ELECTRICITY LAWYER

SSA OFF-GRID FRAMEWORK AND RURAL ELECTRIFICATION TOOLKIT

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LIST OF ABBREVIATIONS

AC	-	Alternating Current
AfDB	-	African Development Bank
ANEREE	-	L'Agence Nationale des Energies Renouvelables et de l'Efficacité
ASER	-	Senegalese Agency for Rural Electrification
CSP	-	Concentrating Solar Power
DC	-	Direct Current
EPSRA	-	Electric Power Sector Reform Act 2005
EPRA	-	Kenya's Energy and Petroleum Regulatory Authority
FGS	-	Federal Government of Somalia
GIS	-	Geographic Information System
IPP	-	Independent Power Producers
IRP	-	Integrated Resource Plan
KW	-	Kilowatt
LED	-	Lighting Emitting Diode
LPG	-	Liquified Petroleum Gas
MARENA	-	Mauritius Renewable Energy Agency
MPPT	-	Maximum Power Point Tracking
MW	-	Megawatt
NEP	-	National Electrification Plan
NERC	-	Nigerian Electricity Regulation Commission
PASE	-	Access to Energy Services Program
PASEL	-	Programme d'appui au secteur de l'elevage (Access to Electricity Project, Burkina Faso)
PRONER	-	National Rural Electrification Programme Ivory Coast
PV	-	Photovoltaic
PNDES	-	Plan National de Développement Économique et Social
REA	-	Rural Electrification Agency
SSA	-	Sub-Saharan Africa
VAT	-	Value Added Tax

1. Introduction to Off-grid and Rural Electrification

For many individuals and businesses around the world today, it is important that they can power their homes and businesses using reliable energy systems. For nations around the world, the per capita energy consumption has been found to have a direct correlation with the per capita gross domestic production (GDP). High-income countries today have annual electricity consumption levels above 3,000kWh per capita. The United States has a per capita energy consumption of 13,000 kWh, while Europe has a per capita energy consumption of 6,500 kWh. It is no surprise that Sub-Saharan Africa (SSA) with the lowest rate of access to electricity also holds the highest level of poverty globally with a per capita energy consumption of 180kWh.Addressing the issue of electricity access in SSA though daunting, is however not impossible. This is based on the fact that, inter alia, the majority of the population without access to electricity are located in rural areas where it is either too expensive to extend the national grid to those areas or the dwellers are unable to afford the tariff rate that is commensurate with extending the grid to those areas. In this light, off-grid systems have been found to be a plausible alternative to extending the national grid to rural areas in terms of economics, cost-effectiveness,and environmental perspectives. This toolkit seeks to provide an assessment of the off-grid and rural electrification framework in SSA. It begins by introducing the off-grid system for rural electrification and proceeds to examine the present state of off-grid utilization and rural electrification in SSA, the policy and governance framework and policy challenges to the off-grid framework and rural electrification in SSA. The toolkit concludes by proposing recommendations for identified challenges for an improved off-grid and rural electrification framework.

1.1 Basics of an Off-grid system

An off-grid power system is defined as a system that is not connected to the power grid and operates independently of the main grid. Off-grid power systems are usually used as a form of power source where the connection to the main grid is inconvenient. The components of an off-grid sol system are divided into four (4) categories:

Source	These refer to the sources of energy, which could be diesel, natural gas, solar, wind, hydropower, etc.
Storage	These are the components that help store the electrical energy for later use such as batteries.
Connections	These refer to pieces that link the system together and they include but are not limited to wires, fuses, control circuits, etc.
Loads	Loads refer to the power consumption of the devices that are being used in the off-grid system.

1.2 Types of Off-grid systems

Off-grid systems are built using AC or DC coupled power sources. The power sources or selection of equipment depends on whether the loads to be powered are AC, DC, or a mixture of both. AC coupled generation sources include common solar inverters while DC-coupled sources include MPPT solar charge controllers. As such the types of off-grid systems include DC only system, Mixed DC and AC system, AC only system, AC system with wind and solar and AC system with back-up.

Types	Particulars
DC only system	The DC only systems are generally small systems powering lighting and low-consumption appliances such as monitoring equipment. The solar panels or wind generator charge the battery and the battery supplies power to the loads.
Mixed DC and AC system	A hybrid DC and AC system is similar to the DC only system, but also includes an AC inverter to enable the use of 230V appliances. The inverter needs to be sized to the peak AC load.
AC only system	With an AC only system, all the loads are run on AC using an inverter to convert power stored in the battery bank to 230V AC. Grid-connected homes all run off 230V AC and thus the wiring of an off-grid home with an AC only system will be the same as the wiring for a grid-connected home.

AC system with wind and solar	The AC system can have two sources of renewable energy. It could have a wind turbine that is connected to a wind turbine controller and a PV array connected to a charge controller which powers the inverters and batteries.
AC system with backup	To avoid sizing for worst case conditions, a backup generator is used. A petrol, LPG, or diesel generating set combined with a battery charger can supply power if the batteries become low.

1.3 Existing Off-grid Operator Models in SSA

The off-grid operator models existing across SSA include the following:

1.3.1 Free-for-use model

Under this model, the customer pays rent to use the stand-alone system while the company retains ownership and ensures that the system is operating properly and is responsible for maintenance. The customer makes a one-time installation payment in addition to reoccurring fixed payments based on the size of the system.

1.3.2 Pay-Go model

This is an installation sale where the customer ends up owning the system after a period. The Agreement between the customer and solar company may be such that the company provides maintenance services until the customer fully pays for the system or, in some scenarios, the customer is responsible for maintenance from the onset. The system blocks automatically where the reoccurring fee is not paid and will remain inaccessible until credit has been restored. The company doubles as the system owner, operator and maintenance provider, and bill collector or the roles can be split, and a separate company can be brought in to handle customer collections.

1.3.3 Micro-grids

These are small utility companies that install a 100kilowatts system or less, used to supply service to small villages in remote locations. The company can retain ownership and operate and maintain the equipment and collect fees for services from customers or the roles can be split among separate entities. The installation and maintenance could also be provided by rural energy cooperatives in certain regions. Micro grid projects can include solar systems, batteries, diesel generators for backup generation, etc. Some models will allow subscribers to prepay for power based on their needs, while others charge a set reoccurring fee.

1.3.4 Mini grids

A mini-grid is a type of off-grid system that involves small-scale electricity generation, usually between 10kW to 10MW. It serves a limited number of consumers via a distribution grid that can operate in isolation from national transmission networks. Mini-grids can supply electrical power to concentrated areas, homes, and businesses that have power above the grid level which varies according to the country.

1.1.1 Stand-alone systems

Stand-alone systems are small electricity systems that are not connected to central distribution system. They provide electricity to individuals, homes, and small businesses. There are about three types of stand-alone systems, and they are illustrated below:

Pico Systems	Home Systems	Productive Systems
Used to power individual appliances	Used to power individual households	Used to power small businesses

1.4 The convergence of an Off-grid system and Rural Electrification

The electricity access challenge in Sub-Saharan Africa (SSA) is in two facets. There is a prevalent lack of access to the national grid and therefore a lack of access to electricity. There is also the issue of inconsistent power supply for the population who are connected to the grid, therefore a lack of reliable electricity. Approximately 600 million people in Sub-Saharan Africa do not have access to electricity. According to the World Bank, the most recent record of electricity access in SSA was estimated to be 48.4% in 2020. Urban areas record an access rate of 78.3%,while 28.7% access rate is recorded in rural areas. It has been submitted that in order for the region to attain universal access to electricity in Africa, 40% of new power connections would most likely be provided by off-grid solutions.

Whereas an increase in generation capacity and strengthening of the power systems including the national grid can ease the electricity challenge for the population with access to electricity, this may have minimal impact for the population that lack access to the national grid, given the huge numbers. As submitted by Power Africa, several of the population without access to the grid may never get connected to the grid, because they live in areas that are too remote to be connected. The population that will be connected in the future will likely face a long wait period as the "infrastructure build-out tries to keep up with population growth". It has also been noted that expanding access cost-effectively and sustainably may pose a serious challenge, particularly, in terms of the cost-effectiveness, as grid electrification involves a substantial cost from building lines, improving capacity, and connecting households. It has also been observed that the cost is higher in Africa than in more densely populated regions of the world.

Consequently, off-grid solutions have been identified as the most viable options for rural electrification. Some of the benefits of facilitating off-grid investments in SSA are identified below.

- Off-grid solutions are cost-effective
- Off-grid solutions are flexible and easy to use
- Off-grid solutions can easily utilise local renewable energy sources to provide electricity
- Off-grid solutions can offer 24/7 service to power a range of electrical appliances compared to the central power grid

Finding affordable off-grid solutions and attendant business models is key in remote rural areas and small cities that are not connected to the grid. It should also be noted that a significant number of people across SSA are living in regions within the proximity of a distribution grid without connection to the grid or are connected illegally.

1.5 Challenges to Off-grid system for Rural Electrification in SSA

There are several challenges in the electricity sectors across Sub-Saharan Africa that prohibit the deployment and utilization of off-grid power systems for rural electrification effectively. Some of these challenges have been identified below:

Scarcity of research and development addressing rural electrification

Lack of technical expertise

Illiteracy and poor sense of ownership by local communities

High connection costs

Aging supply plant technology

Lack of saving culture which puts sustainability of off-grid solutions at risk

2. The Present state of Off-grid utilisation and rural electrification in SSA

2.1 Analysis of the scope of Off-grid deployment and utilisation in SSA

Among the regions in SSA, East Africa stands out for its effective utilization of off-grid solutions. The region has increased its electricity access rate by more than 4% from 2014 to 2018. The countries that are at the forefront of this development are Kenya, Rwanda, and Ethiopia. For Kenya, the progress is attributed to factors such as continuous support from the government for decentralized systems through effective incentives.

In Central Africa, however, the utilization of off-grid solutions in accelerating electricity access has been slow. On the other hand, West Africa and Southern Africa have achieved better progress in this regard. For instance, in Ghana, the Government introduced a Master Plan containing six implementation phases to achieve universal access in the country by 2030. This Plan supported the use of both the main grid, mini-grids, and renewable stand-alone systems which was most appropriate in the region. In Nigeria, the Rural Electrification Agency (REA) was established to accelerate the electricity access rate in the country through grid extension and green mini-grids.

It is recorded that as of 2019, about 15 million people were connected to mini-grids in Africa, while in SSA, the number of people gaining access through solar home systems has increased from 2 million in 2016 to almost 5 million in 2018.

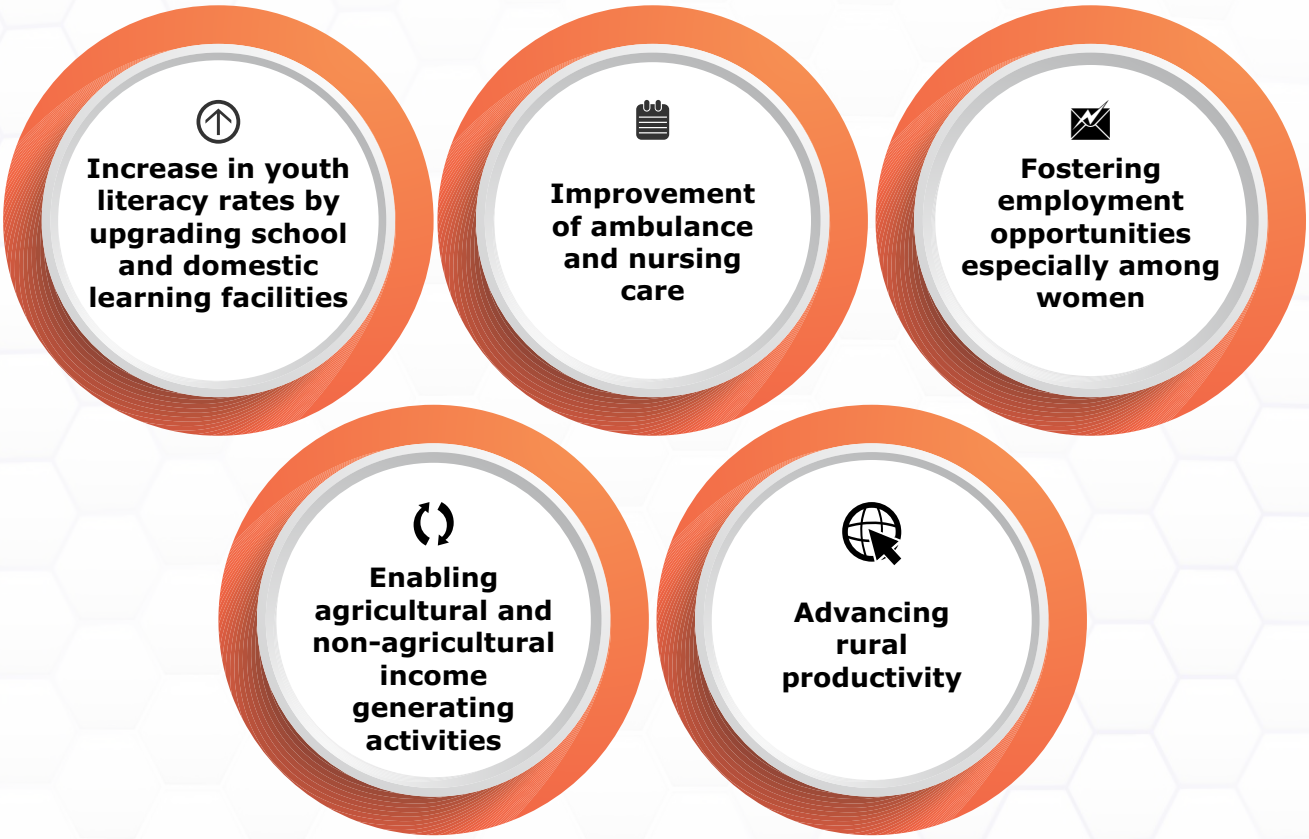
This energy access route has been focused on a few countries: in 2018, Kenya, Tanzania, and Ethiopia accounted for nearly half of all new connections. Solar home systems connect 32 percent of rural homes in Ethiopia and roughly 15 percent in Rwanda. Solar home systems with less than 50 watts of power are mostly used to provide energy services such as energy-efficient televisions and cooling fans.

2.2 Analysis of the scope of Rural Electrification in SSA

Rural Electrification is defined as the process of bringing electrical power to rural and remote areas in the region. Research has shown that about half of the population in SSA are without access to electricity and the countries with the highest lack of access rate include: Nigeria, Democratic Republic of Congo, Ethiopia, Tanzania and

Uganda. Thus, decentralized solutions are regarded the least-cost way to provide power to more than half of the population to gain access by 2030.

Rural electrification has been defined as the percentage of the rural population with access to electricity. It is a crucial part of socio-economic development in the following ways:



Sub-Saharan Africa's rural electrification rate is 14% significantly lower than any other region of the world. Countries like Ghana and Senegal successfully increased their rural electrification rates and reduced their urban electrification bias between the years 1990-2010.

2.3 Challenges to Off-grid Deployment and Rural Electrification in SSA

1.1.1 Policy and governance Framework for Off-grid and Rural Electrification

The place of strategic policy and regulatory framework cannot be over-emphasized in any sector of the economy where an upscale or increased investment is desired. A policy and governance framework consists of the binding rules, strategies, institutions, and associated processes that govern the sector. An ideal and effective

off-grid policy that fosters rural electrification must embody key principles as discussed below.

2.3.1.1 Stability and longevity

Off-grid systems, particularly mini-grids can be financed by public institutions or private bodies, which may be supported by government subsidies. Private investors invest in mini-grids for profit making and would need an assurance that support mechanisms put in place for the benefit of their mini-grid investment will be stable and predictable throughout the life span of the project. Illustratively, lease contracts or permits, and licences could be open-ended or include clauses for simple renewal.

2.3.1.2 Clear and comprehensive

Areas within a regulatory framework with respect to mini-grid projects that require specific clarity are permitted tariffs, license, and permit requirements, import duties, VAT, company taxes, and possible subsidies and incentives. This would allow the investor project anticipated profits, determine the period within which investment can be recouped and determine whether such a project is viable. On the other hand, without clear tariff regulations, customers are vulnerable and are put on the edge of excessively high tariff structures which could deter rather than promote energy access. Also, with customer affordability being threatened, investors are unable to adequately forecast their cost, revenue and profit trajectory. Furthermore, clarity entails integrating a clear methodology for calculating the compensation to be paid to the owner of the mini-grid in the event of connection to the national grid which must take into account the value of the asset in addition to the business value.

2.3.1.3 Accessibility

The framework should ensure easy accessibility to support measures such as financial subsidies. In addition, agencies or organizations which have been placed to manage these processes must be easily accessible.

2.3.1.4 Cost-effectiveness and Efficient

A cost-effective policy is one that gets rid of excessively complicated administrative procedures. An ideal off-grid policy and regulatory framework should address likely avenues for delays in licencing, permits, accessing support, and responding to enquiries.

2.3.1.5 Simplified

Off-grid policies should be simple to follow and where possible, it has been

suggested, that regulations could be exempted completely for very small mini-grids (micro-grids).

2.3.2 Institutional Framework

2.3.2.1 Effective and efficient institutions

The institutions put in place must be able to balance institutional, political, and financial realities with rural development aspirations with the aim to achieve maximum electricity access. The place of the institutions is to perform their specific roles and responsibilities to support off-grids. Given that there are likely to be several institutions with responsibilities in a typical off-grid framework, it is important that specific responsibilities are allocated to a single actor or there is split responsibility, alongside the need for proper coordination in carrying out those responsibilities to aid ease of entrance and operation of the off-grid systems by investors. Contradictory regulatory procedures must be avoided at all costs.

3. SSA Country Analysis of the Current Off-grid Framework in Place &Gaps Identified

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
1	**Angola**	There are no off-grid-specific regulations in Angola. However, there is the Angola Electricity Act, the Energy Generation, Transmission, Distribution, and Supply Regulation Decree no. 76/21 which makes references to processes for licencing as an electricity generator, transmitter, distributor, or supplier and is said to apply to mini-grids and stand-alone systems.
2	**Benin**	Benin has in existence the Benin Off-Grid Electrification Regulation Decree No. 2018-415.
3	**Botswana**	Botswana has aNational Energy Policy 2021 which is targeted at guiding the management and development of Botswana's energy sector, especially the penetration of new and renewable energy sources into the country's energy mix. Part of this renewable energy mix is projected to utilise off-grid systems. As such, this regulation can be said to form a part of any subsequent off-grid framework. The Republic of Botswana utilising AfDB financing is currently in the process of operationalizing policy and regulatory framework for Integrated Resource Plan (IRP) implementation and Development of regulatory instruments and technical studies to support IPP facilitation rollout: Botswana National Grid Code, Electricity Cost of Service Study and Tariff Framework, and Licensing Framework.
4	**Burkina Faso**	Burkina Faso has a General Energy Regulation Law, 2017 which aims at 45% electricity access by 2020 and 65% by 2030. While there is no specific national program for the development of the off-grid sector, there are several overlapping government and donor-funded initiatives supporting rural electrification including the Access to Energy Services Program (PASE), which committed to electrifying 600 settlements; (ii) the PNDES Structural Reforms and Investment Plan, providing off-grid solar systems to 300 localities through 2020; and (iii) the World Bank Lighting Africa rural electrification program, PASEL, implemented by the Ministry of Energy between 2004 and 2017 and subsequently by ANEREE. Furthermore, Electrification Development Tax and value added tax (VAT) incentives have been adopted to prioritize stand-alone systems These can be said to be component parts of the Burkina Faso off-grid framework.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
5	**Burundi**	Burundi has an Electricity Law 2015. There is also a Rural Electrification Agency and a Burundi off-grid Access Project by the World Bank underway. However, there is no regulatory framework specific to off-grid systems in the country.
6	**Cameroon**	There is currently no energy/electricity law with off-grid provisions but there is a planned National electrification policy with off-grid provisions underway. However, Subsidies, tax exemptions, or related incentives for solar equipment/stand-alone systems exist.
7	**Cape Verde**	Cape Verde has no off-grid-specific framework in place. Nonetheless, the 2008 Cape Verde National Energy Policy outlines a long-term vision of "a future independent of fossil fuels", made possible through investment in and adoption of renewable energy and alternative technologies. In this line, the Government of Cape Verde has chosen to exclusively promote micro-grids based on 100% renewable energy with a special emphasis on their financial sustainability and the promotion of management systems capable of guaranteeing the operation, maintenance, and renovation of the infrastructure. In addition, public-private-partnerships is a key part of this process.
8	**The Central African Republic**	There is currently no national electrification policy with off-grid provisions. However, the 2005 Electricity Code includes Energy/electricity law with off-grid provisions and there are currently national programs promoting off-grid market development underway.
9	**Chad**	No off-grid specific regulatory framework.
10	**Comoros**	There are several on-going electrification projects which incorporate off-grid systems, but there is no off-grid framework in place.
11	**Djibouti**	A Global Environment Facility sponsored Program commenced in 2019 which is expected to cover the promotion of off-grid policies in Djibouti.
12	**Democratic Republic of Congo**	There is an Electricity Law of 2014 that allows for private operators but there is no framework specific to off-grid systems.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
13	**Equatorial Guinea**	No off-grid specific regulatory framework
14	**Eritrea**	No off-grid specific regulatory framework
15	**Ethiopia**	Ethiopian Energy Authority approved the Mini-Grid Directive N0. 268/2020 • Defined licencing period and licence types • Incorporation community engagement in tariff determination • A robust tariff determination approach, incorporation of tariff cross-subsidisation, and tariff Approvals and reviews. • Renewables obligation in electricity generation • Stipulated provisions on the sale of the asset after the project period • Transparency in Grid Expansion plan and clear compensation pathway. • Complaint Handling systems to be formed by licences
16	**Gabon**	Nooff-grid specific regulatory framework.
17	**The Gambia**	There is currently no off-Grid framework in the Gambia. However, the government has set a target to connect one-third of the rural population through off-grid solutions by 2030 and the Ministry of Petroleum and Energy has approached the Economic Consulting Associates to develop a framework for Green Mini-Grid electrification in the Gambia and the licencing framework in the Gambia includes on-grid and off-grid electricity.
18	**Ghana**	Ghana's Renewable Energy Act (Act 832) 2011 aims at promoting the development, utilization, management, and supply of heat and power delivered in an efficient and environmentally friendly manner. The Ghana government anticipated the construction of 55 renewable energy mini-grids by 2020 and 300 by 2030. As such, this legislation forms a part of the off-grid regulatory framework.
19	**Guinea**	Guinea has a national electrification policy with off-grid provisions commonly referred to as LPDSE. There is also a 2017 Rural Electrification Law with off-grid provisions. However, these regulations are regarded as lacking transparency and competitive procurement procedures along with a large tariff deficit and technical and commercial losses undealt with.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
20	**Guinea-Bissau**	The Regional off-Grid Electrification Project expected to run until August 2022 was recently presented by the Guinea Bissau Government to investors, international partners, and entrepreneurs, with the purpose of increasing electricity access to households, businesses, and public facilities. Part of its purpose is to help countries including Guinea Bissau create an enabling environment to accelerate the electricity access of vulnerable populations living in rural areas. It is anticipated that an off-grid framework will form part of this enabling environment.
21	**Ivory Coast**	There is no off-grid regulatory framework. However, Ivory Coast has a national rural electrificationprogramme (PRONER) that aims to connect all households in the country's rural area to electricity in the next five years as of 2021.Off-grid deployment is anticipated to form a major part of this programme. The 206 Decree has Energy/electricity law off-grid provisions.
22	**Kenya**	The Kenyan Regulatory framework was found to have the following gaps: • Lack of clarity around tariff setting • Unclear timeline for grid expansion • Lack of incentives/subsidies leading to difficulty in accessing grants and high electricity cost. Kenya's Energy and Petroleum Regulatory Authority (EPRA) has developed the Energy (Mini-Grid) Regulations 2021) that is aimed at spurring investment in mini-grid solutions and accelerating universal access to electricity in the country. The regulation addresses; • Consensus for mini-grid tariff approval • Licensing requirements • Guidelines for operations performance and reporting requirements
23	**Lesotho**	UNDP is currently supporting Lesotho to develop a regulatory framework for off-grid developments.
24	**Liberia**	2015 Electricity Law of Liberia established the Liberia Electricity Regulatory Commission The Liberia Electricity Regulatory Commission established a regulatory framework for the off-grid sub-sector among which is the Micro Utility Regulation for the off-grid electricity sub-sector. There is also a licensing handbook and Administrative Procedures Regulations to provide an understanding of the licencing process by potential investors.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
25	**Madagascar**	2015 Madagascar New Energy Policy. This policy is not specifically centred around off-grid, however, the policy encourages the development of public-private partnership schemes and concessions with a goal to increase household electricity access through grid extensions, scaling up decentralized power production from renewables, and affordable lighting solutions for rural households.
26	**Malawi**	Malawi's Regulatory framework for Mini-Grids includes: • The National Energy Policy 2018 sets the renewable energy mix to increase from 10% in 2016 to 23% by 2030 with an agenda to increase energy access to over 80% of the population of Malawi living in rural areas and Mini-gridsare set to play a significant role in the upscale. • The Malawi Renewable Energy Strategy 2017 sets a target to scale up operational Mini-Grids to at least 50 by 2025 and, • The Malawi Action Agenda 2030 on Energy indicates a trend of 900 electricity consumers per year to source electricity from Mini-Grids until 2030
27	**Mali**	No off-grid specific regulatory framework.
28	**Mauritania**	No off-grid-specific regulatory framework.
29	**Mauritius**	While the Mauritius Renewable Energy Agency (MARENA) under the MARENA Act 2015empowered MARENA to, among other things, oversee and promote the development of renewable energy in Mauritius, including research and innovation, there is no off-grid regulatory framework in Mauritius.
30	**Mozambique**	Decree No. 93/2022 Regulation on Access to Energy in off-grid areas covers aspects such as the feasibility of mini-grid projects, with emphasis on the regime of interconnection to the National Electricity Grid and tariff regime, thus making mini-grid projects an effective and attractive solution for private investment.
31	**Namibia**	No off-grid-specific regulatory framework.
32	**Niger**	No off-grid-specific regulatory framework.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
33	**Nigeria**	Nigeria has the Electric Power Sector Reform Act No. 6 of 2005 which created the Nigeria Electricity Regulatory Commission (NERC) with the authority to create specific regulations for the advancement of electricity access. The NERC, pursuant to the ESPRA created the Mini-Grid Regulation 2016, which contains provisions on licencing, tariff pricing, grid extension, etc.
34	**Rwanda**	The Government of Rwanda has specified that 52% of households are to be connected to the grid, while 48% are to be serviced using off-grid technologies. The National Electrification Plan (NEP)provides guidance on which areas will be serviced by solar home systems and mini-grids, and which will be connected to the grid There also exist Ministerial Guidelines on Minimum Standard Requirements for Solar Home Systems (Ministerial Guidelines). However, there is a major challenge in terms of affordability for achieving universal energy access. Additional support in terms of subsidy is required from government and development partners to improve the affordability of solar home systems.
35	**Sao Tome and Principe**	The licencing framework in Sao Tome and Principe covers both on-grid and off-grid systems. However, there is no specific off-grid framework in the region.
36	**Senegal**	The National Electrification Strategy, Senegalese Agency for Rural Electrification – (ASER), and the Local Rural Electrification Initiatives propose to foster the development of the off-grid sector.
37	**Seychelles**	No off-grid specific regulatory framework.
38	**Sierra Leone**	No off-grid specific regulatory framework.
39	**Somalia**	Somalia's Power Master Plan of 2019 reveals the Federal Government of Somalia's (FGS) commitment to developing the energy sector. The Power Master Plan proposes the establishment of modern cost-effective reliable electricity supply systems supplied through a centralised grid system and off-grid solutions. Somalia Rural Electrification Strategy is underway. It is expected that the strategy will set the foundation for an enabling environment for market development and private sector investment in the sector and guide future investments in the off-Grid Solar sector.

S/N	COUNTRY	LEGISLATIONS/REGULATIONS/POLICIES
40	**South Africa**	The Energy Regulation Act 2006
41	**South Sudan**	No off-grid specific regulatory framework.
42	**Sudan**	No off-grid specific regulatory framework
43	**Swaziland**	The Eswatini Electricity Act of 2007 provides that any person involved in the generation, transmission, distribution, or supply of electricity in the country is required to be licenced by Energy Regulatory Authority (which places a licencing requirement for mini-grid/off-grid systems except those specifically exempted by the Minister)in Eswatini. However, there is no clear-cutframework for investments in a Mini/off-grid regulatory framework.
44	**Tanzania**	Energy and Water Utilities Authority Act 2003 established small power purchase agreements and a standardized tariff methodology which is connected to the mini-grid and existing isolated mini-grids. There is also the Rural Energy Act 2005 and Electricity Act 2008 with fragments on mini-grid utilisations. However, there is a need for an all-encompassing off-grid regulatory framework to guide investments in the region.
45	**Togo**	Togo has a national electrification policy with off-grid provisions – the Togo Electrification Strategy. However, its Energy/electricity law, unfortunately, does not include an off-grid provision. There are however subsidies, tax exemptions, or related incentives for solar equipment/stand-alone systems.
46	**Uganda**	Uganda has an Isolated Grid System Regulation, 2020 which is aimed at encouraging further private sector investment and achieving Uganda's ambitious national electrification target of 80% electricity access by 2040.
47	**Zambia**	Energy Regulation Board's Technical Regulations for Mini-grid Renewable Energy Generation, Distribution and Supply 2018
48	**Zimbabwe**	Zimbabwe's National Renewable Energy Policy has off-grid renewable energy development in rural areas with a special focus on mini-grid as a part of the policy.

4. Policy Challenges to Off-grid framework and Rural Electrification in SSA

4.1 Policymaker preferences across SSA

Presently, policymakers across SSA sometimes do not view the use of alternative energy resources such as off-grid solar as producing real electricity. This is because many people across SSA have a clear preference for on-grid connections over the use of decentralized technologies for off-grid electrification. This is due to a lack of awareness as to the benefits of alternative energy use, lack of skills, knowledge, documented experiences and open source quality data on renewable mini-grids; and difficulties with estimating demand for off-grid users which is often an error-prone planning activity. Also, for a long time, urban electrification has been prioritized over rural electrification, due to increased rates of rural-urban migration across the continent and presently, off-grid and mini-grid system installations are often complex and expensive across SSA.

4.2 Supply-demand hurdle

Research suggests that in rural SSA, where most of the non-electrified households live, demand is very low, meaning an investment in or promotion of alternative energy resources for off-grid electrification may not yield expected returns over time. Also, in areas where electricity users have high demand, renewable energy resources cannot fully guarantee such demand as these resources are usually capable of supplying lighting, device charging, and household entertainment, and not sufficient for industrial activities. In addition, the satisfaction of user demands by off-grid electrification is challenged by the variability of supply with these renewable energy resources, particularly wind and solar energy that are highly dependent on the variability of wind speed and intensity of sunshine respectively.

4.3 Urban-Rural regional disparity

The major difference between urban and rural areas regarding off-grid electrification is the price difference between these areas. Customers in the rural areas are engaged in high investments and high operational costs compared to those in the urban areas which already have existing on-grid electrification as the main support mechanism. In addition, there are technological complexities with installation

processes and maintenance problems brought by the combination of political instability and commercial risks often faced in rural and remote areas that lead to sustainability issues for any investments in rural electrification.

4.4 Impractical Strategies

In cases where countries decide to create regulatory frameworks for off-grid and rural electrification, due to a lack of information and technical standards, policy makers often end up incorporating impractical strategies within the content of such frameworks. Many off-grid electrification strategies of SSA countries do not contain long-term electrification and energy access plans for off-grid areas. There is also an absence of clear information concerning licensing, technical system design, financing and tariff setting in the regulatory framework which hampers particularly, private sector involvement in the off-grid sector.

5. Proposed recommendations for challenges raised

5.1 Private and Public investments into Off-Grid technologies

Off-grid technologies are lower-cost alternatives to grid electrification when the capital outlay associated with connecting distant communities to the grid is factored. Also, the costs of off-grid technologies such as solar lighting devices and solar home systems in combination with improved batteries and LED lights have decreased considerably over the last decade. Per the World Bank, a solar lamp costs around $10 and a 20-Watt solar home system costs $200; and experts anticipate that these prices will decrease over time. Solar panels can provide electricity supply for lighting, device charging and entertainment in households and micro-enterprises in rural areas across SSA.

Research also suggests that off-grid solar is highly valued by the rural population, as people may be more amenable to dedicate parts of their incomes to investing in off-grid solar rather than grid electricity. As to the question of how users with higher demands may have their electricity needs met, such users with the means to pay for diesel generators may resort to the use of generators in the short term. Subsidies will also be required to increase access through investment in off-grid solar amongst the poorer residents in rural areas; such subsidy schemes should be consistent with active private sector participation in the off-grid solar market and transparent in terms of duration and phasing-out.

Investments into off-grid technologies should see an adoption of mainly renewable and PV-hybrid technologies. These will include decentralized systems such as concentrated solar power (CSP) plants, small diesel power generations, and renewable technologies such as biomass, PV systems, small wind, and small hydropower systems that use components like batteries, diesel generators, and pedal generators, etc. Also, hybrid systems such as a PV-wind system can mitigate the challenge of wind and solar intensity variation. Another off-grid strategy is microgrids which are also autonomous and decentralized systems.

5.2 Education and awareness

Awareness should be created amongst policymakers in SSA countries about the affordability of off-grid technologies and the realization that a given budget for supporting household electricity access can provide more constituents with an acceptable level of service if used for off-grid solar rather than grid electrification. Such awareness should also integrate the public sector, civil society organizations, microfinancing companies and other stakeholders in the power sectors of SSA countries on the benefits of renewable energy use in off-grid electrification.

5.3 Adequate Policy Support

The challenge of policymakers lacking complete and accurate information regarding rural areas requiring off-grid solutions needs to be resolved by the governments of SSA countries. With adequate information, policymakers will be able to create regulatory environments for investments in off-grid technologies, particularly mini-grids that have payback periods exceeding several years. Such regulatory environments should comprise agreements or subsidies that are valid for ideally ten years or longer to mitigate risks for investors. Policymakers should incorporate into their renewable energy / rural electrification frameworks, incentives such as lower taxes that will strengthen the distribution of renewable energy in the SSA market.

5.4 Monitoring Tools

Governments of SSA countries should complement overarching off-grid electrification strategies with monitoring tools that track the progress of the implementation of such strategies. Such monitoring tools should be coordinated and managed by a cross-government taskforce to reduce risks of overlap and duplication of efforts. Examples of freely available software that can be used in monitoring such implementation include OnSSET and PyPSA. OnSSET is a GIS based optimization tool that has been developed to support electrification planning and decision making for the achievement of energy access goals in currently unserved locations. It has a flexible and modular code basis and allows the customization of resolution of analysis, GIS input data, technology types & costs in addition to electrification policies as needed. PyPSA on the other hand is a free software that is suitable for researchers, planners and utilities who need a fast, easy-to-use and transparent tool for power system analysis. It calculates static power flow, linear optimal power flow, security-constrained linear optimal power flow and total electricity/energy system least-cost investment optimisation.

DISCLAIMER

The devised method of data representation and the mode of populating the information in this Toolkit document is not premised on and does not in any way imply the opinion of International Organizations, Ministries, Governmental Bodies and Regulatory Entities of SSA countries, relating to the legal status of the country, the territory, boundary, or delimitation of the country's frontiers.

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