In most instances, the licensing process requires both electricity sector and non-electricity- sector approvals. The development of a licensing process requires regulators to make decisions on several key issues, including

- Whether and in which cases to require a license;
- What process to use in issuing licenses;
- How long licenses will last, and whether they will be exclusive;
- Whether license holders will be permitted to resell their rights.

This section covers the key decisions regulators will need to consider when designing a licensing process. It is important to note two additional aspects of the coverage:

- **The section addresses licensing options only for autonomous mini-grids.** The licensing process and related decisions may differ for interconnected mini-grids, and regulators may want to take a bifurcated approach to licensing autonomous versus interconnected mini-grids. (Readers are encouraged to consult the "Further Reading" sections, which include resources that discuss licensing for interconnected mini-grids.)
- **The section discusses only the initial licensing decisions regulators will need to consider for an autonomous mini-grid project.** As discussed in Section 1.7, it will be important for regulators to also establish a streamlined and easy to navigate licensing process with information accessible online and coordinated with other entities approval processes. Regulators may want to consider a stakeholder outreach and engagement strategy on the approval process. Furthermore, as noted in Section 1.12, regulators should develop a licensing process that allows the mini-grid to transition to the appropriate type of energy service company if the national grid arrives.

[19] Tenenbaum et al., 2014

Guiding Questions:

- Does the regulator have the capacity, authority, and resources to effectively manage the licensing process?
- What licensing protocols will minimize risks and costs for developers, while ensuring that developers are reliable, responsible, and in compliance with regulatory rules?
- Will all mini-grid projects require a license?
- Will all mini-grid projects be subject to the same process and requirements for obtaining a license?
- What will the procedure be for obtaining a license?
- What approvals (if any) will developers need to obtain in order to qualify for a license?
- What information will developers need to provide in license applications?
- Are there standard forms or templates to ensure that developers provide the required information in the correct format?
- How will this process be coordinated with other approval processes?
- Will information be provided online? Will links be provided to direct applicants to other organizations websites and approvals?
- What will be the outreach and education process to educate stakeholders on the licensing process?
- Will mini-grid projects be granted exclusive rights over the service area?
- What will be the length of the license? Will renewal or extension be permitted?
- Will modifications to the licenses be permitted, such as change of ownership?

1.8.1 Requiring a License

The regulator will need to consider whether all mini-grid projects will require a license. Countries have taken various approaches to this decision, and are increasingly taking a capacity-based approach to this decision (Section 1.4). Countries are creating classes or categories of mini-grids based on the project capacity (kW, MW, kVA).[20] Projects falling below a specific capacity threshold are exempt from the licensing process, and projects falling above are subject to licensing requirements. For example, Mali does not require a license for projects of 20 kW or less. Zimbabwe and Tanzania do not require a license for projects of 100 kW or less (in fact, Tanzania does not require a generation license for projects below 1 MW). Namibia does not require a license for projects of 500 kW or less, and Rwanda's requirements vary depending on whether projects are considered large, medium, small, or very small (IRENA, 2016b). For projects below 2 MW, Uganda offers a less in-depth licensing process called a license exemption. In some instances, regulators have allowed projects falling under the capacity threshold to voluntarily go through the licensing process.[21] Regulators have also used different licensing requirements depending on technology. For example, a hydro or biomass project may have different licensing requirements than a solar or wind project.

Countries have taken various approaches to the licensing decision, and are increasingly taking a capacity-based approach (Section 1.4). Countries are creating classes or categories of mini-grids based on the project capacity. Projects falling below a specific capacity threshold are exempt from the licensing process, and projects falling above are subject to licensing requirements. (IRENA, 2016b).

Some countries do not require a license at all, and use a simplified registration process for systems under a certain capacity or during the infancy of their mini-grid sector.[22] The non-electricity-sector approvals may still apply, such as environmental approvals, land and natural resource rights, and the right to operate a business. This approach allows the mini-grid regulatory authority to collect basic information about mini-grid projects and developers, which can then be used to develop a database to support national rural electrification planning. The regulator may then consider adopting a licensing process once the mini-grid sector has matured. In instances where a license is not required , mini-grid developers may have the option of voluntarily obtaining a license. For example, in Tanzania for projects less than 1 MW, developers may apply for a voluntary license, and if granted, may reserve a project site during the development process, thereby increasing the security of their investment and reducing risk during the project development phase (IRENA 2016b).

[20] As commented previously in the guide, when developing project categories or classes based on capacity, it is important to consider other factors such as technology, project demand, or other indicators. For example, regulators will want to consider that a 1 MW hydro project is different than 1 MW of solar PV in terms of quantity of electricity generated, customers served, and environmental impact etc.

[21] Project developers may want to go through the process to ensure they receive the right to a particular site, or to demonstrate to investors that the project has received approval from the regulatory agency.

[22] Tenenbaum et al., 2014

Option 1: Do not require a license for mini-grid projects, but require all mini-grid developers to register as a business and obtain required non-electricity-sector approvals

Benefits	Drawbacks
• Reduces project development costs for mini-grid developers. • Requires fewer financial and staff resources from the regulatory authority.	• Regulators give up ability to protect end users from predatory or suspect mini-grid developers. • Regulators do not obtain comprehensive information on all mini-grid projects or developers. • Developers lose the security that a license provides over their investment, which can introduce additional project risk.

Recommended Steps for Regulators

- Evaluate non-electricity-sector approval processes to determine whether sufficient information is collected to adequately evaluate project developers and protect end users.[23]
- If insufficient, identify basic criteria and information regulators would like to collect and outline how the information will be collected and maintained.
- Establish a system for information sharing between the mini-grid regulatory authority and other governmental agencies requiring approvals.
- Establish a system for integrating information on mini-grid projects and developers into the country's rural-electrification planning process.

[23] Many countries have some sort of consumer protection authority, which can serve a purpose similar to that of an energy regulatory agency.

Option 2: Adopt an approach to licensing based on the capacity of the mini-grid

Benefits	Drawbacks
• May cut down on the length and complexity of the approval process thereby reducing development risks and costs. • May decrease number of projects that require review, freeing up staff resources.	• Regulators do not obtain information on all mini-grid projects or developers. • Some mini-grid projects will be developed without being reviewed by the regulatory agency, potentially resulting in varied quality and reliability of mini-grids. • Developers give up the security that a license provides, potentially introducing additional risk. • Developers may opt to build projects that do not require a license.

Recommended Steps for Regulators
• Determine the capacity classes for mini-grid projects (Section 1.4). • Establish licensing requirements for each class. • Develop an approval process for licensing. This could include: o Identify basic criteria and information regulators would like to collect from mini-grid developers. o Outline how the information will be collected and maintained. o Develop a timeline and process for material review. o Establish a standardized list of application requirements. o Develop a checklist of application requirements for developers. o Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality. o Clearly outline the submission process for applications. o Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. o Make all licensing information and requirements publicly available on the regulator's website. o Clearly communicate and disseminate requirements online or otherwise.

Option 3: Adopt an approach to licensing based on the capacity of the mini-grid, and a voluntary licensing process for developers that are not required to obtain a license

Benefits	Drawbacks
• Regardless of project capacity, developers have the option to voluntarily obtain a license, increasing the security of their investments and reducing project risks.	• Regulators do not obtain information on all mini-grid projects or developers. • Some mini-grid projects will be developed without being reviewed by the regulatory agency, potentially resulting in varied quality and reliability of mini-grids. • The voluntary license may not increase security of an investment if it does not include legal rights to develop or operate. • Developers may opt to build projects that do not require a license.

Recommended Steps for Regulators
• Establish voluntary licensing requirements. • For those exempted from the required licensing process, establish an approval process for voluntary licensing and outline the rights associated with a voluntarily license. For instance, security of a site during the development phase, or exclusivity to serve a specific area. An approval process could include: o Identify basic criteria and information regulators would like to collect from mini-grid developers. o Outline how the information will be collected and maintained. o Develop a timeline and process for material review. o Establish a standardized list of application requirements. o Develop a checklist of application requirements for developers. o Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality. o Clearly outline the submission process for applications. o Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. o Make all licensing information and requirements publicly available on the regulator's website. o Clearly communicate and disseminate requirements online or otherwise.

Option 4: Require all mini-grid projects to follow the same licensing process

Benefits	Drawbacks
• Allows regulators to maintain maximum control over project deployment. • May result in greater consistency across mini-grid projects.	• May lead to lengthy, time-intensive reviews for small scale projects. • Development risks and costs may increase, making developers less likely to enter a country's market. • Requires regulatory capacity to carry out licensing review for small projects.

Recommended Steps for Regulators

- If a licensing process has already been established, no additional steps are required.
- If a licensing process has not been established, see Section 1.7 on developing an approval process for mini-grid projects. Developing an approval process should include:
    - Identify basic criteria and information regulators would like to collect from mini-grid developers.
    - Outline how the information will be collected and maintained.
    - Develop a timeline and process for material review.
    - Establish a standardized list of application requirements.
    - Develop a checklist of application requirements for developers.
    - Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality.
    - Clearly outline the submission process for applications.
    - Communicate the review and approval timeline and how applicants will be notified regarding the status of their application.
    - Make all licensing information and requirements publicly available on the regulator's website.
    - Clearly communicate and disseminate requirements online or otherwise.

1.8.2 Licensing Rights

Regulators can grant a variety of rights to developers through different types of licenses (RECP et al., 2013a):

- A **provisional license** grants the developer exclusive or nonexclusive rights to a project site for a specified period of time, in order to conduct preparatory activities such as assessment studies, financial structuring, land acquisition, and construction. Such a license can help the developer secure financing, important business documents (e.g., incorporation, tax registration), and building permits (EUEI PDF, 2014).
- A **generation, distribution, and sale license**[24] grants the developer authority to generate, distribute, and sell electricity. (In some countries, such as Zambia, sale is separately licensed.)

Regulators can also offer a **single license** that includes the rights of both a provisional license and a generation, distribution, and sale license. In this guide, "single license" refers to a license that provides both (1) the rights normally allowed under a provisional license and (2) the rights normally allowed under a generation, distribution and sale license.

Given the small-scale nature of mini-grids, it is recommended that regulators keep project costs low by minimizing the number of separate licenses and requiring no more than two licenses: (1) a single license or (2) a provisional license, followed by a generation, distribution, and sale license. As discussed in Section 1.4licensing requirements can be based on the capacity of the project.

Given the small-scale nature of mini-grids, it is recommended that regulators keep project costs low by minimizing the number of separate licenses and requiring no more than two licenses: (1) a single license that includes the rights of both a provisional license and a generation, distribution, and sale license or (2) a provisional license, followed by a generation, distribution, and sale license.

Regulators can also use a concession model to provide rights to developers. A concession is a contract between a public entity (e.g., the regulator) and a private entity (e.g., the developer) that grants the private entity the right to build, operate, and maintain assets for the generation, distribution, and sale of electricity to end users for a given number of years in specific service areas. The concession usually comes with favorable terms—such as financial incentives, preferential tariff arrangements, or a guarantee that no other entities will be allowed to operate mini-grids in the same area. Concessions are almost always awarded through a competitive bidding process, and often require the private entity to deliver a specified quality of service and a certain number of connections. Regulators can also issue competitive bids for concession schemes, which allow developers to bid for larger and/or multiple service areas and to aggregate mini-grid projects. Such flexibility can help developers reduce costs and improve profitability by increasing efficiency in a number of areas, including planning, financing, administration, equipment supply, and operations and maintenance (EUEI PDF, 2014; IRENA, 2016b). The licensing model and the concession model can reduce development risks and costs by guaranteeing

[24] The right to generate, distribute and sell electricity can be issued as: (1) three separate licenses, (2) two licenses where the right to generate and distribute, or the right to distribute and sell, or the right to generate and sell are bundled together, and the outstanding right is licensed separately or (3) one license where the right to generate, distribute and sell electricity are jointly licensed.

developers the right to a service area for a specified period. The licensing model is more closely aligned with decentralized approaches to mini-grid development, where the developer approaches regulators with proposals to develop projects on particular sites. The concession model is often more closely aligned with a centralized approach to mini-grid development, where the regulator puts out a competitive tender for select service areas (IRENA, 2016b).

License or Concession Exclusivity, Duration, Renewal and Revocation

As regulators consider mini-grid licensing or concession terms, they must also determine whether developers will be provided with exclusive or nonexclusive rights, the duration of the license, whether the license will be eligible for renewal, and whether the license can be revoked. Exclusivity, duration, renewal, and revocation must be considered for all categories of licenses: provisional licenses; generation, distribution, and sale licenses; single licenses; and concessions. Regulators will need to develop policies and processes for exclusivity, duration, renewal and revocation.

When discussing exclusivity, it is important for operators to understand that with an exclusive right to develop and operate, comes an obligation to serve the area. Regulators may want to consider an operators ability to serve an area and history of performance when issuing a license or deciding to renew or revoke a license.

Box 9 Establishing License Duration

If regulators choose to place a time limit on a license, they will need to decide on the appropriate duration. The duration should be short enough to incentivize developers to make progress, but long enough for preparatory activities.

Provisional licenses: Usually provided for one to several years. Tanzania and Sri Lanka, for example, provide twelve-month provisional licenses, while Kenya provides provisional licenses for three years and Nepal for five (EWURA, 2016; Tenenbaum et al., 2014).

Generation, distribution and sale license, or concessions the duration: Often15 to 25 years—long enough to amortize all assets under the specified tariff regime (IRENA, 2016b).

In the case of renewal, regulators must decide what justifications they will accept and develop an application process, including the evidence required. For revocation, regulators will need to outline the grounds and process for revoking a license or concession and granting it to another developer. Like all other policies and processes, they should be clear and straightforward.

The reselling of licenses or concessions should also be considered to avoid speculation and to promote sustainable and responsible project development (Section 1.8.4).

The following table outlines factors regulators should consider when making decisions related to exclusivity, duration, renewal and revocation.

Table 8. Exclusivity, Duration, Renewal, and Revocation Decision-making Factors

Option	Benefits	Drawbacks
Exclusivity		
Exclusive	• Reduces development and operational risk by ensuring that no other developer will attempt to assess or develop a site. • Can guarantee service by obligating the operator to serve the community.	• Grants the developer a monopoly over a given service area. • May provide no incentive for a developer to proceed with a project, since there is no threat of a new entrant.
Non-Exclusive	• Maintains a competitive market and may encourage developers to build their projects quickly and efficiently, before another developer enters the service area. • Allows new entrants to provide service to areas that are underserved by existing operators.	• Does not protect a developer's right to a site or service area and can add significantly to project risks and costs. • May not obligate the developer to serve the community. • Can create a situation where more than one developer carries out expensive preparatory activities for the same site, but only one receives a generation, distribution, and sale license (IRENA, 2016b). • May prevent an area that would otherwise be a good candidate for an autonomous mini-grid from being developed due to lack of site security.
Duration		
Time Limit	• Acts as both a carrot and a stick, motivating developers to move forward.	• Time limit may pressure developers and impact the quality of studies for a provisional license or the quality of the mini-grid and electricity service.
No Time Limit	• There is pressure on the developer to build the project before a new developer enters the area.	• May provide no incentive for a developer to proceed with a project, since there is no threat of a new entrant.
Renewal		
Can Renew	• Provides regulators flexibility when addressing different situations. • *Example*: Project developers may experience legitimate delays that prevent them from completing preparatory activities during the provisional licensing period. • *Example*: The length of a generation, distribution, and sales licenses may initially be tied to the estimated arrival of the national grid or the useful life of a specific technology—but the grid may	• Unfeasible or unworkable projects may be granted renewal and prevent electricity services from reaching unserved or underserved areas.

Option	Benefits	Drawbacks
	not arrive as planned, or a technology's useful life may be longer than expected.	
Cannot Renew	• Acts as both a carrot and a stick, motivating developers to move forward.	• Regulator is inflexible and not able to consider and accommodate legitimate reasons for renewing a project license.
Revocation		
Can Revoke	• Provides regulator flexibility to revoke a license or concession and grant it to another developer. • *Example*: a developer fails to fulfill the terms of an agreement or abandons a project.	• Could create a situation where a license is revoked on baseless grounds.
Cannot Revoke	• Regulator cannot revoke a license on baseless grounds.	• Regulator has no way to stop a mini-grid from being developed or operating that is using poor practices, has failed to fulfill the terms of an agreement or abandons a project.

Given the breadth of issues that need to be considered in the licensing process, it would be difficult to include all possible scenarios; thus, the following options reflect some of the most common licensing approaches. It is important to note that the options are not mutually exclusive.

Option 1: Grant a single license providing exclusivity to a service area for a specific time period with an option for renewal.

Benefits	Drawbacks
• Simplifies and streamlines the licensing process and reduces transaction costs for mini-grid developers and regulatory agencies. • Reduces development and operational risk by ensuring no other developer will attempt to develop a site. • Motivates the developer to assess and develop the site quickly. • Requires the developer to serve the area.	• Regulator gives up a level of control over the mini-grid development process.

Recommended Steps for Regulators
• Establish eligibility criteria and requirements for a single licensing process. • Clearly outline the steps for applying for a single license, including the documentation required of the developer. • Develop templates to ensure that developers will provide the requested information in the appropriate format. • Develop a checklist of application requirements for developers. • Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. • Develop a policy for renewal and revocation of licenses. • Make all licensing information publicly available on the regulator's website.

Option 2: Grant a provisional, exclusive license for a specified time period. Require a second application for a generation, distribution, and sale license for a specified time period. Provide the option for renewal.

Benefits	Drawbacks
• Regulators have two opportunities to review and approve the license application of mini-grid developers and have more control over the mini-grid development process.	• Increases the duration of the licensing process, which can add risk and increase costs for mini-grid developers.

Recommended Steps for Regulators
• Establish eligibility criteria and requirements for a two-step licensing process. • Clearly outline the steps for applying for a provisional license and a generation, distribution and sale license, including the documentation required of the developer. • Develop templates to ensure that developers provide the requested information in the appropriate format. • Develop a checklist of application requirements for developers. • Clearly outline the submission process for applications. • Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. • Develop a policy for renewal and revocation of licenses. • Make the information publicly available on the regulator's website.

For more information on how to establish a two-step licensing procedure, see the "Further Reading" section after the "License Resale" section.

Option 3: Grant an exclusive concession contract that provides the right to build, operate, and maintain assets for the generation, distribution, and sale of electricity for a given time period in a specified service area. Provide the option for renewal.

Benefits	Drawbacks
• Protects the developer's investment by providing exclusivity over service areas for a specified period of time. • Reduces project development and operational costs and risks. • Allows the regulator to select the bidder that best meets the needs of the service areas and provides the regulator greater control over the process. • Requires the developer to serve the area.	• For regulators, establishing a competitive concession process is very time-intensive. • For developers, applying for a competitive concession is a time-consuming process with no guarantee of selection. • Provides developers with a monopoly over the service area, potentially strengthening the developer's position and weakening that of the regulators and end users.

Recommended Steps for Regulators
Establish a process for competitive concessions that includes the following elements: • Establishing eligibility criteria and requirements; • Clearly outlining the steps for applying for a concession, including the documentation required of the developer; • Developing templates to ensure that the developer provides the requested information in the appropriate format; • Developing a checklist of application requirements; • Clearly outlining the submission process for applications; • Communicating the review and approval timeline and how applicants will be notified regarding the status of their application; • Developing a policy for renewal and revocation of licenses; and • Making concession information publicly available on the regulator's website.

For more information on how to establish a competitive concession process, see Section 1.8.3 and the "Further Reading" section after the "License Resale" section.

1.8.3 License Award Process

The license award process is related to the question of who should control the mini-grid project-development process. There are two main approaches to the award process: a centralized approach and a decentralized approach, which are not mutually exclusive. Under the centralized approach, regulators designate service areas that are eligible for mini-grid development, ideally through the rural-electrification planning process (see Section 1.1), and issue a competitive bid for a concession contract or concession schemes (see Box 10). Under the decentralized approach, mini-grid developers approach the regulatory authority with proposals to develop projects within certain areas and go through a licensing process. Either approach can be effective, and both can be applied in parallel, but regulators should consider which is most appropriate to their specific situation.

Box 10: Concession Award Process

As discussed in Section 1.8.2, a concession is a contract between a public and private entity granting the exclusive right to build, operate, and maintain assets for the generation, distribution, and sale of electricity to end users for a given number of years in specific service areas (EUEI PDF, 2014). Because they involve the development and operation of an entire electricity system, autonomous mini-grids are particularly well suited to concessions. Creating a single concession contract for generation, distribution, and sale can often help minimize costs for developers and regulators—and, in turn, for customers. When awarding a concession contract, regulators should ensure that the size of the service area and the terms of the concession are suitable to attract developers (RECP et al., 2013a).

The concession is usually awarded through a competitive bidding process, the aim of which is often to procure the lowest cost for developing and operating mini-grids. Establishing a concession process typically involves establishing a number of standard processes, documents, and contracts—including competitive bidding procedures, requests for proposals (and associated document templates), contract award and monitoring processes, standard concession contracts, and operations and maintenance (O&M) contracts (if O&M will be provided by a different entity). Since this guide addresses only autonomous mini-grids, a PPA would not be required; however, if the generator or the distributor are separate entities for an autonomous mini-grid, some sort of underlying contract may be required to govern their agreement. A standard PPA may need to be developed if and when the national grid arrives in the specific service area (Sections 0 and 3).

Option 1: Allow developers to propose locations and award licenses through the established licensing process

Benefits	Drawbacks
• Allows developers to have greater control over the mini-grid development process. • The process may be less time intensive and costly relative to running a competitive bidding process.	• Developers may not select sites that are within the government's high priority areas for mini-grid development. • Due to the noncompetitive process, licenses may be awarded to less experienced or more expensive mini-grid developers. • A noncompetitive award process could be more susceptible to corruption as fewer people may be involved in review and selection.

Recommended Steps for Regulators
• Establish an application, review, and award process for licenses. • Incorporate information about the license award process into the guidelines for the mini-grid approval process, and publicize the guidelines widely.

Option 2: Award a concession contract or scheme through a competitive process. The government identifies appropriate locations for mini-grid development and solicits bids

Benefits	Drawbacks
• More likely that the mini-grid will be located in a suitable high-priority area. • The regulator can lay out the preferred requirements and qualifications for bidders and the terms of the award. • The process may increase the likelihood of selecting the most qualified, experienced and low-cost mini-grid developer.	• Developing and running a competitive process can be time-consuming and costly. • Regulators may struggle to attract enough interest from qualified bidders to run a competitive process. • A competitive process may favor experienced mini-grid developers and may prevent new companies from entering the market.

Recommended Steps for Regulators

- Establish a competitive bidding procedure, including a request-for-proposal process that outlines eligibility and scoring criteria.
- Develop document templates.
- Develop a contract award and monitoring process.
- Develop a standardized concession contract and/or a standardized O&M contract if the O&M will be provided by a different entity.
- If necessary, develop a standard PPA contract.
- If the regulator has limited experience with competitive bidding, consider partnering with a more experienced government agency or a development organization.
- Incorporate the final process into mini-grid approval guidelines, and publicize the guidelines widely.

1.8.4 License Resale

Regulators will need to decide whether to allow developers that have been granted licenses or concessions to resell their rights to third parties. The reselling of licenses or concessions should be seriously considered as it can create speculation and hinder mini-grid development.

If resale is allowed, regulators should outline a potential resale process. For example, regulators could mandate a competitive process in which qualified developers or operators bid for the license or concession. Regulators may also want to review the new owners' experience and qualifications to ensure they are similar to those of the original holder and that all terms of the original license or concession remain intact. To control price gouging or speculation, regulators may also want to set limits on the price of the resale. If resale is restricted, regulators will need to determine how to manage service areas that will no longer be developed. Regulators may also want to allow some time for the market to evolve before settling on a resale approach.

In cases when resale is not desired, regulators may consider establishing time-limits, penalties and/or revoking license or concessions when holders are unable to develop projects (Section 1.8.3).

Option 1: Do not allow any resale of license or concession rights

Benefits	Drawbacks
• Allows the regulator to maintain authority over the license-holding parties.	• May prevent any development from taking place within the service area if the original license or concession holder proves unable or unwilling to develop or operate a project.

Recommended Steps for Regulators
• Review other countries' experiences with license and concession resale. • Establish a license and concession resale policy. • Incorporate resale information into guidelines for the mini-grid approval process, and publicize the guidelines widely.

Option 2: Allow license or concession resale to any party that meets the original eligibility criteria and agrees to the original terms

Benefits	Drawbacks
• Maintains the regulator's authority over the licensing and concession process. • Ensures the mini-grid developer meets the same set of eligibility criteria and conditions that were applied to the original license or concession holder. • Increases the likelihood that the site will be developed even if the original developer was unwilling or unable to move forward with the project.	• Does not necessarily address issues associated with the resale price of the license. • Developers may arbitrarily increase the price of the license to a value they deem fair.

Recommended Steps for Regulators
• Review other countries' experiences with license and concession resale. • Establish a license and concession resale policy. • Consider including some guidance related to resale price. • Incorporate resale information into the guidelines for the mini-grid approval process, and publicize the guidelines widely.

Option 3: Allow license or concession resale to any party that meets the original eligibility criteria and terms, but consider capping the price at the level specified in the original license or concession application

Benefits	Drawbacks
• Maintains the regulator's authority over the licensing process. • Increases the likelihood that a particular project will be developed by a qualified party. • Reduces any price risk or speculation associated with the license or concession value, thereby protecting against any potential impact on the retail tariff.	• May prevent developers from receiving fair-market value for their license or cause the new developer to be overcharged.

Recommended Steps for Regulators
• Review other countries' experiences with license and concession resale. • Establish a license and concession resale policy. The policy may include stipulations related to regulatory review before a sale is authorized or final and could consider capping the resale price to prevent price gauging or speculation . • Incorporate information on license and concession resale into the mini-grid approval process guidelines, and publicize the guidelines widely.

Further Reading

Provides detailed guidance on approval processes for mini-grids, including licensing:

- Tenenbaum et al. 2014. *From the Bottom Up.* Chapter 4: Regulatory Processes and Approvals: Who Approves What? https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Provides detailed information on options for licensing mini-grid projects, including awarding licenses:

- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-Grids*. Chapter 3: Policies and Regulations to Support Private Sector Mini-Grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Innovation_Outlook_Minigrids_2016.pdf

- EUEI-PDF. 2014. *Mini-Grid Policy Toolkit*. Chapter 6: Level D—Licences and Contract Regulation. http://www.minigridpolicytoolkit.euei-pdf.org/

Tools

Provides a detailed overview of mini-grid licensing procedures and outlines a potential licensing process, including accompanying documents; publication of license application; granting of the license; modifications to the license; standardized content for generation, distribution, and supply licenses; and templates for generation and distribution licenses:

- RECP et al. 2013. *Guidelines on Ownership, Funding and Economic Regulation*. Chapter 2: Mini-grid licensing procedures & standardised licence templates. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Provides procurement guidelines for competitive bidding for concession contracts, including a standardized concession agreement:

- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation*. Chapter 4: Procurement Guidelines for Competitive Bidding. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Provides a template concession agreement:

- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation*. Chapter 5: Standardized Concession Agreement. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Provides templates, including a distribution license, generation license, and a power purchase agreement:

- RECP et al. 2013. *Legal Templates*. http://minigridpolicytoolkit.euei-pdf.org/downloads

Country Example

Provides an example of a concession contract:

- AMADER and Yeelen Kura. 2001. *Mali Concession Contract*. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Mali11CONCESSION0CONTRACT0YK.pdf

Tanzania's mini-grid information portal provides comprehensive information for mini-grid developers and other stakeholders on the approval process for mini-grid projects, including licensing requirements:

- Tanzania Mini-Grid Information Portal. http://www.minigrids.go.tz/en

Provides easily accessible, publicly available rules that govern regulatory and procedural matters for the development of small power projects in Tanzania:

- Energy and Water Utilities Regulatory Authority. 2016. *The Electricity (Development of Small Power Projects) Rules, 2016*.

http://www.minigrids.go.tz/Files/The_Electricity_Development_of_Small_Power_Projects_Rules_2016.pdf

The guide to mini-grid licensing in Kenya—compiled by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) following the implementation of a pilot hybrid mini-grid project—is a good example of a how a country can clearly outline its licensing process and make it easily accessible:

- Osawa, B. 2015. *How Do We License? A Guide to Licensing a Mini-Grid Energy Service Company in Kenya*. https://www.giz.de/en/downloads/GIZ2015-ProSolar-Licensing-Guidebook.pdf

The following case studies review the licensing process for Namibia and Zimbabwe:

- RECP et al. 2014. *Namibia Case Study: Gap Analysis and National Action Plan*. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids
- RECP et al. 2013. *Zimbabwe Case Study: Gap Analysis and National Action Plan*. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Box 11: Licensing in Uganda

Approvals

All mini-grid projects are subject to electricity sector and non-electricity-sector approvals. Within the electricity sector, Electricity Regulatory Authority's (ERA) must approve applications for licenses and exemptions; REA is also involved in the review process. For non-electricity-sector approvals, the National Environmental Management Authority (NEMA) must approve the environmental impact report or assessment, in order for ERA to issue the license. (In the case of hydropower, projects are subject to review and approval by the Directorate of Water Resource Management (DWRM as well.) According to mini-grid developers, it can be difficult to navigate the approvals process for the license exemption, particularly the order and coordination of approvals.

Licensing

Uganda takes a bifurcated approach to licensing:

Projects greater than 2 MW are required to obtain a license. Parts V and VI of the Electricity Act 1999, Chapter 45, outline the licensing process, including the timeline, requirements, and rules for obtaining a license. The ERA website and the ERA's Renewable Energy Investment Guide provide further detail, including a process diagram and timeline (see below).

Projects less than 2 MW are not required to obtain a license, and instead go through a license exemption process and are issued a certificate of exemption. Part XIV, Section 114 of the Electricity Act 1999 grants ERA the authority to issue a certificate of exemption, allowing projects whose capacity does not exceed 2 MW to generate, distribute, and sell electricity. Further rules issued under Electricity Order 2007 address license exemptions for isolated grid systems (Electricity [License Exemption] [Isolated Grid System] Order 2007). Electricity Order 2007 requires a certificate of exemption and outlines high-level rules for tariff approval, technical standards, reporting, interconnection to the main grid, customer service, dispute settlement, and upgrading capacity above 2 MW. It also includes the application for the certificate of exemption.

A brief description of the two licensing processes and their associated rules follows.

Licensing for Projects (Greater Than 2 MW). Approvals are obtained through the existing licensing process for independent power projects, which involves a two-step process: (1) application for a permit to carry out a feasibility study and other preparatory activities that are required to apply for a license; (2) application for a license to generate and sell electricity. The licensing process for projects greater than 2 MW is clearly illustrated in the Licensing Cycle section of the Renewable Energy Investment Guide: http://www.era.or.ug/index.php/opportunities/investment/renewable-energy-investment-guide

In the first step, the developer provides preliminary information and obtains a permit from ERA to conduct a feasibility study. The permit process is supposed to be completed within three months. Once the permit is obtained, the developer is given exclusive rights to a particular energy-generation resource in a defined area for 18 months, during which time the feasibility study will be conducted and submitted for review and approval.

During this phase, the developer is also responsible for obtaining other necessary approvals, including environmental approvals from NEMA (and DWRM for hydro projects). ERA is not responsible for coordinating the approvals process between agencies but does provide comments on the environmental report submitted to NEMA, which NEMA takes into consideration during its approval process.

A developer that has completed the feasibility study and acquired the necessary approvals can then apply to ERA for a license. The license application and approval process is supposed to be completed within 180 days.

- The licensing fee depends on the size of the project (see ERA's licensing schedule for more information on licensing fees).
- The license term is site-specific and is based on a number of factors, including the expected lifetime of the proposed technology and the cost-recovery period.
- Developers have the option of proposing a license term, which ERA approves or amends. The average license is for 23 years and includes the time required to construct the project; no license is valid for more than 40 years.
- Developers may resell licenses: a developer can even sell exclusive rights to a site obtained in the first step of the license application process.

License Exemptions for Projects (Less Than 2 MW). Exemptions are also a two-stage process. The developer must first complete a feasibility study and acquire the necessary approvals from NEMA (and DRWM for hydro projects) for a given site. As part of that process, the developer must submit an environmental report to NEMA, which ERA will comment on. ERA does not coordinate the various approvals for the developer.

A developer whose feasibility study has been approved by NEMA (and DWRM for hydro projects) and ERA may apply for a license exemption; only when the exemption is granted is the developer granted exclusive rights to generate, distribute, and sell electricity in a given area, at which point many of the same terms of a full license apply.

- License exemptions have no predetermined length; applicants specify their preferred length, which is approved or adjusted by ERA.
- The license exemption fee is US$3,500.

The licensing process in Uganda has been the subject of considerable attention. Although the licensing process for IPPs has been streamlined and simplified, challenges remain with the license exemption process. Among those identified by mini-grid developers were the following:

- Lack of clarity regarding the order of approvals, required documents, and process for submitting information;
- The lengthy time needed to obtain a certificate of exemption (several developers said that they waited a year or longer for approval);
- The lack of provisional rights to a site during the feasibility stage;
- Difficulty finding the necessary expertise and covering the cost of feasibility studies; and
- License exemption fee is burdensome of some smaller projects.

Among the suggestions for improving the license exemption process were the following:

- Develop a guidance document that outlines the license exemption process and make it easily accessible on ERA's website. The document could include a process chart that details the order of electricity sector and non-electricity-sector approvals and the associated timeline similar to the licensing cycle illustration included in ERA's Renewable Energy Investment Guide.
- Develop an online exemption application, or an application that can be downloaded from ERA's website. Ideally, the application would include templates for the required documentation.
- Establish a one-stop shop within ERA for mini-grid projects, including a single point of contact who would coordinate the approvals process and liaise with developers.

Box 12: Country Spotlight: An Evolving Permitting and Licensing Process for Mini-Grids in Kenya

Kenya's mini-grid approval process is currently governed by the Energy Act, 2006, and Energy (Electricity Licensing) Regulations, 2012, which include specific rules for issuing licenses for electricity generation and distribution. In implementing this legislation, the Energy Regulatory Commission, Kenya's national regulatory authority, opted not to require licenses for systems below 3 MW. Instead, developers are obliged only to submit an application for a permit, which is free of charge (Energy [Electricity Licensing] Regulations, 2012; Osawa, 2015).

In response to rapid changes in Kenya's energy sector, the government recently reviewed the Energy Act, 2006, and drafted a new Energy Bill, 2015—which, once it is enacted, will repeal the previous legislation (Mussa & Anjarwalla, 2016). Among other changes, such as reforms of the energy governance structure, the new bill will require any entity that wishes to generate, transmit, distribute, export, or supply electricity, irrespective of system size, to obtain a license from the Energy Regulatory Commission (Energy Bill, 2015). Hence, all mini-grid developers will be required to submit a license application that meets the conditions outlined in the bill. Furthermore, under the new bill, regulators will have just 15 days (rather than the current 90) to inform developers of the receipt of their application. Whether these changes in the approval process will positively impact Kenya's mini-grid sector remains to be seen.

Box 13: Country Spotlight: Tanzania's Clear and Accessible Guidelines for Licensing

Tanzania's Electricity Act, 2008, requires all small power producers with generating capacity above 1 MW to obtain a license from the Energy and Water Utilities Regulatory Authority (EWURA). The act also called for EWURA to develop license application procedures for the electricity sector. Accordingly, EWURA has established a straightforward and accessible approval and licensing process for small power project developers.

In 2011, EWURA published the *Guidelines for Development of Small Power Projects*, which outlines the technical, commercial, and regulatory requirements applicants must meet to obtain a license and develop projects (EWURA, 2011). The guidelines, publicly accessible on EWURA's website, provide details on each step and prerequisite for developing small power projects, from acquiring land lease and water rights (for hydropower projects) to final operation and reporting. In the spirit of light-handed regulation, which aims to minimize the amount of information required and expedite the process, EWURA uses standardized application forms, all of which are included in the guidelines (Kahyoza & Greacen, 2011).

In August 2016, EWURA, the Ministry of Energy and Minerals, and the Rural Energy Agency of Tanzania, with support from the International Finance Corporation, launched a web portal (http://www.minigrids.go.tz/) to provide comprehensive information on licensing, financing, and regulation for mini-grid developers. One key application of the web portal is translating the license application requirements documented in the guidelines into an accessible format to enable mini-grid developers to understand the regulatory framework. The portal also allows developers to filter application requirements and forms based on generation capacity, technology, and whether their system is intended to interconnect with the national grid. Overall, Tanzania's approach is a good example of clear and accessible licensing and approval processes for mini-grids.

1.9. ENVIRONMENTAL REGULATION

Environmental regulation for mini-grids can be used to mitigate the environmental footprint of generation and distribution facilities and protect against resource depletion. Regulators can develop environmental standards for mini-grid facilities and monitor compliance by requiring the submission of environmental impact assessments (EIAs) during the mini-grid project approval process (see Section 1.7). However, holding all mini-grid projects to the same environmental standards can place prohibitive cost burdens on developers of small or low impact projects. Regulators must balance the country's environmental goals with their desire to support mini-grid deployment.

Many countries require some form of environmental review of large infrastructure projects, which is often applied to mini-grid projects as well. In countries that have more flexible environmental review processes, regulators decide what form of environmental review to apply specifically to mini-grids. In addition to general environmental review, certain classes of projects may be subject to extra scrutiny (e.g., projects located in particularly environmentally sensitive areas, such as wetlands) or review by additional parties (e.g., hydroelectricity projects, which may be reviewed by water resource management authorities).

Regulators should also consider if environmental regulations are applicable/mandated during and at the end of a projects life. Regulators should define or request protocols for proper management, transport, and recycling and disposal of energy technologies, their respective components, and other waste generated during a projects lifecycle. For example, regulators may wish to develop disposal protocols for energy storage technologies, such as lead acid batteries, which if not disposed of properly can cause soil pollution and health risks to communities.

Finally, regulators may want to consider socio-cultural regulations, policies, or recommendations for developers. The objective of socio-cultural regulations is to ensure local culture, context, sacred areas, social customs, gender, child protection, and other cross cutting issues are respected and maintained. This is particularly important to consider when external developers, NGOs, or other entities are entering remote areas. In particular cases, protocols for archaeological findings might be necessary. One approach is to require or suggest developers adhere to development practice codes of conduct or social and environmental standards, such as the IFC Performance Standards.

Guiding Questions:

- How do concerns about environmental impact interact with concerns about energy access?
- Would environmental regulations comparable to those used for large infrastructure projects place undue burdens on the developers of small mini-grid projects?
- Do regulatory agencies have the staff capacity and resources to manage the EIA process for mini-grids?
- What process will be used for the environmental approval of mini-grid projects?
- If EIAs will be part of the environmental approval process for mini-grid projects, how will they be coordinated with the license approval process?
- How does the environmental approval process align with the approval process of the mini-grid regulatory authority?

Option 1: Require environmental review for all mini-grid projects

Regulators may subject all mini-grid projects to a full environmental review. Such reviews are often multi-agency efforts led by the government authority with principal responsibility for environmental protection. This approach usually follows the country's established framework for evaluating the environmental impacts of proposed infrastructure projects.

Benefits	Drawbacks
• A full environmental review of each mini-grid project ensures that regulators fully understand the impacts of proposed projects, enabling them to make informed decisions in which project benefits are weighed against environmental impacts.	• Environmental review can be a time- and resource-consuming process for both developers and the government, and can add significant costs to mini-grid projects (especially small projects), for which economic sustainability is already a concern.

Recommended Steps for Regulators

- Consult with the governmental agencies with authority over environmental protection regarding the environmental review process for mini-grid projects.
- Determine when environmental review will take place in relation to other energy sector and non-energy-sector approvals.
- Determine the role and authority of the mini-grid regulator in the environmental review process.
- Develop guidelines on the environmental review process for mini-grid projects, and make the guidelines easily accessible by including them (1) on the websites of both the environmental authority and mini-grid regulators and/or (2) in the country's guidelines on the mini-grid approval process.

Option 2: Adopt an environmental review process based on project classes such as capacity, technology, location, or anticipated effect

This option recognizes that the risks of environmental impacts can vary widely across projects and that the costs of environmental review can be substantial, particularly for developers of small projects. Under this approach, the country's framework for evaluating the environmental impacts of proposed infrastructure projects may need to be modified. This could take several forms:

- Environmental review could be streamlined for projects below a certain capacity threshold, for which the costs of review would be burdensome (if capacity thresholds are how mini-grids are classified, as described in Section 1.4, these same thresholds could be used for environmental review).
- Environmental review of technologies that are expected to have minimal environmental impact could be streamlined or waived (for example, wind and solar projects are likely to have fewer direct impacts on the environment than hydroelectricity projects).
- Environmental review of projects in locations that are not environmentally sensitive could be relaxed or waived, with full review reserved for sensitive areas (such as wetlands, rivers, or lakes).

Benefits	Drawbacks
• Recognizes that environmental review can be costly for developers, particularly in the case of small projects, and would therefore require full review only when called for by project technology, capacity, or location, or by expected environmental impact.	• By relaxing environmental review requirements for some project classes or categories, regulators and policy makers risk overlooking specific impacts that a full review might reveal.

Recommended Steps for Regulators
• Collaborate with governmental agencies with authority over environmental protection to design an environmental review process that recognizes differences in expected environmental impacts by project class or category; as part of this process, consult with mini-grid developers and other key stakeholders, such as environmental protection advocates. • Identify the classes or categories of projects (whether by capacity, location, or technology etc.) that are expected to have minimal environmental impact; then determine, in consultation with stakeholders, the extent to which environmental review requirements could be relaxed or waived for each class. • Ensure that the final approach to environmental review is consistent with the requirements of any relevant environmental legislation. • Determine when the environmental review will take place in relation to other energy sector and non-energy-sector approvals. • Determine the role and authority of the mini-grid regulator in the environmental review process. • Develop guidelines on the environmental review process for mini-grid projects, and make the guidelines easily accessible by including them (1) on the websites of both the environmental authority and the mini-grid regulator and/or (2) in the country's guidelines on the mini-grid approval process.

Further Reading

Provides guidance on environmental regulation and approvals:

- Tenenbaum et al. 2014. *From the Bottom Up.* Chapter 4: Regulatory Processes and Approvals: Who Approves What? https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y
- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. Chapter 6: Level C—Customer Protection and Environmental Policy and Regulation. http://www.minigridpolicytoolkit.euei-pdf.org/

Box 14: Environmental Regulation in Uganda

Mini-grid projects in Uganda are required to undergo an environmental review and approval process led by the National Environmental Management Authority (NEMA) (NEMA, 2004). NEMA coordinates the review process with the Ministry of Energy and Mineral Development (MEMD) (and with the Directorate of Water Resource Management [DWRM] as well, when hydropower projects are under review). NEMA's environmental impact review process for energy projects is outlined in the *Environmental Impact Assessment Guidelines*. (This discussion draws heavily on the guidelines.)

The environmental review process depends on the size, location, type, and potential impacts of the energy project. A project may be subject to an environmental project brief, an environmental impact review, or an environmental impact assessment, each of which has varying levels of rigor. Some projects may be required to go through an environmental and social impact assessment, but the guidelines do not provide details on this process.

All mini-grid developers must submit a project brief to NEMA. Once a complete project brief is submitted, NEMA and MEMD have 14 days to review the brief, provide comments to the developer, and undertake an environmental screening process to determine the required level of environmental review. There are three levels of screening; if it is determined during the first level that the project will not cause adverse environmental impacts, it is exempt from further environmental assessment and approved.

Projects that are considered to have some potential for adverse environmental impact proceed to screening level two. If it is determined that the impacts can be mitigated, the developer may be required to undertake an environmental impact review (EIR) to identify the mitigation measures. Following the EIR, NEMA and MEMD have up to 30 days to determine whether the mitigation measures are sufficient and either approve the project or recommend a full environmental impact assessment (EIA). Projects that require EIAs are placed in screening level three and must undergo an environmental impact study (EIS).

NEMA provides the developer with a list of approved technical consultants that can conduct the EIS. During the EIS, the project developer consults with NEMA, MEMD, and other stakeholders and prepares a scoping report. Once the scoping report is complete, the developer works with a technical consultant to develop a terms of reference (TOR), which is then reviewed by NEMA and MEMD. Once the TOR is approved, the consultants prepare the EIS, which is jointly reviewed by NEMA and MEMD. On the basis of the review of the EIS, NEMA approves the project unconditionally or with conditions, or disapproves the project. After approval by NEMA, MEMD, and other licensing authorities a record of decision is prepared.

If the project is approved, the developer will be licensed to implement the project in accordance with the mitigation plan stipulated in the EIS and any other terms or conditions attached to the approval. If the project is denied but there is room to mitigate the impacts, the developer is encouraged to make changes and resubmit for review.

All projects that undergo an EIS must develop a monitoring plan for the operational phase. Projects are also required to undergo environmental evaluation by MEMD and the developer during implementation and after decommissioning. The environmental impacts of hydropower projects are monitored by DWRM as well.

1.10. TECHNOLOGY REQUIREMENTS

Mini-grid projects rely on a wide range of renewable and nonrenewable generation technologies (e.g., wind, solar, hydro, biomass, diesel) that have different levels of efficiency. The choice of technology can have significant impacts on both up-front construction costs and long-term operation and maintenance costs (and, therefore, cost recovery requirements). Governments may favor certain generation technologies and wish to require or incentivize their use. Where this is the case, policy makers should consider what sort of financial support structure is best suited to encourage the use of those technologies (see Section 1.6).

Depending on a government's goals, regulators and policy makers may choose to restrict mini-grid development to a specific set of technologies. Among the more common technologies used to serve mini-grids are the following:

Table 9. Common Technologies Employed by Mini-grids

Technology	Description
Solar PV 	Solar energy can be an attractive technology for mini-grid development: it is clean, does not rely on costly fuel inputs (e.g. kerosene or diesel), has low operating costs, and is easily deployed in remote areas. The major drawback is intermittency: irregular generation due to variations in the availability of the solar resource at a given time and place (e.g., at night or during inclement weather). To address this issue, solar projects are often paired with a backup power supply such as an energy storage system or a diesel generator. When a solar PV system is paired with batteries, the batteries are charged when the solar project generates excess power, and provide backup power when the system is not generating power. When a solar PV system is paired with a diesel generator to form a hybrid system, the diesel generator is used as a backup power source when the solar facility is not generating power. Some solar-based mini-grids are deployed without backup equipment; the disadvantage of such stand-alone systems is that power is available only when the sun is shining; the advantage is the potential to minimize project development and operating costs, as backup power supplies add to total costs. Solar PV facilities generate power in the form of direct current; in national grid applications, this power is converted to alternating current by inverters, system components that add to the total cost of the system. In some autonomous applications, small, solar-based mini-grids operate entirely on direct current to avoid the cost of an inverter; this poses difficulties, however, for eventual connection with the national grid (see Section 3 and Box 32).

Wind	Due to its lack of emissions and fuel requirements, wind energy can also be an attractive technology for mini-grid development. The potential for off-grid wind applications is somewhat limited, however, as not all areas have adequate wind resources for generation. Additionally, wind projects also suffer from similar (and less predictable) intermittency issues as solar projects, and must also be paired with a backup technology to ensure continuous power availability.
Bioenergy	Bioenergy comes in many forms, and refers broadly to projects that generate power by combusting either biomass (such as agricultural byproducts, wood, or even landfill waste) or biogas (such as the products of anaerobic biodigestion). Because of its reliability, bioenergy can be an attractive generating source compared with wind and solar, but it does require a stable source of fuel. In certain applications, such as agricultural communities with significant amounts of agricultural waste product, biomass can prove to be not only a stable source of energy, but an added revenue source for agricultural producers. The carbon and local environmental impacts of biomass (e.g., deforestation) can vary significantly, depending on the fuel source and specific project characteristics.
Hydroelectricity	High reliability and lack of fuel needs make small-scale hydro an attractive source of power. However, the applicability of hydro for power generation is limited to areas with consistent water flow, which may be affected by seasonal patterns and/ or impacted by climate change as drought and rain patterns change. Additionally, hydroelectric power should be considered in the relation to other priorities for water use, as well as in relation to potential environmental impacts (such as impeding fish migration). Some hydroelectric projects require the use of a reservoir. Small hydro projects are often constructed as "run of river" projects, which do not require a reservoir but are more sensitive to fluctuations in water flows.
Energy Storage	While not a source of electricity generation, energy storage can provide valuable services to a mini-grid. Its use has become more common as technology costs have declined. Various thermal, mechanical, and electrochemical energy storage technologies exist, but lead acid and lithium-ion batteries (electrochemical) are typically most prevalent. Energy storage is often paired with intermittent renewable resources like wind and solar to store excess electricity in times of abundance and provide electricity when those sources are not producing (e.g. at night for solar). In addition to load shifting, energy storage can balance and maintain power quality on the grid by providing frequency regulation, voltage support, and other ancillary services.

Diesel and Other Fossil Fuels	Many mini-grid systems are powered by fossil fuels, often by diesel gensets (a combined diesel engine and electric generator). Diesel gensets are often paired with renewable projects that offer intermittent power (such as wind or solar) to form hybrid generating systems. Diesel gensets have the advantage of reliable generation and often affordable up-front costs. However, they also have several disadvantages: (1) high operating costs (because of their fuel needs) and (2) negative environmental and health impacts (due to local air pollution and carbon emissions). As a result, many governments and international organizations discourage the deployment of diesel gensets and instead encourage clean-energy-based mini-grids, hybrid systems, or the conversion of diesel gensets to clean energy or hybrid systems.

The following factors regulators and policy makers should consider when deliberating eligible technologies:

- **Cost**—both construction and operating costs;
- **Resource availability**, as some technologies (such as hydroelectricity) cannot be deployed in all communities;
- **Reliability**, as some technologies provide power intermittently, unless paired with a backup power system;
- **Local air pollution and carbon emissions**, particularly in the case of diesel gensets;
- **Availability, transport, and logistics risk**, particularly for diesel fuel which needs to be transported to remote areas;
- **Local environmental impacts**, particularly in the case of some bioenergy and hydroelectricity applications; and
- **Eventual grid connection,** particularly as it relates to (1) intermittent renewables, which must be backed up by the national grid, and (2) solar mini-grids that generate direct current, which cannot be interconnected without upgrades to the distribution grid.

Box 15: Technology and Subsidy Considerations: Transitioning from Diesel to Renewable-Energy Based Mini-grids

Transitioning from diesel-based to renewable-energy based mini-grids has become a challenge in many countries such as Indonesia, Colombia, Brazil, Panama, and Cambodia, to mention a few. In certain circumstances, remote diesel mini-grids are benefiting from on-going subsidies for diesel fuel and therefore have no incentive to transition to cleaner sources of energy, even if such transition could lower generation costs and improve the quality of service. Regulators are facing the challenge of how to phase out fuel subsidies and transition or redirect them towards capital-intensive investments rather than ongoing costs. As policy makers and regulators consider technology requirements, it is important to consider what grants or subsidies are in place that could interfere with achieving technology specific goals.

Guiding Questions:

- Are there any specific generation technologies (such as renewable energy technologies) that the government wishes to prioritize for mini-grid development?
- Are there any specific generation technologies that the government wishes to limit for mini-grid development?

Option 1: Require all mini-grid projects to use one or more preferred technologies

Benefits	Drawbacks
• Requiring developers to choose from a menu of preferred technologies can help countries reach renewable-energy, energy-efficiency, or carbon-reduction targets while still providing developers with a degree of choice over technology.	• Depending on the preferred technologies, some mini-grids could prove costlier than those that rely on technologies that developers might otherwise select. • Developers may be subject to higher capital costs, as well as higher O&M costs without fiscal support from the government (e.g. if the preferred technologies require more frequent maintenance). • Developers may struggle to secure additional financing or recover costs, and may rely more heavily on government support due to higher costs.

Recommended Steps for Regulators
• To gain the perspective of both developers and government agencies, consider meeting with (1) mini-grid developers, (2) the government agencies in charge of leading efforts to meet renewable-energy, energy-efficiency, and carbon-reduction targets, and (3) the government agencies with authority to develop financial incentives. The discussion could focus on the country's available renewable energy resources, the need for technology requirements, and on technology-specific incentives for mini-grids. • On the basis of discussions, select the preferred technologies. • In close collaboration with policy makers, consider whether financial incentives would be needed to meet the country's mini-grid development goals. • Once the approach is finalized, develop easily accessible guidelines on the preferred technologies for mini-grid project developers.

Option 2: Adopt a technology-neutral approach to mini-grid development

Under the technology-neutral approach, mini-grid developers can propose renewable or nonrenewable generation technologies.

Benefits	Drawbacks
• A technology-neutral approach allows developers to decide which technology option is most appropriate for their business model, service area, risk appetite, and funding.	• Developers may choose diesel-powered mini-grids (which are cheaper in some instances), a technology-neutral approach may hinder a country from reaching renewable-energy, energy-efficiency, or carbon-reduction targets. • Although diesel systems have lower up-front costs than renewable energy technologies, volatile fuel prices often lead to higher operating costs—and, in turn, to higher tariffs or more frequent tariff adjustments. • If tariffs increase, some means must be found to offset those increases. National-grid customers may increasingly cross-subsidize mini-grid customers, and/or governments may need to provide direct subsidies. Governments will need to consider their willingness to provide such subsidies.

Recommended Steps for Regulators
• No steps are required, as there is no need to adopt or change any policies or incentives to pursue a technology-neutral approach.

Option 3: Allow mini-grids to use any generation technology, but provide incentives for the use of select technologies

Benefits	Drawbacks
• Balances governmental and developer control. • Developers maintain full control over the technology selection—but, given the incentives, are likely to choose a government-preferred technology. • Ideally, this approach allows the government to meet renewable-energy, energy-efficiency, and carbon-reduction targets, and enables developers to undertake financially viable projects.	• To enable developers to properly manage their projects, the government will need to set up a clear and transparent incentive program. • Developers may end up relying on government incentives. • Sudden and unanticipated changes in incentives could greatly impact the financial viability of mini-grid projects. • Solar PV and wind mini-grids commonly need a back-up power supply such as a diesel generators or energy storage. Having no incentives or limiting the use of diesel generators, for example, could hinder solar or wind deployment, comprise the quality of service, or limit a developer's interest.

Recommended Steps for Regulators

- To gain the perspective of both developers and government agencies, consider meeting with (1) mini-grid developers, (2) the government agencies in charge of leading efforts to meet renewable-energy, energy-efficiency, and carbon-reduction targets, and (3) the government agencies with authority to develop financial incentives. The discussion could focus on the country's available renewable energy resources, the need for technology requirements, and on technology-specific incentives for mini-grids.
- On the basis of discussions, select the preferred technologies.
- Consider the types of incentives that would meet the desired goals.
- If necessary, consider working with a development partner or hiring an expert consultant to explore the most appropriate incentives, given the circumstances in the country.
- Once the approach is finalized, develop easily accessible guidelines on the preferred technologies and associated incentives for mini-grid project developers.

Further Reading

Provides a detailed discussion of the potential benefits and financial viability of renewable-energy-based hybridization of isolated mini-grids.

- Al-Hammad et al. 2015. *Renewable Energy in Hybrid Mini-Grids and Isolated Grids: Economic Benefits and Business Case*. http://fs-unep-centre.org/sites/default/files/publications/hybridgrids-economicbenefits.pdf
- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. Annex 1: Mini-Grid Technologies. http://www.minigridpolicytoolkit.euei-pdf.org/
- IRENA. 2016. *Innovation Outlook: Renewable Mini-Grids*. Section 2: Types of Renewables-Based Mini-Grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Innovation_Outlook_Minigrids_2016.pdf
- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-grids*. Chapters 2 and 3. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf

1.11. REPORTING AND FILING REQUIREMENTS

Reporting and filing requirements enable regulators to monitor the performance and regulatory compliance of mini-grid projects and operators; this information is critical to the regulation of the electricity industry. Regular reports may include information such as retail sales, daily hours of service, total number of customers, number of customers by sector, energy consumption by customer type, and planned and unplanned outages.

It is important to note that reporting requirements may be burdensome for developers who lack the technology or human resource capacity to collect and process the required data. Regulators should avoid placing undue administrative burdens on developers, and should consider providing training and/or financial support, if necessary.

Furthermore, regulators may require additional reports from projects that meet certain criteria. For instance, operators that receive consumer subsidies may be required to report how those subsidy dollars were put to use; project developers using particular generation technologies may be required to submit specific operational or environmental data.

It is important to note that reporting requirements may be burdensome for developers who lack the technology or human resource capacity to collect and process the required data. Regulators should avoid placing undue administrative burdens on developers, and should consider providing training and/or financial support, if necessary.

This section covers many of the major decisions associated with reporting and filing requirements. For more in-depth coverage, readers should consult the *Quality Assurance Framework for Mini-Grids* developed by the National Renewable Energy Laboratory and the U.S. Department of Energy (see Box 16).

Guiding Questions:

- What information does the regulatory authority need to effectively regulate mini-grids?
- Are reporting requirements for mini-grids overly burdensome for project developers?

Box 16: Quality Assurance Framework for Mini-Grids: Accountability Framework

One of the elements of the Quality Assurance Framework developed by National Renewable Energy Laboratory and the U.S. Department of Energy, is an accountability framework for isolated power systems. One of the goals of the framework is to define and formalize the relationship between mini-grid developers, regulators, investors, and customers, including the exchange of information between those parties. To ensure high quality customer service and define assessment and reporting protocols for mini-grid operators, the accountability framework follows a "truth-in-advertising" approach. The framework has two main components:

Consumer Accountability. Focusing on the agreement between the consumer and provider of energy services, consumer accountability helps to ensure that the service expected is rendered through appropriate checks and balances, strengthening consumer confidence. Improved confidence will increase a consumer's willingness to pay for service since there is a documented understanding of the service being provided for the payments being made. Additionally, through a defined project specific process there is recourse for consumers who do not believe they are receiving the level of service expected. A defined accountability framework also solidifies the concept of a business relationship between a buyer and seller of a commodity, in this case energy services.

Utility Accountability. Focusing primarily on the agreement between the provider of energy services and the government, regulators, or funders, utility accountability calls for the systematic collection and dispersal of information about the energy services system. This information can be used both (1) internally, by the service provider (e.g., mini-grid) to improve operational management and facilitate long-term energy planning, and (2) externally, by regulators, funders, or other interested parties. The information must be collected in a way that ensures high quality and reliability. Utility accountability can be achieved through two forms of reporting:

- *Technical Reporting*. The main elements of technical reporting for mini-grids include assessment of power quality and reliability, energy production and consumption, generation sources, and system efficiencies. The goal of technical reporting is not only to document performance of the power system in terms of meeting contractual requirements for delivery of energy services, but also to report on the efficiency and reliability of those services. Technical reporting allows consumers and regulators, as well as the mini-grid operator, to track the quality of the service, the efficiency of how energy is being generated and sold, and finally how these change over time.
- *Business Reporting*. A primary objective of business reporting is to create transparency on the operational soundness, financial condition, and growth potential of the operating entity. This is important for regulators, subsidy administrators, customers, lenders, and potential public or private investors. Business reporting helps provide a basis for accurate risk assessment, which can increase confidence and lower capital costs. The main elements of business reporting include payment collection rates, electrification rates, customer characteristics, service calls, and safety concerns. As part of business reporting, other documents should also be readily available, such as licenses, permits, generic use agreements, and standard rate schedules.

Generally, the accountability framework advises that reporting requirements, including the selection of technical and business data to be collected, should take the cost of data collection into account, and balance the desire for information with the expense of monitoring and analysis. For example, small projects may not need, or be able to afford, the level of reporting that is appropriate for large systems.

Source: Baring-Gould et al., 2016.

Option 1: Do not require mini-grid operators to file any reports

Regulators are likely to want to establish some sort of reporting requirements, but the option of not requiring reports is included to emphasize that in the absence of a formal reporting process, developers will de facto be required to provide nothing.

Nevertheless, regulators may choose not to require any information from operators. Under this particularly light-handed approach to mini-grid regulation, regulators and policy makers would have little information to support the governance of the mini-grid sector. One option is to gradually phase in reporting requirements as the capacity of mini-grid operators increases or as specific business or technical data becomes necessary.

Benefits	Drawbacks
• Mini-grid operators can operate freely, with minimal regulatory oversight. • Reduces the cost of data collection for mini-grid operators and the cost of monitoring and analysis for regulators.	• Regulators will have no information to use in the oversight of the mini-grid sector. • Rural electrification officials will have no basis on which to evaluate electrification efforts.

Recommended Steps for Regulators
• No action is required.

Option 2: Require regular reports from all mini-grid operators

Regulators may want some form of routine reporting from mini-grid operators, such as an annual report. One approach would be to define a set of reporting requirements that would be applied to all mini-grid operators. In developing these requirements, regulators should be aware that mini-grid projects are of a substantially smaller scale than national-grid utilities, and should adjust reporting expectations accordingly. Regulators should determine how much information is needed to effectively manage the mini-grid sector, and request only the necessary information from operators.

Benefits	Drawbacks
• Regulators can ensure that they have the information they need to effectively oversee the mini-grid sector.	• Unless streamlined, may burden developers and operators who lack the technology or human resource capacity to collect the required data. • Even moderate reporting can burden small mini-grid projects (some have just a few kilowatts in capacity).

Recommended Steps for Regulators
• Confer with rural electrification authorities to determine what information is needed from mini-grid operators to achieve key policy and regulatory objectives. • Engage a variety of project developers to help vet the list of reporting requirements, to identify any that may be too burdensome. It is important to note that once this feedback is taken into consideration, regulators have final responsibility for determining which information is required to effectively oversee the mini-grid sector. • After formalizing reporting requirements, ensure that they are accessible to mini-grid developers by including them in the licensing requirements, on the regulator's website, or in the country's guidelines for the mini-grid sector. • Account for the resources needed to comply with reporting requirements and, if necessary, provide training and/or financial support for compliance. • Develop reporting templates to ensure that mini-grid developers provide the requested information in the desired format. Ensure that the templates are easily accessible to mini-grid developers.

Option 3: Adopt reporting requirements based on project classes or categories such as capacity, technology, location, or other special circumstances

Regulators can opt to relax reporting requirements based on project criteria (e.g., system capacity or number of customers) or to require certain information only in special circumstances (e.g., when unplanned outages occur). If classed or categories of projects are developed, as described in Section 1.4, these same classes or categories could be used for reporting requirements.

Benefits	Drawbacks
• Regulators who adopt flexible reporting requirements based on project criteria can avoid overburdening small mini-grid operators with requirements that may be difficult to meet.	• By collecting less information from mini-grid operators or collecting it less frequently, regulators may limit their understanding of the mini-grid sector and thereby undermine their own effectiveness. • Even though many developers may not need to file reports under this approach, those who do may find the requirements burdensome.

Recommended Steps for Regulators

- Confer with rural electrification authorities and mini-grid developers to establish reporting requirements based on criteria such as project capacity, technology, location, number of customers, or special circumstances.
- In developing reporting requirements, balance the need for data with the cost of data collection.
- After finalizing reporting requirements, make them easily accessible to mini-grid developers by including them in the licensing requirements, on the regulator's website, or in the country's guidelines for the mini-grid sector.
- Develop reporting templates to ensure that mini-grid developers provide the requested information in the desired format. Ensure the templates are easily accessible to mini-grid developers.

Further Reading

Provides information on reporting requirements for mini-grids:

- Tenenbaum et al. 2014. *From the Bottom Up.* Chapter 4; Final Thoughts. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Box 17: Reporting Requirements in Uganda

All mini-grid projects in Uganda are required to report regularly on operations. Projects that are 2 megawatts (MW) or larger must provide quarterly and annual reports to the Electricity Regulatory Authority; smaller, license exempt projects must provide only annual reports. Requested data includes information on customers and sales, as well as other operational figures. While smaller project developers tended to view these requirements as manageable and necessary, the West Nile Rural Electrification Company (WENRECO), the only mini-grid operator classified as large, viewed its required quarterly reporting as burdensome, noting that the reporting process had been designed for main-grid distribution companies that are much larger than WENRECO. In particular, the company noted that requirements for regular demand modeling require sophisticated software that it does not have access to, posing a significant cost burden.

Box 18: Country Spotlight: Reporting Requirements for Small Power Producers in Tanzania

The Energy and Water Utilities Regulatory Authority (EWURA) of Tanzania requires all small power producers, regardless of system capacity, to submit an annual report on technical and business operations no later than 90 days after the end of the fiscal year (Electricity [Development of Small Power Projects] Rules, 2016). The *Guidelines for Development of Small Power Projects*, issued by EWURA in 2011, outlines the legal framework and processes for developers and provides a form for operators to fill out and submit to regulators. The following list includes some of the information requested in the form (EWURA, 2011):

- Location of facility;
- Connection point;
- Type of fuel;
- Nameplate capacity (kilowatts [kW]);
- Number of retail customers;
- Minimum and maximum expected capacity to sell (kW);
- Minimum and maximum capacity consumed by seller (kW);
- Annual electricity production during the calendar year (kWh);
- Annual electricity sales during the calendar year (kWh);
- Amount of electricity sold to distribution network operators (kWh); and
- Amount of electricity sold to retail customers (kWh).

In late 2015, EWURA published draft rules on accident reporting for electricity providers and requested public comment. Although the document's current status is unclear, the Electricity (Accident Reporting) Rules, 2015, specify that any accidents that occur as a result of activities of an electricity provider and result in serious personal injury, loss of life, or property damage must be reported to EWURA within 24 hours; this requirement applies to all licensees within the electricity sector, including operators of small systems that are exempt from license applications. Licensees are also required to keep a record of such incidents and submit an accident report to the regulator (EWURA, 2015).

Further Reading:

- Guidelines for Development of Small Power Projects: Form for Annual SPP Reporting. *The Electricity (Accident Reporting) Rules, 2015:* Accident Reporting Form: http://144.76.33.232/wp-content/uploads/2015/08/Approved-Small-Power-Projects-Development-Guidelines-March-2011.pdf

1.12. OWNERSHIP FOLLOWING CONNECTION TO THE NATIONAL GRID

Because many emerging economies lack clearly defined regulations regarding mini-grid ownership and business models following connection to the national grid, connection issues are often resolved on a case-by-case basis (Greacen, Engel, & Quetchenbach, 2013). This section discusses regulation of the ownership and operation of mini-grid assets in the case of eventual grid connection. (See Section 3 for a discussion of how to enforce technical standards that will enable mini-grids' eventual connection to the national grid.)

A straightforward approach is needed to ensure that the private sector has the confidence to invest in mini-grids. Without knowledge of what would happen if the national grid were extended to areas served by mini-grids—in particular, whether and how mini-grid operators would be compensated for any lost revenue—investors will be rightfully cautious.

A straightforward approach to ownership following connection to the national grid is needed to ensure that the private sector has the confidence to invest in mini-grids. Without knowledge of what would happen if the national grid were extended to areas served by mini-grids—in particular, whether and how mini-grid operators would be compensated for any lost revenue—investors will be rightfully cautious.

It is important to note that a regulatory agency can make more than one ownership and business model option available to mini-grid developers and operators.

In considering how to approach ownership of mini-grid assets in the case of grid extension, regulators must consider two key issues:

- Whether mini-grid infrastructure is (1) technologically capable of being connected to the national grid and (2) able to meet the technical standards of the national grid (this is addressed in detail in Section 3).
- Whether the mini-grid operator will maintain ownership and operating rights over any aspect of the mini-grid infrastructure (i.e., generation assets, distribution assets, neither, or both).

There are several ownership and business model options that can be pursued for interconnecting remote mini-grids to the national grid. The options are briefly described below and are covered in more detail in the following sections (Tenenbaum et al., 2014; Greacen, Engel, & Quetchenbach, 2013). It is important to note that a regulatory agency can make more than one option available to mini-grid developers and operators. If more than one option is provided, the mini-grid developer and operator will likely select the option that is most economically viable. For example, if one of the options was to become a small power producer (SPP), but the feed-in-tariff offered was too low for economic viability, the mini-grid operator may decide to sell its assets.

- Small Power Distributor (SPD): The mini-grid converts from operating as an autonomous mini-grid to a SPD that buys electricity at wholesale from the national or regional utility and resells it at retail to its local customers.
- Small Power Producer (SPP): The mini-grid sells electricity to the operator of the national grid (or some other designated entity), but no longer sells electricity to retail customers.

- **Combined SPP and SPD:** The SPP converts from operating an autonomous mini-grid to operating an SPD that buys electricity at wholesale from a national or regional utility and resells it at retail to its local customers. It also maintains an existing or new small generator as a backup generator and/or as a supply source to the national grid and retail customers.
- **Sell Assets:** The mini-grid sells its distribution grid to the national grid operator or some other entity designated by that national government or regulator and receives compensation for the sale of its assets.
- **Abandon or Move:** The distribution grid and generator are abandoned, sold for scrap, or moved. The connecting utility builds and operates a new distribution system to serve customers in the area.

Regulators should consult mini-grid developers and operators and other stakeholders as they review and select options for ownership following the arrival of the national grid.

If regulators take no action to coordinate mini-grid deployment with grid extension, the de facto result may be that mini-grid projects do not interconnect, will continue to operate independently of the national grid, and could compete with the national grid network. This is certainly not a desirable result, as it results in duplicative infrastructure, limits the ability of the mini-grid operator to continue to earn an ROI, and can create confusion among customers. However, it has occurred in the past. In at least one case in India, for example, the national grid was extended to an area served by a mini-grid, and now operates in competition with the mini-grid (Vaidyanathan, 2015).

Guiding Questions:

- Should infrastructure developed for mini-grid projects be directly incorporated into the national grid in the case of grid extension?
- What role should mini-grid operators have in owning or operating mini-grid infrastructure after connection to the national grid?
- What roles do private sector actors (e.g., independent power producers, distribution network operators) currently play in the national grid, and could mini-grid operators transition into these roles following connection to the national grid?
- How will mini-grid developers be compensated for loss of revenue that may occur due to changes in ownership following connection to the national grid?
- What will be the process for transitioning mini-grid ownership?

Option 1: Small Power Distributor (SPD) - Allow mini-grids to become distribution-only systems, and retire generation assets or sell them to a governmental entity or utility

Regulators could allow mini-grid operators to continue to operate the mini-grids' distribution infrastructure, but would either transfer ownership of generation assets to national-grid power producers or retire them altogether. In this case, it would be important for the regulator to establish a process for calculating the value of the generation assets and for compensating the mini-grid operator if the assets are sold or retired. Under this scenario, mini-grid operators would effectively function as distribution network operators and would maintain normal retail-service relationships with customers. They would also agree to a wholesale PPA with national grid actors that would govern the price and conditions of power supply to the distribution network.

Benefits	Drawbacks
• Mini-grid operator maintains a portion of their regular business. • Mini-grid operator would be treated in same regulatory manner as current distribution network operators. • Mini-grid operator continues normal customer service relationship.	• Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods, and standards are not already in place to facilitate the transition (e.g. calculating a price for generation assets, wholesale PPA rates, the requirements of the distribution network operator, the roles, responsibilities and relationship between the utility and distribution operator etc.). • Generation assets may be retired before the end of their useful life. • Can be challenging to ensure mini-grid operators receive a fair price for generation assets that provide a reasonable return on investment.

Recommended Steps for Regulators

- Develop a licensing process through which mini-grid operators can legally transition into small power distributors.
- In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for the unrecovered costs of generation assets that will be retired or transferred to national entities.
- Establish a mechanism for compensating mini-grid owners.
- Define the terms and conditions of the wholesale power tariff that will govern power purchases between the new distribution-only system and the national grid, and develop a PPA template.
- Determine if there will be any changes in the retail tariff or terms of service for customers, and ensure that any changes are communicated.
- Develop a process for ensuring mini-grids are technologically capable of interconnection and meet the same technical standards as the national grid.
- Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection.
- On the basis of the preceding steps, develop guidelines that outline the process to be followed when the national grid arrives.
- Make the guidelines publicly available and accessible to mini-grid stakeholders.
- If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.

Option 2: Small Power Producers (SPP) - Allow mini-grids to become generation-only systems that sell all their power to the national grid

Regulators could opt to transfer ownership of distribution assets to a national-grid distribution network operator but allow mini-grid operators to maintain ownership of generation assets. In this scenario, the national grid operator or other appropriate entity would distribute and sell power to mini-grid customers, and mini-grid operators would effectively function as independent power producers. As such, they would agree to a PPA (or other payment mechanism, such as a feed-in tariff) that would govern the sale of power from the generation asset to the national grid. If the mini-grid operator financed the distribution assets, the regulator would need to consider establishing a process for calculating the value of the distribution assets and for compensating the mini-grid operator.

Benefits	Drawbacks
• In countries where independent power producers already play a defined role, this approach reflects the current ownership structure of the national grid. • Avoids a situation where regulators must oversee a patchwork of small distribution networks in the long term, thus conserving regulatory resources.	• May not be viable if small, independent power producers do not already have a defined role in the national grid. • Transition will affect the customer service relationship, which may be complicated if the mini-grid payment and metering structure differs from that of the national grid. • Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods and standards are not already in place to facilitate the transition (e.g. determining which party is responsible for technical upgrades or interconnection costs).

Recommended Steps for Regulators

- Develop a licensing process through which mini-grid operators can legally transition into small power producers.
- In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for the unrecovered costs of distribution assets that will be retired or transferred to national entities.
- Establish a mechanism for compensating mini-grid owners.
- Define the terms and conditions of the agreement that will govern the sale of electricity from the small power generator to the national grid, and develop a PPA template.
- Develop a plan to transition customer retail service from the mini-grid to the national grid network operator, and communicate the plan and any changes in the retail tariff or terms of service to customers.
- Develop a process for ensuring generation assets are technologically capable of interconnection and meet the same technical standards as the national grid.
- Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection.
- On the basis of the preceding steps, develop guidelines that outline the process that will be followed when the national grid arrives.
- Make the guidelines publicly available and accessible to mini-grid stakeholders.
- If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.

Option 3: Combined SPP and SPD - Allow mini-grids to continue to generate, distribute, and sell electricity - with the added ability to buy and sell power from and to the national grid

Regulators may prefer that there be no transfer in ownership or operations when the national grid extends to areas served by mini-grids. In this scenario, an interconnection would be made between the national grid and the mini-grid, and the mini-grid operator would agree to a wholesale power tariff that would govern transfers of electricity back and forth between the mini-grid and national grid. It would then be up to the mini-grid operator to decide whether to meet customers' energy needs with power generated by the mini-grid, power imported from the national grid, or a combination of the two. The mini-grid operator would effectively function as a distribution network operator that also owns a local power supply.

Benefits	Drawbacks
• Assets would be owned and operated by original developer, which has developed systems to manage those assets. • No need to transfer customers to the national grid utility or to communicate any changes in tariff structure or customer service. • Reduces costs for mini-grid operator; customer tariffs may also potentially be lower. • Mini-grid operator can switch back and forth between imported and locally generated power, depending on cost. • Operator can sell excess power to the national grid.	• May be undesirable to have pockets of the grid operated by independent entities. • Mini-grid ownership not integrated into existing organizational roles of national electricity grid. • May be more in line with national electrification goals to have centralized ownership and operation of mini-grid assets. • Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods and standards are not already in place to facilitate the transition (e.g. determining which party is responsible for technical upgrades or interconnection costs).

Recommended Steps for Regulators
• Develop a licensing process through which mini-grid operators can legally transition into new roles as (1) grid-connected small power distributors and (2) owners of local power supply. • Define the terms and conditions of the wholesale power tariff that will govern power purchases between the mini-grids and the national grid, and develop a PPA template. • Determine if there will be any changes in retail tariffs or terms of service for customers, and ensure that any such changes are communicated. • Develop a process for ensuring that mini-grids are technologically capable of interconnection and meet the same technical standards as the national grid. • Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection. • On the basis of the preceding steps, develop guidelines that outline the process that will be followed when the national grid arrives. • Make the guidelines publicly available and accessible to mini-grid stakeholders. • If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.

Option 4: Sell Assets - Transfer ownership and operation of all mini-grid assets to a governmental entity or a utility

Regulators may prefer that either the government or a designated national-grid utility take possession of all mini-grid infrastructure in the case of interconnection to the national grid. Under this scenario, the mini-grid operator would cease operations entirely, and the mini-grid developer would need to be compensated for, at a minimum, any unrecovered costs from project development and operations that would otherwise have been recouped through revenues from electricity sales or incentives. Unrecovered costs could include the original cost of the assets, such as generation equipment, less accumulated depreciation.

In this approach, the role that mini-grid operators play in national rural electrification is explicitly temporary. As long as this is clearly communicated to developers in advance and investors are made whole (compensated for the depreciated value of generation and distribution assets and the net present value of future cash flows) in the event of grid interconnection, temporary ownership should not pose significant barriers to private sector investment.

Benefits	Drawbacks
• Highly compatible with a centralized planning approach and may be the simplest and most beneficial approach for the country's electric industry operations in the long term. • Allows infrastructure to be operated by normal electricity grid actors.	• Technological or equipment differences between the national grid and mini-grids may cause issues and complicate the interconnection process. • May complicate the relationship with mini-grid customers, particularly if the mini-grid uses a different payment or metering system. • Need to ensure the mini-grid operator is fairly compensated for mini-grid assets. • Can be costly and timely to establish a process for calculating the value at which the mini-grid operator will be compensated for mini-grid assets.

Recommended Steps for Regulators

- In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for unrecovered costs and lost revenues.
- Establish a mechanism for compensating mini-grid owners.
- Determine the process for transferring ownership.
- Determine if there will be any changes in retail tariffs or terms of service for customers, and ensure that any such changes are communicated.
- Develop a process for ensuring that mini-grids are technologically capable of connection and meet the same technical standards as the national grid.
- Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection.
- On the basis of the preceding steps, develop guidelines that outline the process that will be followed when the national grid arrives.
- Make the guidelines publicly available and accessible to mini-grid stakeholders.
- If mini-grids are already active in the country, proactively communicate the ownership after connection to mini-grid developers and operators.

Option 5: Abandon or Move - The distribution grid and generator are abandoned, sold for scrap, or moved

If regulators take no action to coordinate mini-grid deployment with grid extension, or the options for transfer of ownership do not meet the needs of the mini-grid developer or operator, the distribution grid and generator could be abandoned, sold for scrap, or moved. In this case, the national or private utility would build and operate a new distribution system to serve customers in the area.

Benefits	Drawbacks
• Limited benefits. • Mini-grid operators may be able to sell the equipment and recoup some costs. • Mini-grid operators may be able to move the mini-grid and establish business in an area where grid extension has not and will not take place in the near future.	• Duplicative investment in Infrastructure. • Limits the ability of the mini-grid operators to earn a return on their investment. • If abandoned or sold, will need to decide who is responsible for the costs of cleaning up the site and properly disposing of equipment to avoid any health or safety concerns for the surrounding community.

Recommended Steps for Regulators
• Consult with the mini-grid community to understand when a mini-grid would be abandoned or moved. • Establish ownership and business model options that minimize the risk of a mini-grid being abandoned or moved. • Develop guidelines for proper disposal of mini-grid equipment if abandoned.

Further Reading

Provides a detailed discussion of the technical and policy aspects of mini-grid interconnection, including a number of examples of approaches used in emerging economies:

- Greacen, Engel, & Quetchenbach. 2013. *A Guidebook on Grid Interconnection and Islanded Operation of Mini-Grid Power Systems Up to 200 kW*. http://www.cleanenergyministerial.org/Portals/2/pdfs/A_Guidebook_for_Minigrids-SERC_LBNL_March_2013.pdf

- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-Grids*. Chapter 3: Policies and Regulations to Support Private Sector Mini-Grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Innovation_Outlook_Minigrids_2016.pdf

Discusses technical and economic considerations for regulating the interconnection of mini-grids and the national grid:

- Tenenbaum et al. (2014). *From the Bottom Up*. Chapters 8 and 10. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?seque%20nce=1&isAllowed=y

Tools

Provides a template for a power purchase agreement:

- RECP et al. 2013. *Legal Templates*. http://minigridpolicytoolkit.euei-pdf.org/downloads

Box 19: Mini-Grid Ownership Following Connection to the National Grid in Uganda

Uganda has not yet developed a process for managing project ownership after interconnection. While licenses provide mini-grid developers with exclusive rights to a site for a defined period, in-country stakeholders expressed conflicting perspectives on whether those rights would continue after grid connection.

All parties interviewed recognize that this is a central issue for the long-term development of a full mini-grid regulatory process. In particular, Electricity Regulatory Authority staff acknowledged the need to compensate developers, in the event that mini-grid operations are ended prematurely due to grid extension. Several stakeholders noted, however, that Uganda has yet to address this issue in depth, largely because the Ugandan mini-grid industry is still in its infancy.

Box 20: Country Spotlight: From Mini-Grid to Small Power Distributor: Cambodia's Approach

The Electricity Authority of Cambodia (EAC) has enacted regulations that allow mini-grid operators to connect to the national electricity grid and transition to distribution network operators. Before this policy was established, mini-grid developers had been reluctant to make infrastructure upgrades to allow grid interoperability, for fear of losing their assets in the event of grid extension to their service areas. Under the new regulations, grid-connected former mini-grid operators can purchase power from the national electricity utility through a wholesale tariff. EAC has allowed both wholesale and retail tariffs to be set at levels that allow these small distribution network operators to be profitable.

Source: Greacen, Engel, and Quetchenbach, 2013.

Box 21: Country Spotlight: Guidelines for Hydropower Interconnection in Sri Lanka

In 2013, through the publication of *Grid Interconnection Mechanisms for Off-Grid Electricity Schemes in Sri Lanka,* the Sri Lanka Public Utilities Commission promulgated clear guidelines for the interconnection of mini-grids. The guidance document specifically concerns the interconnection of small hydropower plants. The guidelines were developed on the basis of a 2010 pilot process that interconnected two micro-hydro facilities, which was conducted by the Federation of Electricity Consumer Societies and the Energy Forum. The pilot process revealed both economic and legal barriers to grid interconnection, which were resolved by the 2013 guidelines.

Under the new regulations, operators of mini-grids larger than 10 kilowatts are permitted to interconnect to the main electricity grid and transition to independent power producers. Operators must obtain their customers' consent before interconnecting. After interconnection, operators are granted a cost-reflective tariff for power production that is implemented through a standardized power purchase agreement (PPA). By the end of 2015, Sri Lanka had connected 154 small hydropower plants with a combined capacity of 306 megawatts, all of which had obtained either a standardized PPA or a letter of intent from the national utility to purchase all electricity generated.

Source: Ceylon Electricity Board, 2016.

2 RETAIL TARIFF REGULATION

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2 RETAIL SERVICE REGULATION

The second major pillar of mini-grid regulation is oversight of the relationship between service providers and customers. The central issue here is whether and how the retail tariff will be regulated—which touches on both the role of regulatory authorities in setting rates, and on the amount service providers charge customers. In addition to addressing the relationship between suppliers and customers, retail service regulation also encompasses a number of other issues, including the specific structure of retail tariffs and the relative amounts paid by different customer classes. In overseeing retail service, regulators have two primary responsibilities: (1) ensuring mini-grids are able to earn a reasonable rate of return, and recover costs in order to invest and maintain projects, and (2) ensuring customers rates are just and reasonable. This section discusses four key issues related to retail service regulation:

- Retail tariff oversight;
- Retail tariff levels;
- Consumer subsidies; and
- Retail tariff structure.

2.1. RETAIL TARIFF OVERSIGHT

The first decision is whether to regulate the retail relationship—specifically, to determine the role of regulators in setting retail service levels. In the case of the national grid, it is generally assumed that regulation of retail rates is required. As natural monopolies or legal monopolies, utilities have far more leverage than the customers they serve; regulation—usually by a government agency or an electricity regulator—ensures that the price customers pay is fair and reasonable.

In mini-grid settings, it can be argued that customers have alternatives to electricity service. Most potential mini-grid customers can meet basic lighting needs with non-electricity energy sources, such as kerosene lanterns. In some cases, potential customers can also meet other energy needs—such as mobile phone charging—through community diesel generators. By this line of reasoning, customers do have alternatives to mini-grid service, albeit ones that may be inferior with respect to health, quality, and convenience. Mini-grid developers must therefore set prices that are low enough, and quality standards that are high enough, to convince potential customers to use their service. By this logic, the mini-grid provider would not have monopoly power, and neither exclusivity nor retail service regulation would be necessary.

Many regulators choose to regulate mini-grid retail service, however, in order to guarantee consumer protection and provide a transparent means of setting electricity prices nationwide. In this case, regulators must determine the process by which they will set rates—either directly or by vetting and approving rates proposed by developers. Regulators may also wish to phase in retail rate regulation over time, once mini-grid developers have recovered their costs.

Decisions about whether and how to regulate retail tariffs must be made in tandem with decisions on the level of retail tariffs; both are discussed in detail in the following sections. Regulators should consider retail service issues as a whole, and arrive at a consistent approach that reflects the needs and priorities of the regulator and the mini-grid sector.

Guiding Questions:

- Is retail rate regulation needed to protect mini-grid customers?
- Do regulators have the staff capacity and resources to effectively oversee mini-grid retail tariffs?
- How involved should mini-grid developers be in determining retail tariffs?

Option 1: Do not oversee retail tariffs

As noted earlier, regulators may determine that retail rate regulation is not necessary, and that customers have adequate leverage to ensure that developers deliver electricity at competitive retail tariffs. In the absence of rate regulation, payments may take a variety of forms (e.g., a flat monthly payment for a certain number of hours of electricity per day) that would be unfamiliar in regulated settings.

Benefits	Drawbacks
• May result in tariff structures that are economically beneficial for both operators and the customers they serve. • Allows market forces to determine tariff levels and regulators avoid setting rates that are too low to allow developers to recover their costs. • Requires little from regulators in terms of resources.	• Developer could charge a fair or unfair price. • May result in customers overpaying in relation to what developers actually need in order to recover their costs (and customers may be particularly likely to do so because of the high prices of energy sources such as kerosene and diesel). • May not enable regulators to ensure customers are paying a fair and transparent price for electricity.

Recommended Steps for Policy Makers
• Little action is required on the part of regulators. • If desired, regulators may require mini-grid developers to submit regular reports on retail rates (see Section 1.11 for a discussion of reporting options), and may reserve the option to intervene in rate setting if necessary. • Communicate that regulators will not oversee retail tariffs by including this information on the regulator's website and in the country's guidelines for the mini-grid sector.

Option 2: Directly set retail tariffs

Should regulators choose to oversee retail tariffs, they may opt to do so directly. Rates may be the same for all mini-grid customers, the same as the national grid tariffs, or calculated on the basis of generation technology, project capacity, or other factors (see Section 2.2).

Benefits	Drawbacks
• Maximizes the control of regulators over pricing and efficiently determining retail rates for many mini-grid projects while limiting a bottlenecked approval process. • May reward effective project developers if they are able to provide services at lower cost and can realize a higher return from the rates set by regulators.	• Could be viewed as heavy-handed, and may ignore important, project-specific factors that inform development costs. • May limit mini-grid development. If a developer is unable to cover costs at the regulated retail tariff level, they may choose not to develop a site—even if customers are willing to pay higher rates for service.

Recommended Steps for Policy Makers
• Consult project developers and communities that would be served by mini-grids to determine a methodology for setting retail rates that are beneficial for developers and communities alike. • Determine whether retail tariffs will be uniform for all projects or vary depending on project-specific factors. • If desired, develop an appeals process to allow exceptions for projects with higher development costs. • Develop guidelines on the tariff review process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 3: Review retail tariffs proposed by mini-grid project developers

An alternative option is for regulators to allow developers to propose retail tariffs, which would then be approved, amended, or rejected.

Benefits	Drawbacks
• Allows appropriate oversight while recognizing the unique costs of each mini-grid project. • Ensures fair tariffs by setting tariffs that take into account both developers' revenue needs and customers' ability to pay.	• Can be time-consuming to accurately assess and adjudicate an appropriate retail tariff. • May demand significant staff time and resources and could lead to delays in regulatory approvals and project development in countries that are host to many mini-grid projects.

Recommended Steps for Policy Makers
• Establish a process for reviewing (and accepting, amending, or rejecting) retail tariff proposals from developers. If a review process is already in place under the country's national grid regulation, it can be adapted for mini-grid projects. • Develop a template to ensure mini-grid developers provide the requested information in the desired format. • Develop guidelines on the tariff review process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 4: Allow an unregulated grace period for retail rates, and implement retail rate regulation in the long term

Regulators could also select a hybrid approach, in which retail rates are unregulated for a certain period, during which developers are permitted to charge whatever is required to recover their costs (Tenenbaum et al., 2014). After that point, a regulated rate is put into effect (either a regulator-determined tariff or a developer-proposed tariff). Regulators could set the same unregulated period for all projects or tie the unregulated period to the developer's cost-recovery needs.

Benefits	Drawbacks
• Allows developers to recover costs (a necessity to attract mini-grid development) while protecting customers from paying high, unregulated tariffs in the long term. • Allows regulators to observe the results of market-based rate setting, which may yield valuable information about the rates that the market will bear.	• Can be more complex to implement the hybrid approach and to explain it to stakeholders. • May still result in developers overcharging during the unregulated period.

Recommended Steps for Policy Makers
• Develop a process for determining the appropriate length of the unregulated period and for overseeing projects during that period. • Identify the metrics that will be used to determine whether regulatory intervention is needed after the initial grace period, and develop a process for collecting the necessary data. • Develop a process for determining an appropriate retail tariff after the unregulated period. • After the unregulated period, develop a template to ensure that mini-grid developers provide the requested information in the desired format. • Develop guidelines on the tariff review process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 5: Regulate rates only in the case of customer disputes

Finally, regulators could adopt a policy of intervening in retail rate setting only in the case of disputes—for example, if a certain number of customers filed complaints regarding the terms of service offered by a mini-grid operator. In the absence of such complaints, however, operators and customers would be free to negotiate their own tariff structures.

Benefits	Drawbacks
• Allows market forces to determine rate levels and structures, but provides a fallback option if customers and operators cannot agree or customers are being taken advantage of.	• Requires careful consideration by regulators to ensure that the process of receiving customer complaints is open and fair, and that regulatory action is taken only when necessary.

Recommended Steps for Policy Makers

- Develop a process for accepting customer complaints and determine a threshold for regulatory action (e.g., a raw number of complaints, or a ratio of complaints to total number of customers).
- Consider developing and implementing an appeals or dispute resolution process.
- In cases where regulatory action will be taken, establish a process for determining a fair and reasonable tariff, including a statutory timeframe in which the regulator is required to act. This would include time for consulting with project developers and communities that would be served by the mini-grid.
- Develop guidelines on tariff review (including procedures for filing complaints, making appeals, and resolving disputes), and make the information easily accessible by posting it on the mini-grid regulator's website and including it in the country's guidelines for the mini-grid sector.

Box 22: Tariff Oversight in Uganda

As Uganda's independent regulatory body, the Electricity Regulatory Authority (ERA) controls all matters related to mini-grid retail service regulation. ERA regulates retail service for mini-grids in the same manner as it regulates national grid distribution operators. Each electric service provider must submit a proposed tariff to ERA, which is reviewed by regulatory staff and subsequently adjusted or approved. Developers noted that the current review process can be quite lengthy, and cautioned that if mini-grid applications were to increase, the process could become rather burdensome, both with respect to time and cost.

2.2. RETAIL TARIFF LEVEL

Setting and approving tariff levels is one of the key roles of regulators. Ideally, mini-grid operators recover capital and operating costs through revenues from customer payments; however, as noted in Section 1.6, revenues may be supplemented by subsidies to ensure an adequate return for developers. As it is generally more expensive to provide electricity service to mini-grid customers than to national-grid customers, mini-grid tariffs designed to fully recover developer costs will likely be higher than tariffs for the national grid—a circumstance that can raise complex equity issues, and that may not be acceptable to policy makers.

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In general, emerging economies rely on three main approaches to setting tariffs:

- **Uniform National Tariffs**. All customers in the same tariff category (e.g., residential, commercial, industrial) pay the same retail tariff, no matter where they live or how they receive their electricity (i.e., from the national grid or a mini-grid).
- **Avoided-Cost Tariffs.** When customers transition from other energy sources to the mini-grid, their bills are equal to or below what they would have paid for past energy purchases (e.g., kerosene for lighting).
- **Cost-Reflective Tariffs.** Tariffs allow mini-grid operators to recover their full capital and operating costs and receive a defined and reasonable return.

It is up to regulators to work with the mini-grid sector to determine which approach is most appropriate for their national context.

Guiding Questions:

- Is it acceptable to charge mini-grid customers a higher rate for electricity than national-grid customers?
- Is it acceptable for national-grid customers to subsidize the electricity consumption of mini-grid customers?
- To what extent do regulators have capacity to set retail tariffs independently for each mini-grid developer?

Option 1: Place no restrictions on retail tariff levels

As noted in Section 2.1, regulators may choose not to regulate retail tariffs. If this is the case, regulators will leave the determination of retail tariff levels to project developers.

Benefits	Drawbacks
• Requires few resources on the part of regulators and avoids potential errors in the calculation of tariffs by allowing project developers to determine tariffs. • Allows mini-grid developers to charge cost-reflective tariffs.	• Creates a risk that customers may overpay for retail service.

Recommended Steps for Policy Makers
• Little action is required to implement a market-based approach. • Consider establishing a retail tariff monitoring regime. • Establish a process for intervening in the tariff-setting process if and when necessary. • Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 2: Apply the national grid tariff to mini-grids

Regulators may choose to offer the same tariff for mini-grid customers as for national-grid customers. As it could be deemed unfair for rural mini-grid customers to pay far more for electricity than urban main-grid customers, this approach could be a desirable means of addressing equity concerns. However, because it is unlikely that revenues from a standard national tariff would allow mini-grid developers to fully recover their costs, regulators should provide a supplemental revenue stream, to ensure that investments in mini-grids remains attractive to the private or public sector. Options include either direct subsidies (see Section 1.6) or a cross-subsidization scheme, in which the necessary funds are collected from national grid customers (see Section 2.3).

Benefits	Drawbacks
• May be politically preferable, as it ensures that tariffs will be standard for all electricity customers across the country. • Ensures that rural customers will not pay more for electricity than urban customers. • Generally viewed as a fair and equitable approach, and is easy to communicate and justify to customers.	• When revenues from a standard national tariff are insufficient for mini-grid developers to recover their costs, regulators will need to implement subsidies to make up the difference. • Developing a sustainable subsidy scheme is often challenging (see Sections 1.6 and 2.3). • Without a supplemental revenue stream, regulators and policy makers run a high risk of discouraging investment in and development of mini-grid projects.

Recommended Steps for Policy Makers

- Implement current national tariffs for mini-grid customers.
- Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.
- To maintain investor confidence, develop a subsidization scheme that will allow developers to recover their costs.
- As an initial step, conduct a study of mini-grid developers' revenue needs and projected revenue gaps. (See Sections 1.6 and 2.3 for further discussion of subsidies).

Option 3: Base retail tariffs on avoided customer costs

In the avoided-costs approach, the retail tariff for electricity from mini-grids is equal to or below what customers would have paid for past energy purchases. To calculate a tariff that will be lower than the cost of previous energy sources, regulators could determine current energy costs and apply a percentage discount. The underlying principle is that if developers can supply higher-quality energy services at a lower rate than customers currently pay for other energy sources, customers will be better off overall.

Benefits	Drawbacks
• Ensures that customers will either save money by purchasing energy from mini-grid developers or will at least receive better services for the same level of expenditure. • Motivates developers to be more efficient, and thereby maximize profits.	• Requires regulators to study the costs in question, which can be difficult to ascertain. • Runs the dual risks of (1) setting a rate that is too low for developers to fully recover costs or (2) setting a rate that is higher than what developers actually need to recover costs. • May be difficult for regulators to find the right balance between these two extremes. • Depending on the quality of service provided by the mini-grid, customers may still need to purchase energy from other sources to reach their desired level of supply, which nullifies the principle on which the tariff is based. • Mini-grid customers are likely to pay more for electricity than national-grid customers.

Recommended Steps for Policy Makers

- Conduct a study of customers' current energy costs in areas to be served by mini-grids.
- To ensure that assessments of energy costs are in line with community experiences and that proposed retail rates are adequate to recover developer costs, consult with mini-grid developers, community stakeholders, and others.
- Share the results of the consultations, provide an opportunity to comment, and incorporate the feedback.
- If tariffs are to be set below the cost of other energy resources, determine an appropriate percentage discount.
- Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 4: Calculate cost-reflective retail tariffs individually for each project

Regulators may wish to set retail rates at a level that will allow developers to recover their capital and operational costs, with a reasonable rate of return. One of the most common means of doing so is using the cost-plus approach factoring in the cost of service and projected customer demand. A cost-plus tariff can be calculated for each project applicant and a project-specific retail rate can be approved (Box 23). As suggested in Section 2.1,, this option may be best implemented by allowing developers to propose a retail rate for regulatory review.

Benefits	Drawbacks
• Cost-reflective tariffs are the most effective option for incentivizing private-sector investment in mini-grids. • Maximizes developers ability to recover costs. • Maximizes regulators' ability to ensure adequate cost recovery.	• Likely to result in dramatically different rates for customers of different electricity providers—an outcome that may not be acceptable to regulators or policy makers. • Rural mini-grid customers are likely to pay more for electricity than urban national-grid customers, and customers in different rural areas may pay different rates for essentially the same level of service. • Could require substantial regulatory resources, particularly if many mini-grid projects are developed in the country.

Recommended Steps for Policy Makers
• Design a standard process for determining appropriate, cost-reflective tariffs for each proposed project.[25] As part of this effort, (1) develop a standard financial model that can be used to evaluate project costs, and (2) establish a target rate of return that developers should receive from mini-grid projects. • Ensure that there is enough staff capacity to review proposed project-specific tariffs. • Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

[25] In many cases, regulatory staff will already have developed such a process (as well as the necessary financial models) in the course of conducting cost-of-service studies for utilities. The existing process can be adapted to suit the case of mini-grid operators, though regulators should consider simplifying the process to reflect the fact that mini-grids are smaller than grid-scale distribution networks.

Option 5: Calculate cost-reflective retail tariffs for certain categories of projects and apply them to the entire class

Regulators may wish to adopt a cost-reflective tariff that applies to an entire class of projects (e.g., projects using a particular generation technology, projects of a certain capacity, or projects within a specific location). Any projects that fall within the same class would be subject to the same retail tariff or a retail tariff cap. As noted in Section 2.1,, the best way to implement this option is to have regulatory staff determine tariffs, rather than soliciting proposed rates from developers.

This approach allows project classes with fundamentally different cost structures to charge different rates. Regulators may also wish to allow higher rates to be charged in areas where grid extension is planned, to shorten the cost-recovery period for mini-grid operators.

Benefits	Drawbacks
• Encourages private-sector investment in mini-grids by offering some promise of a specified return. • Lessens the resource requirements associated with project-specific tariffs. .	• Will result in significant differences in the amount customers pay for energy from different service providers like the project-by-project option. • Risks overlooking differences in cost-recovery requirements for certain projects within the same class.

Recommended Steps for Policy Makers
• Develop a framework for classifying mini-grid projects on the basis of technology, capacity, location, or other factors. • Conduct a study of the projected cost-recovery needs for each class, and develop a standard retail tariff for each. • Share the framework and the findings from the cost-recovery study with mini-grid developers and other stakeholders and invite comment. • On the basis of feedback from stakeholders, design a standard process for determining appropriate, cost-reflective tariffs for each class of projects. As part of this effort, (1) develop a standard financial model that can be used to evaluate project costs within each class, and (2) establish a target rate of return. • Consider whether to allow adjustments based on project-specific circumstances. • Consider implementing an appeals process for projects that are unable to recover costs through the designated tariff. • Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Box 23: Cost-Plus Approach for Setting Cost-Reflective Tariffs

One of the most common approaches to setting cost-reflective tariffs is the cost-plus method. Under the cost-plus approach, the regulatory asset base is determined by assessing the value of the asset in use for the regulated service. The objective is to determine what it would cost to replace the asset today, factoring in inflation and depreciation.

Using the cost-plus approach for each mini-grid project requires significant regulatory resources. As a result, some countries, such as Nigeria and Senegal, are in the process of establishing more standardized procedures. In Senegal, they are developing tariff caps for different classes of projects based on technology and subsidy level. In Nigeria, the regulator is developing a cost-plus software tool.

Source: IRENA 2016b

Further Reading

Discusses tariff regulation and retail tariff setting in detail:

- EUEI PDF. 2014. *Mini-Grid Policy Toolkit*. Chapter 4: Mini-Grid Economics. http://www.minigridpolicytoolkit.euei-pdf.org/
- IRENA. 2016. *Policies and Regulations for Private Sector Renewable Energy Mini-Grids*. Chapter 3: Policies and Regulations to Support Private Sector Mini-Grids. http://www.irena.org/DocumentDownloads/Publications/IRENA_Policies_Regulations_minigrids_2016.pdf
- Tenenbaum et al. 2014. *Bottom-Up Approaches*. Chapter 9: Regulatory Decisions for Small Power Producers Serving Retail Customers: Tariffs and Quality of Service. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?sequence=1&isAllowed=y
- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation.* Chapter 7: Standard Tariff Methodology. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Tools

Provides an Excel-based tool for evaluating and setting retail tariffs:

- EUEI PDF. 2014. *Retail Tariff Tool*. http://minigridpolicytoolkit.euei-pdf.org/support-tools

  Provides a standardized tariff-setting tool:

- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation*. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Box 24: Retail Rate Levels in Uganda

The Electricity Regulatory Authority (ERA) works with developers to determine individual tariffs for each project. The developer proposes a retail tariff that adequately covers costs, and ERA reviews the proposed tariff and either amends or approves it. Tariffs are automatically updated quarterly, based on inflation and other factors, and service providers undergo a full rate review every five years. Developers may request additional reviews if warranted by a change in the project's financial condition, though developers noted that this can be a lengthy process.

Although the tariffs are in theory supposed to be cost reflective, in practice they are close to the national grid tariff. Stakeholders from government and the private sector stated that it is difficult to adhere to the cost-reflective principle. Government officials noted that it can be politically challenging to charge poor rural customers higher rates than the national tariff and to charge customers who live in close proximity dramatically different rates (e.g., a village that is grid connected may be closely located to a village that relies on a mini-grid). Officials also expressed concern about rural customers' ability to pay higher tariffs.

Several developers noted that they were able to charge a rate that was close to the rate for the national grid. One observed that this was possible because of financial support from the Rural Electrification Agency, which came in the form of distribution-grid funding. Others noted that they charged rates that were above national levels, or planned to gradually increase rates to a level above national tariffs. A number of developers also noted that the tariffs they charged were inadequate to fully recover their costs at current demand levels, and/or that projected payback times were longer than normally expected by East African businesses.

Box 25: Country Spotlight: Peru's Approach to Rural Retail Tariff Regulation

In 2007, the Peruvian government passed a comprehensive rural-electrification law to increase the level of rural electrification, which was at 30 percent at the time (General Law of Rural Electrification, 2007; Revolo, 2009). The law states that OSINERGMIN (Organismo Supervisor de la Inversión en Energía y Minería), the national regulatory authority, is responsible for determining maximum rural retail rates that will ensure the economic sustainability of rural electrification (Ministry of Energy and Mines, 2007). Under this mandate, OSINERGMIN has capped rural retail tariffs at the maximum regulated urban retail rate (Revolo, 2009).

To sustain the reduced rural tariffs and promote investments in rural electricity, the government has established three types of subsidies. Two of the subsidies—a capital cost subsidy and an operational cost subsidy for both generation and distribution—are designed to reduce development and distribution costs for isolated mini-grids and are financed by the rural electrification fund, the national budget, and international loans and grants. The third subsidy, which is directly applied to the rural retail rate, is a cross-subsidy scheme funded by a 3% surcharge on all customers who consume more than 100 kilowatt-hours (kWh) of electricity per month (Tenenbaum et al., 2014). The beneficiaries of the cross-subsidy are customers of both autonomous and grid-interconnected systems who consume up to 100 kWh per month (Revolo, 2009).

The cross-subsidy is administered by OSINERGMIN, which is responsible for calculating the amount each utility has to contribute, as well as the amount each rural electricity service provider will receive, based on the number of customers (Tenenbaum et al., 2014). This subsidy has reduced retail rates for rural, isolated mini-grid customers with monthly consumption of 30 kWh or less by up to 62.5% (Revolo, 2009). Customers with monthly consumption of 30 to 100 kWh are not charged for 18.75 kWh of their total electricity consumption, to subsidize their electricity cost. Overall, Peru realized a significant increase in electricity coverage in rural areas within a span of three years, reaching 55 percent by 2010 (World Bank, 2011).

2.3. CONSUMER SUBSIDIES

As noted in Section 1.6, the two main types of subsidies relevant to mini-grid development are producer subsidies and consumer subsidies. This section focuses on the regulation of consumer subsidies, which can take one of two forms:

- A connection subsidy, which reduces the cost of connecting to the mini-grid; or
- A consumption subsidy, which reduces the retail tariff on an ongoing basis.

Connection costs can be quite high, and are often burdensome for mini-grid customers. Connection subsidies are one-time, up-front payments that cover those costs. Consumption subsidies are ongoing payments that are often funded through cross-subsidization schemes.

The goal of any mini-grid consumer subsidy program is to improve electricity access and affordability. Subsidies should be large enough to accomplish their goal but low enough to conserve scarce resources.

Guiding Questions:

- Does the government have sufficient resources to subsidize connection or consumption costs?
- Is cross-subsidization among customer classes politically feasible and publicly acceptable?
- Are subsidies best used to allow more customers to connect to mini-grids, or to reduce retail tariffs?

Option 1: Provide no consumer subsidies, including cross-subsidies, to mini-grid customers

It is not a given that subsidies must or should be provided to mini-grid customers, particularly if developer subsidies are sufficient to reduce retail tariffs to an affordable level. If customers are capable of paying connection and consumption costs, subsidies may not be needed to secure widespread energy access. This is particularly true if customers can obtain loans to cover connection costs.

Benefits	Drawbacks
• Preserves government funds for other purposes and mitigates the need for cross-subsidization from other ratepayers.	• Goals for rural electrification may not be achieved, if customers are unable to pay connection or consumption fees without subsidies of some sort.

Recommended Steps for Policy Makers
• No action is required if regulators choose not to offer consumer subsidies. • Consider conducting a study, with community stakeholder participation, to evaluate the ability of rural mini-grid customers to pay connection and consumption costs.

Option 2: Subsidize customer connection costs

Up-front connection costs can be a significant barrier to mini-grid participation. Customers capable of paying ongoing consumption costs may be unable to afford the cost of the initial connection. Costs may be subsidized either through grants or low-cost loans. Grants can be either direct (from government or other donors) or indirect, in which case developers are required to waive connection fees, and the government compensates them to make up the difference.

Benefits	Drawbacks
• Can be a particularly effective targeted use of subsidies that increases access to energy and create new customers for mini-grid developers.	• Connection cost subsidies can require a substantial funding commitment from government or international development agencies. • May be challenging to establish a long-term, sustainable funding source to subsidize connection costs.

Recommended Steps for Policy Makers
• Determine whether subsidies should be (1) provided directly to customers or to developers on their behalf; (2) structured in the form of a grant or a low-cost loan; or (3) waived. • Consult mini-grid developers and other key stakeholders during the decision-making process. • If connection costs are subsidized or waived, identify another means of providing developers with the funds needed to recover costs. • Once the approach is selected, develop guidelines that describe the government's approach to customer subsidies and outline the process for accessing them. This information should be made easily accessible on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Option 3: Rely on national-grid customers to cross-subsidize retail tariffs of mini-grid customers

In a cross-subsidy scheme, national-grid rates increase slightly so that mini-grid rates can be lowered; the extra funds collected from national-grid customers are then used to compensate mini-grid operators for the decrease in revenue that results from charging lower tariffs. Such a scheme could be implemented either by generally increasing retail tariffs for national grid customers, or by adding a special charge to the bills of national-grid customers. The mechanism for implementing a cross-subsidization scheme will vary depending on the ownership structure of the national electric grid. Where both the national grid and mini-grids are state owned, the national utility may simply charge a slightly higher, but uniform, tariff to all customers and use the additional revenues to subsidize the cost of operating mini-grids. In contexts with private ownership of mini-grids, a special charge may be added to national-grid customer tariffs, which is then collected and conveyed to mini-grid operators to make up for the reduction in mini-grid retail rates. If a country opted to apply a uniform national tariff to mini-grid customers (see Section 2.2), a cross-subsidy would be one means of ensuring cost recovery on the part of mini-grid operators.

Benefits	Drawbacks
• May be a politically preferable in addressing the high costs of mini-grid service where urban customers with the ability to pay, support electricity service for rural customers who have limited ability to pay. • Can make it possible to charge mini-grid customers the standard national tariff, as the resulting decrease in revenue would be addressed.	• Shifts the costs of mini-grid development and operations onto national-grid customers, potentially raising equity concerns. • Countries with a low electrification rate can have limited opportunities for cross-subsidies, as the small number of national-grid customers may have difficulty bearing the costs of extensive mini-grid deployment.

Recommended Steps for Policy Makers
• To determine an appropriate cross-subsidy amount, consider conducting a study of both national-grid and mini-grid customers' ability to pay. • Establish a mechanism for collecting a portion of retail revenue from national-grid customers to support cost recovery for mini-grid projects—for example, through direct payments to mini-grid operators. • Once a decision is made on the structure of cross-subsidization, develop guidelines that outline the process for disbursing payments to mini-grid operators and make the guidelines easily accessible.

Option 4: Cross-subsidize retail tariffs within classes of mini-grid customers

Regulators may also wish to allow cross-subsidies across different classes of mini-grid customers. Typically, this would mean that mini-grid customers with a higher ability to pay (e.g., industrial or commercial facilities) would pay a higher rate for electricity, while mini-grid customers with a lower ability to pay (typically residential customers) would pay a lower rate. This scheme could be implemented either through a cost-reflective tariff or a tariff based on avoided costs, with separate discount levels for different customer classes (see Section 2.2).

Benefits	Drawbacks
• Allows developers to maximize the number of customers who can pay for service, without relying on external subsidies or cross-subsidies from national-grid customers.	• May be seen as inequitable as it assigns different prices to different customers and may therefore be politically unfavorable. • Could be open to criticism for discouraging private sector investment in rural areas since industrial customers can pay more for electricity and would likely be given a higher tariff. • Risks encouraging industrial customers to use other sources of power (such as diesel gensets), rather than purchasing from a mini-grid operator. • Likely viable only in service territories where there are customers with greater ability to pay (e.g., industrial or commercial customers).

Recommended Steps for Policy Makers
• Conduct a study to consider the viability of imposing different tariffs on different classes of customers. • Share the study findings with mini-grid developers and operators, solicit comments, and incorporate input into the final study. • Incorporate the study findings into the cost models that are used to set mini-grid retail tariffs. • Implement the cross-subsidy scheme in close consultation with mini-grid developers. • Once the cross-subsidy is in place, establish a mechanism for monitoring whether tariffs provide an appropriate amount of revenue to mini-grid operators, and adjust if needed. • Develop guidelines that describe the regulator's approach to cross-subsidies for retail tariffs and make the information easily accessible to mini-grid developers and operators.

Further Reading

Provides detailed guidance on regulatory treatment of consumer subsidies, including examples from specific countries:

- Tenenbaum et al. 2014. *From the Bottom Up*. Chapter 5: The Regulatory Treatment of Subsidies, Carbon Credits, and Advance Payments. https://openknowledge.worldbank.org/handle/10986/16571
- RECP et al. 2013. *Guidelines on Ownership, Funding, and Economic Regulation.* Chapter 7: Standard Tariff Methodology. http://www.euei-pdf.org/en/recp/supportive-framework-conditions-for-green-mini-grids

Box 26: Consumer Subsidies in Uganda

Uganda's Electricity Regulatory Authority (ERA) does not offer direct subsidies to end users. In theory, customers pay cost-reflective tariffs that fully cover the costs of providing service, as well as a connection cost that fully covers the cost of grid connection. Mini-grid developers noted that in practice, however, the tariff approved by ERA is often not fully cost reflective and is instead adjusted downward to be closer to national tariff levels. In addition, as the cost of connection is often too high for rural customers, in certain cases the Rural Electrification Agency through the Rural Electrification Fund has subsidized or covered customer connection costs. Moreover, the Uganda Energy Credit Capitalization Company developed a partnership with Centenary Bank to offer low-cost financing for connection costs to customers of the West Nile Rural Electrification Company. Nonetheless, covering customer connection costs is not standard practice.

Box 27: Country Spotlight: Cross-Subsidization in the Philippines

The Cross-Subsidy

The Energy Regulatory Commission (ERC) of the Philippines has established a cross-subsidy that is designed to lower electricity tariffs for mini-grid customers in rural areas. The subsidy is funded through a "universal charge" on the electricity bill of national-grid customers. The funds go directly to the mini-grid operator and are designed to cover the difference between the operator's costs and the revenues collected from mini-grid customers. The subsidy ensures that mini-grid customers' tariffs are no more than 50% of national-grid tariffs.

As generation costs come down, the government is expected to gradually phase out the subsidy. However, as most mini-grids in the Philippines are diesel-based, the continued volatility of diesel prices has delayed the phase-out.

Challenges in Phasing Out the Subsidy

The ERC has the authority to set and adjust retail tariffs as well as consumer subsidies but has struggled to do so over the past decade. The regulator noted that it is difficult to reduce subsidies and raise tariffs when electricity prices have remained low and constant for an extended period. Moreover, the regulator faces a dual challenge: trying to raise mini-grid customers' tariffs while reducing mini-grid operators' subsidies. It is especially difficult to reduce subsidies to mini-grid operators because they have been given no incentive to reduce their generation costs, refurbish or upgrade their power plants, or improve the efficiency of their operations. As a result, their operating costs remain relatively high, and they are very dependent on the subsidies.

Source: Interview with Floresinda G. ("Rexie") Baldo-Digal, Director III of Regulatory Operations Service, Energy Regulatory Commission, the Philippines.

2.4. RETAIL TARIFF STRUCTURE

Retail tariff structure refers to both payment structures (e.g., flat or per-kilowatt-hour charges) and metering mechanisms (prepaid or postpaid). Retail tariffs are usually structured as **energy-based payments**, **demand-based payments**, **flat payments**, **pay-as-you-go payments**, or a combination there of.

- Energy-based payments are based on the amount of energy consumed (measured in kilowatt-hours [kWh]).
- Demand-based payments are based on the peak power consumed (measured in kW) in a given payment period.
- Flat payments are fixed payments per month (or other payment period), regardless of consumption level.
- Pay-as-you-go (PAYG) payments are based on pre-purchasing "energy credits" when possible and that can be consumed when desired.

Other options for structuring retail tariffs that often build off some of the principles discussed above include (Philipp, 2014):

- Energy as a service: energy is not sold per unit of energy, but for the energy service provided.
- Per-device tariff: the fee is based on the number and types of devices.
- Seasonal tariff: the price is established based on the seasonal variation of renewable energy availability (e.g. for hydropower systems there may be one price during the dry season and one price during the wet season).
- Lifeline and inverted block tariff: the tariff increases with consumption and there is often a cross-subsidy from high to low-consumption customers.
- Binomial tariff: a fixed value is paid per month usually in accordance to the available power (per kW) and a variable cost is paid for the electricity consumed (per kWh).
- Time of Use (TOU) tariffs: the tariff can vary by time of day (peak/non-peak) and can be responsive to the generation costs during different times of the day. Could also be affected by the need of energy storage or a diesel generator to guarantee the availability of electricity/power at a certain moment in time.

Additionally, tariffs can either be **prepaid** or **postpaid**. In the case of prepaid tariffs, customers pay for a certain amount of electricity up front. Once the corresponding amount of electricity has been used, customers can top up their account, if desired. In the case of postpaid tariffs, customers are billed for the cost of their electricity consumption at the end of the billing period.

Regulators may allow mini-grid operators to determine payment structures and metering mechanisms, or they may require operators to use the same structure and mechanism as the national grid.

Guiding Questions:

- What retail tariff structure offers the right incentives to mini-grid operators and customers?
- What retail tariff structure is the most appropriate or similar to current economic practices?

Option 1: Do not require a specific tariff payment or metering structure

Regulators may wish to allow developers to select their own tariff payment structures and metering mechanisms. In this case, there is likely to be some variety: for example, some operators may select an energy-based system, while others will opt for a flat monthly fee and use load limiters to manage customer demand. Operators may choose to implement different metering mechanisms as well (prepaid versus postpaid).

Benefits	Drawbacks
• Allows operators to tailor their systems to their business model. • May increase the likelihood that projects will be economically sustainable. • Avoids the risk of inadvertently requiring a payment or metering system that is difficult to implement for mini-grid projects. • Enables mini-grids to cater to the needs of customers who earn seasonal or otherwise irregular income.	• May increase the difficulty of eventually integrating mini-grids into the national grid, as both metering technology and customer expectations may differ across regions. • May raise burden on regulatory staff, who must review and compare drastically different retail tariff structures and ensure that they are reasonable.

Recommended Steps for Policy Makers

- Communicate to mini-grid operators that they are free to implement their own tariff payment structure and metering systems.
- Make the information easily accessible to mini-grid developers and operators.
- Develop a plan for how payment and metering systems will change upon arrival of the national grid; for example, determine whether customers will continue to use existing payment and metering systems or transition to the system in place on the national grid. (See Section 3 for more detailed discussions of the technical aspects of grid connection.)
- Adjust the process for reviewing developers' tariff proposals to accommodate different payment and metering methods.

Option 2: Require mini-grid operators to use the same payment structure and metering mechanism as the national grid

Under this approach, mini-grid operators would be required to adopt the national-grid tariff payment structure and metering requirements. In general, national-grid utilities use an energy-based payment system. National-grid metering systems differ across countries, but most have specific metering requirements.

Benefits	Drawbacks
• Standardizing payment structures and metering systems. • Can reduce demands on regulatory staff, as retail tariffs from different mini-grid projects can easily be compared to each other and to national-grid tariffs.[26] • Can improve communications with consumers, who will follow a similar payment structure nationwide. • Can ease the difficulties associated with connection in the event of national grid extension.	• Some mini-grid business models may have difficulty adapting to a standardized structure. • For example, it may be difficult for a solar-based mini-grid project to accommodate a kWh-based payment system that does not send price signals to customers regarding times of peak or off-peak use.

Recommended Steps for Policy Makers
• Consult with mini-grid developers and operators about the prospect of requiring the same payment structure and metering mechanisms as the national grid, and incorporate the feedback into decision making. • On the basis of the consultations, develop rules on payment structure and metering systems and share them widely with mini-grid developers and operators. This could include (1) posting the rules on the regulator's website, (2) including them in guidance on tariff rate setting and technical standards, and (3) incorporating them into the country's guidelines for the mini-grid sector. • If mini-grids are already active in the country, develop a transition strategy, or consider allowing older systems to maintain their current payment and metering systems and applying the rules to new mini-grids. • Update tariff review and approval processes to accommodate standardized payment structures and metering systems.

[26] Standardizing payment structures does not mean that tariffs are equal across all mini-grid projects; it simply means that payment structures will be identical (e.g., energy-based). The retail tariff level is a different decision, and is discussed in Section 2.2.

Further Reading

Provides a detailed discussion of payment mechanisms and metering options:

- Tenenbaum et al. 2014. Bottom-Up Approaches. Chapter 9: Regulatory Decisions for Small Power Producers Serving Retail Customers: Tariffs and Quality of Service. https://openknowledge.worldbank.org/bitstream/handle/10986/16571/9781464800931.pdf?sequence=1&isAllowed=y

Box 28: Metering Mechanisms in Uganda

Prepaid metering is required throughout Uganda, for both mini-grid and national grid customers. Several developers noted that these requirements impose additional up-front costs on their part. One developer noted, however, that they had received funding support from the Rural Electrification Agency for meter upgrades, and that prepaid metering had made business operations easier. With universal prepaid metering, mini-grid customers are charged for consumption per kilowatt-hour.

3 TECHNICAL STANDARDS

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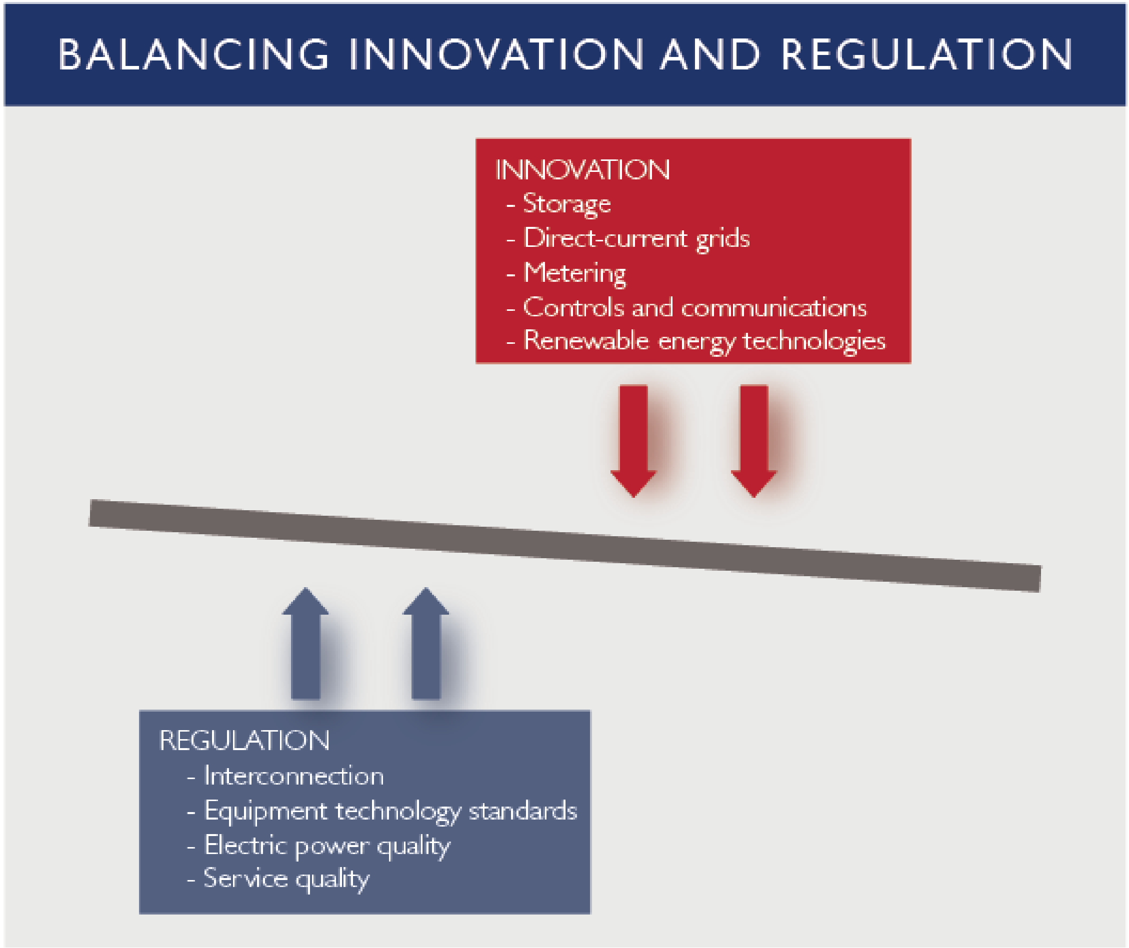
3 TECHNICAL STANDARDS

Technical standards are the third pillar of mini-grid regulation. Regulators are responsible for determining technical standards for eventual connection to the national grid; for equipment; for the quality of the electricity supplied; and for service quality.

One of the key concepts regulators must consider when developing technical standards for grid connection is interoperability. Interoperability refers to the capability of two or more networks, systems, devices, or components to interact, communicate, and exchange information securely and effectively (IEEE, 2011). Interoperability is relevant to both mini-grid connection to the national grid (Section 3), and to the connections between mini-grids and their own equipment (Section 3.2). Interoperability will be addressed throughout this section.

Regulators must determine whether to require mini-grids to comply with national-grid technical standards or to allow for more flexible requirements (which may facilitate the deployment of autonomous mini-grids). Regulators must then develop procedures, specifications, and monitoring systems that ensure safe, reliable, affordable, and quality access to electricity. At the same time, regulators should avoid imposing burdensome standards that would render mini-grid development prohibitively expensive, discourage the growth of the sector, or hinder innovation (Figure 5).

Figure 5: Balancing Regulation and Innovation



This section focuses on four key issues that may necessitate regulation:

- Interconnection of mini-grids to the national grid;
- Technology standards for mini-grids;
- Electric power quality; and
- Service quality.

3.1. INTERCONNECTION TO THE NATIONAL GRID

As rural electrification efforts continue, areas targeted for autonomous mini-grid development today may eventually connect to the national grid. Regulators can require mini-grids to be compatible with national-grid technical standards from the beginning, or can require technical upgrades when the grid arrives. Regulators must bear in mind that designing and constructing a mini-grid to comply with national grid standards can be costly and cumbersome for mini-grid developers and may create barriers to deployment, especially for smaller-scale mini-grids. If the goal is to encourage mini-grids, regulators may want to develop more flexible technical standards for grid connection.

In order to interconnect to the national grid, mini-grids must be compatible with the national grid's conductor characteristics, distribution network, generation equipment, grounding, inverters, nameplate capacity, surge protection, switchgear, and transformers. The ability of the mini-grid to interconnect to the national grid—commonly referred to as "grid-readiness"—can be required from the outset or delayed until the national grid arrives.

When interconnecting a mini-grid to the national grid, one of the major concerns is maintaining power quality. To guarantee power quality, mini-grid developers and operators, regulators, and the national utility need to consider several technical issues, including the following (Grimley & Farrell, 2016; Greacen, Engel, & Quetchenbach, 2013):

- The ability to disable mini-grid equipment that modulates fuel supply (in the case of diesel or hybrid systems);
- The ability to quickly disconnect and reconnect the mini-grid to the national grid during distribution-network failures;
- The ability of the mini-grid to change over to islanded mode, in which the mini-grid disconnects from the national grid but still produces power for the mini-grid;
- The assessment/analysis of electrical ratings and fault ratings;
- The impact of mini-grid storage systems on power quality; and
- Overall compliance with national grid standards.

Another interconnection consideration is different operating regimes of the national grid vs the mini-grid. For example, in some remote areas the national grid operator may only provide 12 hours of service or less[27], meanwhile the mini-grid may have the capacity to provide 24 hours of service. This can create an interconnection challenge, but it can be managed through flexible interconnection standards. Fortunately, technological innovations are starting to ease many of the technical challenges, including those associated with hardware integration (IRENA 2016a). Nevertheless, a number of issues still remain, and must be taken into account by mini-grid developers, regulators, and the

[27] This is the case for diesel-based generation which is costly and hence the grid operator maintains limited service to reduce running costs.

national utility, in the event of interconnection to the national grid. (See Section 1.5 for a discussion of mini-grid ownership structures following connection to the national grid.)

One of the main options for easing the technical challenges of grid interconnection is to develop grid interconnection standards, which are usually included in the national grid codes.[28] Few efforts are currently being made, however, to establish such standards, e.g. interoperability requirements that are specific for autonomous mini-grids. Thus far, the development of information and standards on interoperability is being led by industry consortiums focused on interconnected rather than autonomous mini-grid deployment. For example, in the United States, the Smart Grid Interoperability Panel (SGIP) focuses mainly on how mini-grids can be integrated into the national grid through embedded networks, smart grids, or interconnected mini-grids (SGIP, 2015; Bower et al., 2014).[29] Additionally, very few countries have developed interconnection standards specific to interconnecting autonomous mini-grids to the national grid. Sri Lanka is one of the few that has successfully developed interconnection standards and procedures for mini-hydropower plants.

As rural electrification efforts continue, areas targeted for autonomous mini-grid development today may eventually connect to the national grid. Regulators can require mini-grids to be compatible with national-grid technical standards from the beginning, or can require technical upgrades when the grid arrives. Regulators must bear in mind that designing and constructing a mini-grid to comply with national grid standards can be costly and cumbersome for mini-grid developers and may create barriers to deployment, especially for smaller-scale mini-grids. If the goal is to encourage mini-grids, regulators may want to develop more flexible technical standards for grid connection.

Box 29: Institute of Electrical and Electronics Engineers 1547: Standard for Interconnecting Distributed Resources with Electric Power Systems

The Institute of Electrical and Electronics Engineers (IEEE) 1547 is an international standard that (1) establishes technical specifications and testing of interconnection and (2) provides requirements on performance, operation, safety, and maintenance. IEEE 1547 focuses on distributed generation (e.g., synchronous machines, induction machines, and power inverters) with an aggregated capacity of 10 megavolt amperes and their interconnection to primary and/or secondary distribution voltages (IEEE, 2014).

Further Reading:

Provides uniform standards and requirements for interconnection and interoperability performance, operation, testing, safety, maintenance, and security considerations:

- IEEE. 2014. *SA—1547: Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*. http://standards.ieee.org/develop/project/1547.html

[28] Grid codes govern the electricity market—ensuring power quality and reliability, security of supply, and stable operation.

[29] The SGIP is a cross-sectoral industry consortium seeking to accelerate grid modernization and establish an energy "internet of things" through knowledge sharing and the development of standards.

In the absence of specific interconnection standards for autonomous mini-grids, regulators can rely on or refer to international interconnection standards for distributed-generation interconnection, which lay out the technical requirements to be met by generation technologies, electrical equipment, and other aspects of electrical power systems (IRENA, 2016c; see Box 29).

As regulators consider regulations for grid connection, they will have to determine how strict technical standards will be, set requirements for communication protocols, and detail the process for interconnection.

Guiding Questions:

- What areas are planned for national grid extensions in the short, medium, or long term?
- Would grid interconnection requirements be burdensome for projects that may require a more immediate return on investment (e.g., small projects, community-owned projects, projects that could run more affordably on direct-current power)?
- What are the potential impacts on mini-grids of not being grid-ready?
- What is the cost of ensuring that mini-grids can connect to the national grid?
- Can mini-grids be upgraded or modified when the national grid arrives?
- Will communication be required between the national grid and mini-grids?
- Are there any discrepancies or challenges with the operating regime of mini-grid and national grid service?

Option 1: Do not require mini-grids to be grid-ready

Regulators may choose not to require mini-grids to adhere to the technical requirements established for the national grid. This approach can be particularly beneficial (1) in areas that have no prospect of interconnecting to the national grid, such as remote islands or communities, and (2) for smaller mini-grids, where the small load does not justify rigorous grid-interconnection regulation. Regulators may also opt to deal with interconnectivity once the national grid arrives, and instead focus on fostering a faster deployment of autonomous mini-grids.

Benefits	Drawbacks
• Significantly lowers the costs for mini-grid developers, particularly in case of smaller systems. • Simplifies the application processes for licenses and concessions. • Provides developers with more system design flexibility and leaves room for innovative solutions. • No need for regulators to dedicate resources to defining procedures, standards, and requirements.	• Can make interconnection more difficult and expensive due to lack of technical regulations. • May result in conflicts between mini-grid developers and the national utility and may complicate or delay the interconnection process—and ultimately impact customers. • Regulators may propose costly and time-consuming interconnection studies in the absence of regulations.

Recommended Steps for Regulators

- Limited action is required from regulators who choose not to impose technical requirements for grid interconnection during the initial construction of mini-grids. As part of making this choice, however, regulators may wish to take the following steps:
  - Engage stakeholders in determining the likelihood that potential mini-grid sites will be interconnected to the national grid.
  - Identify barriers, including potential costs, if mini-grid developers must adhere to technical requirements.
  - Develop a process for dealing with technical issues as they arise.
  - Define the ownership model, as well as technical and economic requirements (e.g., tariff review and setting), before interconnection (see Section 1.5 and 2).
  - Develop recommendations or nonbinding guidelines on interconnection that mini-grid developers can take into consideration when developing projects.
  - Define a standard method for carrying out technical studies before grid connection. The method should address procedures, responsibilities, time frame, and costs.

Option 2: Develop interconnection requirements based on project classes or categories

Using a classification system provides a more flexible approach to determining interconnection requirements. Under this option, regulators establish standard technical regulations for mini-grid interconnection based on project classes, which can take into account capacity, location, technology, or other characteristics (See Section 1.4 and Rickerson et al. 2012 for other considerations related to mini-grid categorization).

Regulators can also determine whether mini-grids have to meet the standards from the outset, or whether adaptations can be made once the national grid arrives. This can depend on factors such as the capacity and location of the mini-grid, and grid extension plans. For example, smaller systems could have less rigorous technical requirements during construction and minimal system upgrades upon interconnection (since they could, for example, be connected to the low-voltage line).

Benefits	Drawbacks
• Protects mini-grid developers from having to comply with excessive requirements for very small projects, or for projects that might never be interconnected to the national grid. • More flexible standards can make the regulatory process more accessible and support mini-grid deployment. • A standard process can lead to quicker response times to interconnection requests. • Relieve mini-grid developers of uncertainty when interconnecting, thereby reducing project costs and risks.	• Can result in a more cumbersome and unpredictable regulatory process, requiring regulators to expend significant resources defining different mini-grid types, establishing different standards and levels of implementation, and addressing other aspects of interconnection. • Setting boundaries between one class of mini-grid and another can be challenging.

Recommended Steps for Regulators

- Assess the variability among current and potential mini-grids, in order to classify by aspects such as capacity, location, and technology.
- Assess the challenges that mini-grid developers might face if technical requirements are too strict or too lenient.
- Based on this assessment, establish different technical requirements and standards for different classes of mini-grid; these requirements and standards could apply to mini-grid equipment during construction, as well as to the technical studies required before interconnection.
- To ensure that the requirements established are (1) realistic for different mini-grid classes and (2) accessible to all developers, adopt a streamlined procedure for interconnection.
- Provide tools—and perhaps funding—to support mini-grid developers.

Option 3: Require all mini-grid projects to be capable of interconnection to the national grid

Regulators can require that all mini-grids—regardless of capacity, location, or technology—be built to the same technical standards as the national grid. In this case, mini-grids will be ready for interconnection and will not require upgrades or major investments when the grid arrives.

Benefits	Drawbacks
• Mini-grids will be ready for interconnection and will not require upgrades or major investments when the grid arrives. • The quality of the electricity provided can generally be expected to be the same across mini-grids and the main grid. • Simplifies the work of regulators, who can implement the same standards and procedures across all mini-grids. • Knowing the national standards upfront, mini-grid developers will have more clarity on investment returns. • The added cost can be built into retail rates under cost-reflective tariffs (if permitted).	• Requires larger investments from mini-grid developers, who will need to dedicate more resources to equipment, testing, and commissioning. • Higher costs will have an impact on retail tariffs, unless they are reduced through government subsidies. • May impose a barrier for smaller-scale projects. • Regulators may face difficulties in implementing the same standards across the wide spectrum of mini-grid types. • Stringent standards may slow down innovation in the mini-grid sector.

Recommended Steps for Regulators
• Make national-grid technical standards available to all mini-grid developers. • Incorporate adherence to national-grid technical standards into the licensing and approvals process. • Establish a streamlined monitoring process for ensuring that mini-grids comply with national-grid standards, including in the testing and commissioning process. • Undertake periodic monitoring to ensure that all mini-grids are operating within the technical parameters of the national grid.

Box 30: Interconnection to the National Grid in Uganda

Uganda's Electricity Regulatory Authority (ERA) requires mini-grids to be compatible with the national grid and to adhere to all national-grid technical standards, including equipment rating and performance, safety, and reliability. ERA staff noted that this is necessary if projects are intended to eventually be connected to the main electricity grid—a strong likelihood in the long term.

To transition from an autonomous mini-grid to an interconnected mini-gird, projects must demonstrate they meet the technical standards of the national grid and apply to ERA for a generation or distribution and sale license for interconnection with the main grid.

Because of the nature of many Ugandan mini-grids, these requirements (particularly those regarding reliability) are occasionally difficult for mini-grid projects to meet. For example, several mini-grids have distribution networks of 100 kilometers or more and serve widely dispersed populations. Hence, reliability can be dramatically hindered (and maintenance costs dramatically increased) by line failures in remote areas.

Many small developers, for whom distribution costs are funded through the Rural Electrification Fund (REF) by the Rural Electrification Agency (REA), have found the requirement to meet national-grid technical standards acceptable because they are not exposed to the costs of compliance. However, the West Nile Rural Electrification Company (WENRECO), which is responsible for distribution costs and has a widely dispersed distribution network, reported that the requirement to meet national standards is burdensome. In WENRECO's view, technical standards developed for populated areas should not be applied to sparsely populated rural areas where they are difficult to meet, and where redundancy in the distribution network is not viable.

Box 31: Country Spotlight: Technical Standards for Interconnection in India

- In India, the relationship between mini-grids and the national grid is still to be determined. Until now, India has had almost no technical standards to enable the interconnection of mini-grids, with some exceptions that vary by state. As a result, developers have been granted the flexibility to select their own equipment and system designs. In some cases, this has supported the deployment of minimalist mini-grids in areas that would otherwise have been unlikely to be the sites of development. For example, the private developer Mera Gao Power had by 2014 deployed hundreds of low-cost, direct-current-based mini-grids in rural areas in the region of Uttar Pradesh (GNESD, 2014). As discussed in Box 32 direct-current-based mini-grids are far more affordable to develop than alternating-current grids, but are expensive and difficult to interconnect to the national grid.
- Currently, national policy guidance stipulates only that if a mini-grid seeks to connect to the national grid, the State Electricity Regulatory Commission must approve the tariff. It seems, however, that India is considering implementing further regulations. In June 2016, the Ministry of New and Renewable Energy (MNRE) closed a comment period on a document containing a proposed regulation that includes grid connection technical standards. According to the document, the MNRE recommends that larger projects (greater than 10 kilowatts) or clustered small projects meet main-grid technical standards, in order to enable interconnection. The document also specifies minimum performance standards designed to achieve 24/7 supply (a minimum of eight hours during peak hours over a 24-hour period), an expectation that is more in line with the quality standards of the national grid than the current performance of mini-grids. Finally, the document proposes mandatory safety and component-quality standards, though specific component-quality guidelines have not yet been published. The MNRE intends to give state authorities responsibility to designate the technical standards that will ultimately be required for connection (MNRE, 2016).
- Beyond technical standards, it appears that more work still needs to be done in terms of designing controls to manage isolation and islanding of mini-grids in a way that both distribution companies and mini-grid operators will find fair. Currently, mini-grid developers are expected to cease generation if the grid arrives at a site, even if the national grid is unreliable and the mini-grid could offer an alternative supply to customers. Once the MNRE puts forth technical standards for mini-grids, it will be easier to understand how those requirements might influence the relationship between mini-grid developers and distribution companies, and anticipate the potential benefits and challenges of the proposal for a substantial overhaul of the off-grid regulatory environment.

Further Reading

Provides technical guidelines and standards, and/or offers considerations relevant for the interconnection of mini-grids:

- Greacen et al. 2013. *A Guidebook on Grid Interconnection and Islanded Operation of Mini-Grid Power Systems Up to 200 kW*. http://www.cleanenergyministerial.org/Portals/2/pdfs/A_Guidebook_for_Minigrids-SERC_LBNL_March_2013.pdf
- IEA. 2011. *Design and Operational Recommendations on Grid Connection of PV Hybrid Mini-Grids*. http://iea-pvps.org/index.php?id=227&eID=dam_frontend_push&docID=1027
- Dvorsky, E., & Hejtmankov, P. 2006. *Microgrid Interconnection to Distribution Power Networks*. https://doi.org/10.1109/TDC.2006.1668505
- IEEE. 2014. SA—1547: *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*. http://standards.ieee.org/develop/project/1547.html

Country Examples

Provides examples of technical guidelines for grid interconnection specific to autonomous mini-grids:

- EWURA. 2011. *Guidelines for Grid Interconnection of Small Power Projects in Tanzania*. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Tanzania_Approved-Guidelines-for-Grid-Interconnection-Part-B-March-2011.pdf
- World Bank. 2012. *TANESCO Grid Code for Embedded Generation*. http://www.minigrids.go.tz/Files/TANESCO_Grid_Code_for_Embedded_Generation.pdf
- Jammu & Kashmir State Electricity Regulatory Commission. 2016. *Draft JKSERC Mini Grid Renewable Energy Generation and Supply Regulations, 2016*. http://www.jkserc.nic.in/Draft%20JKSERC_Mini%20Grid%20Renewable%20Energy%20Generation%20and%20Supply_%20Regulations.pdf
- Uttar Pradesh Electricity Regulatory Commission. 2016. *Draft Mini-Grid Renewable Energy Generation and Supply Regulations, 2016*. http://uperc.org/App_File/DRAFTREGULATIONS-MINIGRID-pdf382016112112AM.pdf
- Ceylon Electricity Board. 2000. *Guide for Grid Interconnection of Embedded Generators*. http://www.ceb.lk/index.php?aam_media=8501
- Public Utilities Commission of Sri Lanka. 2013. *Grid Interconnection Mechanisms for Off-Grid Electricity Schemes in Sri Lanka*. https://www.scidev.net/filemanager/root/site_assets/sa/Final-Report-Web-Load.pdf.

3.2. TECHNOLOGY STANDARDS FOR EQUIPMENT AND FUNCTIONALITIES

Regulators must determine whether mini-grids will be subject to technology standards. The adoption of technology standards can ensure quality and make monitoring easier. On the other hand, excessively stringent requirements can hinder development, limit innovation, and require considerable review and monitoring from regulators.

In this report, mini-grid technology includes not only hardware and software equipment, but also the functionalities of the technology—the core use or set of uses for a technology in a renewable mini-grid. Bearing this in mind, mini-grid technologies can be classified under six core functionalities (IRENA, 2016a):

- Planning and design;
- Generation;
- Storage;
- Communication, management, and measurement;
- Conversion; and
- Consumption.

The one standard that is nonnegotiable is electrical safety, which should be included regardless of regulators' decisions on other standard (Section 3.4). ***All the options below require electrical safety standards.***

Design standards are important for ensuring the appropriate operation and long-term sustainability of the technology. Lack of design standards can lead to early system failure (Dutt & MacGill, 2013). An example of a valuable design standard is IEC 62257, Recommendations for Small Renewable Energy and Hybrid Systems for Rural Electrification, which provides guiding principles for design and other system characteristics (IEC, 2013a). In the Cook Islands, for example, the electric utility Te Aponga Uira encourages the use of common design standards for installed mini-grids in the outer islands—to ease training of personnel, to support familiarity with the equipment, and to ensure proper maintenance.

The one standard that is nonnegotiable is electrical safety, which should be included regardless of regulators' decisions on other standard (Section 3.4). ***All the options below require electrical safety standards.***

Regulators can define strict standards for the technology used to construct and operate mini-grids. For example, regulators may require all PV modules to comply with specific safety qualifications, such as IEC 61730 (IEC, 2013b). Regulators should also keep in mind that some technology may need to meet more stringent standards, in order to address location-specific conditions such as severe weather or inaccessibility. For instance, in areas that are prone to cyclones and hurricanes, such as Pacific and Caribbean islands, regulators may want to require or encourage equipment resistant to high winds and construction practices such as burying the distribution network.

Guiding Questions:

- Are there existing technology standards for mini-grid functionalities and are they easily available and accessible to project developers?
- Is there a need to standardize mini-grid technologies?
- To ensure the long-term operational sustainability of mini-grids, does it make sense to be stringent with design, operation, equipment, and other technology standards?
- Do regulators have the staff capacity and resources to effectively understand the different technologies and functionalities?
- Are requirements within the technical and economic reach of mini-grid developers?
- Will technology standards affect project costs or service?

Option 1: Do not set technology standards

Regulators may wish to avoid setting standards for mini-grid technology, instead allowing developers or external parties (e.g., international agencies, private companies, or NGOs) to select the products that are most appropriate for the specific project.

Even where technology standards are waived, however, regulators should impose a minimum standard for service quality and reliability, to ensure access and avoid system failure (Section 3.4).

Benefits	Drawbacks
• Can simplify development and lower costs. • Can be beneficial for smaller systems, for locally developed projects, or for community-based innovations. • Permits regulators to avoid the resource-intensive process of developing and overseeing technology standards.	• Substandard equipment or technology may enter the market. Results may include system failures, lower service quality, and even health and safety risks—ultimately hindering the future development of the sector. • The use of outdated, inadequate, or unnecessary equipment is a particular risk in the case of large-scale, top-down schemes that fail to assess or consider beneficiaries' needs.

Recommended Steps for Regulators
• No action is needed if regulators opt not to impose technology standards for mini-grid equipment. Regulators may be well-advised, however, to consider the following actions: o Develop guidelines that encourage (but do not require) the use of specific technologies. o Develop recommendations (e.g., suggested evaluation criteria) for mini-grid tendering processes. o Establish voluntary regulations, such as service-quality standards or design and installation guidelines, to avoid system failure and guarantee long-term project sustainability.

Option 2: Develop technology standards specific to autonomous mini-grids

Regulators may want to impose standards for certain technologies; for example, they may require compliance with particular international standards, or require all mini-grids to have specific capabilities. Standards can address a range of issues, including equipment quality, warranty, operation, durability, and country of origin; certifications; environmental sustainability; installation procedures; and good practices. To make it easier for developers to select appropriate products, countries have in some instances preapproved equipment that complies with technical standards. In the solar PV grid-connected market, for example, Australia preapproves and/or registers PV modules that comply with technical standards, are tested in-country (to avoid counterfeit products), or go through a national certification process.[30] Similar methods could be applied to mini-grid technologies, including energy storage, inverters, transformers, generators, and wiring, among other key components.

To encourage the design and use of technology and equipment that is fit-for-purpose, regulators may also wish to use flexible, tailored standards. For example, in Uttar Pradesh, India, for systems of less than 10kW capacity, mini-grid operators are not required to construct power-distribution networks that conform to the technical standards defined by the distribution license, and may instead select the design and equipment that are most appropriate to their situation (Uttar Pradesh Electricity Regulatory Commission, 2016). Regulators may also want to maintain flexibility to allow for innovative technologies. Finally, they may wish to be flexible about verifying compliance. For example, accessing remote areas can be very expensive; hence, verification processes tailored to the setting—such as third-party verification by community members—may be put in place. A regional approach could also prove to be more effective, e.g. mini-grid standards for the Pacific.

Benefits	Drawbacks
• Can ensure project quality. • Can improve monitoring, increase regulator's and operators' familiarity with equipment, and improve long-term project sustainability. • Ensures that equipment is fit-for-purpose and prevent the use of inappropriate equipment.	• Developing mini-grid-specific standards, guidelines and verification procedures, is a time-consuming process that requires extensive research and resources. • Compliance with very strict standards may also prove costly for developers, and the required products may not be available in the local market.

[30] This approach may increase costs for developers, and also requires adequate facilities to be in place in-country.

Recommended Steps for Regulators

- Identify the technology standards used in the national grid that are applicable to mini-grids (e.g., standards for PV modules).
- Determine which mini-grid-specific standards to differentiate from the national grid (e.g., metering technologies).
- Determine how extensively and how strictly to regulate technology.
- Determine where greater flexibility will promote innovation or encourage deployment of mini-grids.
- Develop technology standards for mini-grids:
    - Regulators may choose to rely on national or international standards as the basis for developing their own requirements.
    - Regulators may wish to rely on a technical committee or industry association to define mini-grid-specific standards for equipment, design, procedures, and rules governing installation, equipment operating conditions, and monitoring activities.
- Engage stakeholders, including mini-grid developers, in the development of standards.
- Once the standards are finalized, make them available and accessible to developers.
- Consider developing design guidelines that outline the technology standards for mini-grids.

Option 3: Require that mini-grid technology adhere to national-grid standards

In some instances, regulators may wish to treat mini-grids like any other electricity network, regardless of size or whether they will eventually be interconnected to the national grid. This approach is often used when regulators do not foresee major challenges to adherence to national standards, the deployment of autonomous mini-grids is limited, or compliance with a specific standard is sought.

Benefits	Drawbacks
• Regulators can rely on existing national standards. • No need to expend resources developing standards from scratch.	• Standards may not cover certain mini-grid-specific technologies, since those are not necessarily used in the national grid. • May hinder innovation by preventing mini-grid developers from developing new technology or tweaking existing technology to adapt to local conditions. • May be complex and resource intensive for mini-grid developers.

Recommended Steps for Regulators
• Review and extend applicable technology standards to autonomous mini-grids. • Inform mini-grid developers about the standards, and make the standards available to developers. • Establish procedures and mechanisms for monitoring compliance with standards.

Further Reading

Provide design guidelines and recommendations for mini-grids:

- Ministry of Energy and Petroleum, Republic of Kenya. 2016. *Current Activities and Challenges to Scaling Up Mini-grids in Kenya*. https://www.esmap.org/sites/esmap.org/files/DocumentLibrary/ESMAP_Kenya%20Roundtable_May%202016_formatted-v4.pdf

- Power and Water Corporation. 2014. *Solar/Diesel Mini-Grid Handbook*. http://acep.uaf.edu/media/87693/SolarDieselGridHandbook.pdf

- Eurobat. 2013. *Battery Energy Storage for Rural Electrification Systems*. http://acep.uaf.edu/media/87693/SolarDieselGridHandbook.pdf

- Sustainable Energy Industry Association of the Pacific Islands & Pacific Power Association. 2012. *Off Grid PV Power Systems: System Design Guidelines*.

http://www.irena.org/documentdownloads/events/2013/march/palau/8_offgrid_designguidelines.pdf

- IEC. 2013a. *Recommendations for Small Renewable Energy and Hybrid Systems for Rural Electrification*. https://webstore.iec.ch/publication/6647
- IEC. 2015. *IEC TS 62257: Recommendations for Small Renewable Energy and Hybrid Systems for Rural Electrification*. https://webstore.iec.ch/publication/23502.

Discusses equipment standards for mini-grids in specific locations:

- Jammu & Kashmir State Electricity Regulatory Commission (JKSERC). 2016. *Draft JKSERC Mini Grid Renewable Energy Generation and Supply Regulations, 2016*. http://www.jkserc.nic.in/Draft%20JKSERC_Mini%20Grid%20Renewable%20Energy%20Generation%20and%20Supply_%20Regulations.pdf
- Uttar Pradesh Electricity Regulatory Commission. 2016. *Draft Mini-Grid Renewable Energy Generation and Supply Regulations, 2016.* http://uperc.org/App_File/DRAFTREGULATIONS-MINIGRID-pdf382016112112AM.pdf

Provides standards for small-scale renewables and stand-alone applications:

- SEANZ. 2009*. Small Scale Renewable Energy Standards Guide*. http://www.seanz.org.nz/files/file/20/Standards+101+Version+1.1.pdf

  Provides information on the design of stand-alone power systems used to supply low-voltage electric power:

- Standards Australia and Standards New Zealand. 2010*. Stand-Alone Power Systems Part 2: System Design.* https://law.resource.org/pub/nz/ibr/as-nzs.4509.2.2010.pdf

  Discusses performance requirements for off-grid inverters:

- Standards Australia and Standards New Zealand. 2009a. *Stand-Alone Inverters—Performance Requirements*. https://shop.standards.govt.nz/catalog/5603:2009(AS%7CNZS)/scope

Tools

Provides tools for rural electrification planning and mapping:

- GIZ. 2015. *Tools for Mini-Grid Practitioners*. http://energyaccess.org/wp-content/uploads/2015/11/mini-grid-tools.pdf

Innovation

Provides information on state-of-the-art technologies and innovation:

- IRENA. 2016a. *IRENA Innovation Outlook: Renewable Mini-Grids*. http://www.irena.org/DocumentDownloads/Publications/IRENA_Innovation_Outlook_Minigrids_2016.pdf

Box 32: Alternating versus Direct Current: The Battle Continues

Mini-grids can be designed to operate on alternating current (AC), direct current (DC), or both.

Benefits of AC and DC

National power grids generally use AC power, and consumer electronic devices are typically designed to use AC power (though some are designed specifically to run on DC power). Requiring AC power in mini-grids can facilitate eventual interconnection to the national grid and help ensure that the same appliances, electrical devices, and equipment can be used on mini-grids and the national grid.

The power from DC grids is generally low (12 to 48 volts [V]) compared to that from AC grids (120 to 240 V), and can only be used once converted to AC power using an inverter. There has nevertheless been a resurgence of DC grids because of their higher efficiency; the increased use of solar PV, which generates electricity in DC; and the increase in the number of DC appliances, such as mobile phones and laptops. DC mini-grids may also provide greater design and spatial flexibility, as well as added safety(EMerge Alliance, 2015; Garbesi, Vossos, & Shen, 2011). Mobile phones, laptops, and LEDs, for example, can be powered more efficiently by DC. Moreover, the use of DC power can trigger the development of flexible, innovative appliances that can function adaptively under many conditions.

AC and DC Network Compatibility

Mini-grid compatibility is determined by two main factors (1) the flexibility of the mini-grid design (e.g. was it designed to be compatible with different equipment or only the specific mini-grid equipment) and (2) the regulatory decisions about technical standards and power supply type (AC or DC).

Interconnecting a DC mini-grid to the national grid could be quite challenging. A converter to manage energy flow would be required, but because there is limited standardization of DC distribution grids there would still be a great deal of uncertainty about other required modifications (IRENA, 2016a). In some cases, however, DC power is a more cost-effective option for mini-grid development: for example, for mini-grids that rely on solar power, developers can avoid the expense of installing and maintaining an inverter (Justo, Mwasilu, Lee, & Jung, 2013).

The Role of Regulators in the AC versus DC Debate

Regulators must determine whether—and in which cases—to require mini-grids to rely solely on AC power or to be more flexible. Regulators can require mini-grids to be designed in a way that allows for electrical equipment compatibility with the national grid, though this may be detrimental to some mini-grid business models. Regulators can also develop mini-grid-specific standards for distribution networks, home wiring, and appliance-user interfaces, or can adopt the standards used for the national grid.

For example, in Jammu and Kashmir, India, the electricity regulatory commission has allowed the public distribution network of mini-grids to be designed to carry either AC or DC current (JKSERC, 2016). The Jammu and Kashmir State Electricity Regulatory Commission has defined power-capacity thresholds that depend on the current and voltage used:

DC: 24 V up to 1 kilowatt (kW) power capacity; 72 V above 1 kW and up to 10 kW power capacity

AC: 220 V up to 10 kW power capacity; 440 V beyond 10 kW and up to 500 kW

3.3. ELECTRIC POWER QUALITY

Electric power quality (EPQ) is generally determined by voltage, frequency, harmonic distortion, and electricity safety requirements. EPQ requirements are outlined in a country's national grid code, and interconnected electricity systems are usually required to meet the requirements.

Regulators must determine whether autonomous mini-grids will be required to meet the EPQ standards outlined in the national grid code. The options are to waive grid-code compliance for mini-grid operators; enact a more flexible, tailored grid code specific to mini-grids; or require mini-grid developers to comply with the national grid code.

The main elements of EPQ standards are described the table below.

Table 10. The Main Elements of Electric Power Quality Standards

Issue	Description
Voltage	Generally, national power grids are governed by a grid code that is developed by a technical committee and approved by government regulators. One item specified in the grid code is the voltage of distribution and transmission networks, which varies across national power grids, and also typically differs between low-voltage distribution networks and high-voltage transmission networks. Ensuring a constant voltage level within a grid protects against fluctuations that may damage generation and distribution equipment, as well as consumer appliances and electronics. If mini-grids are developed at a different voltage from the national power grid, electrical equipment may not be compatible across the two grid networks, and extensive upgrades may be required when mini-grids are connected to the grid.
Frequency	Generally, national power grids must operate within narrow acceptable frequency bands (measured in hertz [Hz]), which are regulated by maintaining a balance between active generation and customer loads. If grid frequency drifts outside the permitted range (e.g., if a large generator suddenly drops off the grid), generation equipment may automatically trip and brownouts may ensue. In the case of mini-grids, developers are responsible for frequency regulation, but often the permitted range of frequency values is broader than that of the national grid.
Harmonic Distortion	Excess harmonic distortion—imperfections in the shape of the sinusoidal voltage wave of a grid—can cause power failures or damage appliances. Generally, the national grid code specifies harmonic distortion requirements for the national grid. Certain generation technologies, such as inverter-based solar PV systems, may contribute to higher harmonic distortion levels within electric grids. Regulators must determine whether to regulate harmonic distortion levels of mini-grids, and whether mini-grids should be held to the same standard as the main power grid.

Issue	Description
Electrical Safety	Electrical safety is a mandatory, nonnegotiable responsibility that must be accounted for in any type of mini-grid. Electrical safety must always be included as part of mini-grid technical standards, and electrical safety provisions must always be applied by developers and enforced by regulators. National grid codes require that grid-connected equipment adhere to certain electrical standards to ensure safe operation. Some countries have adopted specific electrical codes or fire codes that further govern electrical equipment installation. Regulators must consider what conditions to impose on mini-grid developers to ensure electrical and fire safety. *All the options below include an electrical safety code.*

Recently, efforts have been made to develop guidance around mini-grid power quality as it relates to service quality. For example, as detailed in Section 3.4 the National Renewable Energy Laboratory (NREL) and the U.S. Department of Energy (DOE), supported by the Clean Energy Ministerial[31], developed a mini-grids quality assurance (QA) framework titled *Quality Assurance Framework for Mini-Grids.* The Quality Assurance Framework (QAF) defines different levels of service that are tailored to different tiers of consumers, focusing on thresholds for power quality, reliability, and availability, and specifies common accountability and performance reporting protocol. Table 13 provides a high-level summary of the standards from a power quality and system performance perspective.

Regulators should consult the QAF and other guidance documents when considering power quality standards.

Guiding Questions:

- What national-grid EPQ standards are achievable for mini-grid developers?
- Would the enforcement of national-grid EPQ standards lead to barriers for developers?
- Is there a governmental body or independent entity with the authority and ability to inspect and enforce EPQ standards for mini-grids?

[31] The Clean Energy Ministerial is a global forum that promotes policies and shares best practices to accelerate the global transition to clean energy. More information can be found at: http://www.cleanenergyministerial.org/

Option 1: Do not require mini-grids to meet any EPQ standards

Regulators can choose to exempt mini-grid developers from all grid codes except safety standards. Under this approach, mini-grid developers have the flexibility to operate mini-grids without limitations, and would not be required to meet performance standards such as voltage or frequency levels. However, customers experiencing low service quality would be permitted to seek dispute resolution from regulators or a third-party organization.

Benefits	Drawbacks
• Spares developers the costs of adhering to strict rules of operation. • Allows more flexibility regarding appliances that can be used in the mini-grid. • Eliminates the need to monitor power quality for the regulator.	• May pose problems regarding service quality (Descheemaeker, Van Lumig, & Desmet, 2015). • Makes future interconnection to the main grid costly and complex. • May damage appliances of end-users and pose risks.

Recommended Steps for Regulators

- Identify potential issues that could arise if there are no EPQ standards in place.
- Develop procedures and guidelines for responding to such issues.
- Consider publishing or facilitating access to the national grid code, or to EPQ standards for mini-grid codes in other countries that have similar conditions.
- Consider recommending that developers use such standards as guidelines.
- Educate end users on the potential impacts of voltage, harmonic, and frequency imbalance.

Option 2: Develop EPQ standards specifically for mini-grids

Regulators may choose to include EPQ standards in the autonomous mini-grid code (See Section 3.4 and information on *the Quality Assurance Framework for Mini-grids*). The EPQ standard could be differentiated for different mini-grid classes. To allow for this level of flexibility, standards need to be more lenient. Regulators who wish to develop mini-grid-specific EPQ standards often request a technical committee to develop the standards, which regulators can then review and approve. EPQ standards compliance would form part of the application process for mini-grid development, including testing, commissioning, and monitoring to ensure proper operation.

Benefits	Drawbacks
• Can ease interconnection with national grid. • Are generally more flexible and more appropriate than national grid standards. • Lowers the risk of damage to appliances and other safety and operational issues.	• Regulators need to dedicate a reasonable amount of resources to develop mini-grid-specific EPQ standards and to determine how to test and monitor compliance. • Defining mini-grid categories might be challenging and may have unintended impacts: for example, mini-grid developers may opt to build smaller systems to avoid complying with standards for larger systems. • Adhering to EPQ standards increases development costs and may be prohibitively expensive for developers of small mini-grids in remote areas. Stringent grid codes can also hinder innovation.

Recommended Steps for Regulators

- Establish a technical committee that will undertake the following steps to develop an EPQ standard specific for autonomous mini-grids:
    - Determine how stringent the technical standards should be, and whether the standards should apply to all mini-grids or only to certain mini-grid classes.
    - Define different classes of mini-grids, and determine compliance levels for each (Section 1.4).
    - Consult with stakeholders—including mini-grid developers, the national utility, distribution-network operators, and other entities involved in the technical operations of the country's grid network—and incorporate their feedback into the final version of the EPQ standards.
- Update application, licensing, monitoring, and reporting processes to incorporate the requirements of the EPQ standards.
- Make the EPQ standards readily available to mini-grid developers.

Option 3: Require mini-grids to follow national-grid EPQ standards

Regulators may require that mini-grids adhere to the national EPQ standards.

Benefits	Drawbacks
• Regulators do not need to define new, mini-grid-specific EPQ standards. • Interconnection to the national grid will be easier, since the mini-grid already complies with all standards.	• Can be prohibitively expensive for mini-grid developers and may discourage investment. • May lead to higher retail tariffs or subsidy payments.

Recommended Steps for Regulators

- Make the national EPQ standards readily available to mini-grid developers.
- Include compliance with the national EPQ standards as part of the approval and licensing process.
- Provide technical assistance to mini-grid developers to support compliance with EPQ standards.
- Establish procedures for testing, commissioning, and monitoring compliance with national EPQ standards, and make these procedures and any associated requirements accessible to mini-grid developers.

Box 33: Country Spotlight: EPQ Standards in the Philippines

For mini-grids that are outside the national grid of Luzon, Visayas, and Mindanao, the Philippine government has developed the *Small Power Plant Guidelines* (Distribution Management Committee, 2013). The guidelines define five mini-grid categories, based on the number or type of distribution utility and/or generating entity. The guidelines also include maximum allowable voltage and frequency variations to which all mini-grid categories must adhere, in order to ensure the quality of electricity.

The guidelines initially targeted diesel mini-grids operating in remote areas; as new, renewable-energy-based-mini-grids have begun to flourish, they have been incorporated into the guidelines as well. The Energy Regulatory Commission (ERC) believes that the development of the guidelines is an important step toward standardizing service quality. Nonetheless, the ERC noted that implementing the guidelines has been challenging, and that full rollout will require further outreach and capacity building for mini-grid developers and operators.

Further Reading

Provides electric power quality standards specific to mini-grids:

- Jammu & Kashmir State Electricity Regulatory Commission (JKSERC). 2016. *Draft JKSERC Mini Grid Renewable Energy Generation and Supply Regulations, 2016*. http://www.jkserc.nic.in/Draft%20JKSERC_Mini%20Grid%20Renewable%20Energy%20Generation%20and%20Supply_%20Regulations.pdf
- Uttar Pradesh Electricity Regulatory Commission. 2016. *Draft Mini-Grid Renewable Energy Generation and Supply Regulations, 2016*. http://uperc.org/App_File/DRAFTREGULATIONS-MINIGRID-pdf382016112112AM.pdf
- EWURA. 2011. *Guidelines for Grid Interconnection of Small Power Projects in Tanzania*. http://ppp.worldbank.org/public-private-partnership/sites/ppp.worldbank.org/files/documents/Tanzania_Approved-Guidelines-for-Grid-Interconnection-Part-B-March-2011.pdf
- Distribution Management Committee. 2013. *Small Grid Guidelines.* The Philippines. "report.spug.ph/articles/Proposed%20Small%20Grid%20Guidelines-DMC.pdf.

Provides standards on safety and installation of off-grid systems:

- Standards Australia and Standards New Zealand. 2009. *Stand-Alone Power Systems*. https://shop.standards.govt.nz/catalog/4509.1:2009(AS%7CNZS)/scope

3.4. SERVICE QUALITY: AVAILABILITY, CAPACITY, AND RELIABILITY

A service quality standard establishes the minimum electric service a mini-grid developer must provide to its customers. The quality of the electric service provided by a mini-grid is mainly determined by availability, capacity, and reliability as defined in the table below.

Table 11. Main Issues Related to Service Quality

Issue	Description
Availability	Refers to the existence and the duration of the electricity service. In the case of the national grid, public utilities are generally required to meet certain availability thresholds—for example, to provide electricity access for 24 hours a day to 100% of customers. In the case of autonomous mini-grids, the requirements may be more flexible—for example, to provide electricity access to more than 80% of the population in a community for more than 8 hours per day. Ideally, service availability would gradually increase over the lifetime of the mini-grid. Regulators can determine various duration levels for different mini-grid types, but the ideal goal is 24-hour service.
Capacity	Refers to the amount of power that is made available to end users, either as maximum instant power (kW) or as a particular amount over a set period of time (kWh). In the case of mini-grids, service tiers are usually set by mini-grid developers, and supply availability is constrained either by generation technology (e.g., solar PV without a diesel or battery backup will not provide nighttime power) or by the size of the generation system (e.g., a small system may be unable to meet full demand during peak consumption periods).
Reliability	Refers to the frequency of unplanned interruptions in supply. Often, national-grid power suppliers are subject to quality thresholds that dictate the number of times per year that supply can be interrupted; such standards are often enforced by penalties or performance incentives. In mini-grid settings, where compliance with reliability requirements can add to development and operating expenses, such standards are more difficult to implement. Regulators must decide whether such requirements are appropriate—and, if so, what standards to use. Among the indexes used to measure reliability are the following: • The System Average Interruption Duration Index (SAIDI);[32] • The System Average Interruption Frequency Index (SAIFI);[33] and • The Customer Average Interruption Duration Index (CAIDI).[34]

[32] SAIDI is a performance indicator that measures the average duration of interruptions a customer experiences over a given time period.

[33] SAIFI is a performance indicator that measures reliability by tracking the average number of interruptions a customer experiences over a period of time, usually one year.

[34] CAIDI is related to SAIDI and SAIFI and provides the average outage duration that would be experienced by a given customer.

More recently, efforts have been made to develop a more multidimensional view of service quality that incorporates additional attributes. Among the various efforts to better define and measure electricity access and associated tiers of service are two different but complementary approaches:

1) World Bank Energy Sector Management Assistance Program (ESMAP) Multi-Tier Framework;
2) The National Renewable Energy Laboratory (NREL) and U.S. Department of Energy (DOE) Quality Assurance Framework for Mini-Grids.

Both are profiled below. Regulators should consider these approaches when thinking through service-quality standards.

As noted in Box 1, the World Bank ESMAP, in consultation with a host of stakeholders, has developed the Multi-Tier Framework (MTF) to measure, monitor, and evaluate energy access. The MTF defines a number of attributes that reflect the performance of the energy supply, including capacity, duration (i.e., daytime and nighttime supply), reliability, quality, affordability, legality, and health and safety (ESMAP 2015). Under the MTF, electricity access is assigned a tier, from Tier 0 (no access) to Tier 5 (the highest level of access). Specialized multi-tier frameworks have also been developed to measure access to electricity, cooking solutions, and space heating for households; productive uses of energy for enterprises; and energy access for community institutions. Table 12 shows a multi-tier matrix for household access to electricity.

More recently, efforts have been made to develop a more multidimensional view of service quality that incorporates additional attributes. Among the various efforts to better define and measure electricity access and associated tiers of service are two different but complementary approaches:

1) World Bank Energy Sector Management Assistance Program (ESMAP) Multi-Tier Framework;

2) The National Renewable Energy Laboratory (NREL) and U.S. Department of Energy (DOE) Quality Assurance Framework for Mini-Grids.

Table 12. Multi-Tier Matrix for Access to Household Electricity Supply (ESMAP, 2015)

Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
1. Capacity	Power*		Very Low Power Min 3W	Low Power Min 50W	Medium Power Min. 200W	High Power Min 800W	Very High Power Min 2 kW
	AND Daily Capacity		Min 12Wh	Min 200Wh	Min 1.0 kWh	Min 3.4 kWh	Min 8.2 kW
	OR Services		Lighting of 100lmhrs per day and phone charging	Electrical lighting, air circulation, television, and phone charging are possible			
2. Duration	Hours per day		Min 4hrs	Min 4hrs	Min 8hrs	Min 16hrs	Min 23hrs
	Hours per evening		Min 1hr	Min 2hrs	Min 3hrs	Min 4hrs	Min 4hrs
3. Reliability						Max. 14 disruptions per week	Max 3 disruptions per week of total duration <2hrs
4. Quality						Voltage problems do not affect the use of desired appliances	
5. Affordability					Cost of standard consumption package of 365 kWh per annum is less than 5% of household income		
6. Legality						Bill is paid to the utility, prepaid card seller, or authorized representative	
7. Health and Safety						Absence of past accidents and perception of high risk in the future	

In addition, NREL and U.S. DOE, supported by the Clean Energy Ministerial, developed the *Quality Assurance Framework for Mini-Grids* and a companion implementation guide titled *Quality Assurance Framework Implementation Guide for Isolated Community Power Systems.* The main objective of the QA framework is to provide structure and transparency for the mini-grid sector while considering the different service levels required to meet the energy needs of various segments of end users in remote areas (Baring-Gould, et. al. 2016). The QA framework defines different levels of service that are tailored to different tiers of consumers, focusing on thresholds for power quality, reliability, and availability, and specifies common accountability and performance reporting protocol. Table 13 provides a high-level summary of the standards from a power quality and system performance perspective.

The initiative enables regulators to integrate level of service concepts into initial assessments of potential mini-grid projects as well as to standardize and implement long-term performance tracking and monitor compliance. The QA framework does not prescribe a standard level of service but follows the flexible, "truth-in-advertisement" approach to create a path to a mature mini-grid market (Baring-Gould et al., 2016). The *QA Framework Implementation Guide* is a companion document to the *QA Framework for Mini-Grids* technical report and provides guidance on implementing the QAF from various stakeholder perspectives that are commonly part of a mini-grid project (Baring-Gould et al., 2017).

Regulators should consult both approaches, along with others, when considering service quality standards. Regulators should decide which attributes to use for describing the quality of service, and how to measure and monitor the quality. Regulators must also balance the cost and time associated with service quality standards: higher levels of service may be more expensive, take longer to develop, and reach fewer communities, but provide more opportunity to power productive uses, whereas lower levels of service may be less expensive, quicker to develop, and reach more communities, but with very basic service. No matter what service quality standard is adopted, regulators should have a minimum service quality standard that is available to all customers, regardless of service tier or customer type (e.g., residential versus commercial)

Guiding Questions:

- What are the standards for service quality on the national grid? Should the same standards apply to mini-grids?
- What electricity supply attributes does the regulator want to consider?
- What is the minimum quality of service the regulator would consider?
- What are customer expectations regarding service quality?
- How important is reliable electricity service to attracting commercial and industrial customers to areas served by mini-grids?

Table 13. Quality Assurance Framework - Summary Level of Service (Baring-Gould, et al, 2016).

Issue	Base Level of Service	Standard Level of Service	High Level of Service
AC Power Quality Phenomena			
Voltage Imbalance	<10%	<5%	<2%
Transients	No protection	Surge protection	Surge protection
Short Voltage Duration Variations	<5/day	<1/day	<1/week
Long Voltage Duration Variations	<10/day	<5/day	<1/day
Frequency Variations	48 Hz < f < 52 Hz	49 Hz < f < 51 Hz	49.5 Hz < f < 50.5Hz
DC Power Quality Phenomena			
Resistive Voltage Drop	<10%	<5%	<2%
Percent Ripple	50% peak to peak (pk-pk)	20% pk-pk	10% pk-pk
DC Ripple & Switching Noises	Unfiltered	Transient noise minimized	Ripple noise also minimized
Transients	No protection	Surge protection	Surge protection
Faults Allowed per Day	<5/day	<2/day	<1/day
Power Reliability			
Unplanned-SAIFI$_{xx}$(1,3)	<52 per year	<12 per year	<2 per year
Unplanned-SAIDI$_{xx}$(1,3)	<876 hours (90% reliability)	<438 hours (95% reliability)	<1.5 hours (99.99% reliability)
Planned-SAIFI$_{xx}$(1,2)	No requirement but should be defined	No requirement but should be defined	<2 per year
Planned-SAIDI$_{xx}$(1,2)	No requirement but should be defined	No requirement but should be defined	<30 minutes - 100% reliability

Issue	Base Level of Service	Standard Level of Service	High Level of Service
(1) System Average Interruption Frequency Index (SAIFI) measures the average number of power outages that an average customer experiences in a year and is defined as Total Number of Customer Interruptions/Total Number of Customers Served. (2) System Average Interruption Duration Index (SAIDI) measures the average number of minutes that an average customer is without power over the defined time period, typically a year. (3) SAIFI and SAIDI are typically assumed for power systems that are specified to provide full-time energy service 24 hours/day. A subscript is used in this report for systems that provide partial hours/day service since the number of planned and unplanned interruptions and length of any interruptions should be normalized by the percent of hours of service			

Option 1: Allow mini-grid developers to determine service quality

Regulators may allow mini-grid developers to determine the level of service quality. Under this approach, the contract between the customer and service provider would state service quality terms.

Benefits	Drawbacks
• Protects regulators from having to use resources to develop mini-grid service quality standards. • Reduces development costs and speeds up development. Can also lower operational costs by allowing developers to avoid spending resources reporting to regulators on service quality. • Allows developers to determine the most appropriate service quality standards for their project context and customers, creating different service quality tiers that reflect the realities of remote areas and meet the needs of various customers.	• May result in lower-quality service, especially when there is no alternative provider and discontinuing service is not an option. • Can lead to conflict or strained relationships within communities, particularly if customers who are of lower socioeconomic status or otherwise disadvantaged (e.g., older adults, people with physical or mental disabilities) can't afford the same level of service as other customers. • Poor or low service quality may not allow for powering productive uses and community services thereby constraining economic development and customer wellbeing.

Recommended Steps for Regulators
No next steps are required under this approach, but regulators may want to consider the following steps: • Suggest a minimum service quality standard that should be available to all customers, regardless of service tier or customer type. • Consider providing recommendations on a dispute resolution mechanism for developers and customers, or requiring developers to outline a dispute resolution procedure. • Provide examples or templates of service quality contracts that developers could use as models for their own customer contracts.

Option 2: Require mini-grid developers to meet national-grid service-quality standards for all consumers

Under this approach, regulators require the same level of service quality, regardless of whether customers are connected to the national grid or an autonomous mini-grid. Regulators who opt to implement national-grid service quality for availability, capacity, and reliability use indexes such as the SAIDI, SAIFI, and CAIDI. Power availability is driven by maximum power available, the amount of electricity available at a given time, and the hours of service per day. Power availability at national-grid levels is commonly 24 hours per day (but could be less in some locations), with few restrictions on or limits to consumption.

Benefits	Drawbacks
• Ensures the same minimum standard of service quality will be available to all end users, providing fair and equal service for all and allowing regulators to avoid dedicating resources to developing tailored standards.	• National-grid quality standards can be ill suited to remote, autonomous mini-grids and can therefore increase the costs of developing and operating such systems.

Recommended Steps for Regulators

- Apply the national-grid service-quality standards to mini-grid service providers.
- Ensure that the standards include a minimum level of service quality that is applicable to all customers, regardless of service tier or customer type.
- Define the penalties the service provider will incur if service quality fails to meet national-grid standards.
- Make service-quality standards available to mini-grid developers.
- Provide capacity building or financial support to help developers achieve compliance.
- Consider providing recommendations on a dispute resolution mechanism for developers and customers, or requiring developers to outline a dispute resolution procedure.
- Provide examples or templates of service quality contracts that developers could use as models for their own customer contracts.

Option 3: Require flexible quality standards based on mini-grid classes or categories that consider capacity, location, or customer type

Finally, regulators can define different levels of service that are tailored to capacity, location, or customer type (e.g., residential or commercial). For example, the requirement to reestablish service within a given period after an outage could be adjusted to account for the challenges associated with mini-grids located in remote or inaccessible areas.

Service quality may also differ by operator and/or customer type. For example, according to the Quality Assurance Framework by the National Renewable Energy Laboratory and the U.S. Department of Energy, regulators can adopt flexible service quality standards for different customer classes. Customers would be informed of the level of service they should expect and could lodge complaints with regulators if the service failed to meet their expectations (Baring-Gould, et al. 2016). Regulators would monitor mini-grid developers by requiring regular reporting on the quality, reliability, and availability of power delivered to customers. In more remote areas, monitoring could be more flexible or delegated to third-party verifiers such as community members. As the mini-grid market matures, regulators can also implement long-term performance tracking mechanisms to ensure the continued accountability of developers and adjust service quality standards if necessary.

Allowing service quality differentiation between mini-grids and the national grid can be less complex and controversial than differentiating across customers within the same mini-grid. However, regulators should make a point of requiring that all customers (at the national level and across mini-grids), are guaranteed a minimum level of service quality, regardless of service tier.

Benefits	Drawbacks
• Regulators can outline minimum service requirements that are achievable for mini-grid developers and still meet the needs of different types of customers. • Relieves developers of the burden of having to comply with service-quality standards that are not commensurate with the capacity or location of their systems. • Better reflects the realities of operating in remote or inaccessible settings.	• Reporting requirements may incur additional cost for service providers which could be burdensome. • Regulators will need personnel and financial resources to monitor service quality and sustain long-term performance tracking. Monitoring different service-quality levels across a single mini-grid may become burdensome. • Defining different service quality tiers across mini-grids and across mini-grid users could be challenging for regulators.

Recommended Steps for Regulators

- Determine roles and responsibilities for meeting service quality standards, particularly where the owner and operator of the mini-grid are different entities.
- Establish a technical committee that will undertake the following steps to develop different service quality tiers for mini-grids:
    - Decide under what conditions and to what extent mini-grid service quality will differ from that of the national grid.

- Determine whether service quality will be allowed to differ between customers served by the same mini-grid, and whether the differentiating factor will be cost.
- Define size categories for mini-grids.
- Identify the criteria that determine the location of a mini-grid.
- Define the types of customers whose service quality cannot be compromised (e.g., schools and health clinics).
- Establish minimum service quality standards that all mini-grid service providers must meet. Ensure that the minimum standard prohibits service providers from providing a lower level of service to customers of lower socioeconomic status who might purchase less electricity.

- Consider providing recommendations on a dispute resolution mechanism for developers and customers, or requiring developers to outline a dispute resolution procedure.
- Provide examples or templates of service quality contracts that developers could use as models for their own customer contracts.

Further Reading

Provides design guidelines and recommendations for service quality standards in mini-grids:

- Baring-Gould et al. 2017. Quality Assurance Framework Implementation Guide for Isolated Community Power Systems. https://www.nrel.gov/docs/fy17osti/68634.pdf
- Baring-Gould et al. 2016. *Quality Assurance Framework for Mini-Grids*. National Renewable Energy Laboratory. https://www.nrel.gov/docs/fy17osti/67374.pdf
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— APPENDICES —

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APPENDIX I: UGANDA MINI-GRID INDUSTRY CASE STUDY

I.1 GENERAL OVERVIEW

Of Uganda's population of 34.6 million, only 20% of households is estimated to have access to electricity. Moreover, of the 75% of the population that lives in rural areas, an estimated 10% has access to electricity[35](Uganda Bureau of Statistics, 2014). Much of the national electric grid is centered around the country's capital, Kampala, and the surrounding area.

Uganda's electricity mix is dominated by hydropower, which accounts for 695 of the 895 megawatts (MW) of total installed capacity. Of those 695 MW, 630 are provided by Uganda's three primary hydroelectricity projects: the Bujagali, Kira, and Nalubaale power plants (ERA, 2015). The remainder of Uganda's large-scale generation comes from thermal (heavy fuel oil) and bagasse cogeneration (ERA, 2015). Among renewable energy resources that may be suitable for mini-grid development, Uganda has ample resources for mini-hydro, solar, and biomass energy, and the possibility of limited opportunities for wind and geothermal (REEEP, 2012).

I.2 ENERGY INDUSTRY STRUCTURE

Before 1999, Uganda's electricity industry was nationalized and run by the Uganda Electricity Board. The industry was significantly restructured under the Electricity Act of 1999. In 2000, the Government of Uganda established the Electricity Regulatory Agency (ERA), an independent authority that regulates all sector activities. In 2001, the Ugandan government unbundled the vertically integrated Uganda Electricity Board into separate generation, transmission, and distribution functions. In that same year, the government established the Rural Electrification Board (REB) to oversee the implementation of rural electrification plans. REB is chaired by the Permanent Secretary of the Ministry of Energy and Mineral Development (MEMD). The Rural Electrification Agency (REA) is a semi-autonomous body that serves as secretariat for the REB by coordinating and implementing rural electrification strategies and activities (World Bank, 2015).

During the restructuring, operation of the country's generation assets was tendered to ESKOM Uganda Limited, a private company based in South Africa, although the assets themselves remain under government ownership. The 1999 Electricity Act also created a role for independent power producers, which are permitted to develop, own, and operate generation projects. Currently, 12 different entities provide grid-connected power in Uganda, 8 of which generate power from hydroelectricity (ERA, 2015).

Transmission remains under government control, and is operated by Uganda Electricity Transmission Company Limited (UETCL). Under power purchase and power sales agreements, UETCL is responsible for metering, purchasing generation, and selling power to distribution network operators according to regulated tariff rates.

As with generation, most distribution assets went through a concession process and are currently being operated by Umeme Limited, a private sector organization that serves much of the national

[35] Five percent of electricity is provided by the national grid with the remaining 5% provided by other sources. Other sources are not defined in the census.

grid. The key exception is in Uganda's West Nile region, where electricity service is isolated from the national grid, and where the distribution concession was awarded to the West Nile Rural Electrification Company (WENRECO).

1.3 KEY GOVERNMENT INSTITUTIONS AND INTERNATIONAL PARTICIPATION

A number of key institutions are involved in the development of energy projects in Uganda, and many of these institutions have some authority over mini-grid development. The role of each institution is detailed in ERA's Renewable Energy Investment Guide, which can be found on its website; brief descriptions follow (ERA, n.d.).

Table 14. Institution Roles in the Development of Mini-grid Regulation in Uganda

Institution	Role and Responsibility
Ministry of Energy and Mineral Development	The Ministry of Energy and Mineral Development (MEMD) is a cabinet-level organization with high-level jurisdiction for all energy policy, including renewable energy. MEMD's mandate is to establish, promote, and sustainably manage the exploration and use of energy and mineral resources to support the social and economic development of Uganda.
Electricity Regulatory Authority	The Electricity Regulatory Authority (ERA) is an independent authority managed by a board of five ministry-appointed members and is responsible for regulation of the electricity sector. The ERA has authority to determine wholesale and retail tariffs; set technical standards for grid infrastructure; approve licenses to generate, distribute, and sell electricity; and otherwise govern the provision of electricity services.
Rural Electrification Board	The Rural Electrification Board (REB) is an appointed board that oversees the Rural Electrification Agency and manages the Rural Electrification Fund (REF).
Rural Electrification Agency	The Rural Electrification Agency (REA), a semi-autonomous body and secretariat to the REB, provides policy guidance to the REB, plans and coordinates Uganda's rural electrification efforts including implementing the Rural Electrification Strategy and Plan (RESP), and administers the REF.
Uganda Electricity Transmission Company Limited	The Uganda Electricity Transmission Company Limited (UETCL) owns and operates transmission lines above 33 kilovolts and is the bulk supplier and single buyer of power for the national grid. Generators of electricity that will be fed into the national grid are expected to sign a standardized power purchase agreement with UETCL.
Uganda Energy Credit Capitalization Company:	The Uganda Energy Credit Capitalization Company (UECCC) is a government-owned company limited by guarantee. UECCC's mandate is to provide a reliable framework for pooling resources from the government, investors, and development partners, and to channel those resources into viable private-sector renewable-energy projects. To this end, UECCC provides financial, technical and other support to facilitate private-sector-led renewable energy projects.

Institution	Role and Responsibility
National Environmental Management Authority	The National Environmental Management Authority (NEMA) is a semi-autonomous institution established in May 1995, under the National Environment Act, Cap. 153. NEMA has principal responsibility for coordinating, monitoring, regulating, and supervising environmental management in Uganda. As part of its mandate, NEMA regulates the environmental impact of power projects, which involves (1) review and approval of environmental project briefs, environmental impact reviews, environmental impact assessments, and resettlement action plans and (2) issuance of certificates of environmental clearance.
Directorate of Water Resource Management	The Directorate of Water Resources Management (DWRM), an agency within the Ministry of Water and Environment, is responsible for managing the country's water resources in an integrated and sustainable manner. Its objective is to secure and provide water of adequate quantity and quality for all social and economic needs for the present and future. DWRM issues surface-water abstraction and construction permits to developers of hydropower projects; it is also in charge of water discharge and underground water-abstraction permits.
Uganda Investment Authority	The Uganda Investment Authority (UIA), is a semi-autonomous government agency that operates in partnership with the private sector to drive national economic growth and development. As a one-stop shop for investors, UIA offers free services and enables investors to register their businesses and obtain all necessary licenses under one roof.
Uganda National Bureau of Standards	The Uganda National Bureau of Standards (UNBS) is a statutory body under the Ministry of Trade, Industry, and Co-operatives. Its mandate is to formulate and promote the use of national standards and to develop quality control and quality assurance systems that will enhance consumer protection, public health and safety, industrial and commercial development, and international trade. As part of its responsibilities, UNBS develops and monitors standards for renewable energy technologies.
Electricity Disputes Tribunal	The Electricity Disputes Tribunal (EDT) reviews and determines all matters referred to it relating to the electricity sector. Its jurisdiction includes electricity disputes between consumers and the public bodies charged with generation, transmission, and distribution of electricity. In exercising its functions, it has the powers of the High Court of Uganda. The decisions of the ERA may be appealed to the EDT.
International Participation	International development partners are very active in electricity planning in Uganda. These agencies provide grants, financing, and technical assistance, and include the U.S. Agency for International Development (USAID), GIZ, Kreditanstalt für Wiederaufbau (KfW), the European Union, and the World Bank.

1.4 RURAL ELECTRIFICATION EFFORTS

Rural electrification is a high policy priority in Uganda and is coordinated primarily through the REA. From 2001 to 2012, the rural electrification program was based on the first RESP, which aimed to increase access to electricity in rural areas from 1% percent in 2001 to 10% by 2010. The first RESP took a decentralized approach and relied heavily on the private sector. For various reasons, the RESP did not achieve its intended results; by the end of 2010, access to electricity in rural areas was less than 4% (REA, 2013).

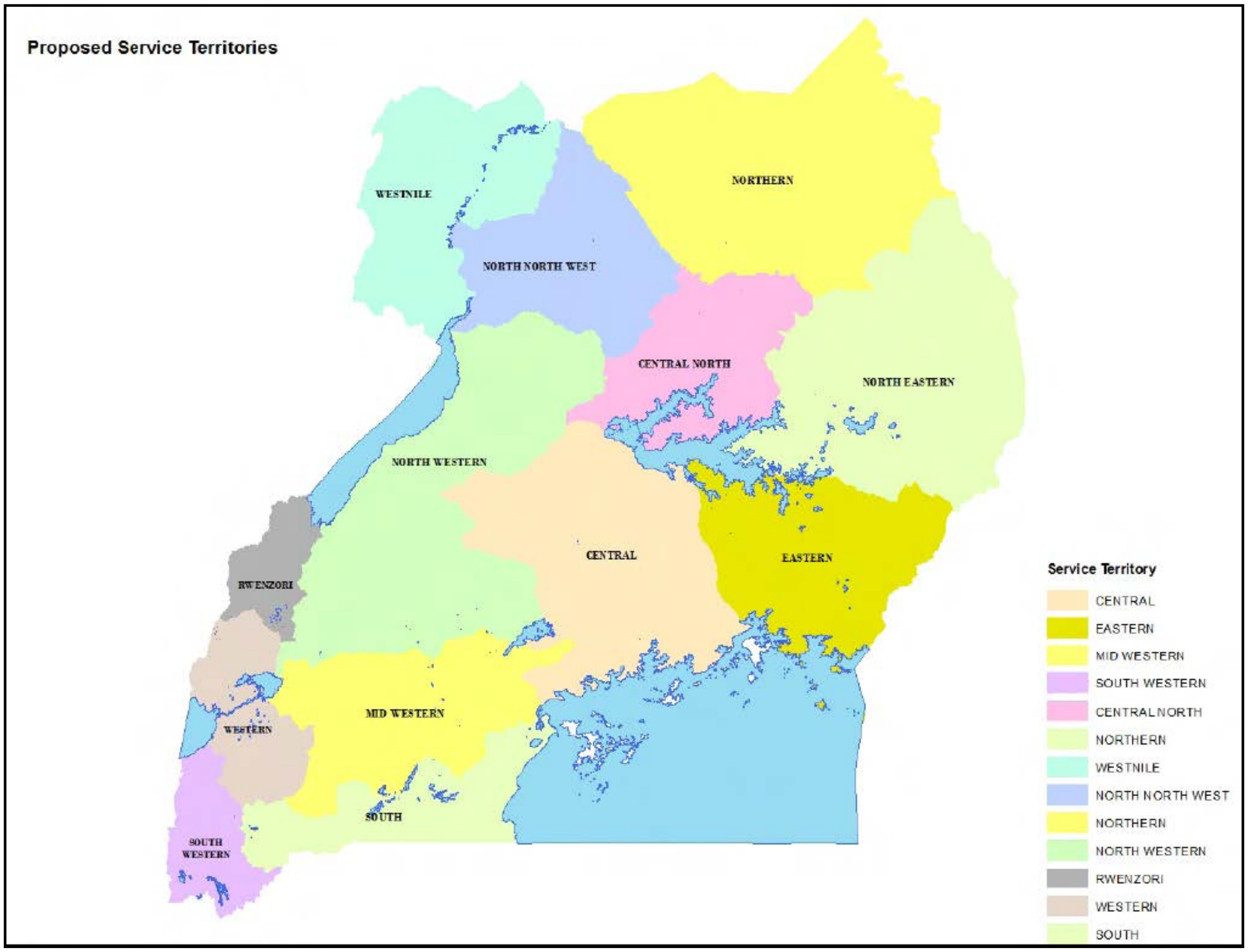
In response, REA developed the second RESP (2013-2022), which was published in 2013. The updated plan calls for a more centralized approach, and is being led by REA in partnership with the private sector. The goal is to increase electrification for rural populations from 7% (as of 2013) to 26% by 2022, and to make progress toward the ultimate goal: 100% rural electrification by 2040.

The second RESP outlines a large-scale planning effort to determine which parts of the country will be served by on-grid or off-grid electricity services. Under the new plan, the non-electrified portions of Uganda will be divided into 13 areas: each will be subject to a rural electrification planning effort, and a competitive bidding process will be used to award a single concession for on-grid electrical service in each territory (Figure 2). For off-grid areas, the RESP envisions that the selected provider or other private sector developers will provide services through renewable-energy-based mini-grids or solar photovoltaic home systems (REA, 2013).

To support these efforts, REA administers the REF, which funds and finances rural electrification projects through grants and subsidies. Funding for the REF comes from parliamentary appropriations, any surplus monies made from the operation of ERA, a 5% levy on transmission bulk purchases of electricity from generation stations, and loans and grants from development partners such as GIZ, the World Bank/International Development Association, Swedish International Development Cooperation Agency, Japan International Cooperation Agency, the government of Norway, Global Environment Facility, and KfW (Mutambi, 2011).

The estimated cost of the second RESP is just over US$950 million. Of this, over 90% is projected to be spent on on-grid electrification, with the remainder split between off-grid electrification, customer financing, technical assistance, and other areas (REA, 2013).

Figure 6: Uganda's 13 Proposed Service Territories



1.5 STATE OF UGANDA'S MINI-GRID PLANNING AND REGULATION

While this guide defines mini-grids as 10 MW or less, mini-grid projects in Uganda are more likely to be less than 2 MW. This case study therefore focuses on Uganda's experience regulating mini-grids with a capacity of 2 MW or less.

A number of mini-grid projects are currently in operation or development in Uganda. Thus far, the government has taken a decentralized approach and primarily relies on developers to propose sites. However, as outlined in the second RESP, the government is beginning to take a more active role in planning for mini-grid development. The RESP outlines a minor role for mini-grids: estimating 8,500 new service connections from mini-grids by 2022, compared with 130,000 new solar home systems and 1,276,500 new connections from grid extensions (REA, 2013).

REA is in the early stages of amending the second RESP to better clarify the role of mini-grids and solar home systems in rural electrification. As part of this process REA is undertaking a master-planning process to identify sites that would be strategic locations for mini-grid development, rather than for grid extension or solar homes systems. REA anticipates running a competitive tender and providing concessions of the identified sites to selected developers, potentially as part of broader concessions to provide distribution service to a region.

Given the current state of mini-grid policy and planning, much of the mini-grid regulatory regime is still under development. Presently, mini-grid projects are regulated based on their capacity. Mini-grids greater than 2 MW in capacity are subject to the same regulations as national-grid independent power projects (IPPs) including licensing, tariff approval, technical standards, and general oversight. Mini-grids less than 2 MW are regulated through a license exemption process that outlines rules for tariff approval, technical standards, reporting, customer service, dispute settlement, and upgrading generation capacity above 2 MW. Autonomous mini-grids are specifically regulated under Electricity Order 2007 No. 39 (Electricity [License Exemption] [Isolated Grid System] Order 2007). While the rules are helpful, they are light on detail. For example, the rules briefly discuss interconnection to the main grid, but do not provide any details on ownership following grid connection. The lack of details has resulted in some misunderstandings among mini-grid developers. ERA is engaged in an ongoing process to update the regulations to better suit small-scale, autonomous applications.

1.6 STATUS OF MINI-GRID DEVELOPMENT IN UGANDA

The mini-grid projects that have been developed or are currently under development in Uganda are located in rural areas of the mainland and on islands in Lake Victoria. Brief descriptions of several of these projects follow. It should be noted that the Bwindi Community Micro Hydro Project Limited and the Kisiizi Hospital Power Limited are active mini-grid projects that are not included in the descriptions below.

West Nile Rural Electrification Company
The West Nile Rural Electrification Company (WENRECO) is a subsidiary of Industrial Promotion Services, the industrial development arm of the Aga Khan Fund for Economic Development. In 2003, WENRECO was the only bidder in the tender for a generation and distribution concession in the West Nile region of Uganda, where an isolated mini-grid was already located. WENRECO procured and installed a 1.5 MW thermal plant, and has since developed a 3.5 MW hydroelectric plant in the area. WENRECO currently has 9,500 customers.

WENRECO's position is slightly different from that of other mini-grid developers for several reasons: it took possession of an existing mini-grid instead of developing a new one; WENRECO, rather than REA, bears financial responsibility for constructing new distribution networks in the region; and WENRECO's hydroelectric project was too large to obtain a license exemption. WENRECO has had significant difficulty meeting ERA's technical requirements, because it must maintain over 150 kilometers of distribution lines. It has also faced challenges in obtaining ERA approval for a tariff that is sufficient to recover its operating and capital costs, and in achieving enough demand to fully utilize its generating capacity (WENRECO recently added a large industrial account, which now accounts for roughly 30% of total demand).

Pamoja Cleantech
Pamoja Cleantech is a subsidiary of a Swedish firm that develops biomass gasification projects in rural villages with agricultural trading centers. Pamoja's model is to purchase agricultural waste by-products from farmers at a local market, gasify the product to produce fuel that is used to power a generator located in town, and sell the resulting power to both local businesses (to power agricultural operations) and local residents. Pamoja, which has developed two pilot projects in Uganda and

currently developing a larger project, is working with REA to fund distribution infrastructure, which has contributed to project cost-effectiveness.

Kalangala Infrastructure Services
Kalangala Infrastructure Services (KIS) is a US$44.5 million Private Infrastructure Development Group (PIDG) project implemented by EleQtra, an international energy-project development firm. KIS provides numerous services to Bugala, an island in the Kalangala District, on Lake Victoria. In addition to power generation (which was the target service of the KIS project), these include road construction, water purification, and ferry service. KIS developed a 1.6-MW, US$15.6 million solar-battery-thermal hybrid project, which currently serves 2,000 households. KIS identified and proposed the site and obtained funding from both private and public sector institutions to construct the plant and the distribution network. Among the institutions were Infraco, the Uganda Development Corporation, Industrial Development Corporation—S.A, Nedbank South Africa, the Emerging Africa Infrastructure Fund, PIDG, USAID, and GuarantCo. ERA approved the license exemption and retail tariff for KIS to construct and own the hybrid power station and to operate and distribute electricity on Bugala.

GRS Associates and Absolute Energy
GRS Associates and Absolute Energy are currently collaborating to develop a 235 kW solar project in Kalangala, a town on Bugala Island in Kalangala District, on Lake Victoria.

Konserve Consult Limited
Konserve is in the process of developing a 300 kW solar photovoltaic project on Kimi Island, in Lake Victoria. To avoid issues associated with costly and hard-to-maintain distribution infrastructure, Konserve opted to locate its project on a small island with a dense population. After over a year, Konserve is close to obtaining the necessary approvals. Konserve expects that its project will yield a 10-year payback, which project staff note is substantially longer than the typical time frame for similar African infrastructure projects.

1.7 SUMMARY OF MINI-GRID STAKEHOLDER EXPERIENCES

Interviews with both public and private sector stakeholders in Uganda indicate that there have been several successes in the mini-grid sector, but that challenges remain.

Successes have included the following:

- Establishing several successful mini-grid projects.
- Working across governmental agencies to approve mini-grid projects;
- Making projects financially viable through support from the REF via REA; and
- Supporting mini-grid developers during the project planning, approvals, and development phases.

Challenges have included the following:

- Identifying project sites (1) that were not already under consideration by another developer; (2) that had sufficient electricity demand; and (3) that had not been designated for grid extension in the short to medium term;
- Finding the necessary expertise for and covering the costs of feasibility studies;

- Navigating the project approvals process (especially the license exemption process and at times the environmental review process);
- Obtaining cost-reflective tariffs that fully recover development and operational costs; and
- Encouraging sufficient demand growth in newly electrified areas to recover development and operational costs.

As Uganda thinks through its mini-grid regulatory framework, it could consider taking the following steps to ease mini-grid development and operation:

- Making the license exemption process easier to navigate. Options include
  - Convening a multi-stakeholder group including (1) mini-grid developers and development partners and (2) representatives of governmental agencies involved in the mini-grid approvals process to evaluate the current approvals process, identify opportunities for streamlining, and update accordingly;
  - Developing a guidance document outlining the license exemption process and making it easily accessible on ERA's website. The document could include a process chart detailing the order of electricity sector and non-electricity-sector approvals and the associated timeline.
  - Developing an online exemption application or an application can be downloaded from ERA's website; the application would include templates for the required documentation.
  - Establishing a one-stop shop within ERA for mini-gird projects, which could include identifying a single point of contact for coordinating the approvals process and liaising with developers.
- Defining the various scenarios for ownership after grid interconnection.
- Defining various classes or categories of mini-grid projects according to capacity, and publicizing the regulations associated with each class.
- Creating specific technical standards and reporting requirements for autonomous mini-grid projects.

To explore the various options for further developing the country's mini-grid regulatory framework, mini-grid stakeholders in Uganda are advised to consult the *Practical Guide to Mini-grid Regulation*.

APPENDIX II. REGULATORY DECISION-MAKING TOOL

The following section summarizes the above narrative description of the various issues and decision points involved in the regulation of mini-grids. Although the discussion above covered a large number of issues, this section focuses on a smaller number of issues that are central to the creation of a mini-grid regulatory regime. These include:

- Approach to Mini-Grid Planning (Section 1.1)
- Mini-Grid Regulatory Authority (Section 1.2)
- Developing a Mini-Grid Definition (Section 1.3)
- Developing Classes or Categories of Mini-Grids (Section 1.4)
- Ownership Model (Section 1.5)
- Approval Processes and Procedures (Section 1.7)
- Licensing (Section 1.8)
- Ownership Following Connection to the National Grid (Section 1.12)
- Retail Tariff Oversight (Section 2.1)
- Retail Tariff Level (Section 2.2)
- Interconnection to the National Grid (Section 3.1)
- Technology Standards for Equipment and Functionalities (Section 3.2)

The following tables are intended to serve as an easy-to-reference summary of the key options, benefits, drawback, and next steps involved in addressing these primary regulatory issues, which are supported and detailed in the text above.

1.1 Approach to Mini-Grid Planning

Should government pursue a centrally-managed or decentralized approach to mini-grid planning?

Options	Benefits	Drawbacks	Next Steps
Adopt a centralized approach This approach implies a significant role for government in determining the timing and location of mini-grid projects, and often includes a governmental role in the development and ownership of mini-grid assets.	• Ensures maximum government control of the mini-grid development process. • Allows for identification of the most suitable sites for mini-grid development (as opposed to grid extension or stand-alone systems) to be identified, and for mini-grids to be developed in these areas (either by government, public utilities, or private-sector partners) in a tightly controlled manner. • Maintains government control of licensing, tariff setting, technical standards, reporting, monitoring, and tracking progress against energy-access targets.	• Requires significant financial and human resources, as well as coordination on the part of government authorities. • Requires significant capacity to identify and assess sites, develop and manage approval processes, and manage competitive bidding processes, among other responsibilities. • May constrain the ability of entrepreneurs and communities to develop projects in areas not included in centralized plans, thereby hindering innovative business models.	• Include the identification of preferred mini-grid project sites in rural electrification planning efforts. • Determine whether to pursue mini-grid development directly, through a state or regional agency or national utility, or by offering project sites for private development. • Ensure that the responsible agency has adequate staff capacity and resources to successfully implement a centralized approach.
Adopt a decentralized approach In a decentralized approach, the government relies on nongovernmental parties to identify and propose potential projects. The government's role is to develop eligibility requirements and determine, based on these criteria, whether proposed projects move forward.	• Takes advantage of varied knowledge and perspectives of diverse nongovernmental actors in determining potential project sites. • Can reduce development costs and risks where developers have more influence over the direction of projects. • Allows governments to be flexible and responsive to demand. • Fosters competition and allows progress to move at the pace of the private sector, given the setup of an enabling regulatory environment.	• May lead to confusion and lack of coordination, particularly if multiple developers are interested in pursuing projects in the general area, or if a developer is interested in a site slated for grid extension. • The government has less control over site selection; as a result, projects may not be developed in areas that would provide the greatest public good.	• Create a full rural electrification plan that identifies areas well-suited for private development and areas where grid extension is planned: this information will be vital to private sector developers. • Develop and publish a set of requirements that mini-grid developers and projects must meet; these should be standardized, transparent, and fair. • Design a project licensing process (Section 1.8) and ensure that the agency responsible for managing this process has adequate staff capacity and resources.

1.2 Mini-Grid Regulatory Authority

What is the appropriate body to regulate mini-grids?

Options	Benefits	Drawbacks	Next Steps
Assign all primary mini-grid regulatory responsibilities to a single central government entity The primary regulatory authority is assigned to a central government entity. However, in this option, other regulatory agencies will continue to be involved in the regulation of mini-grid projects.	• Provides a "one-stop-shop" for all stakeholders, including private developers, communities, and end users. • Mini-grid developers could access all the information they need on permitting and licensing, retail tariffs, and technical standards from one place. • Due to minimal cross-agency collaboration, it may enable a streamlined regulatory process.	• Efficient development and implementation of regulations requires significant financial resources. • As development grows, the regulatory authority could experience high volumes of requests pertaining to licensing or technical inspection of generation and distribution facilities, which may be beyond its capacity. • Capacity constraints could be an impediment, as timely responses to applications and inquiries are critical for reducing project development costs. • Regulatory authority may not be physically present in areas where mini-grid deployment is taking place, which makes it less accessible to developers and customers. • Regulatory authority may find it difficult to monitor end-user satisfaction and developers' adherence to regulations. due to the inaccessibility of remote areas.	• Identify central government entities that could play the role of mini-grid regulator. • Initiate a stakeholder consultation process to collect input from governmental and nongovernmental stakeholders (see Table 5). • Incorporate input from stakeholders and work with relevant government agencies and policy makers to select and designate a regulatory authority. • Assess whether national legislation needs to be amended to move forward with providing regulatory authority. If so, amend the legislation. • Adopt a policy framework that guides and supports the local and regional regulatory process. • Empower local or regional entities with the authority, practical tools, and resources to effectively regulate mini-grid development.
Assign all regulatory responsibilities to local or regional government bodies	• Useful for countries that have regions with diverse social and economic conditions. • Local public agencies familiar with the socioeconomic and political context of their region may be better suited to regulate mini-grids operating in their area. • May help address the human-and financial-capacity constraints that can arise from having a single, centralized regulatory authority.	• May result in imbalanced market growth, poor standardization across regions, or both. • May result in a patchwork of regulations that vary across regions and are difficult for mini-grid developers to navigate. • Mini-grid developers may then avoid certain regions, hindering mini-grid development. • Select regional or local regulators may also have fewer financial and	Central Government Policy Makers: • Work with regional and local entities and other stakeholders to identify regional regulatory bodies that could have regulatory authority over mini-grids. • Initiate a stakeholder consultation process to collect input from nongovernmental stakeholders (see Table 5). • Incorporate stakeholder input and designate the appropriate regional and local entities. • Assess whether national legislation needs to enable regulatory authority. If so, establish legislation to grant regulatory authority to local or regional government bodies.

	• May be more likely to be physically present and accessible to developers and customers than a centralized body.	human resources to regulate mini-grids within their jurisdictions. • Could prove to be costlier compared to a centralized approach.	• Adopt a policy framework that guides and supports local and regional regulatory processes. • Empower regional governments with the authority, practical tools, and resources to effectively regulate mini-grid development. <u>Regional Governments:</u> • Work with the central government and other stakeholders to identify the appropriate agency to regulate mini-grid development. • Support the stakeholder consultation process. • Incorporate input from the stakeholder consultation process and work with the central government to designate the regulatory authority. • Assist as needed to ensure the local or regional entity is granted regulatory authority. • Provide adequate staff and resources to the local or regional entity.
Adopt a decentralized regulatory institutional arrangement Regulatory responsibilities are divided between various governmental entities (e.g., rural electrification agencies, regional or local administration, public utilities and village representatives).	• Enables institutions participating in the mini-grid regulatory process to contribute some amount of human and financial capacity, ideally relieving the burden on the central government. • A decentralized arrangement allows public institutions that have experience with or capacity for highly technical or specialized regulations to collaborate with other agencies to fulfil regulatory responsibilities.	• A fragmented institutional structure, in which regulatory responsibilities are distributed among several entities, could lead to a disorganized system hindering mini-grid deployment. • Constant cross-agency communication and collaboration are essential if the performance and efficiency of one agency is closely tied to the performance of another. • May require new roles at the national level to oversee, coordinate, and monitor the function and quality of the regulatory process (IFC, 2010).	• Assemble a multi-agency group of policy makers who—with input from nongovernmental stakeholders—will map out (1) the electricity-sector regulatory tasks associated with mini-grid development and operations and (2) the governmental bodies best equipped to serve each function. • Designate the selected government bodies. • Determine whether national legislation needs to be amended to move forward with providing regulatory authority. If so, amend the legislation to grant regulatory authority to the designated government bodies. • Identify the method by which the designated entities will collaborate and communicate; if desired or necessary, assign responsibility for coordination to a single entity. • Assemble a special task force that will meet regularly to discuss issues and resolve problems as they arise. The task force should consist of representatives from each agency involved in mini-grid regulation, and should include a representative from the ministry of energy or equivalent agency. Where applicable, the task force could be organized and led by the mini-grid coordinating agency. • Adopt a policy framework that guides and supports the government bodies in regulating the mini-grid sector.

1.3 Developing a Mini-Grid Definition

What definition is most appropriate for mini-grids?

Options	Benefits	Drawbacks	Next Steps
Define mini-grid in relevant national laws, plans, policies, and regulations.	• Provides greater clarity and certainty to mini-grid developers and operators regarding how a given project will be considered, classified, and assessed by the regulator.	• Mini-grid definitions may not keep pace with changes or advancements in mini-grid technologies and their respective efficiencies. • Too narrow of a definition may constrain mini-grid development and advancement. • Too broad of a definition may permit unforeseen or unanticipated types of projects.	• Assess national laws, plans, policies and regulations for mini-grid definitions. • Consult with stakeholders to gain different perspectives on mini-grid definitions. • Evaluate different countries mini-grid definitions. • Adopt a definition for mini-grid and include in relevant laws, plans, policies and regulations. • Review definition periodically and update as necessary.

1.4 Developing Classes or Categories of Mini-Grids

What categories or classifications are most appropriate for mini-grids?

Options	Benefits	Drawbacks	Next Steps
Develop mini-grid classes or categories and adopt regulation based on classes.	• Provides more certainty and predictability to mini-grid developers and operators on how a specific project will be regulated. • Can decrease requirements and regulations for smaller projects with less impact. • Can reduce resources the regulator must dedicate to each mini-grid project.	• Developing categories can be a time-consuming process. • Depending on how categories or classes are structured, they can unintentionally favor specific technologies.	• Assess national laws, plans, policies and regulations for mini-grid classifications or categorization. • Evaluate different countries mini-grid classifications. • Consult mini-grid developers, operators and other stakeholders on proposed categories and segmentation to ensure they align with the private sector's approach to mini-grid development and market needs. • Adopt mini-grid categories and include in relevant laws, plans, policies and regulations. • Review categories periodically and update as necessary.

1.5 Ownership Model

Who should own and operate mini-grids?

Options	Benefits	Drawbacks	Next Steps
Utility ownership The national utility is designated as the owner and operator of all mini-grids. The utility would be in charge of mini-grid operations, maintenance, and tariff collection.	• Public utilities have proven technical expertise from operating and maintaining the national grid. • Public utilities have better access to government funding for rural electrification, which can be put towards mini-grid development in remote areas. • Tariffs could be more affordable for low-income customers if cross-subsidies are used. • If community members are employed, could lead to job creation and stronger investment in service quality and management.	• May not allow for rapid scale-up of mini-grid deployment, as utilities tend not to invest in-mini grids voluntarily, unless directed by the government. • National utilities risk financial failure due to the high cost of operating mini-grids in remote areas, unless provided with adequate support from the government. • Due to remote locations of mini-grids, national utilities might neglect operation and maintenance responsibilities, potentially raising disputes with community members.	• Provide a clear mandate to the national utility (or other designated public entity) to pursue mini-grid development efforts, in tandem with a rural electrification authority or other agency responsible for leading electrification planning efforts. • Identify priority areas for mini-grid development through a master planning process. • Develop clear schedules for when priority areas and other regions will be subject to mini-grid development and eventual grid expansion. • Provide the necessary capital funding to national utilities to pursue a robust mini-grid development process. • Provide necessary operational funding to operate and maintain the systems over its lifetime.
Private and community ownership Mini-grids are owned and operated solely by private or community actors. In such arrangements, governments can encourage development through public grants, subsidies, and loan guarantees.	• Most efficient approach for rapid rural electrification and scale-up of mini-grid deployment (according to some experts). • Combined, private and community ownership models can lead to rapid deployment in previously unserved areas. • Since managers and operators of community owned mini-grids are also the customers, this may lead to stronger investment in service quality and management. • Can generate jobs for local entrepreneurs and community members.	• Rarely commercially viable in rural areas without funding support from the government. • Community ownership model is frequently faced with challenges related to lack of local skills necessary to operate and manage mini-grids. • Private ownership model could lead to inefficiencies in providing electricity service, since operator would benefit from higher sales and may not be interested in energy efficiency. • Requires significant regulatory capacity for a robust policy and regulatory framework.	<u>Central Government Policy Makers</u>: • Outline clear guiding principles that support and promote private sector and community participation. <u>Regulators</u>: • Develop and implement regulations that create an enabling environment, while also ensuring safe, high-quality electricity service for rural customers. • Adopt (I) common regulations that must be adhered to by all mini-grid developers or (2) regulations that are exclusively applicable to each group or sector (community organizations, cooperatives, and private developers). • Make all relevant regulations on ownership publicly accessible to ensure fair treatment of all stakeholders.

Hybrid ownership Public and private organizations are allowed to own and operate mini-grids, either independently or through public-private partnerships.	• Enables governments to mitigate the limitations associated with the first two models by allowing all actors to participate. • Likely to create market competition in mini-grid development, potentially leading to improved quality of electricity services for rural populations. • Encourages the participation of various entities that may not necessarily have the capacity to develop mini-grid projects independently; this can be particularly valuable in remote areas.	• Governments may have conflicting interests or a bias towards protecting state-owned utilities from competitors. • Requires substantial regulatory capacity due to diversity of actors involved. • Could lead to inefficiencies in providing electricity service, since private operator would benefit from higher sales and may not be interested in energy efficiency.	Central Government Policy Makers: • Adopt mini-grid policies that reflect objectives and priorities under the hybrid ownership model. • Devise affordable and sustainable fiscal policies to encourage private sector and community participation. Regulators: • Develop and implement regulations that outline the requirements that must be met by each type of mini-grid developers (includes private enterprises, community organizations or cooperatives, or public utilities). • To guarantee fair treatment of all stakeholders, make all ownership regulations publicly accessible.

1.7 Approval Processes and Procedures

How should mini-grids be approved?

Options	Benefits	Drawbacks	Next Steps
Apply the existing approval process for independent power producers (assuming an approval process already exists).	• Relevant government and regulatory agencies do not have to dedicate staff time and resources to develop a new or revised process.	• Approval processes designed for independent power producers may be ill suited for small, autonomous mini-grid projects and may not appropriately address the diversity of mini-grid project sizes, technologies, and business models. • An approval process that is onerous, complicated, lengthy, or costly could lead to higher development costs and risks, and thereby create a major barrier to market entry.	• As long as a country has an approval process outlined for independent power producers, no next steps are required.
Develop a specific approval process for mini-grid projects.	• Increases the efficiency and effectiveness of the project approval process. • Improves the experience of government agencies and project developers. • Cuts down mini-grid project development cost. • Mitigates project development risks. • Eliminates barriers to market entry.	• Requires time and resources from the relevant government agencies and other stakeholders that will be involved in the process.	Policy Makers: • Designate an agency that will be responsible for reviewing, developing, and enforcing the approval process for mini-grid projects, including licensing and tariff review. The agency could be the entity that has mini-grid regulatory authority or broader authority over rural electrification. Among the agency's responsibilities could be the following: coordinating stakeholders; documenting and publicizing application processes and procedures; managing both electricity sector and non-electricity-sector approvals; delivering capacity-building training; and facilitating the delivery and administration of financial incentives (RECP et al., 2013b). • Arrange for the designated agency to convene a stakeholder group that includes (1) representatives from the regulatory agencies and other governmental agencies that are responsible for electricity-sector and non-electricity-sector approvals and (2) other key stakeholders, such as mini-grid developers, investors, representatives of civil society, and target beneficiaries (see Table 5). Regulators: • Review the existing approval process; identify ways to make the process clearer, more straightforward, and efficient; develop draft guidelines that define the steps of the revised approval process, including the succession of reviews; validate the draft guidelines with stakeholders; finalize the guidelines on the basis of stakeholder feedback and make them publicly available and easily accessible; update as necessary.

1.8 Licensing

What process should regulators use to license mini-grid developers?

1.8.1 Requiring a License

Options	Benefits	Drawbacks	Next Steps
Do not require a license for mini-grid projects, but require all mini-grid developers to register as a business and obtain required non-electricity sector required approvals	• Reduces project development costs for mini-grid developers. • Requires fewer financial and staff resources from the regulatory authority.	• Regulators give up ability to protect end users from predatory or suspect mini-grid developers. • Regulators do not obtain comprehensive information on all mini-grid projects or developers. • Developers lose the security that a license provides over their investment, which can introduce additional project risk.	• Evaluate the non-electricity sector approval processes to determine whether sufficient information is collected to adequately evaluate project developers and protect end users. • If insufficient, identify basic criteria and information regulators would like to collect and outline how the information will be collected and maintained. • Establish a system for information sharing between the mini-grid regulatory authority and other governmental agencies requiring approvals. • Establish a system for integrating information on mini-grid projects and developers into the country's rural-electrification planning process.
Adopt a tiered approach to licensing based on the capacity of the mini-grid.	• May cut down on the length and complexity of the approval process thereby reducing development risks and costs. • May decrease number of projects that require review, freeing up staff resources.	• Regulators do not obtain information on all mini-grid projects or developers. • Some mini-grid projects will be developed without being reviewed by the regulatory agency, potentially resulting in varied quality and reliability of mini-grids. • Developers give up the security that a license provides, potentially introducing additional risk. • Developers may opt to build projects that do not require a license.	• Determine the capacity tiers for mini-grid projects. • Establish licensing requirements for each tier. • Develop an approval process for licensing. This could include: o Identify basic criteria and information regulators would like to collect from mini-grid developers. o Outline how the information will be collected and maintained. o Develop a timeline and process for material review. o Establish a standardized list of application requirements. o Develop a checklist of application requirements for developers. o Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality. o Clearly outline the submission process for applications. o Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. o Make all licensing information and requirements publicly available on the regulator's website. o Clearly communicate and disseminate requirements online or otherwise.

Adopt a tiered approach to licensing based on the capacity of the mini-grid and a voluntary licensing process for mini-grid developers not required to obtain a license	• Regardless of project capacity, developers have the option to voluntarily obtain a license, increasing the security of their investments and reducing project risks.	• Regulators do not obtain information on all mini-grid projects or developers. • Some mini-grid projects will be developed without being reviewed by the regulatory agency, potentially resulting in varied quality and reliability of mini-grids. • The voluntary license may not increase security of an investment if it does not include legal rights to develop or operate. • Developers may opt to build projects that do not require a license.	• Establish voluntary licensing requirements. • For those exempted from the required licensing process, establish an approval process for voluntary licensing and outline the rights associated with a voluntarily license. For instance, security of a site during the development phase, or exclusivity to serve a specific area. An approval process could include: o Identify basic criteria and information regulators would like to collect from mini-grid developers. o Outline how the information will be collected and maintained. o Develop a timeline and process for material review. o Establish a standardized list of application requirements. o Develop a checklist of application requirements for developers. o Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality. o Clearly outline the submission process for applications. o Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. o Make all licensing information and requirements publicly available on the regulator's website. o Clearly communicate and disseminate requirements online or otherwise
Require all mini-grid projects to follow the same licensing process	• Allows regulators to maintain maximum control over project deployment. • May result in greater consistency across mini-grid projects.	• May lead to lengthy, time-intensive reviews for small scale projects. • Development risks and costs may increase, making developers less likely to enter a country's market. • Requires regulatory capacity to carry out licensing review for small projects.	• If a licensing process has already been established, no additional steps are required. • If a licensing process has not been established, see Section 1.7 on developing an approval process for mini-grid projects. Developing an approval process should include: o Identify basic criteria and information regulators would like to collect from mini-grid developers. o Outline how the information will be collected and maintained. o Develop a timeline and process for material review. o Establish a standardized list of application requirements. o Develop a checklist of application requirements for developers. o Develop templates to ensure that developers provide the requested information in the appropriate format and to the expected level of quality. o Clearly outline the submission process for applications. o Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. o Make all licensing information and requirements publicly available on the regulator's website. o Clearly communicate and disseminate requirements online or otherwise.

1.8.2 Licensing Rights			
Options	**Benefits**	**Drawbacks**	**Next Steps**
Grant a single license that provides exclusivity to a specific service area for a specific period of time and provide the option for renewal.	• Simplifies and streamlines the licensing process and reduces transaction costs for mini-grid developers and regulatory agencies. • Reduces development and operational risk by ensuring no other developer will attempt to develop a site. • Motivates the developer to assess and develop the site quickly. • Requires the developer to serve the area.	• Regulator gives up a level of control over the mini-grid development process.	• Establish the eligibility criteria and requirements for a single licensing process. • Outline the steps for applying for a single license, including the documentation required of the developer. • Develop templates to ensure that developers will provide the requested information in the appropriate format. • Develop a checklist of application requirements for developers. • Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. • Develop a policy for renewal and revocation of licenses. • Make the information publicly available on the regulator's website.
Grant a provisional, exclusive license for a specific period of time. Require a second application for a generation, distribution, and sale license for a specified period of time. Provide the option for renewal.	• Regulators have two opportunities to review and approve the license application of mini-grid developers and have more control over the mini-grid development process.	• Increases the duration of the licensing process, which can add risk and increase costs for mini-grid developers.	• Establish eligibility criteria and requirements for a two-step licensing process. • Clearly outline the steps for applying for a provisional license and a generation, distribution and sale license, including the documentation required of the developer. • Develop templates to ensure that developers provide the requested information in the appropriate format. • Develop a checklist of application requirements for developers. • Clearly outline the submission process for applications. • Communicate the review and approval timeline and how applicants will be notified regarding the status of their application. • Develop a policy for renewal and revocation of licenses. • Make the information publicly available on the regulator's website.

Grant an exclusive concession contract to a project developer that provides the right to build, operate and maintain assets for the generation, distribution and sale of electricity to end users for a given number of years in specific service areas; provide the option for renewal at the regulator's discretion.	• Protects the developer's investment by providing exclusivity over service areas for a specified period of time. • Reduces project development and operational costs and risks. • Allows the regulator to select the bidder that best meets the needs of the service areas and provides the regulator greater control over the process. • Requires the developer to serve the area.	• For regulators, establishing a competitive concession process is very time-intensive. • For developers, applying for a competitive concession is a time-consuming process with no guarantee of selection. • Provides developers with a monopoly over the service area, potentially strengthening the developer's position and weakening that of the regulators and end users.	• Establish a process for competitive concessions that includes the following elements: o Establishing eligibility criteria and requirements; o Clearly outlining the steps for applying for a concession, including the documentation required of the developer; o Developing templates to ensure that the developer provides the requested information in the appropriate format; o Developing a checklist of application requirements; o Clearly outlining the submission process for applications; o Communicating the review and approval timeline and how applicants will be notified regarding the status of their application; o Developing a policy for renewal and revocation of licenses; and o Caking concession information publicly available on the regulator's website. • *See Section 1.8.3 for more information on how to establish a competitive concession process.*

1.8.3 License Award Process

Options	Benefits	Drawbacks	Next Steps
Allow developers to propose locations and award licenses through the established licensing process.	• Allows developers to have greater control over the mini-grid development process. • The process may be less time intensive and costly relative to running a competitive bidding process.	• Developers may not select sites that are within the government's high priority areas for mini-grid development. • Due to the noncompetitive process, licenses may be awarded to less experienced or more expensive mini-grid developers. • A noncompetitive award process could be more susceptible to corruption as fewer people may be involved in review and selection.	• Establish the application, review and award process for licenses. • Incorporate information about the license award process into mini-grid approval process guidelines and publicize widely (see Section 1.8.3).
Award a concession or concession schemes through a competitive process, where the government identifies an appropriate location for mini-grid development and solicits bids from mini-grid developers.	• More likely that the mini-grid will be located in a suitable high-priority area. • The regulator can lay out the preferred requirements and qualifications for bidders and the terms of the award. • The process may increase the likelihood of selecting the most qualified, experienced and low-cost mini-grid developer.	• Developing and running a competitive process can be time-consuming and costly. • Regulators may struggle to attract enough interest from qualified bidders to run a competitive process. • A competitive process may favor experienced mini-grid developers and may prevent new companies from entering the market.	• Establish a competitive bidding procedure including a request for proposal process that outlines eligibility criteria and scoring criteria. • Develop document templates. • Develop a contract award and monitoring process. • Develop a standardized concession contract and/or a standardized operations and maintenance (O&M) contract if the O&M will be provided by a different entity. • If necessary, develop a standardized power purchase agreement contract. • Consider partnering with a more experienced government agency or development organization. • Incorporate the final process into mini-grid approval guidelines and publicize widely (see Section 1.7).

1.8.4 License Resale

Options	Benefits	Drawbacks	Next Steps
Do not allow any resale of license or concession rights.	• Allows the regulator to maintain authority over the license-holding parties.	• May prevent any development from taking place within the service area if the original license or concession holder proves unable or unwilling to develop or operate a project.	• Review other countries' experience with license and concession resale. • Establish a license and concession resale policy. • Incorporate the information into guidelines for the mini-grid approval process and publicize widely.
Allow license or concession resale to any party that meets the original eligibility criteria, and agrees to the original terms.	• Maintains the regulator's authority over the licensing and concession process. • Ensures the mini-grid developer meets the same set of eligibility criteria and conditions that were applied to the original license or concession holder. • Increases the likelihood that the site will be developed even if the original developer was unwilling or unable to move forward with the project.	• Does not necessarily address issues associated with the resale price of the license. • Developers may arbitrarily increase the price of the license to a value they deem fair.	• Review other countries' experiences with license and concession resale. • Establish a license and concession resale policy. • Consider including some guidance related to resale price. • Incorporate resale information into the guidelines for the mini-grid approval process, and publicize the guidelines widely.
Allow license or concession resale to any party that meets the original eligibility criteria, but cap the level specified in the original license or concession application.	• Maintains the regulator's authority over the licensing process. • Increases the likelihood that a particular project will be developed by a qualified party • Reduces any price risk or speculation associated with the license or concession value, thereby protecting against any potential impact on the retail tariff.	• May prevent developers from receiving fair-market value for their license or cause the new developer to be overcharged.	• Review other countries' experiences with license and concession resale. • Establish a license and concession resale policy. The policy may include stipulations related to regulatory review before a sale is authorized or final and could consider capping the resale price to prevent price gauging or speculation. • Incorporate information on license and concession resale into the mini-grid approval process guidelines, and publicize the guidelines widely.

1.12 Ownership Following Connection to the National Grid

Who owns the mini-grid assets following connection to the national grid?

Options	Benefits	Drawbacks	Next Steps
Small Power Distributor (SPD) - Allow mini-grids to become distribution-only systems, and retire generation assets or sell them to a governmental entity or utility. Mini-grid owner paid for non-recovered generation infrastructure costs and becomes a distribution network operator.	• Mini-grid operator maintains a portion of their regular business. • Mini-grid operator would to be treated in same regulatory manner as distribution network operators. • Mini-grid operator continues normal customer service relationship.	• Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods, and standards are not already in place to facilitate the transition (e.g. calculating a price for generation assets, wholesale PPA rates, the requirements of the distribution network operator, the roles, responsibilities and relationship between the utility and distribution operator etc.). • Generation assets may be retired before the end of their useful life. • Can be challenging to ensure mini-grid operators receive a fair price for generation assets that provide a reasonable return on investment	• Develop a licensing process through which mini-grid operators can legally transition into small power distributors. • In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for the unrecovered costs of generation assets that will be retired or transferred to national entities. • Establish a mechanism for compensating mini-grid owners. • Define the terms and conditions of the wholesale power tariff that will govern power purchases between the new distribution-only system and the national grid, and develop a PPA template. • Determine if there will be any changes in the retail tariff or terms of service for customers, and ensure that any changes are communicated. • Develop a process for ensuring mini-grids are technologically capable of interconnection and meet the same technical standards as the national grid. • Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection. • On the basis of the preceding steps, develop guidelines that outline the process to be followed when the national grid arrives. • Make the guidelines publicly available and accessible to mini-grid stakeholders. • If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.
Small Power Producers (SPP) - Allow mini-grids to become generation-only systems that sell all their power to the national grid.	• In countries where independent power producers already play a defined role, this approach reflects the current ownership structure of the national grid. • Avoids a situation where regulators must oversee a patchwork of small distribution networks in the long term, thus conserving regulatory resources.	• May not be viable if small, independent power producers do not already have a defined role in the national grid. • Transition will affect the customer service relationship, which may be complicated if the mini-grid payment and metering structure differs from that of the national grid.	• Develop a licensing process through which mini-grid operators can legally transition into small power generators. • In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for the unrecovered costs of distribution assets that will be retired or transferred to national entities. • Establish a mechanism for compensating mini-grid owners. • Define the terms and conditions of the agreement that will govern the sale of electricity from the small power generator to the national grid, and develop a PPA template.

		• Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods and standards are not already in place to facilitate the transition (e.g. determining which party is responsible for technical upgrades or interconnection costs).	• Develop a plan to transition customer retail service from the mini-grid to the national grid network operator, and communicate the plan and any changes in the retail tariff or terms of service to customers. • Develop a process for ensuring generation assets are technologically capable of interconnection and meet the same technical standards as the national grid. • Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection. • On the basis of the preceding steps, develop guidelines that outline the process that will be followed when the national grid arrives. • Make the guidelines publicly available and accessible to mini-grid stakeholders. • If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.
Combined SPP and SPD - Allow mini-grids to continue to generate, distribute, and sell electricity—with the added ability to buy and sell power from and to the national grid. Mini-grid is connected to national grid and able to buy and sell power with national grid.	• Assets would be owned and operated by original developer, which has developed systems to manage those assets. • No need to transfer customers to the national grid utility or to communicate any changes in tariff structure or customer service. • Reduces costs for mini-grid operator; customer tariffs may also potentially be lower. • Mini-grid operator can switch back and forth between imported and locally generated power, depending on cost. • Operator can sell excess power to the national grid.	• May be undesirable to have pockets of the grid operated by independent entities. • Mini-grid ownership not integrated into existing organizational roles of national electricity grid. • May be more in line with national electrification goals to have centralized ownership and operation of mini-grid assets. • Can be a timely and potentially costly process for both the regulator and mini-grid operator if processes, methods and standards are not already in place to facilitate the transition (e.g. determining which party is responsible for technical upgrades or interconnection costs.	• Develop a licensing process through which mini-grid operators can legally transition into new roles as (1) grid-connected small power distributors and (2) owners of local power supply. • Define the terms and conditions of the wholesale power tariff that will govern power purchases between the mini-grids and the national grid, and develop a PPA template. • Determine if there will be any changes in retail tariffs or terms of service for customers, and ensure that any such changes are communicated. • Develop a process for ensuring that mini-grids are technologically capable of interconnection and meet the same technical standards as the national grid. • Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection. • On the basis of the preceding steps, develop guidelines that outline the process that will be followed when the national grid arrives. • Make the guidelines publicly available and accessible to mini-grid stakeholders. • If mini-grids are already active in the country, proactively communicate the ownership after connection policy to mini-grid developers and operators.

Sell Assets - Transfer ownership and operation of all mini-grid assets to a governmental entity or a utility. Mini-grid owner compensated for non-recovered project development and operations costs and ceases operations.	• Is highly compatible with a centralized planning approach and may be the simplest and most beneficial approach for the country's electric industry operations in the long term. • Allows infrastructure to be operated by normal electricity grid actors.	• Technological or equipment differences between the national grid and mini-grids may cause issues and complicate the interconnection process. • May complicate the relationship with mini-grid customers, particularly if the mini-grid uses a different payment or metering system. • Need to ensure the mini-grid operator is fairly compensated for mini-grid assets. • Can be costly and timely to establish a process for calculating the value at which the mini-grid operator will be compensated for mini-grid assets.	• Communicate requirements early to project developers that all mini-grid assets be transferred to national grid industry actors in the event of grid interconnection. • In collaboration with the mini-grid community, develop a methodology for appropriately compensating developers for unrecovered costs and lost revenues. • Establish a mechanism for compensating mini-grid owners. • Determine the process for transferring ownership. • Determine if there will be any changes in retail tariffs or terms of service for customers, and ensure that any such changes are communicated. • Develop a process for ensuring that mini-grids are technologically capable of connection and meet the same technical standards as the national grid. • Develop an outline of the interconnection process and determine who will be responsible for costs associated with technical upgrades prior to interconnection. • Develop guidelines that outline the process that will be followed when the national grid arrives. • Make the guidelines publicly available and accessible to mini-grid stakeholders. • If mini-grids are already active in the country, proactively communicate the ownership after connection to mini-grid developers and operators.
Abandon or Move - The distribution grid and generator are abandoned, sold for scrap, or moved. If the regulator takes no action, national or private utility will build a new distribution system.	• Limited benefits. • Mini-grid operators may be able to sell the equipment and recoup some costs. • Mini-grid operators may be able to move the mini-grid and establish business in an area where grid extension has not and will not take place in the near future.	• Duplicative investment in Infrastructure • Limits the ability of the mini-grid operators to earn a return on their investment • If abandoned or sold, will need to decide who is responsible for the costs of cleaning up the site and properly disposing of equipment to avoid any health or safety concerns for the surrounding community.	• Consult with the mini-grid community to understand when a mini-grid would be abandoned or moved. • Establish ownership and business model options that minimize the risk of a mini-grid being abandoned or moved. • Develop guidelines for proper disposal of mini-grid equipment if abandoned.

2.1 Retail Tariff Oversight

Should regulators determine retail rates and what process should they use?

Options	Benefits	Drawbacks	Next Steps
Do not oversee retail tariffs. Regulators may determine that retail rate regulation is not necessary. In the absence of rate regulation, payments may take a variety of forms (e.g., a flat monthly payment for a certain number of hours of electricity per day).	• May result in tariff structures that are economically beneficial for both operators and the customers they serve. • Allows market forces to determine tariff levels and regulators avoid setting rates that are too low to allow developers to recover their costs. • Requires little from regulators in terms of resources.	• Developer could charge a fair or unfair price. • May result in customers overpaying in relation to what developers actually need in order to recover their costs (and customers may be particularly likely to do so because of the high prices of energy sources such as kerosene and diesel). • May not enable regulators to ensure customers are paying a fair and transparent price for electricity.	• Little action is required on the part of regulators. • If desired, regulators may require mini-grid developers to submit regular reports on retail rates (see Section 1.10 for a discussion of reporting options), and may reserve the option to intervene in rate setting if necessary. • Communicate that regulators will not oversee retail tariffs by including this information on the regulator's website and the country's guidelines for the mini-grid sector.
Directly set retail tariffs. Regulators may opt to oversee retail tariffs directly. Rates may be the same for all mini-grid customers, or calculated on the basis of generation technology, project capacity, or other factors.	• Maximizes the control of regulators over pricing and efficiently determining retail rates for many mini-grid projects while limiting a bottlenecked approval process. • May reward effective project developers if they are able to provide services at lower cost and can realize a higher return from the rates set by regulators.	• Could be viewed as heavy-handed, and may ignore important, project-specific factors that inform development costs. • May limit project site selection by developers. If a developer is unable to cover costs at the regulated retail tariff level, they may choose not to develop a site—even if customers are willing to pay higher rates for service.	• Consult project developers and communities that would be served by mini-grids to determine a methodology for setting retail rates that are beneficial for developers and communities alike. • Determine whether retail tariffs will be uniform for all projects or vary depending on project-specific factors. • If desired, develop an appeals process to allow exceptions for projects with higher development costs. • Develop guidelines on the tariff process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.
Project specific reviewal process on retail tariffs proposed by developers. Regulators could allow developers to propose retail tariffs, which would then be approved, amended, or rejected.	• Allows appropriate oversight while recognizing the unique costs of each mini-grid project. • Ensures fair tariffs by setting tariffs that take into account both developers' revenue needs and customers' ability to pay.	• Can be time-consuming to accurately assess and adjudicate an appropriate retail tariff. • May demand significant staff time and resources could lead to significant delays in regulatory approvals and project development in countries that are host to many mini-grid projects.	• Establish a process for reviewing (and accepting, amending, or rejecting) retail tariff proposals from developers. If a review process is already in place under the country's national grid regulation, it can be adapted for mini-grid projects. • Develop a template to ensure mini-grid developers provide the requested information in the desired format. • Develop guidelines on the tariff review process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.

Allow an unregulated grace period for retail service, and implement retail rate regulation in the long term. Regulators could select a hybrid approach, in which retail rates are unregulated for a certain period during which developers are permitted to charge whatever is required to recover their costs. After that point, a regulated rate is put into effect.	• Allows developers to recover costs, while protecting customers from paying high, unregulated tariffs in the long term. • Allows regulators to observe the results of market-based rate setting, which may yield valuable information about the rates that the market will bear.	• More complex to implement and to explain to stakeholders. • Would still be a risk of developers overcharging during the unregulated period.	• Develop a process for determining the appropriate length of the unregulated period and for overseeing projects during that period. • Identify the metrics that will be used to determine whether regulatory intervention is needed after the initial grace period, and develop a process for collecting the necessary data. • Develop a process for determining an appropriate retail tariff after the unregulated period. • After the unregulated period, develop a template to ensure that mini-grid developers provide the requested information in the desired format. • Develop guidelines on the tariff review process for mini-grid projects and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector.
Regulate rates only in the case of customer disputes. Regulators could adopt a policy of intervening in retail rate setting only in the case of disputes—for example, if a certain number of customers filed complaints regarding the terms of service offered by a mini-grid operator.	• Allows market forces to determine rate levels and structures, but provides a fallback option if customers and operators cannot agree or customers are being taken advantage of.	• Requires careful consideration on the part of regulators to ensure that the process of receiving customer complaints is open and fair, and that regulatory action is taken only when necessary.	• Develop a process for accepting customer complaints and determine a threshold for regulatory action (e.g., raw number of complaints, or a ratio of complaints to total number of customers). • Consider developing and implementing an appeals or dispute resolution process. • In cases where regulatory action will be taken, establish a process for determining a fair and reasonable tariff. This would include consulting with project developers and communities that would be served by mini-grids. • Develop guidelines on tariff review (including procedures for filing complaints, making appeals, and resolving disputes), and make the information easily accessible by posting it on the mini-grids regulator's website and including it in the country's guidelines for the mini-grid sector.

2.2 Retail Tariff Level

What methodology should regulators use to establish retail rate levels?

Options	Benefits	Drawbacks	Next Steps
Place no restriction on retail tariffs.	• Requires few resources on the part of regulators and avoids potential errors in the calculation of tariffs by allowing market forces to determine tariffs • Allows mini-grid developers to charge cost-reflective tariffs.	• Creates a risk that customers may overpay for retail service	• Little action is required to implement a market-based approach. • Consider establishing a retail tariff monitoring regime. • Establish a process for intervening in the tariff-setting process if becomes necessary. • Develop guidelines on the tariff-setting process and make the information easily accessible.
Apply the national grid tariff to mini-grids. In this case, regulators would also provide a supplemental revenue stream to ensure investments in mini-grids remain attractive to the private sector.	• May be politically preferable, as it ensures that tariffs will be standard for all electricity customers across the country • Ensures that rural customers will not pay more for electricity than urban customers. • Generally viewed as a fair and equitable approach, and is easy to communicate and justify to customers.	• When revenues from a standard national tariff are insufficient for mini-grid developers to recover their costs, regulators will need to implement subsidies to make up the difference. • Developing a sustainable subsidy scheme is often challenging (see Sections 1.6 and 0). • Without a supplemental revenue stream, regulators and policy makers run a high risk of discouraging investment in and development of mini-grid projects.	• Implement current national tariffs for mini-grid customers. • Develop guidelines on the tariff-setting process and make the information easily accessible by including it on the mini-grid regulator's website and in the country's guidelines for the mini-grid sector. • To maintain investor confidence, develop a subsidization scheme that will allow developers to recover their costs. • As an initial step, conduct a study of mini-grid developers' revenue needs and projected revenue gaps. (See Sections 1.6 and 2.3 for further discussion of subsidies).
Base retail tariffs on avoided customer costs. In this approach, the retail tariff for electricity from mini-grids is equal to or below what customers would have paid for energy purchases.	• Ensures that customers will either save money or receive better services for the same level of expenditure. • Motivates developers to be more efficient, and thereby maximize profits.	• Requires regulators to study the costs in question, which can be difficult to ascertain. • Runs the dual risks of (1) setting a rate that is too low for developers to fully recover costs or (2) setting a rate that is higher than what developers actually need to recover costs. • May be difficult for regulators to find the right balance between these two extremes. • Depending on the quality of service provided by the mini-grid, customers	• Conduct a study of customers' current energy costs in areas to be served by mini-grids. • To ensure that assessments of energy costs are in line with community experiences and that proposed retail rates are adequate to recover developer costs, consult with mini-grid developers, community stakeholders, and others. • Share the results of the consultations, provide an opportunity to comment, and incorporate the feedback. • If tariffs are to be set below the cost of other energy resources, determine an appropriate percentage discount. • Develop guidelines on the tariff-setting process and make the information easily accessible.

		may still need to purchase energy from other sources to reach their desired level of supply, which nullifies the principle on which the tariff is based. • Mini-grid customers are likely to pay more for electricity than national-grid customers	
Calculate cost-reflective retail tariffs individually for each project. Regulators may set retail rates at a level that will allow developers to recover their capital and operational costs.	• Cost-reflective tariffs are the most effective option for incentivizing private-sector investment in mini-grids • Maximizes developers ability to recover costs. • Maximizes regulators' ability to ensure adequate cost recovery.	• Likely to result in dramatically different rates for customers of different electricity providers—an outcome that may not be acceptable to policy makers. • Rural mini-grid customers are likely to pay more for electricity than urban national-grid customers, and customers in different rural areas may pay different rates for essentially the same level of service. • Could require substantial regulatory resources, particularly if many mini-grid projects are developed in the country.	• Design a standard process and financial model for determining appropriate, cost-reflective tariff for each proposed projects. As part of this effort, (1) develop a standard financial model that can be used to evaluate project costs, and (2) establish a target rate of return that developers should receive from mini-grid projects. • Ensure that there is enough staff capacity to review proposed project-specific tariffs. • Develop guidelines on the tariff-setting process and make the information easily accessible.

Calculate cost-reflective retail tariffs for certain categories of projects and apply them to the entire class. In this approach, regulators can establish different rates for projects with fundamentally different cost structures.	• Encourages private-sector investment in mini-grids by offering some promise of a specified return. • Lessens the resource requirements associated with project-specific tariffs.	• Will result in significant differences in the amount customers pay for energy from different service providers like the project-by-project option. • Risks overlooking differences in cost-recovery requirements for certain projects within the same class.	• Develop a framework for classifying mini-grid projects on the basis of technology, capacity, location, or other factors. • Conduct a study of the projected cost-recovery needs for each class, and develop a standard retail tariff for each. • Share the framework and the findings from the cost-recovery study with mini-grid developers and other stakeholders and invite comment. • On the basis of feedback from stakeholders, design a standard process for determining appropriate, cost-reflective tariffs for each class of projects. As part of this effort, (1) develop a standard financial model that can be used to evaluate project costs within each class, and (2) establish a target rate of return. • Consider whether to allow adjustments based on project-specific circumstances. • Consider implementing an appeals process for projects that are unable to recover costs through the designated tariff. • Develop guidelines on the tariff-setting process and make the information easily accessible.

3.1 Interconnection to the National Grid

Should mini-grids be required to meet national grid technical standards?

Options	Benefits	Drawbacks	Next Steps
Do not require mini-grids to be grid-ready. Regulators may choose not to require mini-grids to meet the national grid technical requirements.	• Significantly lowers the costs for mini-grid developers, particularly in case of smaller systems. • Simplifies the application processes for licenses and concessions. • Provides developers with more system design flexibility and leaves room for innovative solutions. • No need for regulators to dedicate resources to defining procedures, standards, and requirements.	• Can make interconnection more difficult and expensive due to lack of technical regulations. • May result in conflicts between mini-grid developers and the national utility and may complicate or delay the interconnection process—and ultimately impact customers. • Regulators may propose costly and time-consuming interconnection studies in the absence of regulations.	Limited action is required from regulators for this option, but regulators may want to consider the following steps: • Engage stakeholders in determining the likelihood that potential mini-grid sites will be interconnected to the national grid. • Identify barriers, including potential costs, if mini-grid developers must adhere to technical requirements. • Develop a process for dealing with technical issues as they arise. • Define the ownership model, as well as the technical and economic requirements, before interconnection (see Section 1.5, 3.1, and 3.2). • Develop recommendations or nonbinding guidelines on interconnection. • Define a standard method for carrying out technical studies before grid connection. The method should address procedures, responsibilities, time frame, and costs.
Develop interconnection requirements based on project classes or categories. Regulators can establish standard technical regulations for mini-grid interconnection depending on project classes, which can include capacity, location, technology or other characteristics, and determine whether mini-grids have to meet the standards from the outset.	• Protects mini-grid developers from having to comply with excessive requirements for very small projects, or for projects that might never be interconnected to the national grid. • More flexible standards can make the regulatory process more accessible and support mini-grid deployment. • A standard process can lead to quicker response times to interconnection requests. • Relieve mini-grid developers of uncertainty when interconnecting, thereby reducing project costs and risks.	• Can result in a more cumbersome and unpredictable regulatory process, requiring regulators to expend significant resources defining different mini-grid types, establishing different standards and levels of implementation, and addressing other aspects of interconnection. • Setting boundaries between one class of mini-grid and another can be challenging.	• Assess the variability among current and potential mini-grids, in order to classify by aspects such as capacity, location, and technology. • Assess the challenges that mini-grid developers might face if technical requirements are too strict or too lenient. • Based on this assessment, establish different technical requirements and standards for different classes of mini-grid; these requirements and standards could apply to mini-grid equipment during construction, as well as to the technical studies required before interconnection. • To ensure that the requirements established are (1) realistic for different mini-grid classes and (2) accessible to all developers, adopt a streamlined procedure for interconnection. • Provide tools—and perhaps funding—to support mini-grid developers.

Require all mini-grid projects to be capable of interconnection to the national grid. Regulators can require that all mini-grids—regardless of capacity, location, or technology—be built to the same technical standards as the national grid.	• Mini-grids will be ready for interconnection and will not require upgrades or major investments when the grid arrives. • The quality of the electricity provided can generally be expected to be the same across mini-grids and the main grid. • Simplifies the work of regulators, who can implement the same standards and procedures across all mini-grids. • Knowing the national standards upfront, mini-grid developers will have more clarity on investment returns. • The added cost can be built into retail rates under cost-reflective tariffs (if permitted).	• Requires larger investments from mini-grid developers, who will need to dedicate more resources to equipment, testing, and commissioning. • Higher costs will have an impact on retail tariffs, unless they are reduced through government subsidies. • May impose a barrier for smaller-scale projects. • Regulators may face difficulties in implementing the same standards across the wide spectrum of mini-grid types. • Stringent standards may slow down innovation in the mini-grid sector.	• Make national-grid technical standards available to all mini-grid developers. • Incorporate adherence to national-grid technical standards into the licensing and approvals process. • Establish a streamlined monitoring process for ensuring that mini-grids comply with national-grid standards, including in the testing and commissioning process. • Undertake periodic monitoring to ensure that all mini-grids are operating within the technical parameters of the national grid.

3.2 Technology Standards for Equipment and Functionalities

Should regulators require mini-grids to meet specific technology standards?

Options	Benefits	Drawbacks	Next Steps
Do not set technology standards. Regulators may avoid setting technology standards and only impose a minimum quality of service and reliability standard. Regulators may instead allow developers or external parties to select the products that are most appropriate for the specific project.	• Can simplify development and lower costs. • Can be beneficial for smaller systems, for locally developed projects, or for community-based innovations. • Permits regulators to avoid the resource-intensive process of developing and overseeing technology standards.	• Substandard equipment or technology may enter the market. Results may include system failures, lower service quality, and even health and safety risks—ultimately hindering the future development of the sector. • The use of outdated, inadequate, or unnecessary equipment is a particular risk in the case of large-scale, top-down schemes that fail to assess or consider beneficiaries' needs.	No action is needed from regulators for this option, however, regulators may be well-advised, to consider the following steps: • Develop guidelines that encourage (but do not require) the use of specific technologies (see Section 1.10). • Develop recommendations (e.g., suggested evaluation criteria) for mini-grid tendering processes. • Establish voluntary regulations, such as service-quality standards or design and installation guidelines, to avoid system failure and guarantee long-term project sustainability.

Develop technology standards specific to autonomous mini-grids.
 	
Regulators may impose standards for certain technologies. These can address a range of issues, including quality, sustainability, and installation procedures, amongst others.
	• Can ensure project quality.
	• Can improve monitoring, increase regulator's and operators' familiarity with equipment, and improve long-term project sustainability.
	• Ensure that equipment is fit-for-purpose and prevent the use of inappropriate equipment.
		• Developing mini-grid-specific standards, along with companion guidelines and verification procedures, is a time-consuming process that requires extensive research and resources.
		• Compliance with very strict standards may also prove costly for developers, and the required products may not be available in the local market.
			• Identify the technology standards used in the national grid that are applicable to mini-grids (e.g., standards for PV modules).
			• Determine which mini-grid-specific standards to differentiate from the national grid (e.g., metering technologies).
			• Determine how extensively and how strictly to regulate technology.
			• Determine where greater flexibility will promote innovation or encourage deployment of mini-grids.
			• Develop technology standards for mini-grids:
			  o Regulators may choose to rely on national or international standards as the basis for developing their own requirements.
			  o Regulators may wish to rely on a technical committee or industry association to define mini-grid-specific standards for equipment, design, procedures, and rules governing installation, equipment operating conditions, and monitoring activities.
			• Engage stakeholders, including mini-grid developers, in the development of standards.
			• Once the standards are finalized, make them available and accessible to developers.
			• Consider developing design guidelines that outline the technology standards for mini-grids.

Require that mini-grid technology adhere to national-grid standards. Regulators may treat mini-grids like any other electricity network, regardless of size or whether it will eventually interconnect to the national grid.	• Regulators can rely on existing national standards. • No need to expend resources developing standards from scratch.	• Standards may not cover certain mini-grid-specific technologies, since those are not necessarily used in the national grid. • May hinder innovation by preventing mini-grid developers from developing new technology or tweaking existing technology to adapt to local conditions. • May be complex and resource intensive.	• Review and extend applicable technology standards to autonomous mini-grids. • Inform mini-grid developers about the standards, and make the standards available to developers. • Establish procedures and mechanisms for monitoring compliance with standards.

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