



Market Map for Off-grid Solar Energy in Zambia

This team has worked to evaluate energy access from the ground up in Zambia.



This report is the culmination of a year-long research project evaluating how to stimulate private sector investment in Zambia's off-grid energy space. Sponsored by **Duke University's Bass Connections and the Energy Access Project**, the team included a diverse array of undergraduate students, graduate students, faculty, and staff. Over the course of a year and two trips to Zambia, the team has met with **over forty stakeholders** from the government, private sector, development agencies, and non-profits. Their resulting work evaluates the **willingness-to-pay** for electricity of consumers across Zambia, features a fully-built and operational **geospatial modeling tool**, and with this report, analyzes the environment for off-grid solar development.

Zambia Market Map Outline

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Market Overview

Electrification Overview

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Stakeholder Analysis

Consumer Data

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Challenges for Solar Off-grid Developers

Sector-wide Challenges

SHS Company Challenges

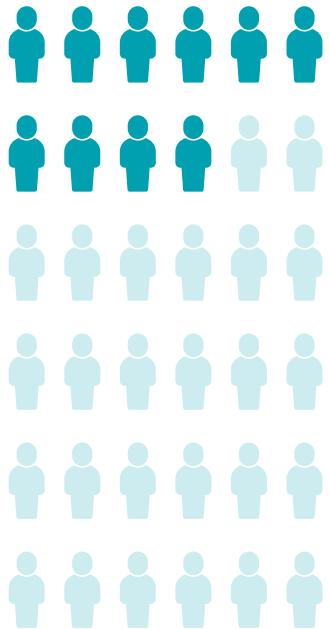
Mini-grid Developer Challenges

Section 1

Market Overview

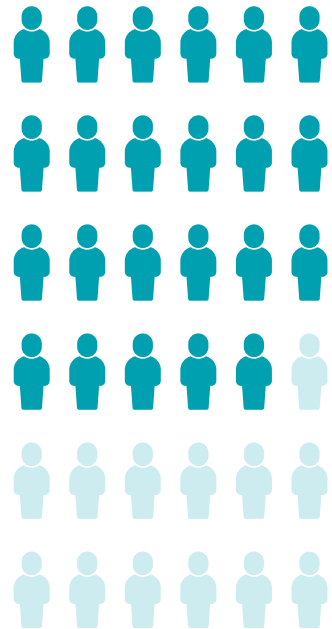
Electrification Rates in Zambia

27.0%



**Total Share
Electrified**

62.0%



**Urban Share
Electrified**

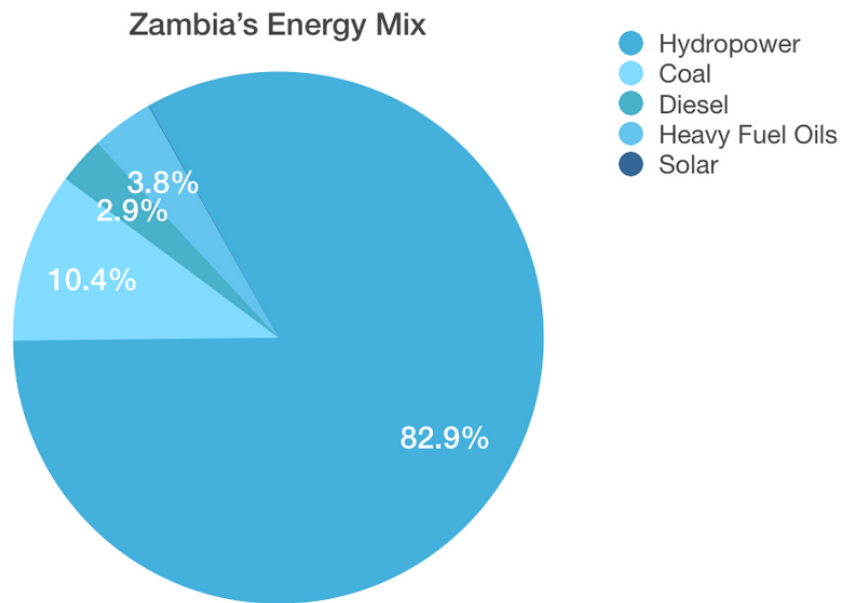
4.5%



**Rural Share
Electrified**

- Major divide between urban and rural populations
- Mining sector: main energy consumer
- Main source of energy: hydropower
- Vertically-integrated state-owned power utility, ZESCO

Energy Mix and Trajectory of Solar Use



- **Droughts have highlighted the need for energy diversification.**
 - The total installed capacity by the end of 2016 was 2740 MW. In a 2016 drought, the energy deficit rose to 1000 MW.
 - Copper industry given priority electricity dispatch, yet they still faced a one-third energy cut.
- **ZESCO aims to increase diversification and trade efforts with other countries like Botswana and Zimbabwe.**

Source: [Reuters](#), [ZESCO](#), Energy Regulation Board Sector Report 2016

Stakeholders: Government Agencies



ZAMBIA
MINISTRY
OF ENERGY

Ministry of Energy

Facilitates energy studies with government funding to meet goal of electrifying 51% of households



ZESCO

Government utility that handles generation, transmission, distribution, and supply of electricity



ERB

Regulates **ZESCO** and the electricity industry by handling both licensing and tariff-setting procedures



REA

Provides oversight on government sponsored projects to advance equitable rural electrification access



Off-Grid Energy Task Force

Embedded in the **Ministry of Energy** to facilitate dialogue with the private sector with aims to improve off-grid energy markets

Stakeholders: Donors & Implementation Partners



U.S. Agency for International Development (USAID)

Assists US Embassy and World Bank on energy sector reform; Finances the **Southern Africa Energy Program** and **US Power Africa** initiative with aims to electrify more people in Sub-Saharan Africa



Swedish International Development Cooperation Agency (SIDA)

Provides access to financial services and clean energy for Zambian farmers; Finances the **Beyond the Grid Fund for Zambia**



German Society for International Cooperation (GIZ)

Works with Zambian government to resolve issues of public finance, including budget preparation and implementation



World Bank

Contributes to the national electrification plan and provides a bail-out program to Zambian government when necessary



Renewable Energy & Energy Efficiency Partnership (REEEP)

Manages the **Beyond the Grid Fund for Zambia** which aims to increase clean energy access and accelerate private-sector growth in energy distribution

Stakeholders: Major Solar Home System and Mini-grid Companies

Fenix Solar

Reached 30,000 Zambian households in nine months.
Owned by ENGIE.

Sigora

Intl' with Zambian branch

Vitalite

Est. in 2013 with first PAYGO model in Zambia.

Muhanya Solar

Largest mini-grid company in Zambia.
3 completed grids.

Standard Microgrid

Power Corner

Owned by ENGIE; one mini-grid in Zambia thus far.

Blue: Solar Home System Company, Orange: Mini-grid Company

Circle size denotes a rough estimate company size, relative to competitors in the solar home system OR mini-grid industry, and their reach in Zambia based off of our meetings with them and online data.

Major Solar Home System Companies in Zambia

Company Name	Description
Fenix Solar	Utilize extensive network of local employees to infiltrate rural areas with their SHS pay-as-you-go model. Fenix International was recently acquired by Engie, which also owns Power Corner. Expanded from Uganda to Zambia in early 2018 and has reached over 150,000 Zambians since. Received funding from Power Africa and Beyond the Grid Fund Zambia.
Vitalite Solar	Sells SHS products, cookstoves, and smartphones with pay-as-you-go model. Vitalite developed an app to manage PAYGO financing for solar and productive use products. Received from Power Africa and Beyond the Grid Fund Zambia.

Major Mini-grid Companies in Zambia

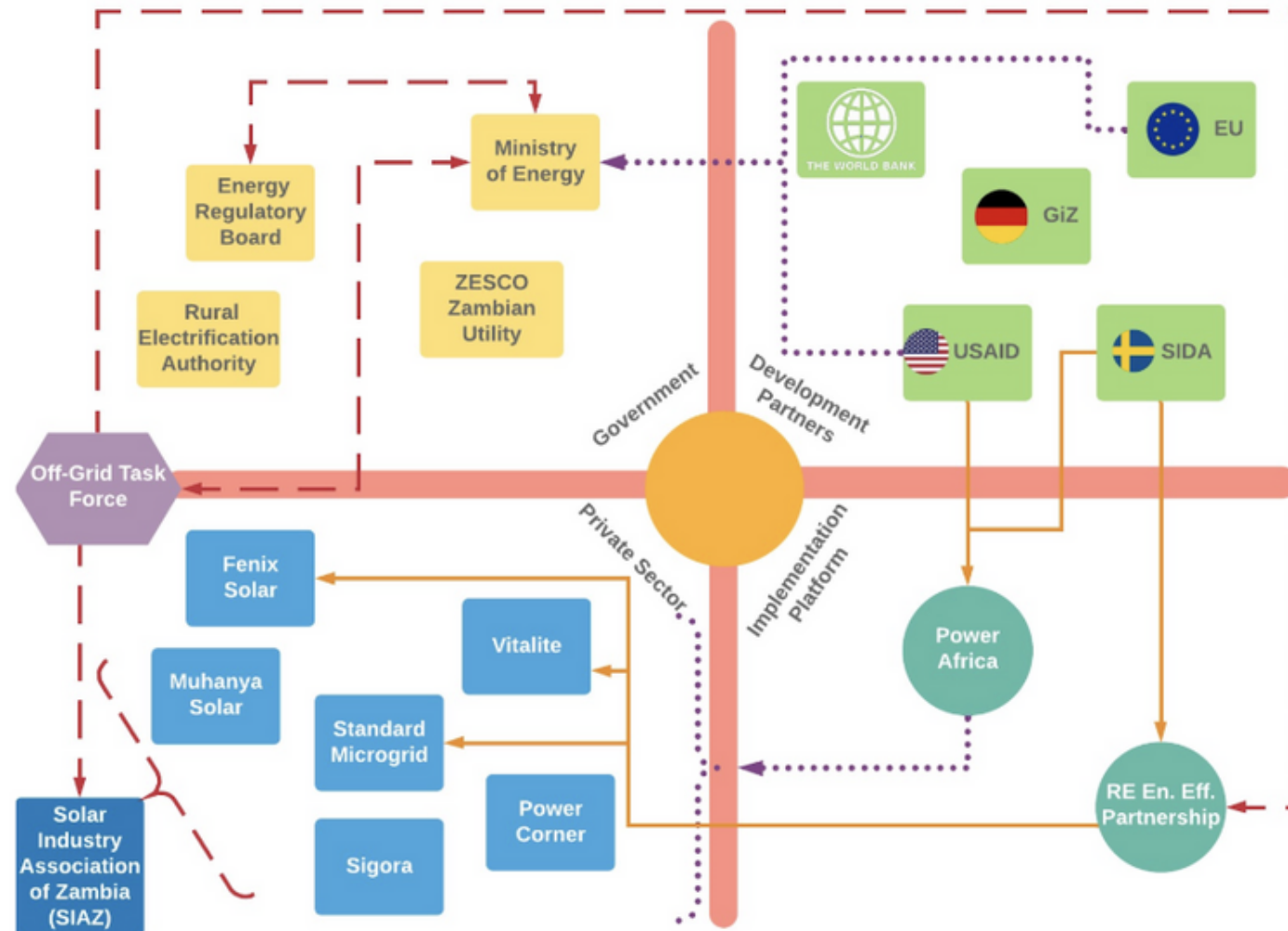
Company	Description
Standard Microgrid	Has standardized a 20 kW microgrid system through which electricity sold in hour blocks for specific applications, rather than pay as you go for unlimited access. They have built 5 systems.
Power Corner	A subsidiary of Engie, commissioned its first Zambian mini-grid in April 2019. Has 13 completed or in construction mini-grids in Tanzania and Zambia and aims to build 2,000 systems by 2025.
Muhanya Solar	Provides a range of solar products and has also constructed a 30 kW mini-grid after receiving a \$100,000 grant from U.S. African Development Foundation in 2017. PAYGO model which deploys agents to collect fees.
Sigora International	Subsidiary of US based Sigora Solar, which is developing a smart meter enabled with mobile payments, anti-theft technology, wifi distribution and more. Smart meter is marketed to energy companies. It's Zambian pilot mini-grid is a 50 kW system serving 213 households with a PAYGO model.

Section Two

Market and Stakeholder Analysis

Stakeholder Map: Off-Grid Energy in Zambia

- Grant Funding
- Technical Support
- Coordination



Funding Programs: Beyond the Grid Fund for Zambia

BGFZ is a program that will run from 2016-2020 that aims to provide energy access to 1M users, electrifying 167k households.

- **€20M results-based social impact procurement fund**
- **Incentivizes rollout and scaling up in areas otherwise seen as non-viable markets**
- **Increases lending capacity of banks to off-grid ventures**

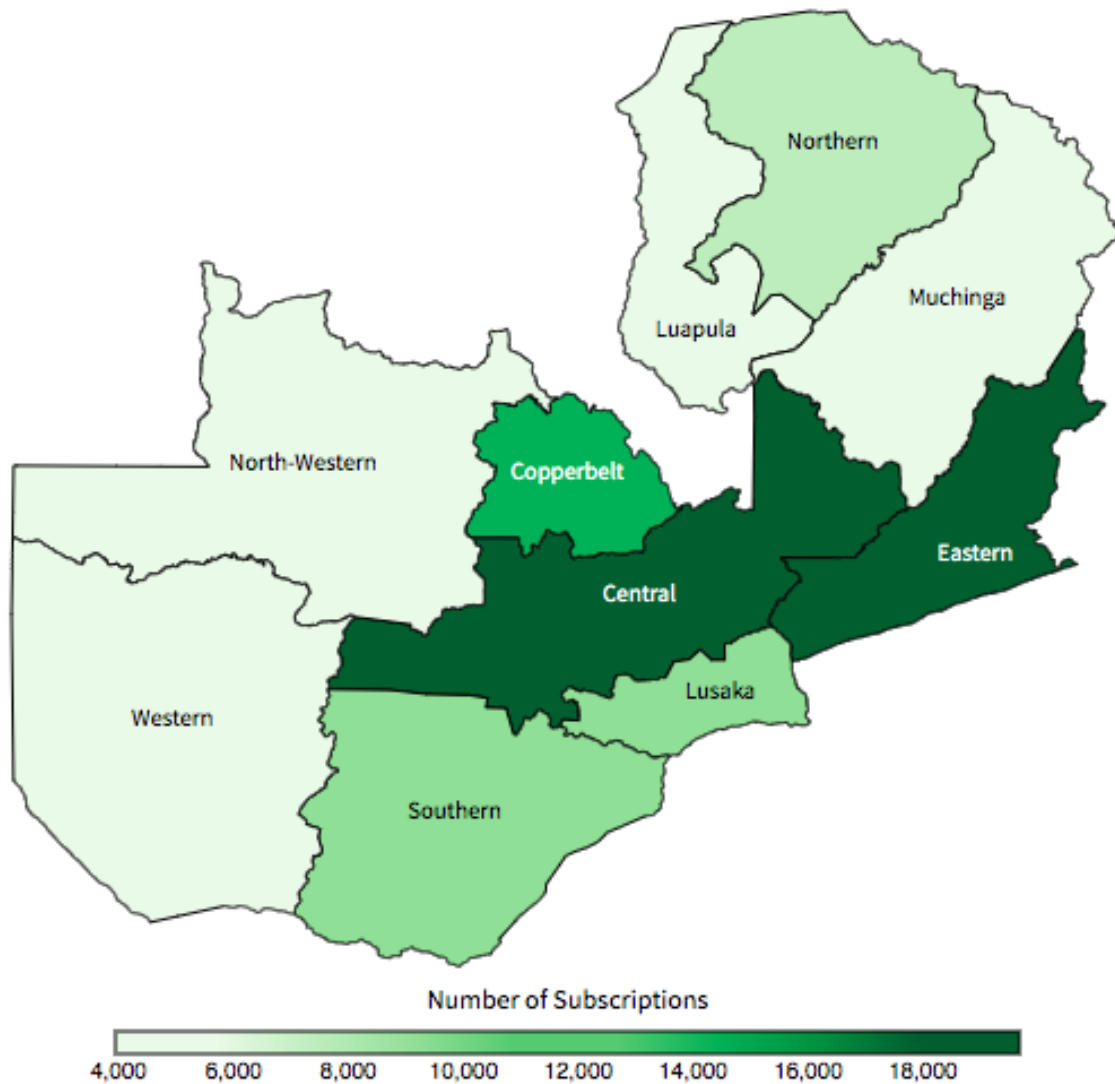
Part of **USAID Power Africa** initiative



Funded by Swedish Embassy and **SIDA**

Managed by **REEEP**





BGFZ has already connected 100,000 households and created over 1,000 jobs

- Partners with four companies: **Fenix Intl.**, **VITALITE Zambia**, **Emerging Cooking Solutions**, and **Standard Microgrid**
- Uses results-based financing to incentivize companies to enter under-served areas
- Over 95% customers rated products/services as 'good' or 'very good'
- Around 25% customers have initiated new income-generating activities since connection
- Around 87% customers spending less on lighting and power
- Beyond the Grid Fund for Africa announced with €48M to bring access to 5M people in Burkina Faso, Liberia, Mozambique, and Zambia

Sources: [EDISON](#) Real-time Data, [BGFZ](#) Press Release (10 April 2019)

Other Funding Sources for Private Companies

Power Africa

- 2017: In partnership with the U.S. African Development Foundation provided \$100,000 to Muhanya Solar
- 2017: With support from the U.S. Trade and Development Agency, funded a feasibility study for 150 mini-grids with Standard Microgrid.

Africa Enterprise Challenge Fund (UK Department for International Development)

- 2018: Granted \$1.6 million to Kazang Solar to provide 7,000 Azuri Quad brand SHSs to rural households. Parent company Kazang has the largest network of vending machines in Zambia.

The Energy and Environment Partnership covering Southern and East Africa (EEP Africa)

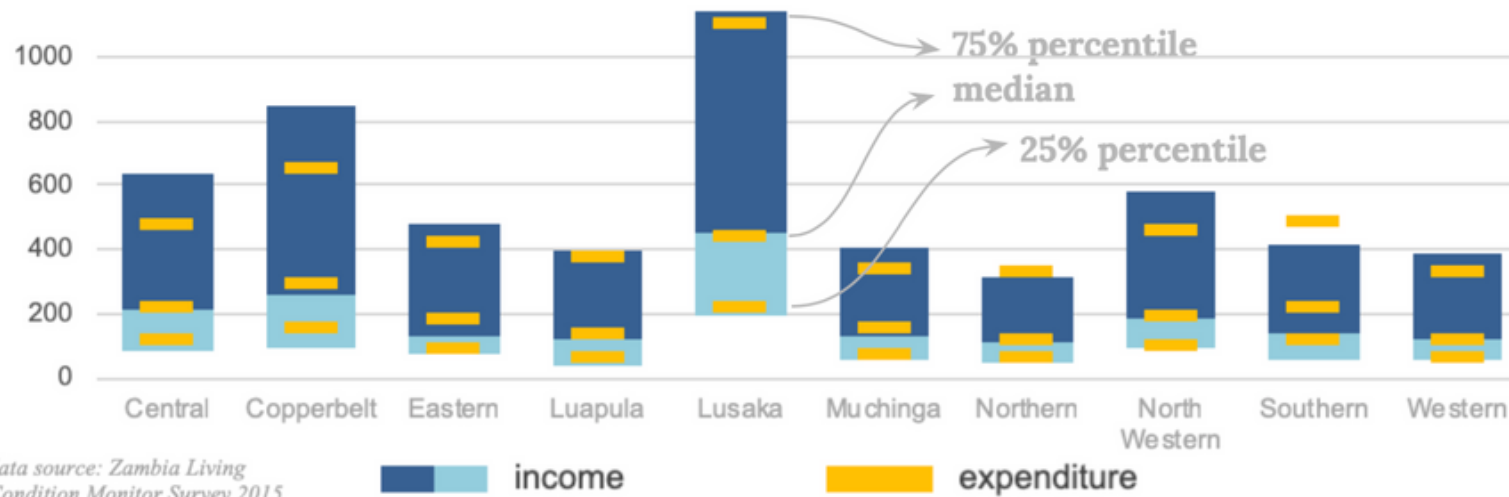
- Provided over 3.3 million EUR in grant funding to renewable energy companies in Zambia, including Vitalite and Emerging Cooking Solutions

EU Electrification Financing Initiative

- Pending: The European Development Fund, the primary EU aid instrument, plans to distribute 40 million EUR to support renewable energy in Zambia, some of which will support private sector companies through loans and grants.

Consumer: Zambian Households

Household per capita monthly Income and expenditure



data source: Zambia Living Condition Monitor Survey 2015

USAID Zambia SHS Affordability Survey



data source: USAID SAEF, 2018

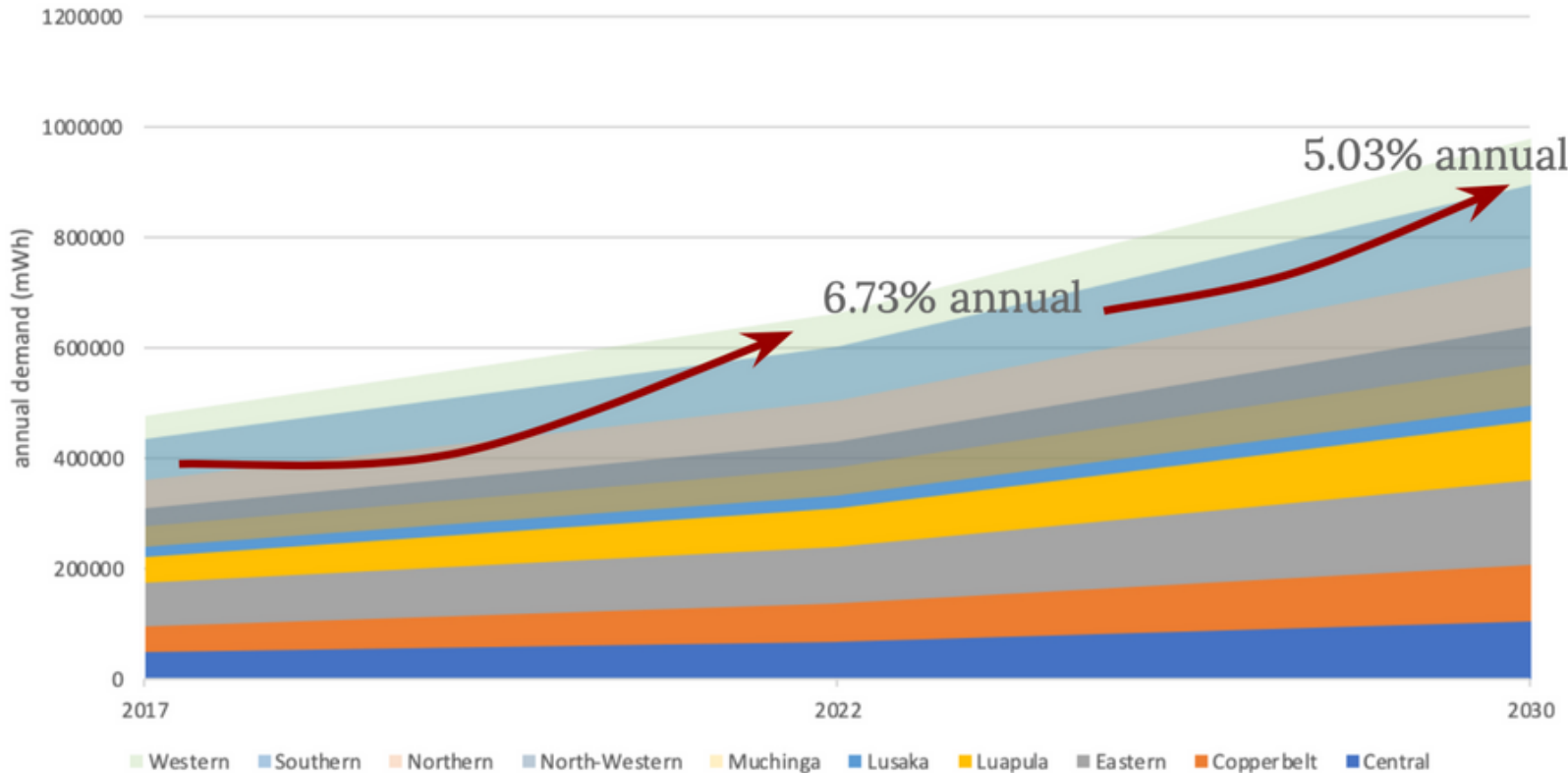
Consumer affordability is a fundamental concern for sustainable market growth

2015 Zambia Living Condition Monitor Survey revealed a low saving rates. On a monthly average basis, the majority of households usually spend most of their income without much to spare.

In 2018 Power Africa household survey, overall more than 60% of surveyed households cited affordability as the main barriers to own an SHS products at a price range of 130-340 kwacha (~ USD 10.2 to 26.7 today)

Consumer: Electricity Demand growth projection

2017-2030 Housholds Demand Growth Projection

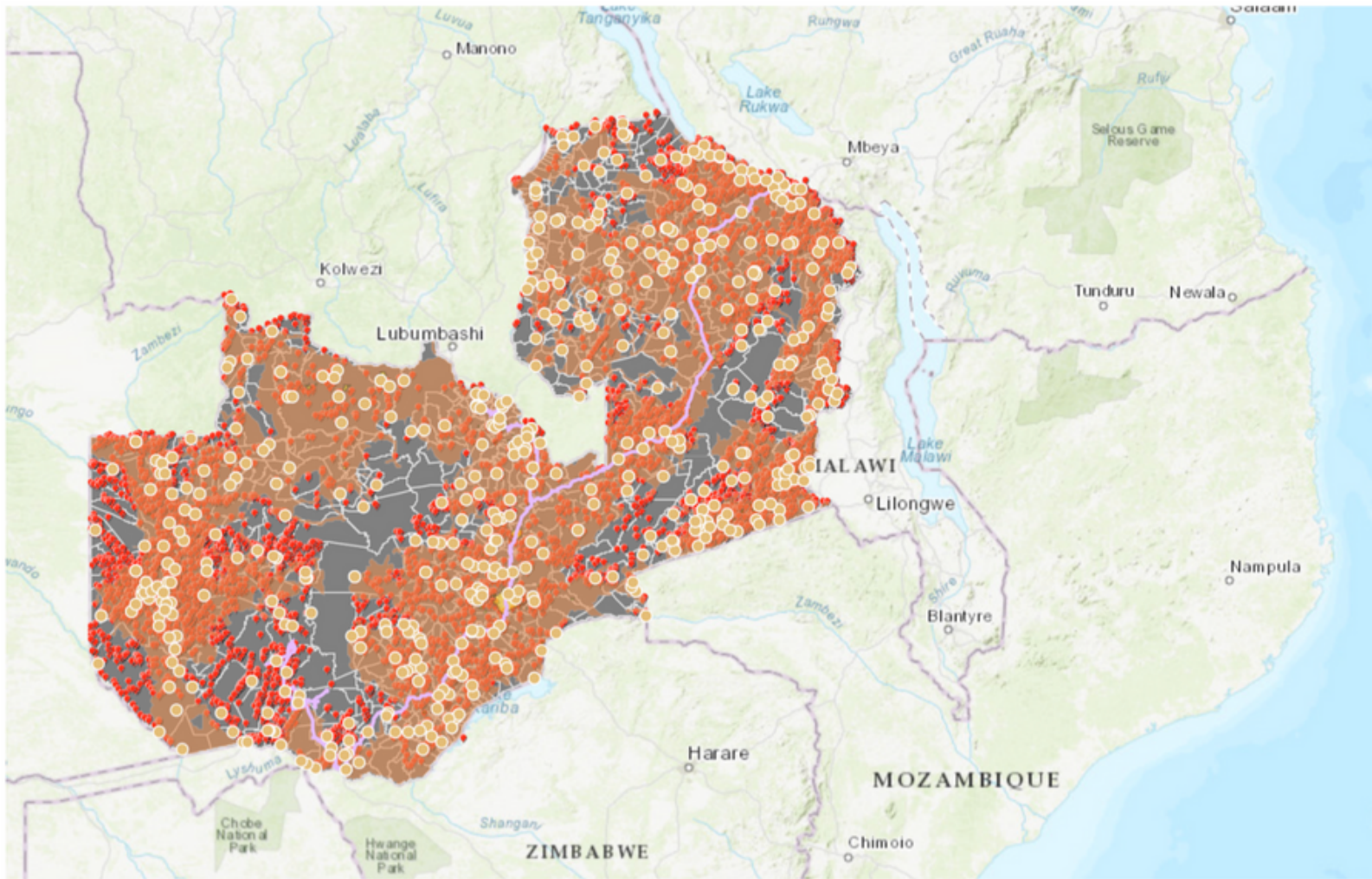


Base case electricity demand growth in Zambia indicates a huge gap in grid electricity sources

Based on the baseline estimates without significant changes in household productivity use, the annual residential demand growth rate from 2017 to 2022 is projected to be 6.73%, and the annual rate from 2022 to 2030 is 5.03%, which remains stable.

Data source: USAID SAEP
geospatial model

Basic market development conditions



Orange shades: cell phone coverage **Yellow dots:** health clinic (can served as anchor loads) **Pink line:** railroad connectivity

Poor connectivity poses challenge for service channel expansion

Apart from affordability, lack of road connectivity in the rural areas slows down the market expansion for off-grid companies.

Stable and relatively larger demand of load can serve as anchor load for a mini-grid site. Health clinics are usually indicators for the presence of anchor load. The relatively low density of health clinics is another potential challenge for quick service deployment expansion.

Section Three

Off-grid Solar Sector Challenges

Sector-Wide Market Challenges

- 1 Lack of concerted government rural electrification agenda**
- 2 Integration of indigenous and foreign owned companies**
- 3 Lack of cost reflective electricity tariffs**

Sector Wide Market Challenges: Lack of concerted government rural electrification agenda

Through its Electricity Services Access Programme (ESAP) the World Bank is facilitating the formation of a National Electrification Program (NEP) for Zambia which aims to refine electrification targets, clarify government agency roles, and set investment and financing targets for the public and private sector. However, private sector developers are concerned a 2019 NEP launch will not be met or, if rolled out, that the NEP will have sufficient stakeholder buy-in to effectively coordinate electrification efforts.

The Rural Electrification Authority (REA) has not published the 2017-2021 Five Year Rolling Plan for rural electrification, which is meant to guide the government rural electrification strategy. Without this document, private sector developers are unaware of REA funding priorities and the locations where off-grid energy access projects will be developed.

SOURCE: NEP WORKSHOP PRESENTATION, 1ST OCTOBER 2018



Sector Wide Market Challenge: **Integration of indigenous and foreign owned companies**

The Beyond the Grid Fund Zambia (BGFZ) incentivized foreign companies, like Fenix International, to enter Zambia's off-grid solar market. The BGFZ funding reduced the relative risk of investment for these companies.

To apply for BGFZ funding, a strong track record of success and substantial financial assets were required, which effectively excluded most indigenous Zambian companies. Many Zambian developers expressed concern that, not only are they effectively unable to apply for funding like the BGFZ, but they are also disadvantaged by the financial support given to foreign companies, which already have extensive financial resources. It is argued that supporting indigenous companies develops domestic business capacity and that domestic companies create business models and products tailored to the Zambian context.

Sector Wide Market Challenge: **Lack of cost reflective electricity tariffs**

Zambia has one of the most underpriced electricity tariffs in Africa. The Energy Regulation Board of Zambia (ERB) approves tariffs for ZESCO (the main grid utility company) and off-grid developers. Beneficially, the ERB's case by case tariff calculations can offer mini-grid operators much needed flexibility in their cost and profit structure by setting off-grid tariffs based on an individual community's ability to pay. However, the non-cost reflectivity of ZESCO tariffs has distorted the electricity market and, some private sector developers suggest, lowered consumer willingness to pay for off-grid electricity.

Source: Batidzirai et al, "Willingness to pay for improved electricity supply reliability in Zambia" 2017, University of Cape Town.

Source: Stakeholder Interviews, March 2019

Solar Home System Market Challenges

- 1 **Low quality solar products on market**
- 2 **Inconsistently applied import tariffs not reactive to solar product development**
- 3 **Low mobile phone and mobile money penetration**

SHS Market Challenge: **Low quality solar products on market**

Vitalite and Fenix International are the top providers of SHS in Zambia. Both provide multi-year warranties for their products and staff internal call centers to provide high quality customer service to their clients.

However, many generic, lower-quality SHSs and solar products are sold without warranty or any means of redress if the device malfunctioned, which happened frequently. The sale of low quality solar products weakens the demand for all similar products. Also low quality products are often cheaper than products sold by branded companies like Fenix, which can skew the perspective of SHS value for the market as a whole.



SHS Market Challenge: Inconsistently applied import tariffs not reactive to solar product development

Technically, the import duty on solar products, like solar batteries and power inverters, is waived in Zambia. In reality, the policy is not applied consistently due to misunderstanding or misinterpretation of solar products. An example given by a SHS developer was that while a simple solar panel may be exempted, a panel with a component attached, like a battery, might be taxed if the customs agent is unfamiliar with the device. Classification of solar products, and resulting import duties, varies by entry port and customs agent. This scenario increases the risk of product innovation because new products may not be exempted from tariffs, which increases developer costs, potentially rendering products unprofitable.

SHS Market Challenges: Low mobile phone and mobile money penetration

Mobile pay-as-you-go models are commonly used by SHS companies to reduce the upfront cost of systems, which is essential when serving populations without access to formal financial services and credits. SHS companies in Zambia also encounter consumers who own mobile phones, but were uncomfortable with mobile banking and preferred to make in person payments. However, in person payments are not always possible, especially to customers living in remote areas or with mobility issues.

As of 2018, telecom leaders Airtel and MTN Zambia had a combined 2.3 M active mobile bankers in a country of over 12 M people. Mobile and banking penetration are generally lower among rural communities, a key demographic of SHS developers. Comparatively, in Tanzania 71% of adults own a mobile phone and 63% use mobile money.

Source: Malakata, Michael "[Airtel Zambia leading race for Zambia's mobile money space](#)" 2018, ITWEB Africa.

Mini-grid Market Challenges

- 1 **Slow and inconsistent licensing procedure**
- 2 **Jurisdiction and risk of grid encroachment**
- 3 **Lack of access to project financing**
- 4 **Lack of anchor clients and productive use of electricity**

Mini-grid Market Challenge: **Slow and inconsistent licensing procedure**

POLICY CHANGE

In March 2019 the ERB released an adapted mini-grid licensing framework. These policies govern the situations in which exclusive and non-exclusive rights to generate and distribute electricity are granted to mini-grid developers and operators.

On paper, policies exist to facilitate licensing for off-grid operators, but implementation is inconsistent. For example, it is the responsibility of the Office for Promoting Private Power Investment (OPPPI) to approve and support private sector energy projects greater than 20 MW. However, one mini-grid developer described needing to have their under 50 kW project approved by the OPPPI, which was unexpected and delayed project implementation. While the March 2019 policy changes are a promising sign, all government agencies involved in the off-grid energy space must internalize and comply with these policies if they are to have their intended impact.

Mini-grid Market Challenge: **Jurisdiction** **and risk of grid encroachment**

POLICY CHANGE

In March 2019 the ERB released technical standards for mini-grid which mandate that systems have the technical capability to integrate with the main grid. These standards are in a trial phase, but have the potential to codify the sale and generation of electricity between mini-grids and the main grid, which could allay some developer concerns regarding grid extension.

Establishing a mini-grid requires a large upfront investment, especially in terms of infrastructure costs. It can take over 5 years to make a return on capital investments. Profitability of a mini-grid can be compromised when the main grid reaches a community where mini-grids are already established. It is difficult for mini-grid developers to anticipate where the grid will expand because lines can be constructed for political purposes or in response to client demand.

In one case, a developer in Zambia constructed a mini-grid only for the ZESCO grid to build a line nearby in response to demand from an anchor client. The financial sustainability of the mini-grid was adversely impacted. Most Zambian mini-grid developers identified enforceable jurisdiction rights, in which they could receive compensation if their exclusive right to generate electricity for a community is infringed upon, as necessary to attract investment and scale their businesses.

notes: I am a bit confused by the word “encroachment”. Does it somewhat imply the expansion is beyond the proper limits? I think grid extension itself essentially is not a very bad thing and the problem in Zambia is probably “unclear extension plan” or “uncertainties in implementation”. “Encroachment” is a bit confusing also because it sometimes has very different meaning in the electricity sector.

Mini-grid Market Challenge: **Lack of access to project financing**



Lack of access to project financing is a barrier to mini-grid companies the world over and Zambia is no exception. Donor funding has been essential in supporting mini-grid projects thus far, but it is unlikely to meet future need. Mini-grid companies must scale to be profitable and, while grant funding has supported the deployment of several systems in Zambia, a company must scale to dozens if not hundreds of mini-grids before reaching profitability. Rather than periodic grant funding, mini-grid companies require consistent subsidies and access to capital to scale their operations, which will be necessary to reach Zambia's electrification targets.

Mini-grid Market Challenge: Lack of anchor clients and productive use of electricity

Mini-grid developers in Zambia seek to engage anchor clients and the business community as core clients due to their high and generally stable need for electricity. Telecom towers and large agro-processing facilities are examples of anchor clients while business clients range from barbers, to corner shops, to maize grinding operations.

However, mini-grid companies in Zambia have found these clients lacking or underdeveloped in the communities they hope to serve. Productive use of electricity generally requires durable equipment and, thus, access to financing which is not always available, especially for rural populations. In addition, establishing a business may require skills or knowledge not readily available in rural communities. One mini-grid company in Zambia expressed the concern that to tap the potential of productive use, they would have to provide business opportunities and support, not just electricity.

Market mapping: data for policy makers and companies



World Bank, ESMAP

NEP Least-cost mapping & models

As part of the National Electrification Programme, incorporate more robust agricultural needs assessment, load forecast, and electricity supply optimization to determine the least cost technology in different regions

National Multi-Tier framework Energy Access Household Energy Survey

Use multi-tier framework to set a baseline to electrification track progress; provide insights on reliability and quality of current electricity service



McKinsey&Company

USAID/McKinsey

Nation-wide willingness-to-pay survey

Currently conducting a nation-wide willingness-to-pay survey

Tailored Geospatial models

Input company-specific data in the least cost geospatial models, currently helping 4 off-grid companies select business sites



Zambia: Living Condition Monitor Survey

Household income, expenditure, poverty level, crop production and other socio-economic conditions