

Country Brief: Mozambique

Off-grid solar power in Mozambique: opportunities for universal energy access and barriers to private sector participation

Pranab Baruah, Brendan Coleman



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Authors

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Summary Messages

1. Mozambique is considerably lagging behind in its goal to achieve universal electricity access by year 2030. Meeting this goal with on-grid electrification programs alone would be financially costly and unrealistic.
2. With falling technology costs, new business models, and thousands of identified potential sites across Mozambique, off-grid solar power is increasingly a cost-effective option to realize full electrification in Mozambique, especially in rural areas.
3. Despite the enormous potential and recent efforts by the government, off-grid solar power has hardly been exploited in the country, and private sector participation in the sector has been limited. Considerable interlinked barriers – including in policy, regulation, financing, and human capacity domains – are hindering private sector participation that is required to scale-up uptakes of solar power in rural Mozambique.
4. Recommended priority actions to systematically address these barriers include: (a) establishing an off-grid taskforce with joint ownership of relevant ministries and representation of key stakeholders; (b) removal of high VAT and import duties on solar power products; (c) establishing and enforcing quality standards for solar power products; (d) enabling the flow of skilled labor from overseas, especially in early development phase of the sector; (e) raising awareness on the opportunities and benefits of off-grid solar power and mobile money; and (f) strengthening and expanding the role of the existing off-grid energy fund.



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Abbreviations and Acronyms

AfDB	African Development Bank Group
ARENE	Autoridade Reguladora de Energia (Energy Regulatory Authority)
BCI	Banco Comercial e de Investimentos Mozambique
BTC	Belgian Development Agency (Belgische Technische Cooperatie)
CAGR	Compound Annual Growth Rate
CNELEC	Conselho Nacional de Electricidade (National Council for Electricity)
CTA	Confederation of Business Associations of Mozambique
DFID	UK Department of International Development
EDENR	Strategy for the Development of New and Renewable Energies
EdM	Electricidade de Moçambique (Mozambican Power Company)
EU	European Union
EUR	Euro
FIT	Feed-in Tariff
FONERWA	Rwanda Green Fund
FUNAE	Fundo Nacional de Energia (National Energy Fund)
GBP	British Pound
GCF	Global Climate Fund
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gas Emissions
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Corporation for International Cooperation)
GoM	Government of Mozambique
GW	Giga Watt
IDCOL	Infrastructure Development Company Limited of Bangladesh
IIM	Institution Industrial de Maputo
IMF	International Monetary Fund
INAE	National Inspectorate for Economic Activities
kWh	Kilo Watt Hour
MIREME	Ministério dos Recursos Minerais e Energia (Ministry of Mineral Resources and Energy)
MZN	New Mozambican Metical
NDC	Nationally Determined Contributions
NGO	Non-Governmental Organisation
NES	National Electrification Strategy of Mozambique
PARP	Poverty Reduction Action Plan 2011-2014
PARPA	Action Plan for Reduction of Absolute Poverty II & III
PAYG	Pay As You Go
PES	Social and Economic Plan
PEDSA	Plano Estratégico para o Desenvolvimento do Sector Agrário (Strategic Plan for Agriculture Development)
PPA	Power Purchase Agreement
REA	Rural Energy Agency, Tanzania
SADC	Southern African Development Community
SE4LL	Sustainable Energy for All
SDG	Sustainable Development Goal
SHS	Solar Home System
TW	Terra Watt
UEM	Eduardo Mondlane University (Universidade Eduardo Mondlane)
UN	United Nations
UNIDO	United Nations Industrial Development Organisation
USD	United States Dollar
VAT	Value Added Tax

I. Objective of this brief

Achieving the SDG 7 – universal access to affordable, reliable, and sustainable energy - is central to achieving many of the SDGs under UN's Agenda 2030. Achievement of universal electricity access is a key target under SDG 7. This brief describes the significant role that the off-grid solar power sector¹ could play in meeting Mozambique's universal electricity access goal, and provides a structured overview of the key barriers hindering private sector participation for scaling-up the sector. The brief concludes with a set of recommendations on priority actions to systematically address major inter-linked barriers.

1 Off-grid solar power sector could cover pico-solar PV, solar home systems, solar micro-/mini-grids, solar/hybrid systems for productive uses such as pumping for irrigation etc.

II. Role of off-grid electrification in realizing Mozambique's universal electricity access goal

At present about 28% of the Mozambique population is electrified. In 2016, about 25% of population was electrified via the grid and 2% via off-grid systems (World Bank, 2017; Robinson et al., 2016). Though the grid connects all 128 district headquarters of Mozambique, access is largely limited to urban areas. Access in the rural population is less than 5% and the priority has been to first connect schools, health centers and administrative posts. Mozambique's population is approximately 29 million in 2017, 70% of which live in rural areas, mainly along its 2700 km coastline.

By 2030, the country will have more than 40 million people or 8 million households. Mozambique's draft National Electrification Strategy (World Bank, 2017)² sets an official target of 100% electrification by 2030, in line with the universal energy access target under UN's SE4ALL objective. MIREME's 2014-23 electrification strategy has a target of 50% by 2023.

Even with 50% grid electrification by 2030, about 4 million households, mostly with incomes of less than \$2 a day, are likely to remain un-electrified at the current rate of electrification. To connect 50% of households, the state utility EdM must increase the connection rate from the current 120,000 to 185,000 a year, requiring an investment of ~\$9 billion (Energy Africa, 2016). To meet the universal access target by 2030, 400,000+ connections would be required annually (World Bank, 2015).

Table 1: Advantages and opportunities for off-grid solar power in Mozambique

Advantages	Opportunities
<ul style="list-style-type: none"> • High quality solar resources endowment across the country • Falling cost of solar power • Strong government interest in off-grid solar power • Role of off-grid solar power is recognized in major national strategies/ plans • Rural energy agency FUNAE has considerable experience with off-grid solar power installations • Success stories in Africa to learn from 	<ul style="list-style-type: none"> • Rapidly falling costs of solar and battery technologies • Increasing retail prices of conventional fuels • Successful regional experiences to emulate from • High penetration of mobile phones and increasing availability of mobile money • Increasing interest from development donors and private sector • Potential many-fold increase in state revenues from expanding extractive industries that could support the sector's development

About third of EdM's customers are concentrated around capital Maputo and surrounding provinces and generates about 65% of EdM's revenue. EdM's financial condition remains weak and the on-grid tariff rates, though increasing, are not cost-reflective. As such, achieving the 2023 and 2030 electrification targets, exclusively with an on-grid electrification program would be unrealistic. Off-grid electrification offers a practical and cost-effective way to electrify significant off-grid populations in Mozambique. Additionally, the demand for electricity is steadily increasing in Mozambique and will increase further with greater industrialization of the country. The demand for power in SADC countries are also expected to increase which could be met with Mozambican exports. Thus, off-grid solutions could complement Mozambique's on-grid electrification program by simultaneously meeting universal electricity access goal, offsetting increasing domestic demand, and enabling greater high-value exports of its on-grid generation to neighboring countries.

² Drafted with World Bank's support, and is currently under review by the Council of Ministers

III. Solar power: an increasingly attractive option for off-grid electrification in Mozambique

Mozambique can meet the off-grid electrification need by utilizing its enormous renewable resources as evidenced by the thousands of identified potential project sites in areas with off-grid population (MIREME, 2014). Both solar and hydropower have significant technical potential estimated at 23 TW and 19 GW respectively.

Currently, hydropower dominates overall production of electricity (at 86% in 2016). Mozambique is the largest producer of hydropower in Africa with production coming mainly from 4 hydropower plants – Cahora Bassa being the largest contributing to more than 90% of total hydropower production in the country. However, being situated in one of the high climate impact hot-spots in Southern Africa, there is considerable uncertainty in Mozambique's hydropower production potential in the future. Simulations of climate impacts indicate gradual reduction of production potential for hydro-electric power plants - both current and proposed - in the Zambezi region where Cahorra Bassa is located (Yamba et al., 2011).

With the climate impact risks surrounding the hydro power generation, solar power is an increasingly attractive off-grid electrification option for Mozambique. Solar irradiation in the country compares with the world's best, averaging at around 2000 kWh/m²/year as evident from figure 1(a) (southern Germany receives ~1200 kWh/m²/year). Driven by rapidly increasing investment and innovation globally, cost of solar PV is falling fast (IRENA, 2017). At the same time, the cost of lithium-ion batteries³ is similarly experiencing dramatic cost reductions (BNEF, 2018)⁴. Both pico-PV and SHS sales grew at 99% CAGR (i.e. doubling annually) and 125% CAGR respectively, and a number of African nations has been a major driver of this growth – with further growth, system costs are likely to fall further.

Mozambique's vast landscape and sparse population is another reason electrification with off-grid solar systems is a more cost-effective option compared to on-grid electrification. Out of the 23 TW technical solar potential, it is estimated that more than 2.7 GW could be relatively easily harnessed. The connection cost per

household for an off-grid solar system such as a SHS⁵ is estimated to be less than \$200 in Mozambique – a mere 6% compared to the ~\$3,500 required for grid connection. Market potential for private-sector led off-grid electrification is identified as approximately 4 million households. In addition, off-grid solar power provides other advantages and opportunities in Mozambique, as indicated in the Table 1, and described throughout the brief.

The connection cost per household for an off-grid solar system such as a solar home system is estimated to be less than ~\$200 in Mozambique – a mere 6% compared to the ~\$3,500 required for a grid connection.

Consumers in Africa is found to save on average \$3.15 for every dollar spent on a pico-PV system (ICF, 2018)⁶ compared to relying on fossil fuel. In addition to saving costs on fuel, energy access with solar power minimizes time spent in sourcing conventional biomass and diesel, enabling more time for other productive activities. Additionally, there are wider economic benefits including enhancing the resilience of communities by minimizing disruption to power supply from natural disasters, which is of great importance in a country with poor infrastructure and increasing climate change related risks. The need for local manufacturing, distribution, operation and maintenance is likely to boost local innovation, entrepreneurship, and employment in rural areas as well. UNEP (2014) found that renewable energy deployment creates an estimated 30 jobs for every 10,000 off-grid households connected. With an increasing population and continued economic growth, overall energy demand in Mozambique is expected to rise further⁷. Promoting off-grid solar solutions will minimize air pollution and GHG emissions associated with conventional fossil-fuel based generation, and would contribute to meeting and enhancing Mozambique's climate commitments in its NDC under the Paris Climate Agreement.

3 Current off-grid systems such as plug and play Solar Home Systems in Africa primarily use lead acid batteries that are cheaper than Li-ion batteries. Li-ion batteries have better depth of discharge and longer life-cycle than lead acid batteries - with falling costs Li-ion batteries are emerging as better cost-effective alternative in off-grid power systems.

4 Equipment prices of solar PV technology fell 80% during 2009-16 (IRENA, 2017), and battery costs fell more than 70% during 2010-16 (BNEF, 2018).

5 A Solar Home System in Africa is typically 10-100 kW and comes with solar panels, batteries (generally lead-acid), and charge controllers – a SHS can typically support applications such as multi-source lighting, mobile phone charging, fans, radio, and TV. Typical cost of sub 1-kW DC-current systems (that avoids an inverter) in Africa range from 4-16 USD/W, and without battery and charge controller 1.9-13.9 USD/W (IRENA, 2016)

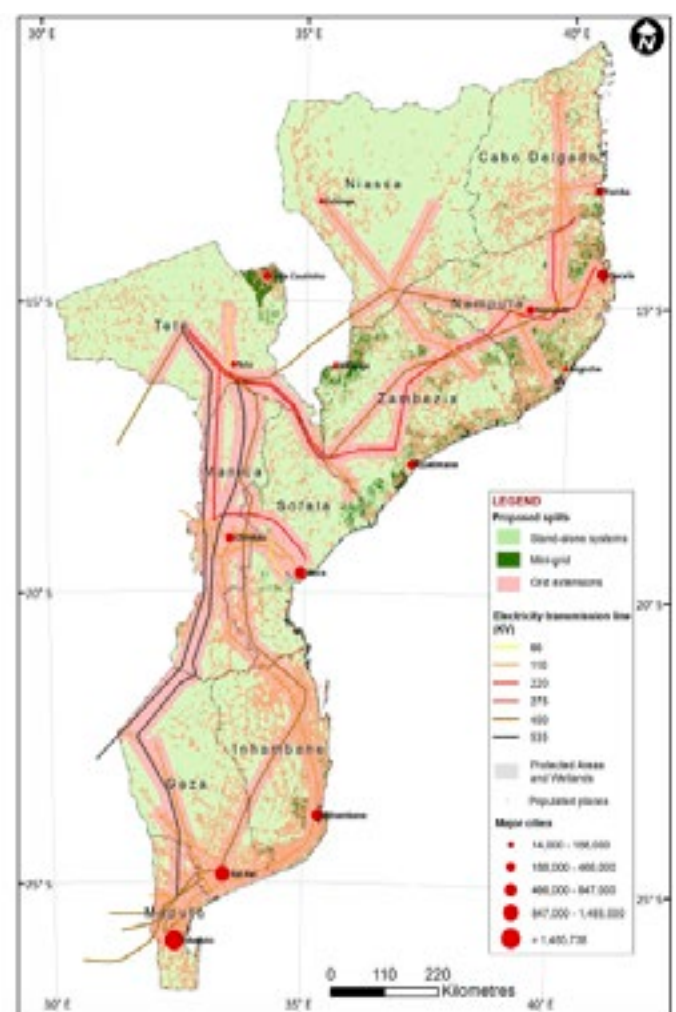
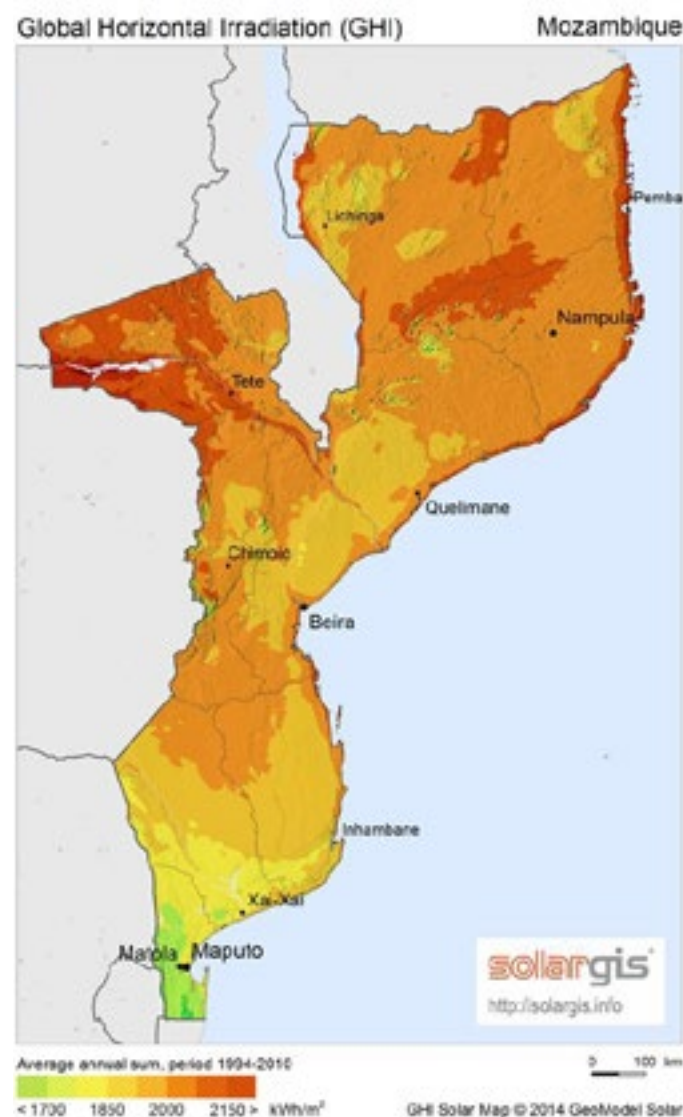
6 Pico-PV are typically 0-10 kW lanterns and simple multi-light systems which may enable mobile charging.

7 Peak demand is increasing at ~11% YoY, and electricity demand including exports ~9% YoY

Off-grid solar power could also greatly support the development of the agriculture sector and other income-generating productive uses for rural development in Mozambique. Irrigation is one of the key areas that off-grid solar power could play a game-changing role for sustainable rural development. Mozambique has ~3.3 million ha of potentially irrigable land with only about 50,000 ha of operational irrigation infrastructure – much of these are concentrated around the center and south of the country and largely for high-value crops such as sugarcane (PEDSA, 2010). Widespread lack of grid

electricity services means that farmers, where they can afford, depend on diesel powered systems. Enhancing the reach of irrigation is a key objective in the government's Strategic Plan on Agriculture Development 2010-2019 (PEDSA, 2010) in order to increase yield for both small-holder and larger farmers. Solar powered drip irrigation systems could support the growth in yield and greater crop variety while managing resilience in the agriculture sector (e.g. by minimizing use of fossil-fuels and the use of water in an increasingly drought-prone country).

Figure 1: (a) Solar irradiation map in Mozambique (image source: SolarGIS, 2018), and (b) high-potential areas for off-grid solar power installations (image source: AfDB, 2017)



IV. Mozambique's experience in the off-grid solar power and private sector participation

Mozambique's rural electrification fund FUNAE has two decades of experience in the off-grid power sector. FUNAE operates as the de facto rural electrification agency. About 3.7 million off-grid customers are estimated to have gained access to modern energy services through FUNAE's off-grid programs – mostly with solar power systems - between 2005-2014⁸. These projects were made possible mainly through international donor support⁹.

In order to scale-up the solar power sector, all relevant ministries and major development strategies of the Government of Mozambique recognize the potential of off-grid solar solutions and the need for private sector participation in accelerating energy access and development in rural areas¹⁰. It is also recognized that harnessing private participation in off-grid energy access can achieve electrification targets with a reduced burden on public finances. To encourage such participation, Ministry of Mineral Resources and Energy (MIREME) and FUNAE developed a comprehensive Mozambique Renewable Energy Atlas (MIREME, 2014) that outlines the high potential renewable resources areas across Mozambique including for solar energy. Based on MIREME and FUNAE recently released a \$500 million off-grid energy project portfolio to help attract private sector and donor financing¹¹.

Despite such positive and commendable steps taken by the government, the off-grid solar power sector in Mozambique is yet to take off and private sector participation in the sector remains limited. Outside of FUNAE-administered donor programs, sale of solar off-grid systems in Mozambique has not been significant until recently. Solar power systems installed by FUNAE have been mainly in schools, administrative offices, hospitals etc. - very few installations targeted households, and many have failed due to operation and management

issues. There has not been a large-scale pico-PV or SHS program in Mozambique targeting households, apart from a limited distribution of solar lanterns around Maputo area by FUNAE. Market development of larger systems such as mini-grids is also yet to achieve traction. The few mini-grids installed by FUNAE have mostly been diesel-powered and many have failed due to operation and maintenance issues.

At present, there are several private companies in the solar business operating in Mozambique¹². However, it is recognised that scaling-up the sector would require addressing a number of inter-linked barriers. The following sections provide a structured overview of the barriers that are hindering private sector participation and the scaling up of off-grid solar power in Mozambique.

8 According to FUNAE, 11 cities, 669 schools, 623 health centres and 77 public buildings were electrified through off-grid PV installations during 2005-2014.

9 Support to FUNAE projects have been through tied aid loans programs from World Bank, Belgium, Germany, European Union, Portugal, Spain, China, India, South Korea, Denmark, Finland etc. Additional support from BTC, GIZ and UNIDO since 2013 has led to increase in access.

10 Strategy for New and Renewable Energy Development (EDENR) 2011-2025, Five-year plan (2015-2019), Poverty Reduction Action Plan (PARP) 2011-14, Action Plan for Reduction of Absolute Poverty (PARPA II 2006-09), and annual Economic and Social Plan (PES, for 2015, 2016, 2017) clearly states the role of solar pv and private sector participation for achieving off-grid energy access and/or rural economic development.

11 Announcement reported at: <https://bit.ly/2PWDQxV> (accessed on September 1, 2018)

12 These companies include Solar Works, Mobisol, Galp, Total, Solarkom, and Bobshop

V. Barriers to private sector participation in the off-grid solar power sector in Mozambique

Table 2 presents the typology used to select and conduct the review of the barriers for private sector participation in the off-grid solar power sector in Mozambique. The review is primarily based on relevant consultancy reports, country briefs, development partner review documents as well as policy and strategy documents. Insights from stakeholder

interviews and interactions with key government agencies, development agencies, NGOs and the private sector entities contributed to the structuring and selection of the barriers presented here – descriptions based on stakeholder interviews are indicated where applicable.

Table 2: Typology of barriers to private sector participation in the off-grid solar power sector in Mozambique

Barrier category	Sub-category reviewed	State of barriers in Mozambique
Economic and infrastructure barriers	<ul style="list-style-type: none"> • Macroeconomic condition • Demand pool size; willingness-to-pay • Quality of transport infrastructure • Other economic-related issues 	<ul style="list-style-type: none"> • Uncertain macroeconomic condition from recent debt situation • Weak demand from sparse rural population with low spending power and willingness-to-pay • Poor market access and investments due to inadequate infrastructure and uncertain security conditions • Expectation of low tariffs from past social electrification programs; prevalence of low-quality batteries
Policy and planning barriers	<ul style="list-style-type: none"> • Off-grid strategy and plans; policy coherence • Policy on duties on solar products • Financial incentive policy 	<ul style="list-style-type: none"> • Lack of operational plans and targets to realize off-grid aspirations in existing strategies, and policy incoherence • High VAT and import duty on solar products • No financial incentives for off-grid generation to offset financing gap from high upfront cost and low national tariffs
Regulatory barriers	<ul style="list-style-type: none"> • Electricity tariff structure • Price of and subsidy on fossil fuels • Off-grid regulations around licensing, concession and grid arrival • Quality standard and consumer protection 	<ul style="list-style-type: none"> • Uniform national tariffs; national tariff inadequate for commercial viability of projects • Cheap subsidized prices for conventional fuels • Unclear regulation around licensing, concessions, and grid arrival • Lack of quality standards, and inadequate consumer protection
Financial Barriers	<ul style="list-style-type: none"> • Access and cost of capital • Micro-lending environment • Import and export of capital • National fund for mobilizing and disbursing (concession) capital 	<ul style="list-style-type: none"> • High cost of capital from local banks, with high interest rates, high collateral, and short tenure consumer lending • Underdeveloped microfinance ecosystem • Complex and difficult import and export of capital • No national fund to mobilize and disburse low-cost finance to private-sector led off-grid projects
Governance and institutional barriers	<ul style="list-style-type: none"> • Regulatory oversight entity • Rural electrification agency • Inter-agency coordination 	<ul style="list-style-type: none"> • No operational energy regulator • Lack of dedicated rural electrification agency overseeing off-grid policy, regulations, planning, and implementation • Inadequate inter-agency coordination
Human resources barriers	<ul style="list-style-type: none"> • Skilled workforce, with local experience 	<ul style="list-style-type: none"> • Inadequate supply of skilled labor and capacity in management, assembly, installation and maintenance of systems
Information barriers	<ul style="list-style-type: none"> • Awareness of technology and related benefits and costs • Availability of market data 	<ul style="list-style-type: none"> • Poor consumer awareness on solar products and mobile banking • Limited market data, such as market size and off-grid consumer lending risk profiles



A solar installation in rural Mozambique
Source: 3E Consulting

V.1. Economic and infrastructure barriers

Uncertain macroeconomic condition

As one of the six African Lion Economies, Mozambique enjoyed strong economic growth averaging 7.5% during 2000-2015. In April 2016, the government disclosed a hidden debt of \$1.4 billion (equal to 10% of national GDP) that escalated Mozambique's public debt to ~85% of GDP, making it one of Africa's most indebted nations. The disclosure led International Monetary Fund (IMF) and other international donors to suspend their aid programs, which was then about a quarter of its budget. The debt crisis depreciated the national currency, the Metical, by 45% and raised food inflation by 36% in 2016. Since then, the government has been pursuing fiscal reforms required by international creditors. Mozambique's credit rating remains poor due to continued delays in debt repayment.

Despite the debt scandal, Mozambique's macro-economic management is considered relatively good, and growth is expected to pick up in coming years, particularly from an expected rise in revenues from extractive industries. With planned natural gas projects and exports realized, Mozambique could become the world's third largest gas exporter by 2025, providing an economic dividend of \$160-200 billion in GDP (in 2014 prices) over 20 years (Deloitte, 2016). Allocating a small portion of such revenues (e.g. through a levy) could serve to incentivize expansion of off-grid energy access with increasingly cheaper solar and related technology costs.

The weak fiscal situation, however, continues to be an overarching barrier in accessing donor financing critical for the development of the off-grid power sector. Recent interactions with donor agencies revealed a gradual uptick of interest in the sector, although many continue to take a 'wait and see' approach until adequate reforms

and lending rules are in place. Nevertheless, several donor programs are upcoming or have begun with the aim of enhancing private sector participation in the off-grid renewables sector – these include programs by the DFID, EU, and BTC¹³.

Weak demand from sparse rural population with low spending power and willingness-to-pay

Mozambique is vast and sparsely populated with 38 people per sq. km of land area compared to Tanzania's 65 and Kenya's 87 (World Bank, 2018). This creates a challenge for off-grid power sectors, especially for mini-grids due to the length of distribution cabling required, and for standalone system suppliers that must provide after-sales services across larger, more inaccessible regions.

UNEP data shows that the off-grid population with an income under \$2 a day is twice as large as the population with an income between \$2-10 a day (BERF, 2016). Historically, consumer subsidies have been provided to cover the upfront costs of technologies with high economic benefit. This approach has been shown to be unsustainable and undermines market development by reducing consumer's willingness to pay. Anecdotal evidence from key sector stakeholders in Mozambique suggests that this is the case in many areas in Mozambique.

13 DFID's BRILHO Program (~ GBP 23 million during 2016-2022); EnDEV program of seven EU donor countries has been supporting solar home systems, pico-solar systems, hydro mini-grids and improved cook stoves; BTC and FUNAE implemented the Renewable Energy for Rural Development (RERD) phase I program of EUR 26.34 million – this was funded by Belgium, and the Netherlands (2010-16) with co-financing by GoM. RERD II during 2017-23 is focusing on capacity building for MIREME and ARENE (approx. EUR 4 million) and developing mini-grid projects focusing on productive uses (approx. EUR 12 million).

Poor market access due to inadequate infrastructure and uncertain security conditions

Poor road conditions, connectivity, and the long distances between project sites and major ports remains a major distribution and maintenance challenge and adds to costs for firms and ultimately consumers. Stakeholder interviews revealed that difficulty in imparting essential training for local capacity building and timely maintenance of installations due to transport infrastructure has led to the failure of off-grid projects in the past. The security situation in high solar potential regions such as Nampula and Cabo Delgado also remains uncertain due to tension and sporadic violence between political factions¹⁴. This at times has been a major barrier for safe transit across the country and has restricted investments in affected areas.

Expectation of low tariffs and other issues

Social electrification projects, where power and equipment were provided at low cost and nominal fee, have created an expectation of 'fair' low price for many rural communities. This creates a barrier to engage these communities in private sector-led schemes where a higher, cost-recovery price is seen as 'unfair'. Cheap, second-hand and low-quality batteries prevalent in rural areas are also found to impact the willingness to adopt solar systems.

Telecommunication towers have served as an important anchor client to make off-grid solar power businesses financially viable (and support expansion of access to nearby communities) in countries like India and Bangladesh. In Mozambique, such a model has not materialized. At present, telecom towers are often not operated 24 hours in Mozambique (affecting mobile connectivity), and there is a perception that solar PV systems are more susceptible to theft. As operators increase their tower operating hours with increasing demand, the case for solar-powered systems is likely to increase.

V.2. Policy and planning barriers

Lack of targets and operational plans, and policy incoherence

All major relevant strategies and plans in Mozambique recognize the role of solar power and private sector participation in the off-grid power sector. However,

currently there is no national target regarding how distributed off-grid power could contribute towards meeting the national electrification target. There is also no target for renewable energy uptake. Additionally, operational plans or dedicated legal and regulatory frameworks are not available to realize off-grid aspirations indicated in national strategies and plans. The draft National Electrification Strategy (World Bank, 2017) is mainly focused on the expansion of the grid, and lacks a target, plan, policies and regulations around off-grid electrification.

A detailed and predictable rural electrification master plan, as available in Kenya, could minimize the risks of grid arrival to off-grid power sites and enable firms to plan their investments, especially for micro- and mini-grids. The availability of a national grid expansion plan is a necessity for formulating such a plan. While proposed national grid extension plans are available from EdM, the status and construction timelines are not published, creating uncertainty for potential firms and financiers.

There is currently a disconnect in current initiatives with off-grid aspirations, as most off-grid power installations remain dependent on government interventions through FUNAE, including channeling most private sector investments (BERF, 2016). Uniform and subsidized tariff structures, high VAT, and import duties on solar power products (described below) also remain contradictory to promoting off-grid power for rural energy access and development.

VAT and import duties, added with other fees could amount to 30-40% of the installation cost of solar products in Mozambique

High VAT and import duties on solar products

Removal of the VAT and import duties on solar products have been one of key drivers of rural electrification programs in countries like Tanzania. In Mozambique, this continues to be a major barrier, as all renewable energy products, including for solar panels, are charged at a high 17% VAT. Additionally, solar products are charged an import duty of 7.5%, regardless of their application. For example, solar panels used in the agriculture sector (e.g. water pumping for irrigation) must pay the duty, even though agricultural equipment is exempt. When fees for facilitation services are considered, these charges could add 30-40% to the total cost of installation.

14 Refer relevant news at: <http://on.ft.com/2mu8V1m>; <http://bit.ly/2zlutwy> (accessed on September 1, 2018)



A solar mini-grid system in Chinhambuzi, Mozambique
Source: Durham University, UK

Stakeholders perceive that these levies are primarily intended to protect domestically produced components, particularly those produced at FUNAE's PV manufacturing facility. A recent study indicates that removal of VAT and import duties on solar products that meet certain quality standards would cost only \$1.1 million over a 10 year period, and would accrue a benefit of \$7.6 million from higher business taxes and VAT on income by employees in the sector. On the consumer side, financial savings from the exemption could reach ~\$14 million and would create thousands of jobs (DFID, 2016).

No financial incentives for off-grid renewable generation

It is essential that off-grid generation such as solar/hybrid mini-grids are subsidized if subjected to uniform tariffs (discussed below) – Kenya has implemented such a scheme that is financed by a national levy on on-grid electricity tariffs. In Mozambique, FUNAE projects are essentially subsidized through grants from donor agencies and with some contributions from the government. Apart from this, currently there is no subsidy or incentive program to attract private sector participation in the off-grid (solar) power sector¹⁵. AfDB's Sustainable Energy Fund for Africa (SEFA) has approved a technical assistance grant to the GoM to enhance the enabling environment for private investments in the country's renewable energy sector. Among others, SEFA's grant would support implementation of FiT for small/medium scale renewable energy projects, provision of standardized PPAs, and development of guidelines for grid connectivity and investor guidelines for prospective developers.

V.3. Regulatory barriers

Uniform national tariffs

Mozambique employs a uniform tariff structure for all power projects. Off-grid projects, such as mini-grids, are made to charge the national tariff (set by EdM) which are not sufficient to cover the operational and maintenance costs let alone provide a return on investment (AfDB, 2017). All mini-grids installed by FUNAE apply the national tariff.

National tariff rates in Mozambique are tiered by consumption and customer type, and fixed regardless of location. Tariffs are subsidized and do not reflect true cost of power generation. The state utility EdM's financial state is weak due to the rapid social electrification drive over the past decade coupled with the low electricity tariff and large outstanding arrears¹⁶.

To mitigate this situation, EdM has significantly increased the tariff rates in recent years¹⁷. Nevertheless, the tariff for low consumption consumers, such as those in off-grid areas, remains unchanged at about 1 MZN per kWh (1.7 USD cents / kWh in September 1, 2018). EdM's operations continue to be heavily dependent on donor support, and

16 EdM's financial woes are primarily due to low tariffs and large arrears. Its operating income is not enough to meet debt payment and interest costs. Analysis done prior to the debt crisis indicates that EdM's financial viability won't improve until end of the decade even with 25% increase over 2015 tariff (World Bank, 2015). EdM's current arrears include from large foreign customers and state agencies – this arrear has been tripling every year for last 3 years (2013-2016) to ~\$150+ million.

17 In Nov 2016, EdM increased tariffs by 27-40% for first time in more than 5 years (as reported in <https://bit.ly/2PY5WIT>, accessed on September 1, 2018). In August 2017, it again revised tariff level by ~30% which was welcomed by IMF (as reported in <https://bit.ly/2wyK5z2>, accessed on September 1, 2018). With this, domestic consumers up to 300 kWh now pays 6.95 MZN/kWh (1 USD = 60 MZN). Nevertheless, tariff for consumers using less than 125 kWh, the most likely category of rural off-grid household customers, is subsidized and unchanged for last several years, and stands at 1.075 MZN/kWh (~0.02USD).

15 With the help of KfW, government is currently reviewing to operationalize a Feed-in-Tariff system (announced in 2014) for on-grid renewables.

such support is likely to be directed towards refinancing its loans and improving its revenue collection and grid maintenance capabilities.

The few mini-grids that have operated sustainably have negotiated exemptions from MIREME and charge monthly subscriptions for services rather than consumption-based billing. However, once the main grid arrives at an area served by a mini-grid, the operators are obliged to revert to a uniform tariff which undermines the business model.

Cheap prices for conventional fuels

Conventional liquid fuels in Mozambique is subsidized and are therefore low cost – this reduces the financial attractiveness of switching to solar power from diesel generation. However, the government has started to gradually remove the subsidies and retail prices are increasing as a result. The price of kerosene, the primary fuel for lighting in off-grid areas, is currently around 0.80 USD per litre¹⁸. In February 2018, petrol and diesel prices were respectively 61.12 MZN (~1 USD) and 56.43 MZN (~0.9 USD) per litre. IMF estimated that fuel subsidies during 2012-14 amounted to 1.1 to 1.5 % of Mozambican GDP.

Unclear regulation around licensing, concession, and grid arrival

Public private contracts in Mozambique are regulated by PPP Law no. 15/2011 (10 August 2011) and Decree no. 16/2012 (4 June 2012) that covers all PPP projects and related concessions (including mega-projects). Electricity Law 21/97¹⁹ covers the production, transportation, distribution and commercialisation of electric energy in Mozambique, as well as the import and export of electricity. The Electricity Law gives EdM the mandate to manage the national electricity grid but specifies that, at local level, private sector actors can generate and distribute power (e.g. through micro/mini-grids). It also regulates licensing and concession terms for generation but doesn't outline operational requirements for off-grid access projects (DFID, 2017). The Law also specifies that private developers can negotiate tariffs with relevant licensing authorities. Both the PPP Law and the Electricity

Law apply to green mini-grid projects. However, inadequate clarity in regulations means that private sector-led mini-grids are made to use the same regulation applicable to the utility-scale energy projects and are thus obliged to charge sub-commercial national tariffs.

The PPP model has the potential to be a scalable model for mini-grids due to its flexibility and adaptability to underlying market conditions (AfDB, 2016). For example, a PPP model in Senegal specifies government ownership for mini-grids, while a private company is given a 15-year concession for operation and maintenance (APP, 2015). Mozambique's current PPP Law has provisions on local government involvement, local investment, and local taxation that could work against off-grid business models and scalability (AfDB, 2017).

In addition, currently mini-grid operators in Mozambique have no regulatory protection, or compensation mechanism from the arrival of the grid. At least three mini-grids have been obliged to charge the national tariffs upon arrival of the grid. Clarification is also required on how the recently announced feed-in-tariff scheme for grid-tied renewable generation could apply to green mini-grids when these are connected to the grid upon its arrival.

Unclear or a lack of regulation in the mini-grid sector also means that small or community-driven businesses are required to operate through FUNAE, which is a barrier to market entry and increased private sector participation.

Lack of quality standards and inadequate consumer protection

FUNAE operates a PV manufacturing plant that recently received (in March 2017) TÜV international quality certification. However, there is no enforcement of quality standards for imported solar products into the country. For example, most pico-PV products imported and sold in Mozambique do not meet Lighting Africa's standard²⁰.

Quality standards for products protect consumer confidence - it minimizes the risk of negative consumer perception and price expectations from cheaper and inferior technologies at the expense of quality-verified (and higher-priced) products. Enforcement of quality standard

18 Government reviews prices every month; prices has increased to MZN 46.98 in February 2018 (as reported in <https://bit.ly/2Pwj1bD>, accessed on September 1, 2018) compared to MZN 40.11 per litre in September 2017.

19 As of October 2018, the Electricity Law is being revised and under public consultation phase.

20 Lighting Africa is an IFC-World Bank project targeting electricity access to 250 million sub-Saharan Africans without electricity Access. Its Lighting Global Quality Test Methodology is considered gold standard for off-grid lighting products.

would also enable greater flow of donor financing that requires the use of quality-verified products.

Mozambique also lacks adequate local testing facilities to establish a quality standard program. Eduardo Mondlane University (UEM) and the Institution Industrial de Maputo (IIM) have testing facilities for pico-solar and Solar Home Systems respectively. However, these are not equipped to administer a full-scale quality standards program. Mozambique's National Inspectorate for Economic Activities (INAE) also requires strengthening to identify and target sub-standard products, and a mandatory minimum warranty for PV products is suggested to improve public acceptance and demand (BERF, 2016)²¹.

V.4. Financial barriers

High cost of capital from local banks

The prime lending rate – the rate that commercial banks charge to most creditworthy customers – in Mozambique has been as high as ~30% in recent years. Local banks also often require 100% collateral for commercial loans. Farmers interviewed in Chokwe district indicated that commercial bank interest rates for loans to replace diesel powered water pumps could be as high as 40%. Prime lending rates since has come down but remains high at 20% (as of November 2018).

Renewable technologies and projects are perceived as high risk by local banks due to their limited experience in the sector. Limited availability/access to risk-profile data for off-grid customers and their low-income status creates an additional barrier for what is already a challenging lending scenario.

Local banks also typically do not have adequate human resources to deal with an area that is currently outside their core business. This results in high transaction costs in the off-grid sector (\$10 for pico-products to \$250 for mini-grids). Additionally, the commonly targeted payback period of around two years for conventional loans does not match the loan tenors required for off-grid projects.

Experiences elsewhere in sub-Saharan Africa have shown that companies selling Solar Home Systems or pico-solar kits are likely to be start-up ventures aiming for rapid growth and with short funding cycles. These companies also

often reinvest their proceeds into further growth, requiring several funding cycles (BNEF, 2016). Mobile banking enabled PAYG business models, that have seen spectacular success in countries like Kenya, Tanzania and Uganda, are able to provide solar power systems to poor customers with a small upfront payment and a leasing model. Access to local capital, to provide such consumer lease finance and required working capital, is therefore critical to the operation and growth of such firms in a nascent market like Mozambique.

Mozambique's Banco Comercial e de Investimentos (BCI) has recently announced that it is offering a concessional credit line of approximately USD 8.3 million for micro, small and medium enterprises in the agribusiness sector that would benefit off-grid energy service providers as well.

Underdeveloped micro-lending ecosystem

While PAYG has been a successful business model in the off-grid power market elsewhere in Africa, in countries such as Bangladesh, rapid uptake of off-grid solar among the poor occurred from the prevalence of local microfinance companies that enabled cash sales (in the absence of PAYG penetration). The microfinancing environment is at an early stage in Mozambique, and lending by existing microfinance institutions in off-grid solar sector is almost non-existent.

Complex and difficult import and export of capital

Import and export of capital in Mozambique involves lengthy procedures, costs, and bureaucratic hurdles. In Africa, external investments in off-grid ventures have been a major driver for companies to scale-up operations and expand into new markets. Large investments from lenders and commercial equity investors are common, especially in PAYG business models – largest transactions in PAYG-based off-grid solar companies are now in the range of \$50-80 million. Less restrictive capital import and export regulation could help Mozambique to bring greater foreign investments into the sector to drive scale-up.

No national fund to mobilize and disburse low-cost finance to private-sector led projects

Dedicated national financing vehicles can serve as a key enabler to pool and disburse limited donor and public-sector resources with focus and could leverage greater private sector and climate finance required to scale-up the nascent off-grid power sector in Mozambique. As the rural electrification fund of Mozambique, FUNAE has been

21 Solar home system firms M-Kopa and Greenlight Planet offer 2-year warranties, while Mobisol offer 3-year warranties on the major components.

largely carrying out this role by identifying, designing, implementing, and at times operating off-grid power projects through pooled donor resources and government contributions. FUNAE's role as the off-grid power fund could be strengthened through capacity development for providing low-cost loans and guarantees etc. (by working with the local banks etc.) to off-grid companies, entrepreneurs and NGOs. Blending commercial debt with concessional loans and grants (e.g. from climate financiers such as Global Climate Fund), is one of the emerging instruments that national funds could use to reduce the cost of lending and attract private developers to the sector. World Bank lending in the off-grid sector of Tanzania along with a risk-sharing component with local TIB Development Bank is such an example. The BRILHO program funded by DFID is expected to provide such loans to off-grid firms in the country and would provide valuable lessons in this area.

V.5. Governance and institutional barriers

No operational energy regulator

Mozambique's Energy Regulatory Authority (ARENE) is currently being operationalized as the country's energy regulator to promote competition in energy services, and with a mandate on tariff-setting across all fuel classes, including in off-grid generation. With the adoption and implementation of the (draft) National Electricity Strategy, ARENE's responsibilities are expected to be clarified, for which no timeline is known at present. Currently, MIREME, through the National Directorate of Electrical Energy, regulates the nation's power sector. ARENE's predecessor, the National Electricity Council (CNELEC), served primarily as an advisory body to the Council of Ministers, the country's highest executive body.

Lack of dedicated rural electrification agency

There is no dedicated rural electrification agency in Mozambique, such as I DCOL in Bangladesh and REA in Tanzania. Rural electrification agencies, in charge of off-grid policies, regulations, implementation plans, and implementation and operational oversight of the sector, could scale-up involvement of NGOs and private sectors as evident in Bangladesh and Tanzania. FUNAE, although set up as a fund, has de facto been carrying out many of the roles of a rural electrification agency. However, greater clarity on and strengthening of FUNAE's role as an energy fund and/or rural electrification agency is

required. In order to enhance the level playing field and spur competition, FUNAE could consider delegating the manufacturing of solar products to the private sector and not participate in public solar tenders.

Inadequate inter-agency coordination

State utility EdM has the mandate to operate the national grid and sets the national power tariffs (under the supervision of directorates in MIREME). It is the primary actor driving the national electrification agenda but EdM's mandate on electrification doesn't explicitly include the off-grid sector.

As such, greater coordination between EdM and FUNAE is essential to ensure that the off-grid sector plays an essential and complimentary role for universal energy access. Regular exchange of data and information, and coordination regarding current and future grid and off-grid investment plans, tariffs etc. are required between these entities.

Given the importance of the off-grid sector to multiple facets of national sustainable development, close cooperation among all relevant government and development donor agencies are required for better flow of information, greater policy coherence, and effective project pipeline development. Stakeholder interviews revealed greater inter-agency coordination as a major enabler for accelerating necessary reforms and removing inter-linked barriers.

V.6. Human resource barriers

Inadequate supply of skilled labor

Inadequate availability of local skills, capacity, and training has been identified as a key barrier by private sector actors, donor agencies as well as ministry officials. Rural areas in Mozambique have low literacy rates, and there are skills shortages across the entire project cycle from management, sales, marketing, financial, engineering to operation and maintenance. In the past, donor-funded projects had to bring installation companies from Malawi and Zimbabwe for installations in institutional buildings due to lack of quality installations by local company.

Vocational training programs to develop the relevant skills base for renewable energy projects are limited. FUNAE has arranged training courses but these are limited to technicians and end users of the projects it has implemented. The Institution Industrial de Maputo



A training on mini-grids for local utility and government officials
Source: Wolly consulting

offers related technical courses. However, classes are not fully subscribed as trained technicians find it hard to find employment opportunities due to the limited size of the market and with FUNAE as the only large employer in the sector.

As such, firms in the sector will have to rely on foreign expertise. Such foreign talent also helps transfer skills to the local populace to develop a sector at its initial growth phase. However, current labor law is not conducive for this – the law requires employment of at least 10 Mozambicans for each foreign employee. Restrictive and expensive visa processes add to this hurdle.

V.7. Information barriers

Poor consumer awareness of solar products and mobile banking

There is a lack of awareness among government agencies and consumers on solar technologies, their associated benefits and applications, and off-grid solar power success stories in countries elsewhere in Africa and Asia.

The PAYG model, that links mobile payment to off-grid solar, has been a primary driver in scaling up the off-grid market in rural East Africa. In fact, East Africa has become a global hub for PAYG, and off-grid companies in the region with PAYG model are receiving large private investments to scale up their operations²². In Mozambique, mobile phone uptake has been rapid (currently at ~85%), and mobile money has been introduced over recent

years. However, recent surveys find that awareness and uptake of mobile money remains low (~13%) compared to countries such as Kenya, Rwanda, Tanzania and Uganda where 66% of these countries' adult population use mobile money (GSMA, 2017). While mobile money is not a necessary condition for the PAYG model, it enables rapid scale-up with a platform that enables payments, collections, monitoring, and credit risk assessment.

Limited market data

Limited availability of market relevant data and information has also been a barrier in Mozambique. In 2016, FUNAE published the Mozambique Renewable Energy Atlas with digital maps of potential off-grid project sites. This has been used extensively in the development of the (draft) National Electrification Strategy to identify a lowest-cost grid expansion strategy. Based on the Atlas, AfDB has recently estimated the market potential for green mini-grids, and the Government has used this to prioritize 600+ potential off-grid project sites that forms a \$500 million portfolio of renewable project to attract funding. FUNAE has feasibility studies for many of these sites. However, access to these could cost upwards of \$1000 per study.

Besides this, there is a scarcity of data for assessing business model viability, such as willingness-to-pay or (micro) credit profiles of rural customers. Payment profile data of rural customers from mobile operators could be invaluable to relevant private sector stakeholders but is also not available.

22 PAYG companies attracted almost \$160 million in 2015 alone (BNEF, 2016), with record \$45 million debt secured by Off-grid Electric and \$80 million debt commitments to M-Copa in October 2017 to provide financing for PAYG solar PV projects. <http://bit.ly/2zDKyn3>, <http://bit.ly/2mq3eBk>

VI. Recommendations

Identifying and addressing the barriers is the basis of formulating effective policies and regulations, and instituting related reforms. The barriers described here, especially those under the policy, regulatory, and financial categories, are often interlinked. As such, a systematic and integrated approach would be key in order to prioritize and initiate cost-effective reforms with limited government resources. Based on the review of barriers, stakeholder interactions, and authors' assessment, the below recommendations are provided with a view on areas requiring urgent attention and that could serve as building blocks for integrated policy-making.

VI.1. Establishing an interagency mechanism on off-grid electrification

Given the importance of the off-grid energy access agenda to rural and national development, it is suggested that the Government of Mozambique sets up a dedicated off-grid energy access taskforce with joint ownership of key relevant ministries and adequate multi-sectoral representation of key players, including from FUNAE, EdM, CTA²³ etc. Such an inter-agency coordination mechanism would raise the profile of the off-grid agenda and help address the inter-linked barriers systematically where continued dialogue and collaboration among multiple stakeholders are required.

The mandate of the taskforce could include: (a) raising the off-grid agenda across key government ministries/agencies through appointment of 'off-grid champions', (b) convening of interagency working groups on major barrier categories in order to identify viable solutions, (c) organizing knowledge-sharing activities in ministries/agencies around relevant costs and benefits, technology and financing innovations, and successful models elsewhere in Africa, and (d) conducting public awareness campaigns on important areas such as mobile money. Collaborative support to establish an interagency mechanism could be sought from development partners, NGOs, local universities etc.

VI.2. Expediting existing initiatives

It is suggested that the government prioritizes and expedites already initiated endeavors by the government and development partners in addressing major barriers around regulation, planning, standards, and human capacity. The majority of relevant analysis, reports, and stakeholder interviews indicated a number of areas that would provide a strong and positive signal to boost private sector participation in the sector – these are: (a) removal of

VAT and import duties for quality certified solar products (it could take the form of a pilot for an initial period), (b) labor laws that would allow firms to employ skilled labor from overseas (e.g. for certain years in the beginning until the market develops), (c) clarify off-grid regulations around tariffs, licensing and concessions, especially for mini-grids, and (d) establish quality standards for solar products.

VI.3. Raising awareness and developing/disseminating market knowledge

Given that Mozambique's off-grid power sector is at an early stage, raising necessary awareness will be important to stimulate market demand. Public campaigns could be initiated starting with high-potential off-grid areas and sectors (e.g. those around productive uses in agriculture). These should cover:

- Building awareness on the use and benefits of mobile money through campaigns with mobile phone operators.
- Building awareness on the costs, benefits, and quality standards around off-grid solar power in partnership with local authorities in priority regions. Solar technologies with specific applications relevant to off-grid commercial customers should be prioritized (such as, farmers using diesel pumps for irrigation, diesel-powered grain mill owners, etc.).

In addition, the government could encourage, facilitate development of, and disseminate key market data useful for designing viable off-grid business models, such as consumer surveys and payment profiles of mobile customers etc.

VI.4. Strengthening the role off-grid infrastructure financing agency

Improving access to low-cost finance is critical for scaling up off-grid solar power. It is suggested that FUNAE's role as an off-grid agency and fund is strengthened by drawing from successful experiences elsewhere such as Tanzania's REA and Bangladesh's IDCOL. Similar to IDCOL, FUNAE's primary role could comprise of mobilizing and disbursing funds to enable private sector projects, as well as designing and overseeing overall implementation of a national off-grid program. Funds could come from national and international sources, and mechanisms could be set up to disburse low-cost debt, subsidies, guarantees etc. to eligible projects by firms, entrepreneurs and NGOs. Experience from upcoming initiatives in the country (such as BRILHO) and existing initiatives outside the country (such as FONERWA in Rwanda and by REA in Senegal) should be considered and learnings incorporated into operational strategies and/or guidelines.

23 The Confederation of Business Associations of Mozambique (CTA) is non-governmental organisation, and is the official representative of the private sector federations, business associations, and chambers of commerce for various trade/business related dialogues with the government.

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The Global Green Growth Institute (GGGI) is a treaty-based international, inter-governmental organization dedicated to supporting and promoting strong, inclusive and sustainable economic growth in developing countries and emerging economies. GGGI is a trusted advisor to governments in over 30 countries transitioning to green economic growth. GGGI works across country Ministries and Departments to explore the value of green growth opportunities in the context of a country's own growth and to help achieve Sustainable Development Goals and Nationally Determined Contribution commitments expressed under the Paris Climate Agreement. Working across the thematic priorities of sustainable energy, green cities, sustainable landscapes, and water & sanitation, GGGI results support 6 outcomes critical to achieving SDGs and NDCs: greenhouse gas emission reduction; creation of green jobs; increased access to sustainable services; improved air quality; adequate access to ecosystem services; and enhanced climate adaptation. GGGI's delivery model combines rigorous technical assistance to governments with green finance mobilization for bankable green growth and climate resilient projects. Our green growth planning work includes: providing sectoral and socio-economic impact assessments to experience, developing and applying practical tools and case studies; developing green growth plans at national or sectoral level; assessing and designing legal and institutional frameworks; providing financial and investment analysis that looks at both investment requirements and potential sources; and developing sectoral and sub-sectoral investment plans and frameworks. GGGI currently counts 30 Members from developed and developing countries. In collaboration with its Members and other public and private sector partners, GGGI is championing green growth and climate resilience in over 30 countries.



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