Zambia Off-Grid Market Selection App -User's Manual

Motivation

One of the most difficult tasks for an off-grid developer of electricity infrastructure, or an electrification system planner, is identifying new markets for expansion. Scouting potential markets is tedious, and data mining can be costly in terms of both time and resources.

Inspired by the USAID Geospatial Model designed by McKinsey & Company to determine the least-cost method of electrification, the Duke University team created this app as a screening tool for new developers in the Zambian energy space to identify new locations to expand into.

This tool gives off-grid developers the freedom to utilize their own criteria for factors important to their respective business models, and system planners the ability to consider different criteria and priorities. After the user specifies individual criteria (as outlined below), the tool then returns a visual layer highlighting wards (the smallest administrative division) or settlements that fit those criteria.

Besides this application, the Duke University team also aims to benefit the Zambian off-grid energy space by:

- Evaluating the policy landscape by examining policy and financial constraints for off-grid developers, recent policy developments of critical importance, and collaborative efforts to change policy within the off-grid community.
- Determining the willingness to pay for electrification in localities in Zambia by integrating data from both the Living Conditions Monitoring Survey and peer-reviewed models.

More information about the status of those processes can be found by reaching out to our team at the Duke Energy Access Project at energyaccess@duke.edu.

To Access the Application: http://bit.ly/2H4GLTY

*If the link above doesn't work on your tablet, please try the full link:

http://dukeuniv.maps.arcgis.com/apps/InteractiveFilter/index.html?appid=da7eb35238d244d8b35b61abbb1f2da0

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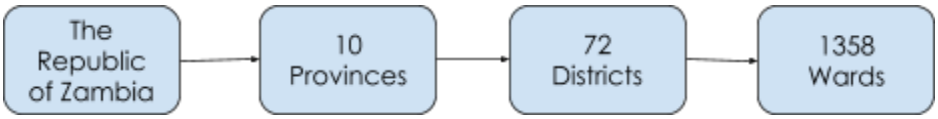
Application Usage

Overview

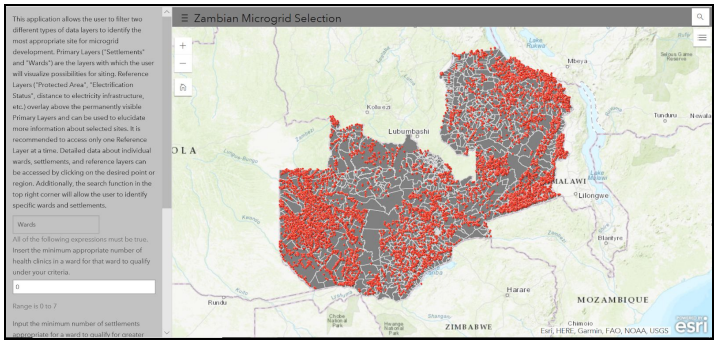
This application visualizes data using "layers," which are geographically oriented, interactive features that are embedded with pertinent information. There are two types of layers in the application. Primary Layers ("Settlements" and "Wards") are the layers with which the user will visualize possible future sites. They are tools that identify promising locations for off-grid electrification based on specific criteria. The other set of layers, Reference Layers, represent additional information about topography and existing infrastructure that is not easily visualized in the Primary Layers. For example, the quality of road structure and specifics regarding protected sites are two classes of information provided in Reference Layers.

Here is the geographic area hierarchy based on the administrative boundaries data we received:



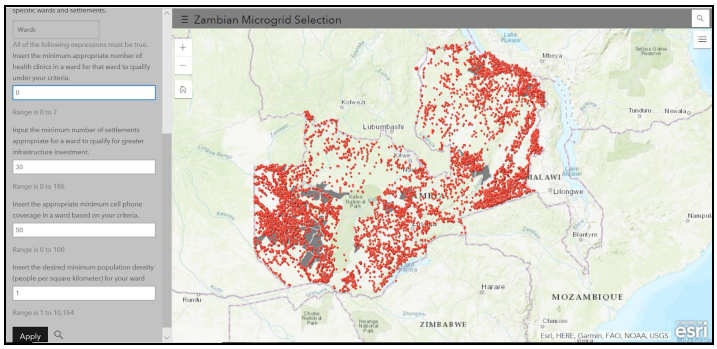
Story Map

Initial Screen



When the application is launched, the user will see the above image. In the top left corner, a description of the application explains the distinction between Primary Layers and Reference Layers. From this point, users can toggle between Primary and Reference Layers and input desired filter criteria for the Primary Layers.

Primary Layers



In either of the ward or settlement Primary Layers, users can enter (integer) numerical values describing specific criteria like population density or percentage cell phone coverage into the appropriate text boxes. After clicking the black "Apply" button, the app will display a mapping of wards and settlements (as shown above)

that fit the criteria entered in the filter. The image above depicts a ward filter showing results for a filter specifying at least 30 unique settlements within the ward, and 50 percent cell phone coverage. All the settlements points are also visualized, because no filter had been applied to the Settlement primary layer though they can be filtered similarly.

The application can identify appropriate wards based on:

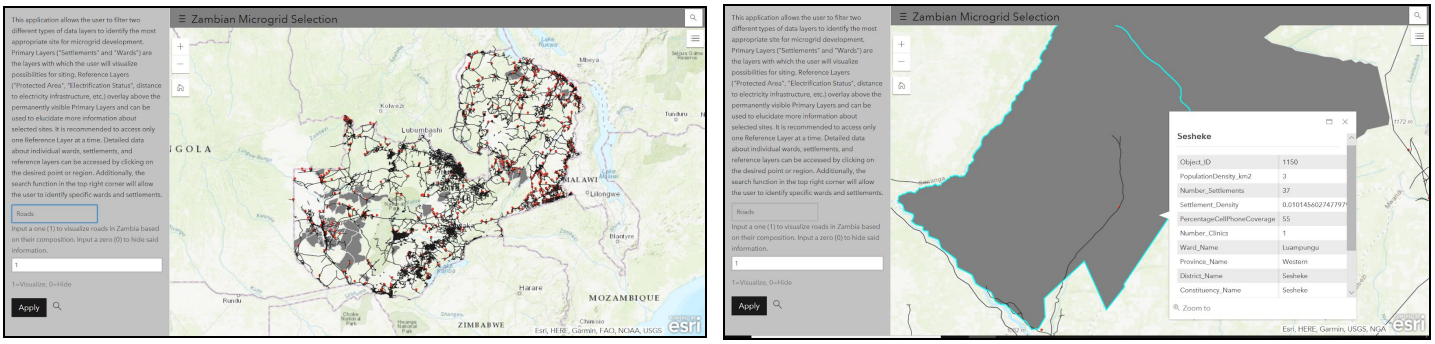
- Desired Minimum number of health clinics
- Desired Minimum number of settlements
- Desired Minimum percentage of mobile signal coverage
- Desired minimum population density
- Minimum price at least 50% of the population is willing to pay
- Minimum price at least 25% of the population is willing to pay
- Minimum price at least 10% of the population is willing to pay

The application can also filter appropriate settlements based on:

- Maximum distance from a railroad
- Maximum distance from a road
- Maximum distance from existing distribution lines
- Maximum distance from existing transmission lines
- Maximum distance from existing substations
- Whether a settlement is located within an electrified area
- Whether a settlement is located within a protected area

*See the Data Sources section below for a brief description of the above criteria.

Reference Layers and Detailed Data



The image on the left highlights the capacity of the application to visualize Reference Layers - in this case, the road network in the country. Reference Layers can be used specifically to interact with more detailed data, a feature that is also built into Primary Layers. Additional data can be mined by selecting a feature about which the user is curious, whether that be a ward (as in the image in the upper right), a settlement, or one of the Reference Layers. This information provides data that is useful in deciding between expansion to multiple viable sites when many might fit the Primary Layer criteria.

Current Reference Layers include existing electrical infrastructure (Transmission Lines, Distribution Networks, Substations), protected areas, electrified areas, mobile signal coverage, roads, railroads and health clinics.

Other Features

The search function allows users to identify data specific to a ward or settlement they may have some prior knowledge of. By typing the settlement or ward name into the search icon at the top right of the page, users can pull up demographic and topographic information for the specified ward or settlement. The app also allows users to zoom to specific wards/settlements after applying filters, so that viable sites based on the input criteria can be better visualized on the Primary layers.

Data Sources

Data	Year	Source	Description	Shown in the Application
Ward Boundaries	2006-2010	Election Commission of Zambia, Stanford University	The boundaries of the smallest administrative division	Ward-level
100m Population Density	2010	WorldPop Africa (Zambia) – School of Geography and Environmental Science, University of Southampton	We used 2015 estimates of people per hectare, unadjusted	Ward-level
GSM Signal Coverage	2015	ZICTA, Investment Profile	We digitized a PDF map with a resolution of 120 ppi	Ward-level
Health Clinics	2006	The World Bank Group	-	Ward-level
Willingness to Pay for Electrification	2019	Duke University Energy Access Project (Rob Fetter)	We calculated the WTP for solar home systems using benefits transfer approach	Ward-level
Electrification Status	2018	USAID Zambia Electrification Geospatial Model (USAID SAEP)	Electrified places were identified with presence of nighttime light emissions or with substation within 2km	Settlement-level
Substation	2018	USAID Zambia Electrification Geospatial Model (USAID SAEP)	-	Settlement-level
Distribution Lines (11kv)	2018	USAID Zambia Electrification Geospatial Model (USAID SAEP)	We only had good-quality data around Lusaka area	Settlement-level
Transmission Network (69 kV or above)	2014	African Development Bank and Open Street Map	We only used the existing transmission network	Settlement-level
Road Network	2018	UN World Food Programme, GeoNode	All road types are considered, including highway, primary road, secondary road, tertiary road, track and trail.	Settlement-level
Railroad	2007	DIVA-GIS	-	Settlement-level
Protected Area	2019	UNEP- WCMC. World Database of Protected Areas	Forest reserve, national park, ramsar site and world heritage site were regarded as protected areas	Settlement-level

Acknowledgment

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