FUNAE
FUNDO DE ENERGIA
Energia para Moçambique

PROGRAMA NACIONAL DE
ENERGIA PARA TODOS

MOZAMBIQUE OFF-GRID ELECTRIFICATION ROADMAP

The Off-Grid Strategy in Support of Achieving SDG7 by 2030 in Mozambique

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ABBREVIATIONS AND ACRONYMS

AECF	Africa Enterprise Challenge Fund
AES	Áreas de Expansão Subsidiadas (Subsidized Expansion Areas)
AFD	Agence Française de Développement (French Development Agency)
AMER	Associação Moçambicana de Energias Renováveis (Mozambican Renewable Energy Association)
AMOMIF	Associação Moçambicana dos Operadores de Microfinanças (Mozambican Association of Microfinance Operators)
ARENE	Autoridade Reguladora de Energia (Energy Regulatory Authority)
ARPU	Average revenue per user
BAGC	Beira Agricultural Growth Corridor Partnership
BOO	Build-Own-Operate
BoP	Bottom of the Pyramid
BTG	Beyond the Grid
CAPEX	Capital Expenditure
CDF	Cash Deposit Fund
CPI	Centro de Promoção de Investimentos (Investment Promotion Center)
DBSA	Development Bank of Southern Africa
ECA	Economic Consulting Associates
EDM	Electricidade de Moçambique
EEP	Energy and Environmental Partnership
EOI	Expression of Interest
ESCO	Energy Service Company
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EVA	Energio Verda Africa
FAO	Food and Agricultural Organization (UN)
FASER	Fund for Sustainable Access to Renewable Energy
FCDO	Foreign, Commonwealth and Development Office
FI	Financial Institution
FM	Fund Manager
FUNAE	Fundo de Energia (Mozambique Energy Fund)
FX	Foreign Exchange
GBP	Pound Sterling
GIS	Geographic Information System
GoM	Government of Mozambique
GMG	Green Mini-Grid
GPRBA	Global Partnership for Results-Based Approaches
HCB	Hidroeléctrica de Cahora Bassa (Cohora Bassa Hydropower plant)
HV	High Voltage
ICT	Information and Communication Technology
IDP	Internally Displaced Person
IFAD	International Fund for Agricultural Development
INE	Instituto Nacional de Estatística (National Statistics Institute)
IPP	Independent Power Producer
IRRIGA	Smallholder Irrigated Agriculture and Market Access Project
IVA	Independent Verification Agent
JICA	Japan International Cooperation Agency
KPI	Key Performance Indicator
kWp	Kilowatt peak
kWh	Kilowatt hour
LNG	Liquified Natural Gas
M&E	Monitoring and Evaluation
MIREME	Ministério dos Recursos Minerais e Energia (Ministry of Mineral Resources and Energy)
MOU	Memorandum of Understanding
MFI	Microfinance Institution
MSME	Micro, Small and Medium Enterprise
MV	Medium Voltage
MZN	Mozambican metical
NES	National Electrification Strategy
O&M	Operations and Maintenance
OGS	Off-Grid Solar
PayGo	Pay-As-You-Go

PPP	Public-Private Partnership
PRG	Partial Risk Guarantee
PROLER	Projeto de Promoção de Leilões para Energias Renováveis
PUE	Productive Use of Electricity
PV	Photovoltaic
RBF	Results-based financing
RERD	Renewable Energy for Rural Development Programme
RISE	Regulatory Indicators for Sustainable Energy
RTM	Route-to-Market
SAEP	Southern Africa Energy Project
SADC	Southern Africa Development Community
SDG	Sustainable Development Goal
SEFA	Sustainable Energy Fund for Africa
SHS	Solar home system
SME	Small Medium Enterprise
SOLTRAIN	Southern African Solar Thermal Training and Demonstration Initiative
SSA	Sub-Saharan Africa
TA	Technical Assistance
UN	United Nations
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
USD	United States Dollar
VAT	Value Added Tax
WFP	World Food Programme
Wp	Watts peak

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BCI Mozambique
BlueZone Consultores
BRILHO/SNV
Enabel
Electricidade de Moçambique (EDM)
ENGIE Energy Access
Epsilon Energia Solar
European Union
GIZ EnDev, Green People's Energy (GPE), GET.invest, and GET.transform
GreenLight Mozambique
Ignite
KfW
Logos Industries
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SIDA
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USAID
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EXECUTIVE SUMMARY

Mozambique has a significant rural electrification challenge, as nearly two-thirds of the country's 30 million people live in dispersed off-grid communities. Although rates of access have improved, the national electrification rate in 2020 was 35%,[1] with a considerable difference between rates of access in urban (73%) and rural (5%) areas.[2] The Government of Mozambique (GoM or "the Government") has committed to achieve universal access to electricity by 2030 through a combination of grid extension and densification and off-grid solutions, including mini-grids and stand-alone systems.[3] To achieve this goal, the GoM adopted the National Electrification Strategy (NES) in 2018, which promotes institutional, technical, financial and regulatory reforms to the electricity market and provides a framework for private sector participation to accelerate universal access.[4] In 2019, the GoM launched the "Programa Nacional de Energia para Todos" [Electricity for All National Program] as a national coordinated plan to provide all Mozambicans with electricity access by 2030.

This Off-Grid Electrification Roadmap[5] has been developed under the initiative and leadership of the Government of Mozambique as a practical and actionable tool that provides a framework for the country to rapidly scale up off-grid solar electrification in support of achieving universal access to electricity by 2030. The main objective of the Roadmap is to promote affordable off-grid electricity access solutions for Mozambicans living in remote and underserved areas. The Roadmap considers a range of possible options to achieve this goal, including fiscal incentives for solar products and providing results-based financing (RBF) for SHS sales.

Figure ES-1 summarizes the key components of the off-grid electrification roadmap.

FIGURE ES-1: KEY COMPONENTS OF THE OFF-GRID ELECTRIFICATION ROADMAP

	The creation of an Off-Grid Solar Platform – chaired by MIREME, FUNAE, EDM and ARENE, and managed by an OGS Platform Coordinator – that meets regularly and includes all project actors in the OGS sector
	A national OGS awareness campaign complimented by provincial roadshow campaigns, educating the public about off-grid solutions, including issues of product quality, while simultaneously engaging with private sector OGS companies to expand their operations in underserved rural markets
	The establishment of an OGS Help Desk that provides technical assistance on demand to private sector OGS companies, NGOs and other development partners working in the sector
	Technical assistance for banks committed to lending to businesses in the OGS sector, including the origination and development of portfolios of bankable clean energy projects
	Outsourcing to a Fund Manager (FM) the management of an OGS Financing Facility and to an Independent Verification Agent (IVA) the monitoring of Roadmap and Financing Facility impacts
	Highly subsidized programs to provide quality-verified solar systems to the Bottom of the Pyramid (BoP) socioeconomic group to ensure universal electricity access beyond just the commercial market

1 Electricidade de Moçambique, Relatório e Contas, Annual Report, 2020: https://www.edm.co.mz/en/node/5321

2 "Tracking SDG7: The Energy Progress Report, 2021," IEA, IRENA, UNSD, World Bank, WHO, 2021: https://trackingsdg7.esmap.org/data/files/download-documents/2021_tracking_sdg7_report.pdf

3 The Government's National Electrification Strategy estimates that 70% of the population will be connected to the grid by 2030, with the remaining balance to be served by off-grid solutions.

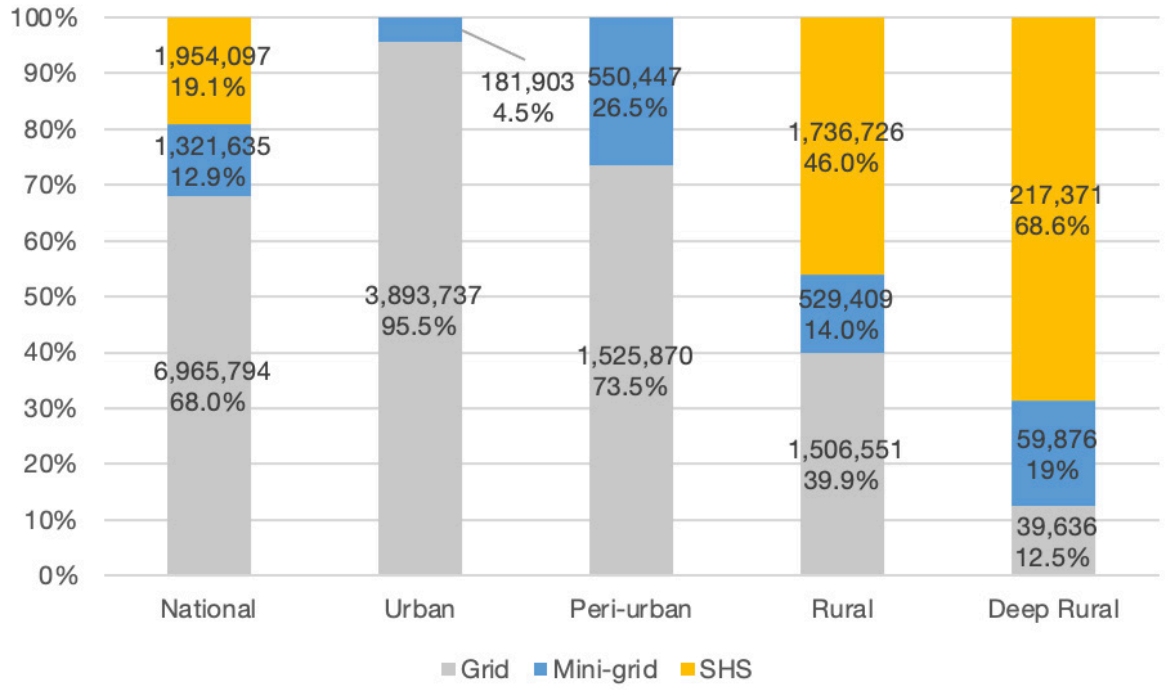
4 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.

5 Also referred to throughout this document as the Off-Grid Solar ("OGS") Roadmap or "the Roadmap."

GIS Analysis

A geospatial analysis was conducted to assess the potential development of electricity access in Mozambique through 2030 in order to help the GoM concentrate its electrification efforts accordingly. According to the GIS analysis, by 2030, an estimated 6.9 million households (68%) will be electrified by the national grid, about 2 million households (19%) will be electrified by SHS, and the remaining balance, about 1.3 million households (13%), will be electrified by mini-grids.[6] The grid access rate declines according to the level of urbanity, with 95% of households located in urban areas connected to the grid compared to 13% of households in deep rural areas. For deep rural areas, stand-alone solar systems (SHS)[7] will be the main source of electrification in 2030 (**Figure ES-2**).

FIGURE ES-2: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, 2030



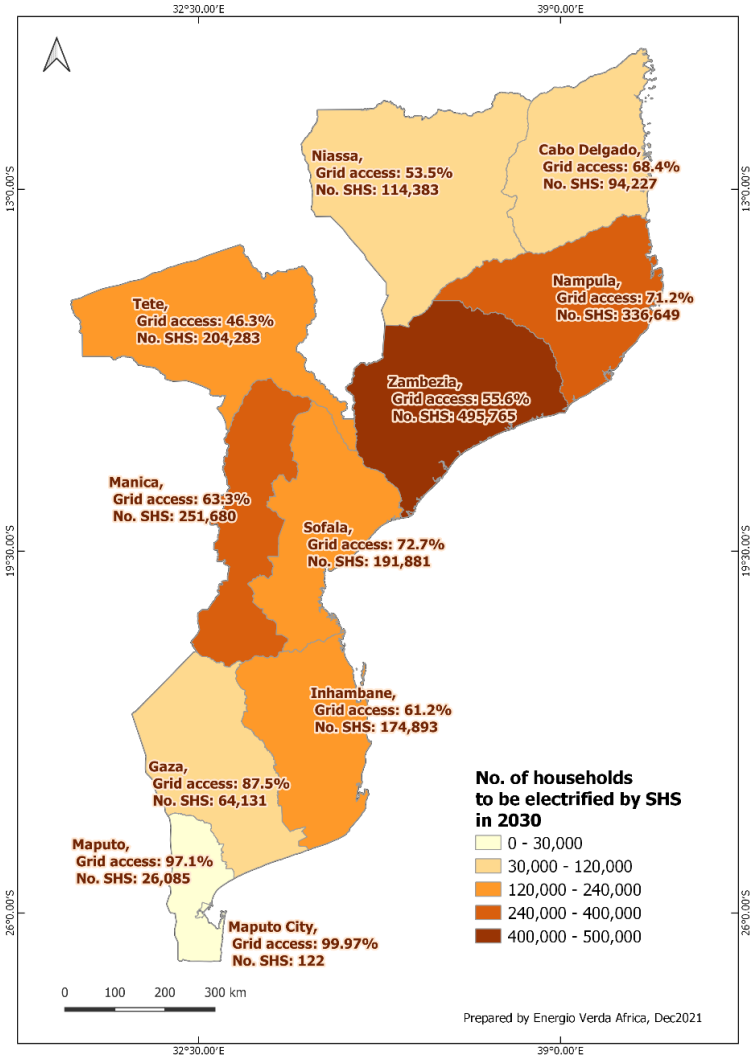
Source: Energio Verda Africa GIS analysis

The province with the largest concentration of households electrified by SHS in 2030 is Zambézia, followed by Nampula and Manica. These three provinces represent the initial priority provinces to be targeted by the Roadmap (**Figure ES-3**).

6 DISCLAIMER: Based on historical context of past performance of EDM grid connections, among other variables, the authors of this report do not believe the 68% grid-connected households target is attainable (the GIS analysis estimated that 55% of households can realistically be connected to the grid by 2030); FUNAE and the GoM have insisted that the 68% figure (which is aligned with the NES target of 70%) is achievable.

7 The terms stand-alone solar system and solar home system (SHS) are used interchangeably throughout this document.

FIGURE ES-3: ESTIMATED GRID ACCESS RATE (%) AND SHS IN NUMBER OF HOUSEHOLDS BY PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

Funding Requirements: Enterprise Capital Needs and Affordability Gap Financing

Successful implementation of the OGS Roadmap will require significant financial resources. The estimated total capital needed for the SHS market segment is USD 1.3B (MZN 83B) – including USD 492.8M (MZN 31.5B) in the form of debt, USD 479.1M (MZN 30.6B) in equity investment, USD 176M (MZN 11.2B) in grant funding for energy access enterprises, and USD 200M (MZN 12.8B) required for affordability gap financing for households (**Figure ES-4**) – which will support the deployment of approximately 5.6 million SHS to achieve universal electrification through 2030, including 1.8 million systems for new permanent connections, 2.8 million systems for temporary pre-electrification, and about 1 million systems for the replacement of retired systems.

FIGURE ES-4: SHS CAPITAL NEEDS BY FUNDING TYPE TO ACHIEVE UNIVERSAL ACCESS BY 2030

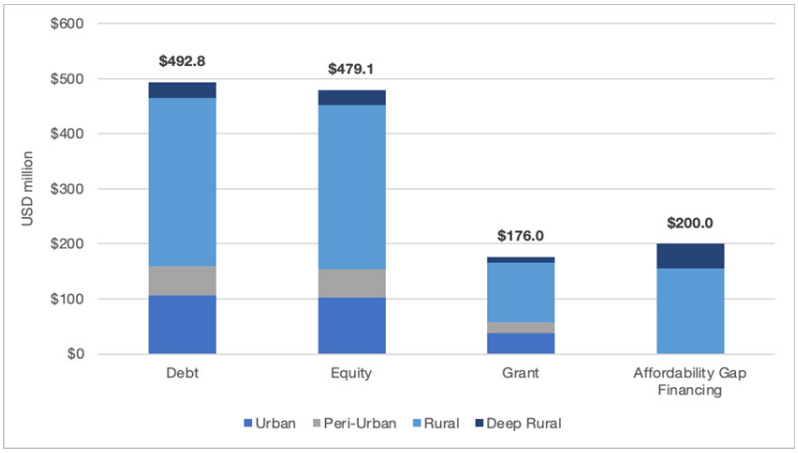


Figure ES-5 presents a breakdown of SHS capital needs by urbanity level. Intuitively, rural areas have the highest SHS capital needs, estimated at USD 866.7M (MZN 55.3B).

FIGURE ES-5: SHS CAPITAL NEEDS BY URBANITY LEVEL

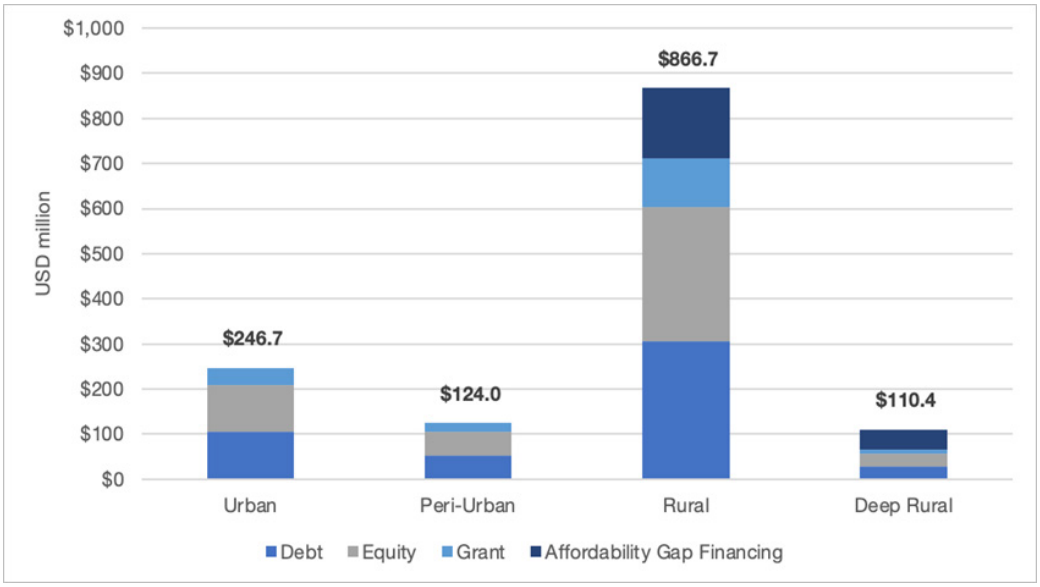
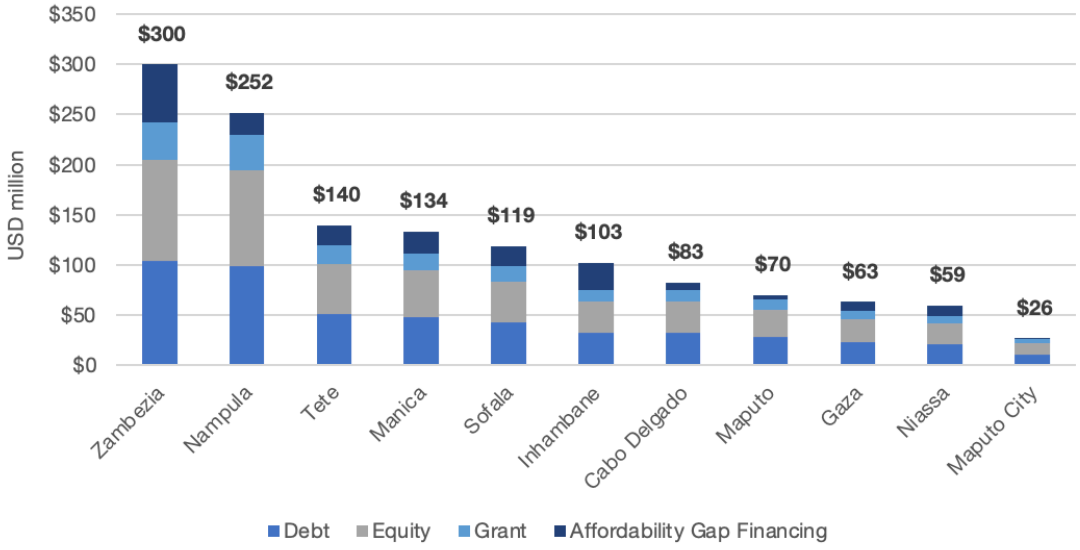


Figure ES-6 shows how SHS capital needs are distributed across the country's 11 provinces. At the provincial level, Zambezia and Nampula have the highest SHS capital needs at USD 300M (MZN 19.2B) and USD 252M (MZN 16.1B), respectively.

FIGURE ES-6: SHS CAPITAL NEEDS BY PROVINCE



An estimated **USD 200M (MZN 12.8B)** is required in affordability gap financing for households to acquire minimum Tier 1 (10W) SHS systems (including replacement of retired systems) in order to achieve universal access.[8] The province of Zambezia has the highest affordability gap financing needs at USD 58M (MZN 3.7B) (**Figure ES-7**).

FIGURE ES-7: AFFORDABILITY GAP FINANCING NEEDS BY PROVINCE

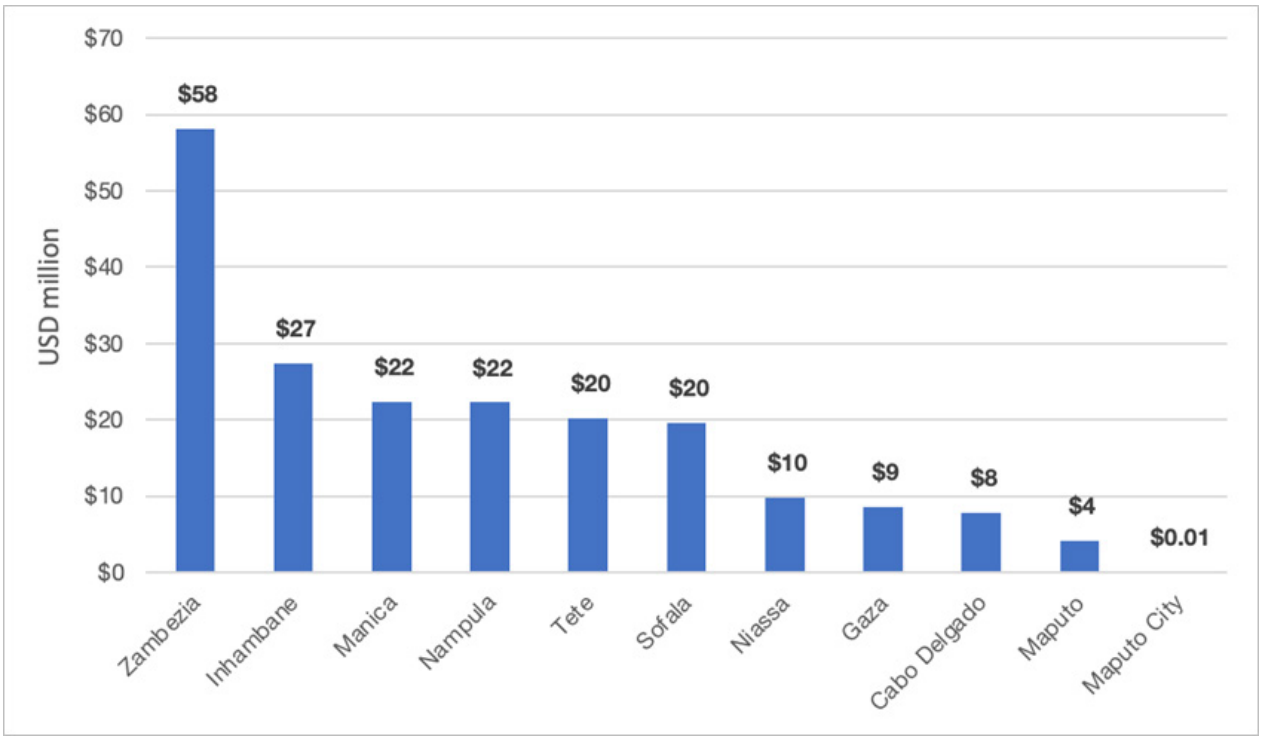
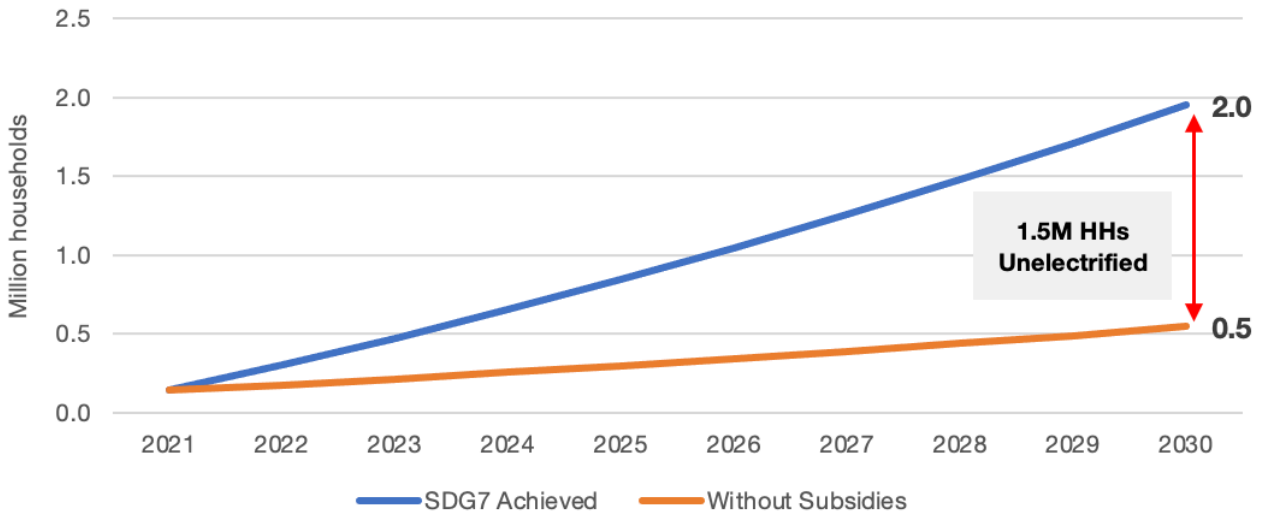


Figure ES-8 illustrates that without affordability gap subsidies, 1.5 million households will remain unelectrified, as only about 500,000 households of the 1.5 million households to be permanently electrified by SHS will be able to afford the systems.

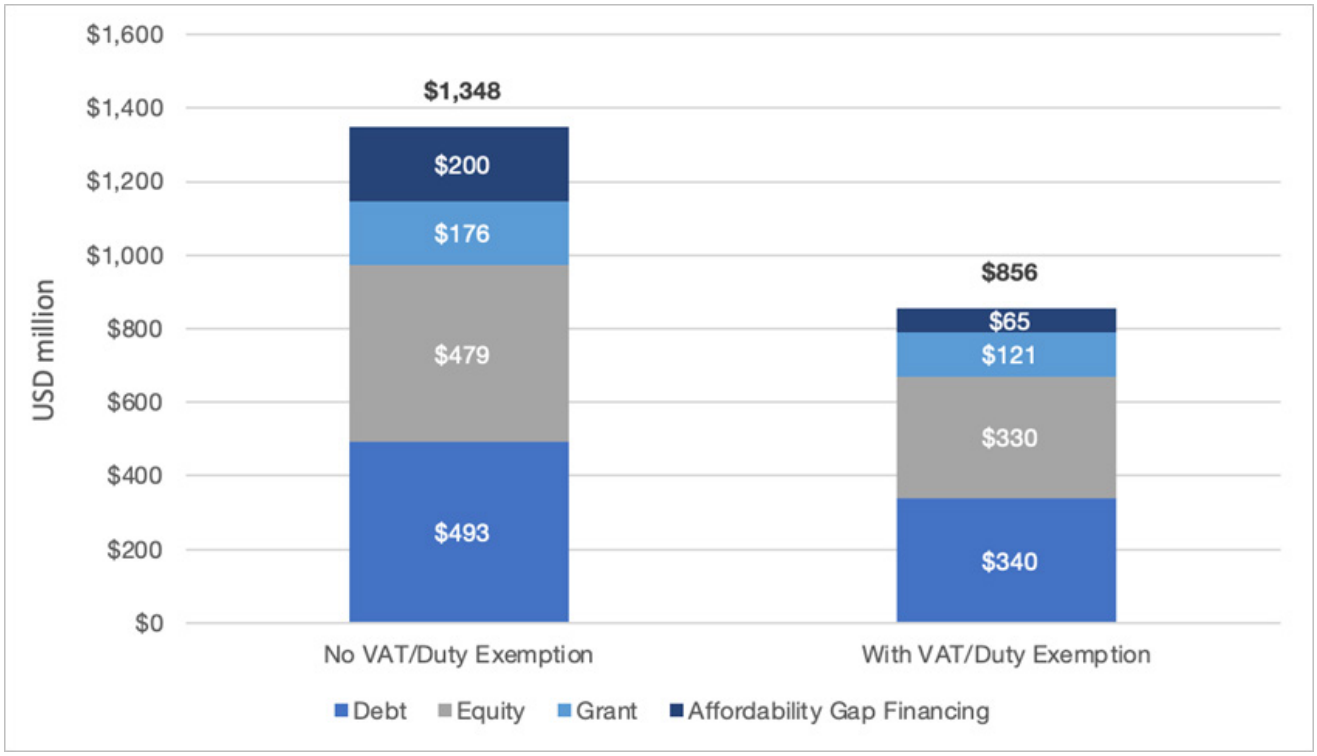
FIGURE ES-8: ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS WITH AND WITHOUT AFFORDABILITY GAP SUBSIDIES



8 This figure excludes SHS required for pre-electrification purposes as it was assumed that households in urban and peri-urban areas that will be electrified by the grid or mini-grids can afford Tier 1 SHS (see **Section 2.3** for more details).

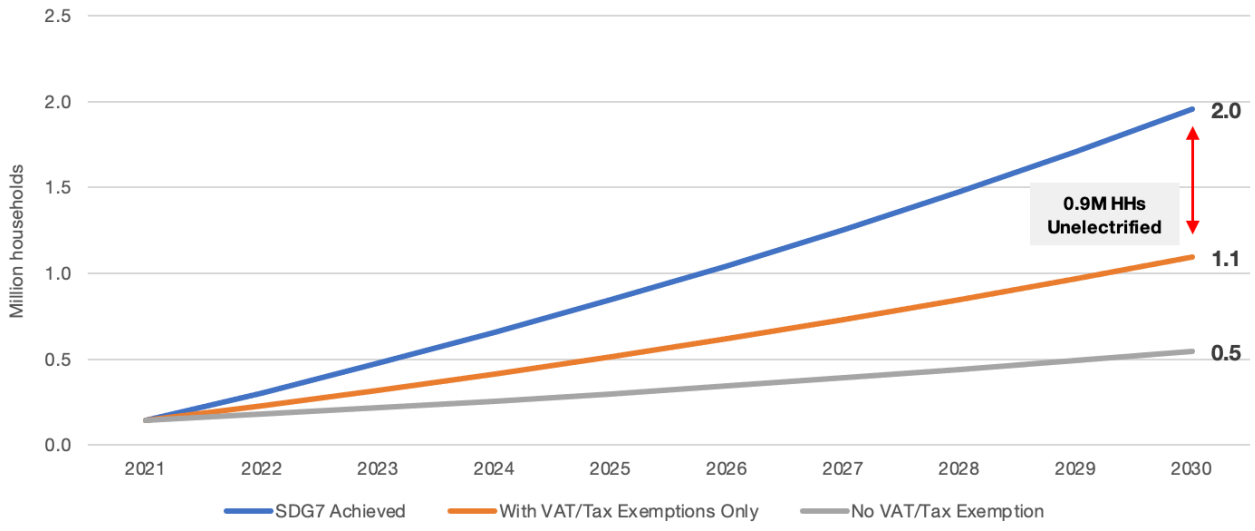
The implementation of import duty and VAT exemptions by the GoM can have a significant impact on the off-grid solar sector's funding requirements through 2030 – and in turn, on the number of households that can be electrified by standalone systems. As illustrated in **Figure ES-9**, import duty and VAT exemptions would **reduce the total amount of funding required by USD 492M (MZN 31B)** from USD 1.3B (MZN 83B) to 856M (MZN 54B), with the affordability gap funding needed dropping from USD 200M (MZN 12.8B) to USD 65M (MZN 4.1B).

FIGURE ES-9: SHS CAPITAL NEEDS WITH AND WITHOUT TAX EXEMPTIONS



The effect of tax exemptions on off-grid solar electricity access penetration through 2030 is significant; **an additional 600,000 households will be able to afford SHS with tax exemptions in place** (about 1.1 million households will be able to afford SHS compared to 500,000 without exemptions), while 900,000 households will still require affordability gap subsidies (**Figure ES-10**).[9]

FIGURE ES-10 ESTIMATED TOTAL NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS WITH AND WITHOUT TAX EXEMPTIONS



9 The model assumed that SHS import duty and VAT exemptions will result in a 45% reduction in the capital cost and end-user prices of the various SHS tiers (see **Section 2.3** for more details).

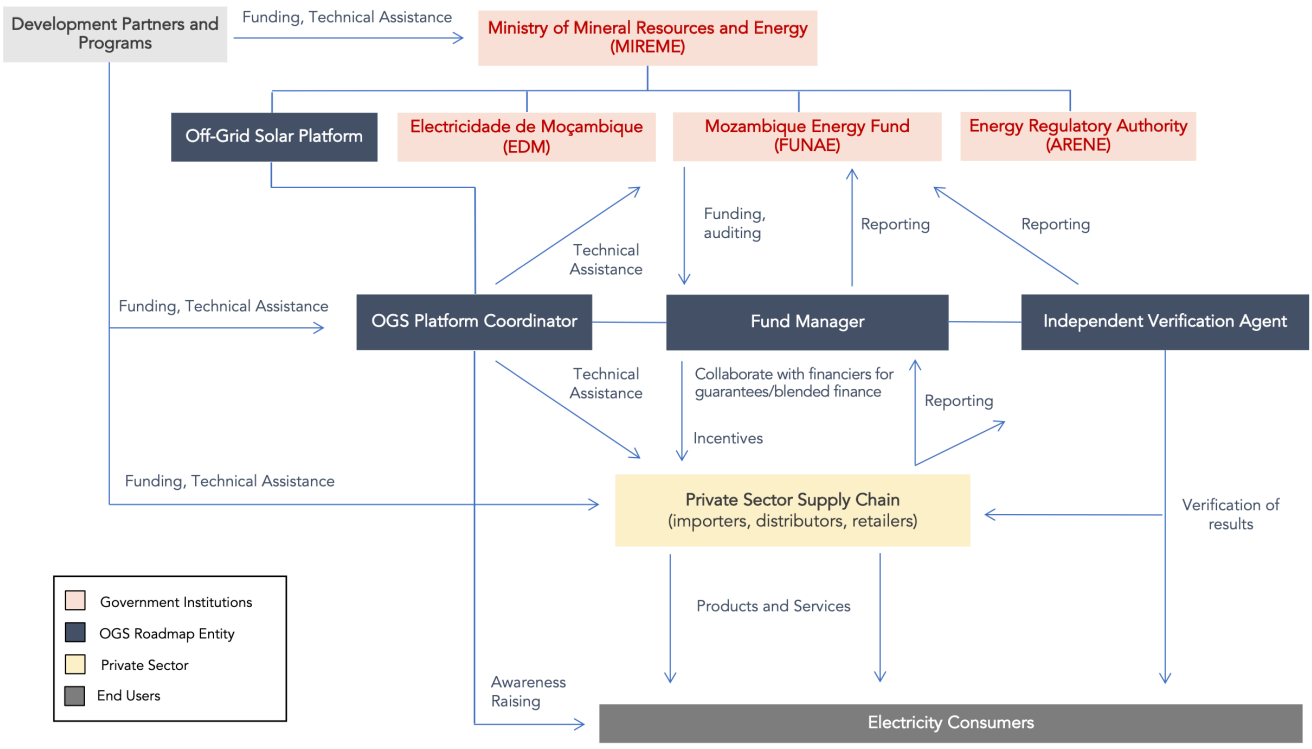
Roadmap Coordination and Implementation

Successful implementation of the OGS Roadmap will require extensive coordination among all public and private sector actors in the off-grid sector. An OGS Platform, with MIREME, FUNAE, EDM and ARENE as members, will be established to facilitate the Roadmap's implementation. To support MIREME and FUNAE with coordination efforts, an OGS Platform Coordinator can either be staffed internally, or an individual or firm can be solicited through a tender process. The Coordinator will serve as Secretary to the Platform group and will work in direct partnership with the GoM.

An OGS Financing Facility will be established to provide grant funding to solar companies operating in the sector through an RBF mechanism, which extends capital to the private sector contingent upon delivery of pre-agreed results that are subjected to independent verification. A Financing Facility Manager (or Fund Manager, FM) will be retained to assist FUNAE with the Roadmap's financing arrangements. During the setup of the new facility's policies and procedures, FUNAE and the FM may identify additional financial products or windows to complement the grant products, such as RBF for productive use of electricity (PUE) equipment purchases or cash-deposit partial risk guarantees to stimulate local bank lending. FUNAE will also be supported by an Independent Verification Agent (IVA) to lead monitoring and verification of the RBF activities.

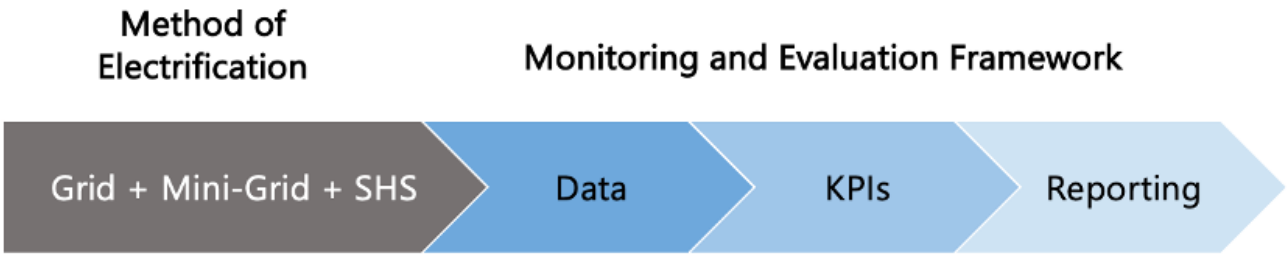
Figure ES-11 presents an overview of the off-grid energy sector in Mozambique under the Roadmap's institutional framework, including the roles and responsibilities of the OGS Platform Coordinator, FM and IVA, GoM institutions, development partners and the private sector supply chain.

FIGURE ES-11: OVERVIEW OF THE ROLES AND RESPONSIBILITIES OF OFF-GRID MARKET ACTORS UNDER THE ROADMAP



The Roadmap also includes a Monitoring and Evaluation (M&E) framework, which outlines the process for tracking and assessing performance of several key indicators through 2030. The framework includes both energy and non-energy indicators that will be measured against baseline figures established in order to assess progress towards 2030 electrification targets and facilitate impact measurement. FUNAE and MIREME will designate resources to review annual reporting and to conduct remote and field survey activities to verify results. **Figure ES-12** presents the process through which information will be collected and analyzed to measure and report on each of the Roadmap's performance indicators through 2030.

FIGURE ES-12: ROADMAP MONITORING AND EVALUATION REPORTING FRAMEWORK



RBF Facility

The OGS Roadmap will require significant financial resources. Public sector subsidies will be in excess of USD 200M, while the capital raised by the private sector will be near USD 1B. Commercial debt for the OGS sector is largely non-existent in Mozambique, leaving standalone solar companies to finance their contribution to the successful implementation of the Roadmap with their own equity resources.[10] The GoM acknowledges the important role of the private sector in achieving universal electrification by 2030; thus, ensuring affordable and sustainable access to finance for OGS companies to scale up their operations is a priority. The Roadmap's strategy aims to facilitate international investment in the off-grid sector, as well as to develop local currency debt financing from the Mozambican banking community to help address these financial challenges.

FUNAE intends to launch its own OGS Financing Facility to help address market barriers to universal energy access to the extent possible with financial solutions. The Facility will support the growth of OGS market players and help the agency play a strategic role in directing funding towards high priority provinces and districts. It will also seek to complement existing OGS facilities in the country that have been launched by other development partners.

Recommended Actionable Priorities

Table ES-1 presents a summary of the Roadmaps' strategic objectives and corresponding proposed actionable priorities to achieve each objective, along with the GoM agencies, provincial authorities, OGS sector service providers, development partners, financiers and other relevant stakeholders that will be needed to achieve universal electrification in Mozambique by 2030.

10 It is expected that early-stage OGS enterprises will rely more on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure debt in order to finance their consumer receivables and inventory finance needs.

TABLE ES-1: MOZAMBIQUE ELECTRIFICATION ROADMAP
SUMMARY OF STRATEGIC OBJECTIVES AND ACTIONABLE PRIORITIES TO ACHIEVE UNIVERSAL ELECTRIFICATION BY 2030

Strategic Objective(s)	Actionable Priorities	Coordinating GoM Agencies and other Relevant Stakeholders	Priority / Timeline[11]
Support off-grid solar market development at the provincial level to achieve universal electrification by 2030 (select target districts within provinces for priority SHS electrification)	Concentrate national and provincial resources (including awareness raising campaigns) to support OGS electrification efforts in the following districts and regions in each province:[12] • **Maputo City**: Catembe and the islands of Inhaca and Xefina Grande • **Maputo**: Magude, Matutuine and Moamba Districts • **Gaza**: Massingir, Mapai and Chigubo Districts • **Inhambane**: Massinga, Funhalouro and Vilankulo Districts • **Manica**: Machaze, Mossurize and Tambara Districts • **Sofala**: Chibabava, Maringue and Nhamatanda Districts • **Zambézia**: Gile, Namarroi and Alto Molocue Districts • **Tete**: Macanga, Maravia and Moatize Districts • **Nampula**: Malema, Erati and Mecuburi Districts • **Niassa**: Mecanhelas, Mavago and Marrupa Districts • **Cabo Delgado**: Namuno, Montepuez and Chiure Districts	• National: MIREME; FUNAE; EDM; ARENE; OGS service providers • Provincial: Council of Provincial Services of State (Infrastructure Provincial Service, Environmental Provincial Service) • With support from: • OGS Platform Coordinator Development Partners	• Medium term [2022-2025] for priority districts • Long-term [through 2030] to achieve universal access

11 Immediate-term = 2022; short-term: 2022-2023; medium-term: 2022-2025; long-term: 2022-2030
12 Based on District Priority Ran**king** in Section 2.2.2.

Address the key barrier of low consumer ability-to-pay	• **Expand fiscal incentives for the OGS industry** by removing all VAT and import duties on solar products, systems and components (i.e., batteries, panels, inverters, etc.) in order to reduce the monthly fee for Tier 1 (10W) SHS to $4.10/ month, which will enable 1.1 million households (56% of the 1.95M households requiring SHS) to afford systems	• National: Ministry of Economy and Finance; MIREME; FUNAE; EDM; ARENE • Provincial: Council of Provincial Services of State (Infrastructure Provincial Service, Environmental Provincial Service) • With support from: • OGS Fund Manager; • OGS Platform Coordinator Development Partners	Immediate-term [2022]
	• **Provide partial risk guarantees to PayGo companies** to lengthen the PAYG tenor on Tier 1 (10W) SHS to 36 months to further reduce the price to $2.75 for the remaining 900,000 households; this will enable an additional 300,000 households to afford SHS without subsidies. Assuming a 50% PRG is provided, the total amount of guarantees required is approximately USD 47M (MZN 3B)	Development Partners	Medium-term [2022-2025]
	• **Provide $43 million (MZN 2.7B) in affordability gap subsidies** in the form of RBFs, direct upfront consumer subsidies for the 600,000 households in the lowest income group to acquire Tier 1 (10W) SHS	Development Partners	Medium-term [2022-2025]
Address the key barriers of market risks and difficult last mile distribution	• **Provide $221 million (MZN 14.1B) in catalytic grants and RBF** to SHS and PUE companies to reduce market risks/ uncertainty and encourage private sector expansion to underserved areas	Development Partners	Medium-term [2022-2025]

Address the key barrier of limited debt funding	• **Provide concessional (low-priced, long-tenor) locally-denominated credit lines** to local FIs (LFIs) • **Provide technical assistance** to build LFI capacity for off-grid lending • **Provide risk mitigation and subordinated debt** instruments including first-loss protection, hedging facilities for off-grid energy debt funds and LFIs lending directly to off-grid enterprises to facilitate access to the $619 million (MZN 39.5B) needed in debt financing	Development Partners	Short-term [2022-2023]
Address the key barrier of a lack of equity investments	• In addition to the catalytic grants, provide some form of "**equity guarantee**" to catalyze the needed $602M (MZN 38.4B) equity investments such as that generally offered by the African Guarantee Fund, which will underwrite return of up to 50% of invested capital (principal only, without any return) after an agreed period of time.[13]	Development Partners	Medium-term [2022-2025]
Increase penetration of mobile network coverage and mobile money services[14]	• Work with provincial authorities and telecommunications providers to **expand mobile network coverage and rates of access to mobile money services** (**Figure 5**) • **Support linkages between OGS companies and telecommunications companies/mobile money service providers** (Mcel, Vodacom, Movitel) to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models at the provincial level[15]	• National: MIREME; FUNAE; ARENE; National Communications Institute of Mozambique (INCM); mobile service providers (Mcel, Vodacom, Movitel); OGS service providers • Provincial: Council of Provincial Services of State (Infrastructure Provincial Service, Environmental Provincial Service) • With support from: OGS Platform Coordinator Development Partners	Medium-term [2022-2025]

13 https://africanguaranteefund.com/product/equity-guarantee/

14 Mobile connectivity and mobile money play a critical role in enabling off-grid solar market growth, particularly for PayGo systems that rely on the interoperability between digital financial services and stand-alone solar devices.

15 See **Section A-2.2.1.6** in A**nnex 1**.

Design and implement a Monitoring and Evaluation Framework to monitor progress and ensure the Roadmap achieves its targets through 2030	• Staff internally and/or retain external M&E specialist to develop M&E framework • Designate M&E unit within MIREME / FUNAE to lead planning, implementation, and monitoring of Roadmap M&E activities • Establish unit within the Ministry of Economy and Finance to collaborate with MIREME, FUNAE and EDM to track basic financial and operational details of the Roadmap • Develop a standardized reporting framework to streamline the process of consolidating data from various GoM agencies on an annual basis • Design and administer (remote/mobile) surveys to collect field data; conduct field visits to complement and verify remote survey data; train field staff to monitor KPIs and impacts; report on results • Evaluate quality of data and key indicators against baseline metrics to gauge Roadmap performance, assess progress and revise plans accordingly	• National: MIREME; FUNAE; EDM; MEF; Ministry of Planning and Development; Ministry of Land and Environment (MTA); Ministry of Gender, Child and Social Action of Mozambique (MGCAS) • Provincial: Council of Provincial Services of State • With support from: • OGS Platform Coordinator • OGS service providers • Development Partners	• Short-term [2022-2023] for staffing and institutional arrangements • Medium-long term [2022-2030] for M&E functions

1. INTRODUCTION

1.1. Background and Context of the Roadmap

The COVID-19 pandemic has had a significant impact on the Mozambican economy. In 2020, Mozambique experienced its first economic contraction in nearly three decades, as the pandemic depressed economic demand, caused disruptions to supply chains, and delayed critical infrastructure investments. The pandemic caused a sudden income loss for enterprises and households, worsening living conditions, especially for the urban poor largely engaged in the informal sector.[16] The economy is still recovering from a slowdown in real GDP growth to 2% in 2019 (compared to 3.3% in 2018) after two cyclones – Idai and Kenneth – hit the country in 2019 and caused unprecedented destruction, leading to a humanitarian crisis.[17] Security also remains an ongoing concern in the northernmost Cabo Delgado Province, where attacks by an insurgency group against the civilian population have created a dangerous and unstable environment and displaced thousands of people.

In the energy sector, the development of Mozambique's abundant mineral and hydrocarbon reserves has the potential to generate substantial wealth and prosperity for the country in the long-term.[18] The national utility, Electricidade de Moçambique (EDM), sources the majority of the country's power from the Cahora Bassa hydropower plant and supplies the remaining balance through a combination of natural gas and diesel-powered generation. Energy demand is mainly driven by extractive industries, infrastructure development and other economic activities concentrated around urban areas.

Mozambique has a significant rural electrification challenge, as nearly two-thirds of the country's 30 million people live in dispersed off-grid communities. Although rates of access have improved, the national electrification rate in 2020 was 35%,[19] with a considerable difference between rates of access in urban (73%) and rural (5%) areas.[20] The Government of Mozambique (GoM or "the Government") has committed to achieve universal access to electricity by 2030 through a combination of grid extension and densification and off-grid solutions, including mini-grids and stand-alone systems.[21]

To achieve this goal, the GoM adopted the National Electrification Strategy (NES) in 2018, which promotes institutional, technical, financial and regulatory reforms to the electricity market and provides a framework for private sector participation to accelerate universal access.[22] In 2019, the GoM launched the "*Programa Nacional de Energia para Todos*" [Electricity for All National Program] as a national coordinated plan to provide all Mozambicans with electricity access by 2030. The program advocates for a complementary approach to electrification, including grid densification and expansion in areas where this is economically feasible, as well as the provision of off-grid electricity services. The program received USD 82M in funding from the World Bank's *ProEnergia* project, as well as additional funding from other donors (USD 69M from the EU, Norway and Sweden). *ProEnergia* is a five-year project (2019-2024) and includes three components: the first component supports the utility, EDM, with densification and short-range grid extension; the second component supports FUNAE with developing off-grid electrification solutions; the third component provides technical assistance and implementation support to both EDM and FUNAE.[23]

This Off-Grid Electrification Roadmap[24] has been developed under the initiative and leadership of the Government of Mozambique as a practical and actionable tool that provides a framework for the country to rapidly scale up off-grid solar electrification in support of achieving universal access to electricity by 2030. The main objective of the Roadmap is to promote affordable off-grid electricity access solutions for Mozambicans living in remote and underserved areas. The Roadmap considers a range of possible options to achieve this goal, including exempting solar products from taxes and providing results-based financing (RBF) for SHS sales.

It is important to note that while some of the information presented in this document pertains to grid and mini-grid electrification, the primary focus of the Roadmap is on the standalone solar sector. Outside of the main grid network, the geographic market for stand-alone solar and mini-grids overlaps, and the emergence of an energy efficient equipment and appliance market contributes to the viability of both off-grid solar and mini-grid businesses. While stand-alone solar systems can support small-scale productive use of electricity (PUE) applications (e.g., irrigation, cold storage, lighting for SMEs etc.), mini-grid electrification provides more power for larger-scale PUE equipment and applications (e.g., milling, agricultural processing) that can add greater value to a local economy.

16 "Mozambique Economic Update: Setting the Stage for Recovery," World Bank, (February 2021): https://openknowledge.worldbank.org/handle/10986/35214
17 Naidoo, K., and Loots, C., "Mozambique- Energy and The Poor: Unpacking the Investment Case for Clean Energy," UN Capital Development Fund (UNCDF), (2020): https://www.undp.org/content/dam/undp/library/km-qap/UNDP-UNCDF-Mozambique-Energy-and-the-Poor.pdf
18 Abrahamson et al., 2013. "Mozambique: Mobilizing Extractive Resources for Development," Columbia School of International and Public Affairs, (May 2013): https://mozambiqueextractivedevelopment.weebly.com/uploads/1/1/0/9/11096909/mozambique_-_extractives_for_prosperity_reduced_3.pdf
19 Electricidade de Moçambique, Relatório e Contas, Annual Report, 2020: https://www.edm.co.mz/en/node/5321
20 "Tracking SDG7: The Energy Progress Report, 2021," IEA, IRENA, UNSD, World Bank, WHO, 2021: https://trackingsdg7.esmap.org/data/files/download-documents/2021_tracking_sdg7_report.pdf
21 The Government's National Electrification Strategy estimates that 70% of the population will be connected to the grid by 2030, with the remaining balance to be served by off-grid solutions.
22 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.
23 World Bank Project Appraisal Document: Mozambique Energy for All (ProEnergia) Project," World Bank Energy and Extractives Global Practice, (March 7, 2019): https://documents1.worldbank.org/curated/pt/594061554084119829/pdf/Mozambique-Energy-for-All-ProEnergia-Project.pdf
24 Also referred to throughout this document as the Off-Grid Solar ("OGS") Roadmap or "the Roadmap."

In this context, and according to how the GoM has defined electricity access in the National Electrification Strategy,[25] the Roadmap considers stand-alone systems as a 'pre-electrification' option to provide an initial level of electricity service to households in areas where the EDM grid network is not likely to reach in the short to medium term. It should be emphasized that while stand-alone systems do not provide the same level of electricity service as mini-grids or the grid network, they still offer wide-ranging socioeconomic benefits and contribute to SDG7 by fuel switching from kerosene to clean electric lighting, which has significant health and environmental benefits.

1.2. Off-Grid Electrification Roadmap

This document presents a Roadmap for the development of the off-grid solar (OGS) sector in Mozambique to achieve universal access to electricity by 2030.

The Roadmap is organized as follows:

I. **Introduction:** Background and context for the Roadmap
II. **Off-Grid Solar Roadmap**: **(2.1)** Review of key objectives, indicators and risks; **(2.2):** GIS analysis of the current OGS market, including a review of OGS market potential by province and a scenario analysis; (**2.3)** assessment of OGS funding needs, including scenario analyses; **(2.4)** roadmap strategy and implementation; (**2.5)** technical and financial resource needs; and (**2.6**); monitoring and evaluation.

Annex 1: Market Assessment: Overview of Mozambique's (**A-1**) energy sector; (**A-2**) off-grid market, including the (**A-2.1**) supply side and (**A-2.2**) demand side; (**A-3**) key barriers to market development; and (**A-4**) opportunities for market growth.

Annex 2: Methodology: (2-A) GIS data collection methodology; (2-B) Remoteness Index scoring methodology used to analyze barriers and risks at the provincial level; (2-C) District Priority Ranking used to prioritize districts for off-grid electrification; (2-D) Methodology to assess solar PUE market funding needs; and (2-E) Summary of the field research activities.

Annex 3: Stakeholder Contact List – List of the individuals and organizations that were consulted with during the course of the assignment.

This report was prepared through a combination of desk research, GIS analysis and extensive consultations with individuals and organizations in Mozambique to assess the off-grid solar market. Stakeholder interviews were conducted with the government/public sector, the donor/development community and with industry/private sector companies across the stand-alone solar supply chain. In order to better understand the perspectives of end-users, focus group meetings were held with representatives from village households and SMEs in rural off-grid communities in 10 of 11 provinces in the country.[26]

25 The NES uses the World Bank's Multi-Tier Framework for Energy Access to define and measure levels of electricity service, and specifies that "during the pre-electrification phase, a lower level of electricity service, including Tier 2 up to Tier 5, will be accepted as a form of transition to a future service level equivalent to that of being connected to the grid network." *See*: https://openknowledge.worldbank.org/handle/10986/24368

26 Attempts to collect data from Cabo Delgado were unsuccessful, as the consultant field survey team was advised against traveling to the province due to the ongoing conflict. The team attempted to reach internally-displaced people living in resettlements in neighboring provinces, but being a situation of national security, an authorization was needed, requiring significant processing time.

2. OFF-GRID ELECTRIFICATION ROADMAP

Based on the analysis and observations presented in the **Annex 1 Market Assessment** (which was prepared from the study of third party OGS sector analyses and best practices, stakeholder consultations, a field mission to Mozambique's provinces, GIS analysis and financial modeling), this section presents the Roadmap for the development of the off-grid solar sector in Mozambique. The Roadmap is designed to provide the GoM with actionable strategies to mobilize off-grid sector development in support of achieving universal access to electricity by 2030.

2.1. Overview of Key Objectives, Indicators and Risks

Mozambique's goal is to achieve Sustainable Development Goal (SDG) 7 – universal access to electricity – by 2030. Based on population projections, it is estimated that there will be approximately 8 million households in Mozambique by 2030 (about 41 million people). To achieve universal access, those 8 million households will need to be electrified through either the EDM network or through off-grid solutions.

Though currently limited in its reach geographically, the EDM grid network provides relatively reliable and affordable electricity. According to several analyses carried out by the GoM and its development partners, grid electrification represents the least-cost option for the majority of the population, driven mainly by the relatively low energy supply cost for EDM, which sources the majority of the country's power from the Cahora Bassa Hydropower Plant at very low cost.[27] Extending the national grid, however, is a slow and costly process – the World Bank estimates that USD 540M will be required annually to fund planned grid extensions under the NES.[28] Moreover, it is not economically feasible to extend the grid in many remote areas of the country, as costs would greatly exceed the potential revenue generated by EDM through the sale of electricity to small, isolated communities. The NES estimates that 70% of the population will be connected to the gridby 2030, with the remaining balance to be served by a combination of mini-grids and stand-alone systems.[29]

The proposed GoM electrification plan under the NES faces several potential barriers and risks. The country is currently in a fragile political and economic situation. Mozambique is involved in twointernal conflicts – one in Cabo Delgado, where Islamic extremist attacks have displaced hundreds of thousands of people and jeopardized billions of dollars of investment in the natural gas sector, and a second conflict in Sofala, where attacks from an opposition militia have impacted critical transport corridors that connect the south and north of the country.[30] The economy is still recovering from two cyclones – Idai and Kenneth – that hit the country in 2019 and caused widespread destruction in the four central provinces of Sofala, Manica, Tete and Zambezia, and in the northern province of Cabo Delgado (Mozambique is generally prone to climate risks and natural disasters, including cyclones, floods and drought). The COVID-19 pandemic has only worsened the country's already difficult economic situation.

In addition to these ongoing challenges, there are several key regulatory issues that need to be addressed in order to support development of the off-grid sector, particularly around the subject of taxation and fiscal incentives. The GoM recognizes the importance of this issue and has been working with its development partners to find a suitable resolution. In September 2021, with support from the FCDO-funded BRILHO programme, the Government approved the 'Regulation for Off-Grid Energy Access,' a new regulatory framework that will provide greater clarity to all actors in the off-grid energy sector.[31]

Another challenge will be to secure the public and private sector financial resources necessary for successful implementation of the OGS Roadmap. The required public sector subsidies will be in excess of USD 200M, while the capital raised by the private sector will be near USD 1B. Commercial debt for the OGS sector is largely non-existent in Mozambique, leaving standalone solar companies to finance their contribution to the successful implementation of the Roadmap with their own equity resources (the Roadmap's strategy looks to develop local currency debt financing from the Mozambican banking sector to help address this). It is expected that early-stage standalone enterprises will be more reliant on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure significant debt that will finance their consumer receivables and inventory finance needs.

The objectives of both the Roadmap and the NES will be affected if the extension of the EDM grid and/or off-grid solar electrification efforts are slowed by any of the abovementioned political, climate and regulatory risks, or if the necessary investment is not forthcoming.

2.2 GIS Analysis of the Off-Grid Solar Market

A geospatial analysis was conducted to assess the potential development of electricity access in Mozambique through 2030 in order to help the GoM concentrate its electrification efforts accordingly. The analysis focuses on the household market and covers the following electrification options:

- Grid densification and extension (EDM);
- Mini-grids for isolated villages with a higher residential energy demand; and
- Stand-alone solutions distributed in areas with a widely dispersed population and for settlements with an estimated energy demand below 0.1kW per year in 2030 (in line with the NES)

27 "Mozambique Geospatial Options Analysis: Towards Universal Electrification," Prepared for the World Bank by Massachusetts Institute of Technology, Tata Power Delhi Distribution Limited, and IIT-Comillas, (February 2019).

28 World Bank Project Appraisal Document: Mozambique Energy for All (ProEnergia) Project," World Bank Energy and Extractives Global Practice, (March 7, 2019): https://documents1.worldbank.org/curated/pt/594061554084119829/pdf/Mozambique-Energy-for-All-ProEnergia-Project.pdf

29 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.

30 "Stand Alone Solar (SAS) Market Update: Mozambique," Tetra Tech International Development, UK Foreign, Commonwealth and Development Office (FCDO) Africa Clean Energy Technical Assistance Facility, (March 2021): https://www.ace-taf.org/wp-content/uploads/2021/04/Stand-Alone-Solar-SAS-Market-Update-Mozambique.pdf

31 "Government of Mozambique approves off-grid energy regulation taking a key step towards universal access," SNV, (15 September 2021): https://snv.org/update/government-mozambique-approves-grid-energy-regulation-taking-key-step-towards-universal

The year 2020 was used as a baseline to provide figures for electricity access rates, total population, the number of SHS and the number of operating mini-grids. The 2017 Population Census was used to estimate population per settlement for the 2020 baseline year, assuming a steady population growth rate of 2.8% for each settlement (the same rate was applied each year through 2030).

A combination of sources and assumptions were used to develop the thresholds for methods of electrification, such as the NES and regional indicators for East Africa. Low income households benefit from the social tariff introduced by EDM (MZN 0.97/kWh – about USD 0.15/kWh) and were assumed to be connected by grid densification by 2030 if located within 2km of an existing medium voltage (MV) line or within 350m of an existing high voltage (HV) line. A tier level was applied to each settlement to estimate the energy demand needed for household customers. Tier 2 access (which typically provides sufficient electricity for lighting, mobile phone charging, a radio and a television) was considered the minimum threshold for household electrification in rural and deep rural areas, while Tier 3 access was applied to urban and peri-urban areas. Annex 2-A provides a description of each Tier level.

TABLE 1: KEY PARAMETERS OF THE GIS ANALYSIS

Method of Electrification	Distance to HV lines	Distance to MV lines	kW/year
Grid connected	<= 350 m (existing lines only)	<= 2 km (existing lines only)	all
Grid connected	<= 5 km	<= 5 km	> 0.1
Mini-grid	>= 30 km	> 5 km	> 0.1
SHS	> 350 m	> 2 km	<= 0.1

HV = High Voltage; MV = Medium Voltage

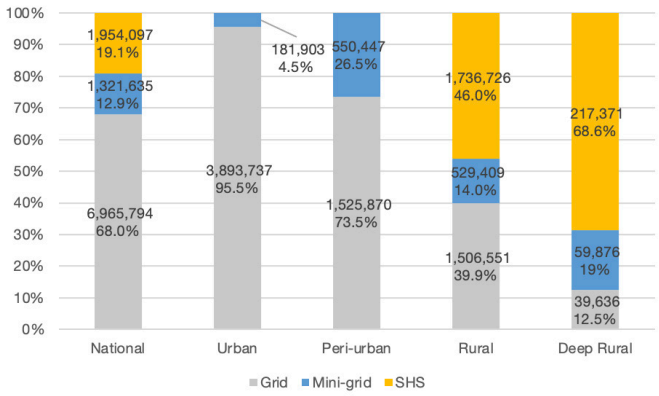
Source: Energio Verda Africa GIS analysis

2.2.1. Overview of Off-Grid Market Potential

According to the GIS analysis, by 2030, an estimated 6.9 million households (68%) will be electrified by the national grid, about 2 million households (19%) will be electrified by SHS, and the remaining balance, about 1.3 million households (13%), will be electrified by mini-grids.[32] The grid access rate declines according to the level of urbanity, with 95% of households located in urban areas connected to the grid compared to 13% of households in deep rural areas. For deep rural areas, stand-alone solar systems (SHS)[33] will be the main source of electrification in 2030 (**Figure 1**).

Using the number of households in 2020 as a baseline and the results of the GIS analysis for 2030, it is estimated that, on average, about **800,000 households** will need to be electrified annually to achieve universal access by 2030. In order to electrify 6.9 million households through grid connections, about 470,000 new customers need to be connected to the grid annually through 2030.[34]

FIGURE 1: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, 2030



Source: Energio Verda Africa GIS analysis

Table 2 shows the estimated number of households that will receive electricity access by electrification method in 2020 and 2030. The analysis assumes linear growth in the number of household connections to achieve the 2030 electrification target.

32 DISCLAIMER: Based on historical context of past performance of EDM grid connections, among other variables, the authors of this report do not believe the 68% grid-connected households target is attainable (the GIS analysis estimated that 55% of households can realistically be connected to the grid by 2030); FUNAE and the GoM have insisted that the 68% figure (which is aligned with the NES target of 70%) is achievable.

33 The terms stand-alone solar system and solar home system (SHS) are used interchangeably throughout this document.

34 For context, in 2019, EDM connected about 170,000 new customers and has set a target of connecting 300,000 customers annually up to 2024 (*Source*: EDM Annual Report, 2019; and EDM Business Plan, 2020-2024).

TABLE 2: ESTIMATED NUMBER OF HOUSEHOLDS RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD, 2020 AND 2030

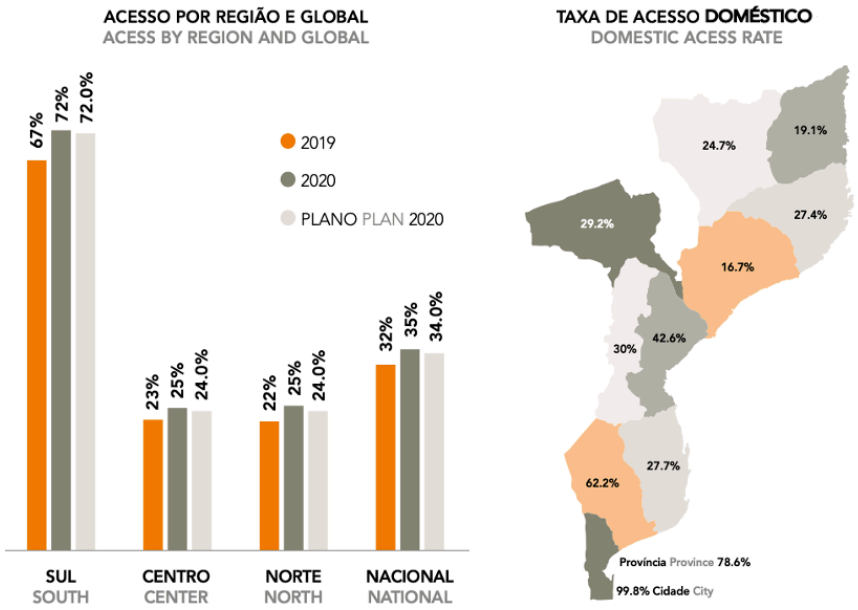
Electrification method	2020 (Baseline)	2030 (GIS results)	Estimated average no. of HHs connected annually through 2030
Grid	2,681,569	6,965,794	476,025
Mini-grid	27,822	1,321,634	143,757
SHS	200,000	1,954,097	194,899 (+ ~1.2 million replacement)[35]
Total	**2,801,558**	**10,241,526**	**814,682**

Source: Energio Verda Africa GIS analysis

2.2.2. Off-Grid Market Potential at the Provincial Level

Mozambique is administratively divided into three regions (south, central and north) and 11 provinces (Maputo City, Maputo Province, Gaza, Inhambane, Niassa, Sofala, Manica, Tete, Zambézia, Nampula and Cabo Delgado). The country has a low demographic density, as about two-thirds of Mozambicans live in dispersed rural areas mainly concentrated along transport corridors and the coastline.[36] Rates of electricity access vary substantially across provinces and districts, with higher levels of access in the southern region (**Figure 2**).[37]

FIGURE 2: RATES OF ELECTRICITY ACCESS BY REGION, 2019-2020 (LEFT) AND PROVINCE, 2020 (RIGHT)



GIS Analysis

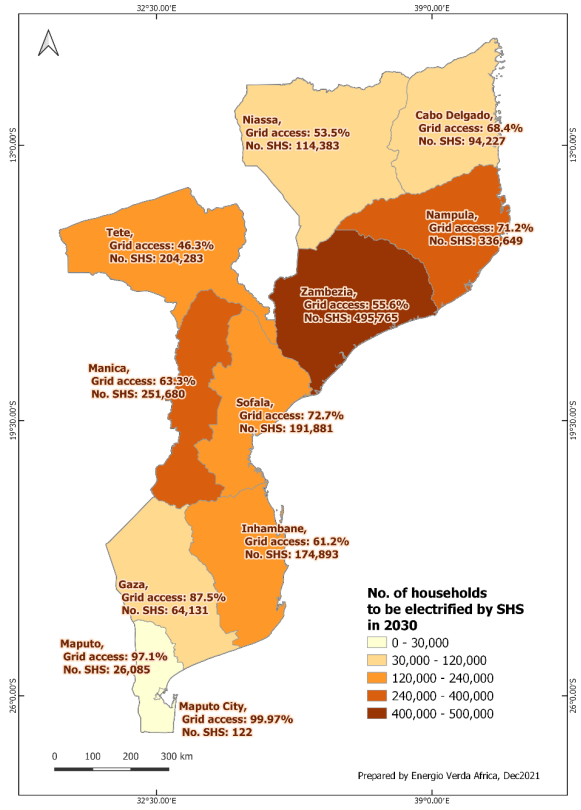
The GIS analysis concluded that the largest number of households in need of electrification by SHS will be located in the highly populated Zambézia Province, followed by the provinces of Nampula and Manica. Manica (Mossurize District) and Zambézia (Milange District) have the districts with the highest concentration of households to be electrified by SHS. Households located in Maputo City and Maputo Province will have nearly universal connection to the national grid, leaving a small number of households for off-grid electrification solutions (**Figure 3**).

35 Solar home systems typically need to be replaced after about five years.

36 "Renewables in Mozambique: National Status Report, 2nd Edition," Associação Lusófona de Energias Renováveis (ALER), (October 2017): https://www.aler-renovaveis.org/en/activities/publications/national-reports/renewables-in-mozambique--country-status-report/

37 Electricidade de Moçambique Relatório e Contas, Annual Report, 2020: https://www.edm.co.mz/en/node/5321

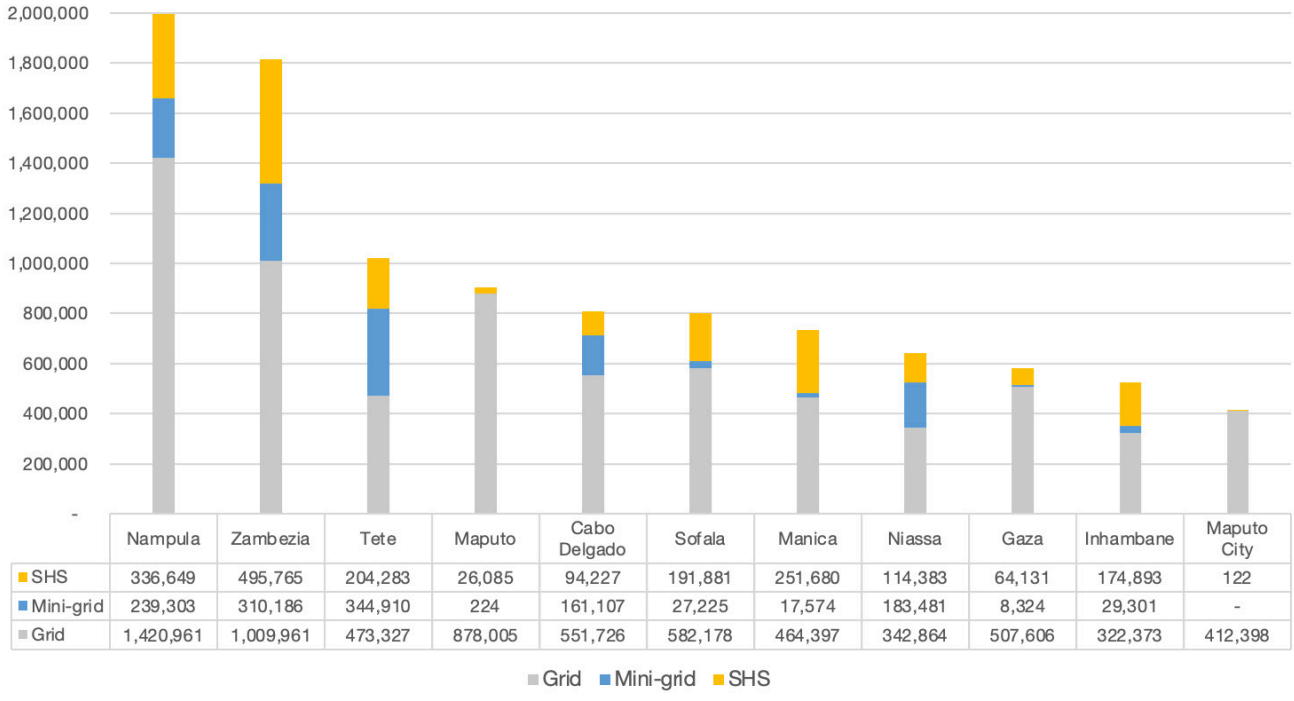
FIGURE 3: ESTIMATED GRID ACCESS RATE (%) AND NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

Figure 4 shows the estimated number of households in each province that will receive electricity access by method of electrification in 2030. Due to its high population, Nampula Province could have the largest number of potential customers connected to EDM grid – and at the same time the second largest number of households electrified by SHS (after Zambézia).

FIGURE 4 SHOWS THE ESTIMATED NUMBER OF HOUSEHOLDS IN EACH PROVINCE THAT WILL RECEIVE ELECTRICITY ACCESS



	Nampula	Zambezia	Tete	Maputo	Cabo Delgado	Sofala	Manica	Niassa	Gaza	Inhambane	Maputo City
SHS	336,649	495,765	204,283	26,085	94,227	191,881	251,680	114,383	64,131	174,893	122
Mini-grid	239,303	310,186	344,910	224	161,107	27,225	17,574	183,481	8,324	29,301	-
Grid	1,420,961	1,009,961	473,327	878,005	551,726	582,178	464,397	342,864	507,606	322,373	412,398

Source: Energio Verda Africa GIS analysis

Replacement of Retired Systems and Pre-electrification

Between 2022 and 2030, a number of existing solar systems in the market will need to be replaced, as solar home systems have a five-year lifetime;[38] therefore, households purchasing a system in a given year are projected to require a new system to maintain access fully five years later. Two sets of systems will need replacement between 2022 and 2030: (i) existing systems will need to be replaced after five years; and (ii) new systems that will be purchased between 2022 and 2025.For households in urban and peri-urban areas, the analysis considered SHS to be a 'pre-electrification' option to provide an initial level of electricity service until the EDM grid network arrives. The systems purchased for pre-electrification will not be replaced, as it is assumed that by the time their five-year life-span is over, the grid (or a mini-grid) will have arrived. Households in rural and deep rural areas are projected to be permanently electrified by SHS through 2030. Out of the 1.95 million households in rural and deep rural areas, it is estimated that 143,000 of these already have SHS – accounting for about 72% of the estimated 200,000 active quality-verified systems – and will only require replacements to remain electrified by 2030.[39]

Funding Requirements: Enterprise Capital Needs and Affordability Gap Financing

A corresponding analysis of SHS enterprise capital needs and affordability gap financing requirements identified the funding needed to achieve universal electrification by 2030 (see **Section 2.3: Off-Grid Solar Funding Needs** for the complete analysis). Off-grid solar enterprise capital needs were calculated based on the projected 2030 SHS electrification rate per province derived from the GIS analysis, and assuming that access increases at an equal pace annually from 2022 to 2030, the number of new SHS connections required each year in each province was determined.[40] In order to calculate the number of new Tier 1 and 2 SHS needed in each province, the model assumed that households would purchase the highest level of electricity service they could afford based on their average monthly energy expenditure, thus accounting for differences in the ability to pay of households in each province by level of urbanity. The affordability gap for households in each income group was calculated by multiplying the difference between the average monthly energy expenditure of the income group and the required USD 7.5 monthly PayGo payment by the PayGo duration of 24 months (plus 2.67 months for the upfront down payment).[41]

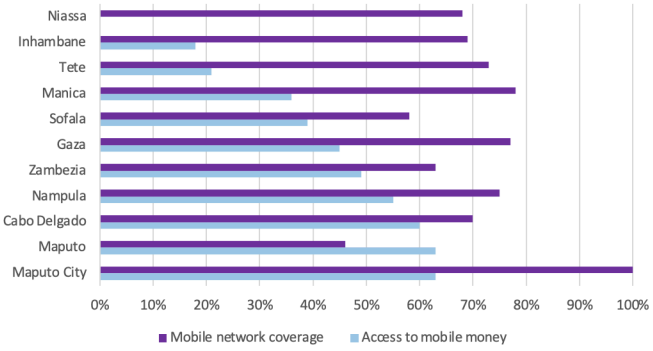
Fiscal Policy / Tax Exemptions

Value added tax (VAT) and duties charged on solar equipment represent a significant barrier to affordability and universal access to electricity in Mozambique. Reducing the tax burden on OGS operators would catalyze off-grid market development and significantly reduce the funding requirements needed to achieve universal electrification by 2030.

Mobile Network Coverage and Access to MobTile Money Services

Mobile connectivity and mobile money play a critical role in enabling off-grid solar market growth, particularly for PayGo systems that rely on the interoperability between digital financial services and stand-alone solar devices. **Figure 5** presents the penetration rates of mobile network coverage and mobile money services in each province.

FIGURE 5: MOBILE NETWORK COVERAGE AND ACCESS TO MOBILE MONEY SERVICES BY PROVINCE, 2019



NOTE: No data was available for mobile money access rates in Niassa Province
Source: USAID SAEP Mozambique Consumer Affordability survey, 2019; BRILHO provincial profiles

Remoteness Index

A Remoteness Index was developed to identify and assess barriers and risks to OGS market development at the provincial and district level. The provinces were ranked based on identified accessibility barriers to supplying off-grid electricity services. Five parameters were used to determine the remoteness index for each province, including:

- level of urbanity (urban, peri-urban, rural and deep rural);
- population density;
- distance to major ports;
- distance to main roads; and
- mobile network coverage.

Table 3 summarizes the average Remoteness Index scores for each province; a higher index score associated with a given category indicates that it is more difficult to access for the supply of electricity services (**Annex 2-B** provides a description of each parameter and the full Remoteness Index scoring methodology).

38 "Lighting Africa: Off-grid Solar Market Assessment in Niger and Design of Market-Based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/; and https://www.greenlightplanet.com/solar-lights-shop/sun-king-home-120/

39 "Can Mozambican Households Afford Solar Home Systems? Insights from a Local Survey: Final Report," United States Agency for International Development: Power Africa, (April 2020): https://pdf.usaid.gov/pdf_docs/PA00WJJH.pdf; and Associação Lusófona de Energias Renováveis (ALER), Associação Moçambicana de Energias Renováveis (AMER) and GIZ GET.invest, 2021. "Briefing: Renewables in Mozambique: 2021," https://www.lerenovaveis.org/contents/lerpublication/aler_mar2021_resumo-renovaveis-em-mocambique-2021.pdf

40 The model assumes electricity access will grow linearly on a percentage basis; however, due to population growth, the number of new connections required annually is not static.

41 See **Section 2.3** for more details on the capital needs assessment methodology.

TABLE 3: AVERAGE REMOTENESS INDEX SCORE BY PROVINCE

National Rank	Province	Average Total Index Number	Level of urbanity	Population density	Distance to major ports	Distance to major roads	Mobile coverage
1	Niassa	10.3	2	2	4	2	1
2	Inhambane	10.0	2	3	4	1	1
2	Tete	10.0	2	2	4	1	1
4	Sofala	9.3	2	2	2	2	2
5	Gaza	9.0	2	2	3	2	1
5	Manica	9.0	2	2	3	2	1
7	Maputo	8.3	2	3	1	1	2
8	Cabo Delgado	8.0	2	2	2	1	1
8	Nampula	8.0	2	2	2	2	1
8	Zambezia	8.0	2	2	3	1	1
11	Maputo City	4.5	2	2	0	1	0

District Priority Ranking

A District Priority Ranking mechanism was developed to prioritize specific districts within each province for off-grid electrification. The rationale for prioritizing districts is that there are limited resources available to provide off-grid electrification services in remote and underserved areas. The results of GIS analysis show that there are different electrification needs in each province/district based on the estimated number of households that will be electrified by SHS through 2030 (determined by assessing various factors, including population density, electricity demand and distance of unelectrified households from the grid).[42]

The District Priority Ranking is based on a composite score that combines the aforementioned Remoteness Index value with the estimated number of households that will be electrified by SHS through 2030 that are located at least 5km from existing and 2km from planned medium voltage lines of the EDM grid network.[43] Districts with a higher overall score – i.e., those with higher average Remoteness Index scores (that are more difficult to access for the supply electrification services) and with more households suitable for SHS (located outside of the EDM grid distance parameters) – are prioritized as districts where national and provincial resources for off-grid solar electrification should be concentrated.

Table 4 lists the 10 districts with the highest composite index scores in Mozambique (see **Annex 2-C** for a complete ranking of all districts in the country).

TABLE 4: DISTRICT PRIORITY RANKING FOR THE 10 HIGHEST COMPOSITE INDEX SCORES IN MOZAMBIQUE

National Rank	Province	District	Composite Index Score
1	Niassa	Mecanhelas	17.3
2	Inhambane	Massinga	16.0
3	Manica	Machaze	15.8
3	Nampula	Malema	15.8
5	Nampula	Erati	15.0
6	Niassa	Mavago	14.8
6	Tete	Macanga	14.8
6	Zambezia	Gile	14.8
6	Zambezia	Namarroi	14.8
10	Zambezia	Alto Molocue	14.5

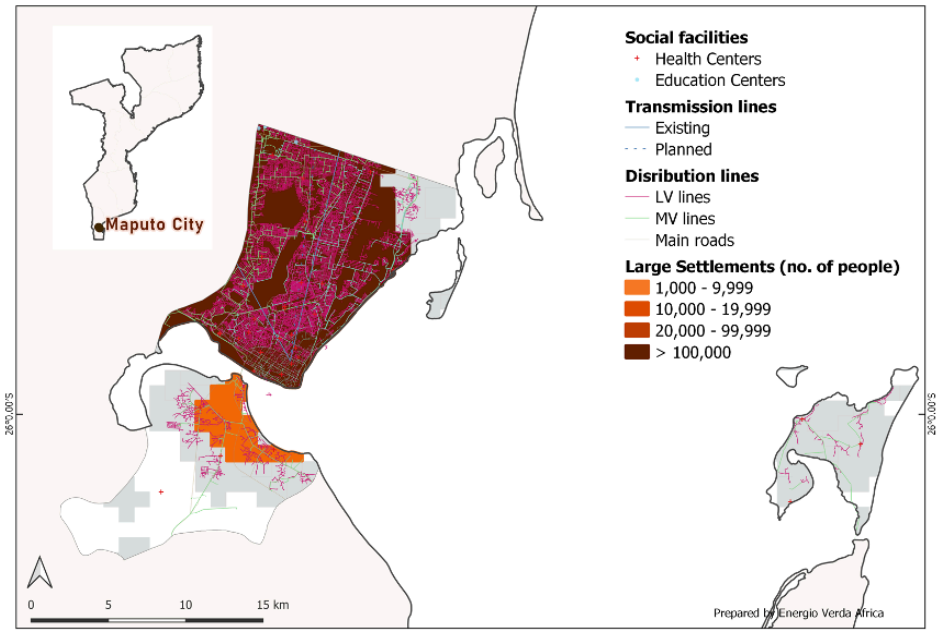
2.2.2.1. Maputo City

This section presents an overview of the off-grid market potential for Maputo City, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

42 See Annex 2-A for Imore details.

43 These distances are used to avoid overlap between EDM (grid extensions) and FUNAE (off-grid) electrification planning and development.

FIGURE 6: MAPUTO CITY ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES



Source: Electricidade de Moçambique; Instituto Nacional de Estatística

Provincial profile	Maputo City is Mozambique's capital and its most populous urban center, with a population of about 1.2 million people.[44] Although it is within Maputo Province, Maputo City is administered as a separate province. Maputo has the country's largest port, making it a hub for domestic and international trade. While economic activity in the capital is largely concentrated in the commercial and services sectors, the agricultural and fishing sectors are also important for employment, income and food security. The entire city has access to a mobile telecommunications network, while access to mobile money services and use by adults is about 60%, which is the highest rate in the country (**Figure 5**).[45]
Electrification status / off-grid solar market activity	Maputo City has the highest electrification rate in the country, exceeding 99%. This rate is driven by household connections to EDM's national grid. The majority of the province's un-electrified households are located on Inhaca Island, which has a significantly lower population density and less dense electricity network (**Figure 6**). Most off-grid solar companies active in Mozambique are headquartered in Maputo City or in Matola, the largest suburb of the capital.
Results of the GIS analysis: new connections required through 2030	**2030 projections:** In 2030, Maputo City will have approximately 412,000 households, of which more than 98% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 99.97% and an estimated 122 households will be electrified by SHS. By 2030, all urban and peri-urban areas will be connected to the grid via densification, while the majority of the province's households that will need to be electrified by SHS are located on the islands Inhaca and Xefina Grande and some on the outskirts of Catembe (**Figure 7**).[46] **Annual electrification targets:** In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of **15,500** households will need grid connections annually • SHS: An average of about **13,000 households** will need to be electrified by SHS annually • Mini-grids: Mini-grids are not an electrification option for Maputo City in 2030

44 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
45 BRILHO Provincial Profile: Maputo City Province, UK Aid and SNV, 2020.
46 See **Annex 2-A** for more details.

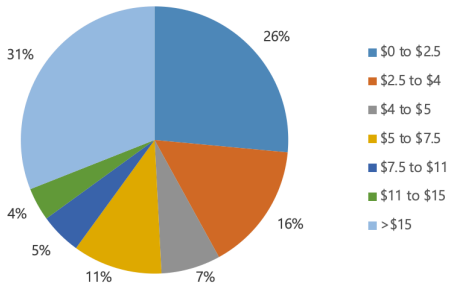
Additional SHS for pre-electrification and replacement of retired systems

In addition to 122 new connections, another 118,794 SHS will need to be deployed for pre-electrification and 47 SHS for the replacement of retired systems, bringing the total number of SHS required in Maputo City through 2030 to 118,963.

SHS Category	Units Required
New Permanent Connections	122
Temporary Pre-Electrification	118,794
Replacement of Retired Systems	47
Total	118,963

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure[47]



It is estimated that the total capital needed by SHS enterprises to deploy about 120,000 SHS to complement grid electrification in achieving universal access in Maputo City Province by 2030 is **USD 26.3M (MZN 1.7B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 10K (MZN 638K)** is required to bridge the affordability gap for off-grid households in Maputo City to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PayGo basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Maputo City Province by 2030 is **USD 26.3M (MZN 1.7B)**, which accounts for approximately 2% of the total capital needed for SHS across the country. **Figure 8** summarizes the volume and blend of financing that is required to achieve universal electricity access in Maputo City Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Maputo City		
National Rank	Barriers / Risks	Districts / regions
11/11	Population density	Inhaca and Xefina Grande islands

Remoteness Index Ranking: Maputo City has the lowest index score in the country (**Table 3**), as there are relatively few constraints to delivering off-grid electricity services in the province. Inhaca Island and the semi-rural area of Catembe have low population density, which increases the cost per connection in these areas.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. The ongoing pandemic, political conflict and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Maputo City Province include:

- Concentrate provincial resources and OGS electrification efforts on households located on Inhaca and Xefina Grande Islands.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 8**, by implementing VAT/import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Maputo City Province by an estimated **USD 11.8M (MZN 750M)**.

Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

47 Due to a lack of data, it was assumed that off-grid households in Maputo City Province have a similar monthly energy expenditure profile as households in Cabo Delgado.

FIGURE 7: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, MAPUTO CITY

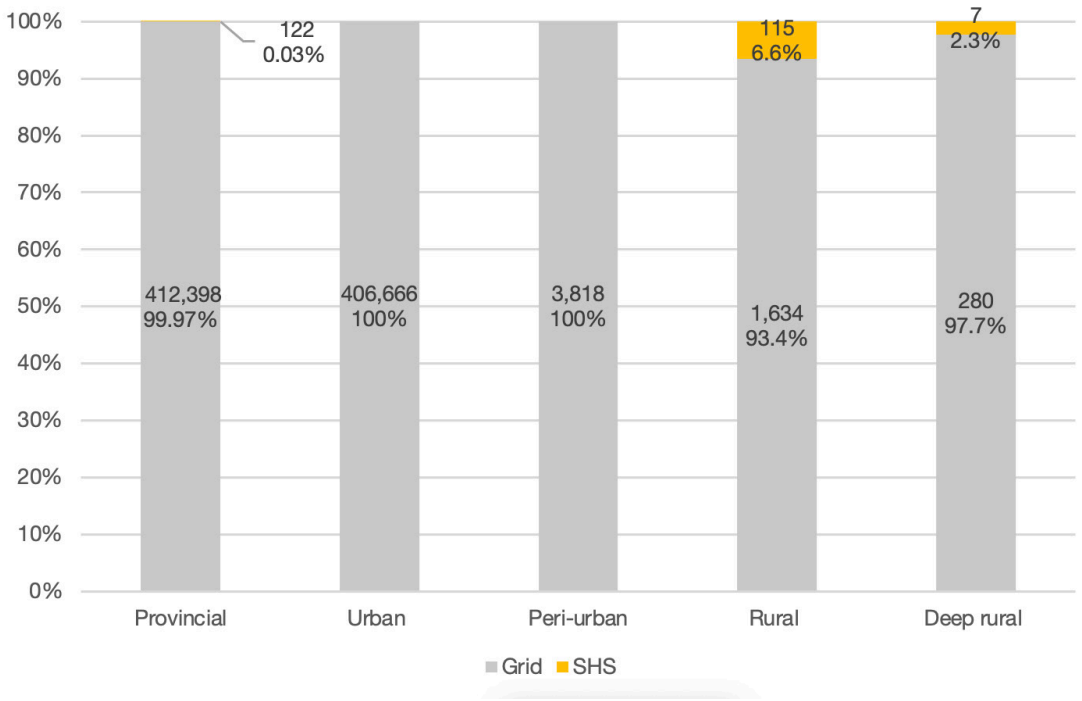
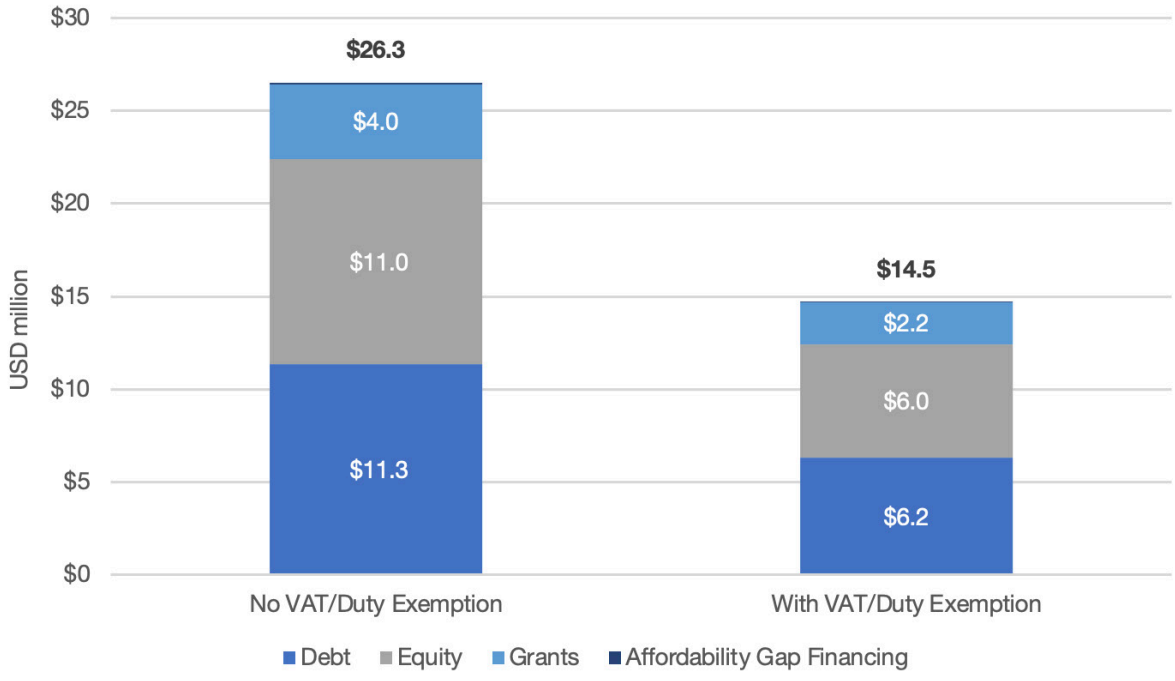


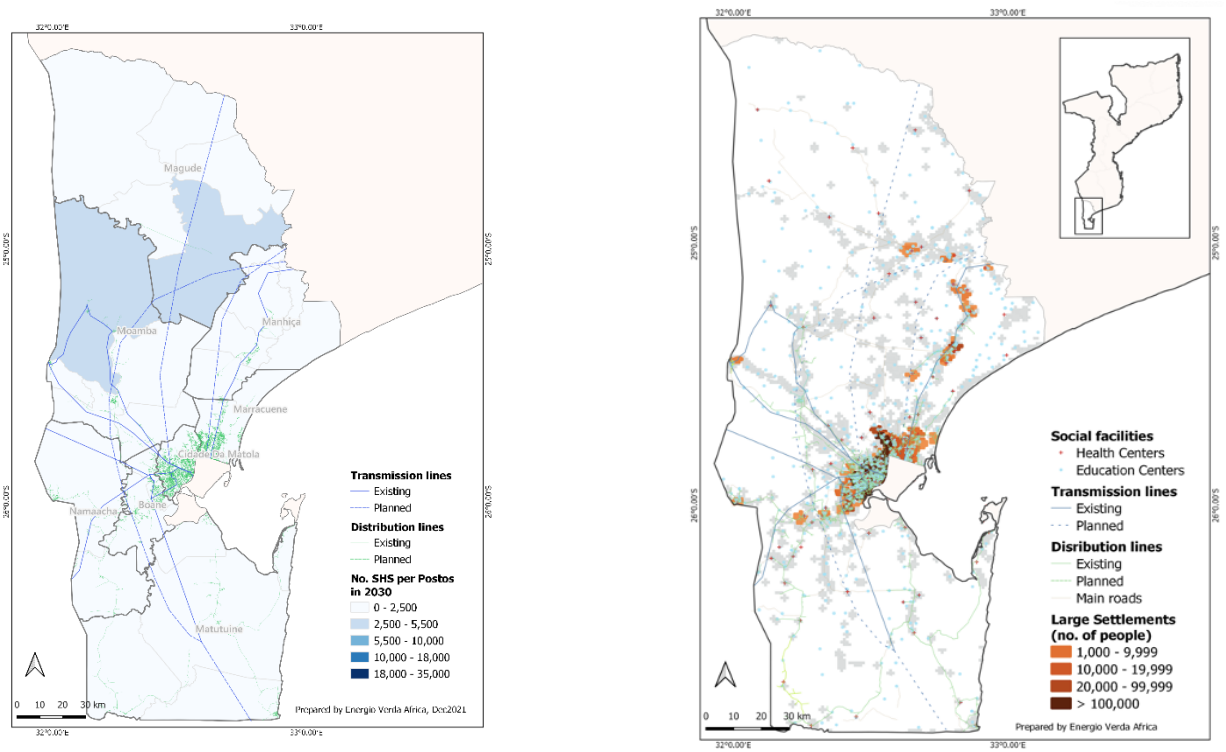
FIGURE 8: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN MAPUTO CITY PROVINCE BY 2030



2.2.2.2 Maputo Province

This section presents an overview of the off-grid market potential for Maputo Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 9: MAPUTO PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda GIS analysis

Provincial profile	Maputo Province is the southernmost province in Mozambique with a population of about 1.9 million.[48] Economic activities are driven by agriculture (subsistence farming of maize, cassava, and groundnuts; the main cash crop is sugarcane), tourism, and artisanal fishing along the coast. About 46% of the province has mobile network coverage, with larger gaps in the more sparsely populated northwest area of the province, while access to mobile money services and use by adults is about 60%, which is the highest rate in the country (**Figure 5**).[49] The Mozal smelter, located near Maputo City, is an aluminum refinery owned by BHP Billiton that buys electricity from the Cahora Bassa Dam (HCB) and also imports electricity from South Africa's Eskom. The project, which is currently undergoing expansion upgrades to boost production, contributes to about one-third of Mozambique's exports.[50]
Electrification status / off-grid solar market activity	Maputo Province has an electrification rate of 78.6%, which is the highest rate of access in the country outside of Maputo City. The population is largely concentrated around Maputo City and the two main roads, with the EDM network covering the more densely populated areas (**Figure 9**). Solar product ownership is relatively high in Maputo Province; in 2019, 34% of surveyed households owned solar products.[51] In the off-grid sector, SolarWorks has two shops in the province, located in Manhiça and Moamba. ENGIE Energy Access has store locations in Boane, Marracuene, Manhiça and Magude. Logos Industries and Dynamiss Trading also operate in the province.

48 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
49 BRILHO Provincial Profile: Maputo Province, UK Aid and SNV, 2020.
50 "Energy Catalyst – Country Guide: Mozambique," Innovate UK and UK Aid, (June 2020): https://energycatalyst.community/developer/wp-content/uploads/2020/12/Country-Guide-Mozambique.pdf
51 USAID SAEP Mozambique Consumer Affordability survey, 2019.

Results of the GIS analysis: new connections required through 2030

2030 projections: In 2030, Maputo Province will have approximately 900,000 households, of which 88% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 97% and about 26,000 households will be electrified by SHS.[52] By 2030, all urban and peri-urban areas will be connected to the grid, while the majority of the province's deep rural households will need to be electrified by SHS (**Figure 10**).[53]

Annual electrification targets: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets:

- Grid connections: An average of **37,000** households will need grid connections annually
- SHS: An average of about **34,000 households** will need to be electrified by SHS annually[54]
- Mini-grids: Mini-grids can be developed to electrify an estimated 224 households in the southern area of Mapulanguene administrative post (Magude District).

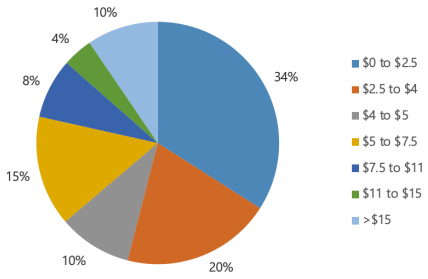
Additional SHS for pre-electrification and replacement of retired systems

In addition to 7,080 new connections,[55] another 258,594 SHS will need to be deployed for pre-electrification[56] and 40,375 SHS for the replacement of retired systems,[57] bringing the total number of SHS required in Maputo Province through 2030 to 306,050.

SHS Category	Units Required
New Permanent Connections	7,080
Temporary Pre-Electrification	258,594
Replacement of Retired Systems	40,375
Total	306,050

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 300,000 SHS to complement grid electrification in achieving universal access in Maputo Province by 2030 is **USD 65.7M (MZN 4.2B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 4.1M (MZN 262M)** is required to bridge the affordability gap for off-grid households in Maputo Province to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PayGo basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Maputo Province by 2030 is **USD 69.8M (MZN 4.5B)**, which accounts for approximately 5% of the total capital needed for SHS across the country. **Figure 11** summarizes the volume and blend of financing that is required to achieve universal electricity access in Maputo Province by 2030 – with and without VAT/duty exemptions.

52 The 26,000 households electrified by SHS in 2030 represent ***permanent connections*** (households in rural and deep rural areas are projected to be permanently electrified by SHS).
53 See Annex 2-A for more details.
54 This is calculated on the basis of 306,050 total SHS required through 2030 divided by 9 years (2022-2030) = 34,000 annual SHS.
55 About 19,000 of the 26,000 total households that can optimally be electrified by SHS are assumed to already have existing SHS (see **Table 5**); as a result, only 7,080 households will require ***new permanent SHS connections*** through 2030.
56 About 258,594 SHS will be required for ***temporary pre-electrification*** (for households in urban and peri-urban areas, the analysis considered SHS to be a 'pre-electrification' option to provide an initial level of electricity service until the EDM grid network arrives; the systems purchased for pre-electrification will not be replaced, as it is assumed that by the time their five-year life-span is over, the grid (or a mini-grid) will have arrived).
57 About 40,375 SHS will be needed for the replacement of retired systems (between 2022 and 2030, a number of existing SHS in the market will need to be replaced, as solar home systems have a five-year life-span).

Off-Grid Solar market barriers and risks	

Remoteness Index: Maputo Province		
National Rank	Barriers / Risks	Districts / regions
7/11	Population density Mobile network coverage	Southern and northern districts

Remoteness Index Ranking: Maputo Province ranks seventh in the country in its index score (**Table 3**). Low population density, especially in the southern and northern districts, was identified as a key barrier, as the cost per connection increases in these areas.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. The ongoing pandemic, political conflict and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

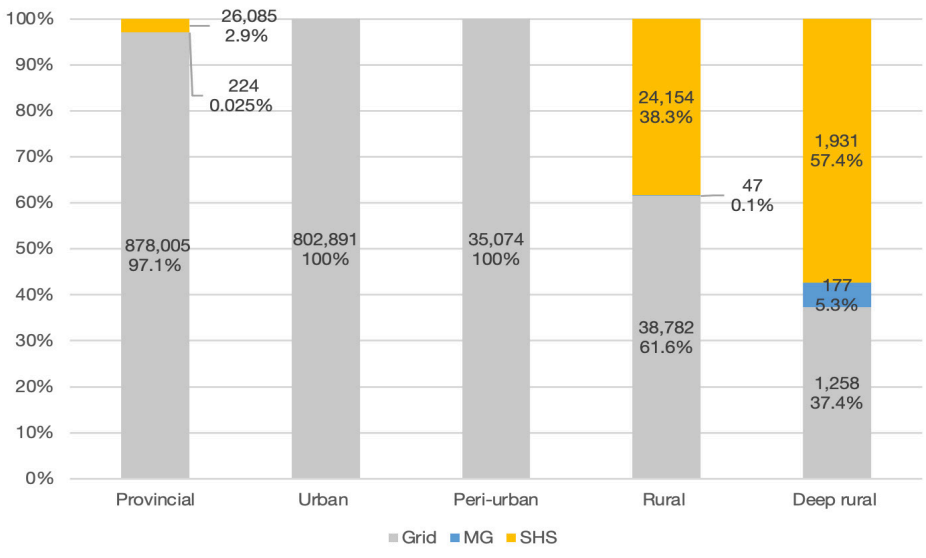
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Maputo Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Magude, Matutuine and Moamba Districts (**Figure 9**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 11**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Maputo Province by an estimated **USD 31.9M (MZN 2B)**.

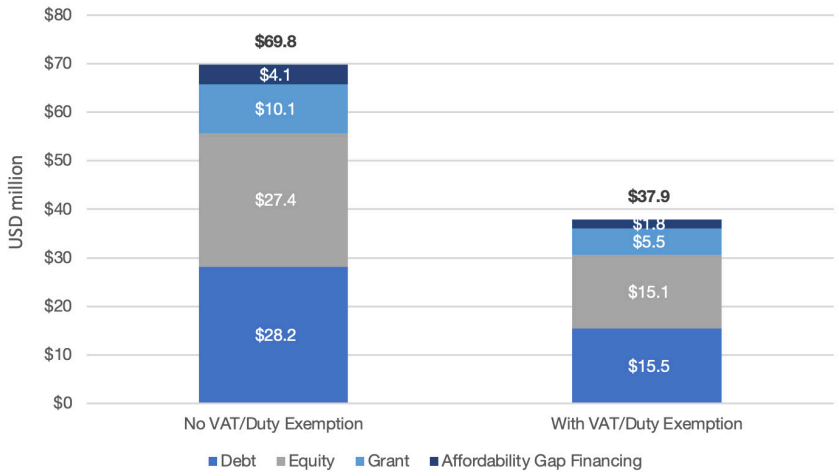
Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

FIGURE 10: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, MAPUTO PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

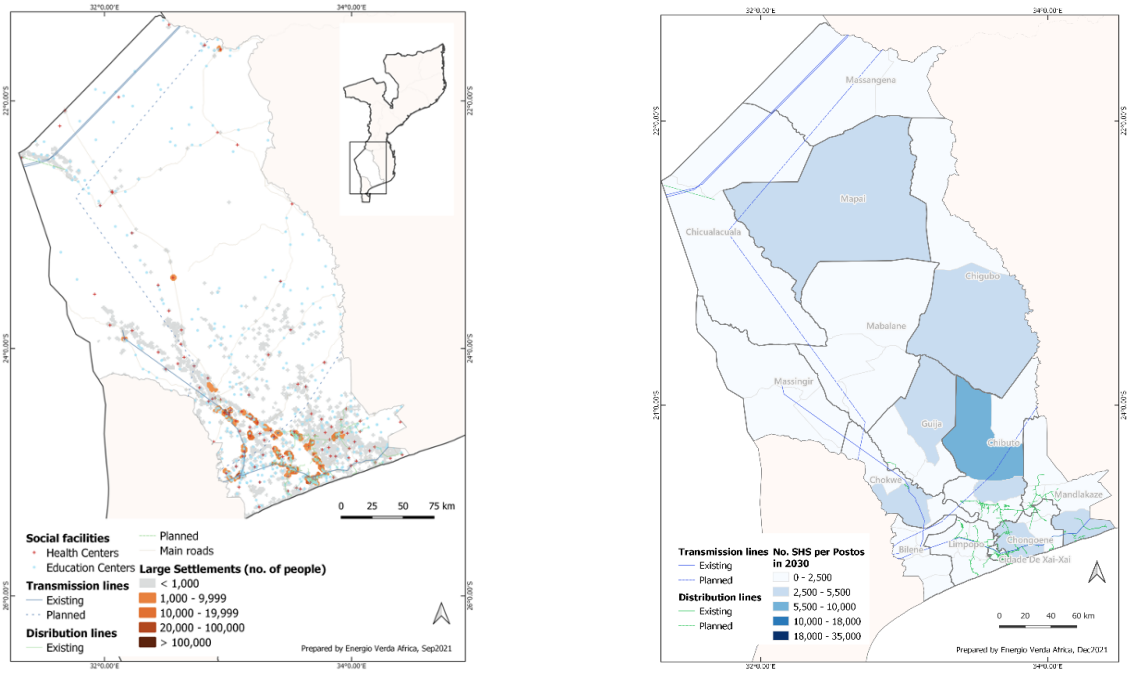
FIGURE 11: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, MAPUTO PROVINCE, 2030



2.2.2.3 Gaza Province

This section presents an overview of the off-grid market potential for Gaza Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 12: GAZA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

Provincial profile

Gaza Province has a population of about 1.4 million.[58] The local economy relies on agriculture (subsistence farming of maize, cassava, beans, sorghum and millet; the main cash crops are rice and sugarcane), artisanal fishing, and tourism (namely Limpopo National Park). About 77% of the province has mobile network coverage, with larger gaps in coverage in the sparsely populated northern districts, while access to mobile money services and use by adults is about 45%, which is among the higher rates in the country (**Figure 5**).[59]

Electrification status / off-grid solar market activity

Gaza has an electrification rate of 62.2%, which is the third highest rate of access in the country. The population is mainly concentrated in the southern districts along the coastline, where the majority of EDM's distribution network is situated (**Figure 12**). In the off-grid sector, SolarWorks is currently operating in Gaza, with two shops located in Chókwè and Chibuto. ENGIE Energy Access also operates in the province, with store locations in Macia, Xai-Xai, Chokwe, Chibuto and Madendere.

Results of the GIS analysis: new connections required through 2030

2030 projections: In 2030, Gaza Province will have approximately 580,000 households, of which 56% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 87.5% and about 64,000 households will be electrified by SHS. By 2030, most urban and peri-urban areas will be connected to the grid via densification, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 13**).[60]

Annual electrification targets: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets:

- Grid connections: An average of 35,500 households will need grid connections annually
- SHS: An average of about 30,000 households will need to be electrified by SHS annually
- Mini-grids: An average of 800 households will need mini-grid connections annually

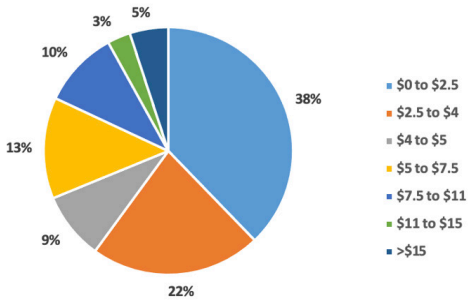
Additional SHS for pre-electrification and replacement of retired systems

In addition to 41,548 new connections, another 162,745 SHS will need to be deployed for pre-electrification and 60,807 SHS for the replacement of retired systems, bringing the total number of SHS required in Gaza Province through 2030 to 265,099.

SHS Category	Units Required
New Permanent Connections	41,548
Temporary Pre-Electrification	162,745
Replacement of Retired Systems	60,807
Total	265,099

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 265,000 SHS to complement grid electrification in achieving universal access in Gaza Province by 2030 is USD 54.7M (MZN 4.5B). In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated USD 8.6M (MZN 549M) is required to bridge the affordability gap for off-grid households in Gaza to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PayGo basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Gaza Province by 2030 is USD 63.3M (MZN 4B), which accounts for approximately 5% of the total capital needed for SHS across the country. **Figure 14** summarizes the volume and blend of financing that is required to achieve universal electricity access in Gaza Province by 2030 – with and without VAT/ duty exemptions.

58 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
59 BRILHO Provincial Profile: Gaza Province, UK Aid and SNV, 2020.
60 See **Annex 2-A** for more details.

Off-Grid Solar market barriers and risks

Remoteness Index: Gaza Province		
National Rank	Barriers / Risks	Districts / regions
5/11	Logistical Mobile network coverage	Northern districts

Remoteness Index Ranking: Gaza Province ranks fifth in the country in its index score (**Table 3**). Logistical constraints were identified as a key barrier, including the relatively high average distance of households to main roads and to the nearest sea port, which increase costs for electricity service providers, particularly in the northern districts of the province that are more difficult to access.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. According to the World Bank, approximately 40% of the population in Gaza lives below the poverty line. In 2019, 60% of surveyed households in Gaza indicated the main reason they do not own a SHS is that they cannot afford one.[61] The ongoing pandemic, political conflict and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

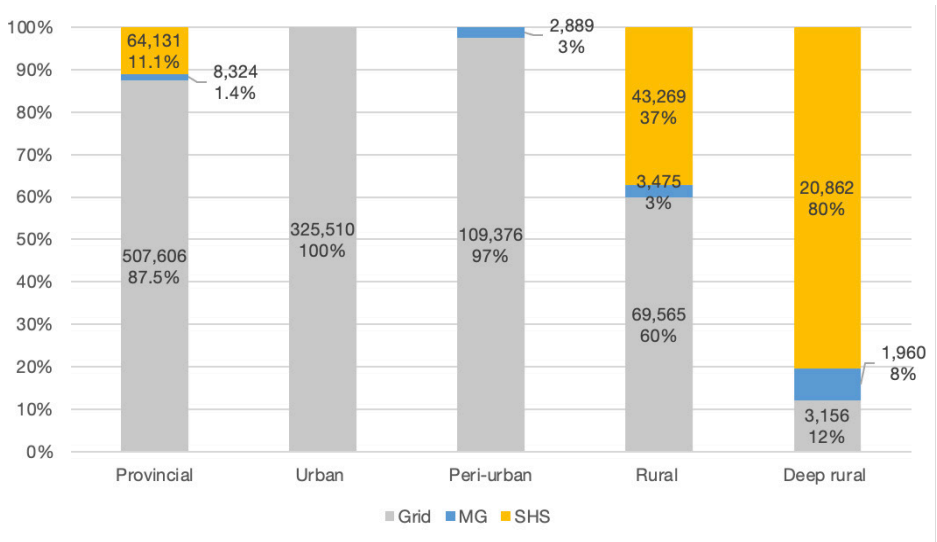
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Gaza Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Massingir, Mapai and Chigubo Districts (**Figure 12**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 14**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Gaza Province by an estimated USD 29.1M (MZN 1.8B).

Source: UK Aid and SNV, 2020; EDM, 2020; AMER and GET.invest, 2021; USAID SAEP, 2020; Energio Verda Africa GIS analysis

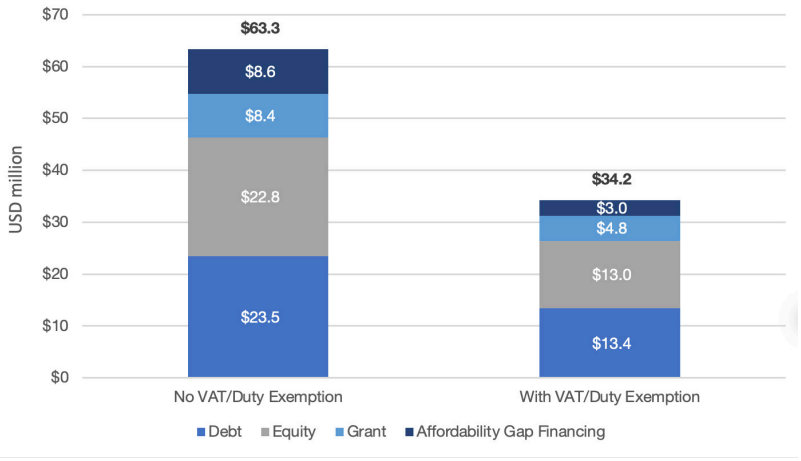
FIGURE 13: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, GAZA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

61 USAID SAEP Mozambique Consumer Affordability survey, 2019.

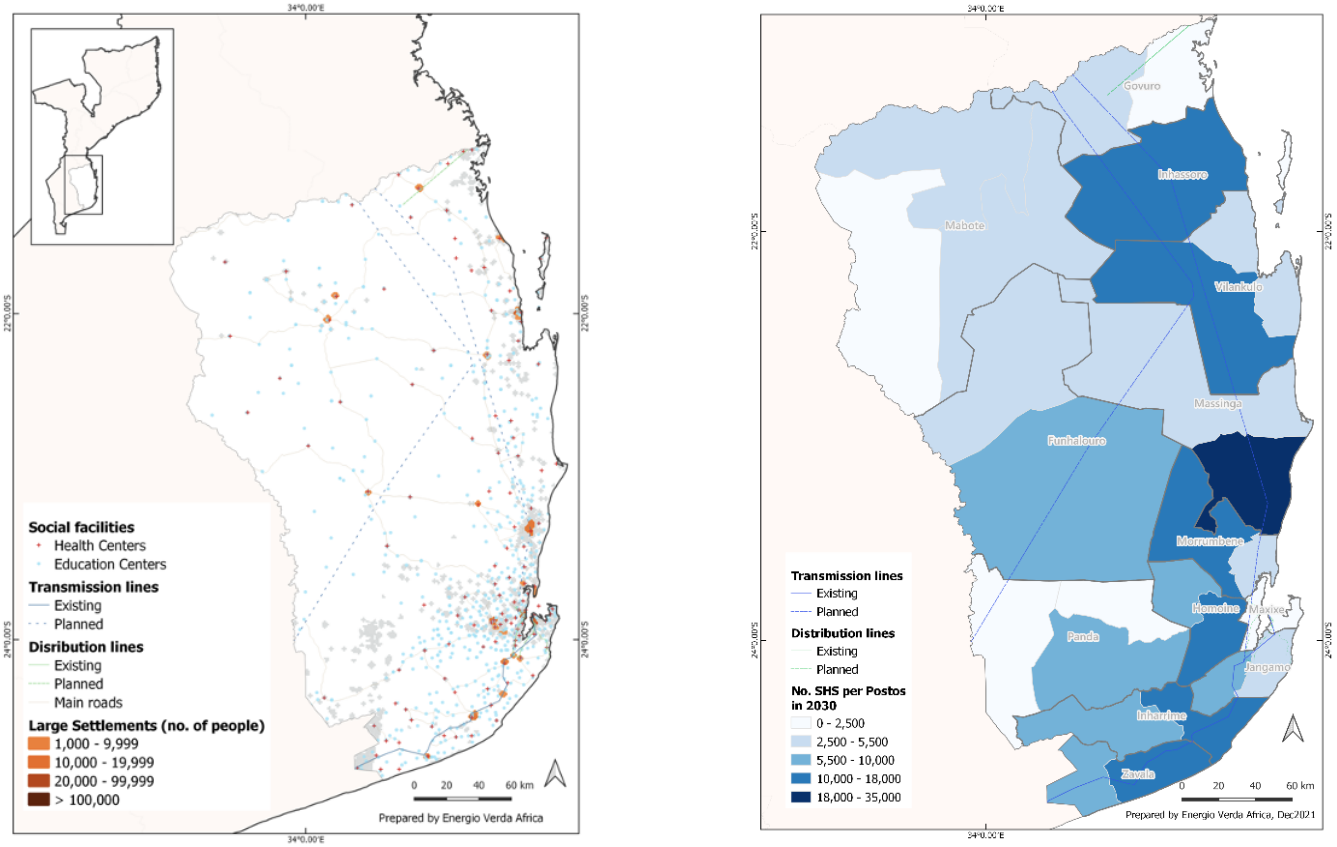
FIGURE 14: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN GAZA PROVINCE BY 2030



2.2.2.4. Inhambane Province

This section presents an overview of the off-grid market potential for Inhambane Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 15: INHAMBANE PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

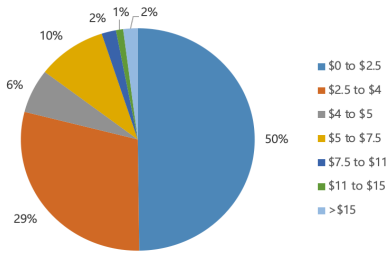
Provincial profile	Inhambane Province is a coastal province in southern Mozambique with a population of about 1.5 million.[62] Maize and cassava are among the main subsistence crops, while tourism and semi-industrial fishing are important contributors to the local economy. About 69% of the province has mobile network coverage, mostly along the coast, while access to mobile money services and use by adults is under 20%, which is among the lowest rates in the country (**Figure 5**).[63] In the extractive industry, ongoing natural gas development in the province aims to deliver gas to the domestic market and South Africa. The Central Termica de Temane project is a 450MW gas-fired power plant that will source gas from the Pande-Temane Inhassoro gas fields in Inhambane to supply power to the EDM network.[64]
Electrification status / off-grid solar market activity	Inhambane has an electrification rate of 27.7%, which is the seventh highest rate of access in the country. The EDM network is concentrated around the cities of Inhambane, Lindela and Maxixe in the southeastern coastal region where the majority of the population resides. The western and northern districts of the province are less densely populated (**Figure 15**). In the off-grid sector, SolarWorks has four shops in the province located in Mabote, Vilanculos, Massinga and Maxixe. ENGIE Energy Access has stores located in Zavala, Inharrime, Maxixe, Massinga and Vilanculos. Logos Industries has an office in Maxixe.
Results of the GIS analysis: new connections required through 2030	**2030 projections**: In 2030, Inhambane will have approximately 500,000 households, of which 30% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 61% and about 175,000 households will be electrified by SHS. By 2030, 94% of urban areas will be connected to the grid, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 16**).[65] **Annual electrification targets**: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of 25,000 households will need grid connections annually • SHS: An average of about 40,000 households will need to be electrified by SHS annually • Mini-grids: An average of 3,200 households will need mini-grid connections annually
Additional SHS for pre-electrification and replacement of retired systems	In addition to 152,310 new connections, another 127,901 SHS will need to be deployed for pre-electrification and 103,685 SHS for the replacement of retired systems, bringing the total number of SHS required in Inhambane Province through 2030 to 383,896.

SHS Category	Units Required
New Permanent Connections	152,310
Temporary Pre-Electrification	127,901
Replacement of Retired Systems	103,685
Total	383,896

62 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
63 BRILHO Provincial Profile: Inhambane Province, UK Aid and SNV, 2020.
64 "Temane gas initiative on course to boost Mozambique's energy security," ESI Africa, (December 11, 2020): https://www.esi-africa.com/industry-sectors/generation/temane-gas-initiative-on-course-to-boost-mozambiques-energy-security/
65 See **Annex 2-A** for more details.

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 400,000 SHS to complement grid electrification in achieving universal access in Inhambane Province by 2030 is USD 75.2M (MZN 4.8B). In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated USD 27.4M (MZN 1.7B) is required to bridge the affordability gap for off-grid households in Inhambane Province to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PayGo basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Inhambane Province by 2030 is USD 102.6M (MZN 6.6B), which accounts for approximately 8% of the total capital needed for SHS across the country. **Figure 17** summarizes the volume and blend of financing that is required to achieve universal electricity access in Inhambane Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Inhambane Province		
National Rank	Barriers / Risks	Districts / regions
2/11	Logistical Population density Mobile network coverage	Northern and western districts

Remoteness Index Ranking: Inhambane Province has the second highest index score in the country (**Table 3**), as several barriers were identified, including low population density and logistical constraints, especially high average distances to the nearest sea port, which increase costs for electricity service providers, particularly in the northern and western districts of the province that are more difficult to access.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. According to the World Bank, approximately 40% of the population in Inhambane lives below the poverty line. In 2019, 43% of surveyed households in the province indicated the main reason they do not own a SHS is that they cannot afford one.[66] The ongoing pandemic, political conflict and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

Actionable priorities to achieve universal access in 2030

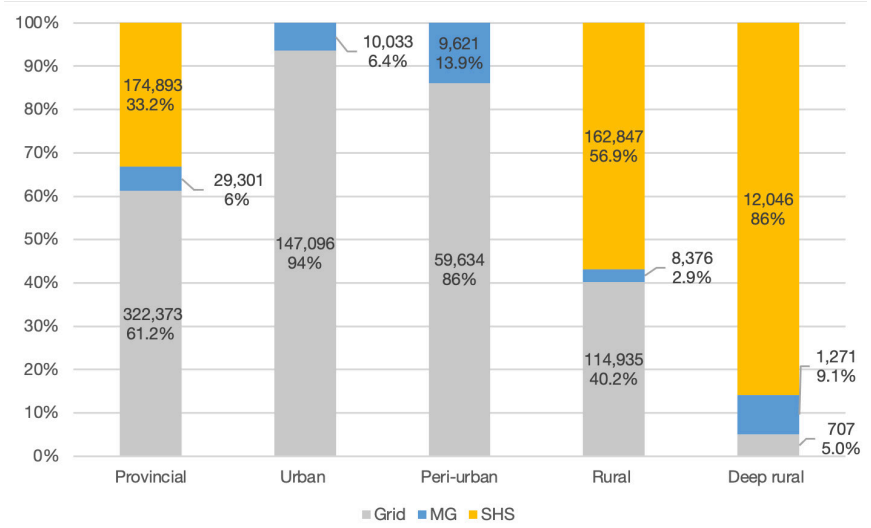
Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Inhambane Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Massinga, Funhalouro and Vilankulo Districts (**Figure 15**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 17**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Inhambane Province by an estimated USD 48.5M (MZN 3B).

Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

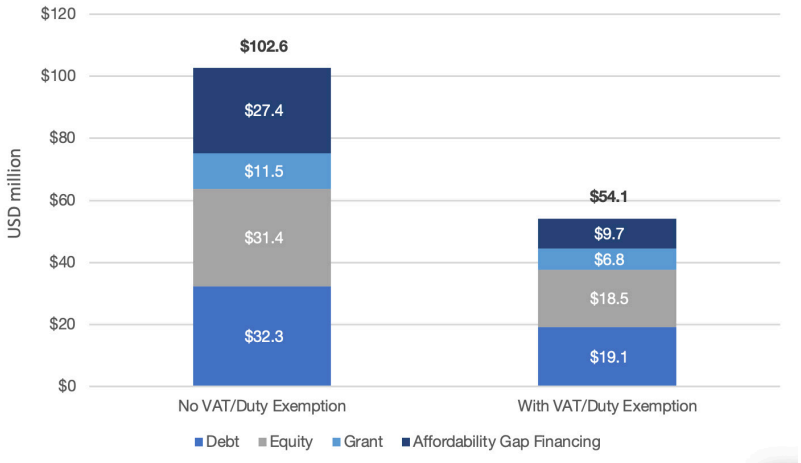
66 USAID SAEP Mozambique Consumer Affordability survey, 2019.

FIGURE 16: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, INHAMBANE PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

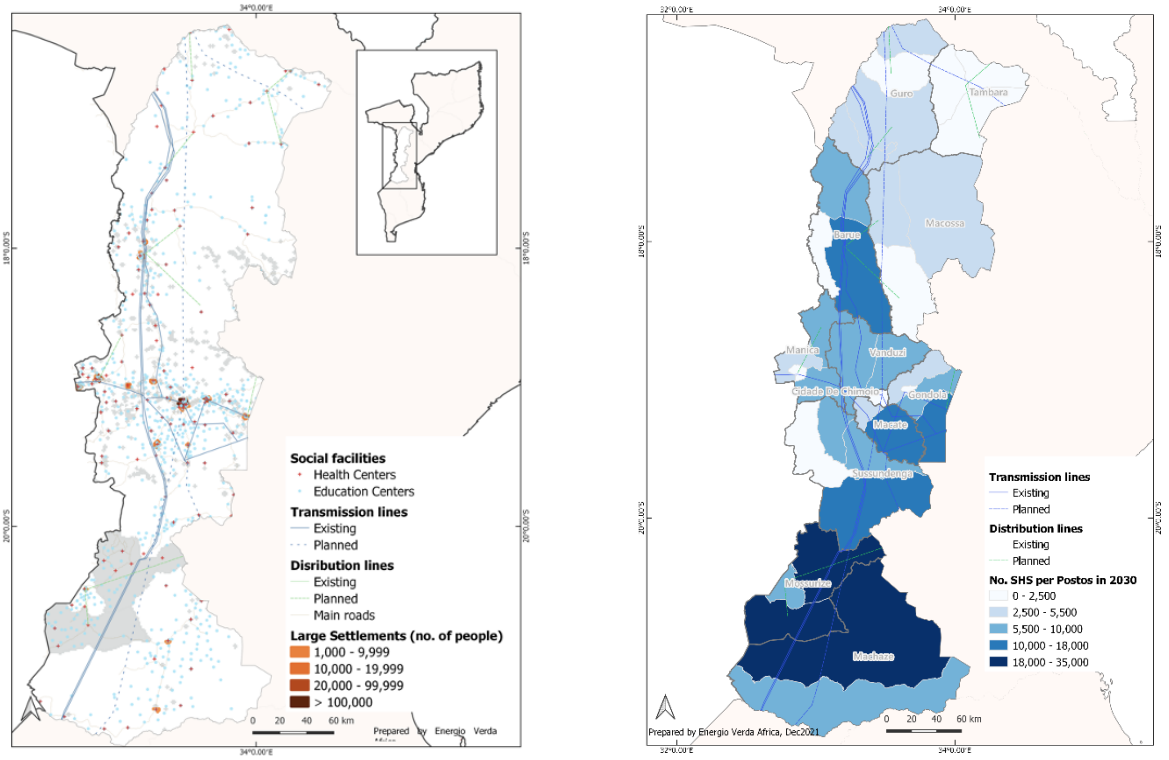
FIGURE 17: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN INHAMBANE PROVINCE BY 2030



2.2.2.5. Manica Province

This section presents an overview of the off-grid market potential for Manica Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 18: MANICA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

Provincial profile

Manica Province is located in central Mozambique with a population of about 1.9 million.[67] The local economy relies on agriculture (subsistence farming of maize and cassava; the main cash crops include bananas, potatoes and tomatoes), livestock production, mining, and tourism (Chimanimani National Reserve). Manica is part of the Beira Corridor – a large area of horticulture production that also covers Sofala and Tete provinces (**Figure 22**). About 78% of the province has mobile network coverage, while access to mobile money services and use by adults is about 35% (**Figure 5**).[68] Manica Province is extremely vulnerable to climate risks. In 2019, the province was hit by Cyclone Idai – one of the worst tropical cyclones on record to affect Africa – which caused extensive flooding and destruction and damaged the livelihoods of the vast majority (85%) of the local population, leading to a humanitarian crisis that the province is still recovering from. Manica was among the four provinces that was worst affected by the disaster, along with Sofala, Tete and Zambézia.[69]

67 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
68 BRILHO Provincial Profile: Manica Province, UK Aid and SNV, 2020.
69 "Eight months after Idai: Chronology of Displacement, Humanitarian Needs and Challenges going forward in Mozambique," International Organization of Migration, Internal Displacement Monitoring Centre, (2019): https://www.internal-displacement.org/sites/default/files/publications/documents/report_dtm_idmc_idai_2019_0.pdf

Electrification status / off-grid solar market activity

Manica has an electrification rate of 30%, which is the fifth highest rate of access in the country. Households connected to the EDM grid are largely concentrated in the provincial capital, Chimoio, as well as other urban centers. In the off-grid sector, SolarWorks is currently operating in Manica, with two shops located in Catandica and Sussundenga. ENGIE Energy Access has store locations in Chimoio, Manica, Inchope, Sussundenga, Vanduzi, Catandica and Guro. Epsilon Energia Solar has an office in Chimoio and operates in the province with funding from GIZ EnDev. Another company, Mofer Lda., is based in Chimoio and provides electricity services in Manica province, including the sale, installation, operation and maintenance of solar equipment.

Results of the GIS analysis: new connections required through 2030

2030 projections: In 2030, Manica will have approximately 730,000 households, of which 33% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 63% and about 250,000 households will be electrified by SHS. By 2030, nearly all urban and peri-urban areas will be connected to the grid, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 19**).[70]

Annual electrification targets: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets:

- Grid connections: An average of **36,000** households will need grid connections annually
- SHS: An average of about **60,000 households** will need to be electrified by SHS annually
- Mini-grids: An average of **1,500 households** will need mini-grid connections annually

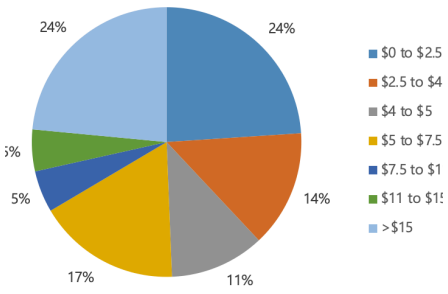
Additional SHS for pre-electrification and replacement of retired systems

In addition to 226,847 new connections, another 170,793 SHS will need to be deployed for pre-electrification and 136,996 SHS for the replacement of retired systems, bringing the total number of SHS required in Manica Province through 2030 to 534,636.

SHS Category	Units Required
New Permanent Connections	226,847
Temporary Pre-Electrification	170,793
Replacement of Retired Systems	136,996
Total	534,636

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 500,000 SHS to complement grid electrification in achieving universal access in Manica Province by 2030 is **USD 111.5M (MZN 7.1B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 22.3M (MZN 1.4B)** is required to bridge the affordability gap for off-grid households in Manica to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Manica Province by 2030 is **USD 133.8M (MZN 8.5B)**, which accounts for approximately 10% of the total capital needed for SHS across the country. **Figure 20** summarizes the volume and blend of financing that is required to achieve universal electricity access in Manica Province by 2030 – with and without VAT/duty exemptions.

70 See **Annex 2-A** for more details.

Off-Grid Solar market barriers and risks

Remoteness Index: Manica Province		
National Rank	Barriers / Risks	Districts / regions
5/11	Logistical Population density Mobile network coverage	Southern districts

Remoteness Index Ranking: Manica Province ranks fifth in the country in its index score (**Table 3**). Many settlements in the province are widely dispersed with low population density, which increases costs for electricity service providers.

Additional logistical constraints include the relatively high average distance of households to main roads and to the nearest sea port, particularly for households in the southern districts of the province that are more difficult to access.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. According to the World Bank, approximately 40% of the population in Manica lives below the poverty line. In 2019, 34% of surveyed households in the province indicated the main reason they do not own a SHS is that they cannot afford one.[71] The ongoing pandemic and recent impacts of Cyclone Idai in 2019 have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

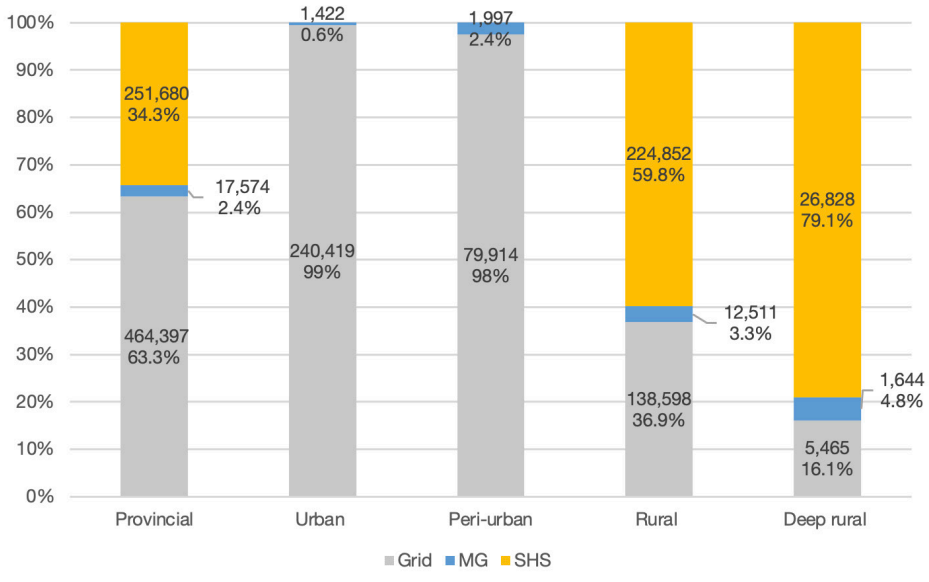
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Manica Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Machaze, Mossurize and Tambara Districts (**Figure 19**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 20**, by implementing VAT/import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Manica Province by an estimated **USD 34.5M (MZN 2.2B)**.

Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

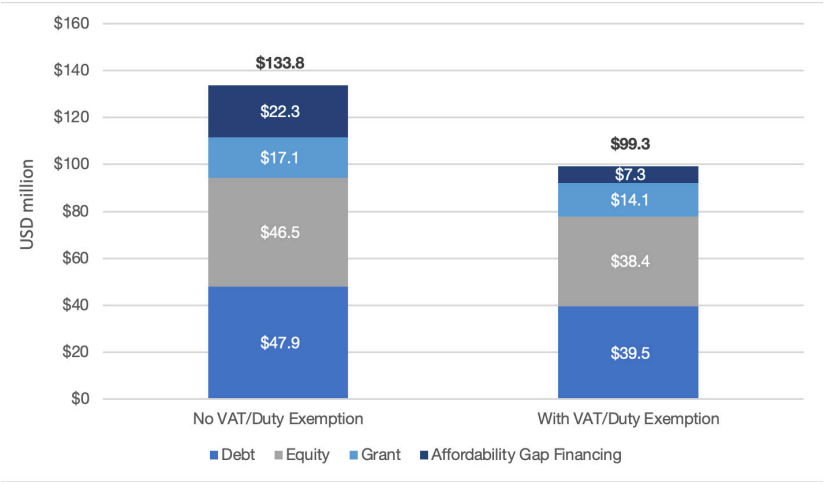
FIGURE 19: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, MANICA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

71 USAID SAEP Mozambique Consumer Affordability survey, 2019.

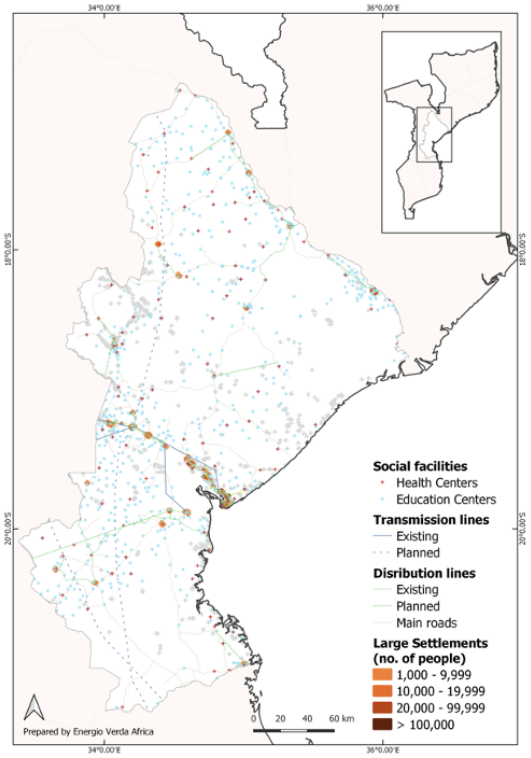
FIGURE 20: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN MANICA PROVINCE BY 2030

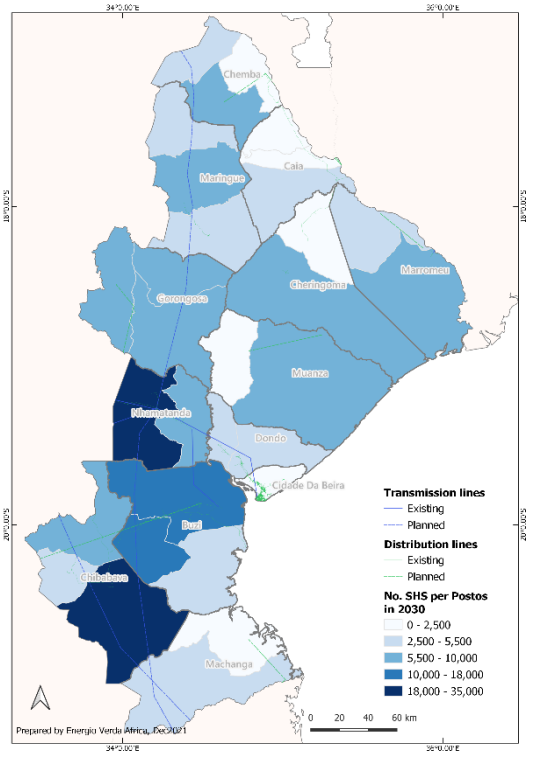


2.2.2.6. Sofala Province

This section presents an overview of the off-grid market potential for Sofala Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 21: SOFALA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)





Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

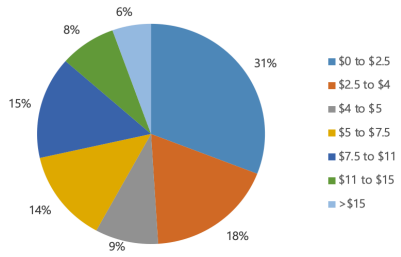
Provincial profile	Sofala is a coastal province in central Mozambique with a population of about 2.3 million.[72] The provincial capital, Beira, is the country's fourth largest city and contains its second largest seaport after Maputo. The local economy relies on the agricultural sector (subsistence farming of maize, rice and cassava; the main cash crops include pineapples, cotton, sesame seeds and sugarcane), as Sofala is part of the Beira Corridor – a large area of horticulture production that also covers Manica and Tete provinces (**Figure 22**). Artisanal fishing and tourism (Gorongosa National Park) are also important economic sectors. About 58% of the province has mobile network coverage, while access to mobile money services and use by adults is about 40% (**Figure 5**).[73] Sofala Province is extremely vulnerable to climate risks. In 2019, following a severe drought in 2015–2016, the province was hit by Cyclone Idai – one of the worst tropical cyclones on record to affect Africa and the Southern Hemisphere – which caused extensive flooding and destruction and damaged the livelihoods of the vast majority (85%) of the local population, leading to a humanitarian crisis that the province is still recovering from. Sofala was among the four provinces that was worst affected by the disaster, along with Manica, Tete and Zambézia.[74]
Electrification status / off-grid solar market activity	Sofala has an electrification rate of 42.6%, which is the fourth highest rate in the country. Households connected to the EDM grid are largely concentrated in the provincial capital, Beira (Figure 21). In the off-grid sector, SolarWorks has two shops located in Muxúnguè and one in Nhamatanda, while Logos Industries has an office in Beira. Another local solar company, Durabal, also operates in the province from an office in Beira.
Results of the GIS analysis: new connections required through 2030	**2030 projections**: In 2030, Sofala will have approximately 800,000 households, of which 45% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 73% and about 190,000 households will be electrified by SHS. By 2030, nearly all urban and peri-urban areas will be connected to the grid, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 23**).[75] **Annual electrification targets**: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of 43,800 households will need grid connections annually • SHS: An average of about 55,000 households will need to be electrified by SHS annually • Mini-grids: An average of 2,900 households will need mini-grid connections annually
Additional SHS for pre-electrification and replacement of retired systems	In addition to 178,547 new connections, another 210,269 SHS will need to be deployed for pre-electrification and 95,525 SHS for the replacement of retired systems, bringing the total number of SHS required in Sofala Province through 2030 to 484,341.

SHS Category	Units Required
New Permanent Connections	178,547
Temporary Pre-Electrification	210,269
Replacement of Retired Systems	95,525
Total	484,341

72 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
73 BRILHO Provincial Profile: Sofala Province, UK Aid and SNV, 2020.
74 International Organization for Migration, 2019.
75 See **Annex 2-A** for more details.

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 500,000 SHS to complement grid electrification in achieving universal access in Sofala Province by 2030 is USD 99.1M (MZN 6.3B). In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated USD 19.5M (MZN 1.2B) is required to bridge the affordability gap for off-grid households in Sofala to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Sofala Province by 2030 is USD 118.6M (MZN 7.6B), which accounts for approximately 9% of the total capital needed for SHS across the country. **Figure 24** summarizes the volume and blend of financing that is required to achieve universal electricity access in Sofala Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Sofala Province		
National Rank	Barriers / Risks	Districts / regions
4/11	Logistical Population density Mobile network coverage	Northern districts

Remoteness Index Ranking: Sofala Province has the fourth highest index score in the country (**Table 3**). Many settlements in the province are widely dispersed and with low levels of population density, which increases logistical costs for electricity service providers.

Additional barriers include the relatively high average distance of households to main roads and to the nearest sea port, particularly for households in the northern districts of the province that are more difficult to access.

Other barriers and risks: There is an ongoing political conflict in Sofala, where attacks from an opposition militia have impacted critical transport corridors that connect the south and north of the country. Given the high rates of poverty in Mozambique, low consumer purchasing power/ ability to pay for electricity access represents the most significant barrier to OGS market growth. In 2019, 59% of surveyed households in Sofala indicated the main reason they do not own a SHS is that they cannot afford one.[76] The ongoing pandemic and recent impacts of Cyclone Idai in 2019 have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Sofala Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Chibabava, Maringue and Nhamatanda Districts (**Figure 21**) and PUE applications for the agricultural sector in the Beira Corridor (**Figure 22**)
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 24**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Sofala Province by an estimated USD 43.6M (MZN 2.7B).

Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

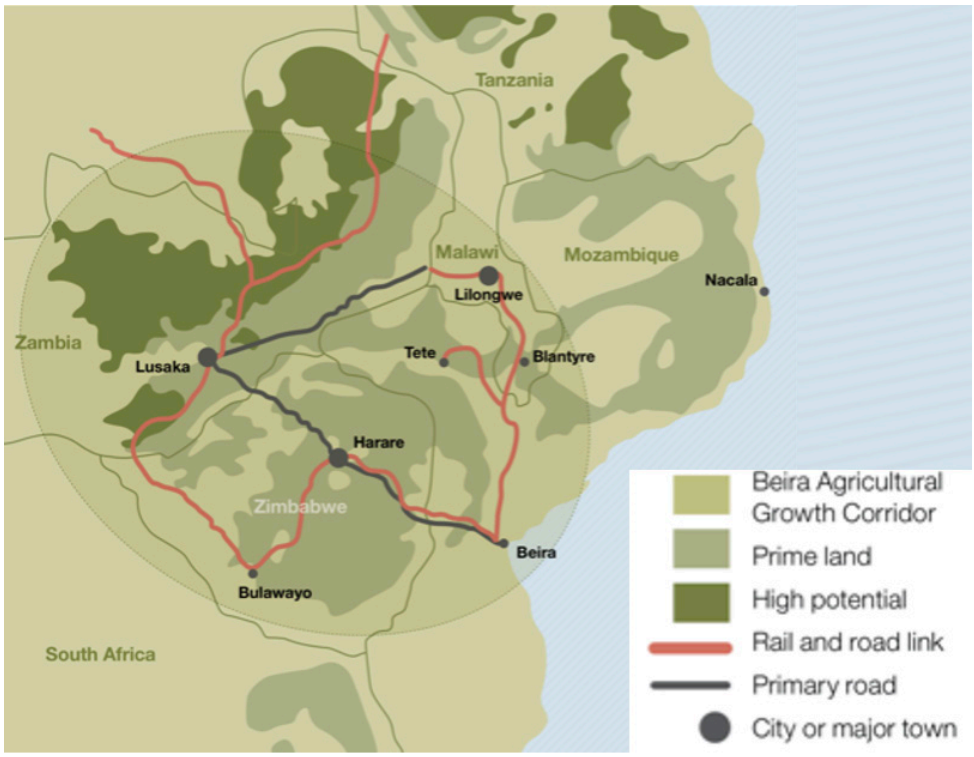
76 USAID SAEP Mozambique Consumer Affordability survey, 2019.

The Beira Corridor is one of Southern Africa's main transport routes. It is a road and rail network linking large parts of Zambia, Malawi, Zimbabwe and Mozambique to the port of Beira on the Indian Ocean. Farmland along the corridor has proven agricultural potential with microclimates suitable for a variety of crops for domestic consumption and export. There are good water resources along the corridor, although a lack of infrastructure means that most agricultural production is rain-fed. Of the over 10 million hectares of arable land available in the Beira Corridor, less than 5% is presently commercially exploited.

Since 2017, the Beira Agricultural Growth Corridor (BAGC) Partnership has helped launch and build the capacity of several farmer associations in the region with the objective of increasing smallholder farmer productivity and financial viability, helping secure access to finance, and facilitating supply chain linkages between farmers and agricultural commodity buyers.[77]

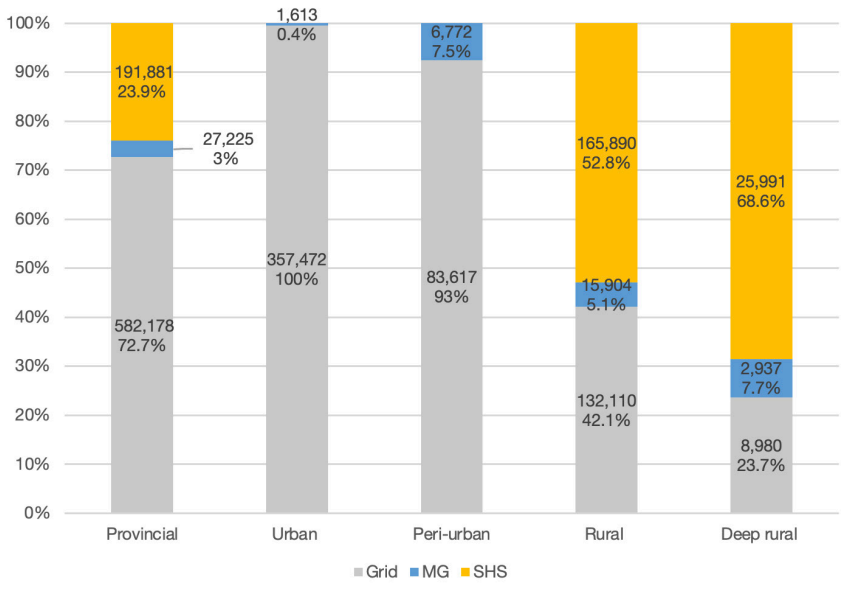
Standalone solar electrification can support small-scale productive use of electricity (PUE) applications in the Beira Corridor, especially for irrigation and cold storage applications, which can reduce post-harvest losses for smallholder farmers.

FIGURE 22: BEIRA AGRICULTURAL GROWTH CORRIDOR



Source: Beira Agricultural Growth Corridor (BAGC) Partnership

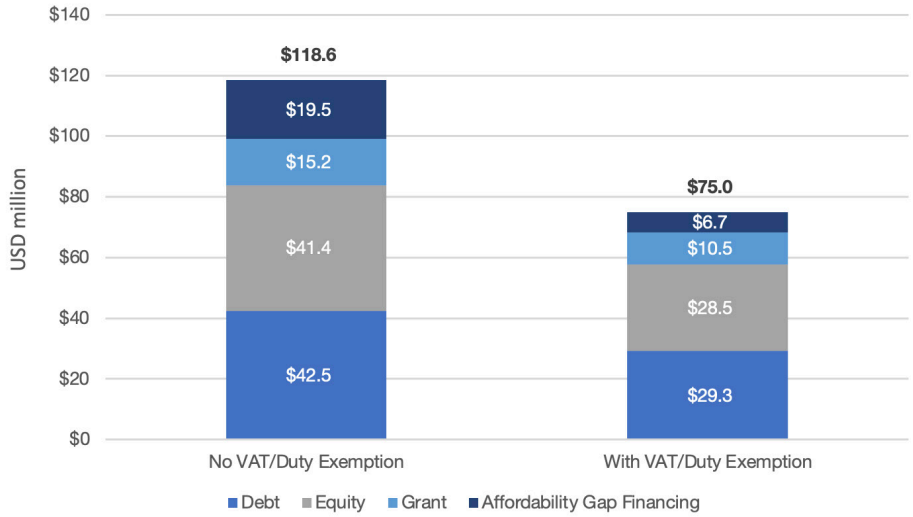
FIGURE 23: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, SOFALA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

77 Beira Corridor: https://beiracorridor.org/farmer-association-strengthening/; and https://beiracorridor.org/results-and-impact/

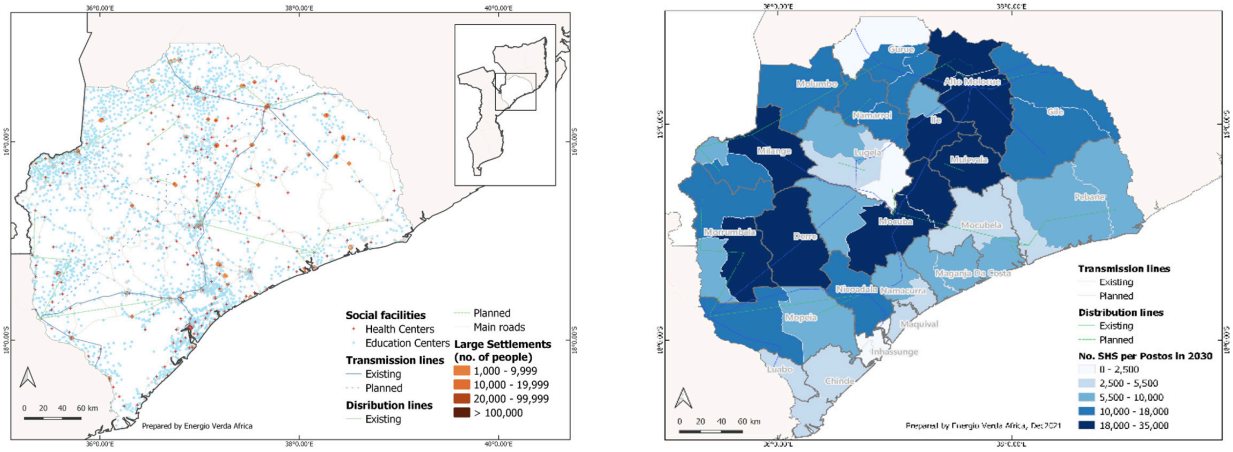
FIGURE 24: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN SOFALA PROVINCE BY 2030



2.2.2.7. Zambézia Province

This section presents an overview of the off-grid market potential for Zambézia Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 25: ZAMBÉZIA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

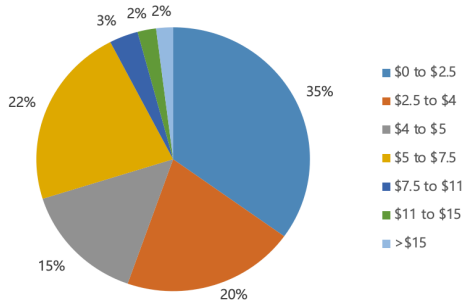
Provincial profile	Located in the central-coastal region, Zambézia is Mozambique's second most populous province, with a population of about 5.2 million.[78] The local economy relies on agriculture (subsistence farming of maize, cassava and millet; the main cash crops include cashews, sesame seeds and cotton), agricultural processing, artisanal fishing and mining. About 63% of the province has mobile network coverage, while access to mobile money services and use by adults is about 50%, which is among the highest rates in the country (**Figure 5**).[79] Zambézia Province is extremely vulnerable to climate risks. It was among the four provinces that was worst affected by Cyclone Idai in 2019, along with Sofala, Manica, and Tete. Deforestation is also a huge problem for the province, as a growing population and persistently low rates of energy access drive demand for wood and bio-energy, particularly charcoal. Between 2001 and 2016, Zambézia lost 5% of its forest cover, mainly due to small-scale slash and burn agriculture and charcoal production.[80]
Electrification status / off-grid solar market activity	Zambézia has an electrification rate of 16.7%, which is the lowest rate of access in the country. In the off-grid sector, ENGIE Energy Access has store locations in Alto-Benfica, Alto Molocue and Mocuba. Epsilon Energia currently operates in Zambézia with funding from BRILHO, while Ignite Mozambique and Dynamiss Trading also operate in the province. SolarWorks plans to extend its operations to the province in the near future.
Results of the GIS analysis: new connections required through 2030	**2030 projections**: In 2030, Zambézia will have approximately 1.8 million households, of which 18% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 56% and about 500,000 households will be electrified by SHS. By 2030, most urban areas will be connected to the grid, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 26**).[81] **Annual electrification targets**: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of 80,400 households will need grid connections annually • SHS: An average of about 134,000 households will need to be electrified by SHS annually • Mini-grids: An average of 33,200 households will need mini-grid connections annually
Additional SHS for pre-electrification and replacement of retired systems	In addition to 483,765 new connections, another 511,787 SHS will need to be deployed for pre-electrification and 211,042 SHS for the replacement of retired systems, bringing the total number of SHS required in Zambézia Province through 2030 to 1,206,594.

SHS Category	Units Required
New Permanent Connections	483,765
Temporary Pre-Electrification	511,787
Replacement of Retired Systems	211,042
Total	1,206,594

78 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
79 BRILHO Provincial Profile: Zambézia Province, UK Aid and SNV, 2020.
80 "Zambézia Landscape Program: Building Livelihoods and Conserving Forests in Rural Mozambique," World Bank, (January 1, 2018): https://documents1.worldbank.org/curated/en/255741537429237774/pdf/130035-WP-PUBLIC-Zambezia-ERP-Brochure-sml.pdf
81 See **Annex 2-A** for more details.

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 1.2 million SHS to complement grid electrification in achieving universal access in Zambézia Province by 2030 is USD 241.8M (MZN 15.4B). In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated USD 58.1M (MZN 3.7B) is required to bridge the affordability gap for off-grid households in Zambézia to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Zambézia Province by 2030 is USD 299.8M (MZN 19.1B), which accounts for approximately 22% of the total capital needed for SHS across the country. **Figure 27** summarizes the volume and blend of financing that is required to achieve universal electricity access in Zambézia Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Zambézia Province		
National Rank	Barriers / Risks	Districts / regions
8/11	Logistical Population density Mobile network coverage	Eastern districts

Remoteness Index Ranking: Zambézia Province ranks eighth in the country in its index score (**Table 3**). Many settlements in the province are widely dispersed and with low levels of population density, particularly in the eastern districts, which increases costs for electricity service providers. The province's relatively high average distance to the nearest sea port was also identified as another key logistical constraint.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. According to the World Bank, approximately 60% of the population in Zambézia lives below the poverty line. The ongoing pandemic and recent impacts of Cyclone Idai in 2019 have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

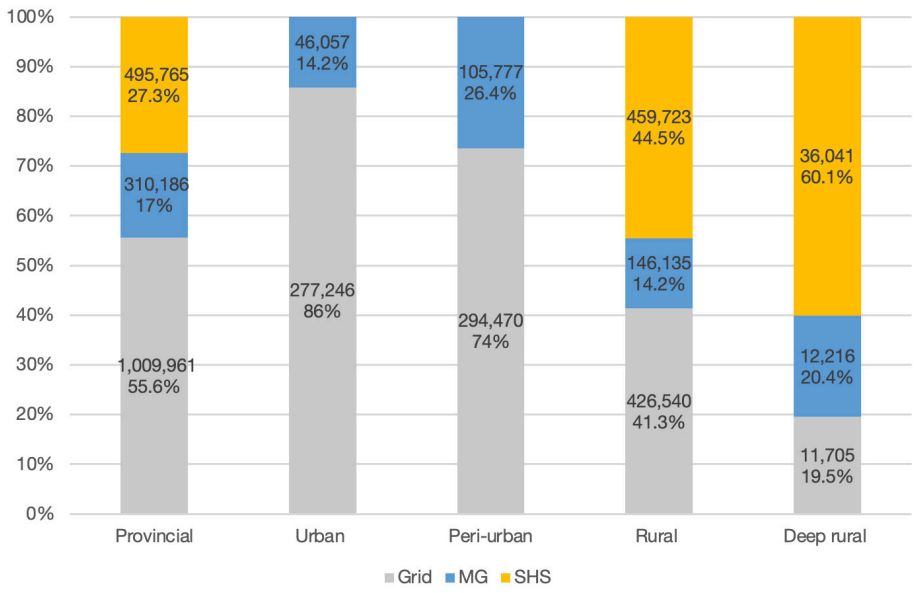
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Zambézia Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Gile, Namarroi and Alto Molocue Districts (**Figure 25**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 27**, by implementing VAT/import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Zambézia Province by an estimated USD 131.1M (MZN 8.3B).

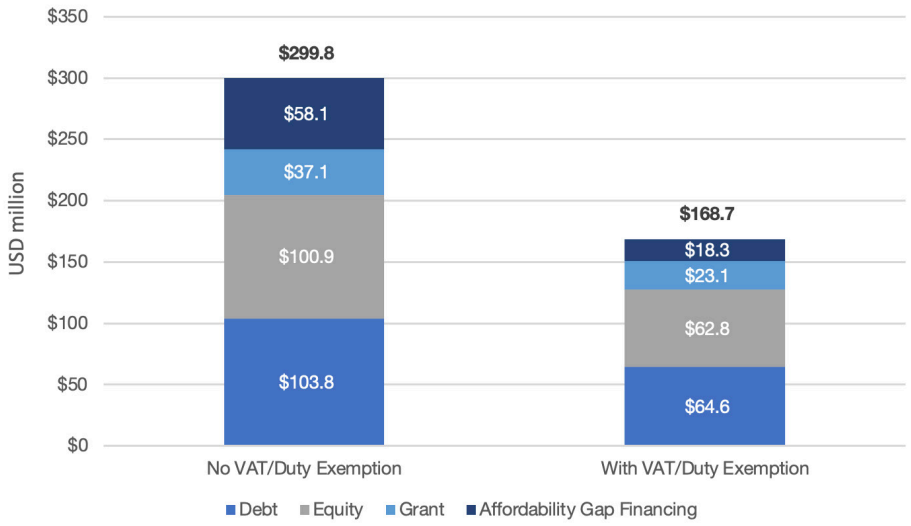
Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

FIGURE 26: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, ZAMBÉZIA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

FIGURE 27: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN ZAMBÉZIA PROVINCE BY 2030

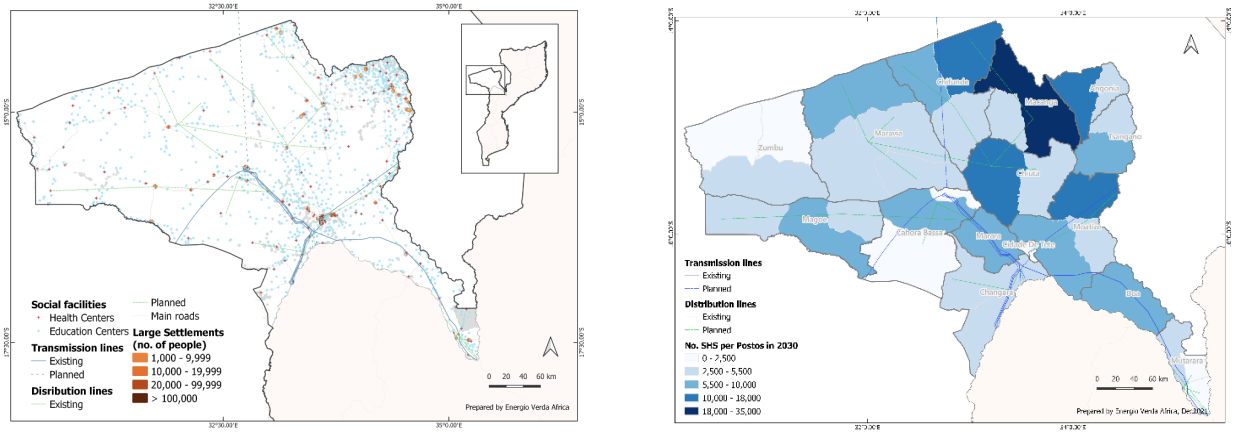


2.2.2.8. Tete Province

This section presents an overview of the off-grid market potential for Tete Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 28: TETE PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND

ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

Provincial profile	Tete is a resource-rich province in northern Mozambique with a population of about 2.6 million.[82] Population density is higher near the province's eastern border with Malawi (**Figure 28**). The local economy relies on agriculture (subsistence farming of maize, beans, sorghum, groundnuts and millet; the main cash crops include cotton and tobacco), artisanal fishing in inland waters, and livestock production.[83] Tete is part of the Beira Corridor – a large area of horticulture production that also covers Sofala and Manica provinces (**Figure 22**).[84] About 76% of the province has mobile network coverage, while access to mobile money services and use by adults is about 20%, which is among the lowest rates in the country (**Figure 5**).[85] The Moatize Basin in Tete has one of the world's largest-known coal reserves, including a significant concentration of high-grade metallurgical coal (unlike thermal coal used in power generation, metallurgical coal is a key raw material in steel production). The Cahora Bassa Dam is also located in Tete on the Zambezi River in the western part of the province. The province is extremely vulnerable to climate risks. It was among the four provinces that was worst affected by Cyclone Idai in 2019, along with Sofala, Manica, and Zambézia.
Electrification status / off-grid solar market activity	Tete has an electrification rate of 29.2%, which is the sixth highest rate of access in the country. The EDM network is largely concentrated around the Cahora Bassa Dam, located on the Zambezi River in the western part of the province. In the off-grid sector, ENGIE Energy Access has store locations in Tete, Changara, Tsangano and Angonia. Epsilon Energia is also active in Tete.
Results of the GIS analysis: new connections required through 2030	**2030 projections:** In 2030, Tete will have approximately 1 million households, of which 20% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 46% and about 200,000 households will be electrified by SHS. By 2030, most urban areas will be connected to the grid, while the majority of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 29**).[86] **Annual electrification targets:** In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of **27,200** households will need grid connections annually • SHS: An average of about **65,000 households** will need to be electrified by SHS annually • Mini-grids: An average of **38,300 households** will need mini-grid connections annually

82 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
83 BRILHO Provincial Profile: Tete Province, UK Aid and SNV, 2020.
84 The World Food Programme (WFP) is currently implementing a 'Zero Post-Harvest Loss Project' in Tete Province, which aims to reduce post-harvest losses at the smallholder level and foster market integration in the region by linking together farmers and agro-processors to strengthen the supply chains of local staple foods (Source: BAGC Partnership: https://beiracorridor.org/zero-post-harvest-loss-project/)
85 BRILHO Provincial Profile: Tete Province, UK Aid and SNV, 2020.
86 See **Annex 2-A** for more details.

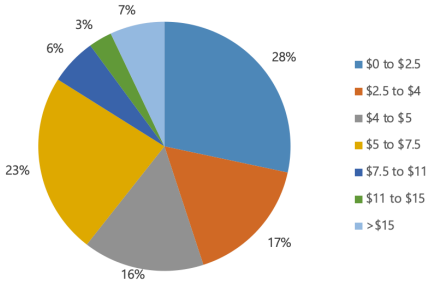
Additional SHS for pre-electrification and replacement of retired systems

In addition to 201,783 new connections, another 294,521 SHS will need to be deployed for pre-electrification and 83,066 SHS for the replacement of retired systems, bringing the total number of SHS required in Tete Province through 2030 to 579,370.

SHS Category	Units Required
New Permanent Connections	201,783
Temporary Pre-Electrification	294,521
Replacement of Retired Systems	83,066
Total	579,370

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 600,000 SHS to complement grid electrification in achieving universal access in Tete Province by 2030 is **USD 119.3M (MZN 7.6B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 20.2M (MZN 1.3B)** is required to bridge the affordability gap for off-grid households in Tete to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Tete Province by 2030 is **USD 139.5M (MZN 8.9B)**, which accounts for approximately 10% of the total capital needed for SHS across the country. **Figure 30** summarizes the volume and blend of financing that is required to achieve universal electricity access in Tete Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Tete Province		
National Rank	Barriers / Risks	Districts / regions
2/11	Logistical Population density Mobile network coverage	Northern and western districts

Remoteness Index Ranking: Tete Province has the second highest index score in the country (**Table 3**), as several barriers were identified, including low population density and logistical constraints, especially high average distances to the nearest sea port, which increase costs for electricity service providers, particularly in the northern and western districts of the province that are more difficult to access.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. In 2019, 68% of surveyed households in Tete indicated the main reason they do not own a SHS is that they cannot afford one.[87] The ongoing pandemic and recent impacts of Cyclone Idai in 2019 have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

87 USAID SAEP Mozambique Consumer Affordability survey, 2019.

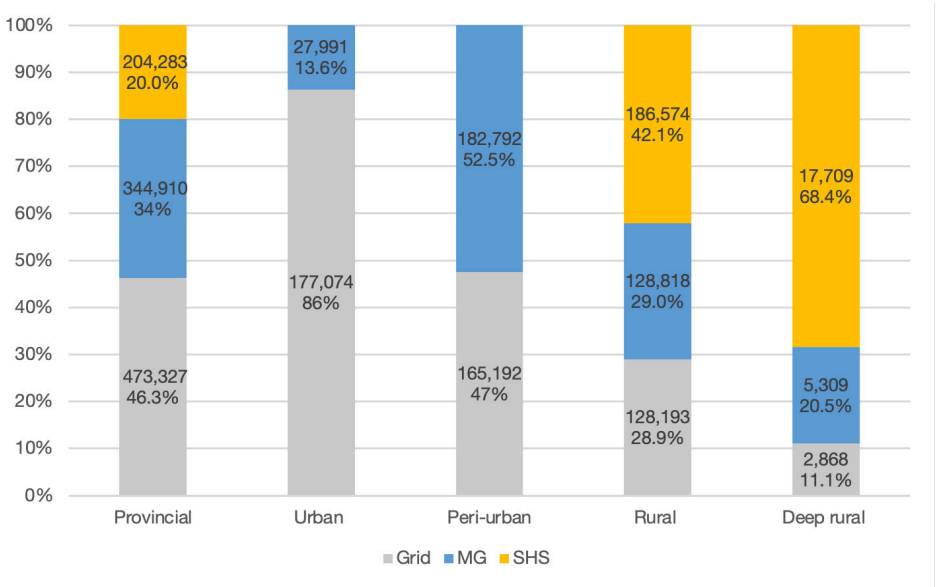
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Tete Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Macanga, Maravia and Moatize Districts (**Figure 28**).[88]
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 30**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Tete Province by an estimated **USD 54.7M (MZN 3.4B)**.

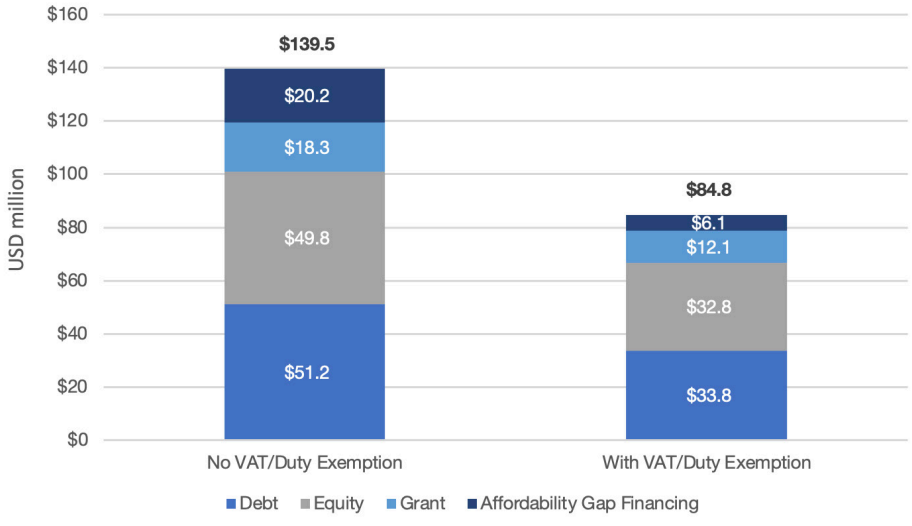
Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

FIGURE 29: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, TETE PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

FIGURE 30: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN TETE PROVINCE BY 2030

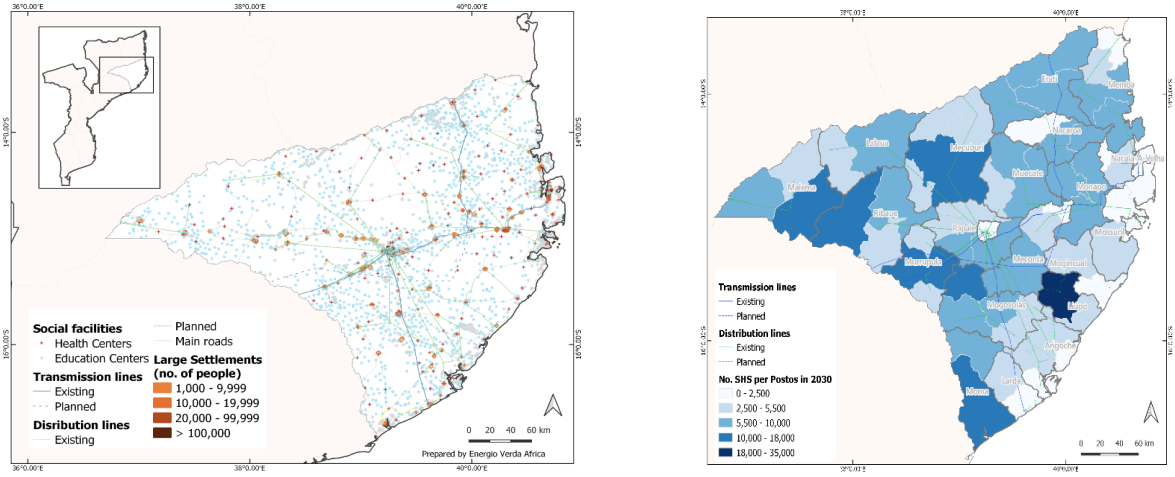


88 The high population density of Angonia District make it an attractive option for mini-grid electrification; however, EDM might target the area in the near future for grid extension given higher levels of electricity demand and the district's road accessibility.

2.2.2.9. Nampula Province

This section presents an overview of the off-grid market potential for Nampula Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 31: NAMPULA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

Provincial profile	Nampula is a coastal province in northern Mozambique with a population of about 5.8 million.[89] It is the country's most populous province. The local economy relies on agriculture (subsistence farming of maize and cassava; the main cash crops include cashews, cotton and tobacco), artisanal fishing and tourism.[90] The commercial production of cotton is particularly important to the local economy, as Nampula contributes to about half of the volume of the country's overall national cotton production.[91] About 75% of the province has mobile network coverage, while access to mobile money services and use by adults is about 55%, which is among the highest rates in the country (**Figure 5**).[92]
Electrification status / off-grid solar market activity	Nampula has an electrification rate of 27.4%, which is the eighth highest rate of access in the country. The EDM network is widespread throughout the province (Figure 31). Nampula has the country's largest off-grid population. Solar product ownership is high in Nampula; in 2019, 51% of surveyed households owned solar products.[93] In 2019, ENGIE Energy Access opened a branch in Nampula in collaboration with FUNAE and the satellite and digital television provider, DStv.[94] In addition to its office in the capital, Nampula, ENGIE also has stores in Murrupula, Ribaue, Nametil, Moma, Namialo, Nacarroa, Memba, Monapo, Nacala and Angoche. SolarWorks is has two shops in the province – one in Nampula and one in Namapa. Logos Industries and Ignite Mozambique also operate in the province.

89 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
90 BRILHO Provincial Profile: Nampula Province, UK Aid and SNV, 2020.
91 Mozambique: Climate change affecting cotton production," Further Africa, (February 6, 2020): https://furtherafrica.com/2020/02/06/mozambique-climate-change-affecting-cotton-production/
92 BRILHO Provincial Profile: Nampula Province, UK Aid and SNV, 2020.
93 USAID SAEP Mozambique Consumer Affordability survey, 2019.
94 "Fenix Mozambique Inaugurates Nampula Branch in Collaboration with FUNAE and DStv," Fenix Intl, (September 20, 2019): https://www.fenixintl.com/blog/fenix-mozambique-inaugurates-nampula-branch-in-collaboration-with-funae-and-dstv/

Results of the GIS analysis: new connections required through 2030

2030 projections: In 2030, Nampula will have approximately 2 million households, of which 33% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 71% and about 330,000 households will be electrified by SHS. By 2030, most urban and peri-urban areas will be connected to the grid, while the majority of the province's deep rural areas will need to be electrified by SHS (**Figure 32**).[95]

Annual electrification targets: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets:

- Grid connections: An average of 105,000 households will need grid connections annually
- SHS: An average of about 120,000 households will need to be electrified by SHS annually
- Mini-grids: An average of 26,500 households will need mini-grid connections annually

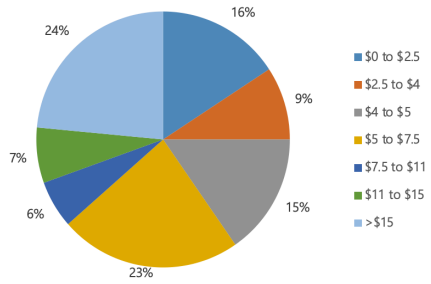
Additional SHS for pre-electrification and replacement of retired systems

In addition to 314,065 new connections, another 592,098 SHS will need to be deployed for pre-electrification and 166,305 SHS for the replacement of retired systems, bringing the total number of SHS required in Nampula Province through 2030 to 1,072,469.

SHS Category	Units Required
New Permanent Connections	314,065
Temporary Pre-Electrification	592,098
Replacement of Retired Systems	166,305
Total	1,072,469

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 1.1 million SHS to complement grid electrification in achieving universal access in Nampula Province by 2030 is USD 229.7M (MZN 14.7B). In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated USD 22.3M (MZN 1.4B) is required to bridge the affordability gap for off-grid households in Nampula to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PayGo basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Nampula Province by 2030 is USD 252M (MZN 16.1B), which accounts for approximately 19% of the total capital needed for SHS across the country. **Figure 33** summarizes the volume and blend of financing that is required to achieve universal electricity access in Nampula Province by 2030 – with and without VAT/duty exemptions.

95 See **Annex 2-A** for more details.

Off-Grid Solar market barriers and risks

Remoteness Index: Nampula Province		
National Rank	Barriers / Risks	Districts / regions
8/11	Logistical Population density Mobile network coverage	Western districts

Remoteness Index Ranking: Nampula Province ranks eighth in the country in its index score (**Table 3**). Many settlements in the province are widely dispersed and with low levels of population density, particularly in the western districts, which increases costs for electricity service providers.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. According to the World Bank, approximately 60% of the population in Nampula lives below the poverty line. In 2019, 49% of surveyed households in the province indicated the main reason they do not own a SHS is that they cannot afford one.[96] The ongoing pandemic, political conflict (the conflict in neighboring Cabo Delgado has led to an influx of IDPs living in resettlement camps in Nampula) and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

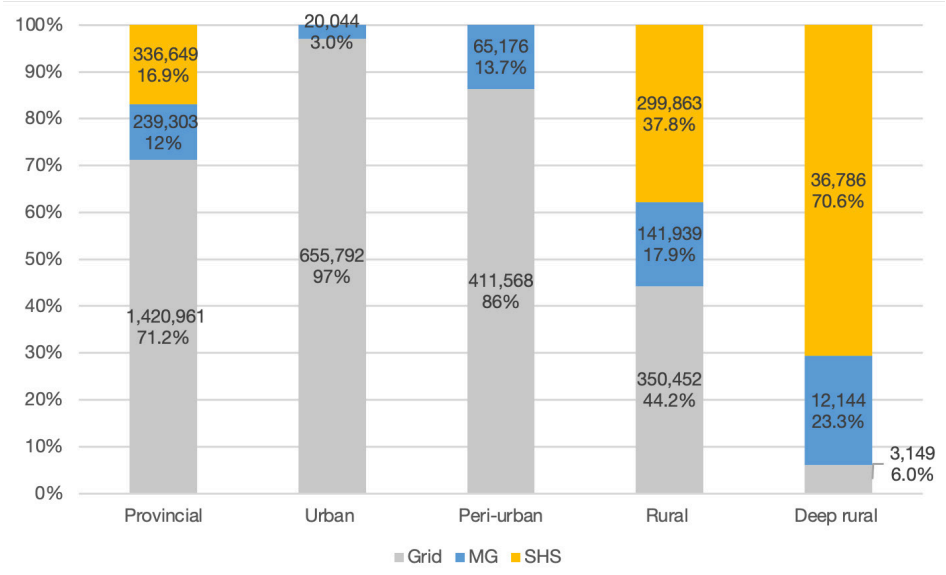
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Nampula Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Malema, Erati and Mecuburi Districts (**Figure 31**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 33**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Nampula Province by an estimated USD 72.5M (MZN 4.6B).

Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

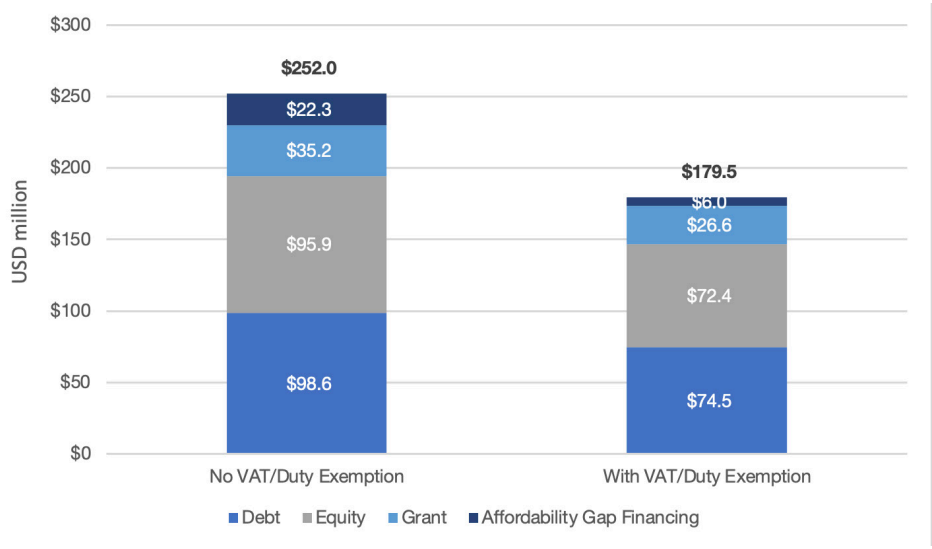
FIGURE 32: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, NAMPULA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

96 USAID SAEP Mozambique Consumer Affordability survey, 2019.

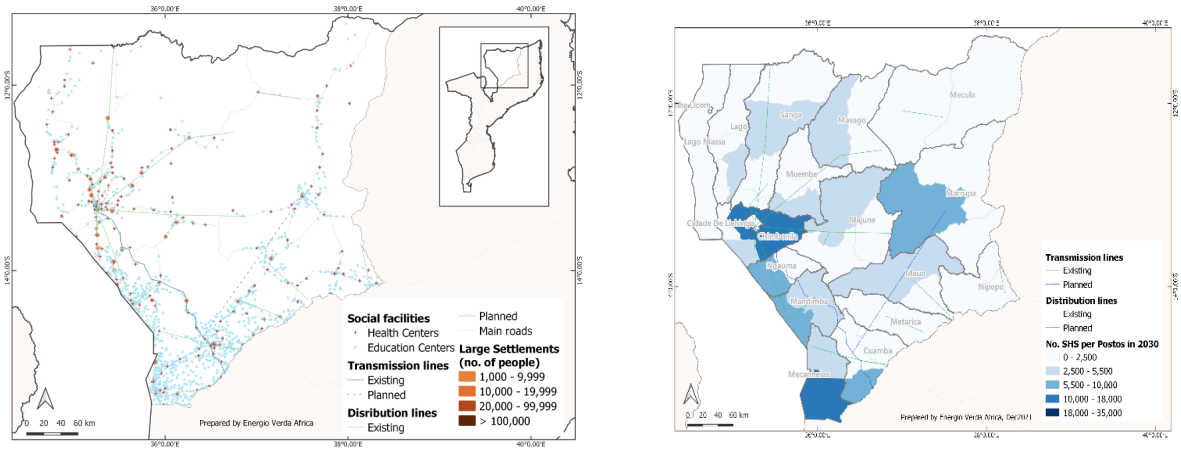
FIGURE 33: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN NAMPULA PROVINCE BY 2030



2.2.2.10. Niassa Province

This section presents an overview of the off-grid market potential for Niassa Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 34: NIASSA PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

Provincial profile	Niassa is a sparsely populated province in northern Mozambique with a population of about 1.8 million,[97] which is largely concentrated in the southwest part of the province. The local economy relies mainly on subsistence agriculture (the main cash crops include cashews, cotton and tobacco), artisanal fishing, tourism, and mining. About 68% of the province has mobile network coverage (**Figure 5**).[98]
Electrification status / off-grid solar market activity	Niassa has an electrification rate of 24.7%, which is among the lowest rates of access in the country, ahead of only Cabo Delgado and Zambézia. The EDM network is mainly concentrated around the provincial capital, Lichinga, near Lake Malawi (**Figure 34**). Ignite is the only company identified with activity in the off-grid sector, as SHS suppliers do not yet have a large presence in the province.

97 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
98 BRILHO Provincial Profile: Niassa Province, UK Aid and SNV, 2020.

Results of the GIS analysis: new connections required through 2030

2030 projections: In 2030, Niassa will have approximately 640,000 households, of which 31% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 53% and about 114,000 households will be electrified by SHS. By 2030, most urban and peri-urban areas will be connected to the grid, while nearly all of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 35**).[99]

Annual electrification targets: In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets:

- Grid connections: An average of **20,400** households will need grid connections annually
- SHS: An average of about **37,000 households** will need to be electrified by SHS annually
- Mini-grids: An average of **19,000 households** will need mini-grid connections annually

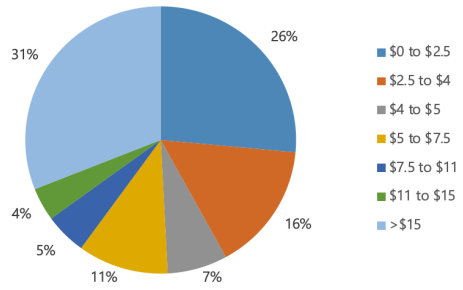
Additional SHS for pre-electrification and replacement of retired systems

In addition to 111.383 new connections, another 178,637 SHS will need to be deployed for pre-electrification and 49,060 SHS for the replacement of retired systems, bringing the total number of SHS required in Niassa Province through 2030 to 339,080.

SHS Category	Units Required
New Permanent Connections	111,383
Temporary Pre-Electrification	178,637
Replacement of Retired Systems	49,060
Total	339,080

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure[100]



It is estimated that the total capital needed by SHS enterprises to deploy about 340,000 SHS to complement grid electrification in achieving universal access in Niassa Province by 2030 is **USD 49.6M (MZN 3.2B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 9.7M (MZN 619.3M)** is required to bridge the affordability gap for off-grid households in Niassa to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Niassa Province by 2030 is **USD 59.3M (MZN 3.8B)**, which accounts for approximately 4% of the total capital needed for SHS across the country. **Figure 36** summarizes the volume and blend of financing that is required to achieve universal electricity access in Niassa Province by 2030 – with and without VAT/duty exemptions.

99 See **Annex 2-A** for more details.

100 Due to a lack of data, it was assumed that off-grid households in Niassa Province have a similar monthly energy expenditure profile as households in Cabo Delgado.

Off-Grid Solar market barriers and risks

Remoteness Index: Niassa Province		
National Rank	Barriers / Risks	Districts / regions
1/11	Logistical Population density Mobile network coverage	Northern districts

Remoteness Index Ranking: Niassa Province has the highest index score in the country (**Table 3**), as several barriers were identified, including low population density and logistical constraints, especially high average distances to the nearest sea port, which increase costs for electricity service providers, particularly in the northern districts of the province that are more difficult to access.

Other barriers and risks: Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth. The ongoing pandemic, political conflict (the conflict in neighboring Cabo Delgado has led to an influx of IDPs living in resettlement camps in Niassa) and recent climate disasters have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

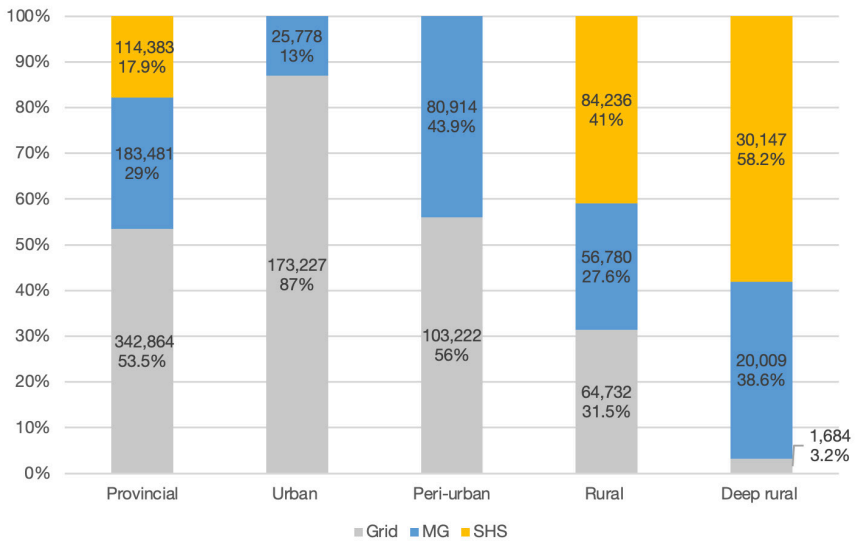
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Niassa Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Mecanhelas, Mavago and Marrupa Districts (**Figure 34**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 36**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Niassa Province by an estimated **USD 10.6M (MZN 677M)**.

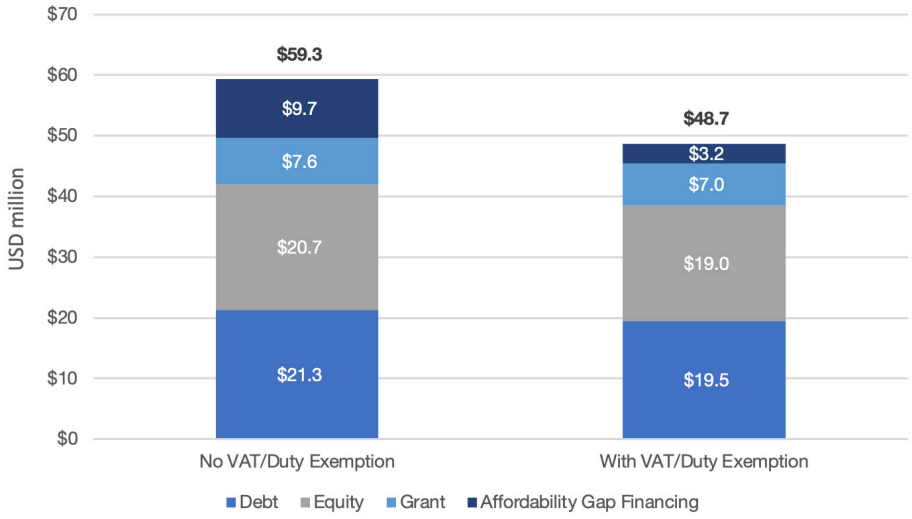
Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

FIGURE 35: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%) RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, NIASSA PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

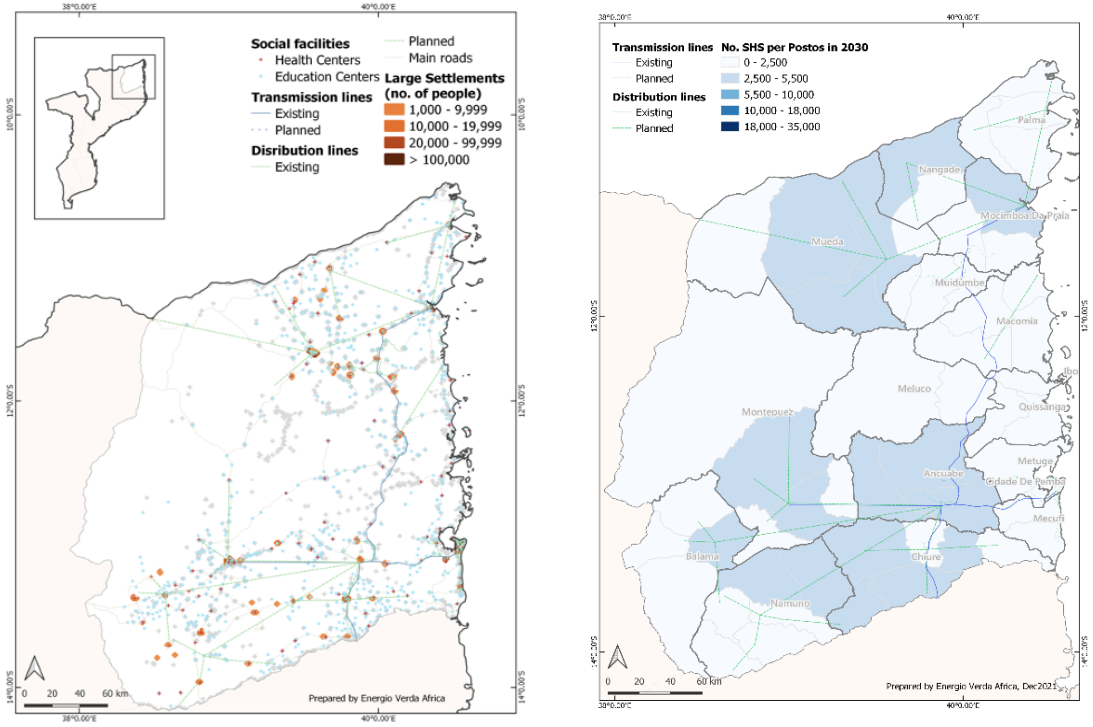
FIGURE 36: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN NIASSA PROVINCE BY 2030



2.2.2.11. Cabo Delgado Province

This section presents an overview of the off-grid market potential for Cabo Delgado Province, including specific electrification targets based on the results of the GIS analysis, the funding required to achieve these targets, OGS market barriers and risks, and a summary of actionable priorities for the GoM and provincial authorities to achieve universal access by 2030.

FIGURE 37: CABO DELGADO PROVINCE ELECTRICITY NETWORK, LARGE SETTLEMENTS AND SOCIAL FACILITIES, 2021 (LEFT) AND ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER DISTRICT, 2030 (RIGHT)



Source: Electricidade de Moçambique; Instituto Nacional de Estatística; Energio Verda Africa GIS analysis

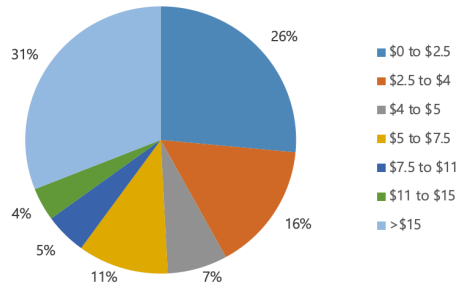
Provincial profile	Cabo Delgado is Mozambique's northernmost province with a population of about 2.3 million,[101] which is largely concentrated along the coast (**Figure 37**). The local economy relies mainly on subsistence agriculture (the main cash crops include cashews and cotton), artisanal and semi-industrial fishing, and livestock production. About 70% of the province has mobile network coverage, while access to mobile money services and use by adults in is about 60%, which is among the highest rates in the country (**Figure 5**).[102] In the extractive industry, natural gas reserves in the Rovuma Basin off the coast of Cabo Delgado are among the largest in the world, with the export of LNG expected to play an important role in the government's long-term development plans. However, gas development in the region was suspended in early 2021 following attacks in the coastal town of Palma, where an LNG export facility is under construction. The ongoing armed conflict in Cabo Delgado has displaced hundreds of thousands of people who are now living in resettlement camps in neighboring provinces. In 2019, Cyclone Kenneth caused widespread destruction in the province and led to a humanitarian crisis.
Electrification status / off-grid solar market activity	Cabo Delgado has an electrification rate of 19.1%, which is among the lowest rates of access in the country, ahead of only Zambézia. Solar product ownership is relatively high in Cabo Delgado; in 2019, 30% of surveyed households owned solar products.[103] Digitech is the only OGS company that reported sales in the province, although there is currently very limited/no activity in the off-grid market due to the ongoing conflict.
Results of the GIS analysis: new connections required through 2030	**2030 projections:** In 2030, Cabo Delgado will have approximately 800,000 households, of which 47% will be located in urban areas. According to the GIS analysis, by 2030, the grid access rate will increase to 68% and about 94,000 households will be electrified by SHS. By 2030, most urban and peri-urban areas will be connected to the grid, while most of the province's rural and deep rural areas will need to be electrified by SHS (**Figure 38**).[104] **Annual electrification targets:** In order to achieve universal electricity access in the province by 2030, EDM and off-grid solar operators will need to meet the following targets: • Grid connections: An average of **49,900** households will need grid connections annually • SHS: An average of **38,000 households** will need to be electrified by SHS annually • Mini-grids: An average of **17,800 households** will need mini-grid connections annually
Additional SHS for pre-electrification and replacement of retired systems	In addition to 93,977 new connections, another 212,724 SHS will need to be deployed for pre-electrification and 36,876 SHS for the replacement of retired systems, bringing the total number of SHS required in Cabo Delgado Province through 2030 to 343,577.

SHS Category	Units Required
New Permanent Connections	93,977
Temporary Pre-Electrification	212,724
Replacement of Retired Systems	36,876
Total	343,577

101 Instituto Nacional de Estatística (INE), Census 2017: http://www.ine.gov.mz/iv-rgph-2017
102 BRILHO Provincial Profile: Cabo Delgado Province, UK Aid and SNV, 2020.
103 USAID SAEP Mozambique Consumer Affordability survey, 2019.
104 See **Annex 2-A** for more details.

Funding requirements: OGS enterprise capital needs + affordability gap financing

Monthly household energy expenditure



It is estimated that the total capital needed by SHS enterprises to deploy about 340,000 SHS to complement grid electrification in achieving universal access in Cabo Delgado Province by 2030 is **USD 74.9M (MZN 4.8B)**. In addition to the enterprise capital needs, based on the estimated monthly energy expenditure of off-grid households in the province, an estimated **USD 7.9M (MZN 504M)** is required to bridge the affordability gap for off-grid households in Cabo Delgado to purchase a minimum Tier 1 (10W) SHS costing USD 200 (USD 7.5 per month over 2 years on a PAYG basis).

Overall, the total combined SHS funding needed to achieve universal electricity access in Cabo Delgado Province by 2030 is **USD 82.8M (MZN 5.3B)**, which accounts for approximately 6% of the total capital needed for SHS across the country. **Figure 39** summarizes the volume and blend of financing that is required to achieve universal electricity access in Cabo Delgado Province by 2030 – with and without VAT/duty exemptions.

Off-Grid Solar market barriers and risks

Remoteness Index: Cabo Delgado Province		
National Rank	Barriers / Risks	Districts / regions
8/11	Logistical Population density Mobile network coverage	Western districts

Remoteness Index Ranking: Cabo Delgado Province ranks eighth in the country in its index score (**Table 3**). Many settlements in the province are widely dispersed and with low levels of population density, particularly in the western districts, which increases costs for electricity service providers.

Other barriers and risks: The ongoing political conflict in Cabo Delgado, which has already displaced hundreds of thousands of people, represents the most significant barrier to OGS market growth in the province. Given the high rates of poverty in Mozambique, low consumer purchasing power/ability to pay for electricity access is another key barrier. The ongoing pandemic and recent impacts of Cyclone Kenneth in 2019 have combined to worsen an already difficult economic situation, particularly for the poorest households at the Bottom of the Pyramid. Insufficient financial incentives for the sector, particularly vis-à-vis the issue of taxation, is hindering OGS market growth.

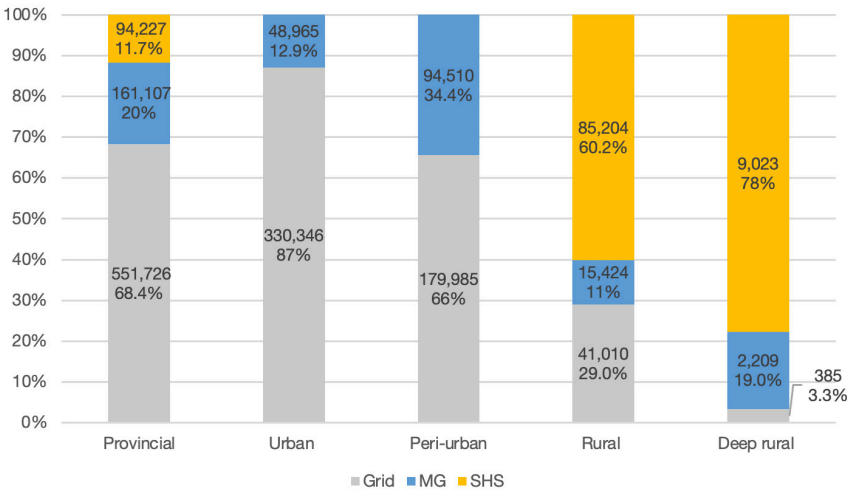
Actionable priorities to achieve universal access in 2030

Actionable priorities for the GoM and provincial authorities to support off-grid solar market growth in Cabo Delgado Province include:

- Concentrate provincial resources and prioritize OGS electrification efforts on households located in Namuno, Montepuez and Chiure Districts (**Figure 37**).
- Support linkages between OGS companies and telecommunications companies / mobile money service providers to increase the uptake of mobile money and facilitate the expansion of PayGo technology platforms and business models in the province.
- Expand fiscal incentives for the OGS industry; as illustrated in **Figure 39**, by implementing VAT/ import duty exemptions, the GoM can reduce the volume of OGS financing required to achieve universal access in Cabo Delgado Province by an estimated **USD 23M (MZN 1.4B)**.

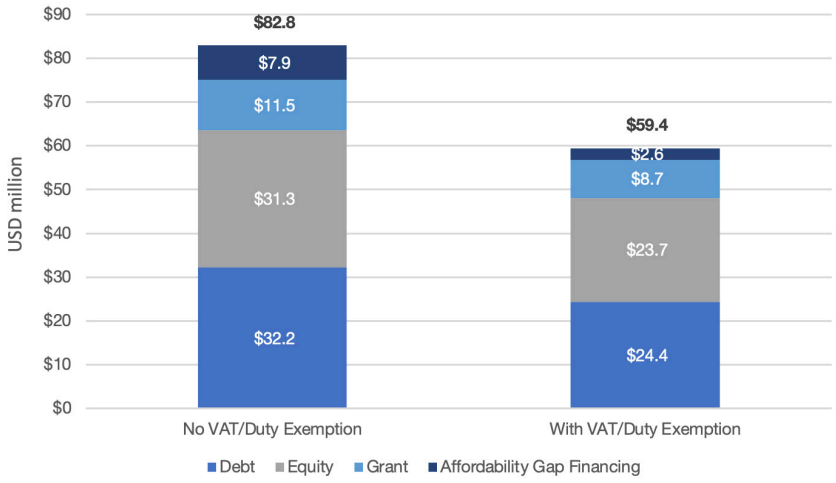
Source: UK Aid and SNV, 2020; EDM, 2020; USAID SAEP, 2020; Energio Verda Africa GIS analysis

FIGURE 38: ESTIMATED NUMBER AND SHARE OF HOUSEHOLDS (%)RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD AND URBANITY LEVEL, CABO DELGADO PROVINCE, 2030



Source: Energio Verda Africa GIS analysis

FIGURE 39: VOLUME AND BLEND OF OGS FINANCING REQUIRED TO ACHIEVE UNIVERSAL ACCESS IN CABO DELGADO PROVINCE BY 2030



2.2.3. Summary of Results

Table 5 presents a summary of the results of the GIS analysis by province, including the total number of SHS needed through 2030 (disaggregated by SHS required for new connections, pre-electrification and the replacement of retired systems) and the total funding required, split between funding requirements with and without VAT and duty exemptions.

It is estimated that approximately **5.6 million SHS** will be deployed in Mozambique through 2030, including 1.8 million systems for new permanent connections, 2.8 million systems for temporary pre-electrification, and about 1 million systems for the replacement of retired systems. The estimated total amount of funding required to support the deployment of 5.6 million SHS over this period – including both enterprise capital needs and affordability gap financing – is about **USD 1.3B (MZN 83B)**.[105] It is estimated that the implementation of VAT and duty exemptions by the GoM would reduce the total amount of funding required to about **856M (MZN 54B)** – representing savings of **USD 492M (MZN 31B)**.

TABLE 5: ESTIMATED TOTAL NUMBER OF SHS NEEDED AND FUNDING REQUIRED BY PROVINCE TO ACHIEVE UNIVERSAL ELECTRIFICATION BY 2030

Province	Total No. of HHs electrified by SHS in 2030 (GIS Data)[106]	No. of existing SHS in the market (2020)[107]	No. of HHs Needing New Connection	Pre-electrification	Replacements	Total SHS needed through 2030	Total Funding Required (USD million)[108]		
							without tax exemptions	with tax exemptions	Δ (savings)
Maputo City	122	-	122	118,794	47	118,963	$26.3	$14.5	$11.8
Maputo	26,085	19,005	7,080	258,594	40,375	306,050	$69.8	$37.9	$31.9
Gaza	64,131	22,583	41,548	162,745	60,807	265,099	$63.3	$34.2	$29.1
Inham-bane	174,893	22,583	152,310	127,901	103,685	383,896	$102.6	$54.1	$48.5
Manica	251,680	24,833	226,847	170,793	136,996	534,636	$133.8	$99.3	$34.5
Sofala	191,881	13,333	178,547	210,269	95,525	484,341	$118.6	$75	$43.6
Zambezia	495,765	12,000	483,765	511,787	211,042	1,206,594	$299.8	$168.7	$131.1
Tete	204,283	2,500	201,783	294,521	83,066	579,370	$139.5	$84.8	$54.7
Nampula	336,649	22,583	314,065	592,098	166,305	1,072,469	$252	$179.5	$72.5
Niassa	114,383	3,000	111,383	178,637	49,060	339,080	$59.3	$48.7	$10.6
Cabo Delgado	94,227	250	93,977	212,724	36,876	343,577	$82.8	$59.4	$23.4
Total	**1,954,099**	**142,672**	**1,811,426**	**2,838,864**	**983,785**	**5,634,075**	**$1,348**	**$856**	**$492**

Source: EDM, 2020; USAID SAEP, 2020; ALER, AMER and GET.invest, 2021; Energio Verda Africa GIS analysis

105 This figure includes USD 493M in debt, USD 479M in equity, USD 176M in grants, and USD 200M in affordability gap financing (see **Section 2.3.2.2** for more details).

106 See Annex 2-A for a description of the GIS methodology, including data sources and underlying assumptions.

107 Out of the 1.95 million households in rural and deep rural areas projected to be permanently electrified by SHS by 2030, it is estimated that 143,000 of these already have SHS (accounting for about 72% of the estimated 200,000 active quality-verified systems) and will only require replacements to remain electrified by 2030.

108 Funding requirements include both enterprise capital needs and affordability gap financing; see Section 2.3.2 for more details.

2.2.3. Scenario Analysis

In addition to the analysis presented in Section 2.2.1 – 2.2.3 above ("high-demand scenario"), which was used to design the RBF facility, a second analysis was conducted to assess a lower level of domestic energy demand that will be more affordable for poorer households ("basic-demand scenario").

Under the basic demand scenario, a Tier 1 level of access was included in the analysis in order to assess how methods of electrification would need to change in order to accommodate basic needs of electricity demand. In the basic demand scenario, Tier 3 was assigned to urban and peri-urban areas; Tier 2 was assigned to rural areas located within 30km of existing MV lines; and Tier 1 was assigned to the remaining rural and deep rural areas.[109] Low-income households were assumed to be connected by grid densification by 2030 if located within 350m of an existing electricity line and 720m from substations.[110]

Table 6 summarizes the parameters that differ between the two scenarios.

TABLE 6: KEY PARAMETERS OF THE HIGH DEMAND AND BASIC DEMAND SCENARIOS

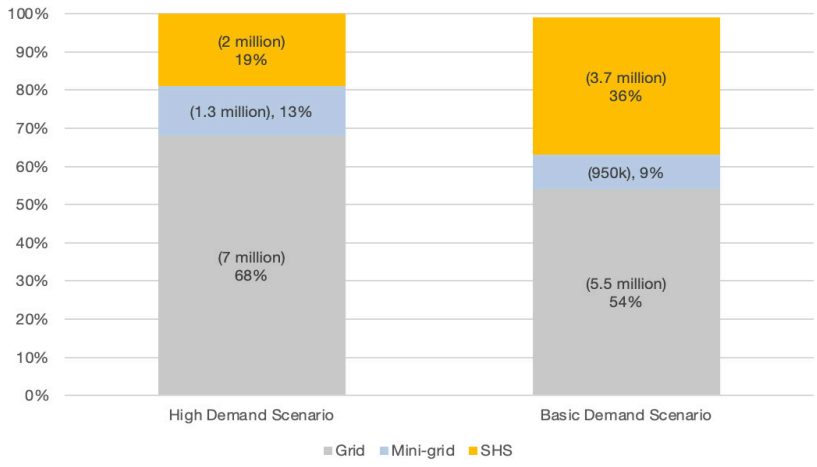
Scenario	Tier level for urban and peri-urban access	Tier level for rural access	Distance to HV lines for grid connection	Distance to MV lines for grid connection	Distance to substations for grid connection
High Demand	Tier 3	Tier 2	<= 350 m (existing lines only)	<= 2 km (existing lines only)	Not applied
Basic Demand	Tier 3	Tier 2: up to 30km distance from the current existing MV lines Tier 1: all others	<= 350 m (existing lines only)	<= 350 m (existing lines only)	<= 720 m

HV = High Voltage; MV = Medium Voltage *Source: Energio Verda Africa GIS analysis*

Figure 40 presents the results of the basic-demand scenario and compares these to the high-demand scenario. According to the basic-demand scenario analysis, by 2030, an estimated 5.5 million households (~54% of the population) will be electrified by the national grid – a decrease from 7 million in the high-demand scenario – and about 3.7 million households will be electrified by SHS – an increase of about 1.7 million from the high-demand scenario.[111]

Using the number of households in 2020 as a baseline and the results of the GIS analysis for 2030, it is estimated that, on average, about 800,000 households will need to be electrified annually to achieve universal access by 2030. In order to electrify 5.5 million households through grid connections, about 320,000 new customers need to be connected to the grid annually through 2030. These numbers are close to EDM's target to connect 300,000 customers annually during 2021-2024.[112]

FIGURE 40: COMPARISON OF THE ESTIMATED NUMBER AND SHARE (%) OF HOUSEHOLDS RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD UNDER TWO SCENARIOS, 2030



Source: Energio Verda Africa GIS analysis

109 See Annex 2-A for a description of each Tier level.

110 Per EDM's design guide, 350m is the recommended maximum distance from transformers to the last customer and the voltage drop limit for LV lines. The same guide indicates that the current maximum distance from transformers to the last customer is 720m. It was therefore assumed that all customers within a distance of 720m to a substation will be connected to the grid.

111 It's quite possible that a smaller percentage of off-grid solutions will be required to achieve SDG7, perhaps as low as 30%. The main driver behind this percentage is the speed with which the EDM national grid develops, its cost and whether or not the required financing is forthcoming, all of which are unknowns.

112 In 2019, EDM connected about 170,000 new customers and has set a target of connecting 300,000 customers annually up to 2024 (Source: EDM Annual Report, 2019; and EDM Business Plan, 2020-2024).

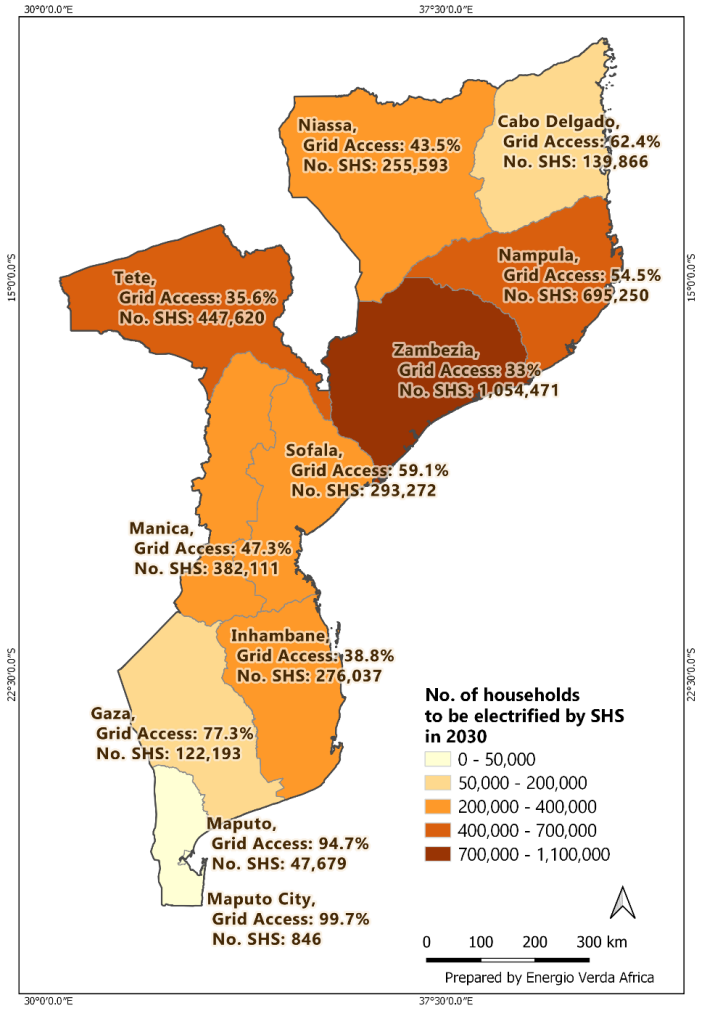
Table 7 presents a comparison of the estimated number of households that will receive electricity access by electrification method in 2030 under each scenario. The analysis assumes linear growth in the number of household connections to achieve the 2030 electrification target.

TABLE 7: COMPARISON OF THE ESTIMATED NUMBER OF HOUSEHOLDS RECEIVING ELECTRICITY ACCESS BY ELECTRIFICATION METHOD UNDER THE BASIC DEMAND AND HIGH DEMAND SCENARIOS, 2030

Electrification method	High-Demand Scenario, 2030 (GIS results)	Basic Demand Scenario, 2030 (GIS results)	High-Demand Scenario No. of HHs connected annually (on average)	Basic Demand Scenario No. of HHs connected annually (on average)	Difference in annual No. of connections between the two scenarios
Grid	6,965,794	5,574,466	476,025	321,433	- 154,592
Mini-grid	1,321,634	952,120	143,756	102,700	- 41,056
SHS	1,954,097	3,714,940	194,899 (+ ~1.2 million replacement)[113]	390,549 (+ ~2.1 million replacement)	+ 195,650
Total	10,241,526	10,241,526	814,682	814,682	-

At the provincial level, the largest number of households that will need electrification by SHS remains Zambézia Province, followed by Nampula and Tete. A large increase in the potential numbers of SHS in Niassa and Tete Provinces can be attributed to a corresponding increase in grid access, as well as to a larger number of settlements being connected to mini-grids (**Figure 41**).

FIGURE 41: ESTIMATED GRID ACCESS RATE (%) AND NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS PER PROVINCE UNDER HIGH DEMAND SCENARIO, 2030



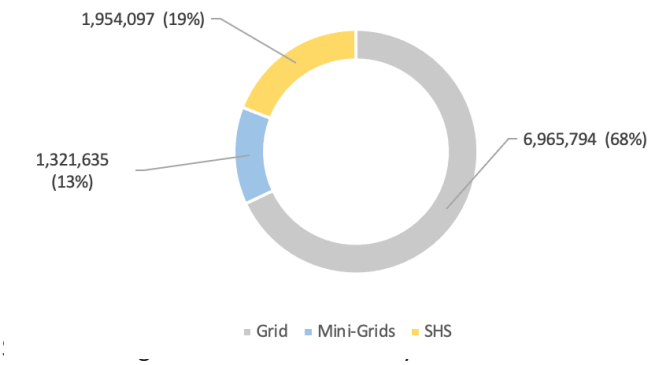
Source: Energio Verda Africa GIS analysis

113 Solar home systems typically need to be replaced after about five years.

2.3. Off-Grid Solar Funding Needs

A financing needs analysis was conducted in order to determine the capital needed to achieve universal electricity access in Mozambique by 2030. The analysis was based on a market accelerated scenario to reach the universal access goal via 68% grid connection (6.7 million households), 19.1% off-grid solar electrification (1.95 million households) and 12.9% mini-grid electrification (1.32 million households), in line with the results of the GIS analysis presented in Section 2.2.

FIGURE 42: TOTAL NUMBER OF HOUSEHOLDS ELECTRIFIED IN 2030 BY ELECTRIFICATION METHOD



The analysis presented in this section is focused on stand-alone solar home systems and stand-alone productive use of energy (PUE) systems. The financing requirements associated with grid and mini-grid electrification are not included in the estimates provided.

2.3.1 Assumptions

A summary of the assumptions and methodology used in the financing needs modelling, in line with the SEforALL Energizing Finance Report methodology, is presented below.

Capital Blend Assumptions

Table 8 summarizes the assumptions on the blend of capital required on average by SHS and PUE system providers. It is expected that early-stage standalone enterprises will be more reliant on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure significant debt that will finance their consumer receivables and inventory finance needs.

TABLE 8: MODEL ASSUMPTIONS FOR AVERAGE CAPITAL BLEND OF OGS COMPANIES[114]

Type of Capital	SHS/PUE Companies
Grant	15%
Equity	42%
Debt	43%

Source: SEforALL Energizing Finance: Taking the Pulse 2019

Household SHS Demand Assumptions

SHS Pricing: **Table 9** presents the retail prices for the two tiers of SHS considered in the analysis. The model conservatively assumes that the cost and consumer-facing retail price of SHS decreases by 2% per annum.[115]

TABLE 9: SHS RETAIL PRICES[116]

Indicator	Tier 1 (10W)	Tier 1 (20W)	Tier 2 (50W)
Retail Price	$200	$300	$940
Down Payment	$20	$30	$94
Monthly Cost	$7.5	$11.25	$23.5
PayGo Period (months)	24	24	36

SHS Design Life: Solar home systems were assumed to have a lifetime of five years; therefore, households purchasing a system in a given year are projected to require a new system to maintain access fully five years later.[117]

SHS Enterprise Capital Needs Calculation: Off-grid solar enterprise capital needs were calculated based on the projected 2030 SHS electrification rate per province derived from the GIS analysis, and assuming that access increases at an equal pace annually from 2022 to 2030, the number of new SHS connections required each year in each province was determined.[118] In order to calculate the number of new Tier 1 and 2 SHS needed in each province, the model assumed that households would purchase the highest level of electricity service they could afford based on their average monthly energy expenditure, thus accounting for differences in the ability to pay of households in each province by level of urbanity.

The analysis also assumes that households determined by the GIS analysis to be appropriate for grid and mini-grid electrification but that will not be connected until 2027-2030 (assuming grid and mini-grid access increases at an equal pace annually) will temporarily require SHS for pre-electrification. Subsequently, the number of gross new SHS required per year

114 "Energizing Finance: Taking the Pulse 2019," Sustainable Energy for All, E3 Analytics and Catalyst Off-Grid Advisors, (2019): https://www.seforall.org/system/files/2019-11/EF-2019-TP-SEforALL-w.pdf

115 It is worth noting that the model was completely based on USD values and does not account for local currency volatility/fluctuations

116 For Tier 1 (10W) systems, the model assumes that the customers will save USD 7.5 monthly for 2.67 months prior, to be able to pay the down payment of USD 20; For Tier (20W) systems, the model assumes that the customers will save USD 11.25 monthly for 2.67 months prior, to be able to pay the down payment of USD 30); For Tier 2 (50W) systems, the model assumes that the customers will save USD 23.5 monthly for 4 months prior, to be able to pay the down payment of USD 94. The analysis did not consider Tier 3 SHS as it was assumed that Tier 3 is not affordable for the vast majority of the Mozambican off-grid population

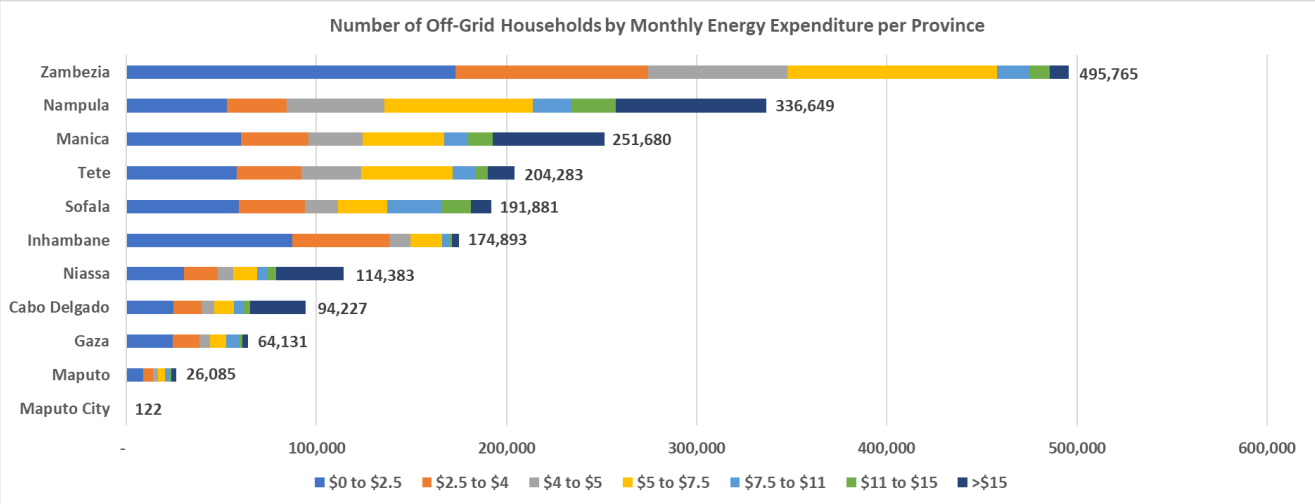
117 "Lighting Africa: Off-grid Solar Market Assessment in Niger and Design of Market-Based Solutions," World Bank, (December 2017): https://www.lightingafrica.org/publication/off-grid-solar-market-assessment-niger-design-market-based-solutions/; and https://www.greenlightplanet.com/solar-lights-shop/sun-king-home-120/

118 The model assumes electricity access will grow linearly on a percentage basis; however, due to population growth, the number of new connections required annually is not static.

was derived by summing the number of new SHS required (both for new permanent connections and temporary pre-electrification) and the number of replacements needed for retirement of systems deployed five years prior. Finally, the total funding needs (including the blend of capital required) for SHS deployed in each province was estimated by multiplying the number of gross new SHS according to tiers required, by the unit capital cost attributable to each system tier.

Household Energy Expenditure Assumptions: Household ability to pay for energy access presents a major obstacle to adoption of off-grid energy solutions (for households) and scaling (for enterprises). It was therefore critical to model the consumer affordability constraints faced by households in Mozambique to determine the affordability gap (shortfall in ability to pay) subsidy needed to enable low-income households to afford the minimum acceptable level of energy services in order to achieve universal electricity access in the country. The affordability calculation was based on data obtained from USAID on the monthly household energy expenditure of off-grid households across seven (7) different income groups in each province (**Figure 43**).[119]

FIGURE 43: ESTIMATED NUMBER OF OFF-GRID HOUSEHOLDS BY MONTHLY ENERGY EXPENDITURE PER PROVINCE, 2030[120]



Source: USAID SAEP, 2020.

In order to determine the ability to pay of the 1.95 million households to be electrified by SHS in the rural and deep rural areas in each province, assumptions were made on the distribution of households by income group and urbanity in each province. It was assumed that households in deep rural areas make up the lowest income group, while households in rural areas make up the higher income groups. Households in urban and peri-urban areas were excluded given that they will be electrified by the grid and mini-grids according to the GIS analysis.[121] The results derived were then used to compute the average monthly household energy expenditure by urbanity in each province. Based on this, the average affordability gap (to acquire a Tier 1 (10W) SHS) for the households that have affordability gaps in each province by urbanity was derived. Also, the percent of households by urbanity in each province that have an affordability gap i.e., cannot afford a minimum Tier 1 (10W) SHS was derived. These figures were used in combination with the number of new SHS required in each province per year to determine the overall total affordability gap subsidy funding needed to achieve universal access.

In addition, the average monthly household energy expenditure by urbanity in each province per year was also used to determine the portion of households in each province that can afford Tier 1 (10W) SHS (including subsidized households), as well as Tier 1 (20W) and Tier 2 (50W) SHS, with the assumption that each household would purchase the highest level of energy services that it could afford.[122]

Agricultural Productive Use Demand Assumptions

Despite growing activity and interest in the agri-PUE sector, a 2019 study carried out by Dalberg Advisors and the World Bank found that only a few agri-PUE applications – namely irrigation, cooling (cold storage and refrigeration) and agricultural-processing – are ready for commercial scale in sub-Saharan Africa.[123] Hence, the demand analysis for the Agri-PUE market segment, which estimates the total funding needs of the agricultural solar productive use market in Mozambique, focused only on these three applications.[124]

119 The model assumes the 7 income groups have the following average monthly energy expenditure: USD 1.25; USD 3.25; USD 4.5; USD 6.25; USD 9.25; USD 13; and USD 15. Due to lack of data, it was assumed that off-grid households in Niassa and Maputo City Provinces have similar monthly energy expenditure profiles as households in Cabo Delgado.

120 USAID SAEP Mozambique Consumer Affordability survey, 2019.

121 It was assumed that households in urban and peri-urban areas requiring SHS for pre-electrification can generally afford a minimum Tier 1 SHS without subsidies

122 According to the USAID survey, "72% of households that own a solar product own a Tier 1 product, while 28% have a TV or larger appliance (Tier 2-3 system)." Thus, it was assumed that 72% of SHS acquired for pre-electrification will be Tier 1 systems, and the remaining 28% will be Tier 2 systems.

123 "The Market Opportunity for Productive Use Leveraging Solar Energy (PULSE) in Sub-Saharan Africa," Dalberg Advisors, Lighting Global and World Bank, (2019): https://www.lightingglobal.org/wp-content/uploads/2019/09/PULSE-Report.pdf

124 For the purpose of this study, "agricultural solar productive use market" refers to stand-alone solar systems under 1 kW bundled with agriculture-related appliances.

As shown in **Annex 2-D**, the capital needs estimation for solar-powered irrigation is based on smallholder irrigation potential (i.e. the amount of irrigable land suitable for smallholder farmers) that could benefit from a 180 Wp solar pumping system that costs USD 650 (MZN 41,600) and has a six-year system life.[125] The funding needs calculation for solar-powered agricultural-processing utilized a series of inputs from the UN Food and Agriculture Organization (FAO) to estimate the smallholder milling potential that could benefit from a solar powered milling system with 55 tons per year milling capacity that costs USD 1,625 (MZN 104,000) and has a 10-year system life.[126] The funding needs calculation for solar-powered cooling/refrigeration utilized most recent data on milk, fish and horticultural production in Mozambique to estimate the number of small-scale traders that could benefit from a 100-liter solar refrigeration system that costs USD 825 (MZN 52,800) and has a six-year system life.[127,128]

The adopted methodology does not take into account affordability (ability to pay) and affordability gap funding requirements, nor does it account for cost and supply chain constraints. It is expected that the market potential will mainly be unlocked by solar companies providing these systems via lease-to-own and energy-as-a-service business models, as most microenterprises will be unable to purchase the systems without financial support. Furthermore, the analysis focused on Agri-PUE systems for microenterprises to demonstrate potential market demand, and thus excludes agricultural applications of larger stand-alone solar systems such as larger milling equipment.

Non-Agricultural Productive Use Demand Assumptions

Productive use applications of solar in the non-agricultural micro, small and medium enterprise (MSME) sectors include clothing (solar-powered sewing machines), carpentry, electronic repair, hairdressing/barbing (solar charged hair clippers), power for restaurants, retail cooling, phone charging, handcrafts, health facilities (vaccine storage), information and communication technologies (ICT), education, task lighting etc. According to a 2020 UNDP study, there are 4.9 million MSMEs in Mozambique, and access to electricity was cited as the most significant barrier to growth by 8% of these MSMEs. Of these, roughly 50% (196,000 MSMEs) operate in the retail sector, which may be served by standalone non-Agri PUE systems.[129] Based on this, the funding needs for non-Agri PUE systems for microenterprises was derived assuming each MSME acquires a USD 625 (MZN 40,000), five-year life system. Due to limited available data, neither the agri-PUE nor the non-agri PUE funding need estimations were disaggregated by province.

2.3.2. Results of the Funding Needs Assessment

Based on the assumptions described above, the results of the analysis conducted revealed that the total combined funding needed for the SHS, Agri-PUE and non-Agri PUE market segments to complement the grid and mini-grids in achieving universal access in Mozambique by 2030 is USD 1.6B (MZN 102.1B), which translates to an average of approximately USD 182M (MZN 11.6B) annually from 2022 until 2030. Of this amount, the total funding needed for the SHS segment targeting households is USD 1.3 billion (MZN 83B), while the funding needed for the agricultural productive use segment and the non-agricultural productive use segment is USD 133.4M (MZN 8.5B) and USD 161.2M (MZN 10.3B), respectively. **Figure 44** and **Figure 45** summarize the volume and blend of financing that is required.

As shown in **Figure 45**, about USD 602M (MZN 38.4B) of the financing required to achieve universal access is projected to be in the form of equity investment in the energy access enterprises operating in the country to support ongoing operational activities and growth. Of this, USD 479.1M (MZN 30.6B) will be required by SHS companies, USD 55.7M (MZN 3.6B) by APUE system providers and USD 67.3M (MZN 4.3B) by PUE system providers.

FIGURE 44: VOLUME AND BLEND OF FINANCING REQUIRED TO CLOSE THE ENERGY ACCESS GAP BY MARKET SEGMENT

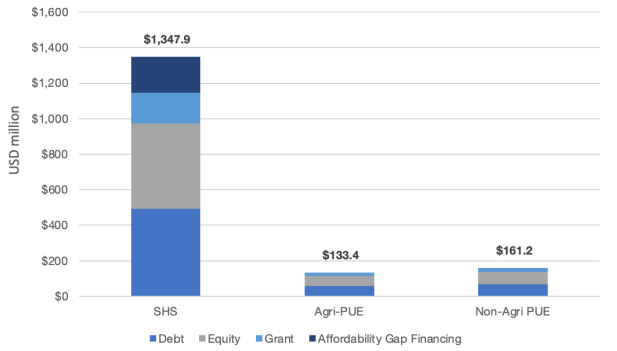
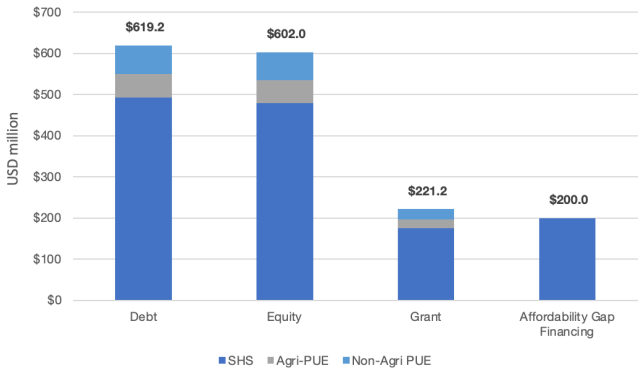


FIGURE 45: VOLUME AND BLEND OF FINANCING REQUIRED TO CLOSE THE ENERGY ACCESS GAP BY FUNDING TYPE



125 Dalberg Advisors, Lighting Global and World Bank, 2019.; and Davies, H., "The Future's Bright for Farmers in Kenya," Futurepump, (June 27, 2017): https://futurepump.com/futures-bright-farmers-kenya; and World Bank, 2017; and Futurepump: https://shop.futurepump.com/products/sf2h-solar-pump?variant=40457377546423

126 Dalberg Advisors, Lighting Global and World Bank, 2019.

127 Dalberg Advisors, Lighting Global and World Bank, 2019.; and SunDanzer: https://sundanzer.com/wp-content/uploads/2021/04/DCR165-Kit-spec-sheet-May-2018.pdf

128 Agri-PUE system prices were not adjusted to the local context of Mozambique

129 Naido o, K., and Loots, C., "Mozambique- Energy and The Poor: Unpacking the Investment Case for Clean Energy," UN Capital Development Fund (UNCDF), (2020): https://www.undp.org/content/dam/undp/library/km-qap/UNDP-UNCDF-Mozambique-Energy-and-the-Poor.pdf

There is also a need for enterprises to borrow capital from external parties to have sufficient liquidity to provide systems on a PayGo basis to their customers. In this regard, USD 619.2M (MZN 39.5B) of the financing need is projected to be in the form of debt. Of this, SHS providers are projected to require USD 492.8M (MZN 31.5B), while APUE and PUE providers are projected to require USD 57.3M (MZN 3.7B) and USD 69.2M (MZN 4.4B), respectively.

In addition, USD 221.2M (MZN 14.1B) of the total funding required is expected to be in the form of catalytic grants to electricity access enterprises mainly to cover market risks and encourage private sector expansion to underserved areas (excludes subsidies required to cover affordability gap). Of this, USD 176M (MZN 11.2B) will be required by SHS companies, USD 20.5M (MZN 1.3B) by APUE providers and USD 24.7M (MZN 1.6B) by PUE providers. On average, the catalytic grant amount needed per SHS deployed is estimated to be USD 31.2 (MZN 2,000), while the catalytic grant amount needed per APUE system and PUE system is USD 100.7 (MZN 6,400) and USD 87.3 (MZN 5,600), respectively.

2.3.2.1. Affordability Gap Funding Needs

Figure 46 shows the average affordability gap (PayGo Price minus household energy expenditure over 24 months) for a minimum Tier 1 (10W) SHS costing USD 200 (MZN 1,280) for households with affordability gap in rural and deep rural areas in each province in 2021 and 2030, accounting for a 2% annual drop in prices. Households in rural Nampula have the lowest average affordability gap, while all deep rural households, assumed to be in the lowest income group with monthly energy spending of USD 0 to 2.5 (MZN 16), have the highest affordability gaps. An estimated USD 200M (MZN 12.8B) is required in affordability gap financing for households to acquire minimum Tier 1 (10W) SHS systems (including replacement of retired systems) in order to achieve universal access.[130] The province of Zambezia has the highest affordability gap financing needs at USD 58M (MZN 3.7B) (**Figure 47**).

FIGURE 46: AVERAGE AFFORDABILITY GAP BY URBANITY LEVEL PER PROVINCE, 2021 AND 2030

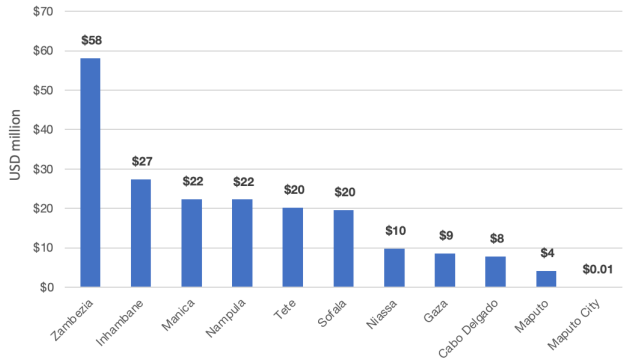


FIGURE 47: AFFORDABILITY GAP FINANCING NEEDS BY PROVINCE

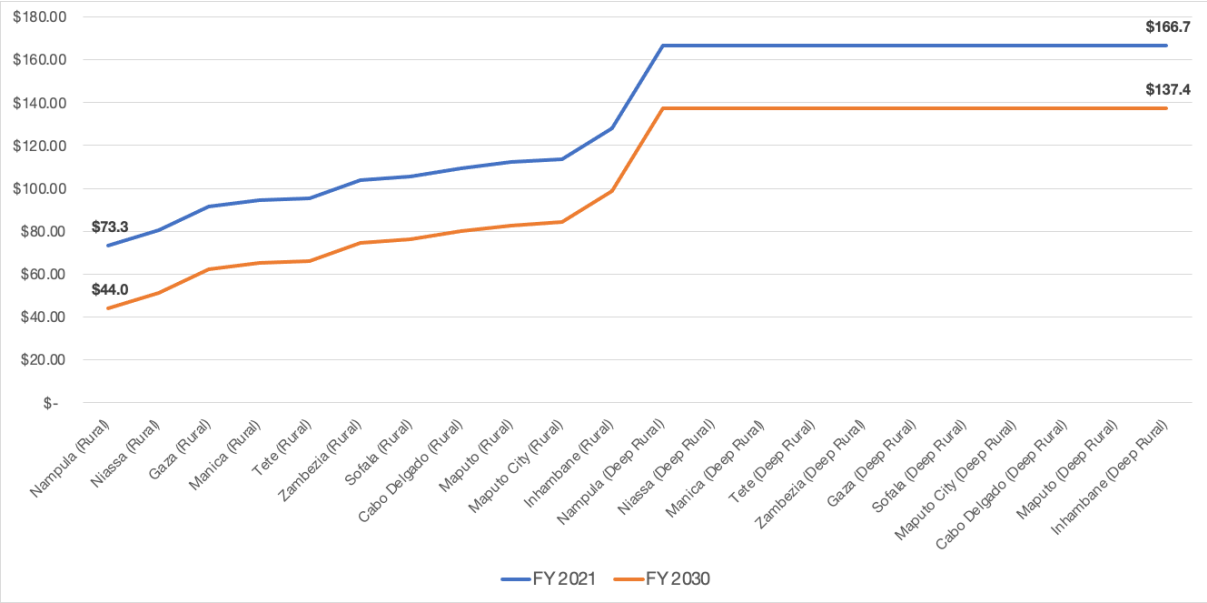
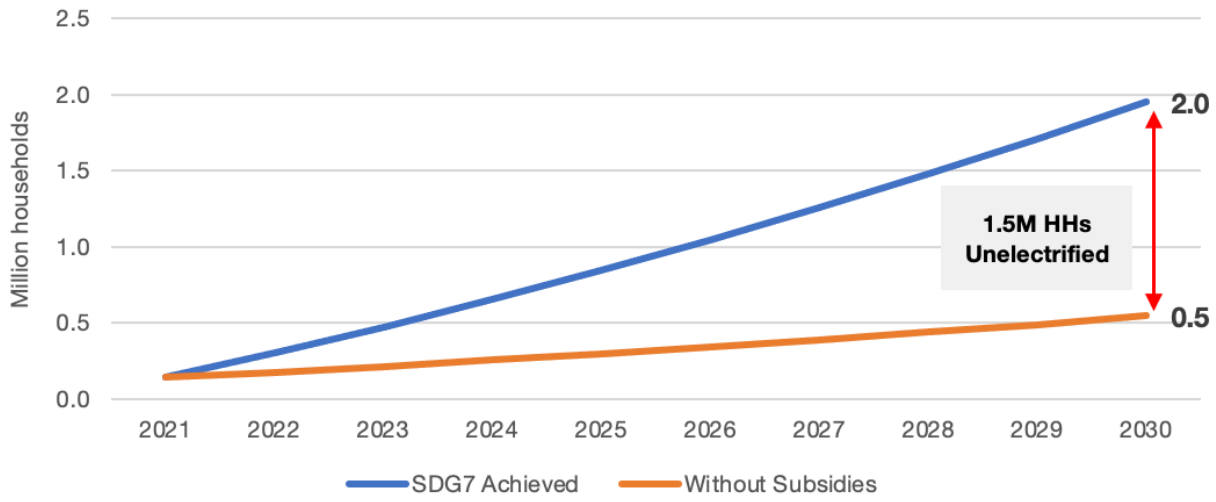


Figure 48 illustrates that without affordability gap subsidies, 1.5 million households will remain unelectrified, as only about 500,000 households of the 1.5 million households to be permanently electrified by SHS will be able to afford the systems.

130 This figure excludes SHS required for pre-electrification purposes as it was assumed that households in urban and peri-urban areas that will be electrified by the grid or mini-grids can afford Tier 1 SHS.

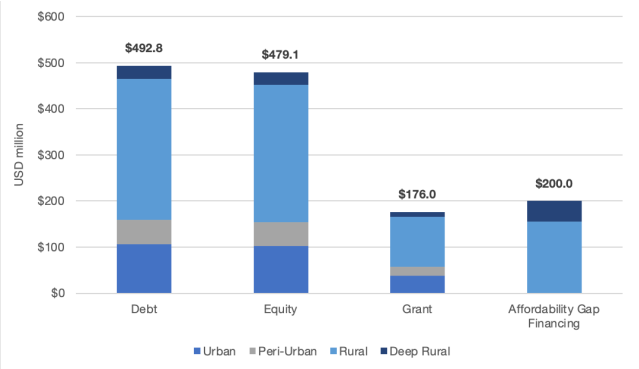
FIGURE 48: ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED VIA SHS WITH AND WITHOUT AFFORDABILITY GAP SUBSIDIES



2.3.2.2. SHS Segment Capital Needs

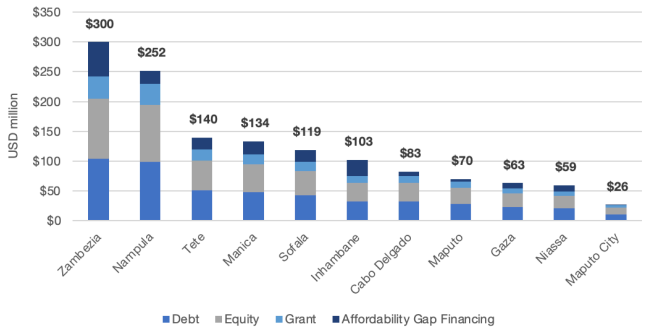
The estimated total capital needed for the SHS market segment is **USD 1.3B (MZN 83B)** comprising of USD 176M (MZN 11.2B) in grants, USD 492.8M (MZN 31.5B) in debt funding, USD 479.1M (MZN 30.6B) in equity investments and USD 200M (MZN 12.8B) in affordability gap financing (**Figure 49**). This funding will support the deployment of approximately **5.6 million SHS**, including 1.8 million systems for new permanent connections,[131] 2.8 million systems for temporary pre-electrification, and about 1 million systems for the replacement of retired systems (see **Table 5**).

FIGURE 49: SHS CAPITAL NEEDS BY FUNDING TYPE



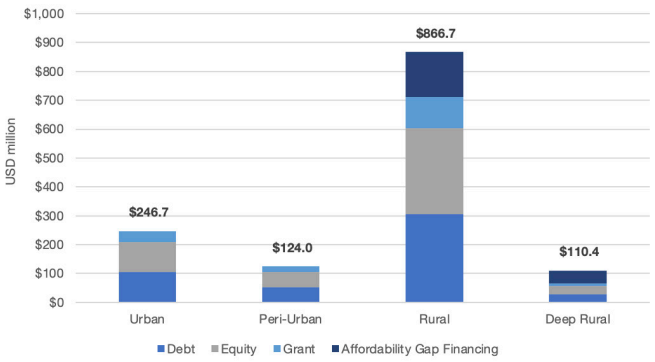
At the provincial level, Zambezia and Nampula provinces have the highest SHS capital needs at USD 300M (MZN 19.2B) and USD 252M (MZN 16.1B), respectively (**Figure 50**).

FIGURE 50: SHS CAPITAL NEEDS BY PROVINCE



By urbanity level, rural areas have the highest SHS capital needs estimated at USD 866.7M (MZN 55.3B) as shown in **Figure 51**. The SHS capital needed for urban and peri-urban areas is solely for pre-electrification.

FIGURE 51: SHS CAPITAL NEEDS BY URBANITY LEVEL

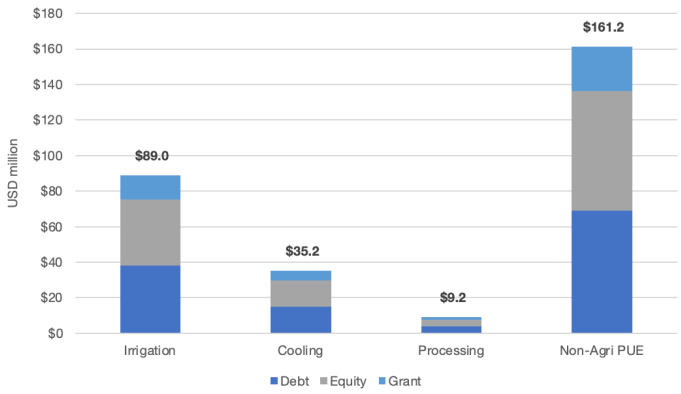


131 Out of the 1.95 million households in rural and deep rural areas projected to be permanently electrified by SHS by 2030, it is estimated that 143,000 of these already have SHS (accounting for about 72% of the estimated 200,000 active quality-verified systems) and will only require replacements to remain electrified by 2030.

2.3.2.3. Productive Use Segment Capital Needs

The estimated total capital needed for the productive use solar market is USD 294.6M (MZN 18.8B). Of this, USD 161.2M (MZN 10.3B) is needed for the non-agricultural productive use solar market, while the estimated total capital needed for the agricultural productive use solar market is USD 133.4M (MZN 8.5B), with the irrigation market segment accounting for the majority of demand at USD 89M (MZN 5.7B), followed by cooling at USD 35.2M (MZN 2.2B) and agricultural processing at USD 9.2M (MZN 587M) as shown in **Figure 52**. This funding will support the deployment of 203,000 agri-PUE solar systems, including 150,000 solar irrigation kits, 47,000 solar cooling systems, and 6,000 solar mills, in addition to 283,000 non-agri PUE systems.

FIGURE 52: PRODUCTIVE USE CAPITAL NEEDS BY MARKET SEGMENT



In terms of capital type, the productive use solar market requires USD 45.2M (MZN 2.8B) in grants, USD 126.5M (MZN 8.1B) in debt funding and USD 123M (MZN 7.9B) in equity investments (**Figure 53**).

FIGURE 53: PRODUCTIVE USE CAPITAL NEEDS BY FUNDING TYPE

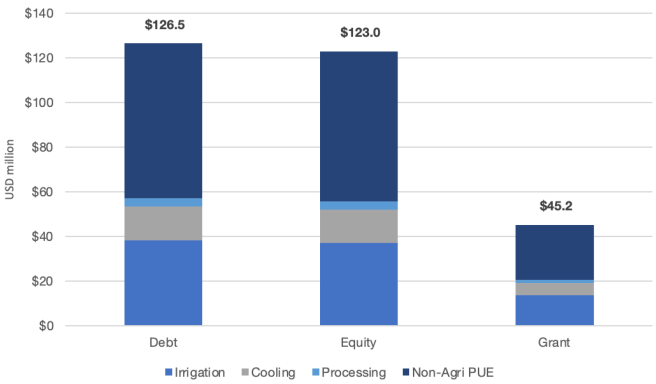


TABLE 10: ESTIMATED TOTAL ANNUAL FINANCING NEEDS SUMMARY

Total Financing Needs Summary											
Market Segment/Funding Type	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Cumulative**	**Cumulative %**
OGS – Total Financing Needs	**$ 193,520,765**	**$ 199,177,439**	**$ 204,893,903**	**$ 247,934,104**	**$ 55,755,841**	**$ 99,416,469**	**$ 102,144,593**	**$ 104,872,096**	**$ 140,178,103**	**$ 1,347,893,312**	100%
of which Grant Financing Needs	$ 27,539,552	$ 28,369,174	$ 29,210,116	$ 34,072,916	$ 6,233,454	$ 11,178,105	$ 11,545,709	$ 11,918,391	$ 15,928,563	$ 175,995,980	13%
of which Equity Financing Needs	$ 74,966,284	$ 77,224,625	$ 79,513,780	$ 92,750,962	$ 16,968,282	$ 30,428,274	$ 31,428,939	$ 32,443,429	$ 43,359,644	$ 479,084,219	36%
of which Debt Financing Needs	$ 77,107,750	$ 79,430,602	$ 81,785,148	$ 95,400,461	$ 17,452,993	$ 31,297,480	$ 32,326,729	$ 33,370,199	$ 44,598,244	$ 492,769,605	37%
of which Affordability Gap Financing Needs	$ 13,907,179	$ 14,153,038	$ 14,384,859	$ 25,709,764	$ 15,101,113	$ 26,512,610	$ 26,843,216	$ 27,140,078	$ 36,291,651	$ 200,043,508	15%
APUE – Total Enterprise Financing Needs	**$ 12,458,875.00**	**$ 12,214,583.33**	**$ 11,975,081.70**	**$ 11,740,276.18**	**$ 11,510,074.68**	**$ 11,284,386.94**	**$ 21,149,369.39**	**$ 20,734,675.87**	**$ 20,328,113.60**	**$ 133,395,436.70**	100%
of which Grant Financing Needs	$ 1,910,277.73	$ 1,872,821.31	$ 1,836,099.32	$ 1,800,097.37	$ 1,764,801.35	$ 1,730,197.40	$ 3,242,762.24	$ 3,179,178.67	$ 3,116,841.83	$ 20,453,077.21	15%
of which Equity Financing Needs	$ 5,200,027.37	$ 5,098,066.05	$ 4,998,103.97	$ 4,900,101.93	$ 4,804,021.50	$ 4,709,825.00	$ 8,827,225.54	$ 8,654,142.69	$ 8,484,453.62	$ 55,675,967.66	42%
of which Debt Financing Needs	$ 5,348,569.90	$ 5,243,695.98	$ 5,140,878.41	$ 5,040,076.87	$ 4,941,251.84	$ 4,844,364.55	$ 9,079,381.61	$ 8,901,354.52	$ 8,726,818.15	$ 57,266,391.83	43%
PUE – Total Enterprise Financing Needs	**$ 13,611,250.00**	**$ 13,344,362.75**	**$ 13,082,708.57**	**$ 12,826,184.88**	**$ 12,574,691.06**	**$ 24,656,256.97**	**$ 24,172,800.95**	**$ 23,698,824.46**	**$ 23,234,141.63**	**$ 161,201,221.26**	100%
of which Grant Financing Needs	$ 2,086,967.55	$ 2,046,046.61	$ 2,005,928.05	$ 1,966,596.13	$ 1,928,035.42	$ 3,780,461.61	$ 3,706,334.91	$ 3,633,661.68	$ 3,562,413.41	$ 24,716,445.38	15%
of which Equity Financing Needs	$ 5,681,000.29	$ 5,569,608.13	$ 5,460,400.13	$ 5,353,333.46	$ 5,248,366.13	$ 10,290,913.99	$ 10,089,131.36	$ 9,891,305.26	$ 9,697,358.10	$ 67,281,416.85	42%
of which Debt Financing Needs	$ 5,843,282.16	$ 5,728,708.00	$ 5,616,380.39	$ 5,506,255.29	$ 5,398,289.50	$ 10,584,881.37	$ 10,377,334.68	$ 10,173,857.53	$ 9,974,370.12	$ 69,203,359.04	43%
Overall Total Enterprise Financing Needs	**$ 322,937,290**	**$ 331,496,385**	**$ 340,118,360**	**$ 386,716,251**	**$ 197,743,977**	**$ 256,445,533**	**$ 272,647,818**	**$ 278,221,282**	**$ 316,640,075**	**$ 2,702,966,971**	100%
of which Grant Financing Needs	$ 79,667,656	$ 82,008,695	$ 84,359,361	$ 91,032,552	$ 64,836,674	$ 73,082,501	$ 76,794,579	$ 78,770,310	$ 84,502,354	$ 715,054,683	26%
of which Equity Financing Needs	$ 112,724,123	$ 115,656,869	$ 118,622,810	$ 132,707,933	$ 57,683,243	$ 76,919,908	$ 82,900,543	$ 84,515,372	$ 96,104,059	$ 877,834,860	32%
of which Debt Financing Needs	$ 116,638,332	$ 119,677,783	$ 122,751,330	$ 137,266,002	$ 60,122,947	$ 79,930,514	$ 86,109,480	$ 87,795,522	$ 99,742,010	$ 910,033,920	34%
of which Affordability Gap Financing Needs	$ 13,907,179	$ 14,153,038	$ 14,384,859	$ 25,709,764	$ 15,101,113	$ 26,512,610	$ 26,843,216	$ 27,140,078	$ 36,291,651	$ 200,043,507.64	7%

TABLE 11: ESTIMATED ANNUAL SHS CONNECTION TARGETS PER PROVINCE, 2022-2030

Cumulative Number of New SHS Connections Per Province									
Province	2022	2023	2024	2025	2026	2027	2028	2029	2030
Nampula	50,627	80,223	111,438	144,337	178,991	215,473	253,857	294,222	336,649
Cabo Delgado	8,623	17,464	26,794	36,633	47,001	57,922	69,417	81,510	94,227
Manica	45,113	66,510	89,069	112,839	137,871	164,216	191,928	221,063	251,680
Sofala	29,278	46,105	63,851	82,554	102,256	122,995	144,816	167,763	191,881
Zambezia	55,131	100,669	148,713	199,369	252,744	308,953	368,111	430,340	495,765
Niassa	12,931	23,416	34,479	46,142	58,431	71,372	84,993	99,320	114,383
Tete	20,483	39,472	59,508	80,634	102,898	126,344	151,024	176,986	204,283
Gaza	26,349	30,309	34,469	38,838	43,426	48,239	53,288	58,582	64,131
Maputo	19,689	20,398	21,131	21,889	22,673	23,483	24,322	25,188	26,085
Inhambane	36,217	50,596	65,752	81,717	98,525	116,210	134,808	154,356	174,893
Maputo City	11	22	34	47	61	75	90	105	122
Total	304,453	475,184	655,237	845,000	1,044,876	1,255,283	1,476,653	1,709,436	1,954,097

TABLE 12: ESTIMATED ANNUAL MINI-GRID CONNECTION TARGETS PER PROVINCE, 2022-2030

Cumulative Number of Mini-Grid Connections Per Province									
Province	2022	2023	2024	2025	2026	2027	2028	2029	2030
Nampula	21,731	44,202	67,915	92,920	119,273	147,029	176,245	206,983	239,303
Cabo Delgado	15,246	30,313	46,211	62,976	80,643	99,250	118,836	139,441	161,107
Manica	2,478	4,458	6,525	8,684	10,939	13,293	15,750	18,315	20,993
Sofala	2,732	5,262	7,932	10,747	13,714	16,839	20,128	23,587	27,225
Zambezia	37,853	66,007	95,708	127,020	160,010	194,749	231,308	269,761	310,186
Niassa	24,714	41,134	58,454	76,712	95,946	116,198	137,508	159,921	183,481
Tete	30,895	63,326	97,548	133,638	171,672	211,731	253,898	298,262	344,910
Gaza	1,478	2,187	2,935	3,722	4,552	5,425	6,343	7,309	8,324
Maputo	67	88	111	134	159	185	212	241	271
Inhambane	2,941	5,664	8,538	11,568	14,761	18,124	21,663	25,386	29,301
Maputo City	-	-	-	-	-	-	-	-	-
Total	140,135	262,641	391,876	528,121	671,669	822,822	981,892	1,149,206	1,325,101

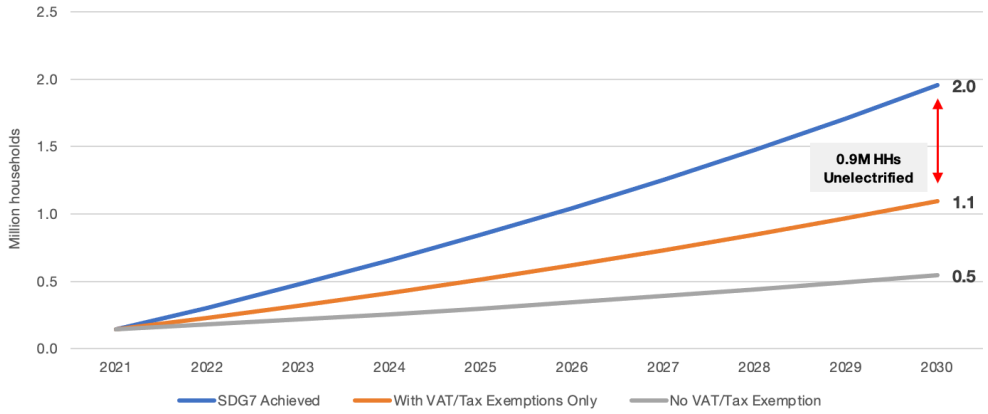
2.3.3. Scenario Analyses

Various scenarios were considered in conducting the financing needs analysis as described in this section.

2.3.3.1. VAT and Duty Exemption Scenario

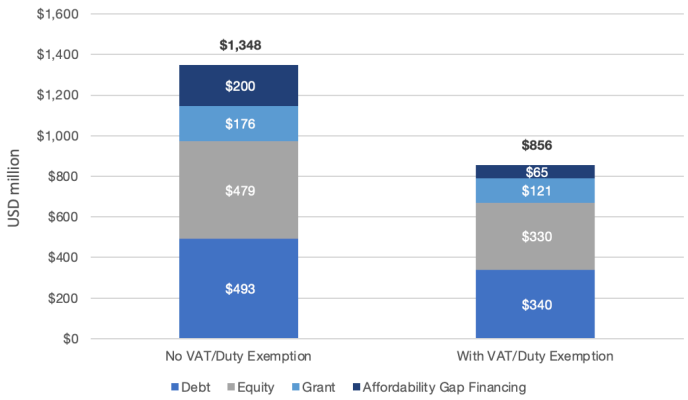
The effect of import duty and VAT exemptions on SHS access penetration up to 2030 was analyzed. The model assumed that SHS import duty and VAT exemptions will result in a 45% reduction in the capital cost and end-user prices of the various SHS tiers. The results show that with exemptions, about 1.1 million households will be able to afford SHS compared to 500,000 without exemptions, while 900,000 households will still require affordability gap subsidies (**Figure 54**).

FIGURE 54: ESTIMATED TOTAL NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 WITH/WITHOUT TAX EXEMPTIONS



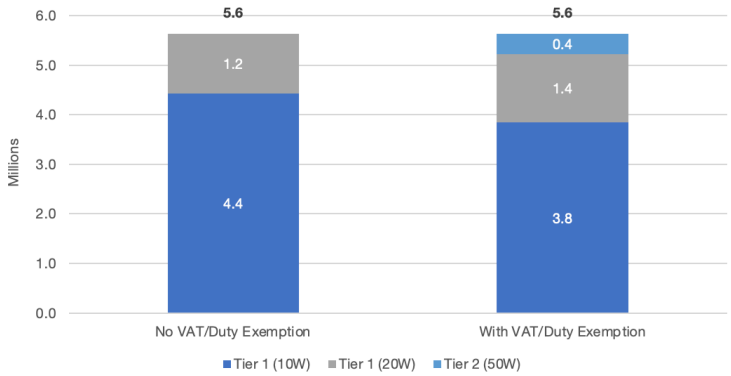
In addition, the total funding needed for the SHS market segment will drop to USD 855.8M (MZN 54.6B) from USD 1.3B (MZN 83B), with the affordability gap funding needed dropping to USD 64.6M (MZN 4.1B) from USD 200M (MZN 12.8B) as shown in **Figure 55**.

FIGURE 55: SHS CAPITAL NEEDS WITH AND WITHOUT TAX EXEMPTIONS



Furthermore, **Figure 56** shows that VAT and duty exemptions will enable more households to afford and purchase Tier 1 (20W) systems, and to a minor extent, Tier 2 (50W) systems.

FIGURE 56: NUMBER OF SHS DEPLOYED BY TIER WITH AND WITHOUT TAX EXEMPTIONS



2.3.3.2. Income per Capita Growth Scenarios

The analysis also considered four different annual GDP per capita growth rate assumptions – 1.6%, 2.3%, 4.5%, 6.8%[132] – to determine how ability to pay for different tiers of access (product sizes, level of access as per the multi-tier access framework) might change up to 2030. The results show that with annual income and energy expenditure growth at 1.6%, 2.3%, 4.5% and 6.8%, the number of households that are able to afford SHS increases to 0.71M, 0.74M, 0.8M and 0.9M, respectively. At 6.8% growth, about 1.1M households will still require affordability gap subsidies (**Figure 57**).

FIGURE 57: ESTIMATED TOTAL NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 UNDER VARIOUS INCOME GROWTH SCENARIOS (WITHOUT TAX EXEMPTIONS)

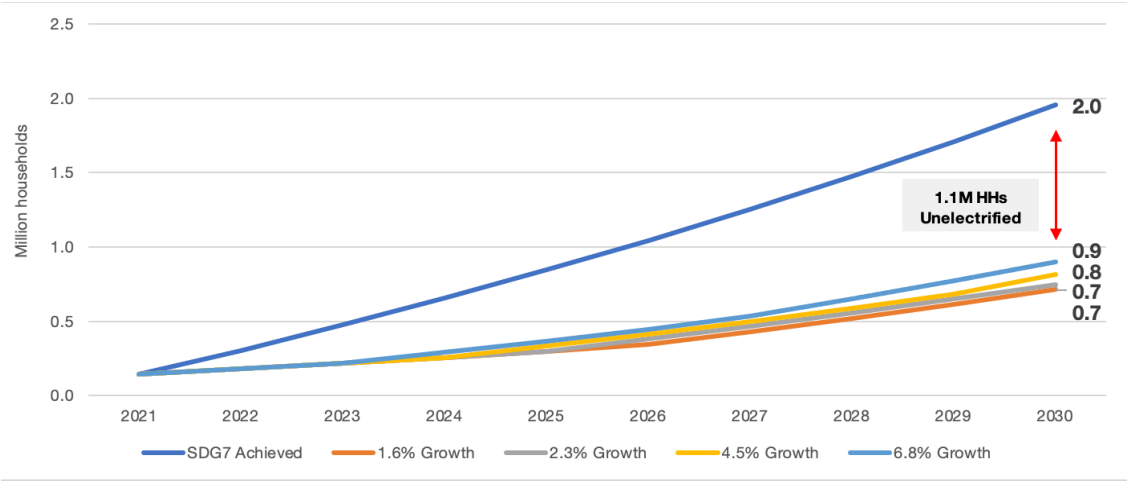
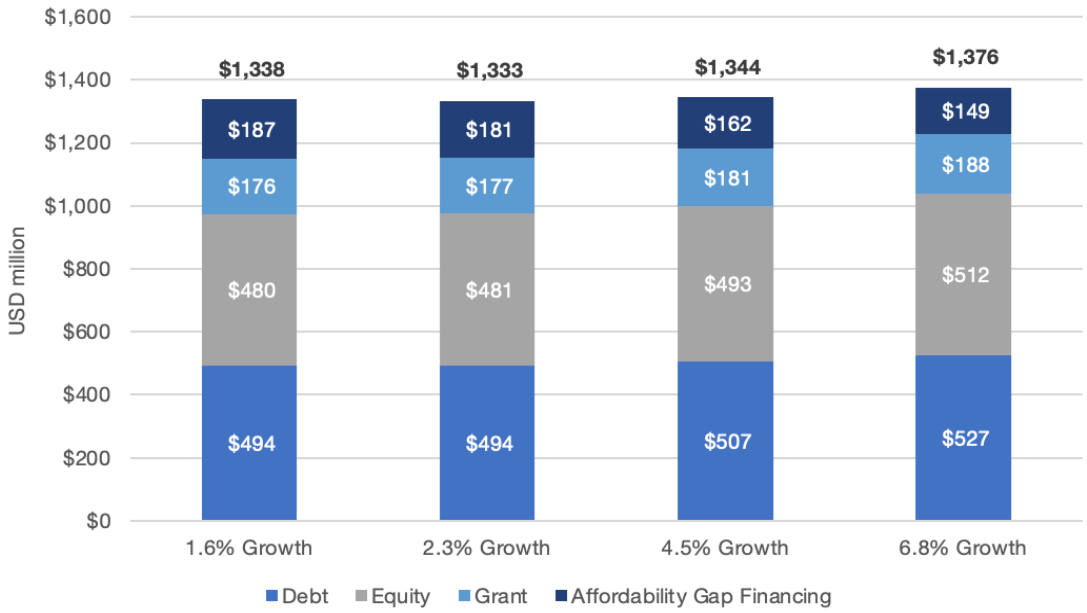


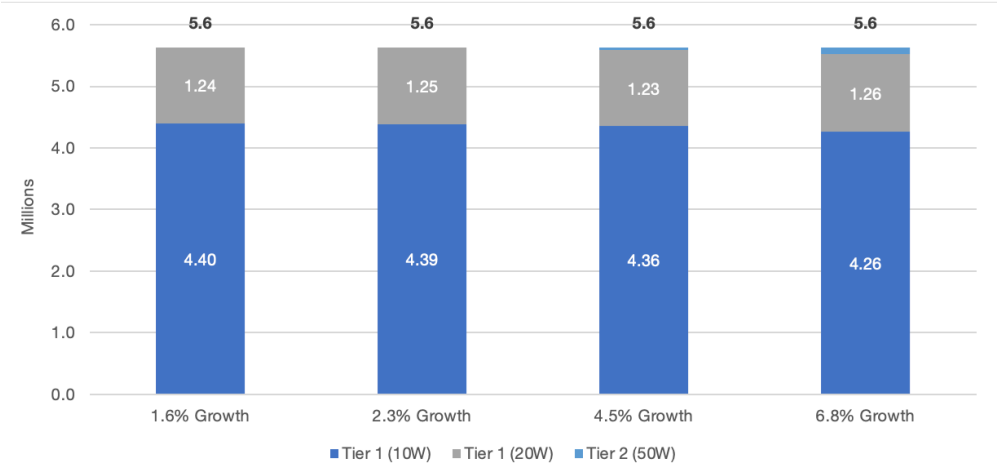
Figure 58 shows how the capital needs for the SHS market segment vary under the income growth scenarios considered without VAT and duty exemptions. As expected, at 1.6% growth and 6.8% growth, the affordability gap financing required drops from USD 187M (MZN 12B) to USD 149M (MZN 9.5B), respectively, while the enterprise capital needs slightly increase from USD 1.34B (MZN 86B) to USD 1.38B (MZN 88B), as more households are able to afford and purchase Tier 1 (20W) and Tier 2 (50W) systems (**Figure 59**).

FIGURE 58: SHS CAPITAL NEEDS UNDER VARIOUS INCOME GROWTH SCENARIOS (WITHOUT TAX EXEMPTIONS)



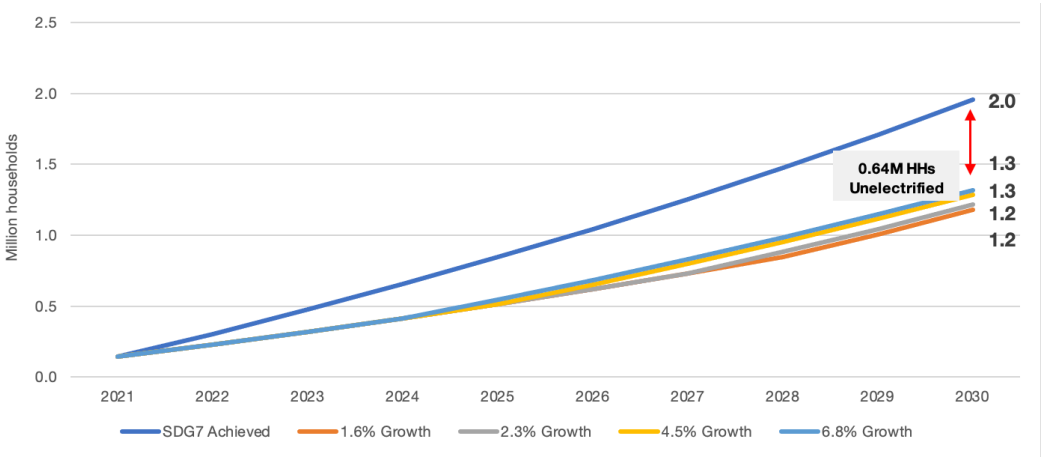
132 AfDB Mozambique Economic Outlook: https://www.afdb.org/en/countries/southern-africa/mozambique/mozambique-economic-outlook#:~:text=Growth%20prospects%20are%20more%20positive,the%20back%20of%20gas%20investments.&text=The%20budget%20deficit%20will%20narrow,and%20to%203.0%25%20in%202022; and
"Mozambique Growth forecast of 1.6% does not consider insurgency in north," Club of Mozambique, (14 May 2021): https://clubofmozambique.com/news/mozambique-growth-forecast-of-1-6-does-not-consider-insurgency-in-north-192173/; and
"Mozambique Set for 4.4% GDP Drop in 2020 and "Modest" Recovery Next Year – EIU," China Lusophone Brief, (17 August 2020): https://www.clbrief.com/mozambique-set-for-4-4-gdp-drop-in-2020-and-modest-recovery-next-year-eiu/

FIGURE 59: NUMBER OF SHS DEPLOYED BY TIER UNDER VARIOUS INCOME GROWTH SCENARIOS (WITHOUT TAX EXEMPTIONS)



With VAT and duty exemptions, the results show that the number of households that are able to afford SHS increases to 1.18M, 1.22M, 1.28M and 1.32M, respectively. At 6.8% growth, about 640,000 households will still require affordability gap subsidies (**Figure 60**).

FIGURE 60: ESTIMATED TOTAL NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 UNDER VARIOUS INCOME GROWTH SCENARIOS (WITH TAX EXEMPTIONS)



In addition, **Figure 61** shows that at 1.6% growth and 6.8% growth, the affordability gap financing required drops from USD 58M (MZN 3.7B) to USD 50M (MZN 3.2B), respectively, while the enterprise capital needs slightly increase from USD 849M (MZN 54B) to USD 880M (MZN 56.1B), as more households are able to afford and purchase the costlier Tier 1 (20W) and Tier 2 (50W) systems (**Figure 62**).

FIGURE 61: SHS CAPITAL NEEDS UNDER VARIOUS INCOME GROWTH SCENARIOS (WITH TAX EXEMPTIONS)

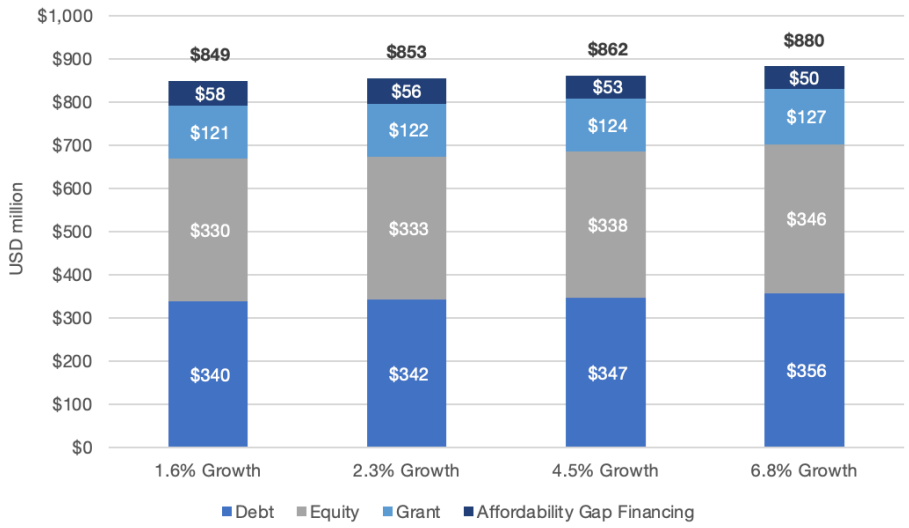
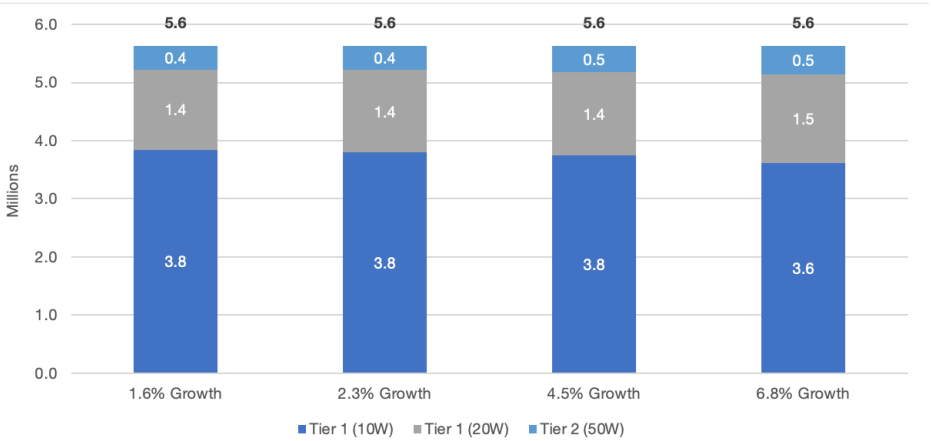


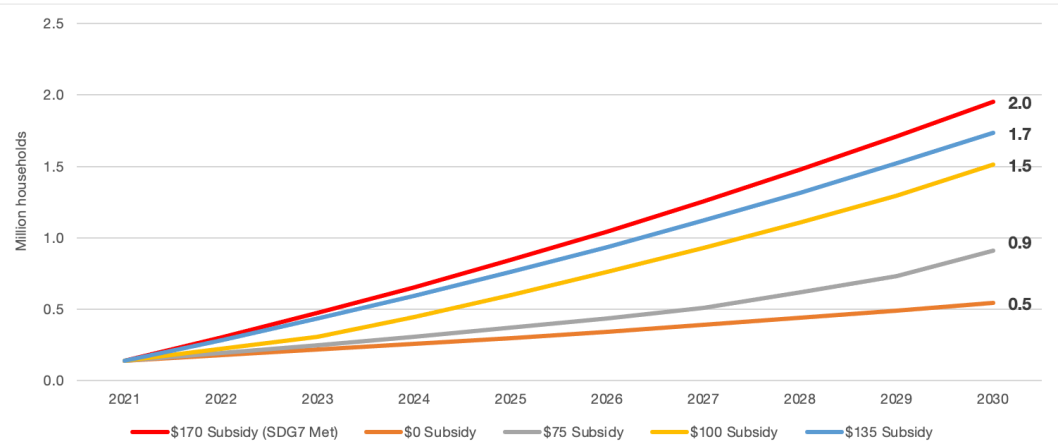
FIGURE 62: NUMBER OF SHS DEPLOYED BY TIER UNDER VARIOUS INCOME GROWTH SCENARIOS (WITH TAX EXEMPTIONS)



2.3.3.3. Subsidy Scenarios

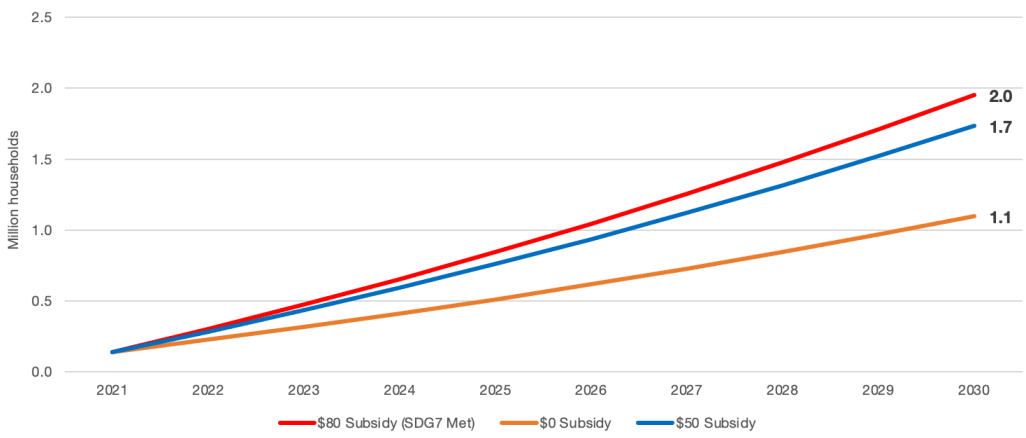
The analysis also considered the projected off-grid access penetration rate until 2030 under different unit subsidy levels. The analysis found that without VAT and duty exemptions, if no affordability gap subsidies are provided, only 500,000 households will be electrified by SHS. However, at subsidy levels of USD 75 (MZN 4,800), USD 100 (MZN 6,400), and USD 135 (MZN 8,640), the number of households gaining access increases to 900,000, 1.5M, and 1.7M, respectively. The remaining 300,000 households will only gain access if a USD 170 (MZN 10,880) subsidy is provided (**Figure 63**).

FIGURE 63: ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 AT VARIOUS SUBSIDY LEVELS (WITHOUT TAX EXEMPTIONS)



With VAT and duty exemptions in place, if no affordability gap funding is provided, 1.1M households will be electrified by SHS. And at a subsidy level of USD 50 (MZN 3,200), the number of households gaining access would increase to 1.7M. The remaining 300,000 households will gain access if a USD 80 subsidy is provided (**Figure 64**).

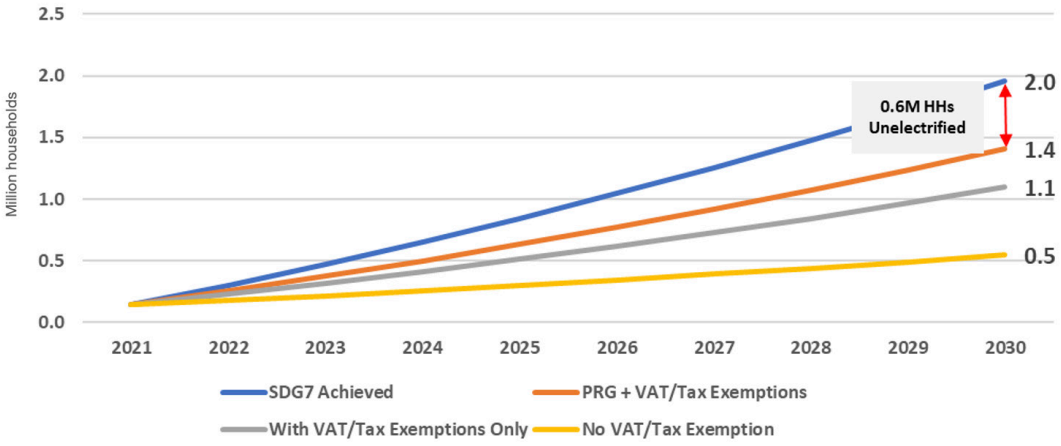
FIGURE 64: ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 AT VARIOUS SUBSIDY LEVELS (WITH TAX EXEMPTIONS)



2.3.3.4. Partial Risk Guarantee Scenario

An analysis of the impact of the provision of a partial risk guarantee to SHS providers to lengthen the PayGo tenor on Tier 1 SHS to 36 months found that with VAT and duty exemptions under a 36-month payment structure, the monthly payments required drop to USD 2.75. At this price, only the 600,000 households in the lowest income group with monthly energy spending of USD 0 to 2.5 (MZN 160), will be unable to afford a system. These households will still require affordability gap subsidies of USD 43M (MZN 2.7B), ranging between USD 60 (MZN 3,850) to USD 44 (MZN 2,800) per unit as prices fall up to 2030 (**Figure 65**).

FIGURE 65: ESTIMATED NUMBER OF HOUSEHOLDS ELECTRIFIED BY SHS THROUGH 2030 WITH A PARTIAL RISK GUARANTEE (WITH TAX EXEMPTIONS)



2.4. Roadmap Strategy and Implementation

This section presents the key components of the OGS Roadmap, including national strategies around planning, coordination, and implementation arrangements, as well as policy, regulatory, awareness, capacity, institutional, and financing issues.

2.4.1. Outstanding Regulatory Issues

There are a number of outstanding regulatory issues in the off-grid energy sector, which the Government has been working to address with support from various development partners. While the existing legal framework offers fiscal benefits for investments in electricity generation that connects to the national grid, it currently does not offer incentives to off-grid sector operators. Solar equipment is still liable to VAT at the rate of 17% and import duties that vary between 7.5% and 20% depending on the component type. Off-grid solar products also face competition from traditional energy sources such as kerosene, which are highly subsidized.[133]

Revising the existing taxation regime to provide fiscal incentives in the form of VAT and import duty exemptions to the OGS sector is a strategic priority for the GoM, as it would greatly reduce the amount of funding required to achieve universal access by 2030 (see **Section 2.3.3.1**). This fiscal measure could begin with a five-year tax holiday for all solar products and equipment (PV panels, lithium batteries, inverters, charge controllers and solar lanterns). At the mid-point of the holiday period (2.5 years), MIREME can commission a study of the effects of the measure on SHS prices (potentially decreasing between 30-45%) and on taxes paid by solar companies (potentially showing that increases in corporate and payroll tax payments more than offset the decreases in import duties and VAT). This evaluation can also be repeated in year 5 of the tax holiday to determine whether or not the initiative should be extended through 2030. Another regulatory measure that is critical to achieving electrification targets by 2030 is approval of mini-grid regulations. Components of these regulations need to include a process for simple registration of a mini-grid and the awarding of a concession, either at the provincial-level (for mini-grids smaller than 150kWp) or at the national level with ARENE (for mini-grids larger than 150kWp). The regulations will also need to include provisions for negotiating cost-reflective tariffs, either with provincial authorities or ARENE. In September 2021, with support from the FCDO-funded BRILHO programme, the Government approved by Decree, the 'Regulation for Off-Grid Energy Access,' a new regulatory framework that will allow for private operators to enter the off-grid market. The Decree will be accompanied by specific regulation to provide greater clarity to all market actors in the off-grid energy sector.[134]

2.4.2. Roadmap Planning and Coordination

The key components of the Roadmap's planning, coordination and implementation framework at the national, provincial and regional level are described below.

2.4.2.1. National-Level

As the national institution responsible for developing rural electrification, FUNAE will be the principal driver of OGS Roadmap planning, coordination and implementation. However, FUNAE is part of MIREME and will also need to collaborate with EDM in order to coordinate on-grid and off-grid development activities. The engagement of the regulator, ARENE, is also required for the successful implementation of the OGS Roadmap, especially as it pertains to the mini-grid sector (registration and licensing of mini-grids, the setting of sustainable and affordable tariffs, etc.). The Ministries of Finance and Planning will also play key roles at the national level.

133 ECA and GreenLight, 2018.

134 "Government of Mozambique approves off-grid energy regulation taking a key step towards universal access," SNV, (15 September 2021): https://snv.org/update/government-mozambique-approves-grid-energy-regulation-taking-key-step-towards-universal

Off-Grid Solar Platform

An Off-Grid Solar Platform, with MIREME, FUNAE, EDM and ARENE as members, is critical to the success of the Roadmap's implementation. To support MIREME and FUNAE with planning, coordination and implementation of the Roadmap, an OGS Platform Coordinator can either be staffed internally, or an individual or firm can be solicited through a tender process. The Coordinator will serve as Secretary to the Platform group and will work in direct partnership with GoM officials to support management and coordination of all OGS-related trainings, awareness-raising and financing campaigns, and monitoring and evaluation (M&E) functions.

One possible option is to establish the OGS Platform as a working group within the Ministry's envisioned Off-Grid Electrification Unit. This working group would be composed of designated staff from the aforementioned public energy sector institutions and would initially operate under the guidance of an external consultant as the Platform Coordinator. In this role, the consultant would be embedded within the GoM and have the following main responsibilities:

- assist the GoM with formal establishment of the OGS Platform, including relevant institutional arrangements, operating guidelines and procedures;
- provide training and capacity building to the OGS Platform/ Off-Grid Electrification Unit; and
- support management and coordination of the multiple OGS Platform activities and work streams associated with implementation of the Roadmap.

While the work of the Platform would be continuous, it would hold quarterly meetings with stakeholders across the donor community and the private sector most active in off-grid development. A preliminary list includes (but is not necessarily limited to) representatives from the following:

- AMER
- BCI Mozambique
- BRILHO/SNV
- Enabel
- Epsilon Energia Solar
- European Union
- ENGIE Energy Access
- GIZ/EnDev Green People's Energy (GPE), GET.invest, and GET.transform
- GreenLight Mozambique
- Norwegian Embassy
- Power Africa
- Sida
- SolarWorks!
- UNIDO
- World Bank

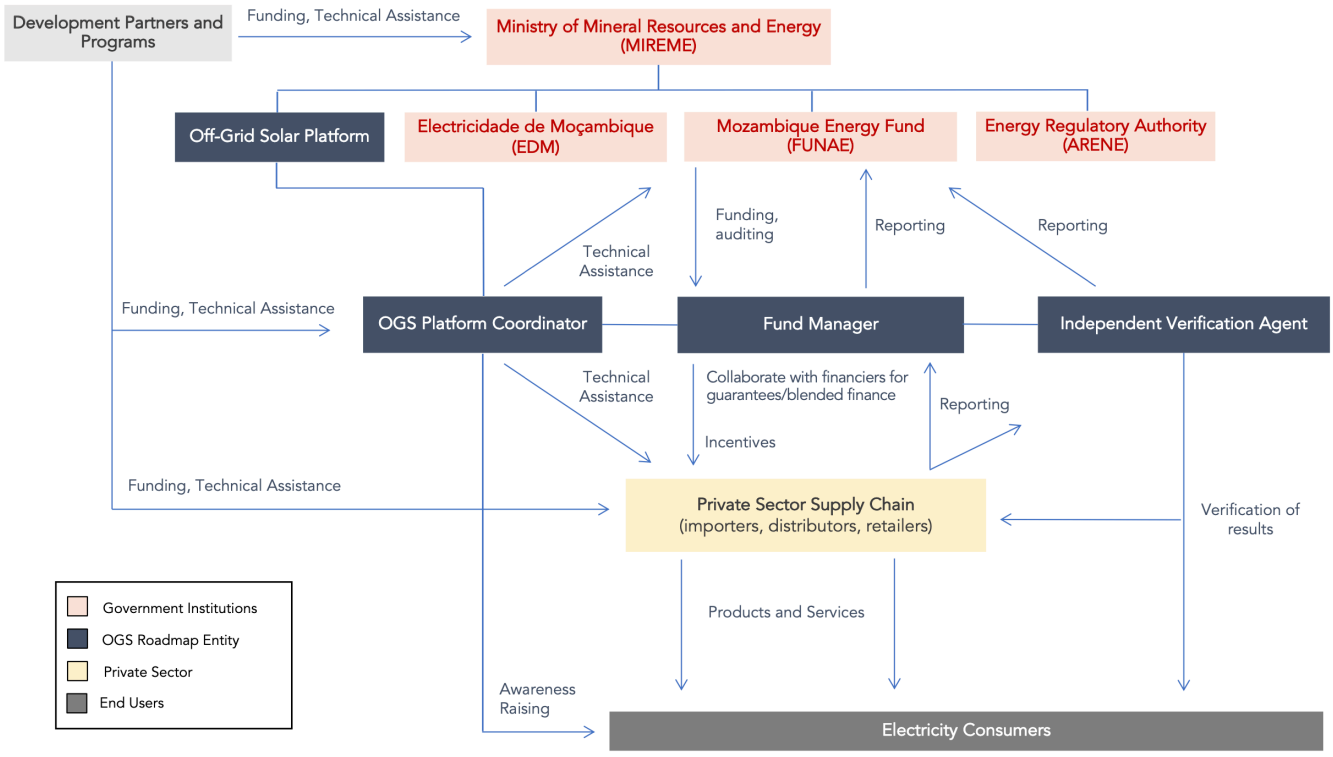
Other private sector representatives as they express interest
The continuous functions of the OGS Platform should include:

Coordination: The primary role of the Platform is to ensure that the different OGS sector activities being implemented by various sector actors complement each other and do not compete or duplicate one another, including (but not limited to) coordination of RBF bonuses, TA and awareness raising activities.
Information sharing: The Platform should be a repository for all information relative to Mozambique's off-grid sector, where both in-country and external actors interested in the sector can access data and project/program details. The Platform could also distill information and produce knowledge products based upon lessons learned, published and shared regularly.
Awareness raising: The Platform will direct a national OGS awareness raising campaign to educate the public on the advantages and limitations of off-grid solar technology. Parts of the campaign will be implemented by other sector stakeholders under the Platform's umbrella. An important aspect of this awareness campaign is educating the public on how to select and purchase quality-verified products with after-sales service, warranties, etc. (and what to avoid).
Technical assistance: The Platform can provide technical assistance to OGS companies and financial institutions (FIs), but more frequently the Platform will assist companies and FIs to source their TA needs from the myriad other actors providing training and capacity building on subjects such as business planning, marketing, financial modeling, PayGo recovery, etc.
Access to finance: The Platform should be staffed with at least one individual with strong project finance skills (perhaps from the OGS Financing Facility Manager) in order to assist OGS companies to determine their financing needs, source and apply for equity, debt and grant funding from the different financiers operating in and outside of Mozambique.

FUNAE will also be supported by an OGS Financing Facility Manager (or Fund Manager, FM) to assist with the Roadmap's financing arrangements, as well as by an Independent Verification Agent (IVA) to lead monitoring and verification activities during the Roadmap's implementation.

Figure 66 presents an overview of the off-grid sector in Mozambique under the Roadmap's framework, including the roles and responsibilities of the OGS Platform Coordinator, FM and IVA, GoM institutions, development partners and the private sector supply chain.

FIGURE 66: OVERVIEW OF THE ROLES AND RESPONSIBILITIES OF OFF-GRID MARKET ACTORS UNDER THE OADMAP



2.4.2.2. Provincial-Level

In addition to national coordination, part of the function/job description of the OGS Platform Coordinator will be to provide guidance to FUNAE to support Roadmap planning and implementation at the provincial level. Administrative functions for Roadmap implementation at the provincial level will require careful planning between the OGS Platform Coordinator/FUNAE and the Secretary of State and Council of the Provincial Services of State Representation – specifically with the Infrastructure Provincial Service and with the Environmental Provincial Service. There are two main types of local authorities: municipalities in the cities and towns, and village councils and chiefs in rural areas, who represent the interests of local communities.

Awareness Raising Campaign / Provincial Roadshow

Awareness raising is critical to the success of the Roadmap's implementation at the provincial level. According to the recent study, 68% of the Mozambican population is "aware of stand-alone solar systems," so the campaign will seek to build upon this figure.[135] Awareness raising will focus on helping consumers better understand how to efficiently make use of energy from off-grid appliances or mini-grid systems, for household, business and productive uses, to avoid consumption of more electricity than required – which leads to higher costs. It is important for consumers to be aware of the wide-ranging benefits of off-grid systems that extend beyond cost and environmental savings. Awareness raising under the Roadmap will be coordinated with the Communication Campaign developed as part of the Programa de Energia para Todos (financed by *ProEnergia*).

The Platform Coordinator and FUNAE can lead a national off-grid solar awareness campaign through marketing, communications and outreach. The campaign will employ a mix of marketing media, including TV, radio, print media, SMS and social media, appropriate to the social, cultural and demographic characteristics of the different provinces and population groups that are being engaged. In addition to educating the public on the advantages and limitations of off-grid solar technology, the campaign will focus on issues of solar product quality (i.e., how to recognize quality products, what to avoid), product disposal and recycling. The campaign may also include community sensitization around electricity use, payment options, and understating the benefits and cost-savings associated with switching from traditional polluting energy sources (e.g., kerosene) to solar technology. Awareness raising activities led by FUNAE under the Roadmap should complement (and utilize the same information dissemination mechanisms of) EDM's existing communications campaign and strategy that it deploys to support extension of the country's grid network.

As part of the national awareness raising campaign, FUNAE can work with provincial authorities to prepare and deliver a 'roadshow' in the specific districts in each province targeted by the Roadmap (see **Section 2.2.5** for a complete list of target districts per province). Provincial OGS roadshows can be piloted in provinces with the greatest OGS market potential, such as Zambezia and Nampula.[136] The roadshow will be well advertised in advance to maximize public attendance and encourage the participation of private OGS companies and NGOs active in the OGS sector. In addition to creating solar awareness among

135 "Stand Alone Solar (SAS) Market Update: Mozambique," Tetra Tech International Development, UK Foreign, Commonwealth and Development Office (FCDO) Africa Clean Energy Technical Assistance Facility, (March 2021): https://www.ace-taf.org/wp-content/uploads/2021/04/Stand-Alone-Solar-SAS-Market-Update-Mozambique.pdf

136 During implementation of the Roadmap, this plan can be revised and updated accordingly by FUNAE to include other parameters that determine priority for off-grid electrification (such as poverty, affordability levels, private sector presence, among others).

consumers, another important objective of these roadshows is to help OGS companies enter rural and deep rural areas and display their product and service offerings, thus expanding their reach geographically while improving OGS accessibility nationally.

All registered solar companies will be permitted to participate in the roadshows, provided that they can prove that their products meet the quality standards outlined by Lighting Global/IEC. The OGS Platform Coordinator (in collaboration with existing projects offering technical assistance such as BRIHLO and EnDev) will look to professionalize the local indigenous Mozambican businesses operating frequently through the informal sectors by providing them with technical assistance.

During the awareness raising campaign, educating consumers will be critical to ensure that they have a good perception of solar products and understand what a good quality product is. Moreover, there is a need to educate households on the potential financial gains of switching to solar energy and ensuring that they are aware of their current energy expenditure. A well-orchestrated community awareness raising campaign should therefore focus on communicating the benefits of renewable energy off-grid systems and products, as well as the harmful impacts of alternatives such as kerosene.

The roadshow activities can include a combination of town hall meetings, community outreach and demonstration sessions, advertisements and other sensitization methods. Consumers benefit greatly from seeing demonstrations and experiencing the products themselves, which helps to build trust and create interest. This would help in educating consumers on correct usage practices and increase their knowledge of the systems, and would in-turn, significantly increase word-of-mouth advertising which plays a significant role in household decisions to use off-grid solar products. It is important that awareness-raising is carried out through means that the community members are familiar with. For example, at local level, especially in the villages, community radio broadcast systems are used as a crucial means of communication by different stakeholders to disseminate relevant information. In urban areas, the use of radio, television, smartphones and websites is common.

Local authorities should also be engaged by FUNAE throughout the Roadmap's planning period to ensure their long-term 'buy-in' especially around issues of local skill development and capacity building to ensure appropriate O&M of systems. Within the communities, efforts should be made to create or strengthen vocational training for basic SHS installation, repair and maintenance services. The National Association of Municipalities of Mozambique ANAMM) was established by the municipalities in 2006 to promote cooperation and solidarity among all municipalities and contributes to the training and professionalization of municipal staff.[137] This body should be strengthened to provide training and certification programs for the overall community to ensure the Roadmap's successful implementation.

2.4.2.3 Regional-Level

At the regional level, planning and coordination should focus on forming or strengthening partnerships with regional entities such as ALER (Lusophone Renewable Energy Association), the East African Centre of Excellence for Renewable Energy and Efficiency (EACREEE), the SADC Centre for Renewable Energy and Energy Efficiency (SACREEE). ALER promotes renewable energy development in Portuguese-speaking countries by providing support to the private sector and acting as a cooperation platform for all stakeholders. EACREEE and SACREEE work extensively to build the capacity of governments to align national policies, laws and regulations with regional frameworks and standards. For instance, in the off-grid solar sector, quality-verified products – and informal market competition – can be partially addressed by using regional testing facilities to test for product quality (whereas customs authorities may not have the local resources to manage this). Regional organization also offer accreditation, training and knowledge-sharing programs that can help build local capacity and bring the technical skills gap so that Mozambique has more locally-qualified personnel.[138]

2.4.3. Capacity Building

The OGS Platform Coordinator can play an important role in building the capacity of all market actors in the off-grid energy sector. This can begin with establishing a web-based OGS 'Help Desk' as a centralized repository for off-grid market information (e.g., modeled after the African Development Bank's Green Mini-Grid Help Desk,)[139] to be used as a resource for Mozambique's OGS sector, especially for documents providing business management or technical knowledge to support indigenous Mozambican business participation in the OGS sector (including suppliers of stand-alone solar systems and productive use equipment and appliances. The Help Desk can function as a "one-stop-shop" to support the private sector with all national or provincial level permits, licensing requirements and regulatory approvals necessary for off-grid projects. The Help Desk will also contain a mechanism whereby companies or NGOs can apply for and be directed to different sources of technical assistance.

2.4.3.1. SMEs and Technicians

Capacity building, training and certification schemes for OGS service providers, installers and technicians are critical to the success of electrification programs as without these, long-term O&M is not possible. Training programs should be set up to certify technicians, after-sales service providers and electrical engineers. The technical capacity of policymakers, regulatory and enforcement agencies, private sector actors (service providers, financiers etc.), industry associations, academia, and others, should be properly developed by the OGS Platform, which can build upon the networks already established by AMER with assistance from development partners.

Mozambican companies will need technical assistance and training in order to compete with the international companies currently dominating the SHS market. Some topics that may be the object of TA or training include (but are not limited to) the following:

137 http://www.clgf.org.uk/default/assets/File/Country_profiles/Mozambique.pdf
138 ECA and GreenLight, 2018.
139 www.gmghelpdesk.afdb.org

- Sales, marketing,
- Business planning
- Costing and pricing
- Accounting and cash flow management
- Financial modeling
- Sales and human resource management
- Business model development

Knowledge sharing and accreditation programs can be implemented though partnerships with academic institutions such as Universidade Técnica de Moçambique (UDM) and industry associations such as Ordem Dos Engenheiros de Moçambique (the Association of Engineers of Mozambique). Academic institutions should be strengthened to serve as centers for providing training, research and certification, promoting the use of off-grid appliances and equipment, and mainstreaming renewable energy into their general curricula so that everyone going through these institutions will be properly equipped with the basic knowledge and benefits of renewable energy practices. Industry associations such as AMER should be equipped to provide professional and vocational trainings and certifications for technicians and engineers to render services that will ensure the efficient performance of appliances and equipment, developing sector-specific training content to be updated regularly as technologies change and new equipment are manufactured, and to enable them to optimize equipment for efficiency purposes rather than only focusing on servicing and repairs.

The Platform should establish a directory of trained technicians, aiming to have a minimum number of trained technicians available in each province. Technicians must be professionally trained and certified to render services that will ensure the efficient performance of appliances and equipment. Additionally, as technologies change, technicians need to update their skills and learn how to safely and properly install and maintain new equipment. There are several institutions currently providing training in the renewable energy industry, including:

- The Lusophone Renewable Energy Association (ALER) is a non-governmental development organization with the mission of promoting renewable energy in Portuguese speaking countries, including Mozambique. ALER is committed to training public and private entities, sharing information and insights for the purpose of attracting investment in renewable energy projects. In 2017, ALER and the African EU-Renewable Energy Cooperation Program (RECP) established the Mozambique Renewable Energy Association (AMER). As the first industry association, AMER is dedicated to the promotion of renewable energy in Mozambique, and training through online courses or short in-person workshops and seminars.
- ALER and AMER recently partnered to host the Europe-Mozambique Investment Forum, which helped create a networking platform for renewable energy stakeholders.
- The Logos Training Centre in Maputo, which is a partnership between Logos Industries and the GREEN Solar Academy.[140] The Center provides theoretical knowledge and practical hands-on experience to ensure participants have comprehensive knowledge of solar PV products.
- The Southern African Solar Thermal Training and Demonstration Initiative (SOLTRAIN) is another institution that provides capacity building and solar system demonstrations in Mozambique.

2.4.3.2. Commercial Banks

Commercial banks need training to better understand the energy access ecosystem, off-grid project origination, loan underwriting and administration, conducting due diligence of project developers and their projects, technology evaluation, financial structuring, project monitoring and evaluation. The aim of this TA is to help enhance the capacity of local FIs to appraise the sector. Lending to the OGS sector from local banks should be encouraged through TA and training to finance end-users, including households and SMEs. One potential partner in this activity is the EU-funded GET.invest platform, which recently launched an initiative to provide this type of capacity building to local FIs in Mozambique.

2.4.3.3. FUNAE

In addition to the indirect training that FUNAE will learn from working directly with the OGS Platform Coordinator, the Coordinator will be tasked with conducting an institutional diagnosis of FUNAE – or commissioning a specialized consultant for this purpose – to identify capacity gaps within the organization. Following the diagnosis, FUNAE should develop a strategic plan to arrive at an appropriate and efficient structure for its future to ensure successful implementation of the Roadmap.

As FUNAE emerges from its previous role as rural energy project developer towards its new, more conventional role as rural electrification agency, some new skills will be needed – and some old skills will become redundant. In its role as proprietor of the OGS Financing Facility, FUNAE will need to know how to originate projects, perform due diligence of developers and their projects and structure financing. As overseer of the Roadmap's Independent Verification Agent (IVA), FUNAE will also require training in project monitoring and evaluation (M&E).

2.4.3.4. Support for the Bottom of the Pyramid

Through a combination of price reductions driven by tax exemptions on solar equipment, RBF subsidies for SHS companies, and economies of scale, the commercial off-grid solar market will continue to grow rapidly in Mozambique. However, there will still be Bottom of the Pyramid (BoP) households that will require some form of demand-side subsidies to bridge the affordability gap. An estimated USD 200M (MZN 12.8B) is required in affordability gap financing for households to acquire Tier 1 SHS systems in order to achieve universal access in Mozambique (see **Section 2.3.2.1**). There are several approaches that can be taken to provide affordability gap funding. One option is to provide results-based finance to OGS companies that install new SHS systems, with the aim of reducing retail prices. The RBF program would need to be designed in a way to force the companies to deploy a majority of the grant (at least 75%) toward price reductions.

A second option is to provide demand-side subsidies to consumers, which can be structured through "energy safety

140 https://www.logosindustries.com/maputo-solar-training-academy/

net" mechanisms such as conditional cash transfers, vouchers and coupons or other modalities to enable households to afford the out-of-pocket expense for Tier 1 SHS. This option, however, would necessitate building an organizational infrastructure to implement the voucher program, and thus would significantly increase the subsidy requirements beyond the estimated USD 200M required. Also, while RBF is designed to place the risk of failure to deliver firmly on the OGS SHS supplier, a voucher program would require large up-front investments by the GoM and development partners, essentially placing the risk of failure on these entities.

2.4.4. Off-Grid Solar Financing Facility

While an Off-Grid financing facility under FUNAE already exists, it is expected to grow considerably in size and importance during the implementation of the OGS Roadmap. FUNAE will engage an independent Facility Manager (FM) to manage the OGS facility. The primary role of the OGS Financing Facility is to provide grant funding to solar companies. During the set-up of new facility policies and procedures FUNAE and the FM may identify additional financial products or windows to complement the grant products, such as RBF for PUE equipment purchases or cash-deposit partial risk guarantees to stimulate local bank lending.

2.4.4.1. Results-Based Financing

Results-based financing mechanisms – which extend capital to the private sector contingent upon delivery of pre-agreed results that are subjected to independent verification – have increasingly become a preferred choice of financing interventions to the public sector in achieving their development objectives. Under an RBF scheme, the risk of performance is transferred entirely to the beneficiary / private sector while enabling the RBF funder to achieve significant leverage on their capital. RBF mechanisms offset the upfront costs involved in expanding a distribution network while providing the beneficiaries the flexibility to invest in various operational expense activities. RBF mechanisms have also provided tremendous focus to the funder by enabling them to target specific geographic areas, technologies, etc.

Several current off-grid projects in Mozambique already offer some form of RBF to companies working in the sector (BRILHO, EnDev-FASER, AECF, Beyond the Grid). Some of these projects mix ex-ante grants in addition to ex-poste RBF, which requires more up-front due diligence than traditional output-based RBF. However, this ex-ante grant does fill an important up-front capital need, especially for the indigenous Mozambican companies. There is, however, a need for coordination between the different RBF mechanisms to avoid having different funds providing subsidies for the same solar installation.

Despite their success in crowding in private capital and creating impact, most RBF mechanisms are one-dimensional – i.e., supporting only the market/geographic expansion with little focus on investing in technology, CAPEX and piloting innovative business models. Developers may still need financing support to achieve early milestones given that RBF payments are back-loaded. Thus, RBF may exclude smaller/earlier-stage local companies that do not have the means to pre-finance the costs of delivery. "Hybrid" RBF schemes being implemented in Mozambique by some projects are valuable for their early-stage support of Mozambican companies. However, ex-ante investments inherently require subjectivity in the up-front due diligence, and funds that provide ex-ante grants run the risk that their investment may be lost and never result in a project on the ground.

2.4.4.2. Local Debt and Risk Sharing

In addition to the RBF, FUNAE (or its selected Fund Manager) could explore other risk sharing or grant options to help pre-fund the RBF awardees or to mobilize more capital to the sector more broadly. Local OGS suppliers would likely require additional financing to be able to implement the RBF's objectives. With their sole equity being insufficient in most cases, risk-sharing and guarantee options could be offered to players willing to participate in such pre-financing, locally and internationally (in addition to the ex-ante grants explored above).

Such options can of course go beyond the RBF program and support any funder willing to consider financing solar companies in Mozambique. Given how substantial the capital requirements are to achieve universal access (see **Section 2.3**), the GoM may consider allocating part of the facility for pure mobilization purposes to leverage the available funds as much as possible in order to bring in even more investment. Such leverage can reach 20x or more over time if recycled.[141] Such an initiative also aims to make investors increasingly more comfortable with local market risk, ideally developing a sustainable flow of local and international capital in Mozambique's off-grid companies.

2.4.4.3. Guarantees for Banks

Major financial sector players such as BCI have expressed interest in starting or increasing their involvement in the access to energy sector. The EU-funded GET.invest program also organized a roundtable in March 2021 about "Supporting Financing Institutions in Mozambique on Renewable Energy" that was well-attended, confirming high interest by local banks (ABSA, Banco Unico, BIM, BCI, FNB, Moza Banco, etc.). However, banks are still deemed very conservative, and rates are too high for most local solar companies. Risk-sharing and guarantee solutions have proven to help lower the risk for banks and the end-rate for their clients.

A number of subsidized lines and guarantees are currently being provided by international donors and programs (e.g., KfW, UNIDO) in the market. BCI has tried forming partnerships with local SHS players to offer financing associated to their products. The scale stays however limited, not exceeding USD 5M in available guarantees and subsidized lines.

FUNAE can explore allocating part of its committed funding to the sector to expand on existing guarantees to banks, or adding new ones, and contributing to lowering the rates. Such FUNAE guarantees can be targeted toward RBF awardees: FUNAE would guarantee a large percentage of the financing that goes toward pre-funding the RBF program (complementing the ex-ante grants when available), helping both local banks and solar companies collaborating for the success of the program *with a lowered cost of capital*. The exact terms of the guarantees (% of risk sharing, % for first loss if any, scope of funding to be covered by FUNAE guarantee, etc.) will be defined by FUNAE and the Facility Manager during implementation.

141 If FUNAE provides 10% first-loss coverage, it will leverage 10X; two cycles of loans = 20x leverage.

Another idea expressed by local lenders is to have the option to have recourse over the RBF payments in case the solar company is in default.

2.4.4.4. Investment Support for International Funders

The energy access sector in Mozambique has seen some international transactions in the past two years. For instance, ElectriFI, Sunfunder and Energize Africa combined committed more than USD 6M to the sector in 2019 (mostly to SolarWorks!). The Development Bank of Southern Africa (DBSA) committed USD 2.2M for Ignite Zambia in 2020 and is open to increasing its commitment to USD 20M depending on the success of the first phase. [142] A substantial part of the funding to international companies is also done at group level, with part of it used in Mozambique. As an example, ENGIE raises low-cost funding through its utility status, and deploys part of it to its local entity (Fenix). The EU is also considering committing an investment window of USD 10-30M to be deployed across mini-grids and SHS in the country to be managed by ElectriFI/EDFI.

However, late 2020 and 2021 have seen a slowing down in off-grid financing due to the pandemic as well as high currency volatility (depreciation of the MZN by more than 20% in 2020 before recovering in June 2021) that is making the hedging of currency risk very costly and adversely impacting the appetite of international lenders.

FUNAE can use part if its rural electrification funding to partner with international companies and energy access funds to offer risk and subordinated capital for their various funding vehicles with exposure to Mozambique. Partnerships with blended-finance/commercial international and regional players (crowd funding platforms, responsAbility, Sunfunder, REEP, EDFIMC, DBSA) can help facilitate investments by limiting the downside and/or adding incentives to the project financing structures:

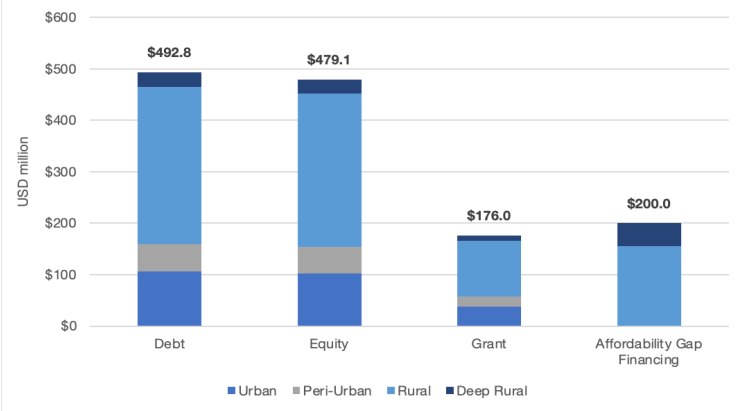
- **Origination and transaction incentives:** FUNAE can provide up to 20% of the investment made into a local off-grid energy (eligible) company, upon closure, as an investment support grant to compensate for the high market entry, due diligence and legal costs taken by the investor. Based on discussions with investors and similar experiences in the agriculture sector (e.g., Acelia), such grant could effectively steer investors to meet FUNAE's targets.
- **Currency risk coverage:** Although the MZN has recently recovered, the past volatility makes it a currency that is one of the most expensive to hedge. FUNAE could provide grant support specifically targeted at covering currency depreciation loss, in the form of a currency depreciation coverage reserve, for instance. FUNAE can also directly cover part of the hedging costs of the MZN. It can partner with the recent TCX and EC Market Creation Facility (MZN is part of the eligible currencies) where the EC covers part of the hedging costs and/or partially replicate such a scheme in a simplified way that is more in line with the sector's needs.

RBF is a great pull solution for rural electrification. However, various players still need commercial funding either to be able to access the RBF funding available or – above all – to be able to fund the approximately 250,000 connections per year required for universal access. FUNAE can explore the above option to stimulate such much needed funding at local and international levels.

2.5. Financial Resource Needs

Successful implementation of the OGS Roadmap will require significant financial resources. The estimated total capital needed for the SHS market segment is **USD 1.3B (MZN 83B)** – including **USD 492.8M (MZN 31.5B)** in the form of debt, **USD 479.1M (MZN 30.6B)** in equity investment, **USD 176M (MZN 11.2B)** in grant funding for energy access enterprises, and **USD 200M (MZN 12.8B)** required for affordability gap financing for households (**Figure 67**) – which will support the deployment of approximately **5.6 million SHS**[143] to achieve universal electrification through 2030.

FIGURE 67: SHS CAPITAL NEEDS BY FUNDING TYPE TO ACHIEVE UNIVERSAL ACCESS BY 2030



142 "DBSA invests in Ignite Moçambique, a rural Off-Grid Energy Provider," Development Bank of Southern Africa, https://www.dbsa.org/press-releases/dbsa-invests-ignite-mocambique-rural-grid-energy-provider

143 This figure includes 1.8 million systems for new permanent connections, 2.8 million systems for temporary pre-electrification, and about 1 million systems for the replacement of retired systems (see **Section 2.2.2** for more details).

2.5.1. Public and Private Sector

Successful implementation of the OGS Roadmap will require significant financial resources. Public sector subsidies will be in excess of USD 200M, while the capital raised by the private sector will be near USD 1B. Commercial debt for the OGS sector is largely non-existent in Mozambique, leaving standalone solar companies to finance their contribution to the successful implementation of the Roadmap with their own equity resources.[144] The GoM acknowledges the important role of the private sector in achieving universal electrification by 2030; thus, ensuring affordable and sustainable access to finance for OGS companies to scale up their operations is a priority. The Roadmap's strategy aims to facilitate international investment in the off-grid sector, as well as to develop local currency debt financing from the Mozambican banking community to help address these financial challenges.

2.5.2. Budgetary

In addition to the funding needs described above, additional resources will be needed to cover the other components of the Roadmap's implementation, including costs for awareness raising activities, capacity building, and hiring the OGS Platform Coordinator, Financing Facility Manager, Independent Verification Agent, and M&E Specialist. It is estimated that an additional USD 3.4M will be needed over the next four years (2022-2025) to finance these components of the Roadmap (**Table 13**).

TABLE 13: ESTIMATED FUNDING NEEDED FOR ROADMAP IMPLEMENTATION ACTIVITIES THROUGH 2025[145]

No.	Description	Amount (USD 000s)
1	Awareness Raising[146]	900
2	Capacity Building and TA	600
3	OGS Platform Coordinator	600
4	OGS Financing Facility Manager	600
5	Independent Verification Agent	300
6	M&E Specialist	400
Total		3,400

- **Awareness Raising:** The Roadmap will sponsor awareness raising activities and marketing events in the targeted provinces and districts. Securing venues, transportation to and from the events, and advertisement of the events will require resources. The Roadmap will support a media campaign (TV, radio, brochures, fliers, etc.) to raise public awareness of the advantages and limitations of off-grid solar technology (including how to differentiate between quality-verified and inferior products and systems). There will be direct costs related to this media campaign, while planning and coordination of all awareness raising activities will be indirect costs. Awareness raising activities led by FUNAE under the Roadmap should complement (and utilize the same information dissemination mechanisms of) EDM's existing communications campaign and strategy that it deploys to support extension of the country's grid network.
- **Capacity Building and Technical Assistance**: The Roadmap will provide technical and financial resources to support capacity building, training and coaching activities for OGS companies, prospective solar technicians and financial institutions. Designing and implementing training modules/relevant certifications, securing partners and skilled trainers for courses and workshops etc. will require resources.
- **OGS Platform Coordinator**: The OGS Platform – which may function as a working group within the Ministry's envisioned Off-Grid Electrification Unit, composed of representatives from MIREME, FUNAE, EDM and ARENE – would initially operate under the guidance of an external consultant as the Platform Coordinator. The consultant would mainly be responsible for assisting with management and coordination of the multiple Platform activities and work streams associated with implementation of the Roadmap (see **Section 2.4.2.1** for more details). It is estimated that the fees for an external Platform Coordinator would be approximately USD 150k per year (USD 600k in total for the four-year implementation period between 2022-2025).
- Additionally, implementation of the Roadmap will require the selection of an **OGS Financing Facility Manager (FM)**, an **Independent Verification Agent (IVA)**, and a **Monitoring and Evaluation (M&E) Specialist**. The FM will be in charge of the design and implementation of the Financing Facility, with the overall objectives of: (i) supporting sustainable access to quality-verified off-grid solar products and systems; and (ii) encouraging growth of early-stage, local solar companies where possible. In its initial stages, most of the Facility will be deployed as result-based financing (RBF), requiring an efficient and transparent verification of the results upon which the payments will be triggered – which is the main responsibility of the IVA. An external consultant may also be hired to manage and oversee the implementation of an M&E framework to assess key performance indicators, measure progress, identify challenges, and improve the Roadmap's implementation to ensure that expected electrification targets are realized through 2030.

144 It is expected that early-stage OGS enterprises will rely more on grant financing and risk tolerant early equity, while more mature businesses will seek to leverage their equity financing to secure debt in order to finance their consumer receivables and inventory finance needs.

145 Through the *ProEnergia* project, the World Bank has already allocated USD 3M in funding to support FUNAE with developing off-grid electrification solutions through the end of 2023 (and will likely extend its financing to the project for an additional period). It is envisioned that *ProEnergia* financing will cover (at a minimum) the FM (#4) and IVA (#5) funding requirements in **Table 13**. However, in order to achieve the objectives of the OGS Roadmap and universal electrification by 2030, the GoM will need to continue to fundraise, especially to increase the volume of funding available to the OGS Financing Facility.

146 Including provincial roadshows to two pilot provinces (Zambezia and Nampula).

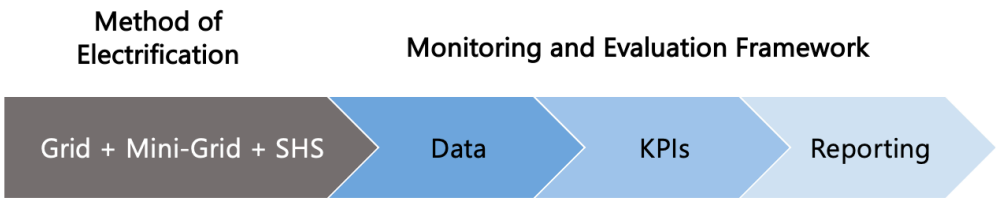
2.6. Monitoring and Evaluation

Monitoring and Evaluation (M&E) is a key component of Mozambique's off-grid electrification Roadmap. At its core, monitoring benefits consumers (who receive the expected product when making a purchasing decision), participant businesses (who are provided a level playing field and do not lose competitiveness by complying), and policymakers (who can assess the effectiveness of their programs and evaluate where improvements can be made). The goal of an M&E framework in this context is to establish quantifiable and objectively verifiable key performance indicators (KPIs) and targets that can be systematically assessed across suitable time intervals in order to measure progress, identify challenges, and improve the Roadmap's implementation to ensure that expected electrification targets are realized through 2030. The Roadmap's M&E function can either be staffed internally, or an M&E specialist (individual or firm) can be solicited through a tender process by FUNAE. Both the IVA and OGS Platform Coordinator can also provide support for implementation of the M&E framework.

2.6.1. Key Performance Indicators

Energy and non-energy indicators will be measured against baseline figures established in **Table 14** in order to assess progress towards 2030 electrification targets and facilitate impact measurement. The M&E specialist must meet with key GoM and industry stakeholders to establish baselines and review reporting indicators annually to gauge progress. In addition, FUNAE and MIREME should designate internal resources to review annual reporting and to carry out field survey activities to verify results. **Figure 68** presents the process through which information will be collected and analyzed to measure and report on each of the Roadmap's performance indicators through 2030. It is anticipated that these activities will be performed on an annual basis to ensure that the country is on track to achieve the 2030 electrification target.

FIGURE 68: ROADMAP MONITORING AND EVALUATION REPORTING FRAMEWORK

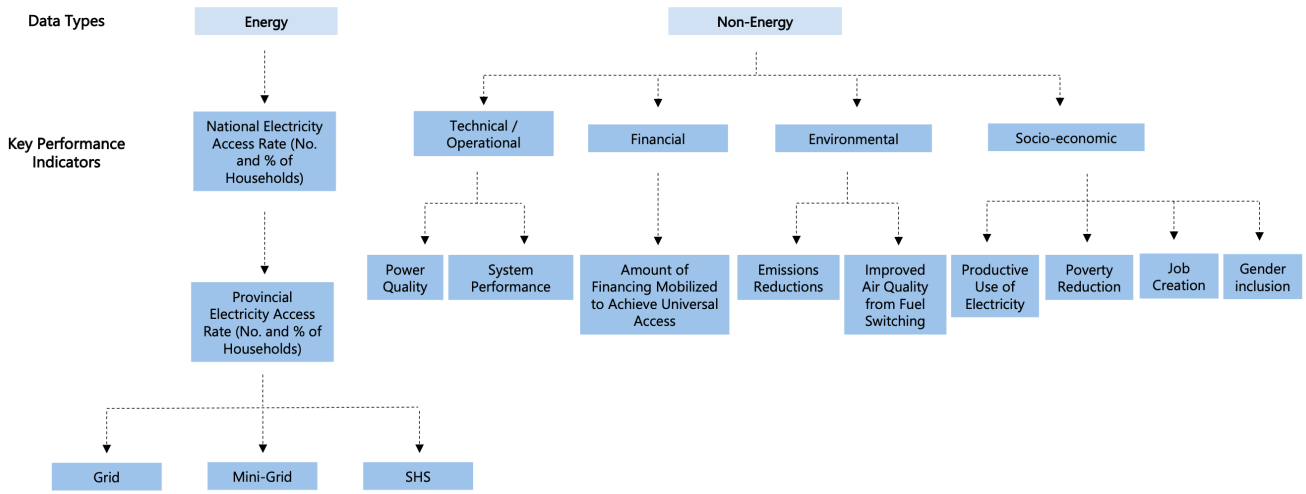


Source: Adapted from Ravanbach et al., 2020.

2.6.2. Monitoring and Evaluation Framework

Key performance indicators (KPIs) to measure, evaluate and report on the Roadmap's progress are summarized in **Figure 69**. The KPIs include a combination of energy (e.g., number of connections; power generation and consumption metrics, etc.) and non-energy (e.g., revenues from pre-paid meters, environmental and social benefits etc.) indicators.[147]

FIGURE 69: KEY PERFORMANCE INDICATORS FOR THE ROADMAP MONITORING AND EVALUATION FRAMEWORK



147 Ravanbach et al, 2020, "Developmenwork for Hybrid Renewable Mini-grids," 2020 Fifteenth International Conference on Ecological Vehicles and Renewable Energies (EVER): https://elib.dlr.de/137771/1/IEEE_PID6617743.pdf

Table 14 presents an M&E framework to track the KPIs in **Figure 69** and ensure that universal electrification is achieved by 2030. The M&E framework includes a description of indicators, baselines, targets, data sources and methods, the frequency of measurement, and GoM agencies responsible for coordination and implementation.

TABLE 14: KEY COMPNENTS OF THE ROADMAP MONITORING AND EVALUATION FRAMEWORK

Key Performance Indicator (KPI)	Description	Baseline (2020)	Target (2030)[148]	Specific data to be monitored and verified	Data sources and methods	GoM agencies / key stakeholders responsible for monitoring and reporting	Frequency
Energy KPIs							
Rate of Electricity Access (%) at National and Provincial level for Households	Number and proportion (%) of households with access to electricity service	2.8 million households receiving access to electricity service (35% of population)	• 6.9 million households (68% of population) electrified by national grid • 1.95 million households (19% of population) electrified by SHS • 1.3 million households (13% of population) electrified by mini-grids	• Household connections through off-grid (SHS) connections • Development and installation of new off-grid solar capacity • Total capacity added (MWp) • Level of energy consumption (kWh)	• GIS analysis/tools • Monitoring of sales figures and/or revenues from pre-paid meters (EDM, private off-grid operators)	MIREME, FUNAE, ARENE, EDM, private off-grid operators	Annually
Non-Energy KPIs							
Technical / Operational	Technical framework to ensure power quality and service quality capacity[149]	• Quality of electricity supply (on-grid) index[150] • Rating – 3 (out of 1 – 7) • Rank – 114 (out of 137) • ESMAP Multi-Tier Framework[151] • Rating: between Tier 1 and 3 for availability and reliability (grid-supplied electricity) • 56% of EDM customers rate quality of grid-supplied electricity as poor, and 26.7% relate service as bad[152]		• Power quality and system performance • Guaranteed hours per day • Frequency of outages • Supported appliances (low power, medium power, high power based on tier of access) • Service quality (capacity, availability, reliability)[153]	• Monitoring of sales figures and/or revenues from pre-paid meters (EDM, private off-grid operators) • Monitoring of systems and service quality • Surveys, discussion groups and other participative methods to assess impacts	MIREME, FUNAE, EDM, private off-grid operators	Annually

148 Energio Verda Africa GIS analysis

149 Bhatia, Mikul; Angelou, Niki. 2015. Beyond Connections : Energy Access Redefined. ESMAP Technical Report: https://openknowledge.worldbank.org/bitstream/handle/10986/24368/Beyond0connect0d000technical0report.pdf?sequence=1&isAllowed=y

150 "Quality of electricity supply," World Economic Forum Global Competitiveness Index: https://tcdata360.worldbank.org/indicators/ha7db856d?country=BRA&indicator=547&viz=line_chart&years=2007,2017

151 Mutsonziwa, Kingstone and Maposa, Obert "Mozambique: Finscope Consumer Survey Report," 2019: https://drive.google.com/file/d/1TYp_gAuemR2rUVUNWeYyA2N9hG5U7qUS/view

152 "Electricidade De Mozambique, EDM Strategy 2018- 2028: Lighting Mozambique's Transformation," (2018): https://www.edm.co.mz/en/document/reports/edm-strategy-2018-2028.

153 Bhatia, Mikul; Angelou, Niki. 2015. Beyond Connections : Energy Access Redefined. ESMAP Technical Report: https://openknowledge.worldbank.org/bitstream/handle/10986/24368/Beyond0connect0d000technical0report.pdf?sequence=1&isAllowed=y

Financial	Amount of financing mobilized to achieve universal access by 2030	1.84 billion by 2030 for SHS market sector[154]		• RBF facility outputs (revenues from sales/ pre-paid meters) • Amount of financing mobilized to meet annual universal access by 2030 • Monitoring of financing mobilized for grant financing, debt financing, equity financing and affordability gap financing	• Monitoring of sales figures and/or revenues from pre-paid meters (EDM, private off-grid operators) • Amount of financing mobilized for each of indicators	Ministry of Economy and Finance (MEF), MIREME, FUNAE, EDM, private off-grid operators	Annually
Environmental	• Greenhouse gas emissions reduced • Improved indoor air pollution mitigated	• 110.07 MtC02e[155] • 2,700 metric tons of kerosene (2018 annual consumption[156] • 28% rely on kerosene lamps, candles and lanterns for lighting[157]	Reduce emissions by 76.5 MtCO2e[158]	• Greenhouse gas emissions averted • Improved air quality from fuel switching (change/ reduction in kerosene use)	• Electricity production and consumption analysis (EDM, private off-grid operators) • Monitoring of sales figures and/or revenues from pre-paid meters (EDM, private off-grid operators) • Monitoring and tracking of sales figures for kerosene	Ministry of Land and Environment (MTA), MIREME, FUNAE, EDM, private off-grid operators[159]	Annually

154 Based on combined provincial SHS estimates needed to achieve universal electricity access
155 "Mozambique – Climate Watch: https://www.climatewatchdata.org/countries/MOZ
156 "Kerosene consumption, Mozambique, Annual," EIA: https://www.eia.gov/opendata/qb.php?category=2135060&sdid=INTL.64-2-MOZ-MT.A
157 Naidoo, Kameshnee and Loots, Christiaan "Mozambique – Energy and the poor," Making Access Possible, 2020: https://www.undp.org/sites/g/files/zskgke326/files/publications/UNDP-UNCDF-Mozambique-Energy-and-the-Poor.pdf
158 Mozambique Intended Nationally Determined Contribution (INDC): https://www4.unfccc.int/sites/NDCStaging/pages/Party.aspx?party=MOZ_
159 "Voluntary National Review of Agenda 2030 for Sustainable Development," MEF: https://unstats.un.org/sdgs/files/meetings/vnr-workshop-dec2019/1.1-Mozambique.pdf

Socio-economic • Socio-economic impacts of electricity access • Gender inclusive development • Productive use of energy / economic activity resulting from access	• 47% (poverty headcount ratio, % of population)[160] • 55% experienced poverty related symptom (past 12 months)[161] • 0.437 Human Development Index (UN Least Developed Nation status)[162] • 46% financially excluded[163] • 65,000 jobs created[164]	• Poverty reduction levels • Financial product uptake • Productive activity (number of new or improved) and direct employment (jobs created)	• Surveys, discussion groups and other participative methods to assess impacts • Monitoring of annual reports (international and domestic) tracking socio-economic development trends and rankings	Ministry of Gender, Child and Social Action of Mozambique (MGCAS), MEF, MIREME, FUNAE, EDM, private off-grid operators[165]	Annual mobile phone surveys, biannual field surveys

160 "Poverty headcount ratio at national poverty levels", World Bank: https://data.worldbank.org/indicator/SI.POV.NAHC?locations=MZ

161 Mutsonziwa, Kingstone and Maposa, Obert "Mozambique: Finscope Consumer Survey Report", 2019: https://drive.google.com/file/d/1TYp_gAuemR2rU-VUNWeYyA2N9hG5U7qUS/view

162 Mozambique UN Least Developed Nation Status: https://worldpopulationreview.com/country-rankings/least-developed-countries

163 Mutsonziwa, Kingstone and Maposa, Obert "Mozambique: Finscope Consumer Survey Report", 2019: https://drive.google.com/file/d/1TYp_gAuemR2rU-VUNWeYyA2N9hG5U7qUS/view

164 Beyond the Grid Fund for Africa: Promoting job creation and skills in the off-grid sector in Uganda: https://www.nefco.int/news/the-beyond-the-grid-fund-for-africa-promoting-the-job-creation-and-skills-development-agenda-in-the-off-grid-sector-in-uganda/

165 "Voluntary National Review of Agenda 2030 for Sustainable Development," MEF: https://unstats.un.org/sdgs/files/meetings/vnr-workshop-dec2019/1.1-Mozambique.pdf

ANNEX 1: MARKET ASSESSMENT

The market assessment presented in this section provides an overview of Mozambique's energy and off-grid sectors (A-1 and A-2, respectively), including both supply side (A-2.1) and demand side (A-2.2) analyses; key barriers to market development (A-3); and opportunities for market growth (A-4). The findings presented below are based on a study of third party off-grid solar (OGS) sector analyses and best practices, as well as extensive consultations with OGS market stakeholders, including a field mission to gather data from off-grid communities in Mozambique's provinces (see Annex 2 for a description of the data collection methodology).

A-1 Energy Sector

The development of Mozambique's abundant mineral and hydrocarbon reserves has the potential to generate substantial wealth and prosperity for the country in the long-term.[166] The national utility, EDM, sources the majority of the country's power from the Cahora Bassa Hydropower plant (Hidroeléctrica de Cahora Bassa, HCB) and supplies the remaining balance through a combination of diesel, gas-fired generation, and solar energy. Electricity demand is expected to increase sharply in the coming decades as the country continues to develop and rates of electricity access increase.[167]

Today, energy demand is mainly driven by extractive industries, infrastructure development and other economic activities concentrated around urban areas. This is particularly true for the mining and natural gas sectors, which require a huge amount of energy to power large-scale mining operations and to develop megaprojects for the production and export of liquefied natural gas (LNG). Natural gas development in the Rovuma Basin off the coast of the northern province of Cabo Delgado was suspended in early 2021 following attacks by Islamic extremist insurgents in the coastal town of Palma. French oil and gas company, Total, declared force majeure and halted construction of its USD 20 billion LNG export facility (the largest project financing transaction in Africa to date).[168] The insecurity has also caused Exxon Mobil to delay the final investment decision on its Rovuma LNG project.[169]

In the renewable energy sector, Mozambique has 55 MW of installed solar generation capacity, with the 40 MW Mocuba solar project in Zambézia Province built by Norwegian developer Scatec Solar providing most of this volume. A second project, the 41 MW Metoro solar project, is being developed by Neoen in Ancuabe district, Cabo Delgado, in partnership with EDM and with funding from the French Development Agency (AFD) under the EU Projeto de Promoção de Leilões para Energias Renováveis (PROLER).[170] Excluding hydropower, the share of renewable energy in the generation mix is expected to increase to 306 MW by 2030, representing approximately 5% of installed capacity in that year.[171]

Mozambique's energy sector is also characterized by a significant energy access deficit, as about two-thirds of the population does not have access to electricity, with very low rates of access in rural areas, where the majority of the population lives. There are a number of barriers to expanding grid-based electricity access, including a limited transmission and distribution system with high technical and commercial losses, a dependence on thermal fuels which are subject to commodity price volatility, and institutional and regulatory constraints, among others. In the off-grid space, the country is currently developing mini-grid regulations and has a sizable, yet nascent and dynamic market for stand-alone off-grid solutions, especially PayGo SHS.[172]

In the off-grid sector, FUNAE is working with various development partners to promote rural electrification. To site just a few examples, GIZ is involved in four projects – EnDev, Green People's Energy, GET.invest and GET.transform. GIZ/Energising Development Mozambique – EnDev Mozambique supports households in connecting to the national grid, assists in the distribution of high-quality photovoltaic products, and strengthens the distribution of clean cooking solutions. Between 2009 and 2021, over 1.9 million people gained access. In July 2019, the multi-donor Energising Development and the German funded Green People's Energy Programme in cooperation with the Foundation for Community Development – FDC (Fundação para o Desenvolvimento da Comunidade) launched the RBF Fund FASER (Fund for Sustainable Access to Renewable Energy). The general objective of the RBF Fund is to stimulate the value- and distribution chain of energy access markets with a strong focus on renewable and decentralized solutions in Mozambique and promote a broader adoption of such technologies across the country (with a strong focus on peri-urban and rural areas). FDC runs the FASER fund as a basket fund and it is open to other donors: Its specific Covid-19 measures started already in 2020; one funded by NORAD and another was upscaled by the EU. Funded by the UK's FCDO, the BRILHO project managed by SNV is similar in design to EnDev (providing TA and RBF for off-grid companies). Other programs include the African Enterprise Challenge Fund (AECF), which is providing TA and grants to off-grid companies in Mozambique. Supported by Sida and Norway, the Beyond the Grid (BTG) program is focusing on mini-grids. Belgian's Enabel is also focused on mini-grids and productive uses of electricity, especially solar irrigation, as well as capacity building at FUNAE.

166 Abrahamson et al., 2013.

167 "Energy Catalyst – Country Guide: Mozambique," Innovate UK and UK Aid, (June 2020): https://energycatalyst.community/developer/wp-content/uploads/2020/12/Country-Guide-Mozambique.pdf

168 Cotterill, J. and Keohane, D., "Total declares force majeure on $20 billion LNG project in Mozambique," Financial Times, (April 26, 2021): https://www.ft.com/content/841a63a7-e89a-45c8-b6b3-22b50e59b14c

169 Elliott, S., "Delay to Rovuma LNG latest setback for Mozambique LNG sector," S&P Global: Platts, (9 April 2020): https://www.spglobal.com/platts/en/market-insights/latest-news/natural-gas/040920-delay-to-rovuma-lng-latest-setback-for-mozambique-lng-sector

170 "Mozambique: Construction of new solar power plant begins," Club of Mozambique, (23 October 2020): https://clubofmozambique.com/news/mozambique-construction-of-new-solar-power-plant-begins-175024/

171 "Briefing: Renewables in Mozambique 2021," Associação Lusófona de Energias Renováveis (ALER), Associação Moçambicana de Energias Renováveis (AMER) and GIZ GET.invest, https://www.lerenovaveis.org/contents/lerpublication/aler_mar2021_resumo-renovaveis-em-mocambique-2021.pdf

172 World Bank Project Appraisal Document: Mozambique Energy for All (ProEnergia) Project, 2019.

A-1.1 Electricity Market

The electricity market in Mozambique is vertically integrated, with state-owned utility, EDM, responsible for the generation, transmission, distribution, and retail sale of electricity throughout the country. The Ministry of Energy (MIREME) is responsible for the development and administration of national energy policy. The energy market is regulated by the Energy Regulatory Authority (ARENE), which was established in 2017 to supersede the National Electricity Council (CNELEC).

The Mozambique Energy Fund (FUNAE), a public institution within MIREME in charge of expanding energy access in off-grid areas, has developed 76 min-grids encompassing 6.3 MW of capacity to date, with feasibility studies prepared for another 50+ locations. For these off-grid projects, retail sales are managed by EDM, while O&M is managed by FUNAE, private operators or the beneficiary communities involved.[173]

In the 2018 National Electrification Strategy (NES), the GoM proposed a "New Electrification Approach" to manage off-grid sector market development, under which off-grid projects within FUNAE's jurisdiction – referred to as Subsidized Expansion Areas (Áreas de Expansão Subsidiadas, AES) – will be eligible to receive funding through a proposed instrument, the Electrification Account, which will function as a revolving fund administered by the Ministry of Economy and Finance to provide financing for off-grid energy projects. It is envisioned that the Electrification Account will be funded mainly by revenues from concessions for power generation.[174]

Table A1 summarizes the institutional and market actors in the electricity sector.

TABLE A1: INSTITUTIONAL AND MARKET ACTORS IN THE ELECTRICITY SECTOR

Institution / Market Actor	Description/Responsibilities
Ministry of Mineral Resources and Energy (Ministério dos Recursos Minerais e Energia, MIREME)	• Ministry responsible for overall energy sector planning, policy development and implementation, as well as management and oversight of all energy sector programs and initiatives to achieve energy policy objectives
Mozambique Energy Fund (Fundo de Energia, FUNAE)	• Government institution under MIREME responsible for providing funding and assistance to develop projects that expand access to low-cost energy services in rural and urban areas and promote sustainable management and conservation of energy resources • Coordinating government agency responsible for off-grid sector projects, programs and activities, with primary focus on the stand-alone market segment • Has been directly involved in the construction of off-grid energy systems, including micro-grids, mini grids, and stand-alone systems
National Directorate for Electrical Energy (NDEE)	• Central technical body within MIREME responsible for the analysis, preparation and elaboration of energy policies[175]
Energy Regulatory Authority (Autoridade Reguladora de Energia, ARENE)	• Regulatory authority responsible for ensuring compliance with the laws and regulations governing the electricity sector, protecting the public interest and guaranteeing the continuity and quality of service • Responsible for issuing licenses to IPPs for electricity generation, the establishment and approval of electricity prices and tariffs and control of the maximum prices of some petroleum fuels
Ministry of Land and Environment (Ministério da Terra e Ambiente, MTA)	• Ministry responsible for overseeing sustainable management of land resources and the environment • Previously the Ministry of Coordination of Environmental Affairs (MICOA) and the Ministry of Land, Environment and Rural Development (MITADER)
Electricidade de Moçambique (EDM)	• Integrated, state-owned national electricity utility responsible for generation, transmission, distribution and retail sale of electricity • Works with MIREME and FUNAE on power sector planning
Investment Promotion Centre (Centro de Promoção de Investimentos. CPI)	• Investment promotion agency responsible for facilitating and working with private investors
Mozambique Association of Renewable Energies (AMER)	• Non-profit association promoting renewable energy and sustainable development in Mozambique through active participation in discourse with political, economic and social decision-making bodies
Independent Power Producers (IPPs)	• Sasol Limited (in partnership with National Oil Company, ENH) • Aggreko • Scatec Solar (Mocuba Solar Project) • Neoen (Metoro Solar Project)

Source: Energy Catalyst – Country Guide: Mozambique, 2020; Company and institution websites

173 World Bank Project Appraisal Document: Mozambique Energy for All (ProEnergia) Project, 2019.
174 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.
175 "Integrated Master Plan Mozambique Power System Development Final Report," Japan International Cooperation Agency (JICA), (February 2018): https://open-jicareport.jica.go.jp/pdf/12318606.pdf

A-1.2 Energy Policy, Legal and Regulatory Framework

Mozambique has made progress in recent decades to reform its power sector, beginning with the 1997 Electricity Act, which established an initial framework to restructure the sector and promote private sector investment and participation,[176] and culminating with the National Electrification Strategy (NES), launched in 2018 under the government's National Energy for All Program, which aims to achieve universal electrification by 2030 and calls for the entry of private operators into the electricity market.[177] The strategy builds on several previous government initiatives to increase energy access. These include Mozambique's five-year plan, most recently updated in 2020,[178] the Integrated Electricity Master Plan (2018-2043)[179] and the New and Renewable Energy Development Strategy (2011-2025),[180] all of which emphasize the importance of off-grid renewable energy solutions (specifically stand-alone solar technology) in meeting the 2030 electrification target.

Despite progress in furthering energy access, Mozambique's current legal framework is limited to solely offering fiscal benefits for investments in electricity generation that connects to the national grid. Moreover, renewable energy technologies, such as solar home systems, are still liable to VAT at the rate of 17% and import duties that vary between 7.5% and 20% depending on the component type. Off-grid solar products also face competition from traditional energy sources such as kerosene, which are highly subsidized.[181] In September 2021, with support from the FCDO funded BRILHO programme, the Government took an important step to approve the 'Regulation for Off-Grid Energy Access,' a new regulatory framework that will provide greater clarity to all actors in the off-grid energy sector.[182]

Table A2 summarizes the energy and electricity sector policies, laws, regulations and roadmaps that have been adopted by the government to date.

TABLE A2: SUMMARY OF ENERGY SECTOR POLICIES, LAWS AND REGULATIONS

Name, Year	Type	Description
Regulation for Off-Grid Energy Access, 2021	Decree	• Regulatory framework that will provide greater clarity to all actors in the off-grid energy sector • The regulation will ensure the necessary conditions for the private sector to develop its activities and protect investments in a diverse set of technologies applicable to the off-grid context, such as solar home systems, mini-grids, and improved cooking solutions
Mozambican Government's Five-Year Plan (Plano Quinquenal do Governo – PQG), 2020-2024[183]	Plan	• Updates the government's previous five-year plan from 2015-2019; includes goal to increase Mozambique's electrification rate to 64% by 2024 • Includes objective to increase energy availability by 600 MW through promoting investments in the public and private sector in new infrastructure while increasing the use of renewables • Supports the country's economic growth and is one of the tools included in ENDE
Economic and Social Plan (Plano Económico e Social – PES), 2020[184]	Plan	• Annual report highlighting priorities for the government in supporting economic and social development • Outlines strategy for implementing the government's five-year plan • Most recent plans support higher electricity access and infrastructure development as top priorities
Decree 10-2020 (Decreto 10-2020)[185]	Decree	• Revokes Decree 48-2007 which previously regulated the licensing of electrical installations • Sets standards for authorizing licenses for the establishment and operation of plants for the production, transmission and distribution of electricity

176 "Mini-Grid Market Opportunity Assessment: Mozambique," African Development Bank, (2017): https://greenminigrid.afdb.org/sites/default/files/GMG%20MDP%20Document%20Series%20%235%20Mozambique%20Assessment%2003-05-17.pdf
177 "Official presentation of the Mozambique National Electrification Strategy 2030," ALER and EDM, (20 November 2018): https://www.aler-renovaveis.org/en/communication/news/official-presentation-of-the-mozambique-national-electrification-strategy-until-2030/
178 "Programa Quinquenal do Governo," República de Moçambique, (2020): http://www.ts.gov.mz/images/PQG_2020.2024_Versao_AR__02042020-min.pdf
179 Integrated Master Plan: Mozambique Power System Development, Final Report, JICA, 2018.
180 "Estratégia de Desenvolvimento de Energias Novas e Renováveis Para o Período de 2011 – 2025," República de Moçambique Ministério da Energia, (2011): https://energypedia.info/images/f/fa/PT-Estrategias_de_Desenvolvimento_de_E._Novas_e_Renovaveis-Ministerio_da_Energia.pdf
181 ECA and GreenLight, 2018.
182 "Government of Mozambique approves off-grid energy regulation taking a key step towards universal access," SNV, (15 September 2021): https://snv.org/update/government-mozambique-approves-grid-energy-regulation-taking-key-step-towards-universal
183 "Programa Quinquenal do Governo," República de Moçambique, (2020): http://www.ts.gov.mz/images/PQG_2020.2024_Versao_AR__02042020-min.pdf
184 "Proposta do Plano Económico e Social para 2020," República de Moçambique, (April 2020) https://www.mef.gov.mz/index.php/documentos/instrumentos-de-gestao-economica-e-social/orcamento-de-estado/oe-2020/803--179/file?force-download=1
185 "Decreto No. 10/2020," República de Moçambique, (March 2020): https://www.salcaldeira.com/index.php/pt/component/docman/cat_view/32-legislacao/71-energia

National Electrification Strategy (Estratégia Nacional de Eletrificação, ENE), 2018-2030[186]	Plan	• Aims to achieve universal electrification by 2030 • Promotes reforms to the electricity market to allow for private sector operators • Defines the role of EDM, FUNAE and private parties • Strategy's new approach provides for the subsidization of electrification costs by a new instrument, the Electrification Account, as well as periodically-adjusted uniform and sustainable cost-recovery tariffs
Integrated Electricity Master Plan, 2018-2043[187]	Plan	• Utilizes a combination of on-grid electrification and off-grid electrification to increase energy access • On-grid electrification prioritizes connecting customers on a lowest-cost basis, extending infrastructure in villages with grid connections to those without • Off-grid electrification to be utilized when extending the national grid is costly, funded by the Energy Fund (FUNAE) and private finance
Law no. 11/2017, of 8 September (Lei 11.2017)[188]	Law	• Creation of the Autoridade Reguladora de Energia (ARENE)
National Development Strategy (Estratégia Nacional de Desenvolvimento - ENDE), 2015-2035[189]	Plan	• Outlines strategy for supporting social and economic growth in Mozambique • Four strategic pillars are identified with goals and benchmarks for each • Energy access is considered an important prerequisite for achieving each of the outlined pillars
National Energy Strategy (Estratégia Nacional de Energia), 2014-2023[190]	Plan	• Outlines vision for electricity sector to overcome challenges and utilize opportunities to harness country's energy resources in sustainable manner • Five key focus areas with a strategy for each: - Regulation: establishment of Energy Regulatory Authority (ARENE) in 2017 to regulate energy sector - Energy Efficiency: legal framework governing energy efficiency, from supply to consumption - Feed-in Tariffs: in 2014, FiT regulations were approved for biomass, wind and small solar and hydro technologies (10kW-10MW); however, connection of these projects to the grid requires further regulation - Electrification: goal to achieve 50% grid access by 2023 - Tariff Calculation Methodology: strategy to determine cost-effective tariffs
New and Renewable Energy Development Strategy (Estratégia de Desenvolvimento de Energias Novas e Renová- veis - EDENR), 2011-2025[191]	Plan	• Revision of 2009 New and Renewable Energy Policy targeting increased diversity and capacity of renewable generation • Outlines renewable energy targets and further establishes sector goals, divided into grid-connected and off-grid renewable energy objectives • The off-grid component of the strategy aims to develop PV production lines to supply the components used in mini-grids and off-grid generation projects
Public-Private Partnerships Law (Lei das Parcerias Público-Privadas), 2011[192]	Law	• Established framework for contracting and implementing PPP's • Governs that all IPPs must sell electricity to EDM under negotiated prices • Revisions for this law are currently underway with the aim of simplification
New and Renewable Energy Development Policy (Política de Desenvolvimento de Energias Novas e Renováveis - PDENR), 2009[193]	Policy	• Promotes access to clean energy through utilizing fair, efficient, sustainable, and culturally sensible sources of new and renewable energy • Objective is to facilitate enhanced quality and accessible prices, to alleviate poverty and to contribute to job creation and national income
Energy Sector Strategy (Estratégia de Energia), 2009[194]	Plan	• Energy policy document that defined the main policy goals of the government, identified objectives in electricity and fuel access in rural and peri-urban areas, encouraged diversification of energy sources, engagement in international cooperation, especially with the Southern African Development Community (SADC) • Highlighted the importance of increasing off-grid electrification efforts by prioritizing expansion of national grid while also providing alternative forms of electricity in rural areas and supporting cooperation between EDM and FUNAE • Emphasized productive and efficient use of energy

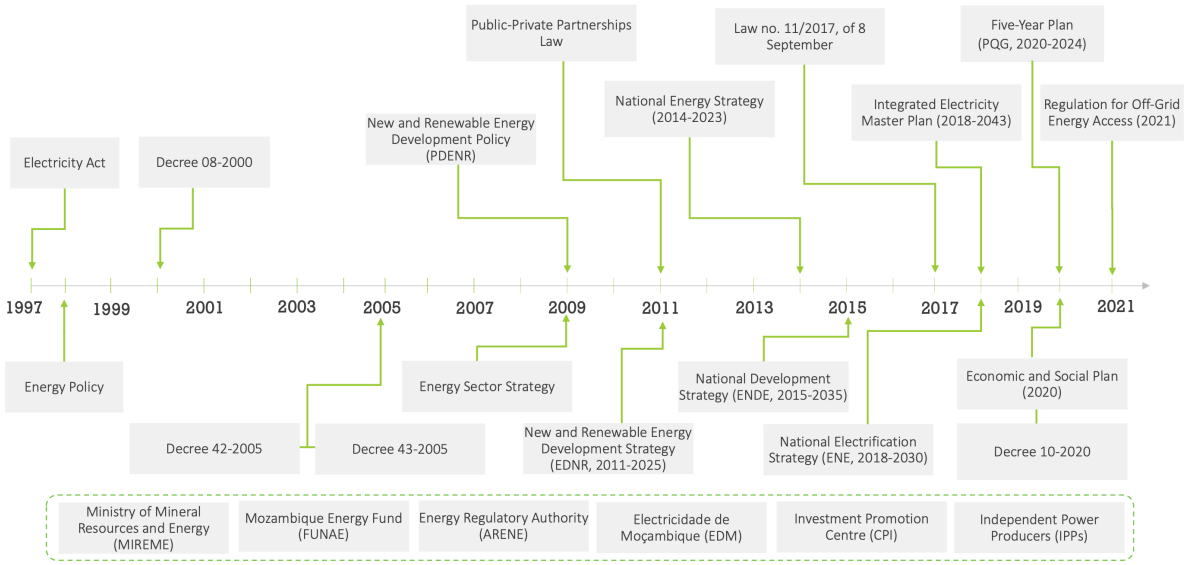
186 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.
187 "Integrated Master Plan Mozambique Power System Development Final Report," Japan International Cooperation Agency (JICA), (February 2018): https://openjicareport.jica.go.jp/pdf/12318606.pdf
188 Henriques et al., "Creation of the Energy Regulatory Authority," HRA Advogados, (2017): https://www.hrlegalcircle.com/xms/files/v1/Publicacoes/2017/201711_Creation_of_the_Energy_Regulatory_Authority__-_Legal_Alert.pdf
189 "National Development Strategy," República de Moçambique, (July 2014): https://www.cabri-sbo.org/en/documents/national-development-strategy-2015-2035
190 Bouene, A., "Pre-Assessment Report of the Mozambican Energy Sector Under the Principles of the International Energy Charter a d the Energy Chapter Treat," (2016): https://www.energycharter.org/fileadmin/DocumentsMedia/Occasional/Mozambican_Energy_Sector.pdf
191 Estratégia de Desenvolvimento de Energias Novas e Renováveis Para o Período de 2011 – 2025.
192 "Lei das Parcerias Público-Privadas," República de Moçambique, (August 2011): http://extwprlegs1.fao.org/docs/pdf/moz165015.pdf
193 "Política de Desenvolvimento de Energias Novas e Renováveis," República de Moçambique, (October 2009): http://extwprlegs1.fao.org/docs/pdf/moz119723.pdf
194 "Estrategia do sector de energia Imprensa Nacional de Mocambique," República de MoçambiqueZ

Decree 43-2005 (Decreto 43-2005)[195]	Decree	• Establishes the Electricidade de Moçambique to manage the national power transmission grid and the dispatch center
Decree 42-2005 (Decreto 42-2005)[196]	Decree	• Establishes standards for planning, financing, construction, possession, maintenance and operation of production, transportation, distribution and sale of energy, as well as the procedures governing management and development of the national electricity transmission network
Decree 08-2000 (Decreto 08-2000)[197]	Decree	• Establishes powers and procedures for the production, transportation, distribution and sale of energy • Details which authority can grant licenses and the duration of different concession agreements
Energy Policy (Política Energética), 1998[198]	Policy	• Outlines government's intent to develop household energy access, competitive business, environmental technology and energy efficiency in the electricity sector • Presents goals to deliver capacity building and improved management targets along with visions for overall energy sector
Electricity Act (Lei da Eletricidade), 1997[199]	Act	• Organizes the energy sector and legal framework for generation, transmission, distribution and sale of energy • Created the advisory body CNELEC and FUNAE • Established provisions for IPPs to sign concession agreements with EDM • Determines methodology by which tariffs are set • Revisions for this law are currently under way include simplifying procedures for small-scale and off-grid projects and accounting for technological developments in renewable energy

Source: AfDB Mini-Grid Market Opportunity Assessment, 2017; Energy Catalyst – Country Guide: Mozambique, 2020; ECA and GreenLight Off-Grid Solar Market Assessment in Mozambique, 2018; De Sousa et al., 2020.[200]

Figure A1 presents an overview of key government stakeholders in the energy sector, as well as a timeline of the plans, strategies, policies, laws and regulations associated with development of the energy sector in Mozambique.

FIGURE A1: KEY GOVERNMENT STAKEHOLDERS, POLICIES, LAWS AND REGULATIONS IN THE MOZAMBICAN ENERGY SECTOR, 1997-2021



195 "Decreto No. 43/2005," República de Moçambique, (October 2005): https://energypedia.info/images/3/3d/PT-Decreto_Nr._43-2005-Conselho_de_Ministros.pdf

196 Decreto No. 42/2005," República de Moçambique, (November 2005): https://www.salcaldeira.com/index.php/pt/component/docman/cat_view/32-legislacao/71Z-energia

197 Decreto No. 8/2000," República de Moçambique, (April 2000): https://www.salcaldeira.com/index.php/pt/component/docman/cat_view/32-legislacao/71-energia

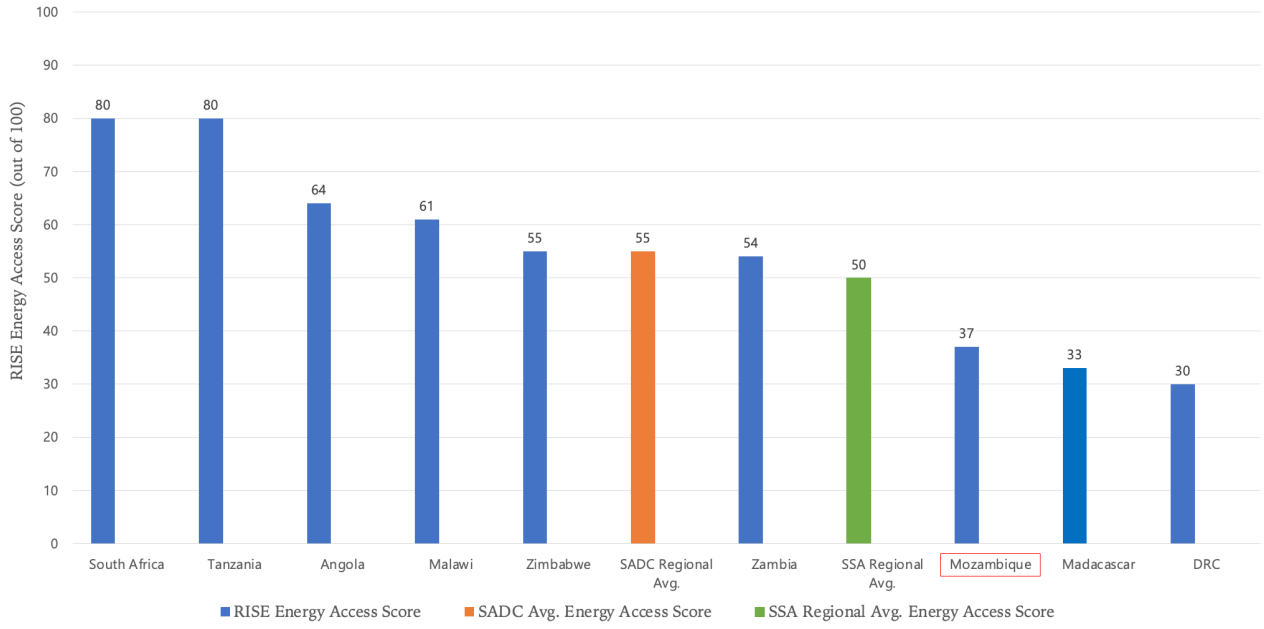
198 "Política Energética Imprensa Nacional de Moçambique," República de Moçambique, (March 1998): https://energypedia.info/wiki/PT_Politica_Energetica_Imprensa_Nacional_de_Mocambique

199 "Lei da Eletricidade," República de Moçambique, (October 1997): https://www.salcaldeira.com/index.php/pt/component/docman/cat_view/32-legislacao/71-energia

200 De Sousa, L. Guilherme, D., and Henriques, M., "Mozambique: Energy 2020," Global Legal Insights, Eight Edition, https://www.vda.pt/xms/files/05_Publicacoes/2019/Livros_e_Artigos/GLI-EN20_Mozambique.pdf

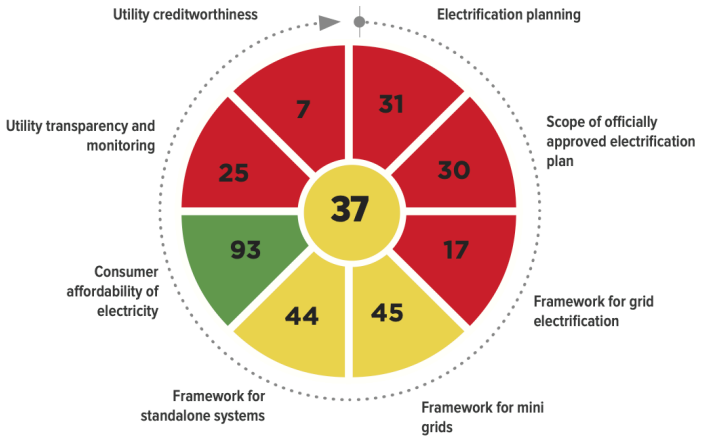
The World Bank's Regulatory Indicators for Sustainable Energy (RISE) is a suite of quantitative and qualitative indicators that assess the legal and regulatory environment for investment in sustainable energy to help identify priority areas for change based on best practices across nations and to foster an enabling environment for sustainable development. In the energy access sector, the RISE index covers indicators such as electrification planning; frameworks for grid electrification, mini-grids, and stand-alone systems; consumer affordability of electricity and utility creditworthiness, among others. As illustrated in **Figure A2**, Mozambique's overall RISE energy access score currently ranks below the regional average for the Southern Africa Development Community (SADC) and Sub-Saharan Africa (SSA) regions. **Figure A3** provides a scoring breakdown for each of the country's energy access RISE indicators, while **Table A3** compares these indicator scores to the two regional averages.[201]

FIGURE A2: RISE ENERGY ACCESS SCORE FOR SADC REGION, 2020[202]



Source: Adapted from World Bank Regulatory Indicators for Sustainable Energy (RISE) index, 2020.

FIGURE A3: MOZAMBIQUE RISE ENERGY ACCESS SCORE BY INDICATOR, 2020



201 World Bank Regulatory Indicators for Sustainable Energy (RISE) Mozambique Country Profile: https://rise.esmap.org/data/files/country-profiles/mozambique.pdf?country=221

202 NOTE: Figure A2 only includes SADC countries for which World Bank RISE data is available.

TABLE A3: RISE ENERGY ACCESS SCORE BY INDICATOR FOR MOZAMBIQUE, SADC AND SSA REGIONS, 2020

Energy Access Indicators	Mozambique Energy Access Indicator Score	Avg. Energy Access Indicator Score for SADC Region	Avg. Energy Access Indicator Score for Sub-Saharan Africa Region
Electrification Planning	31	54	48
Scope of Officially Approved Electrification Plan	30	42	39
Framework for Grid Electrification	17	60	45
Framework for Mini Grids	45	66	56
Framework for Stand-alone Systems	44	62	53
Consumer Affordability of Electricity	93	85	73
Utility Transparency and Monitoring	25	69	59
Utility Creditworthiness	7	44	36

Source: Adapted from World Bank Regulatory Indicators for Sustainable Energy (RISE) index, 2020.

A-2 Off-Grid Sector

Electricity access remains a critical development challenge for Mozambique, as nearly two-thirds of the country's 30 million people live in rural off-grid communities dispersed throughout the provinces. Although rates of access have improved, the national electrification rate in 2020 was 35%,[203] with a considerable difference between rates of access in urban (73%) and rural (5%) areas.[204] The off-grid stand-alone solar market has experienced considerable growth in recent years. The country is still in the process of developing mini-grid regulations to promote private sector engagement in the sector.

A-2.1 Supply-Side Analysis

Mozambique is considerably behind in its goal of achieving universal electricity access by 2030, which will require a combination of grid extensions and off-grid solutions. Despite the country's enormous solar potential, the private sector solar market has been limited by various policy, regulatory and financing constraints, which must be addressed to ensure the off-grid solar sector can scale-up quickly and efficiently to meet the country's electrification targets.

The analysis in this section is based upon stakeholder interviews and surveys conducted with suppliers of stand-alone solar systems, PUE equipment and mini-grid developers in May and June 2021, as well as these previous third-party off-grid solar market assessments conducted in Mozambique, including the following:

Tetra Tech International Development, "Mozambique Stand-Alone Solar Market Update," 2021[205]
Economic Consulting Associates (ECA) and GreenLight, "Off-Grid Solar Market Assessment in Mozambique", 2018[206]
Global Green Growth Institute (GGGI), "Off-grid solar power in Mozambique: opportunities for universal energy access and barriers to private sector participation," 2019[207]
RVO, "Final Energy Report, Mozambique," 2018[208]
ALER and AMER: GET.invest "Briefing: Renewables in Mozambique," 2021[209]
The surveys of off-grid solar operators aimed to answer the following questions:

- Who are the major companies and how do they operate (i.e., what business models do they utilize)?
- Where do they operate?
- What products do these suppliers sell and at what prices?
- What are their current sales volumes and projections for the future?
- Do the companies have access to finance?
- What are the major barriers/challenges these off-grid SMEs (and their collaborators) face?

A-2.1.1 Suppliers of Stand-alone Systems

The off-grid market assessment conducted by ECA and GreenLight in 2018 inventoried 21 companies selling solar electric systems. The more recent analysis by Tetra Tech International Development identified six stand-alone solar PayGo companies currently operating in the market.[210] It is likely that the number of companies active in the market contracted due to the 2019 cyclones and subsequent economic downturn. Although the number of companies has perhaps lessened, sales

203 Electricidade de Moçambique, Relatório e Contas, Annual Report, 2020: https://www.edm.co.mz/en/node/5321
204 "Tracking SDG7: The Energy Progress Report, 2021," IEA, IRENA, UNSD, World Bank, WHO, 2021: https://trackingsdg7.esmap.org/data/files/download-documents/2021_tracking_sdg7_report.pdf
205 "Stand Alone Solar (SAS) Market Update: Mozambique," Tetra Tech International Development, UK Foreign, Commonwealth and Development Office (FCDO) Africa Clean Energy Technical Assistance Facility, (March 2021): https://www.ace-taf.org/wp-content/uploads/2021/04/Stand-Alone-Solar-SAS-Market-Update-Mozambique.pdf
206 "Off-Grid Solar Market Assessment in Mozambique: Final Report," Economic Consulting Associates and GreenLight, World Bank Lighting Africa (December 2018): https://www.lightingafrica.org/wp-content/uploads/2019/07/Mozambique_off-grid-assessment.pdf
207 Baruah, P. and Coleman, B., "Off-grid solar power in Mozambique: opportunities for universal energy access and barriers to private sector participation," Global Green Growth Institute, (2019): https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/20190218_-Country-Brief_Mozambique.pdf
208 Mokveld, K. and von Eije, S., "Final Energy Report: Mozambique," RVO.nl, Netherlands Enterprise Agency, Ministry of Economic Affairs and Climate Policy, (2018): https://www.rvo.nl/sites/default/files/2019/01/Final-Energy-report-Mozambique.pdf
209 "Briefing: Renewables in Mozambique 2021," ALER, AMER and GIZ GEZ
210 Digitech, Dynamiss Trading, Ignite Mozambique, Epsilon Energia, Fenix International, and SolarWorks!

of SHS are considerably on the rise, having doubled between 2019 and 2020.[211] Recent growth of the PayGo business model has altered market dynamics to the point that meeting the goal of universal electricity access by 2030 is becoming feasible. Combined, the three biggest PayGo suppliers in the market are currently realizing sales of between 10,000 and 15,000 SHS per month.[212]

The off-grid solar market increases in size moving from the south to the north of the country, where rural populations are large but more dispersed and where the EDM grid network is limited. In turn, most solar companies begin operations in Maputo City and Maputo Province and gradually expand northward, through Gaza and Inhambane, with smaller footprints currently in the northern provinces. Retailing solar systems becomes more costly and more difficult as companies move from urban to peri-urban to rural/remote areas, driven by higher distribution costs and limited ability to pay.

Solar companies provide a variety of solar products, technologies and services. The main business models deployed by local companies are cash/over-the-counter sales and PayGo. Cash sales business models can be further categorized by those that integrate systems from the different components (PV panels, charge controllers, inverters, batteries) as opposed to those that sell packaged kits. Under a PayGo business model, customers make regular payments typically on a monthly basis via mobile money service until the system is fully paid off (usually after about 18-24 months). A variant of PayGo schemes is the difference between paying-to-own in installments versus merely leasing a system and paying for the electricity delivered (energy-as-a-service or fee-for-service).

The majority of products sold by the active solar companies in Mozambique tend to be Tier 1 and Tier 2 SHS and pico-solar products designed to power light fixtures, televisions, cellphones, radios, and other small electronic appliances. The size of systems sold varies by supplier but can be as small as 4Wp and get up to 400Wp for Tier 2 and 3 systems. While pricing varies depending on the size of the system, the average cost of an entry-level Tier 1 SHS sold by formal suppliers (including down payment and monthly repayment over two years) is USD 126. This is substantially higher than the average cost of purchasing a SHS through the informal market (roughly USD 50) but includes after-sales service.[213]

SolarWorks! is another PayGo supplier with sales volumes comparable to those of ENGIE, roughly 3,000 SHS per month. SolarWorks! is a South African firm, operating in seven of Mozambique's 11 provinces. In the household sector, the company relies on RBF payments to sell small SHS to BoP customers, while also selling larger systems to households that include TVs and/or a refrigerator. Outside of the household market segment, an important business is providing stand-alone systems for public infrastructure projects. SolarWorks! currently has a contract with USAID to install 92 systems in rural health clinics on a build-own-operate (BOO) basis. The company also has a grant from the African Enterprise Challenge Fund to provide solar pumps in Nampula Province.

ENGIE Energy Access (formerly Fenix), a subsidiary of the French energy conglomerate Engie, is one of main SHS companies in the market. ENGIE specializes in the sale of small SHS on a PayGo basis. ENGIE will be joined in Mozambique by two sister companies – Mobisol for the commercialization of larger stand-alone solar systems and PowerCorner for mini-grids.
Fenix was originally a highly successful Ugandan PayGo company before ENGIE purchased it. Arriving in Mozambique in only 2019, ENGIE also operates in Zambia, Nigeria, Benin and the Côte d'Ivoire. ENGIE offers four SHS models, the smallest powering two lights and a cellphone charger, costing USD 7 per month over 24 months, after a USD 13 down payment. For slightly more, USD 10 per month, you can get the same system with a radio. This is ENGIE's most popular model. Most customers would like to have the model that comes with a TV, but at USD 20 per month it is unaffordable to most. Systems come with a three-year warranty and are sold countrywide through commissioned sales agents (approximately 350) and shops (of which there are 27).[214]
As of 2022, ENGIE had sold over 80,000 SHS across eight provinces in Mozambique. The company projects that it will sell 60,000 SHS in 2023 – if RBF grants continue to be made available and *without* import duty and VAT exemptions. If tax exemptions are implemented, ENGIE believes 2023 sales would be between 150-200,000 systems. This is primarily because they can reduce prices and make their systems more affordable to more homes.

211 Stand Alone Solar (SAS) Market Update: Mozambique, Tetra Tech International Development, 2021.
212 Stakeholder interviews, 2021.
213 Stand Alone Solar (SAS) Market Update: Mozambique, Tetra Tech International Development, UK FCDO, 2021.
214 "Fenix International to Launch Off-Grid Solar in Mozambique in partnership with leading operator Vodacom," Africa News, (12 September 2019): https://www.africanews.com/2019/09/16/fenix-international-to-launch-off-grid-solar-in-mozambique-in-partnership-with-leading-operator-vodacom//

Epsilon Energia is a local Mozambican competitor of the international companies described above. It is perhaps disadvantaged financially because it does not have the same capital resources as its international counterparts – resources that can be used to purchase and maintain stock, or to finance expansion into new geographic areas. On the other hand, a local company like Epsilon can have strategic advantages in that it knows the country better than foreign companies.
Epsilon's business was significantly hurt by the 2019 cyclones, with damage to its SHS and commercial and industrial (C&I) installations (the company has since recovered). Epsilon has offices in Maputo and Manica provinces and currently receives RBF funding from BRILHO in Zambézia and from EnDev in Manica.[215] Epsilon sells Greenlight Planet's Sun King SHS, a 6Wp system that powers three lights and phone charging for USD 180 over 24 months.[216] For its larger systems, Epsilon procures its solar system components on the free market, primarily sourced from China. Epsilon also installs and provides O&M for business installations (C&I). Additionally, the company is developing a containerized solar cold storage technology that it intends to deploy as a new service line, which would include community management and PayGo financing to provide post-harvest storage for perishable agricultural produce, increasing produce life and therefore price and profit.

When interviewed, off-grid suppliers in Mozambique consistently indicated that VAT and import duties are significant barriers to scaling up their businesses, as they force off-grid SMEs to pass along the higher costs to customers, thereby driving up default rates and creating negative feedback loops. Similarly, the lack of financial incentives and reliance on grants and subsidies to make certain Tier 1 stand-alone products profitable is another issue preventing suppliers from maximizing volume and impact.

Systems provided through grants have a market-distorting effect whereby customers – particularly those in remote regions – do not understand the true cost of providing service, which can set unrealistic expectations about how much they should pay for power. Consumer education and awareness raising around this issue is therefore critical. This can be a challenge, especially given the relatively low level of financial literacy that is typical of rural areas of Mozambique. Financial literacy drives consumer decision-making and understanding of benefits and cost-savings – in this case, the savings associated with switching from more costly and traditional polluting energy sources (e.g., kerosene) to solar power.

Generally, local companies do not view the informal market for solar systems as a significant threat or competition. They believe that the quality of their products and after-sales service bests what is available on the informal market. They also believe that the PayGo business model matches the Mozambican population's ability and willingness to pay – i.e., that households really cannot afford the cash up-front payments required by the informal market. When interviewed, several solar companies indicated that dividing the country geographically between various donor projects and programs was an inefficient approach to rural electrification and contrary to the principles of free enterprise.

There are a number of development partners supporting the OGS sector in Mozambique, including the World Bank, FCDO, SIDA Beyond the Grid Fund (BTG), SIDA Africa Enterprise Challenge Fund (AECF), Enabel, and GIZ. Two programs in particular target the stand-alone solar market segment:

- **EnDev,** the first programme in Mozambique for energy access has been Energising Development. Since 2007 it has been active in Mozambique and its support has been crucial to the nascent off-grid market up until now. We have basically provided financial and technical assistance support in every imaginable aspect of operating an energy product or service business in Mozambique. Over the years, we have built excellent and trustful relationships with over 20 companies that now exist, and dozens of distributors and retailers more. After all these years of support and training, many of these companies reached a point in which they were ready to properly manage and deliver on a complex, results-based financing mechanism; EnDev successfully piloted the RBF approach in Mozambique. Since over 2 years, the RBF FASER**,** (Fondo de Acesso sustentável as energias renováveis em Moçambique, Fund for Sustainable Access to Renewable Energies and Efficient Technologies) is hosted and managed by FDC (Foundation for Community Development). Through the support to more than 20 private companies, FASER has provided access to more than 600,000 people since July 2019, among them more than 88,000 SHS. Out of the total GIZ Energy Cluster of EUR 48.9 million, EUR 14 million funded by Germany, the Netherlands, Norway, Switzerland and the EU, are allocated to the FASER fund. FASER currently consists of five distinct funding windows: 1) The Access window focuses on providing access to energy for households. 2) The Productive Use window focuses on providing solutions to SMEs for the productive use of energy. 3) The Humanitarian window is designed to ensure that "no one is left behind", specifically target regions that are affected by humanitarian crises, such as Manica and Sofala which were hit by cyclone IDAI. 4) The COVID-PAY Window is a special financing window dedicated to ensuring that so far over 175,000 people continue to have access to energy and to ensure business continuity of PAYGO Solar PV suppliers in Mozambique during the Covid-19 pandemic. 5) The Social Infrastructure window was initiated in 2021 with the target to electrify rural health centres.

215 http://www.epsilonenergia.co.mz/Contact-Us
216 http://www.epsilonenergia.co.mz/Product

- **BRILHO**, funded by UK FDCO (GBP 22.8M over five years through 2024), provides grants and RBF primarily to 10-15 OGS companies (not mini-grids until there are regulations), but also to a few companies providing clean cooking solutions. The grant amounts, including the RBF amount, vary from company to company, from province to province, and from Tier 1 to Tier 2. There is an additional 25% RBF top-up for productive use applications. BRILHO has at least one business initiative that touches each of the 11 provinces. BRILHO maintains a roster of clean energy SME consultants that are to provide technical assistance to the OGS companies. They identify companies to support through tendering and reverse auction approach. BRILHO has supported an estimated 26,000 SHS to date.

A-2.2.1 Suppliers of Productive Use Equipment

The market for PUE suppliers in Mozambique is still nascent. While the PUE sector has experienced recent growth as public awareness and market support continue to increase, there is no data available to quantify the degree of this growth. The agriculture sector, which accounts for roughly 25% of Mozambique's GDP, represents an immense opportunity for productive use applications, but to date little of this market has been realized. A limited number of companies (BlueZone, Future Pump, Water Irrigation Solutions, True-North and SolarWorks!) offer solar water pumps and irrigation systems, and they compete with local hardware stores that import pumps from Asia and South Africa, but who do not specialize in sizing and installation.

The price of PUE products varies based on the product and size of the system. Solar water pumps can range from USD 500 - 1,500, with surface pumps significantly cheaper. Pump suppliers generally employ cash/over-the-counter sales business models – not PayGo – as these local companies do not have the capital or microfinance capabilities. To date, most direct PUE system sales have been to farmers with large-scale operations rather than to smallholders or rural farmers.

The PUE market will grow alongside the mini-grids market. Mini-grids need PUE applications to be economically viable and mini-grid developers actively promote the development of PUE customers for their networks. On the other hand, stand-alone solar systems can rarely power high-consuming PUE applications (pumping, milling, cold storage) economically.

A-2.2.2 Mini-Grids

Mozambique's mini-grid market, or green mini-grids (GMGs), is the least developed off-grid sector. An analysis conducted in 2017 by the AfDB estimated that 5.6 million people in Mozambique would have been best served through mini-grids, or about one-sixth of the total population. The report also estimated a market size of USD 63.2 million, based on monthly household energy expenditures.[217] As of now, private sector involvement is almost non-existent, except in the context of public projects and O&M contracts, mainly due to regulatory limitations preventing the direct billing and sale of electricity to customers. There is currently no specialized mini-grid legislation, so all projects up to this point have been developed through FUNAE, which currently has 76 mini-grids in operation or under construction, which will account for more than 6 MW of installed capacity.[218] The mini-grid sector is approximately three to four years behind the PayGo SHS sector. Draft mini-grid regulations have been developed by ARENE and are under review. The draft regulations appear to be progressive, allowing for mini-grid registration for GMGs under 150kWp in size to be conducted at the provincial level, and from 150kWp to 1MW concessions to be awarded by ARENE. The regulations also refer to the need for mini-grids to apply cost-reflective tariffs, instead of the national EDM tariffs (which are prohibitively low to provide for GMG economic viability, even in the case of large RBF bonuses). It is possible that a mini-grid developer will be able to negotiate a tariff with the community and then the provincial government or ARENE based upon an evaluation of its financial model. The successful implementation of these regulations would be a breakthrough and have great benefit to the future mini-grids sector. However, the enactment of mini-grids regulations is contingent on passage of a new Electricity Law, which has been under review for several years.

Like the PayGo SHS sector, Mozambique's mini-grid sector might end up being dominated by the French energy company, ENGIE. PowerCorner, a mini-grid company operating in Tanzania and Zambia, and deploying a pre-fab containerized technological approach, will also be established in Mozambique. Combining with sister companies Fenix and Mobisol, the group will go under the name of ENGIE Energy Access (EEA). Another GMG developer, Sunkofa, was established by a group of young ex-PowerCorner/Engie employees. Both are competing for the outstanding Beyond the Grid tender for the BOO rights to 57 mini-grid sites.

The current lack of regulations and policies are the main barrier preventing off-grid SMEs from scaling up the GMG market. Developing the legal framework and policies to simplify concession and licensing, clarify operating tariff issues and the limits of action for each private sector entity is imperative for this to occur. The market is also inhibited by investor hesitancy to finance projects below USD 5 million. Subsidizing projects, or incentivizing companies to create portfolios of projects, which would push total project costs over this threshold, could overcome this.

A-2.1 Demand-Side Analysis

The analysis in this section is based upon stakeholder interviews, focus group meetings held with more than 700 household consumers of off-grid solar products and systems throughout Mozambique's provinces (excluding Cabo Delgado) in June 2021 (see **Annex 2-E**) and three previous studies of consumer attitudes toward off-grid solar PV technology in Mozambique:

- Economic Consulting Associates (ECA) and GreenLight, 2018[219]

217 "Mini-Grid Market Opportunity Assessment: Mozambique," African Development Bank, (2017): https://greenminigrid.afdb.org/sites/default/files/GMG%20MDP%20Document%20Series%20%235%20Mozambique%20Assessment%2003-05-17.pdf

218 ALER, AMER and GIZ GET.invest, Briefing: Renewables in Mozambique 2021,

219 "Lighting Africa: Off-Grid Solar Market Assessment in Mozambique: Final Report," Economic Consulting Associates and GreenLight, World Bank, (December 2018): https://www.lightingafrica.org/wp-content/uploads/2019/07/Mozambique_off-grid-assessment.pdf

- USAID Southern Africa Energy Program (SAEP), 2020[220]
- TechnoServe: "Baseline survey for Fenix [ENGIE] customers," 2021[221]

The ECA-GreenLight market assessment included a household survey in Maputo, Manica and Zambézia provinces. Under the USAID SAEP study, 2,700 households participated in interviews across nine provinces (excluding Niassa Province and Maputo City). The TechnoServe consumer survey was conducted with about 300 of ENGIE's customers after they had purchased a SHS from the company.

A-2.1.1 Solar Home Systems and Household Consumers

The focus group meetings with household consumers of SHS were guided by the following discussion questions:

- Where geographically do consumers have access to EDM, generators or solar energy technologies and which (mini-grids, SHS)?[222]
- What alternatives to electricity are currently being used for lighting and connectivity?
- How much are consumers spending to meet their energy needs (and as % of income)?
- What are prevalent perceptions of EDM, generators and solar energy technology (questions relating to perceptions will require disaggregation by gender and by the decision-making power of the respondent)?
- What is the current level of accessibility of consumers to solar energy technology (proximity to nearest retailers)?
- Do consumers have any access to financing to purchase solar energy technology and if so, through which channels?
- How is the mobile network, what is the current level of mobile phone ownership, and what is the current use of mobile payment (disaggregated by gender)?
- Do attitudes or perceptions towards solar technology differ between provinces or between those living in urban, peri-urban, rural or deep rural areas?
- Do attitudes or perceptions differ based on gender or between income levels?
- How much can households realistically pay for Tier 1, Tier 2, Tier 3 stand-alone systems? Or Tier 4 mini-grid delivered power?

A -2.1.1.1 Alternative Sources of Energy

Batteries, kerosene, and to a lesser extent candles and firewood are the most common substitutes for electricity. Studies report that Mozambican households nationally (not just rural) spend on average USD 12 per month on energy-related expenses (batteries for torches, kerosene for lanterns, the cost of charging Studies differ on how affordable solar home systems are for Mozambican households. While the 2020 USAID study puts the percentage of households that can afford a SHS at 24%, the 2018 ECA-GreenLight report indicates that, on average, more than half of non-electrified households are able to afford a small solar system. A pico solar lantern that costs USD 0.88 per month on a 24-month PayGo plan is affordable to 94%, 98% and 86% of off-grid households in Manica, Zambézia and Maputo provinces, respectively. A SHS system that allows the user to power three light bulbs, charge a mobile phone and power a a cell phone, including transportation). This average is biased high because it also includes the cost of electricity by the few that have access and that often spend more money on energy than the national average. The number of Mozambicans with EDM connections spend far more than USD 12 per month on energy, however a much larger of the population – without EDM access – spend less. 64% of ENGIE customers report paying MZN 100 or less per week (USD 1.66, or USD 6.66 per month) on energy related expenses before purchasing their SHS.

By contrast, the smallest 10Wp Tier 1 solar home system (two lights) sold by ENGIE costs USD 7 per month over two years. The total cost of the system, including the USD 18 down payment, is USD 186. For USD 8 per month a household can buy the same system with a radio (or have four lights and a TV for USD 16 per month).

When interviewed, off-grid solar operators in Mozambique indicated that import duties and VAT charged on solar equipment represent a significant barrier to affordability and universal access to modern energy. Higher costs result in a correlated increase in default rates by PayGo customers, which in turn forces PayGo companies to increase the allowance for default risk in system prices, thereby increasing prices and defaults, an unfortunate cycle in the wrong direction.[223]

Currently, all renewable energy technologies are subject to 17% VAT (paid up-front at the port of entry) and between 7.5% and 20% import duty, depending on the component type. An estimated 30-40% of the cost of a solar system is associated with taxes when fees provided to customs agents are included. Thus, the above-mentioned Tier 1 solar system with a radio could sell for USD 5 per month if the equipment and supply were exempted from taxes, vastly improving affordability for those at the Bottom of the Pyramid. The USAID SAEP report states that a price drop of USD 2.50 per month could double the number of households that can afford a SHS.[224]

A -2.1.1.2 Ability to Pay

Achieving universal electricity access in Mozambique is an immense challenge given the levels of poverty in the country. Approximately three-quarters of the population lives below the international poverty line of less than USD 1.90 per day, while GDP per capita is just over USD 500 – fourth lowest in the world. The COVID-19 pandemic has only worsened the country's already difficult economic situation. Low consumer purchasing power/ability to pay for electricity access represents the most significant barrier to OGS market growth; in a 2019 survey conducted by USAID SAEP of 2,700 households nationwide, 41% of households indicated the main reason they do not own solar home systems is that they cannot afford one.[225]

220 "Can Mozambican Households Afford Solar Home Systems? Insights from a Local Survey: Final Report," United States Agency for International Development: Power Africa, (April 2020): https://pdf.usaid.gov/pdf_docs/PA00WJJH.pdf

221 "Baseline survey for Fenix customers in Mozambique: Survey results," TechnoServe, (February 2021).

222 This question was addressed through GIS analysis.

223 Stakeholder interviews, 2021.

224 USAID, 2020.

225 USAID SAEP Mozambique Consumer Affordability survey, 2019.

radio is affordable to 87%, 72% and 82% of households across the same provinces at USD 4.90 on a 24 month PayGo plan. Meanwhile, a system that costs USD 22.6 per month and can power a small TV is only affordable to 12%, 19% and 22% of total households across the three provinces.[226]

According to the ENGIE consumer survey, 85% of those who pay in installments spend more than USD 7.50 per month. The same survey found overwhelming client satisfaction with their SHS purchase, with over 80% of respondents saying that systems are very affordable. Inhambane and Zambézia have the highest proportion of children in school, which is an indicator that serves as proxy for willingness to pay for a solar system.

While the smallest SHS's sold through informal channels will have an average price of USD 50 (paid cash up-front), 75% of those who currently own solar products bought them through a one-time payment. An estimated 41% of households that do not yet own a SHS say they cannot afford one, with the highest proportions in Tete, Gaza and Sofala. One-quarter of households surveyed by USAID say that they plan to buy a SHS soon, with the largest proportions coming from Cabo Delgado, Maputo and Nampula.

Another report prepared by ENGIE and the Mozambique Renewable Energy Association (AMER) claims that a subsidy of USD 50 per system is needed to make SHS affordable for the 20% of the population making up the low income market – below the middle income market (22%) and above the very low income (28%) and lowest income (29%) market segments. According to the same report, "These (lowest income) households are not expected to be viable customers at any retail price-point and should be targeted by donor programs."[227] Answering the affordability question conclusively is critical, as it has direct bearing on the sizing of any eventual RBF tool to support the SHS sector.

A -2.1.1.3 Perceptions of Solar Electricity

Given the relative youth of the Mozambican solar market, awareness and ownership of solar technology is relatively high. Two-thirds of households have heard of solar PV technology, while 27% of households already own and use a system. Three-fourths of those households own a modest Tier 1 system, with the other 25% owning a larger Tier 2 or Tier 3 system that can power a TV or other appliances.

The 2018 ECA-GreenLight study found that 90% of the residents of Maputo Province were aware of solar energy while only 20% in Zambezia Province were similarly aware. This has likely changed over the last two years as ENGIE has become active in Nampula. Most households (51%) are aware of SHS technology because their neighbors or friends own one.

Though roughly half of respondents questioned in the study believed solar products to be of good quality, the favorable perception is likely increasing with the growth of PayGo companies, which is likely marginalizing cash sales from informal market kiosks. One PayGo representative felt that the informal sellers did not represent competition in the market because so few consumers can afford to pay for an entire system with cash up-front. One-fifth of ENGIE customers purchased their SHS from ENGIE after already owning another solar system (and presumably not being satisfied with it). This trend towards PayGo companies and away from informal sector suppliers is a positive development for the quality of systems being installed. The PayGo companies sell pre-fabricated kits of international standard, while the informal sector suppliers sell systems and system components of all qualities, from good to bad.

In a recent survey, 61% of female ENGIE customers say that their decision to buy a SHS was theirs alone (without consulting their husband). Greater than 90% of all ENGIE customers say that they were encouraged to buy a SHS by either a neighbor or a sales agent (about 50/50), the former indicating that word-of-mouth marketing is effective and that customers are generally happy with their purchase. A total of 93% of purchases were of ENGIE's two smallest and cheapest systems, both including a 10Wp PV panel and powering a few lights and a phone charger, but the latter also including a radio. The principal reasons for purchasing a SHS are to have lighting and to charge a cell phone.

There are currently no government measures aimed at ensuring the quality of off-grid solar products sold in Mozambique, which means that there are inferior quality products on the market (largely from China, Tanzania, South Africa, Malawi, Zambia and elsewhere). However, getting the government involved in quality assurance would likely increase bureaucracy and the difficulties companies encounter getting their imported products out of ports. Awareness raising aimed at consumers – either by companies themselves or via a national campaign managed by FUNAE - is perhaps a more seamless way to control quality on the off-grid solar market.

One factor that negatively affects growth in the SHS market is that a large share of households express concern that there are not technicians available to fix their home system if something goes wrong. In Cabo Delgado and Manica, the most common reason for not owning a solar product is that there are no nearby service providers.

A -2.1.1.4 Accessibility

In Cabo Delgado and Manica provinces, the most common reason provided by interviewees for not owning a solar product is that there are no nearby service providers.[228] Given the security situation, the market in Cabo Delgado is not going to develop any time very soon.
ENGIE's business started two years ago in the country's three southernmost provinces of Maputo, Gaza and Inhambane, and these provinces still represent the majority of their sales. They have, however, recently opened sales outlets in Nampula, where their sales are growing. ENGIE is selling on average 3,000 Tier 1 systems per month. SolarWorks is deployed in seven provinces and is also selling 2-3,000 systems per month, primarily Tier 1 systems. SolarWorks has a contract with USAID to install 92 systems 1kWp or larger in rural health centers. A key question, however, is how these systems will be maintained after they are installed.

Of course, there are traders in all of the provinces, especially informal traders out of kiosks in the market place. Solar

226 ECA and GreenLight, 2018.
227 Hodgkinson, L. and Smeshko, N., "Challenges in the Solar Home Industry in Mozambique," Associação Moçambicana de Energias Renováveis (AMER), (February 2021): https://amer.org.mz/9036/?lang=en
228 "Can Mozambican Households Afford Solar Home Systems? Insights from a Local Survey: Final Report," USAID SAEP, 2020.

equipment is imported from China and Europe. The main business model deployed by local off-grid solar companies is cash/over-the-counter sales. There is evidence, however, that informal sector solar sales are increasingly being crowded out and replaced by the plethora of PayGo systems.

A -2.1.1.5 Consumer Finance

Banks in Mozambique are not yet lending significantly to consumers for the purchase of solar products. This is because their perceived risks are high and the transaction cost of managing large numbers of small loans is also high. This is a crucial obstacle to the growth of the country's off-grid solar market. Companies cannot expand purely based upon RBF grants and equity – they need debt as well.

The PayGo business model is one way to partially address to debt needs of the customers in the sector. However, the PayGo companies cannot grow at the rate required by the universal access goal if they must keep large volumes of consumer debt on their balance sheets. They need credit in local currency and on reasonable terms to expand quickly and nationally.

A -2.1.1.6 Mobile Network and Mobile Money

The expansion of digital financial services, especially mobile money, has created new opportunities to better serve the lower-income and rural population, women and other groups that are traditionally excluded from the formal financial system. Digital payments increase transparency across the private, public, and development sectors and support economic growth by driving cost savings, efficiencies, and higher productivity. Mobile connectivity and mobile money also play a critical role in enabling off-grid solar market growth, particularly for PayGo systems that rely on the interoperability between digital financial services and stand-alone solar devices. In fact, most of the growth in the off-grid solar sector to date has been limited to countries with strong mobile money ecosystems.[229]

In Mozambique, according to a study of the mobile sector commissioned by USAID in 2016, mobile coverage (at least a 2G signal) is approximately 82% across urban and rural communities, while 33% of mobile phone users had used mobile money services.[230] Mozambican Carteira Móvel launched mobile money in the country in 2011, while Vodacom launched M-PESA in 2013. The use of mobile money is increasing rapidly in the country. The typical mobile money transaction is just over USD 8, about the same as a monthly payment for a small PayGo SHS (which costs about USD 7.50). Despite an increase in the overall use of mobile money services, some communities have difficulty using these services due to a lack of local agents where they can deposit and withdraw money. Another key barrier is a lack of literacy and digital skills, particularly in rural areas, where 37% of surveyed households cited this as the most important barrier to using mobile money services.[231]

Mobile phone use decreases among the population when moving from south to north. Men are 22% more likely to use a phone than women, and people with a formal education are four times more likely to use a mobile phone than those with no formal education. These figures are relevant for solar providers (or a national solar awareness campaign) that use mobile phone SMS messages for marketing purposes. One-third of mobile phone users report charging their phones at a charging station; most people without electricity charge their phones at a neighbor or friend's house.[232]

Off-grid solar system providers must choose between the two networks to make transactions with their customers because Mozambican law does not allow the companies to collaborate and process transactions across both networks simultaneously (i.e., a customer cannot send money from within the Tmcel network to a recipient within the Vodacom network). Frequently in rural areas, only one of the two networks provides coverage, with Vodacom and Movitel having the largest shares of coverage (**Figure A4**). The result is that PayGo companies relying on the Vodacom network are not interested in expanding business into rural areas where there is only Tmcel coverage, and vice versa. This dynamic poses a significant barrier to off-grid market expansion.

For Mozambique to meet its universal electrification target by 2030, greater coordination is needed between FUNAE and the country's telecommunications operators. This is particularly important for reaching customers at the bottom of the pyramid, as PayGo solar businesses – whose business model relies on widespread mobile network coverage and mobile money services – provide household-scale solar energy with a payment scheme tailored to low-income customers, thus allowing poor households to pay for solar products in small affordable increments.

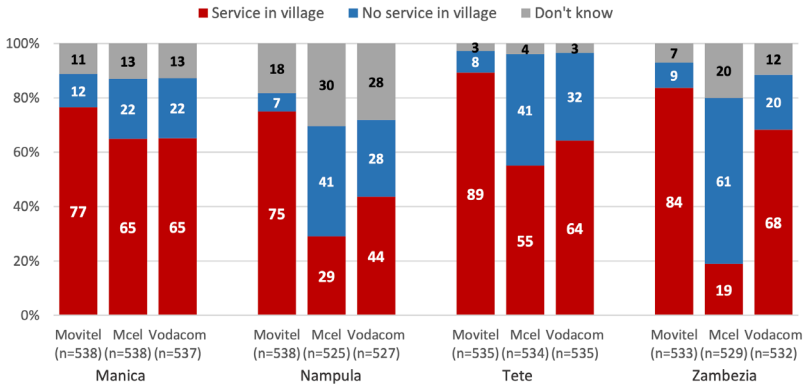
229 "The Fight for Light: Improving Energy Access through Digital Payments," United Nations Capital Development Fund, (July 2017): https://btca-prod.s3.amazonaws.com/documents/291/english_attachments/Full-Energy-Case-Study.pdf?1499786348

230 "Mozambique Mobile Access and Usage Study: Household Survey Results," United States Agency for International Development, Mobile Solutions Technical Assistance and Research (mSTAR) Project, (October 2016): https://pdf.usaid.gov/pdf_docs/PA00MGDF.pdf

231 "The State of Mobile Internet Connectivity 2020," GSMA, (2020): "https://www.gsma.com/r/wp-content/uploads/2020/09/GSMA-State-of-Mobile-Internet-Connectivity-Report-2020.pdf

232 "Mozambique Mobile Access and Usage Study: Household Survey Results," United States Agency for International Development, Mobile Solutions Technical Assistance and Research (mSTAR) Project, (October 2016): https://pdf.usaid.gov/pdf_docs/PA00MGDF.pdf

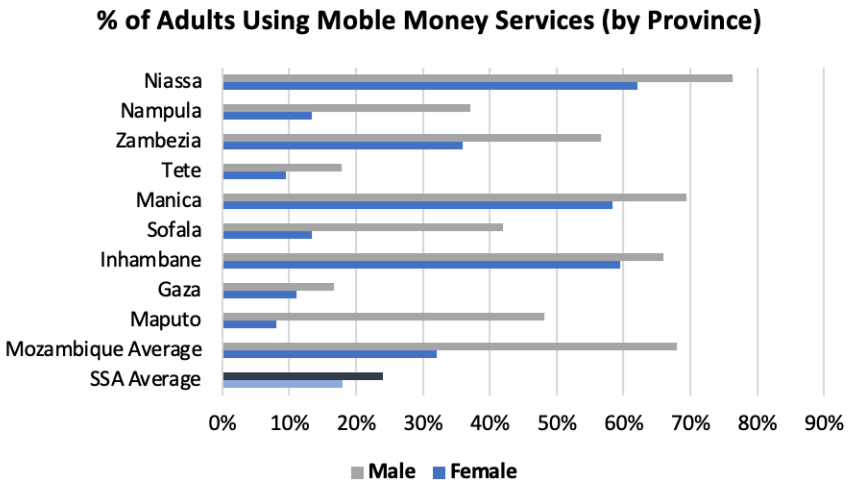
FIGURE A4: MOBILE SERVICE PROVIDER AVAILABILITY IN RESPONDENT COMMUNITIES BY PROVINCE



Source: USAID Mobile Solutions Technical Assistance and Research Project

Field data gathered from the provincial mission shows the breakdown of focus group participants who use mobile money services by province, which are then compared to the national average for Mozambique and Sub-Saharan Africa (**Figure A5**).

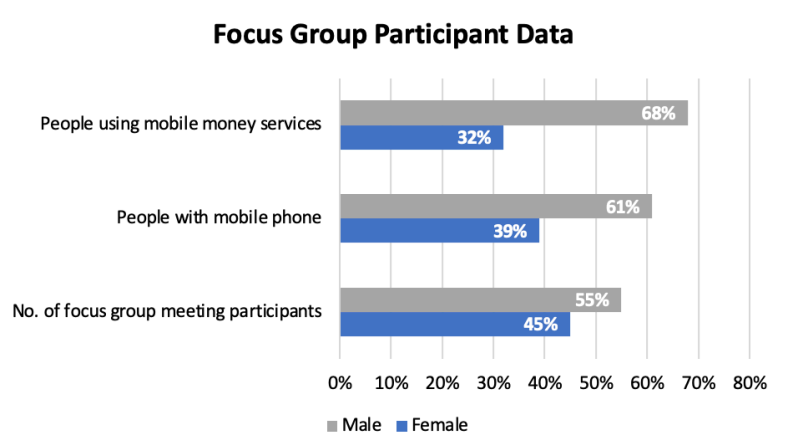
FIGURE A5: SHARE OF FOCUS GROUP PARTICIPANTS (%) USING MOBILE MONEY SERVICES BY PROVINCE



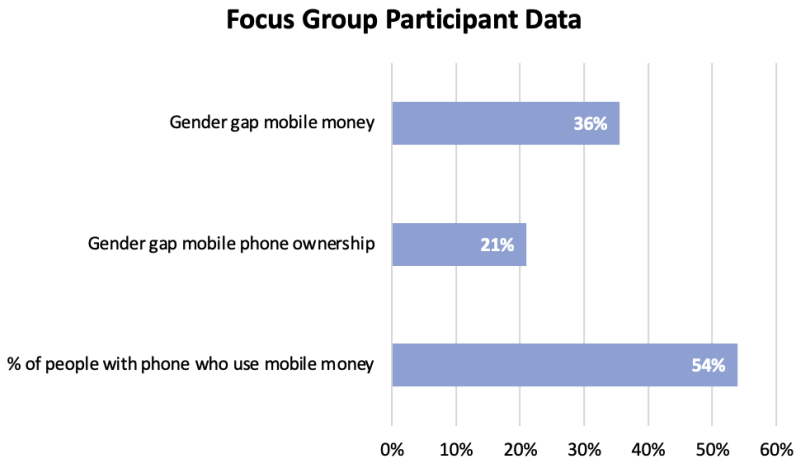
Source: GreenMax Capital Advisors field surveys, 2021; World Bank Global Findex, 2017.

The data extracted from the focus group meetings held in off-grid communities in each province (see **Annex 2-E**) also provided insights at the country level, such as the percentage of people (by gender) using mobile money services, mobile phone ownership (**Figure A6**), the gender gaps between these statistics and the overlap of mobile phone owners who also use mobile money services (**Figure A7**).

SHARE OF FOCUS GROUP PARTICIPANTS (%) WHO OWN A MOBILE PHONE AND USE MOBILE MONEY SERVICES (FIGURE A6), DISAGGREGATED BY GENDER (FIGURE A7)

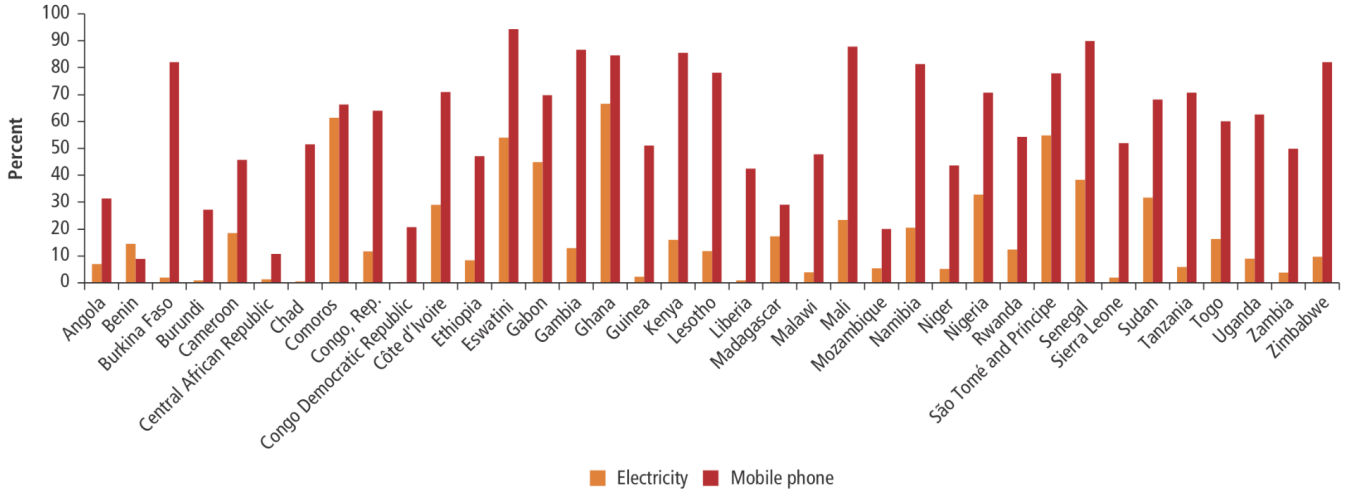


Source: GreenMax Capital Advisors field surveys, 2021.



The field data broadly aligns with the results of a pan-African study carried out in 2016 examining rates of mobile phone ownership vis-à-vis electricity access in Sub-Saharan Africa (**Figure A8**).[233]

FIGURE A8: ELECTRICITY ACCESS AND MOBILE PHONE OWNERSHIP IN SUB-SAHARAN AFRICA, 2016 (% OF RURAL HOUSEHOLDS)



Source: World Bank, 2019.

A-2.1.2 Off-Grid Schools and Healthcare Facilities

Although the EDM grid connects all 128 district headquarters of Mozambique, access is largely limited to urban areas. Many district capitals have to depend on expensive and often unreliable power generation with diesel generators. Outside of these towns, electricity access in rural communities is extremely limited, and the priority has been given to first connect schools, healthcare facilities and administrative posts.[234] According to the Integrated Power System Development Master Plan, in 2018, the estimated number of non-electrified schools and clinics in Mozambique stood at 968 and 280, respectively.[235]

To date, donors, NGOs and FUNAE have been the primary providers of off-grid solar projects and systems to support electrification of rural school and health clinics, administrative post buildings, solar pumps with water tanks, gas stations and other social infrastructure. These projects, made possible mainly through international donor support, have been evenly deployed all over the country, focusing mainly on schools, health centers and administrative offices.[236] While several of these projects remain operational, many are currently out of commission due to a lack of regular/on-going O&M.

233 Blimpo, M., and Cosgrove-Davies, M., "Electricity Access in Sub-Saharan Africa: Uptake, Reliability, and Complementary Factors for Economic Impact," AFD and World Bank, Africa Development Forum, (2019): https://openknowledge.worldbank.org/bitstream/handle/10986/31333/9781464813610.pdf?sequence=6&isAllowed=y

234 "Green Growth Potential Assessment: Mozambique Country Report," Global Green Growth Institute (GGGI), (May 2018): https://www.greengrowthknowledge.org/sites/default/files/downloads/resource/GGPA-Mozambique-Final-Report.pdf

235 Integrated Master Plan: Mozambique Power System Development, Final Report, JICA, 2018.

236 Renewables in Mozambique – National Status Report, ALER, 2017.

As the implementing agency of the Energy Development and Access Project, FUNAE conducted O&M for solar systems installed at health centers and schools in peri-urban and rural areas. According to FUNAE, the sustainability of such O&M schemes is largely contingent upon the receipt of available funding from partners and the deployment of technicians with the right skills and training. Providing O&M is particularly cumbersome in remote areas that are hard to reach because of the country's poor road network.[237] Technological innovations such as remote monitoring of system performance using cellular network coverage makes O&M less daunting, but it still has to be paid for, including amortization to replace worn out parts (i.e., batteries).

Another approach taken by FUNAE to operate and maintain off-grid solar systems has been through the selection of local agents to supervise these operations. This has in turn led to the organization of training activities across the country for this purpose. By the end of 2017, FUNAE had carried out PV maintenance training activities directed at students from basic and medium level of Technical-Professional Schools from all Provinces. These sessions were funded within the scope of the Renewable Energy for Rural Development Programme (RERD), with the initiative reaching approximately 150 students across the country.[238] Similarly, under the World Bank's Energy and Access Project (EDAP), a total of 21 field technicians were trained across Manica (4), Cabo Delgado (7), Niassa (5), and Inhambane (5) provinces.

In May 2021, USAID's Power Africa program awarded a grant to renewable energy company SolarWorks! Mozambique, to install off-grid solar powered electrical systems (sized from 1.5 kWp and larger) in 92 rural health facilities in Sofala Province, where 90% of health facilities have no regular access to electricity. The grant also includes funds for one-year post-installation O&M contracts.[239] Questions remain around the long-term O&M of these systems, as on-going O&M for 92 systems could cost approximately USD 30,000 per year.[240]

From surveys conducted by ECA and GreenLight in 2018, when asked if public institutions would be willing to pay for a connection, 42% of the institution's caretakers (teacher, school director, nurse, doctor) stated that they would be willing, but the majority observed that it is not a decision the school/ health facility can make. It is dependent on the availability of government funds. Obviously, all stated that electricity would help in improving service provision, including offering night classes at schools for those who work during the day, and in the health sector for emergency services during the night and for powering equipment and providing cold storage for medicine.[241]

The Muhalaze Health Centre was found to be spending about USD 200 monthly on energy from EDM prior to purchasing a solar system to pump water. Upon acquiring the system, the Centre experienced a near 58% drop in their monthly expenditure on energy and was able to use funds from the savings to purchase new medical equipment to improve the quality of service provided.[242]

The critical problem to solve related to off-grid solar for rural schools and health care facilities is, "who pays?" As these institutions and installations represent a public service, normally the government pays for the investment and continues to pay ongoing O&M through public budgets. Alternatively, a private company can serve as an ESCO to the health center or school, but then the government needs to pay the ESCO a fair tariff for the electricity consumed. There are questions as to whether the GoM would be willing or able to meet its financial obligations under either scenario.

The following two case studies are examples of how the healthcare sector was integrated with off-grid development in Sierra Leone (**Box A1**) and Malawi (**Box A2**).

237 Elahi, R. et al., "Increasing Human Capital by Electrifying Health Centers and Schools through Off-Grid Solar Solutions," World Bank Group, (2020): https://documents1.worldbank.org/curated/en/772071580275548144/pdf/Increasing-Human-Capital-by-Electrifying-Health-Centers-and-Schools-through-Off-Grid-Solar-Solutions.pdf

238 Renewables in Mozambique – National Status Report, ALER, 2017.

239 "US government lights up 92 health facilities in Sofala province with a $320,000 investment in solar power," Club of Mozambique, (14 May 2021): https://clubofmozambique.com/news/u-s-government-lights-up-92-health-facilities-in-sofala-province-with-a-320000-investment-in-solar-power-192154/?utm_source=The+Mozambican+Investor_&utm_campaign=0ac5a4c46a-EMAIL_CAMPAIGN_2017_05_25_COPY_01&utm_medium=email&utm_term=0_d3b369a42d-0ac5a4c46a-206626381

240 Stakeholder interviews, 2021.

241 Renewables in Mozambique – National Status Report, ALER, 2016.

242 ECA and GreenLight, 2018.

BOX A1: SIERRA LEONE RURAL RENEWABLE ENERGY PROJECT[243]

In 2016, with funding from the UK Foreign Commonwealth and Development Office (FCDO), Sierra Leone's Ministry of Energy launched the Rural Renewable Energy Project (RREP), a GBP 34 million project being administered by the UN Office for Project Services (UNOPS) which aims to establish an enabling environment for a private sector-driven rural mini-grid market in the country. The project has an objective of supplying up to 5 MW of renewable electricity in rural communities through the installation of at least 94 solar mini-grids throughout the country. The first phase of the RREP involved the installation of 6 kWp solar generation systems in 54 Community Health Centers (CHH) as pilot sites in 14 districts across Sierra Leone. Under the project's business model, in return for use of the land on which to build the power stations, the CHC are provided with up to 6 kWh/day of electricity, an arrangement managed through an agreement between the MoE, the Ministry of Health and the Ministry of Local Government and Rural Development. The Community Health Centers in 50 of the communities were subsequently expanded into small mini-grids with capacity of 16-36 kWp, extending electricity access to surrounding households, schools and businesses. Construction of all 50 mini-grids was completed in 2018 under the supervision of UNOPS. Community Health Centers were established as baseline facilities for electrification under the program following the onset of the Ebola crisis, which made it a priority for the Government to provide rural health clinics with a reliable source of electricity. The RREP is a good example of a public ownership and private management model, whereby mini-grids in the country are privately operated and maintained under long-term concession agreements, while the public sector retains ownership of the assets and provides subsidies to ensure electricity tariffs are affordable to rural customers.

Source: Sierra Leone Ministry of Energy

A Community Health Center electrified under the Rural Renewable Energy Project, Port Loko District, Sierra Leone

Source: UNOPS

BOX A2: SOLAR HEALTHCARE DISPENSARIES AND MEDICINE STORAGE FACILITIES IN MALAWI

The frequency of electricity blackouts in rural communities in Malawi has made the storage of vital medicines in local clinics very difficult. The private company Resolve Solution Partners engineered a solution through the provision of a distributed renewable energy system which fortified the ability of local healthcare facilities in affected communities. The company designed, built and installed 239 solar pharmaceutical dispensaries equipped for the storage of medicines across the rural countryside, nearly half of which were deployed in underdeveloped areas lacking central power grid access. In addition to the ability to store temperature-sensitive medicines and vaccines, the project has also provided a place for users to recharge phones and maintain communication. The systems are owned by the Ministry of Health, and the long-term sustainability of these solar healthcare dispensaries is ensured through a two-year post-implementation maintenance service level agreement and the comprehensive training and orientation of end-users at the healthcare facility.

Source: RESOLVE Solution Partners

243 Rural Renewable Energy Project: http://www.energy.gov.sl/home/rural-renewable-energy-project/

A-3 Market Barriers

Despite Mozambique's slower pace of off-grid development, the country has a number of advantages in its favor promoting universal energy access, including a highly active and engaged donor and development community, political will, and the existence of private sector companies and energy service providers with a presence almost nationwide. On the other hand, Mozambique also faces obstacles towards achieving its electrification objectives, including high levels of rural poverty and low ability to pay, the size of the country and dispersed nature of its settlements and unresolved regulatory issues, among others. This section will provide an overview of these key barriers to off-grid market development.

A-3.1 Ability to Pay

The ability to pay in rural areas of Mozambique is extremely low and often dependent upon the seasonality of income. Nearly three-quarters of the population lives below the international poverty line of less than USD 1.90 per day.[244]

A report released by the Mozambique Renewable Energy Association (AMER) in collaboration with the major PayGo suppliers estimates that 29% of the country's off-grid population will not be able to afford SHS under commercial circumstances. **Table A4** shows how much a typical rural household in Mozambique spends on energy. It is important to note that the *total energy expenditure* figure – MZN 937 (USD 15) – includes a long "tail" skewed towards the higher income portions of the population. According to AMER, in order to match the ability to pay of 1.8 million rural homes, the cost of today's smallest SHS would need to decrease by 30-40%.[245]

TABLE A4: MONTHLY SPENDING FOR RURAL HOUSEHOLDS

Total monthly spending	3709 MZN	
Cooking fuel	224 MZN	6%
Lighting	292 MZN	7%
Charging phones	190 MZN	5%
Batteries	284 MZN	5%
Total energy expenditure	*937 MZN*	*24%*

Source: ECA and GreenLight, 2018.

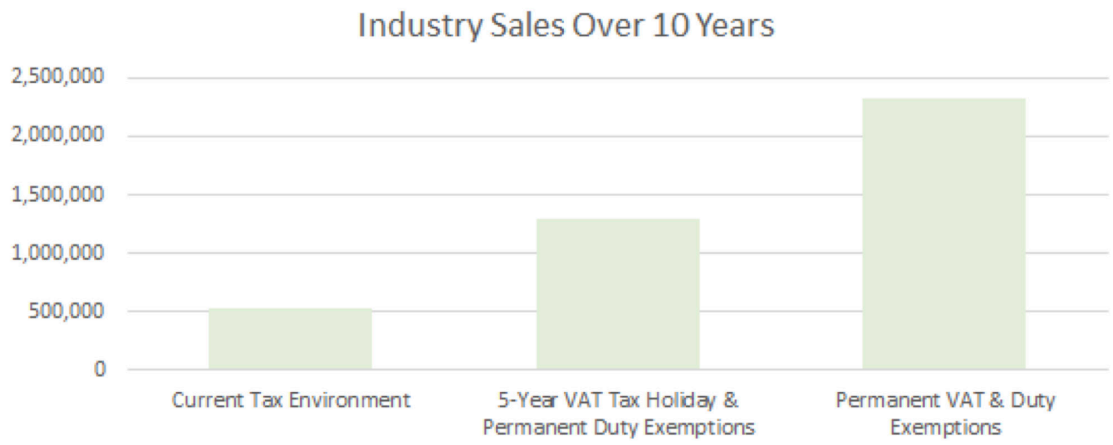
A-3.2 Taxes and Affordability

Solar technology is exempt for import duties and value-added taxes (VAT) throughout the East African Community, a measure that has resulted in millions of rural households being electrified through solar home systems. This is not the case in Mozambique, where SHS and solar lanterns are liable to VAT at the rate of 17% and import duties that vary between 7.5% and 20%, depending on the component. In reality, the total tax burden on a SHS is between 30-40% of the final sales price when fees provided to customs agents and other payments are taken into account. As a result, a small SHS that can sell for USD 111 (and USD 4 per month under PayGo scheme) sells for USD 186 instead.[246]

The industry has proposed a five-year tax holiday on solar technology (PV panels, lithium batteries, charge controllers, inverters and solar lanterns). The result would be an increase in taxes collected by the Revenue Authority, as increased sales and market growth would lead to more corporate profit and payroll taxes being paid. With these tax exemptions in place, the estimated addressable market for SHS would increase from 650,000 households to 1.8 million households, with corresponding increases in OGS industry sales (**Figure A9**). Tax exemptions combined with RBF bonuses could make SHS affordable for more than 3 million rural families by 2030.[247]

244 "Mozambique – Off-Grid Energy Market Assessment," GreenLight, (September 2019): https://beyondthegrid.africa/wp-content/uploads/MOZ-Green-light-Off-Grid-Energy-Market-Analysis.pdf
245 Hodgkinson and Smeshko, 2021.
246 Stakeholder interviews, 2021.
247 Hodgkinson and Smeshko, 2021.

FIGURE A9: HOW FISCAL INCENTIVES IMPACT OFF-GRID SOLAR INDUSTRY SALES



Source: Hodgkinson and Smeshko, 2021; Fenix [ENGIE] Mozambique financial analysis

"With full tax incentives and the committed grant money to rural electrification, Mozambique has an opportunity to unlock the fastest rural electrification program seen in Africa."

A-3.3 Awareness, Product Quality and the Informal Market

Almost 20% of ENGIE customers previously owned a different SHS before replacing it with a ENGIE PayGo model.[248] This implies that customers were not satisfied with their prior system, most likely bought from a local market and made up of disparate components. It is unlikely that a typical customer can recognize the difference between good and poor solar components, but it is not difficult to teach people how to judge. An acceptable solar product should meet four basic criteria:

- Is the product labeled and does the label include the company's web address? If yes, is it easy to go on the internet and verify that the company is well established and that it meets quality standards in its country of origin;
- Does the product come with a user-manual?
- Does the product come with a warranty, and is the retailer ready to respect the warranty in the case of component failure?
- Is the product damaged in any way? For example, if a solar panel has even a small crack in one of its cells, it will not work.

This simple message, spread widely among the population through a marketing and awareness-raising campaign, can protect consumers from misguided purchases. When interviewed, PayGo companies operating in the market indicated that they do not necessarily see the informal market as competition to their product offer, because they do not believe that the majority of their potential customers can or want to pay cash up-front for a SHS.[249]

A national solar energy project in Tanzania attempted to involve the Tanzanian Bureau of Standards by having them control and test imported solar products for quality. The effect was that importing solar products became bureaucratic and added considerably to the weeks of processing time at ports of entry. A more effective approach would be to require that solar companies desiring to benefit from donor/government financing demonstrate that their products meet international standards. There is an existing quality standards framework and certification program through Lighting Global that is ready-made for this purpose – the Verasol Quality Assurance program.[250] The government/FUNAE can also establish an energy product information database and share it publicly to provide relevant market information to interested parties.

A-3.4 Capacity

A-3.4.1 SMEs and Technicians

While large international companies operating in the country have access to loans, equity and other international funds to finance their growth and development, it is more difficult for local companies to access the funding and assistance they need to expand their business. A targeted capacity building program focusing on different stages of solar companies, their capital structure, funding needs, and risk profiles should be offered with the objective of crowding in commercial financing to the sector. Capacity building at the SME level is critical to ensure that companies have the proper financial management and accounting systems in place and are at the level of in-house expertise required to structure their companies to take on debt obligations.

At present, there is little to no local capacity to manage O&M of systems in off-grid areas, outside of the technicians employed by the principal PayGo companies. Specialized technicians operate in mostly urban areas and are often not present in rural areas. As a

248 Baseline survey for Fenix customers in Mozambique: Survey results, TechnoServe, (February 2021).
249 Stakeholder interviews, 2021.
250 Verasol: https://verasol.org/updates/verasol-to-begin-issuing-verasol-certificates-for-quality-verified-solar-energy-kits

consequence, off-grid systems that are not being managed by FUNAE tend to fall into disrepair after a short period of time if they are not properly maintained (i.e., replacing batteries, inverters, etc.). According to FUNAE, the sustainability of O&M schemes is largely contingent upon the receipt of available funding from partners and the deployment of technicians with the right skills and training. Providing O&M is particularly cumbersome in remote areas that are hard to reach because of the country's poor road network[251]. Technological innovations such as remote monitoring of system performance using cellular network coverage makes O&M less daunting, but it still has to be paid for, including amortization to replace worn out parts (i.e., batteries).

Another approach taken by FUNAE to O&M of off-grid solar systems has been through the selection of local agents to supervise these operations. This has in turn led to the organization of training activities across the country for this purpose. By the end of 2017, FUNAE had carried out PV maintenance training activities directed at students from basic and medium level of Technical-Professional Schools from all Provinces. These sessions were funded within the scope of the Renewable Energy for Rural Development Programme (RERD), with the initiative reaching approximately 150 students across the country.[252] However, these trainings have been limited to technicians and end users of projects FUNAE has implemented.

The Institution Industrial de Maputo (IIM) offers training in related technical courses, but most are not fully subscribed, with technicians reporting difficulties finding employment opportunities due to the limited size of the market and dependence on FUNAE.[253] This forces firms in the sector to rely on foreign expertise, but current labor laws (requiring employment of at least 10 Mozambicans for each foreign employee) create additional hurdles and expenses.

A-3.4.2 Commercial Banks

Off-grid energy projects have largely been carried out with the assistance of donor agencies, development partners and/or DFIs, as most local financial institutions (FIs) remain cautious of entering the market due to high perceived risk. Relatively high real interest rates, large collateral requirements, and the short tenor of typical loans offered by local FIs hamper financing of the off-grid solar sector. Local financial partners will therefore need capacity building and TA across several key focus areas to improve their understanding of the solar industry, its structure and supply chain, and its accompanying innovations.

Capacity building to help FIs develop specialized off-grid lending products for implementation in the market is also critical for generating corresponding demand for any guarantee and credit enhancement products that may be offered through FUNAE's OGS Financing Facility. Potential key areas of focus for TA and capacity building of FIs include (but are not limited to) the following:

- Identification of off-grid energy opportunities in line with the FI's lending strategy;
- Establishment of an off-grid finance unit within the FI;
- Training of bank credit department and account representative personnel on features of off-grid solar finance (e.g., PayGo financing schemes) to originate deals and appropriately assess the credit risk of stand-alone solar firms and projects;
- Due diligence support to qualify products and approve vendors;
- Support with structuring and development of off-grid energy financial products as well as building deal flow/project origination
- Off-grid energy portfolio supervision/reporting and impact assessment/evaluation
- Off-grid energy marketing strategy

It is important to state that the level of TA for each FI should be customized and based on the current status of the institution's green lending business. To achieve this, a review of the capacity, policies and procedures of each FI should be conducted to identify internal gaps and challenges that may impede off-grid lending. A set of guidelines should be developed to systematically assess TA needs in a standardized way. The TA needs assessment/review should cover the following:

- Credit and risk management policy
- Loan disbursement procedures
- Portfolio monitoring and reporting guidelines
- Off-grid energy lending knowledge and capacity
- Environmental, Social and Governance (ESG) Systems
- Environmental and Social Risk Management (ESRM) Policy and Procedures

251 Elahi, R. et al., "Increasing Human Capital by Electrifying Health Centers and Schools through Off-Grid Solar Solutions," World Bank Group, (2020): https://documents1.worldbank.org/curated/en/772071580275548144/pdf/Increasing-Human-Capital-by-Electrifying-Health-Centers-and-Schools-through-Off-Grid-Solar-Solutions.pdf

252 Renewables in Mozambique – National Status Report, ALER, 2017.

253 Off-grid solar power in Mozambique: opportunities for universal energy access and barriers to private sector participation, GGGI 2019.

BOX A3: USAID CEADIR – LOCAL FINANCIAL INSTITUTION CAPACITY BUILDING PROGRAM

The USAID Climate Economic Analysis for Development, Investment and Resilience (CEADIR) program took place from 2016 to 2018 across eight West African countries (Côte d'Ivoire, Ghana, Guinea, Liberia, Niger, Nigeria, Senegal and Sierra Leone), with the objective of strengthening the capacity of local FIs for clean energy lending. The program engaged with FIs to address their common challenges by developing the capacity of bank staff to provide loans for various clean energy technologies and business models and adapting their support to the specific context of each country. CEADIR supported local banks by delivering national workshops on stand-alone solar and mini-grids, which was complemented with one-on-one TA to help banks develop clean energy lending strategies.[254]

Source: USAID

A-3.4.3 FUNAE

Since its inception, FUNAE has played the conflicting roles of rural electrification fund and project developer simultaneously. This dynamic has inhibited private sector participation in off-grid market development and resulted in off-grid projects being largely regarded as social projects. There is an absence of a viable and cost-reflective tariff system. There is also frequent discussion of conflicts of interest between the multiple roles played by FUNAE (project originator, funder, developer, etc.).[255]

With support from MIREME, ARENE and others, the GoM is contemplating a series of pending electricity market reforms which aim to establish a framework to encourage private sector project developers to enter the market. If passed, this would in turn leave FUNAE solely in the role of rural electrification agency. FUNAE will likely need capacity building in order to successfully manage this transition and take on the role of Mozambique's rural energy agency (REA).

FUNAE senior management and staff can benefit from reviewing the operations of other successful REAs across the continent, such as those in Nigeria and Tanzania. FUNAE staff will likely need training on how to perform due diligence on private companies and their projects. FUNAE would likely also benefit from training in financial modeling and financial structuring. FUNAE currently has roughly 150 employees, the majority (~60%) of which administrative or other roles, while the remaining 40% are qualified technical and managerial staff. It remains unclear whether this staffing structure is rationalized for the role of a rural electrification agency (other REAs across the continent do not have this many employees).

A-3.5 Coordination

There is a plethora of projects on-going or being designed targeting Mozambique's off-grid solar market. Some appear to have very similar service offerings, such as EnDev and BRILHO, without any open channels of communication between themselves. Both projects provide technical assistance to off-grid solar companies (as well as efficient stove and mini-grid companies) but through different platforms. Both projects provide ex-ante and ex-poste grants (RBF in the case of BRILHO) but using different fund management arrangements and different systems for verifying installations and impacts. There are different projects targeting the PUE sector that don't know about each other. There is no mechanism that brings these diverse initiatives together, coordinating them to move together in one direction.

There is an Energy Sector Working Group for development partners, currently chaired by AfDB. But this Working Group is very high level, meets infrequently, and doesn't aim to coordinate but rather to inform, share information or debate a particular topic (i.e., mini-grid regulations). The subjects addressed by the Group are naturally dominated by the large investments made into EDM infrastructure. The Working Group does not include the GoM (MIREME, EDM, FUNAE or ARENE). In the absence of Government participation in such a coordinating body, each different branch of the Government's energy apparatus is obliged to maintain unique bilateral relationships with each development partner and project. This is one of the reasons that the off-grid sector is made up of several competing initiatives.

There is also overlap between the mandates, resources and activities of FUNAE and EDM, which creates additional challenges for off-grid sector development. In the case of social service provision, this kind of institutional arrangement is inefficient and unproductive. A coordinating entity is needed to ensure that various stakeholders coordinate their projects and programs to avoid overlap and redundancy. With the right level of institutional capacity building, this is a role that FUNAE can take on.

A-4 Market Opportunities

Off-grid solar solutions present various opportunities for economic growth and sustainable development, including through productive use applications, improved public services, and the growth of new local industries and indigenous companies that can offer employment opportunities to the local population.

254 USAID CEADIR: https://www.climatelinks.org/resources/renewable-energy-lending-west-africa
255 Green Growth Potential Assessment: Mozambique Country Report, GGGI, 2018.

A-4.1 Productive Use Applications

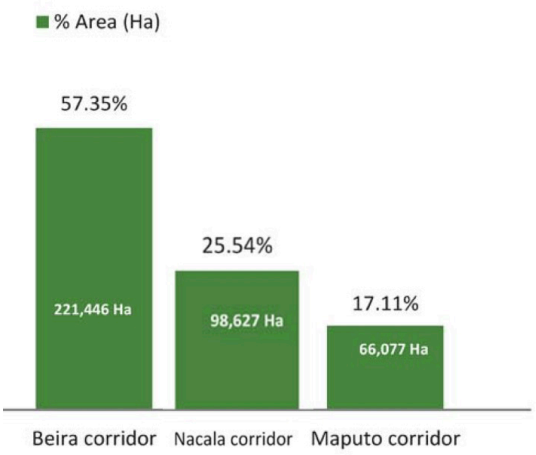
A-4.1.1 Agriculture

Agricultural practices, especially for smallholder farmers, can benefit from a wide range of off-grid solar technologies such as water pumping and irrigation, milling, and refrigeration, among others.

The agricultural sector employs more than 80% of Mozambique's labor force and contributes to about 25% of GDP, with smallholder farmers accounting for 95% of the country's agricultural production. Difficult access to credit and markets, low use of improved inputs and the dominance of rain-fed agriculture make the sector vulnerable to shocks.[256] Chronic food insecurity forces a large share of farmers to depend on staple food crops such as maize, cassava, and rice, which account for nearly half of the country's agricultural production (in hectares). The country has vast untapped potential for agricultural output, as only about 15% of farmable land is being cultivated.[257]

The largest area of horticultural production in the country is in the Beira corridor (see **Figure 14**), which encompasses the provinces of Manica, Sofala and Tete, followed by the Nacala corridor, which covers Nampula, Niassa and parts of Zambézia and Cabo Delgado, and the Maputo corridor, which supplies the Maputo City market (**Figure A10**).[258]

FIGURE A10: GEOGRAPHIC DISTRIBUTION OF FARMERS AND SHARE OF TOTAL AREA UNDER HORTICULTURE PRODUCTION (HA)



Source: Ministry of Agriculture (2011 Census); INE

In Manica, Sofala and Tete provinces, the Beira Agricultural Growth Corridor (BAGC) Partnership is working with development partners to help secure access to financial services for smallholder farmers and agri-business operators throughout the region. An MOU has been signed with the International Fund for Agricultural Development (IFAD)-funded Rural Enterprise Finance Project, under which BAGC will facilitate access by rural business operators to financial services by developing business plans for financing.[259]

Water Pumping and Irrigation

Most farms in Mozambique still rely on rain-fed irrigation. However, climate change has caused extreme variability in weather patterns, forcing farmers to adapt their irrigation techniques.[260] Solar powered irrigation technology provides a more cost-effective and environmentally sustainable alternative to expensive and polluting diesel-powered pumps, while also enabling farmers to efficiently use water and capitalize on prime growing seasons, even in the absence of rain. Solar tube well technology is easy to install, requires low maintenance, and is ideal for farming in remote communities (**Box A4**).

256 "Mozambique at a glance," UN Food and Agricultural Organization (FAO): http://www.fao.org/mozambique/fao-in-mozambique/mozambique-at-a-glance/en/
257 "Agriculture and food security in Mozambique," USAID, (March 24, 2021): https://www.usaid.gov/mozambique/agriculture-and-food-security
258 "Horticulture Market Study in Mozambique," Netherlands Enterprise Agency, Ministry of Economic Affairs and Climate Policy, (April 2014): https://www.rvo.nl/sites/default/files/2016/05/Horticulture-and-potato-market-study-in-mozambique.pdf
259 BAGC Partnership: https://beiracorridor.org/results-and-impact/
260 Davies, H., "Mozambique: Changing Irrigation Practices Led By A Changing Climate," Future Pump, (July 4, 2018): https://futurepump.com/mozambique-changing-irrigation-practices/

Increased instances of erratic and unpredictable weather patterns due to climate change (e.g., drought, heavy rainfall, changing growing seasons etc.) reduce farmer productivity, particularly at the smallholder level. In Uganda, this trend has prompted the government to focus development initiatives on providing sustainable and affordable irrigation for off-grid rural smallholder farmers, who make up 80% of farmers in the country. With decreasing capital costs, solar water pumps are gradually becoming a cost-effective and sustainable solution for rural farmers to reduce their reliance on rain-fed agriculture and diesel alternatives. Although most solar water pumping systems to date have functioned as stand-alone systems, solar water pumping and irrigation technologies that are suited for commercial and industrial applications can benefit from mini-grid power.[261]

Source: Uganda Off-Grid Energy Market Accelerator and USAID Power Africa

There are several development programs and initiatives in Mozambique targeting PUE in water pumping and irrigation:

- The BAGC Partnership is supporting implementation of the World Bank's Smallholder Irrigated Agriculture and Market Access Project (IRRIGA), which provides financing, TA and capacity building to farmers to promote sustainable development and management of irrigated agriculture.[262]
- UNIDO and GEF are also providing technical expertise and financial support for the installation of PUE systems in rural areas, as part of the Towards Sustainable Energy for All in Mozambique (TSE4ALLM) project. As of March 2020, TSE4ALLM has installed over 80 PUE irrigation systems, covering 31 hectares of farmland and benefitting over 4,000 farmers.[263]
- Enabel is about to launch a project to provide RBF for solar pumps, at USD 200 subsidy for each pump, targeting Manica and Zambézia Provinces.

Agricultural Processing

Cereal crops like maize, sorghum, millet, and rice are grown in Mozambique and provide an opportunity for value addition through hulling or milling. Off-grid communities throughout the country use maize or rice milling equipment that is typically powered by diesel generators. Fuel switching to solar (or solar diesel hybrid) equipment therefore represents an opportunity, although the up-front cost of purchasing this equipment remains a barrier, especially for farmers at the smallholder level. Mills are also high volume consumers of electricity, the volumes of which stand-alone solar systems cannot currently provide affordably. Off-grid milling businesses are best supplied with electricity through mini-grids (and the mini-grids simultaneously need these PUE clients to achieve their own financial viability).

Solar drying of tobacco, cassava, fruit and other cash crops are PUE applications that can greatly benefit rural farmers, particularly for products that are exported. Solar dryers are able to dry large quantities of fruits, vegetables, meat, and other products which can prevent food loss, generate income, and safeguard food security.[264]

A-4.1.2 Cold Storage and Refrigeration

The provision of rural cold chains has very high economic development co-benefits. Rural cold chain projects can improve the income of smallholder farmers (or fishermen) by drastically reducing waste and can improve access to health services by securing economic delivery of medicines and vaccines. Cooling systems integrated with community mini-grids can also be used where larger cold chain applications exist, such as ice manufacture.

Agriculture and Fishing

Solar-powered refrigerators and freezers can serve multiple purposes in rural areas of Mozambique. Solar refrigeration enables traders and livestock farmers to sell dairy products, while cold storage of agricultural produce can help extend the life of produce, reduce post-harvest losses and increase output (**Box A5**).

261 "Productive Use of Energy in Uganda: Learning from the Uganda Off-Grid Energy Market Accelerator (UOMA)," Uganda Off-Grid Energy Market Accelerator; USAID, (October 2020): https://uoma.ug/wp-content/uploads/2020/10/UOMA-PUE-white-paper.pdf

262 Smallholder Irrigated Agriculture and Market Access Project: https://projects.worldbank.org/en/projects-operations/project-detail/P164431

263 "Smallholder farmers in Mozambique embrace solar energy," TSE4ALLM, https://www.tse4allm.org.mz/index.php/en/midia/pequenos-agricultores-em-mocambique-adotam-a-energia-solar

264 USAID Off-Grid Productive Use of Energy Catalogs: https://www.usaid.gov/powerafrica/beyondthegrid/off-grid-solar-market-assessments#PUEcatalogs

BOX A5: COLD CHAIN SOLUTIONS FOR INDIAN BANANA FARMERS

India is the global leader in banana cultivation. In 2013, Danfoss, a Danish multinational manufacturing firm that offers energy system management services, partnered with the Indian government and the Confederation of Indian Industry to form a task force that aimed to deliver cold chain solutions to banana farmers in order to reduce post-harvest losses. With support from local industry associations, the task force conducted a feasibility study of the banana sector to assess how cold chains could be utilized to reduce losses and boost export revenue. The study's findings helped educate farmers on cold chain infrastructure and technologies, resulting in a 300% increase in farmer income and a 20% reduction in post-harvest losses. By 2018, India began exporting bananas to Europe. India's government is now exploring how cold chain solutions can be applied to other agricultural crops/sectors.[265]

Source: Danfoss

The fisheries sector in Mozambique, which includes industrial, semi-industrial and artisanal fishing, accounts for about 4% of the country's exports. It is also the most important source of food and employment for coastal communities, which represent more than two-thirds of the population.[266] The prevailing challenges across the fisheries value chain in Mozambique are similar to those of the agricultural sector, including high post-harvest losses due to inefficient processing methods, a lack of cold storage, transport challenges and limited access to credit. The artisanal fish value chain is where losses are the highest, mainly due to a lack of cold storage facilities, which are vital to the fishing industry (**Box A6**).

BOX A6: SOLAR POWERED REFRIGERATION FOR FISH STORAGE IN VANUATU

In Vanuatu, the National Green Energy Fund (NGEF) was established in 2018 as an independent public entity to source funds to help the government achieve its energy targets. In 2020, the NGEF launched its first pilot project – a VT30 million concessional loan to a fishing cooperative on the remote island of Futuna for the purchase of a solar powered refrigeration system that local fishermen will use to store their fish safely before sale. The system was installed at the Futuna fish market by an approved supplier. The Department of Energy is implementing the project with the support of the Cooperatives Department. Fishing is a main economic activity on Futuna where planes and cargo ships rarely visit. Being one of the most isolated islands in the country makes it hard to transport fish to urban markets. The new refrigeration system solves this logistical challenge, while also replacing an expensive and polluting diesel-powered system with renewable solar power.[267]

Source: Global Green Growth Institute

Healthcare

Off-grid solar can provide reliable electricity access and cold storage solutions to the rural health sector. The COVID-19 pandemic has exposed the risks around lack of cold storage in public health systems, particularly vis-à-vis the safe and effective delivery of life-saving vaccines and other medications. A recent grant provided through USAID Power Africa is supporting off-grid solar electrification of rural health facilities in Sofala Province (see **Section A-2.2.2**).[268]

Tourism

In addition to storing produce, refrigeration can increase the income of rural SMEs by providing ice to businesses that require cold storage, including stores, restaurants and tourism operators. Tourism is a key industry in Mozambique, providing services to more than 2.03 million visitors per year and accounting for about 2% of the country's GDP. Much like other services, tourism has been negatively impacted by the COVID-19 pandemic, accounting for a significant share of job losses.[269] In Mozambique, the sector includes SMEs providing accommodation options in off-grid areas. These operators can benefit from off-grid solar lighting and refrigeration, which allows them to provide higher levels of services to visitors and reduce costs by fuel switching from diesel generation to a renewable source of electricity.

A-4.1.3 Connectivity

Mobile network connectivity is essential for off-grid solar market development. Mobile phone charging provides a primary productive use application for off-grid solar, while mobile phone access and network connectivity drive commerce and employment in rural areas. The penetration of mobile money services is also critical, as it drives greater financial inclusion, expands consumer financing

265 "The World's Banana Giant is Awake," Danfoss, (26 February 2019): https://www.danfoss.com/en/about-danfoss/news/cf/the-world-s-banana-giant-is-awake/

266 Pereira et al., "Mozambique Marine Ecosystems Review," Foundation Ensemble, Maputo, (December 2014): https://www.fondationensemble.org/wp-content/uploads/2015/01/Mozambique_Marine_Review_Final_12-01-2014.pdf

267 Roberts, A. "National Green Energy Fund launches first projects," Daily Post, (March 2, 2020): https://dailypost.vu/news/national-green-energy-fund-launches-first-projects/article_c70f15dc-5c03-11ea-85dc-2f7a58c215be.html

268 "Solar Investment Helps Mozambique Power Health Facilities," Africa Defense Forum, (June 8, 2021): https://adf-magazine.com/2021/06/solar-investment-helps-mozambique-power-health-facilities/

269 "Mozambique Economic Update: Setting the Stage for Recovery," World Bank, (February 2021): https://openknowledge.worldbank.org/handle/10986/35214

options and promotes gender inclusivity. Mobile phones and connectivity are also a necessary precursor to PayGo solutions in the off-grid solar sector. By expanding mobile phone network coverage, particularly broadband services, Mozambique can become a more attractive market for PayGo solar companies (see **Section A-2.2.1.6**).

At the community level, increased connectivity arising from electricity access also means improved security, opportunities for activities at nighttime (social gatherings, entertainment, etc.) and the corresponding increases in economic and productive activity arising from this (e.g., schools, offices and shops are able to stay open later).

A-4.2 Public Services

Off-grid solar electrification offers wide-ranging social benefits. There are clear development benefits arising from energy access, such as improvements to public healthcare (e.g., emergency operations that can happen through the night, cold storage for vaccines and medications) and education (lighting for schools allow classes to take place later in the day). Off-grid solar access also leads to cost savings for public institutions, which increases funding available for other public services. As a clean energy technology, there are also improved health outcomes and pollution mitigation from the replacement of kerosene, diesel generators and batteries, as well as reduction in deforestation (bioenergy).

A-4.3 Indigenous Companies and Employment

The advent of off-grid electricity leads to job creation and business opportunities across various sectors of the rural economy. Revenue from these productive activities can also generate local economic development and growth, which in turn improves communities' ability to pay for electricity.[270]

Mini-grids can provide a wide range of income-generating opportunities, with trade being facilitated greatly by the availability of electricity, as retail shops can be open longer hours and sell more products. Local entrepreneurs can utilize power to develop and grow rural enterprises (opportunities for PUE specific to the context of Mozambique are outlined in **Section A-4.1**).

In the off-grid sector, local companies face capacity and funding constraints to expanding their business. Despite being well positioned to serve last-mile customers, locally-owned companies have been far less successful at accessing sources of capital to grow their businesses compared to international firms. Capacity building and technical assistance needs to target local SMEs in the sector as well as FIs who are capable of provided local currency financing. In the mini-grids market segment, a supportive regulatory framework must be implemented to attract private sector involvement in development of the sector.

A-4.4 Gender Implications

The inclusive participation of women will be essential for Mozambique to achieve its universal electrification objectives. Yet, significant gender disparities and inequities exist, particularly in access to education, rates of enrollment among women compared to men, and economic status.[271] These dynamics are magnified in rural areas, particularly among poorer segments of the population with lower rates of electricity access. Energy access is linked to poverty and education; electricity access can improve the quality and availability of educational services and increase the likelihood that children will attend and complete school.[272] On the other hand, energy poverty often affects women specifically, who are disproportionately exposed to indoor air pollution arising mainly from the use of wood fuels for cooking.[273]

Clear information is needed for policymakers to understand the needs and priorities of women in the context of rural electrification and sustainable development. Women-owned SMEs also stand to benefit from off-grid solar solutions, which can power the development of rural businesses and improve both women's incomes and decision-making power in local communities.[274] Given that the off-grid market is only beginning to emerge in the country, women are not yet highly engaged in the off-grid sector and will need more training and skills development in this regard.

Some of the key government and donor initiatives pertaining to gender in the energy sector are presented in **Table A5**.

270 Borgstein, E., Wade, K., and Mekonnen, D., "Capturing the Productive Use Dividend," Rocky Mountain Institute, (April 2020): https://rmi.org/insight/ethiopia-productive-use/

271 Mozambique ranks 142nd out of 189 countries according to the UNDP's Gender Inequality Index, which measures several indicators to assess levels of gender inequality in areas of health, access to education, economic status and empowerment.

272 Karekezi, S. et al, "Energy, Poverty and Development," (2019): https://iiasa.ac.at/web/home/research/Flagship-Projects/Global-Energy-Assessment/GEA_Chapter2_development_hires.pdf

273 "The Energy Access Situation in Developing Countries: A Review Focusing on the Least Developed Countries and Sub-Saharan Africa," United Nations Development Programme and World Health Organization, (2009): http://www.undp.org/content/dam/undp/library/Environment%20and%20Energy/Sustainable%20Energy/energy-access-situation-in-developing-countries.pdf

274 Soler, A. et al., "Women Entrepreneurs as Key Drivers in the Decentralised Renewable Energy Sector: Best Practices and Innovative Business Models," Alliance for Rural Electrification, (November 2020): https://www.ruralelec.org/sites/default/files/Gender%20%26%20Energy%20Publication.pdf

TABLE A5: SUMMARY OF ENERGY SECTOR GENDER PROGRAMS AND INITIATIVES

Name of Program	Description
World Bank Impact Evaluation of Interventions to Support Women-Owned Firms in three cities in Mozambique[275]	• Impact evaluation to gather data on the entrepreneurial behavior, business success, and the personal and household attitudes and behavior of 1,700 women business owners that form part of this study, and on 850 spouses/partners/significant others of 850 of the 1,700 women business owners, for a total of 2,550 surveys. • This data collection will be conducted in the context of the Women Entrepreneurs Finance Initiative (We-Fi) Bottom-up vs. top-down interventions to foster female entrepreneurship in Mozambique. The evaluation will be led by the World Bank's Africa Gender Innovation Lab; the World Bank Finance, Competitiveness and Innovation Global Practice; the University of Warwick and Leuphana University of Lueneburg
Resilience Building for Women Entrepreneurs in Mozambique[276]	• The Women Entrepreneurship Finance Initiative (We-Fi)'s project in Mozambique aims to expand access to markets and finance of women-owned/led SMEs. • One of the project's core capacity building interventions is the Gender-Centered Design Program (MUVA PAM), which is an acceleration program that supports women entrepreneurs in Mozambique to become more innovative, while developing opportunities and solutions for other women as suppliers, workers, and clients.
World Bank Country Partnership Framework (CPF) for Mozambique	• The proposed project will support, under Focus Area 2 ("Investing in Human Capital"), the strategic objective of Enhancing the Skills Base and Improving Health Service Delivery by providing electricity service access to public institutions within the project target areas. Furthermore, the project will contribute to the CPF's cross-cutting issues, such as gender and climate change, by supporting equal access to low-emission, renewable energy mini-grids and SHSs, reducing women's exposure to indoor air pollution and providing them with access to better health services, particularly for maternal services.
Enabel Capacity Building at MIREME and ARENE[277]	• Initiative provides access to clean, affordable, sustainable energy in Mozambique to promote economic development, poverty reduction, environmental sustainability and gender equity. • Includes advice on gender-responsive policy frameworks; the promotion and training of women in business management and sustainable energy technology; and the promotion of equitable power relations within households, workplaces and communities.
Gender Equality Policy and Implementation Strategy	• In 2018, the government updated the Gender Equality Policy and Implementation Strategy (2006) to promote inclusion of women in decision-making processes that lead to access to energy, water and relevant infrastructure, as well as resilience to climate change impacts.[278]

275 World Bank Group: https://nl4worldbank.org/2021/03/23/ec2-baseline-survey-of-impact-evaluation-of-interventions-to-support-women-owned-firms-in-three-cities-in-mozambique/

276 https://we-fi.org/building-resilience-in-mozambique-gender-centered-design-training/

277 "Institutional and Organisational Strengthening and Capacity Development in the Ministry of Energy," (2020): https://open.enabel.be/en/MOZ/2127/1054/u/mainstreaming-gender-in-the-renewable-energy-sector-in-mozambique.html

278 Stand Alone Solar (SAS) Market Update: Mozambique, Tetra Tech International Development, UK FCDO, 2021.

ANNEX 2: METHODOLOGY

This report was prepared through a combination of desk research, GIS analysis and extensive consultations with individuals and organizations in Mozambique to assess the off-grid solar market. Stakeholder interviews were conducted with the government/ public sector, the donor/development community and with industry/private sector companies across the stand-alone solar supply chain. In order to better understand the perspectives of end-u sers, focus group meetings were held with representatives from village households and SMEs in rural off-grid communities in 10 of 11 provinces in the country.[279] A complete list of interviewed stakeholders is provided in **Annex 3**.

ANNEX 2-A: GIS ANALYSIS METHODOLOGY

Overview of Key Parameters

The GIS analysis estimated the potential off-grid solar (OGS) market by assessing the potential energy demand per settlement, which requires an understanding of the population per settlement. The population cluster published on Mendeley Data ('Mendeley Population Cluster') was used to estimate the potential OGS market for settlements from 2020 to 2030. The analysis assumed that all currently electrified households identified in the Mendeley Data are either electrified by the national grid or by mini-grids / isolated grids. **Table A6** summarizes the data layers and parameters used in the GIS analysis.

TABLE A6: DATA LAYERS AND PARAMETERS USED IN THE GIS ANALYSIS

Indicator	Description	Source
Settlement layer	The Mendeley population clusters include the following data: • id – The IDs are given as a unique number for each cluster • Country - Name of the country. • Population – This is the population in each cluster obtained from the population dataset. The population in these clusters are calibrated to 2016 population values • NightLight – This value is obtained from the night-time light map and represents the maximum luminance detected in each cluster based on the 2016 stable light product available. • ElecPop – The number of people in each cluster who live in areas in which the stable light product detect light sources. • Area – The area of each cluster given in square kilometers. • IsUrban – Classifies areas as either urban (2), peri-urban (1) or rural (0).[280]	Mendeley Population Cluster[281]
Electricity Network	Location of the existing electricity network (HV, MV and LV lines); Approximate location of potential HV and MV lines	EDM - Electricidade de Moçambique in May 2021
Roads	Location of trunk, primary and secondary roads	OpenStreetMap
Energy demand per settlement	Energy demand is calculated as number of households per settlement[282] * targeted Tier level	Settlement layer and targeted Tier level as per the multi-tier electricity access framework

Urban population settlements are often located closer to the existing grid network. They are typically characterized by higher population density, increased economic activity and higher rates of electricity access and demand. The opposite is true for rural settlements. The rural areas of Mendeley population clusters were further divided into rural and deep rural areas. Deep rural areas are located further than 30km from a primary road and have a population of less than 100 people.

Based on this urban - rural classification, a tier level was assigned to each settlement to estimate the energy demand needed for household customers as follows:

- Tier 3 for urban and peri-urban areas;
- Tier 2 for rural areas and deep rural areas

279 Attempts to collect data from Cabo Delgado were unsuccessful, as the consultant field survey team was advised against traveling to the province due to the ongoing conflict/insecurity. The team attempted to reach internally-displaced people living in resettlements in neighboring provinces, but being a situation of national security, an authorization was needed, requiring significant processing time.

280 The degree of urbanization used follows the Global Human Settlement layer (GHSL) based on population density, contiguity and population size. This is a global definition proposed by a consortium of international organizations (EU, OECD, World Bank, FAO, UN-Habitat, ILO): https://ghsl.jrc.ec.europa.eu/degurba.php

281 Khavari, Babak; Korkovelos, Alexandros; Sahlberg, Andreas; Fuso-Nerini, Francesco; Howells, Mark (2020), "PopClusters", Mendeley Data, V6, doi: 10.17632/z9zfhzk8cr.6

282 Urban and peri-urban areas = 3.7 people per household; rural and deep rural areas = 4.4 people per household

The tier levels follow the World Bank ESMAP Multi-tier Framework for Energy Access (**Table A7**):[283]

TABLE A7: MULTI-TIER FRAMEWORK FOR ENERGY ACCESS

Tier	Description
Tier 0	No access
Tier 1	Task lighting and phone charging; about 4.5kWh/year
Tier 2	General lighting, phone charging and television and fan; about 62 kWh/year
Tier 3	Tier 2 and any medium power appliances; about 550 kWh/year
Tier 4	Tier 3 and high-power appliances; about 1,099 kWh/year
Tier 5	Tier 2 and any very high- power appliances; about 3,000 kWh/year

Source: World Bank Energy Sector Management Assistance Program

Underlying Assumptions and Limitations

The analysis focused on the household market and covers the following electrification options:

- Grid densification and extension (EDM);[284]
- Mini-grids or isolated grids for isolated villages with a higher residential energy demand; and
- Standalone solutions distributed in areas with a widely dispersed population and for settlements with an estimated energy demand below 0.1kW per year in 2030 (in line with the NES)

The year 2020 was used as a baseline to provide figures for electricity access rates,[285] total population, the number of SHS and the number of operating mini-grids. The 2017 Population Census was used to correlate population per settlement for the 2020 baseline year, assuming a steady population growth rate of 2.8% for each settlement (the same rate was applied each year through 2030).

A combination of sources and assumptions were used to develop the thresholds for methods of electrification (**Table A8**), such as the NES[286] and regional indicators for East Africa. Low income households' benefit from the social tariff introduced by EDM (MZN 0.97/kWh – about USD 0.15/kWh) and were assumed to be connected by grid densification by 2030 if located within 2km of an existing medium voltage line or within 350 m of an existing high voltage line.[287]

TABLE A8: KEY PARAMETERS OF THE GIS ANALYSIS

Method of Electrification	Distance to HV lines	Distance to MV lines	kW/year
Grid connected	<= 350 m (existing lines only)	<= 2 km (existing lines only)	all
Grid connected	<= 5 km	<= 5 km	> 0.1
Mini-grid	>= 30 km	> 5 km	> 0.1
SHS	> 350 m	> 2 km	<= 0.1

HV = High Voltage; MV = Medium Voltage *Source*: Energio Verda Africa GIS analysis

Table A9 summarizes the underlying assumptions and limitations of the GIS analysis.

283 https://mtfenergyaccess.esmap.org

284 Approximate location of grid extension lines; EDM carried out a feasibility study to connect administration posts; direct linkages from substations via identified connection points were assumed for MV extensions.

285 A national electrification rate of 35% was used (Source: Electricidade de Moçambique, Relatório e Contas, Annual Report, 2020: https://www.edm.co.mz/en/node/5321)

286 National Electrification Strategy, 2018-2030. Ministry of Mineral Resources and Energy, Government of Mozambique.

287 Per EDM's design guide, 350m is the recommended maximum distance from transformers to the last customer and the voltage drop limit for LV lines.

TABLE A9: SUMMARY OF UNDERLYING ASSUMPTIONS AND LIMITATIONS

Indicator	Description
Population	• The population in clusters are calibrated to 2016 population values and adjusted to 2017 census at provincial levels • A population growth rate of 2.8% per year was applied to each settlement to reach population numbers up to the year 2030
Households	• Urban and peri-urban areas = 3.7 people per household • Rural and deep rural areas = 4.4 people per household
Electrified areas	• In the year 2019, an electrified region that does not produce constant light at night throughout the year or whose light levels are very low might not appear electrified • All electrified areas as identified through the night lights are considered to be connected to the national grid or to isolated grids / mini-grids • The electrification numbers for SHS for the baseline year in 2020 are derived from Tetra Tech/FCDO Ace-TAF, 2021;[288] • The total SHS split by distribution between provinces is from ALER, 2021;[289] • Levels of urbanity – urban (13%), peri-urban (14%) and rural (73%) – are from USAID, 2020[290]
Electrification by national grid – grid extension	• EDM carried out a feasibility study to electrify administration posts by 2030. The exact route of electricity network to connect these centers is not yet determined, direct linkages from substations via identified connection points were assumed. Further planned extension of the electricity network was not finalized by the time of writing this report; therefore, the study mainly considered grid densification. It was assumed that all customers within 2km of existing MV lines an 350m of existing HV lines will be connected to the grid.
Energy demand	• Energy demand is calculated as number of households per settlement * targeted Tier level (Tier 3 for urban & peri-urban areas, Tier 2 for rural and deep rural areas). These assumptions following the government standards for supplying electricity solutions.

ANNEX 2-B: REMOTENESS INDEX SCORE

A Remoteness Index was developed to assess and rank Mozambique's provinces and districts based on identified accessibility barriers to supplying off-grid electricity services. Five parameters were used to determine the remoteness index:

i. level of urbanity (urban, peri-urban, rural and deep rural);
ii. population density;
iii. distance to major ports;
iv. distance to main roads; and
v. mobile network coverage.

Table A10 presents the Remoteness Index methodology. Each parameter assumes the average per settlement per province (e.g., on average, settlements in Cabo Delgado are 100-200km away from the closest major port). **A higher index number associated with a given category indicates that it is more difficult to access for the supply of electricity services**.

288 Tetra Tech International Development, UK Foreign, Commonwealth and Development Office (FCDO) Africa Clean Energy Technical Assistance Facility, 2021. "Stand Alone Solar (SAS) Market Update: Mozambique," https://www.ace-taf.org/wp-content/uploads/2021/04/Stand-Alone-Solar-SAS-Market-Update-Mozambique.pdf

289 "Briefing: Renewables in Mozambique 2021," ALER, AMER and GIZ GET.invest, https://www.lerenovaveis.org/contents/lerpublication/aler_mar2021_resumo-renovaveis-em-mocambique-2021.pdf

290 United States Agency for International Development, 2020. "Can Mozambican Households Afford Solar Home Systems? Insights from a Local Survey: Final Report," USAID Power Africa, (April 2020): https://pdf.usaid.gov/pdf_docs/PA00WJJH.pdf

TABLE A10: REMOTENESS INDEX METHODOLOGY

Remoteness Indictor	Unit	Description	Criteria	Index Number
Level of Urbanity	urban, peri-urban, rural, deep rural	Settlements in deep rural areas are more difficult to access for the sale and customer service of electricity solutions.	Urban	0
			Peri-urban	1
			Rural	2
			Deep rural	3
Population Density	People per km^2	Distribution and customer service of electricity solutions is more difficult in areas of low population density, given the long distances between households.[291]	>3,000	0
			1,500-3,000	1
			1,000-1,500	2
			50-1,000	3
			0-500	4
Distance to major ports	km	Average distance to major seaports (in km). Suppliers of electricity solutions are importing equipment/ parts via one of five main seaports.[292]	0-50 km	0
			50-100 km	1
			100-200 km	2
			200-300 km	3
			>300 km	4
Distance to main roads	km	Average distance to main roads (trunk, primary, secondary). Settlements located farther from the main roads are more difficult to reach, resulting in higher logistics costs.	0-10 km	0
			10-20 km	1
			20-30 km	2
			30-40 km	3
			>40 km	4
Mobile network coverage	% network coverage in the province	Average mobile phone coverage of the province, evenly distributed by urbanity. Households in areas of mobile phone coverage can benefit from the PayGo solutions for SHS	90-100%	0
			60-90%	1
			30-60%	2
			0-30%	3

Table A11 shows the Remoteness Index scores by province, split by level of urbanity; **Table A12** shows an average of totals by province.

291 For split by urbanity the densities of urban and peri-urban areas were calculated based on their populated areas only, whereas the rural and deep rural densities were calculated based on the remaining province area.

292 The five major sea ports are located in the cities of Maputo City, Beira, Quelimane, Nacala and Pemba: https://www.searates.com/maritime/mozambique.html

TABLE A11: REMOTENESS INDEX SCORES BY PROVINCE, SPLIT BY LEVEL OF URBANITY

Province	Urbanity				Population density				Distance to major ports				Distance to main roads				Mobile Coverage				Total Index number				Total Index number	Average Total Index number
	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	Province Total	
Niassa	0	1	2	3	0	1	4	4	4	4	4	4	0	1	1	4	1	1	1	1	5	8	12	16	41	10.3
Inham-bane	0	1	2	3	1	2	4	4	4	4	4	3	0	0	0	4	1	1	1	1	6	8	11	15	40	10.0
Tete	0	1	2	3	0	1	4	4	4	4	4	4	0	0	1	4	1	1	1	1	5	7	12	16	40	10.0
Sofala	0	1	2	3	0	1	4	4	2	2	2	2	0	1	1	4	2	2	2	2	4	7	11	15	37	9.3
Gaza	0	1	2	3	0	1	4	4	2	3	3	3	0	1	1	4	1	1	1	1	3	7	11	15	36	9.0
Manica	0	1	2	3	0	1	3	4	3	3	3	3	0	1	1	4	1	1	1	1	4	7	10	15	36	9.0
Maputo	0	1	2	3	0	2	4	4	1	1	1	2	0	0	0	4	2	2	2	2	3	6	9	15	33	8.3
Cabo Delgado	0	1	2	3	0	1	4	4	2	2	2	2	0	1	0	4	1	1	1	1	3	6	9	14	32	8.0
Nam-pula	0	1	2	3	0	1	3	4	2	2	2	2	0	1	1	4	1	1	1	1	3	6	9	14	32	8.0
Zambe-zia	0	1	2	3	0	1	3	4	2	2	3	3	0	0	1	3	1	1	1	1	3	5	10	14	32	8.0
Maputo City	0	1	2	3	0	1	3	4	0	0	0	0	0	1	0	3	0	0	0	0	0	3	5	10	18	4.5

TABLE A12: AVERAGE REMOTENESS INDEX SCORE BY PROVINCE

Rank	Province	Average Total Index Number	Level of urbanity	Population density	Distance to major ports	Distance to major roads	Mobile coverage
1	Niassa	10.3	2	2	4	2	1
2	Inhambane	10.0	2	3	4	1	1
2	Tete	10.0	2	2	4	1	1
4	Sofala	9.3	2	2	2	2	2
5	Gaza	9.0	2	2	3	2	1
5	Manica	9.0	2	2	3	2	1
7	Maputo	8.3	2	3	1	1	2
8	Cabo Delgado	8.0	2	2	2	1	1
8	Nampula	8.0	2	2	2	2	1
8	Zambezia	8.0	2	2	3	1	1
11	Maputo City	4.5	2	2	0	1	0

ANNEX 2-C: DISTRICT PRIORITY RANKING

A District Priority Ranking mechanism was developed to prioritize specific districts within each province for off-grid electrification. The rationale for prioritizing districts is that there are limited resources available to provide off-grid electrification services in remote and underserved areas. The results of GIS analysis show that there are different electrification needs in each province/ district based on the estimated number of households that will be electrified by SHS through 2030 (determined by assessing various factors, including population density, electricity demand and distance of unelectrified households from the grid).[293]

The District Priority Ranking is based on a composite score that combines the aforementioned Remoteness Index value with the estimated number of households that will be electrified by SHS through 2030 that are located at least 5km from existing and 2km from planned medium voltage lines of the EDM grid network.[294] Districts with a higher overall score – i.e., those with

293 See **Annex 2-A** for more details.

294 These distances are used to avoid overlap between EDM (grid extensions) and FUNAE (off-grid) electrification planning and development.

higher average Remoteness Index scores (that are more difficult to access for the supply electrification services) and with more households suitable for SHS (located outside of the EDM grid distance parameters) – are prioritized as districts where national and provincial resources for off-grid solar electrification should be concentrated.

Table A-13 presents the District Priority Ranking methodology.

TABLE A13: DISTRICT PRIORITY RANKING METHODOLOGY

Unit / Indicator	Description	Criteria	Index Number
Total Index number by urbanity	Summary of index numbers per level of urbanity per district	-	-
Total Index number	Summary of index numbers per district	-	-
Average total index number	Average of the total index number per district	-	-
No. SHS Distant	Estimated number of households suitable for SHS electrification (GIS analysis), located at least 5km from existing and 2km from planned medium voltage lines	-	-
Value SHS	Average distance to major seaports (in km). Suppliers of electricity solutions are importing equipment/parts via one of five main seaports	<1,000	0
		1,000-5,000	1
		5,000-10,000	2
		10,000-15,000	3
		15,000-20,000	4
		20,000-40,000	5
		>40,000	6
Combined ranking	Sum of Average total index number and Value SHS to identify districts with highest priority for off-grid solar electrification		

Table A-14 provides a breakdown of the District Priority Ranking for all districts in Mozambique, followed by district rankings and scores disaggregated by province.

TABLE A14: DISTRICT PRIORITY RANKING FOR OFF-GRID SOLAR ELECTRIFICATION IN MOZAMBIQUE

No.	Province	District	Total Index number	Avg. Total Index Number	No. SHS Distant	Value SHS	Composite Ranking
1	Niassa	Mecanhelas	53	13.3	18,327	4	**17.3**
2	Inhambane	Massinga	44	11.0	25,111	5	**16.0**
3	Manica	Machaze	43	10.8	34,677	5	**15.8**
4	Nampula	Malema	43	10.8	21,781	5	**15.8**
5	Nampula	Erati	40	10.0	20,689	5	**15.0**
6	Niassa	Mavago	51	12.8	5,557	2	**14.8**
7	Tete	Macanga	39	9.8	27,437	5	**14.8**
8	Zambezia	Gile	39	9.8	22,902	5	**14.8**
9	Zambezia	Namarroi	39	9.8	22,423	5	**14.8**
10	Zambezia	Alto Molocue	34	8.5	45,063	6	**14.5**
11	Manica	Mossurize	33	8.3	50,612	6	**14.3**
12	Manica	Tambara	49	12.3	5,358	2	**14.3**
13	Nampula	Mecuburi	37	9.3	21,522	5	**14.3**
14	Tete	Maravia	40	10.0	15,699	4	**14.0**

No.	Province	District	Total Index number	Avg. Total Index Number	No. SHS Distant	Value SHS	Composite Ranking
15	Tete	Moatize	36	9.0	22,918	5	**14.0**
16	Zambezia	Gurue	31	7.8	45,662	6	**13.8**
17	Inhambane	Funhalouro	46	11.5	9,326	2	**13.5**
18	Niassa	Marrupa	44	11.0	7,949	2	**13.0**
19	Tete	Magoe	44	11.0	9,641	2	**13.0**
20	Zambezia	Milange	28	7.0	47,435	6	**13.0**
21	Zambezia	Molumbo	36	9.0	16,616	4	**13.0**
22	Inhambane	Vilankulo	31	7.8	20,802	5	**12.8**
23	Sofala	Chibabava	31	7.8	27,578	5	**12.8**
24	Tete	Chiuta	39	9.8	14,880	3	**12.8**
25	Zambezia	Morrumbala	27	6.8	41,276	6	**12.8**
26	Gaza	Massingir	46	11.5	1,759	1	**12.5**
27	Inhambane	Morrumbene	34	8.5	18,076	4	**12.5**
28	Manica	Guro	38	9.5	10,987	3	**12.5**
29	Nampula	Muecate	34	8.5	18,846	4	**12.5**
30	Niassa	Chimbonila	38	9.5	12,795	3	**12.5**
31	Tete	Zumbu	42	10.5	7,221	2	**12.5**
32	Manica	Sussundenga	29	7.3	32,610	5	**12.3**
33	Tete	Angonia	37	9.3	14,005	3	**12.3**
34	Tete	Cahora Bassa	37	9.3	10,435	3	**12.3**
35	Tete	Chifunde	29	7.3	24,028	5	**12.3**
36	Zambezia	Mocuba	25	6.3	44,756	6	**12.3**
37	Zambezia	Mopeia	33	8.3	15,980	4	**12.3**
38	Zambezia	Pebane	33	8.3	17,253	4	**12.3**
39	Gaza	Mapai	44	11.0	4,505	1	**12.0**
40	Manica	Barue	32	8.0	19,232	4	**12.0**
41	Nampula	Mogovolas	28	7.0	24,636	5	**12.0**
42	Tete	Tsangano	36	9.0	14,560	3	**12.0**
43	Cabo Delgado	Namuno	39	9.8	9,990	2	**11.8**
44	Gaza	Chigubo	39	9.8	5,386	2	**11.8**
45	Inhambane	Inharrime	31	7.8	17,579	4	**11.8**
46	Manica	Manica	31	7.8	18,586	4	**11.8**
47	Nampula	Ribaue	27	6.8	21,982	5	**11.8**
48	Sofala	Maringue	35	8.8	14,872	3	**11.8**
49	Sofala	Nhamatanda	27	6.8	27,891	5	**11.8**
50	Zambezia	Lugela	31	7.8	18,504	4	**11.8**
51	Gaza	Chibuto	34	8.5	10,373	3	**11.5**
52	Gaza	Guija	38	9.5	6,940	2	**11.5**
53	Manica	Vanduzi	30	7.5	17,219	4	**11.5**
54	Niassa	Metarica	42	10.5	2,617	1	**11.5**
55	Zambezia	Ile	26	6.5	35,147	5	**11.5**
56	Inhambane	Inhassoro	33	8.3	10,505	3	**11.3**
57	Inhambane	Mabote	37	9.3	7,617	2	**11.3**
58	Nampula	Lalaua	33	8.3	11,032	3	**11.3**
59	Niassa	Sanga	37	9.3	6,173	2	**11.3**
60	Gaza	Chicualacuala	40	10.0	2,667	1	**11.0**
61	Gaza	Massangena	40	10.0	2,790	1	**11.0**

No.	Province	District	Total Index number	Avg. Total Index Number	No. SHS Distant	Value SHS	Composite Ranking
62	Inhambane	Homoine	28	7.0	17,548	4	**11.0**
63	Nampula	Moma	28	7.0	19,332	4	**11.0**
64	Nampula	Murrupula	28	7.0	15,556	4	**11.0**
65	Niassa	Lago	36	9.0	7,007	2	**11.0**
66	Niassa	Mecula	44	11.0	400	0	**11.0**
67	Sofala	Buzi	24	6.0	25,243	5	**11.0**
68	Sofala	Chemba	32	8.0	10,654	3	**11.0**
69	Manica	Gondola	23	5.8	24,687	5	**10.8**
70	Niassa	Maua	35	8.8	6,839	2	**10.8**
71	Sofala	Gorongosa	27	6.8	18,801	4	**10.8**
72	Sofala	Machanga	35	8.8	5,348	2	**10.8**
73	Tete	Changara	35	8.8	8,364	2	**10.8**
74	Cabo Delgado	Montepuez	34	8.5	8,821	2	**10.5**
75	Nampula	Memba	26	6.5	18,075	4	**10.5**
76	Cabo Delgado	Chiure	29	7.3	11,819	3	**10.3**
77	Inhambane	Zavala	25	6.3	19,778	4	**10.3**
78	Niassa	Cuamba	33	8.3	8,742	2	**10.3**
79	Niassa	Nipepe	37	9.3	2,752	1	**10.3**
80	Gaza	Mandlakaze	36	9.0	4,148	1	**10.0**
81	Inhambane	Panda	32	8.0	8,872	2	**10.0**
82	Niassa	Muembe	36	9.0	4,607	1	**10.0**
83	Niassa	Ngauma	32	8.0	8,213	2	**10.0**
84	Sofala	Marromeu	32	8.0	8,389	2	**10.0**
85	Gaza	Mabalane	35	8.8	3,206	1	**9.8**
86	Maputo	Magude	31	7.8	8,268	2	**9.8**
87	Nampula	Larde	31	7.8	6,421	2	**9.8**
88	Nampula	Mossuril	31	7.8	7,232	2	**9.8**
89	Niassa	Mandimba	31	7.8	9,311	2	**9.8**
90	Sofala	Muanza	31	7.8	8,824	2	**9.8**
91	Cabo Delgado	Mueda	30	7.5	9,910	2	**9.5**
92	Manica	Macossa	30	7.5	8,829	2	**9.5**
93	Nampula	Mogincual	34	8.5	4,401	1	**9.5**
94	Sofala	Cheringoma	30	7.5	6,549	2	**9.5**
95	Zambezia	Derre	22	5.5	18,861	4	**9.5**
96	Cabo Delgado	Macomia	29	7.3	5,124	2	**9.3**
97	Inhambane	Govuro	33	8.3	4,917	1	**9.3**
98	Nampula	Nacaroa	25	6.3	14,684	3	**9.3**
99	Niassa	Majune	33	8.3	3,991	1	**9.3**
100	Zambezia	Maganja Da Costa	25	6.3	12,858	3	**9.3**
101	Zambezia	Mocubela	25	6.3	10,134	3	**9.3**
102	Cabo Delgado	Balama	28	7.0	5,865	2	**9.0**
103	Nampula	Monapo	20	5.0	17,254	4	**9.0**
104	Zambezia	Chinde	28	7.0	6,708	2	**9.0**
105	Cabo Delgado	Palma	31	7.8	3,574	1	**8.8**
106	Maputo	Matutuine	31	7.8	1,629	1	**8.8**
107	Maputo	Moamba	27	6.8	5,263	2	**8.8**
108	Zambezia	Luabo	31	7.8	4,050	1	**8.8**

No.	Province	District	Total Index number	Avg. Total Index Number	No. SHS Distant	Value SHS	Composite Ranking
109	Manica	Macate	18	4.5	17,993	4	**8.5**
110	Tete	Mutarara	26	6.5	5,106	2	**8.5**
111	Cabo Delgado	Muidumbe	29	7.3	1,970	1	**8.3**
112	Niassa	Lago Niassa	33	8.3	533	0	**8.3**
113	Sofala	Caia	25	6.3	6,056	2	**8.3**
114	Tete	Doa	25	6.3	9,807	2	**8.3**
115	Zambezia	Mulevala	17	4.3	19,905	4	**8.3**
116	Nampula	Meconta	20	5.0	12,203	3	**8.0**
117	Nampula	Rapale	20	5.0	13,627	3	**8.0**
118	Cabo Delgado	Meluco	27	6.8	2,052	1	**7.8**
119	Cabo Delgado	Nangade	27	6.8	3,893	1	**7.8**
120	Inhambane	Jangamo	23	5.8	9,764	2	**7.8**
121	Nampula	Liúpo	27	6.8	4,130	1	**7.8**
122	Gaza	Bilene	26	6.5	3,231	1	**7.5**
123	Gaza	Limpopo	26	6.5	1,814	1	**7.5**
124	Cabo Delgado	Ancuabe	21	5.3	7,687	2	**7.3**
125	Nampula	Angoche	21	5.3	5,932	2	**7.3**
126	Cabo Delgado	Ibo	28	7.0	132	0	**7.0**
127	Zambezia	Namacurra	20	5.0	9,576	2	**7.0**
128	Gaza	Chongoene	23	5.8	3,220	1	**6.8**
129	Zambezia	Nicoadala	15	3.8	10,432	3	**6.8**
130	Tete	Marara	18	4.5	7,759	2	**6.5**
131	Cabo Delgado	Mocimboa Da Praia	21	5.3	3,452	1	**6.3**
132	Gaza	Chokwe	20	5.0	2,946	1	**6.0**
133	Cabo Delgado	Quissanga	19	4.8	2,330	1	**5.8**
134	Inhambane	Maxixe	23	5.8	253	0	**5.8**
135	Nampula	Nacala-A-Velha	15	3.8	5,272	2	**5.8**
136	Sofala	Dondo	15	3.8	7,996	2	**5.8**
137	Zambezia	Maquival	19	4.8	3,840	1	**5.8**
138	Gaza	Cidade De Xai-Xai	22	5.5	-	0	**5.5**
139	Inhambane	Cidade De Inhambane	22	5.5	721	0	**5.5**
140	Maputo	Manhiça	18	4.5	3,954	1	**5.5**
141	Cabo Delgado	Metuge	16	4.0	1,354	1	**5.0**
142	Nampula	Ilha De Moçambique	20	5.0	458	0	**5.0**
143	Zambezia	Inhassunge	16	4.0	3,143	1	**5.0**
144	Maputo City	Cidade De Maputo	19	4.8	-	0	**4.8**
145	Niassa	Cidade De Lichinga	19	4.8	476	0	**4.8**
146	Tete	Cidade De Tete	19	4.8	536	0	**4.8**
147	Cabo Delgado	Mecufi	13	3.3	1,052	1	**4.3**
148	Maputo	Namaacha	17	4.3	719	0	**4.3**
149	Maputo	Boane	16	4.0	135	0	**4.0**
150	Maputo	Marracuene	16	4.0	296	0	**4.0**
151	Cabo Delgado	Cidade De Pemba	14	3.5	-	0	**3.5**

No.	Province	District	Total Index number	Avg. Total Index Number	No. SHS Distant	Value SHS	Composite Ranking
152	Zambezia	Cidade De Quelimane	14	3.5	364	0	**3.5**
153	Nampula	Cidade De Nampula	13	3.3	134	0	**3.3**
154	Manica	Cidade De Chimoio	12	3.0	576	0	**3.0**
155	Sofala	Cidade Da Beira	7	1.8	1,132	1	**2.8**
156	Maputo	Cidade Da Matola	10	2.5	-	0	**2.5**
157	Nampula	Nacala	7	1.8	150	0	**1.8**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Maputo	Magude	0	1	2	3	1	2	3	3	2	2	2	2	0	0	0	4	1	1	1	1	4	6	8	13	31	7.8	8,268	2	**9.8**
Maputo	Matutuine	0	1	2	3	1	2	3	1	2	1	1	2	0	0	0	4	2	2	2	2	5	6	8	12	31	7.8	1,629	1	**8.8**
Maputo	Moamba	0	1	2	3	0	3	3	3	1	1	1	2	0	0	0	3	1	1	1	1	2	6	7	12	27	6.8	5,263	2	**8.8**
Maputo	Manhiça	0	1	2	3	1	1	3	0	1	1	1	0	0	0	0	0	1	1	1	1	3	4	7	4	18	4.5	3,954	1	**5.5**
Maputo	Namaacha	0	1	2	3	0	1	1	0	1	0	0	0	0	0	0	0	2	2	2	2	3	4	5	5	17	4.3	719	0	**4.3**
Maputo	Boane	0	1	2	3	2	1	3	0	0	0	0	0	0	0	0	0	1	1	1	1	3	3	6	4	16	4.0	135	0	**4.0**
Maputo	Marracuene	0	1	2	3	1	2	3	0	0	0	0	0	0	0	0	0	1	1	1	1	2	4	6	4	16	4.0	296	0	**4.0**
Maputo	Cidade Da Matola	0	1	2	3	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	5	3	10	2.5	-	0	**2.5**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Gaza	Massingir	0	1	2	3	1	1	2	3	3	3	3	3	4	3	2	4	2	2	2	2	10	10	11	15	46	11.5	1,759	1	**12.5**
Gaza	Mapai	0	1	2	3	2	2	3	3	4	4	4	4	0	0	1	3	2	2	2	2	8	9	12	15	44	11.0	4,505	1	**12.0**
Gaza	Chigubo	0	1	2	3	0	2	3	3	0	4	4	4	0	4	1	4	1	1	1	1	1	12	11	15	39	9.8	5,386	2	**11.8**
Gaza	Chibuto	0	1	2	3	0	1	3	3	2	3	3	3	0	1	1	4	1	1	1	1	3	7	10	14	34	8.5	10,373	3	**11.5**
Gaza	Guija	0	1	2	3	1	1	3	3	2	3	3	3	0	0	1	4	2	2	2	2	5	7	11	15	38	9.5	6,940	2	**11.5**
Gaza	Chicualacuala	0	1	2	3	1	2	3	3	4	4	4	4	0	1	0	4	1	1	1	1	6	9	10	15	40	10.0	2,667	1	**11.0**
Gaza	Massangena	0	1	2	3	0	2	3	3	0	3	4	4	0	4	3	4	1	1	1	1	1	11	13	15	40	10.0	2,790	1	**11.0**
Gaza	Mandlakaze	0	1	2	3	1	2	2	3	3	3	3	3	0	1	1	4	1	1	1	1	5	8	9	14	36	9.0	4,148	1	**10.0**
Gaza	Mabalane	0	1	2	3	1	1	3	3	3	3	3	3	0	0	1	4	1	1	1	1	5	6	10	14	35	8.8	3,206	1	**9.8**
Gaza	Bilene	0	1	2	3	1	2	3	0	2	2	2	0	0	0	0	0	2	2	2	2	5	7	9	5	26	6.5	3,231	1	**7.5**
Gaza	Limpopo	0	1	2	3	1	2	3	0	2	2	2	0	0	0	0	0	2	2	2	2	5	7	9	5	26	6.5	1,814	1	**7.5**
Gaza	Chongoene	0	1	2	3	0	1	2	1	2	2	3	3	0	0	0	3	0	0	0	0	2	4	7	10	23	5.8	3,220	1	**6.8**
Gaza	Chokwe	0	1	2	3	0	1	3	0	2	2	2	0	0	0	0	0	1	1	1	1	3	5	8	4	20	5.0	2,946	1	**6.0**
Gaza	Cidade De Xai-Xai	0	1	2	3	0	0	2	0	2	2	2	0	0	0	0	0	2	2	2	2	4	5	8	5	22	5.5	-	0	**5.5**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Inhambane	Massinga	0	1	2	3	2	3	3	3	4	4	4	4	0	0	0	3	2	2	2	2	8	10	11	15	44	11.0	25,111	5	**16.0**
Inhambane	Funhalouro	0	1	2	3	2	3	3	3	4	4	4	4	0	0	1	4	2	2	2	2	8	10	12	16	46	11.5	9,326	2	**13.5**
Inhambane	Vilankulo	0	1	2	3	1	1	3	2	3	3	4	4	0	1	0	3	0	0	0	0	4	6	9	12	31	7.8	20,802	5	**12.8**
Inhambane	Morrumbene	0	1	2	3	2	3	3	0	4	4	4	0	0	0	0	0	2	2	2	2	8	10	11	5	34	8.5	18,076	4	**12.5**
Inhambane	Inharrime	0	1	2	3	1	1	2	3	4	4	4	3	0	0	0	3	0	0	0	0	5	6	8	12	31	7.8	17,579	4	**11.8**
Inhambane	Inhassoro	0	1	2	3	2	2	3	3	3	3	3	3	1	0	1	3	0	0	0	0	6	6	9	12	33	8.3	10,505	3	**11.3**
Inhambane	Mabote	0	1	2	3	1	2	3	3	3	3	3	3	0	1	1	4	1	1	1	1	5	8	10	14	37	9.3	7,617	2	**11.3**
Inhambane	Homoine	0	1	2	3	1	2	3	0	4	4	4	0	0	0	0	0	1	1	1	1	6	8	10	4	28	7.0	17,548	4	**11.0**
Inhambane	Zavala	0	1	2	3	1	2	3	0	3	3	3	0	0	0	0	0	1	1	1	1	5	7	9	4	25	6.3	19,778	4	**10.3**
Inhambane	Panda	0	1	2	3	0	1	2	3	4	4	4	3	0	1	0	4	0	0	0	0	4	7	8	13	32	8.0	8,872	2	**10.0**
Inhambane	Govuro	0	1	2	3	1	2	3	3	2	2	2	2	0	2	1	3	1	1	1	1	4	8	9	12	33	8.3	4,917	1	**9.3**
Inhambane	Jangamo	0	1	2	3	1	2	2	0	4	4	4	0	0	0	0	0	0	0	0	0	5	7	8	3	23	5.8	9,764	2	**7.8**
Inhambane	Maxixe	0	1	2	3	1	2	2	0	4	4	4	0	0	0	0	0	0	0	0	0	5	7	8	3	23	5.8	253	0	**5.8**
Inhambane	Cidade De Inhambane	0	1	2	3	1	1	2	0	4	4	4	0	0	0	0	0	0	0	0	0	5	6	8	3	22	5.5	721	0	**5.5**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				No. SHS Distant	
Manica	Machaze	0	1	2	3	1	1	3	3	3	3	2	3	2	3	1	4	2	2	2	2	8	10	10	15	43	10.8	34,677	5	**15.8**
Manica	Mossurize	0	1	2	3	2	1	2	1	3	3	3	3	0	1	1	3	1	1	1	1	6	7	9	11	33	8.3	50,612	6	**14.3**
Manica	Tambara	0	1	2	3	0	1	2	3	4	4	4	4	3	4	2	4	2	2	2	2	9	12	12	16	49	12.3	5,358	2	**14.3**
Manica	Guro	0	1	2	3	0	1	3	3	4	4	4	4	0	1	1	3	1	1	1	1	5	8	11	14	38	9.5	10,987	3	**12.5**
Manica	Sussundenga	0	1	2	3	0	1	3	3	2	2	2	3	0	0	0	3	1	1	1	1	3	5	8	13	29	7.3	32,610	5	**12.3**
Manica	Barue	0	1	2	3	0	1	2	3	3	3	4	0	0	0	3	1	1	1	1	1	4	6	8	14	32	8.0	19,232	4	**12.0**
Manica	Manica	0	1	2	3	1	1	2	1	3	3	3	3	0	0	1	3	1	1	1	1	5	6	9	11	31	7.8	18,586	4	**11.8**
Manica	Vanduzi	0	1	2	3	0	1	3	3	2	3	2	2	0	0	1	3	1	1	1	1	3	6	9	12	30	7.5	17,219	4	**11.5**
Manica	Gondola	0	1	2	3	0	1	2	0	2	2	2	0	0	0	0	0	2	2	2	2	4	6	8	5	23	5.8	24,687	5	**10.8**
Manica	Macossa	0	1	2	3	0	1	3	3	0	3	3	3	0	0	1	3	1	1	1	1	1	6	10	13	30	7.5	8,829	2	**9.5**
Manica	Macate	0	1	2	3	0	1	2	0	0	2	2	0	0	0	1	0	1	1	1	1	1	5	8	4	18	4.5	17,993	4	**8.5**
Manica	Cidade De Chimoio	0	1	2	3	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	2	3	4	3	12	3.0	576	0	**3.0**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Sofala	Chibabava	0	1	2	3	0	1	2	3	2	2	2	2	0	0	0	3	2	2	2	2	4	6	8	13	31	7.8	27,578	5	**12.8**
Sofala	Maringue	0	1	2	3	1	2	3	3	3	3	3	3	0	0	1	3	1	1	1	1	5	7	10	13	35	8.8	14,872	3	**11.8**
Sofala	Nhamatanda	0	1	2	3	0	1	1	2	1	1	1	2	0	0	1	3	2	2	2	2	3	5	7	12	27	6.8	27,891	5	**11.8**
Sofala	Buzi	0	1	2	3	1	2	2	3	0	0	1	1	0	0	1	3	1	1	1	1	2	4	7	11	24	6.0	25,243	5	**11.0**
Sofala	Chemba	0	1	2	3	0	1	3	2	3	3	3	3	0	0	1	3	1	1	1	1	4	6	10	12	32	8.0	10,654	3	**11.0**
Sofala	Gorongosa	0	1	2	3	0	1	2	2	2	2	2	2	0	0	1	3	1	1	1	1	3	5	8	11	27	6.8	18,801	4	**10.8**
Sofala	Machanga	0	1	2	3	1	0	2	3	2	2	2	3	3	1	4	1	1	1	1	1	7	7	8	13	35	8.8	5,348	2	**10.8**
Sofala	Marromeu	0	1	2	3	0	0	0	1	2	2	2	2	3	4	2	4	1	1	1	1	6	8	7	11	32	8.0	8,389	2	**10.0**
Sofala	Muanza	0	1	2	3	1	2	3	3	2	1	1	1	0	2	1	4	1	1	1	1	4	7	8	12	31	7.8	8,824	2	**9.8**
Sofala	Cheringoma	0	1	2	3	1	1	2	2	2	2	2	2	0	2	0	4	1	1	1	1	4	7	7	12	30	7.5	6,549	2	**9.5**
Sofala	Caia	0	1	2	3	0	1	2	2	2	2	3	3	0	0	1	3	0	0	0	0	2	4	8	11	25	6.3	6,056	2	**8.3**
Sofala	Dondo	0	1	2	3	0	0	1	0	0	0	0	0	0	0	0	0	2	2	2	2	2	3	5	5	15	3.8	7,996	2	**5.8**
Sofala	Cidade Da Beira	0	1	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	7	1.8	1,132	1	**2.8**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Zambezia	Gile	0	1	2	3	1	2	3	3	3	3	3	0	0	1	3	2	2	2	2	6	8	11	14	39	9.8	22,902	5	**14.8**
Zambezia	Namarroi	0	1	2	3	1	3	3	3	3	3	3	2	1	1	3	1	1	1	1	7	9	10	13	39	9.8	22,423	5	**14.8**
Zambezia	Alto Molocue	0	1	2	3	1	1	3	2	3	3	3	0	1	1	3	1	1	1	1	5	7	10	12	34	8.5	45,063	6	**14.5**
Zambezia	Gurue	0	1	2	3	0	1	2	2	3	3	3	3	0	0	1	3	1	1	1	1	4	6	9	12	31	7.8	45,662	6	**13.8**
Zambezia	Milange	0	1	2	3	1	1	2	2	3	3	3	3	0	0	1	3	1	0	0	0	4	5	8	11	28	7.0	47,435	6	**13.0**
Zambezia	Molumbo	0	1	2	3	0	2	4	3	0	3	3	3	0	0	1	3	2	2	2	2	2	8	12	14	36	9.0	16,616	4	**13.0**
Zambezia	Morrumbala	0	1	2	3	0	1	2	3	2	2	2	2	0	0	0	3	1	1	1	1	3	5	7	12	27	6.8	41,276	6	**12.8**
Zambezia	Mocuba	0	1	2	3	1	2	3	3	2	2	2	1	0	0	0	3	0	0	0	0	3	5	7	10	25	6.3	44,756	6	**12.3**
Zambezia	Mopeia	0	1	2	3	0	1	2	2	2	2	2	1	1	1	1	4	2	2	2	2	5	7	9	12	33	8.3	15,980	4	**12.3**
Zambezia	Pebane	0	1	2	3	1	1	2	3	3	3	3	3	0	1	0	3	1	1	1	1	5	7	8	13	33	8.3	17,253	4	**12.3**
Zambezia	Lugela	0	1	2	3	2	1	3	1	2	2	2	3	0	1	1	3	1	1	1	1	5	6	9	11	31	7.8	18,504	4	**11.8**
Zambezia	Ile	0	1	2	3	1	3	3	0	3	3	3	0	0	0	0	0	1	1	1	1	5	8	9	4	26	6.5	35,147	5	**11.5**
Zambezia	Derre	0	1	2	3	0	2	3	3	0	2	2	1	0	0	0	3	0	0	0	0	0	5	7	10	22	5.5	18,861	4	**9.5**
Zambezia	Maganja Da Costa	0	1	2	3	1	1	2	2	1	1	1	1	1	1	0	3	1	1	1	1	4	5	6	10	25	6.3	12,858	3	**9.3**
Zambezia	Mocubela	0	1	2	3	1	1	2	1	2	2	2	2	1	1	1	3	0	0	0	0	4	5	7	9	25	6.3	10,134	3	**9.3**
Zambezia	Chinde	0	1	2	3	0	1	1	2	1	1	1	2	0	1	1	3	2	2	2	2	3	6	7	12	28	7.0	6,708	2	**9.0**
Zambezia	Luabo	0	1	2	3	0	1	1	2	0	2	2	2	0	4	3	4	1	1	1	1	1	9	9	12	31	7.8	4,050	1	**8.8**
Zambezia	Mulevala	0	1	2	3	0	3	3	0	0	3	2	0	0	0	0	0	0	0	0	0	0	7	7	3	17	4.3	19,905	4	**8.3**
Zambezia	Namacurra	0	1	2	3	1	1	2	1	1	1	1	1	1	1	0	3	0	0	0	0	3	4	5	8	20	5.0	9,576	2	**7.0**
Zambezia	Nicoadala	0	1	2	3	0	1	2	2	0	0	0	1	0	0	0	3	0	0	0	0	0	2	4	9	15	3.8	10,432	3	**6.8**
Zambezia	Maquival	0	1	2	3	0	1	1	0	0	0	0	0	1	1	1	0	2	2	2	2	3	5	6	5	19	4.8	3,840	1	**5.8**
Zambezia	Inhassunge	0	1	2	3	0	1	1	0	0	0	0	0	0	0	0	0	2	2	2	2	2	4	5	5	16	4.0	3,143	1	**5.0**
Zambezia	Cidade De Quelimane	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	3	4	5	14	3.5	364	0	**3.5**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Tete	Macanga	0	1	2	3	0	1	2	3	4	4	4	4	0	0	0	3	2	2	2	2	6	8	10	15	39	9.8	27,437	5	**14.8**
Tete	Maravia	0	1	2	3	1	1	3	3	4	4	4	4	0	2	1	3	1	1	1	1	6	9	11	14	40	10.0	15,699	4	**14.0**
Tete	Moatize	0	1	2	3	0	0	1	2	4	4	4	4	0	0	0	3	2	2	2	2	6	7	9	14	36	9.0	22,918	5	**14.0**
Tete	Magoe	0	1	2	3	1	1	2	2	4	4	4	4	0	3	1	4	2	2	2	2	7	11	11	15	44	11.0	9,641	2	**13.0**
Tete	Chiuta	0	1	2	3	0	1	2	2	4	4	4	4	0	0	1	3	2	2	2	2	6	8	11	14	39	9.8	14,880	3	**12.8**
Tete	Zumbu	0	1	2	3	0	1	2	3	0	4	4	4	0	1	1	4	3	3	3	3	3	10	12	17	42	10.5	7,221	2	**12.5**
Tete	Angonia	0	1	2	3	0	1	3	3	4	4	4	4	0	0	1	3	1	1	1	1	5	7	11	14	37	9.3	14,005	3	**12.3**
Tete	Cahora Bassa	0	1	2	3	0	1	2	4	4	4	4	4	0	0	0	4	1	1	1	1	5	7	9	16	37	9.3	10,435	3	**12.3**
Tete	Chifunde	0	1	2	3	0	0	2	2	4	4	4	4	0	0	0	3	0	0	0	0	4	5	8	12	29	7.3	24,028	5	**12.3**
Tete	Tsangano	0	1	2	3	0	1	3	3	4	4	4	4	0	0	0	3	1	1	1	1	5	7	10	14	36	9.0	14,560	3	**12.0**
Tete	Changara	0	1	2	3	0	1	3	3	4	4	4	4	0	1	1	4	0	0	0	0	4	7	10	14	35	8.8	8,364	2	**10.8**
Tete	Mutarara	0	1	2	3	0	1	2	0	3	3	3	0	0	0	0	0	2	2	2	2	5	7	9	5	26	6.5	5,106	2	**8.5**
Tete	Doa	0	1	2	3	0	0	1	1	3	3	3	4	0	0	0	1	3	0	0	0	0	3	4	7	11	25	6.3	9,807	2	**8.3**
Tete	Marara	0	1	2	3	0	1	3	0	0	4	4	4	0	0	0	0	0	0	0	0	0	0	6	9	3	18	4.5	7,759	2	**6.5**
Tete	Cidade De Tete	0	1	2	3	0	0	1	0	4	4	4	0	0	0	0	0	0	0	0	0	4	5	7	3	19	4.8	536	0	**4.8**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Nampula	Malema	0	1	2	3	1	2	3	3	4	4	4	4	0	0	1	3	2	2	2	2	7	9	12	15	43	10.8	21,781	5	**15.8**
Nampula	Erati	0	1	2	3	1	2	3	3	2	2	2	2	2	1	4	2	2	2	2	2	7	9	10	14	40	10.0	20,689	5	**15.0**
Nampula	Mecuburi	0	1	2	3	0	1	3	3	3	3	3	2	1	3	1	4	1	1	1	1	5	9	10	13	37	9.3	21,522	5	**14.3**
Nampula	Muecate	0	1	2	3	0	1	3	3	2	2	2	2	2	1	4	1	1	1	1	1	5	7	9	13	34	8.5	18,846	4	**12.5**
Nampula	Mogovolas	0	1	2	3	0	1	3	0	3	3	3	0	0	0	1	0	2	2	2	2	5	7	11	5	28	7.0	24,636	5	**12.0**
Nampula	Ribaue	0	1	2	3	0	1	3	0	3	3	3	0	0	0	0	0	2	2	2	2	5	7	10	5	27	6.8	21,982	5	**11.8**
Nampula	Lalaua	0	1	2	3	0	1	3	3	0	3	3	3	0	0	0	3	2	2	2	2	2	7	10	14	33	8.3	11,032	3	**11.3**
Nampula	Moma	0	1	2	3	0	1	3	0	3	3	3	0	0	1	0	0	2	2	2	2	5	8	10	5	28	7.0	19,332	4	**11.0**
Nampula	Murrupula	0	1	2	3	1	1	3	0	3	3	3	0	0	0	0	0	2	2	2	2	6	7	10	5	28	7.0	15,556	4	**11.0**
Nampula	Memba	0	1	2	3	1	1	3	3	1	1	1	1	0	1	0	3	1	1	1	1	3	5	7	11	26	6.5	18,075	4	**10.5**
Nampula	Larde	0	1	2	3	0	0	2	1	3	3	3	3	1	1	1	3	1	1	1	1	5	6	9	11	31	7.8	6,421	2	**9.8**
Nampula	Mossuril	0	1	2	3	1	1	3	3	0	1	1	1	1	1	1	3	2	2	2	2	4	6	9	12	31	7.8	7,232	2	**9.8**
Nampula	Mogincual	0	1	2	3	0	1	3	3	0	2	2	2	0	2	1	4	2	2	2	2	2	8	10	14	34	8.5	4,401	1	**9.5**
Nampula	Nacaroa	0	1	2	3	0	1	3	3	1	1	1	2	0	0	0	3	1	1	1	1	2	4	7	12	25	6.3	14,684	3	**9.3**
Nampula	Monapo	0	1	2	3	0	1	2	0	1	1	1	0	0	0	0	0	2	2	2	2	3	5	7	5	20	5.0	17,254	4	**9.0**
Nampula	Meconta	0	1	2	3	0	1	3	0	2	2	2	0	0	0	0	0	1	1	1	1	3	5	8	4	20	5.0	12,203	3	**8.0**
Nampula	Rapale	0	1	2	3	0	1	3	0	2	2	2	0	0	0	0	0	1	1	1	1	3	5	8	4	20	5.0	13,627	3	**8.0**
Nampula	Liúpo	0	1	2	3	0	0	2	1	2	2	2	2	1	2	0	3	1	1	1	1	4	6	7	10	27	6.8	4,130	1	**7.8**
Nampula	Angoche	0	1	2	3	0	0	1	0	3	3	3	0	1	0	0	0	1	1	1	1	5	5	7	4	21	5.3	5,932	2	**7.3**
Nampula	Nacala-A-Velha	0	1	2	3	1	1	3	0	0	0	0	0	0	0	0	0	1	1	1	1	2	3	6	4	15	3.8	5,272	2	**5.8**
Nampula	Ilha De Moçambique	0	1	2	3	0	1	2	0	1	1	1	0	0	0	0	0	2	2	2	2	3	5	7	5	20	5.0	458	0	**5.0**
Nampula	Cidade De Nampula	0	1	2	3	0	0	1	0	2	2	2	0	0	0	0	0	0	0	0	0	0	2	3	5	13	3.3	134	0	**3.3**
Nampula	Nacala	0	1	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	7	1.8	150	0	**1.8**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Niassa	Mecanhelas	0	1	2	3	0	1	2	3	4	4	4	4	4	3	2	4	3	3	3	3	11	12	13	17	53	13.3	18,327	4	**17.3**
Niassa	Mavago	0	1	2	3	0	1	1	3	4	4	4	4	4	4	4	4	2	2	2	2	10	12	13	16	51	12.8	5,557	2	**14.8**
Niassa	Marrupa	0	1	2	3	1	2	3	4	4	4	4	4	0	0	0	4	2	2	2	2	7	9	11	17	44	11.0	7,949	2	**13.0**
Niassa	Chimbonila	0	1	2	3	0	0	3	0	4	4	4	4	0	1	1	3	2	2	2	2	6	8	12	12	38	9.5	12,795	3	**12.5**
Niassa	Metarica	0	1	2	3	0	1	3	3	4	4	4	4	0	0	1	4	2	2	2	2	6	8	12	16	42	10.5	2,617	1	**11.5**
Niassa	Sanga	0	1	2	3	0	0	3	4	4	4	4	4	0	0	0	4	1	1	1	1	5	6	10	16	37	9.3	6,173	2	**11.3**
Niassa	Lago	0	1	2	3	0	0	2	3	4	4	4	4	0	1	0	4	1	1	1	1	5	7	9	15	36	9.0	7,007	2	**11.0**
Niassa	Mecula	0	1	2	3	0	3	3	3	0	4	3	4	0	4	2	4	2	2	2	2	2	14	12	16	44	11.0	400	0	**11.0**
Niassa	Maua	0	1	2	3	1	2	3	3	4	4	4	4	0	0	1	3	0	0	0	0	5	7	10	13	35	8.8	6,839	2	**10.8**
Niassa	Cuamba	0	1	2	3	0	0	1	1	4	4	4	4	0	1	1	3	1	1	1	1	5	7	9	12	33	8.3	8,742	2	**10.3**
Niassa	Nipepe	0	1	2	3	2	0	2	2	4	3	3	4	3	3	2	3	0	0	0	0	9	7	9	12	37	9.3	2,752	1	**10.3**
Niassa	Muembe	0	1	2	3	0	1	2	3	4	4	4	4	2	2	1	3	0	0	0	0	6	8	9	13	36	9.0	4,607	1	**10.0**
Niassa	Ngauma	0	1	2	3	0	1	3	3	4	4	4	4	0	0	0	3	0	0	0	0	4	6	9	13	32	8.0	8,213	2	**10.0**
Niassa	Mandimba	0	1	2	3	0	1	2	2	4	4	4	4	0	0	1	3	0	0	0	0	4	6	9	12	31	7.8	9,311	2	**9.8**
Niassa	Majune	0	1	2	3	0	0	3	3	0	4	4	4	0	0	1	4	1	1	1	1	1	6	11	15	33	8.3	3,991	1	**9.3**
Niassa	Lago Niassa	0	1	2	3	0	0	1	1	4	4	4	4	1	2	2	4	0	0	0	0	5	7	9	12	33	8.3	533	0	**8.3**
Niassa	Cidade De Lichinga	0	1	2	3	0	0	1	0	4	4	4	0	0	0	0	0	0	0	0	0	4	5	7	3	19	4.8	476	0	**4.8**

		U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D	U	P	R	D				Value SHS	
Cabo Delgado	Namuno	0	1	2	3	0	1	3	3	3	2	2	3	1	2	1	4	2	2	2	2	6	8	10	15	39	9.8	9,990	2	**11.8**
Cabo Delgado	Montepuez	0	1	2	3	0	0	3	4	2	2	2	3	0	0	0	4	2	2	2	2	4	5	9	16	34	8.5	8,821	2	**10.5**
Cabo Delgado	Chiure	0	1	2	3	0	1	3	3	1	1	1	2	0	0	0	3	2	2	2	2	3	5	8	13	29	7.3	11,819	3	**10.3**
Cabo Delgado	Mueda	0	1	2	3	0	1	3	3	2	3	3	2	0	0	0	3	1	1	1	1	3	6	9	12	30	7.5	9,910	2	**9.5**
Cabo Delgado	Macomia	0	1	2	3	0	0	3	3	1	2	2	2	0	2	1	3	1	1	1	1	2	6	9	12	29	7.3	5,124	2	**9.3**
Cabo Delgado	Balama	0	1	2	3	0	0	3	3	3	3	3	3	0	0	1	3	0	0	0	0	3	4	9	12	28	7.0	5,865	2	**9.0**
Cabo Delgado	Palma	0	1	2	3	0	1	3	2	3	3	3	3	0	0	0	3	1	1	1	1	4	6	9	12	31	7.8	3,574	1	**8.8**
Cabo Delgado	Muidumbe	0	1	2	3	0	1	3	3	2	2	2	2	0	0	1	3	1	1	1	1	3	5	9	12	29	7.3	1,970	1	**8.3**
Cabo Delgado	Meluco	0	1	2	3	0	1	3	3	0	1	1	2	0	2	1	3	1	1	1	1	1	6	8	12	27	6.8	2,052	1	**7.8**
Cabo Delgado	Nangade	0	1	2	3	0	1	3	0	3	3	3	0	0	0	0	0	2	2	2	2	5	7	10	5	27	6.8	3,893	1	**7.8**
Cabo Delgado	Ancuabe	0	1	2	3	0	1	3	0	1	1	1	0	0	0	0	0	2	2	2	2	3	5	8	5	21	5.3	7,687	2	**7.3**
Cabo Delgado	Ibo	0	1	2	3	0	0	1	3	1	1	1	1	2	3	2	3	1	1	1	1	4	6	7	11	28	7.0	132	0	**7.0**
Cabo Delgado	Mocimboa Da Praia	0	1	2	3	0	0	2	2	2	2	2	2	0	0	0	3	0	0	0	0	2	3	6	10	21	5.3	3,452	1	**6.3**
Cabo Delgado	Quissanga	0	1	2	3	0	0	2	0	1	1	1	0	0	0	0	0	0	2	2	2	2	3	4	7	5	19	4.8	2,330	1	**5.8**
Cabo Delgado	Metuge	0	1	2	3	0	0	2	0	0	0	0	0	0	0	0	0	2	2	2	2	2	3	6	5	16	4.0	1,354	1	**5.0**
Cabo Delgado	Mecufi	0	1	2	3	0	0	3	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	2	6	4	13	3.3	1,052	1	**4.3**
Cabo Delgado	Cidade De Pemba	0	1	2	3	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	3	4	5	14	3.5	-	0	**3.5**

ANNEX 2-D: ESTIMATED AGRICULTURAL PRODUCTIVE USE SOLAR MARKET FUNDING NEEDS

AGRICULTURAL PUE APPLICATIONS – IRRIGATION											
Non-Equipped Irrigation Potential (hectare)[295]	X	20%[296] X 19.1%[297]	=	Off-Grid Smallholder Irrigation Potential (hectare)	Divided by 1 hectare[298]	=	Estimated No. of Irrigation Kits Needed	X	$650 unit cost[299] / life of system (6 years) X 9 years	=	Estimated Funding Needs for Off-Grid Solar Irrigation
AGRICULTURAL PUE APPLICATIONS – AGRICULTURAL PROCESSING											
Cereals, roots, tuber crops (tons)[300]	X	30%[301] X 50%[302] X 19.1%[303]	=	Off-Grid Smallholder Milling Potential (tons)	Divided by 55 tons per year milling capacity	=	Estimated No. of Solar Mills Needed	X	$1,625 Unit Cost[304] / life of system (10 years) X 9 years	=	Estimated Funding Needs for Off-Grid Solar Milling
AGRICULTURAL PUE APPLICATIONS – COOLING											
Milk, fish and horticultural production (tons)[305]	X	33%[306] X 50%[307] X 19.1%[308]	=	Off-Grid Smallholder Sales Potential (tons)	Divided by 2.5 tons per year milling capacity per trader per year	=	Estimated No. of Traders Needing Cooling System	X	$825 Unit Cost[309] / life of system (6 years) X 9 years	=	Estimated Funding Needs for Off-Grid Solar Cooling

ANNEX 2-E: SUMMARY OF FIELD RESEARCH

The field research mission to the provinces included three main activities in each province:

(1) Meetings with FUNAE delegates and local government officials to obtain provincial GIS data on off-grid schools and health facilities;
(2) Surveys of private sector companies/SMEs selling off-grid solar products and systems in the provinces (both formal and informal sector companies); and
(3) Focus group meetings with consumers of off-grid solar products and systems.

The survey that was administered to off-grid solar suppliers is included below, followed by a summary of the off-grid community focus group activities in each province.

SUPPLIER SURVEY

General Information Questions

1. What is your name?
2. Please provide the best email address to contact you for follow-up questions.
3. What is the name of your business?
4. How would you categorize your business?
    a. Solar electric system vendor
    b. EE appliance and equipment vendor
    c. Productive-use appliance and equipment vendor
    d. Other (please specify)
5. Where is your business located?
6. In what provinces are your clients located?
    a. Cabo Delgado Province
    b. Gaza Province
    c. Inhambane Province
    d. Manica Province
    e. Maputo City
    f. Maputo Province
    g. Nampula Province
    h. Niassa Province
    i. Sofala Province
    j. Tete Province

295 AQUASTAT – Food and Agriculture Organization: http://www.fao.org/nr/water/aquastat/data/query/index.html?lang=en
296 Assumption that 20% of Non-Equipped Irrigation Potential will be exploited by non-subsistence smallholder farmers
297 Assumption that by 2030, 68% of the population will be covered by the main grid while 12.9% will have mini grid access and the remainder 19.1% served by stand-alone solar systems.
298 Average Size of Smallholder farm. See: "Lessons Learned in the Development of Smallholder Private Irrigation for High Value Crops in West Africa," World Bank, (2011): http://siteresources.worldbank.org/INTARD/Resources/West_Africa_web_fc.pdf
299 180W solar pumping kit: https://shop.futurepump.com/products/sf2h-solar-pump?variant=40457377546423
300 Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF
301 Assumption that 30% of the production of the crop types most relevant for agro-processing is in smallholder farmer production systems; See: https://www.lightingglobal.org/wp-content/uploads/2019/09/PULSE-Report.pdf, p. 52
302 Assumption that 50% of produce is sold directly to large-scale processors
303 Assumption that by 2030, 68% of the population will be covered by the main grid while 12.9% will have mini grid access and the remainder 19.1% served by stand-alone solar systems.
304 See: https://www.lightingglobal.org/wp-content/uploads/2019/09/PULSE-Report.pdf, p. 53
305 Food and Agriculture Organization: http://www.fao.org/faostat/en/#data/RF and https://data.worldbank.org/indicator/ER.FSH.PROD.MT
306 Assumption that one-third of produce types most relevant for refrigeration and cold storage is traded through small-scale trade; See: https://www.lighting-global.org/wp-content/uploads/2019/09/PULSE-Report.pdf, p. 4
307 Assumption that 50% of produce is traded immediately and do not need direct storage; See: https://www.lightingglobal.org/wp-content/uploads/2019/09/PULSE-Report.pdf, p. 54
308 Assumption that by 2030, 68% of the population will be covered by the main grid while 12.9% will have mini grid access and the remainder 19.1% served by stand-alone solar systems.
309 See: https://www.lightingglobal.org/wp-content/uploads/2019/09/PULSE-Report.pdf, p. 55

k. Zambezia Province

7. If known, in what districts are your clients located?

Questions about the business

8. What products and services do you offer that are related to solar energy or the efficient use of electricity (e.g., solar home system, solar pump, energy efficient appliances, installation, operation and maintenance, etc.)?
9. Who are your customers?
    a. Residential/households
    b. Commercial/industrial
    c. Government/public sector
    d. Agriculture/farming/productive-use
    e. Other (please specify)
10. What brands of these products do you sell?
11. At what prices do you provide these products or services?
12. How many units of your primary product do you sell in an average month?
13. What other businesses do you collaborate with that are important to the success of your company (e.g., your wholesalers, sales agents, installers, financiers,
14. Are there enough trained technicians to help install or repair the products that you sell?

Perceptions of the business

15. Is your business difficult? Is it hard to sell your products or services?
16. What do people in your area think about solar energy products, like home systems or pumps?
17. What strategies do you use to increase your sales?
18. Do you sell on credit or work with a microfinance institution?
19. If you sell on credit, what are the terms (i.e., interest rate, number of payments, etc.)
20. Is there a reason you don't sell on credit?

Obstacles, challenges and opportunities

21. What are the major problems that your business faces?
22. Have you ever received a loan from a bank or microfinance institution?
    a. Yes
    b. No
23. If you wanted a loan, could you get one?
    a. Yes
    b. No
24. If you wanted to secure a loan, what bank or microfinance institution would you be likely to use?
25. If you could get a loan, how much would you ask for?
26. What interest rate could you afford, and over what period of payback?
27. What problems do your collaborators (e.g., your wholesalers, sales agents, installers, financiers, etc.) face in their businesses?
28. Do you sometimes buy from your wholesaler on credit?
29. What makes you optimistic about the future of your business?
30. What advice would you give to the government to help you grow your business?

OFF-GRID COMMUNITY FOCUS GROUP MEETINGS

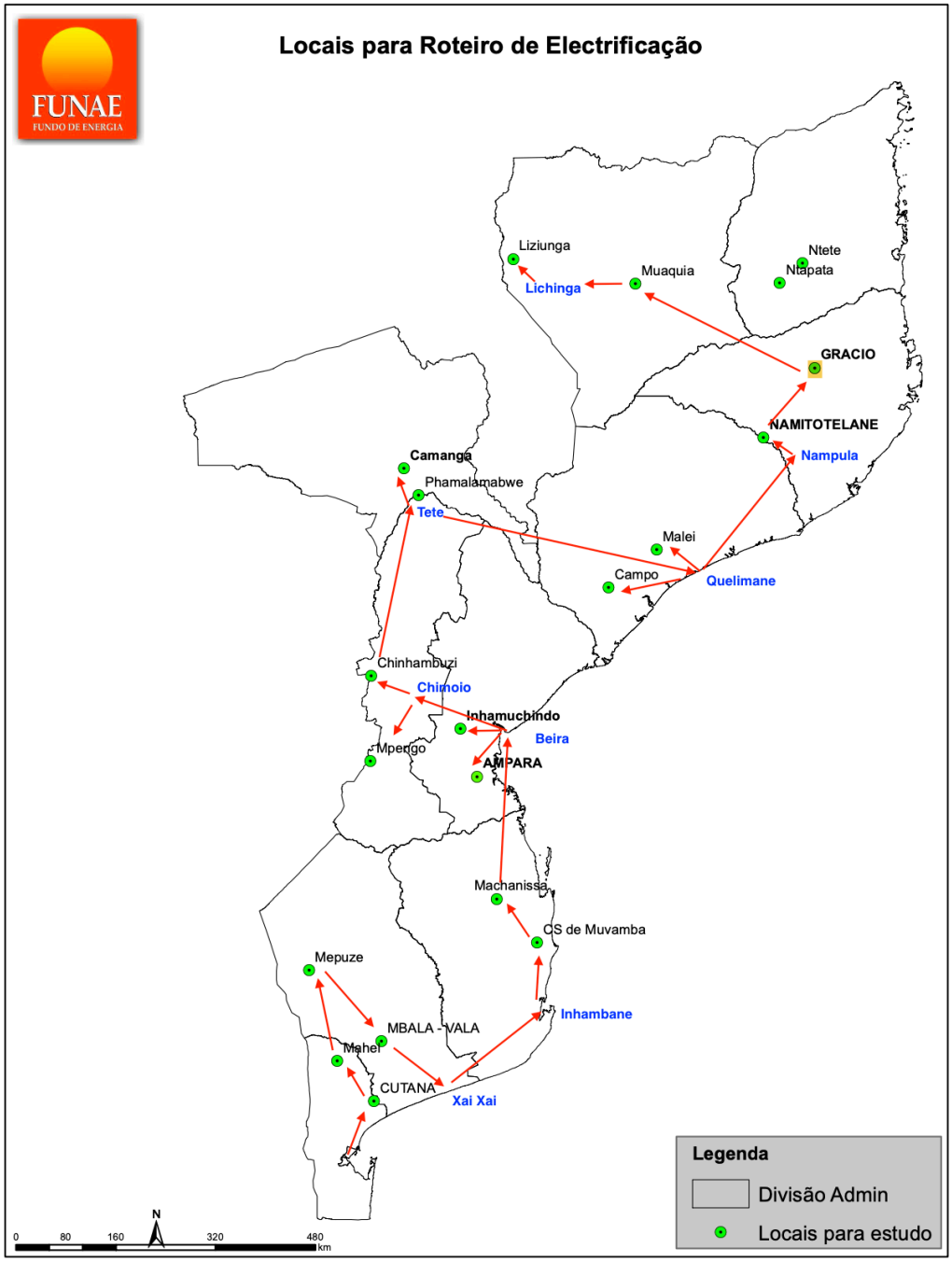
	No. of focus group meeting participants	
	Female	**Male**
Maputo	62	27
Gaza	27	24
Inhambane	42	50
Sofala	15	31
Manica	36	59
Tete	63	56
Zambezia	25	53
Nampula	15	35
Niassa	37	59
	322	**394**
%	**45%**	**55%**

A total of **716 household consumers** across nine (9) provinces – Maputo Province, Gaza, Inhambane, Sofala, Manica, Tete, Zambezia, Nampula, and Niassa (Maputo City and Cabo Delgado were excluded) – participated in the focus group meetings, with a gender balance of 55% male to 45% female.

A summary of the field research, including maps and photos from the mission to the provinces, is presented below.

PROVINCIA, DISTRITO, LOCAL AND KM

Província	Distrito	Local	Km
Maputo	Manhiça	Cutana	150
	Magude	Mahele Sede	229
Gaza	Guija	Mbalavala	260
	Mapai	Mepuzi	575
Inhambane	Massinga	Muvamba	137
	Vilankulo	Machanissa	150
Sofala	Buzi	Inhamuchindo	182
	Buzi	Ampara	211
Manica	Mossurize	Mpengo	195
	Manica	Chinhambuzi	85
Tete	Changara	Dinheiro	70
	Marara	Camanga	32
Zambezia	Mopeia	Posto campo	140
	Namacura	Malei	102
Nampula	Muecate	Gracio	130
	Murrupula	Namitotelane	100
Niassa	Majune	Muaquia	180
	Lago	Liziunga	85

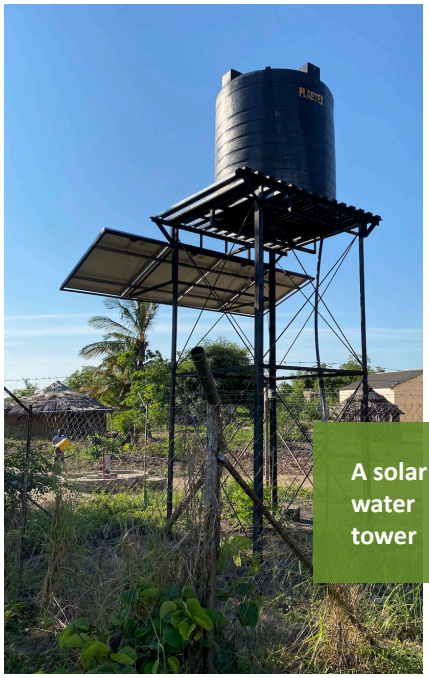


A grain mill in Inhamuchindo, Sofala Province

An informal market trader in Ampara, Sofala Province

Off-grid community focus group meeting in Cutana, Maputo Province

Off-grid solar lighting products sold at an informal market in Xai-Xai, Gaza Province



A solar water tower

Off-grid community focus group meeting in Machanissa, Inhambane Province

Chief of Administrative Post of Chinhambuzi, Manica Province

A local store operated by FUNAE in Inhamuchindo, Sofala

An administrative post in Mopeia-Posto Campo, Zambezia Province

Off-grid community focus group meeting in Malei, Zambezia Province

Off-grid community focus group meeting in Muecate -Gracio Nampula Province

Fish stored in a freezer in Murrupula -Namitotelane, Nampula Province. The fishing industry supports rural livelihoods in many rural and off-grid areas of Mozambique, with locals relying on fishing both for subsistence as well as modest income. The fishing sector can benefit from off-grid electrification, as solar-powered ice boxes/ refrigeration can be utilized by rural communities to store fish for consumption and sale.

Off-grid community focus group meeting in Liziunga, Niassa Province

ANNEX 3: STAKEHOLDER CONTACT LIST

Below is an alphabetized list of the organizations and key stakeholders that were consulted with during the course of the assignment.

Organization	Name of Contact	Position/Title
MAPUTO CITY / DONOR COMMUNITY		
AMER	Ricardo Pereira	President
AMOMIF	Francisco António Souto	President
BCI Mozambique	Epifânia Stella Ernesto Gove	Principal
BlueZone Consultores	Ana Catela	Managing Director
BRILHO/SNV	Javier Ayala	Team Leader
BRILHO/SNV	Pedro Moleirinho	Renewable Energy Consultant
Enabel	Mark Hoekstra	Rural Project Development Manager
ENGIE Energy Access	Nikita Smeshko	Operations and Strategy Director
Epsilon Energia Solar	Anton Arkhipov	Managing Director
European Union	Jesus Gavilan Marin	Energy Programme Officer
GIZ Get.invest	Jose Mestre	Technical Advisor
GIZ/EnDev	Maria del Rosario Fischer	Team Leader
GreenLight Mozambique	Boris Atanassov	Director
KfW	Steffen Beitz	Portfolio Manager
Norwegian Embassy	Endre Ottosen	First Secretary, Energy
SIDA	Samer Fayadh	Senior Advisor, Energy and Infrastructure
SolarWorks	Arnoud Vroomen	Managing Director and Founder
SolarWorks	Nuno Lopes	Director
Sunkofa	Irene Calvé Saborit	Co-Founder and Director
Sunkofa	Antoine Verye	Co-Founder and Chief Financial Officer
UK FCDO	Sergio Dista	Private Sector Development
UNIDO	Jaime Comiche	Country Representative
UNIDO	Vincente Matsinhe	National Project Coordinator
USAID	Maggie Northman	Energy Team Leader
USAID	Armando Abacar	Energy Project Manager
MAPUTO PROVINCE		
FUNAE	Herminio Massingue	Focal Point
Dynamiss Trading	Eric Laborda	Managing Director
Kadambo	Moises Paco	Director
Digiteh	Agostinho Massarongo	Managing Director
GAZA PROVINCE		
FUNAE	Herminio Massingue	Focal Point
Direccao de Infra-estruturas de Gaza	Alberto Matusse	Provincial Director
Solarworks!	Antonio Covane	Sales Agent
INHAMBANE PROVINCE		
FUNAE	Luis Machava	Focal Point
ENGIE Energy Access	Augusto Munguambe	Sales Agent
Logos Industries	Fernando Maundze	Shop Manager
MANICA PROVINCE		
FUNAE	Osvaldo Maguessere	Focal Point

Electro Leo & Servicos	Ricardo Pitroce	Director
MONFER	Monica Silva	General Director
SOFALA PROVINCE		
FUNAE	Domingos Jemusse	Focal Point
FDC DURABAL	Amilton Jacob	Sales Agent
TETE PROVINCE		
FUNAE	Antonio Chamuca	Focal Point
Kuanga Electronicos	Julio Gomes	Managing Director
ZAMBEZIA PROVINCE		
FUNAE	Mariolizio Guimaraes	Focal Point
Saja Trading	Jamal Lasmin	Sales Agent
Baling International	Antonio Suleman	Sales Agent
NAMPULA PROVINCE		
FUNAE	Miguel Totoca	Focal Point
Logos Industries	Francisco Manuel Ferro	Sales Agent
ENGIE Energy Access	Amina Rabaju Assane	Administrative Official
Solarworks!	Evelien Rietdijk	Solar Pumps Specialist
Ignite	Peter Ruwizhu	Focal Point
NIASSA PROVINCE		
FUNAE	Paulino Nimone	Focal Point
FUNAE	Victor Raul	Provincial Delegate
SOCIN, Lda	Joele Samuel	Sales Agent
CABO DELGADO PROVINCE		
FUNAE	Mario Toca	Focal Point

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