WORLD BANK GROUP
Energy & Extractives

ENERGYDATA.INFO TRAINING

Naichen Zhao & Chris Arderne
World Bank Group

The Summer School on Modeling Tools for Sustainable Development
Trieste - June 14, 2017

Overview

1. World Bank Group – Open Data and Analytics Program
2. Using Advanced Data Techniques in Energy Planning
3. Why Open Data?
4. Using the ENERGYDATA.INFO Platform
5. Collecting, Improving and Validating Data

Overview

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Strategic Objective

Global WBG initiative with objective to…

"Make energy sector data, visualizations and modelling tools increasingly accessible to our teams, client governments, partners and other stakeholders"

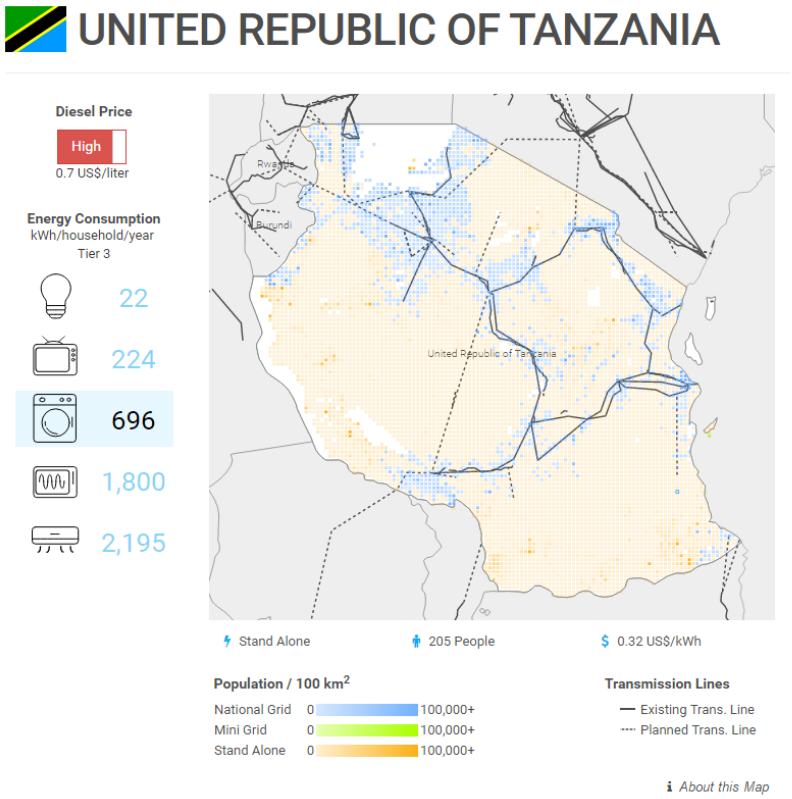
Data Analytics within the Energy & Extractives Sector

- Vast **increase in use of software and applications in recent years**, including national planning, monitoring, site selection and project design tools
- Based on more **detailed demand data** (i.e. bottom-up approach to modelling)
- **Dynamic**, with ability to adjust parameters and roll-out sequencing
- **Visualizations** provide a very useful stakeholders' engagement tool
- Inform **policy and investment decisions** with more precision
- Allows for a **transparent** balancing of infrastructure decisions
- **Long term trend** driven by (i) an exponential availability of **data**, (ii) increased availability of on-demand **computational power** through the cloud, (iii) increased availability of **open source software**, (iv) advancement in **analytical algorithms**.

National-level Energy Planning Analytics Examples

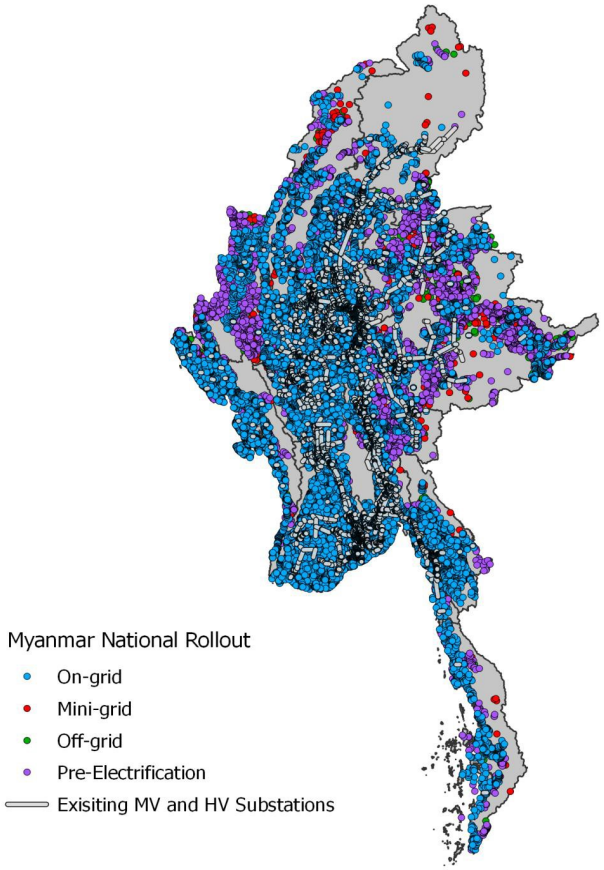
UN DESA - KTH University

(2030 universal access target)



Columbia University - Myanmar NEP

(2030 universal access target)



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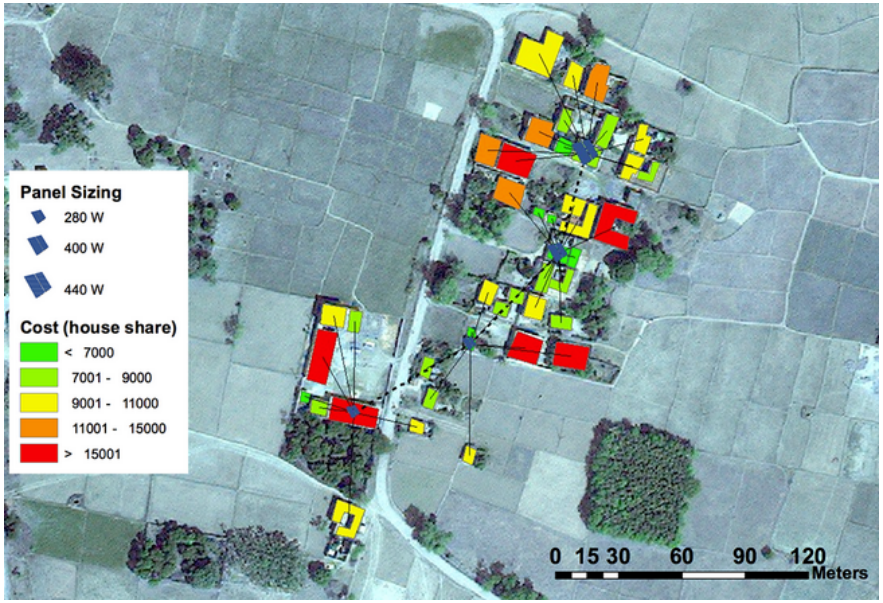
Project-level Energy Analytics Examples

MIT / Pontecomillas - GridForm

(Site selection and minigrid system design tool)



Powerhive – SWARM

(Private solution for sites' identification and selection)

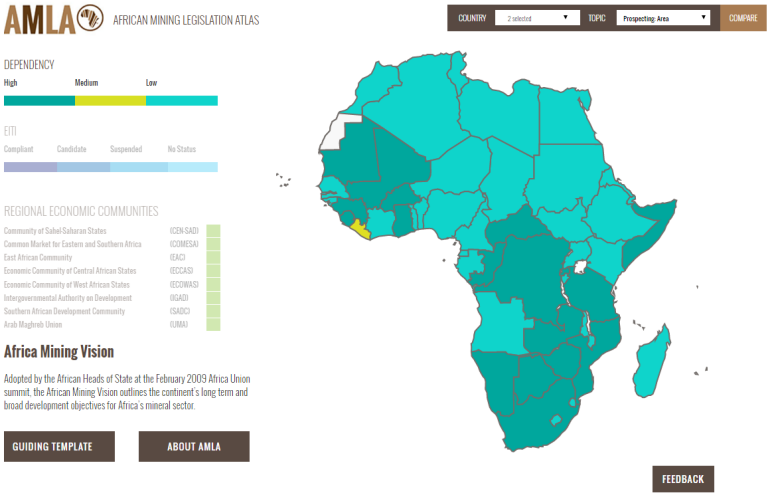
Site identification and selection

We can rapidly identify the best microgrid locations by using our proprietary SWARM software to remotely analyze sites based on financial, technical, and geospatial data. Whether an electrification project is for a single village or a large region, we can provide detailed site analyses that are ranked based on profit potential. When it's time for ground-truthing and customer acquisition, our software will streamline the process so that your team can work quickly and efficiently.

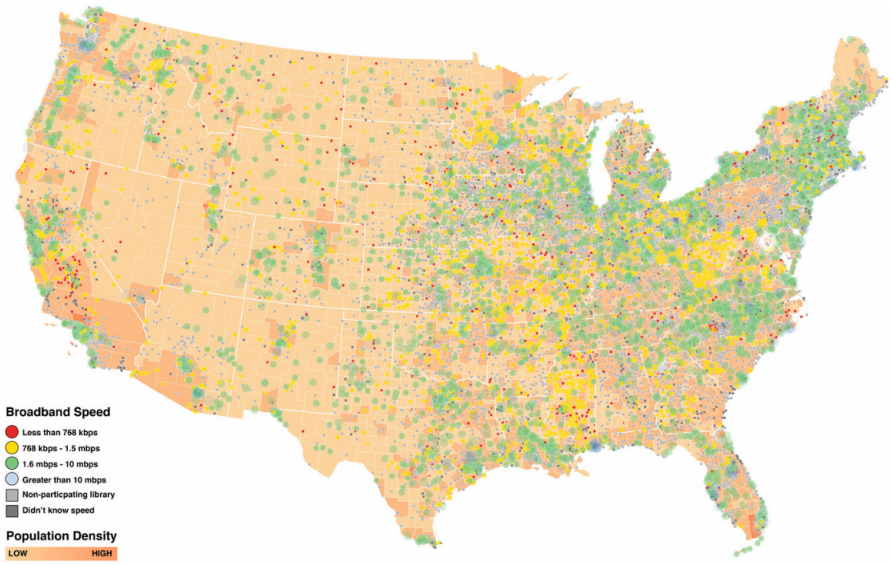
See also http://www.developmentmaps.org/ for a different example of private sector offerings in GIS analytics for off-grid site identification

Data Visualizations Examples

Regulations – IDB Climatescope & WB AMLA



Surveys – National & Subnational



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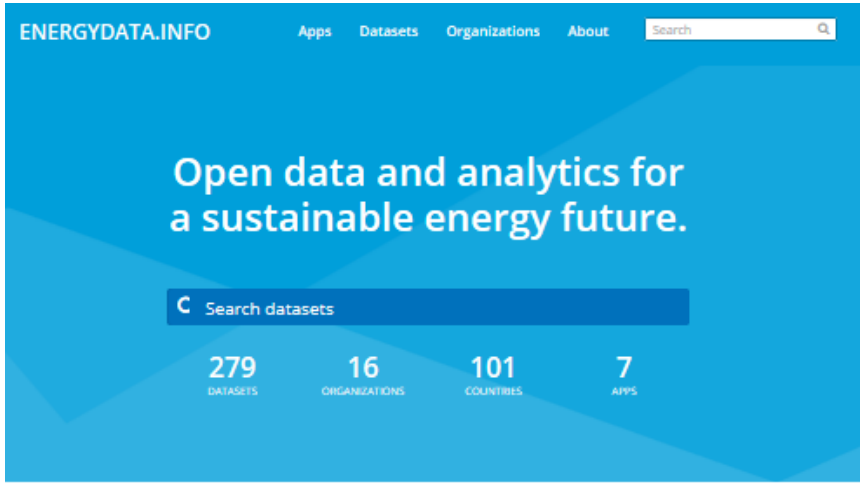
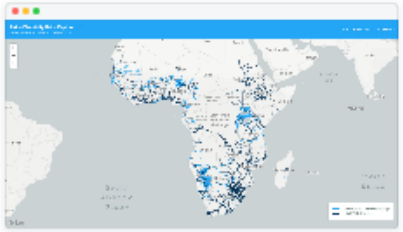
WBG EEX Open Data Platform - www.energydata.info

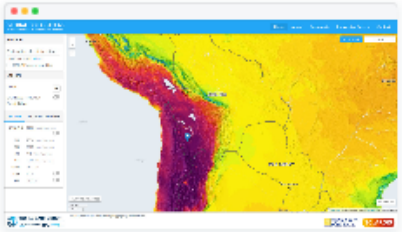


Featured Apps



Africa Electricity Grids Explorer

BY THE WORLD BANK GROUP



Global Solar Atlas

BY THE WORLD BANK GROUP

View all apps ›

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About ENERGYDATA.INFO

- **ENERGYDATA.INFO** is an **open data platform** providing access to datasets and data analytics that are relevant to the energy sector
- It has been developed as a public good available to governments, development organizations, non-governmental organizations, academia, civil society and individuals to **share data and analytics**
- Aimed at supporting the **United Nations' Sustainable Development Goal 7** of ensuring access to affordable, reliable, sustainable and modern energy for all

- The World Bank Group (WBG) strives to **enhance public access** to and use of data that can support development impact. The platform is designed according to open data and open source standards and principles
- It is powered by the **open-source** data portal platform CKAN, and it is developed publicly on GitHub. More information on CKAN and GitHub can be accessed at ckan.org and github.com

Data Partnerships

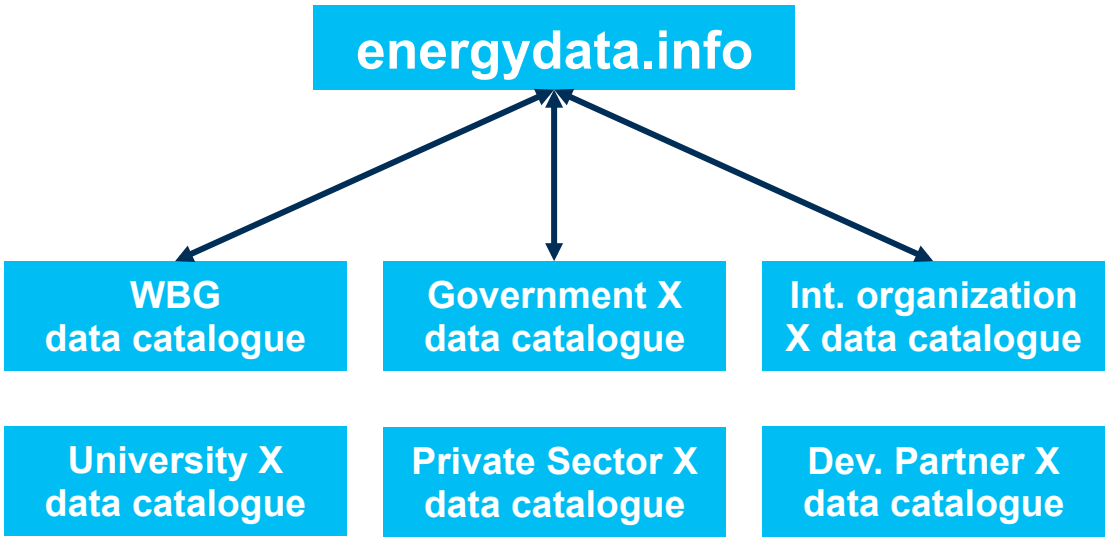
1 AGGREGATION

Governments, International organizations, research institutions and private sector stakeholders collect large amounts of data that is largely unavailable or scattered

2 COLLECTION

Big data and machine learning offer an opportunity to efficiently address data gaps at scale

3 PARTNERSHIP MODEL



WORLD RESOURCES INSTITUTE

UNDESA

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

giz

KTH VETENSKAP OCH KONST

orange

Massachusetts Institute of Technology

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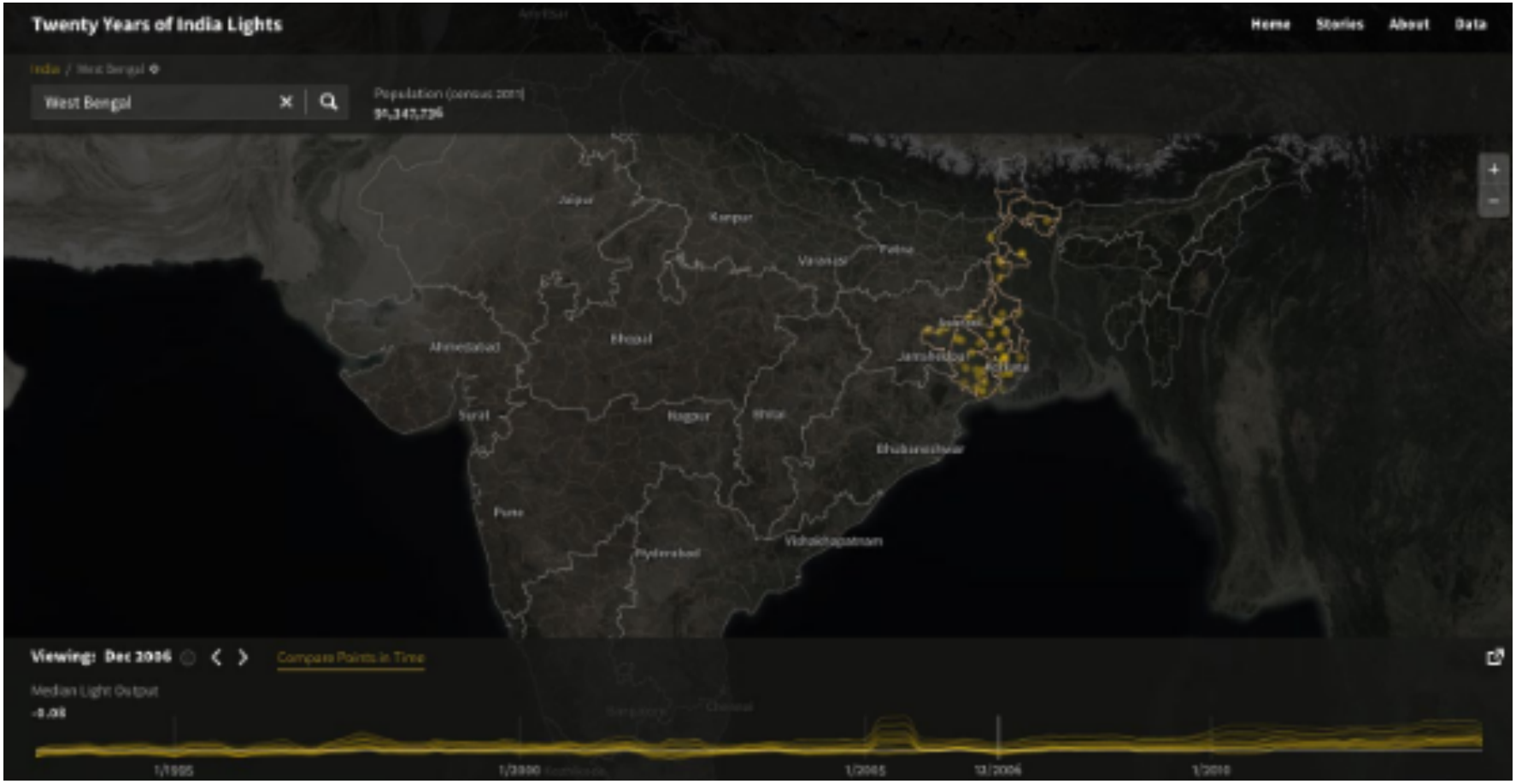
Tool 1: India Night Lights (WB)



Monitor rural electrification in 600,000 villages over twenty years. From space.

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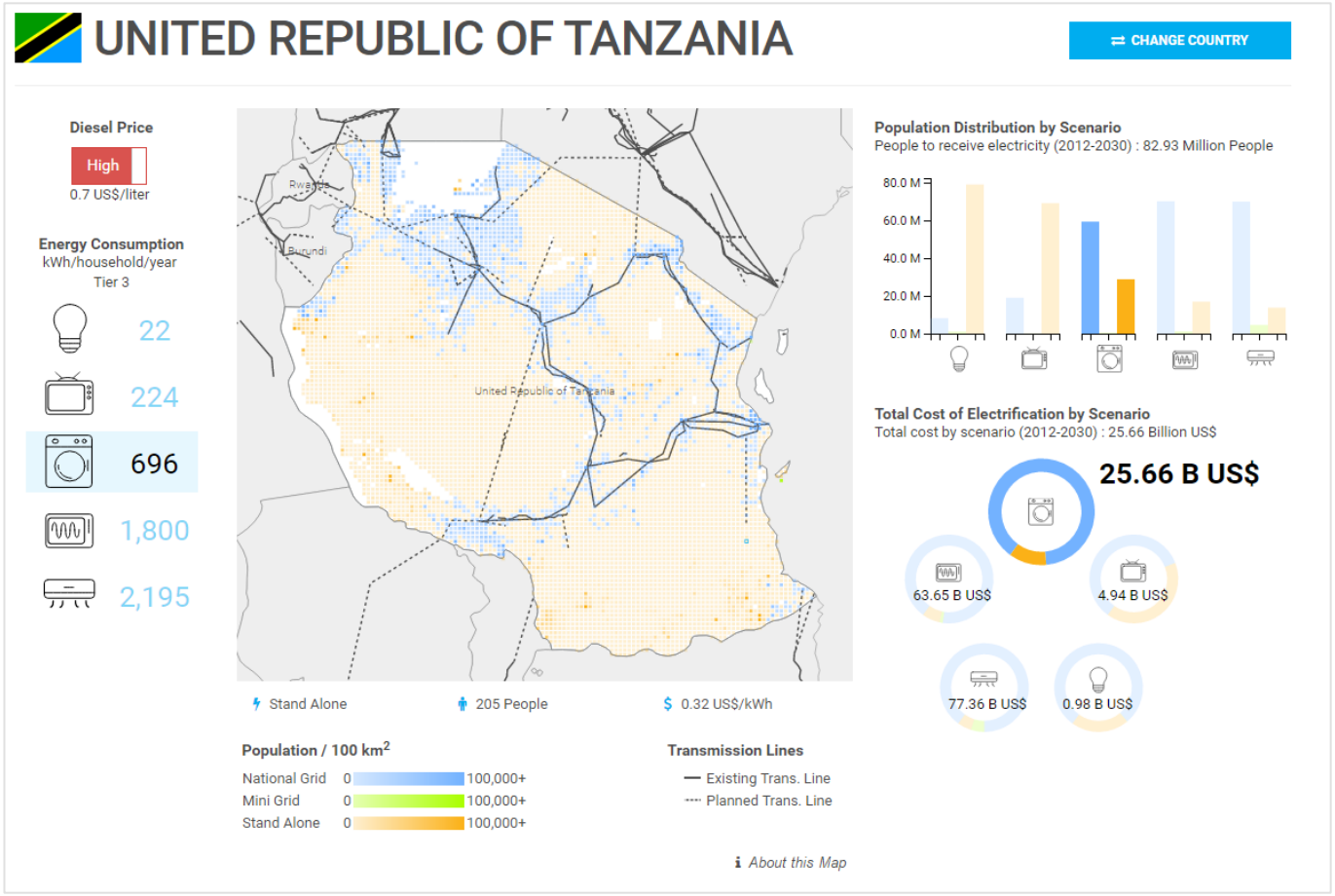
Tool 2: High Level Least Cost Options Plan (UN-KTH)



Estimate the mix of technologies that will provide universal electricity access at the lowest cost.

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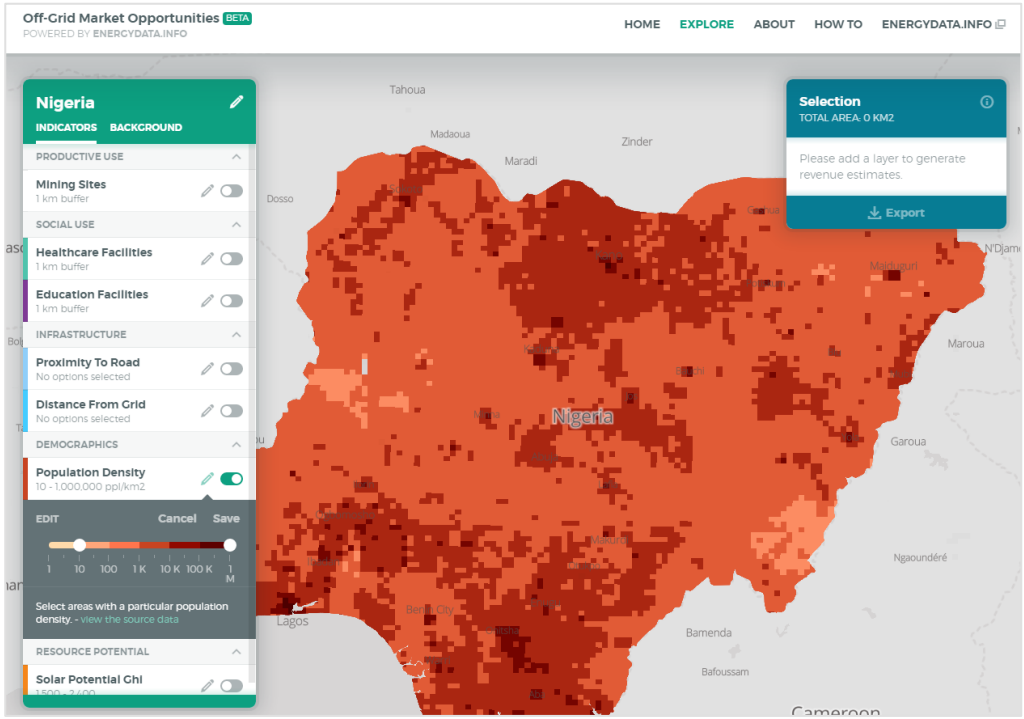
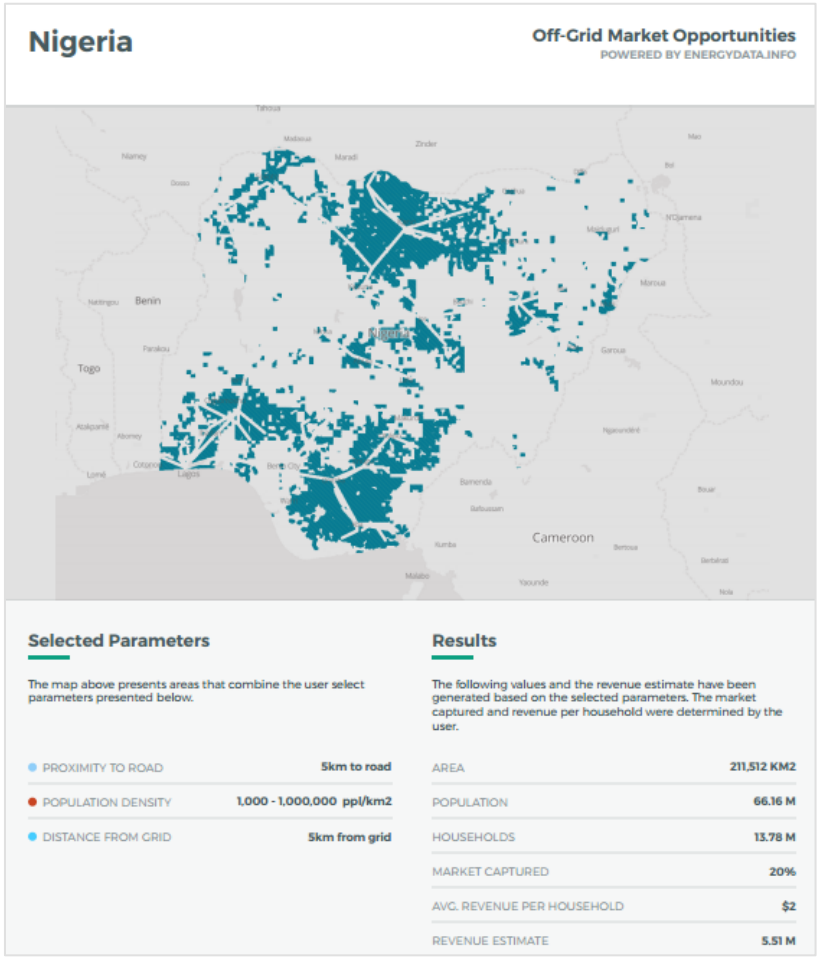
Tool 3: Off-Grid Market Opportunities (IFC)





Open source application to estimate market opportunities for off-grid energy services in Sub-Saharan Africa.

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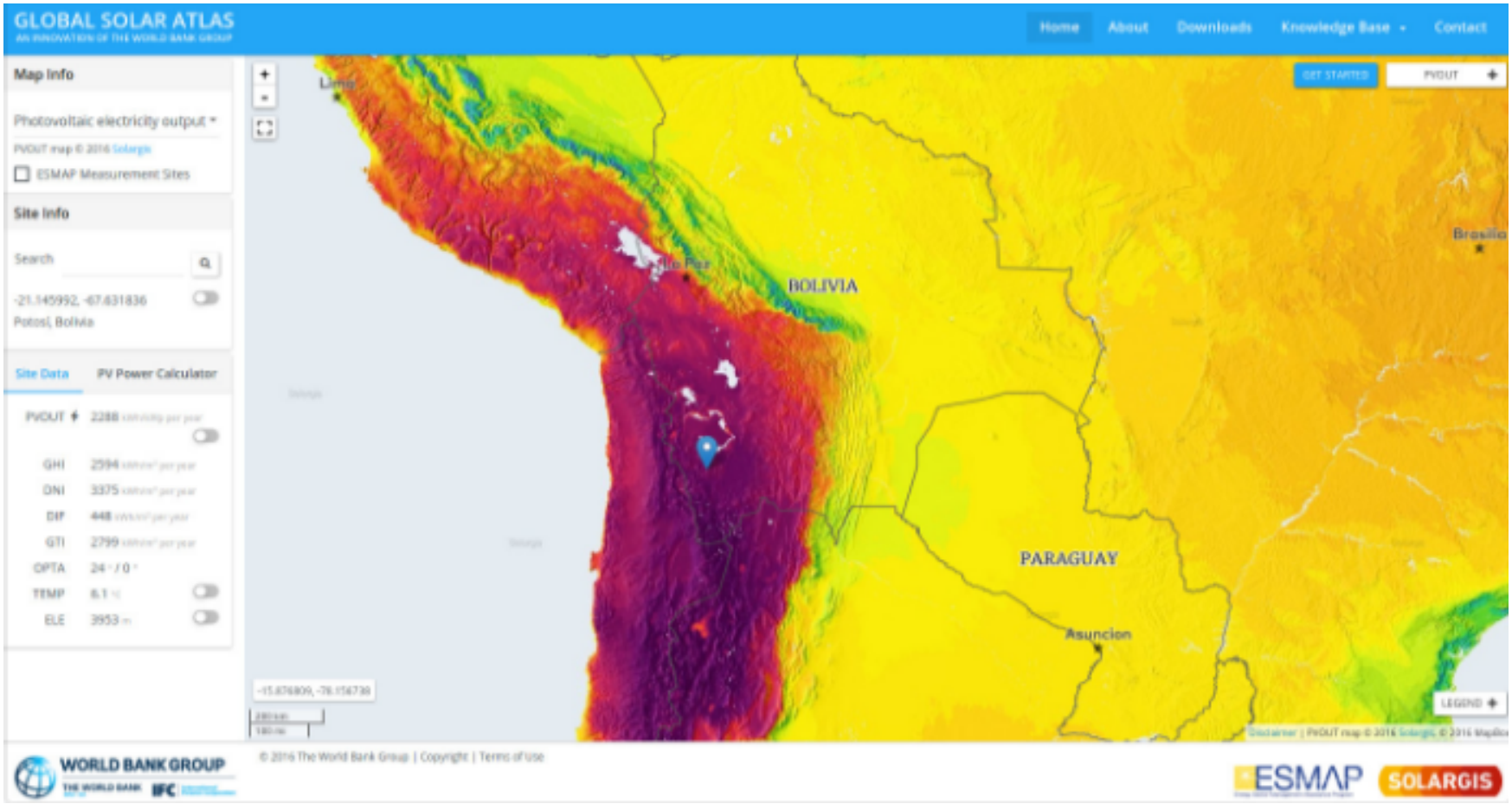
Tool 4: Global Solar Atlas (ESMAP - WB)



Access solar power potential globally and perform simple electricity output calculation for any given location

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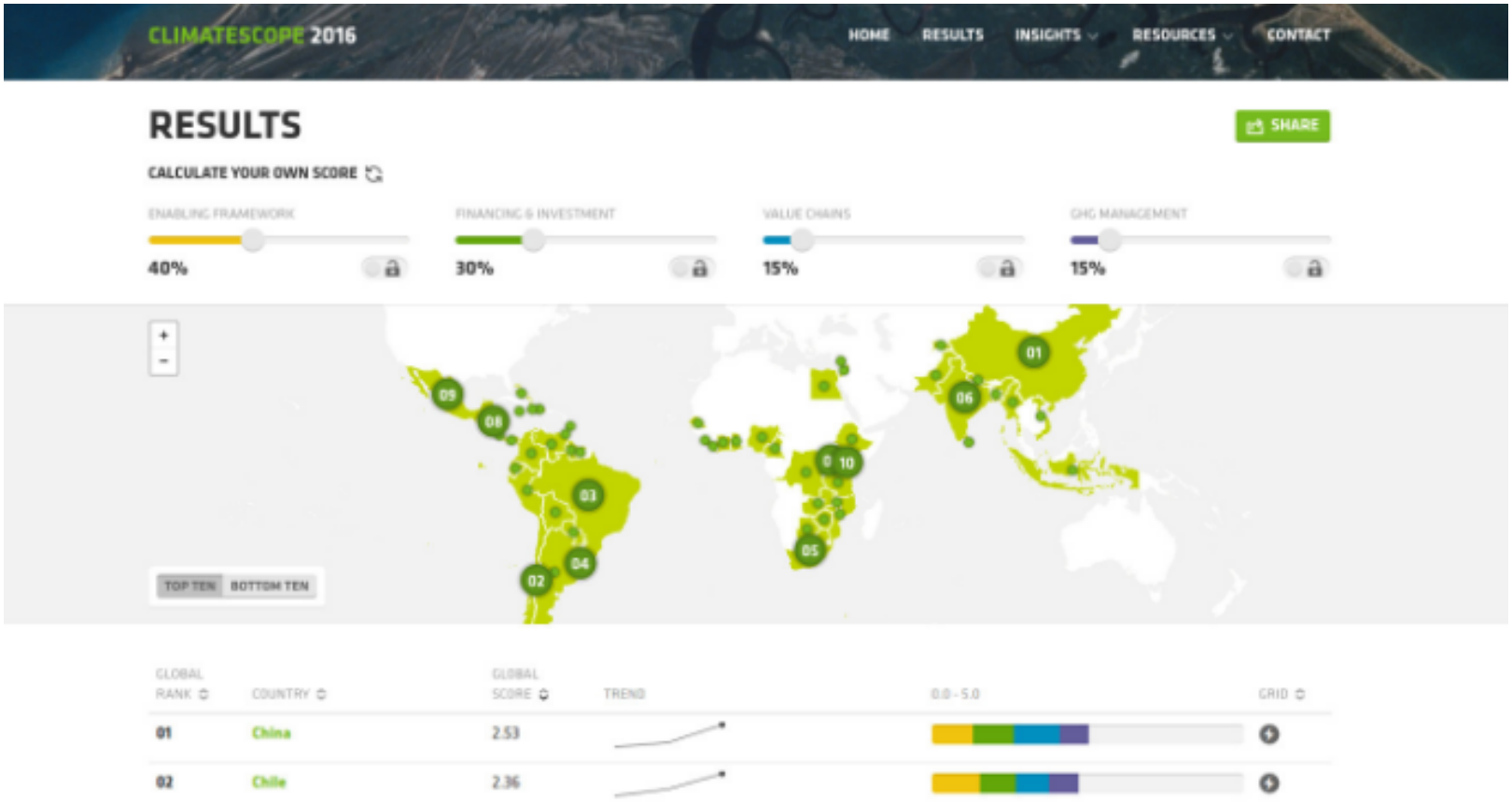
Tool 5: Climatescope (Bloomberg New Energy Finance)



Compare conditions for clean energy investment on and off the grid in 58 emerging markets.

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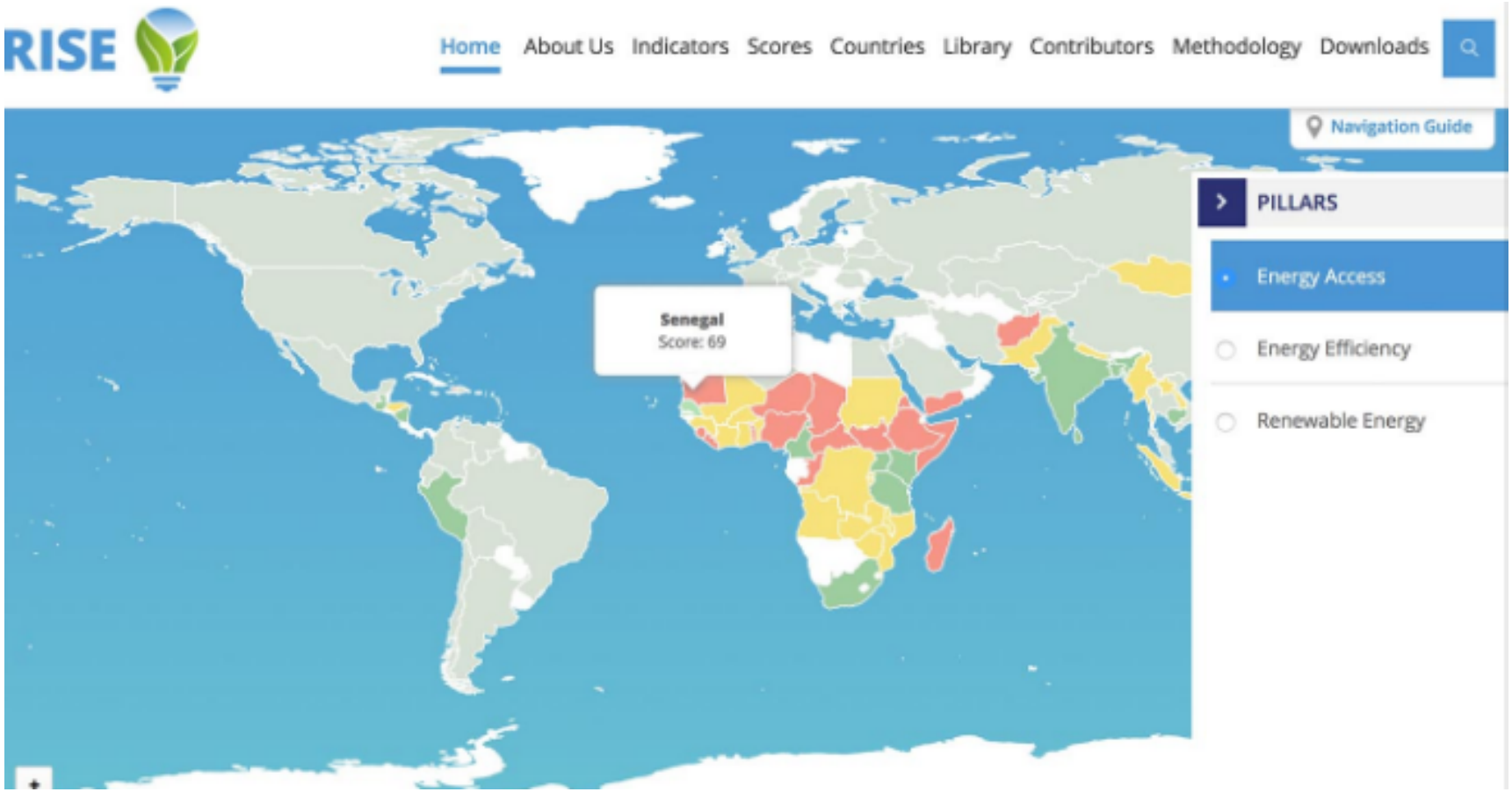
Tool 6: RISE (World Bank Group)



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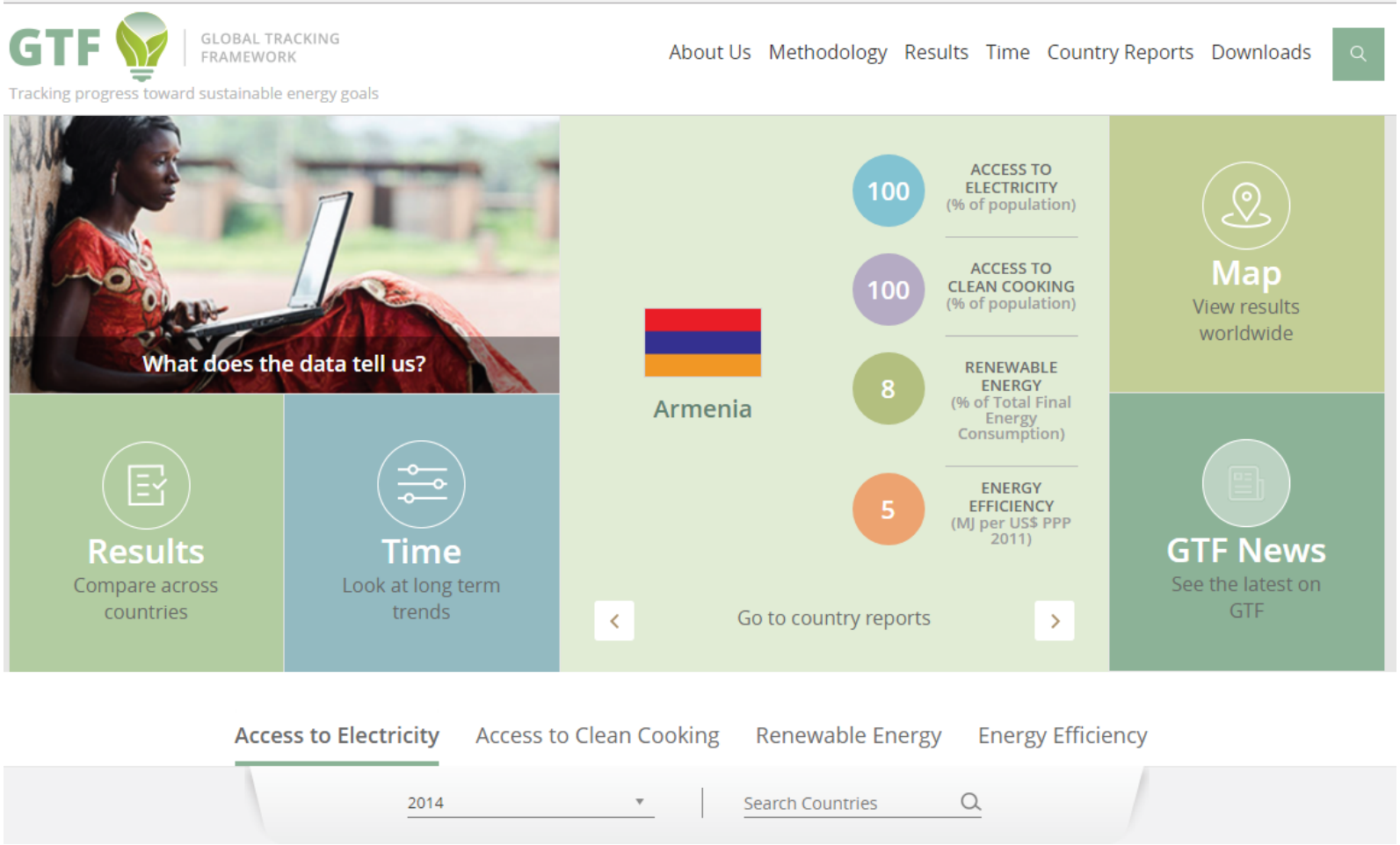
Regulatory Indicators for Sustainable Energy (RISE) is a comprehensive policy scorecard assessing the investment climate for sustainable energy in 111 countries.

Tool 7: GTF (World Bank Group)



Global Tracking Framework (GTF) provides a global dashboard to register progress on energy access, energy efficiency and renewable energy.

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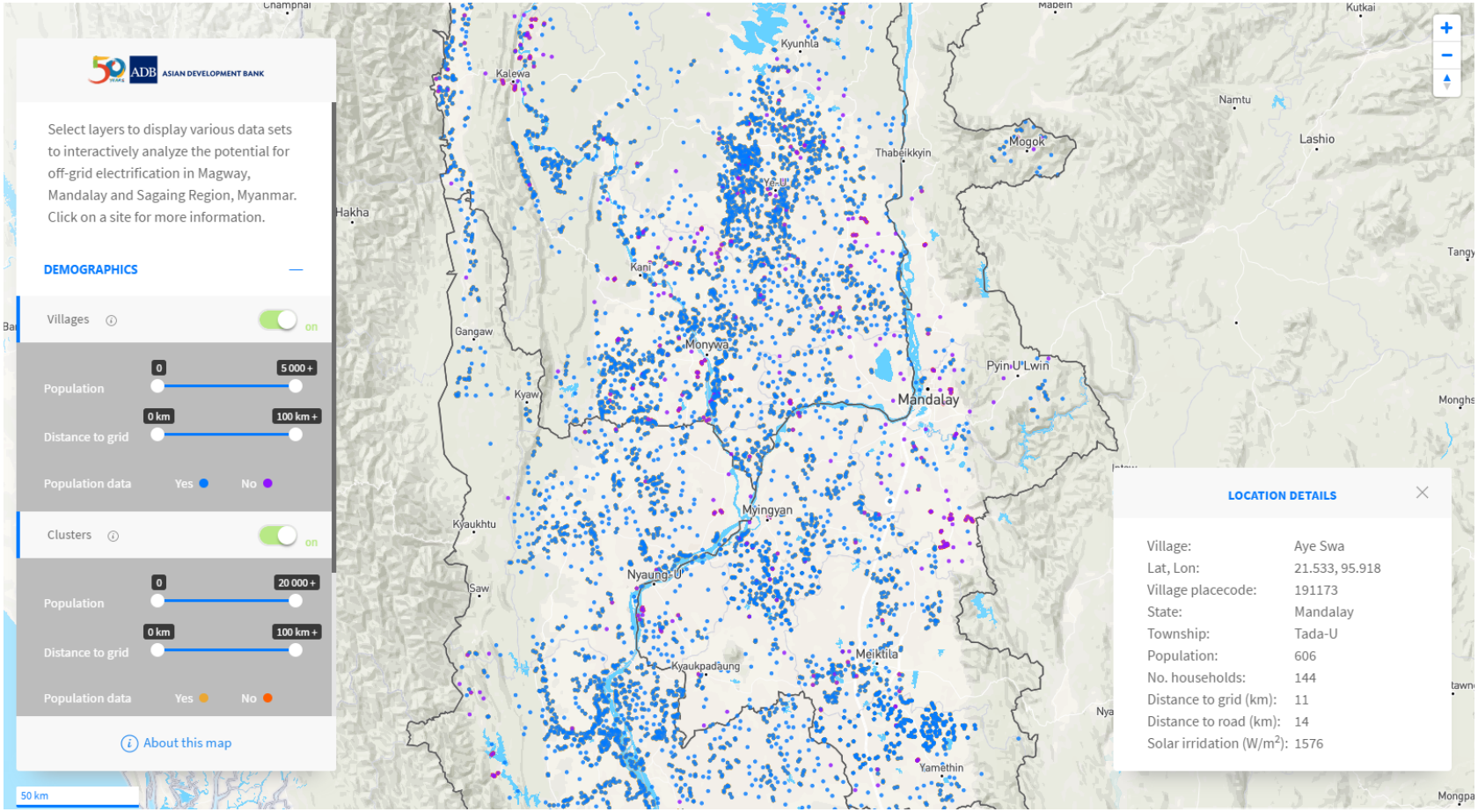
Tool 8: Myanmar Off-Grid Analytics (Integration & Reiner Lemoine Institut)



Visualizes data of the current status of electrification and presents renewable energy potentials to showcase the off-grid investment potential.

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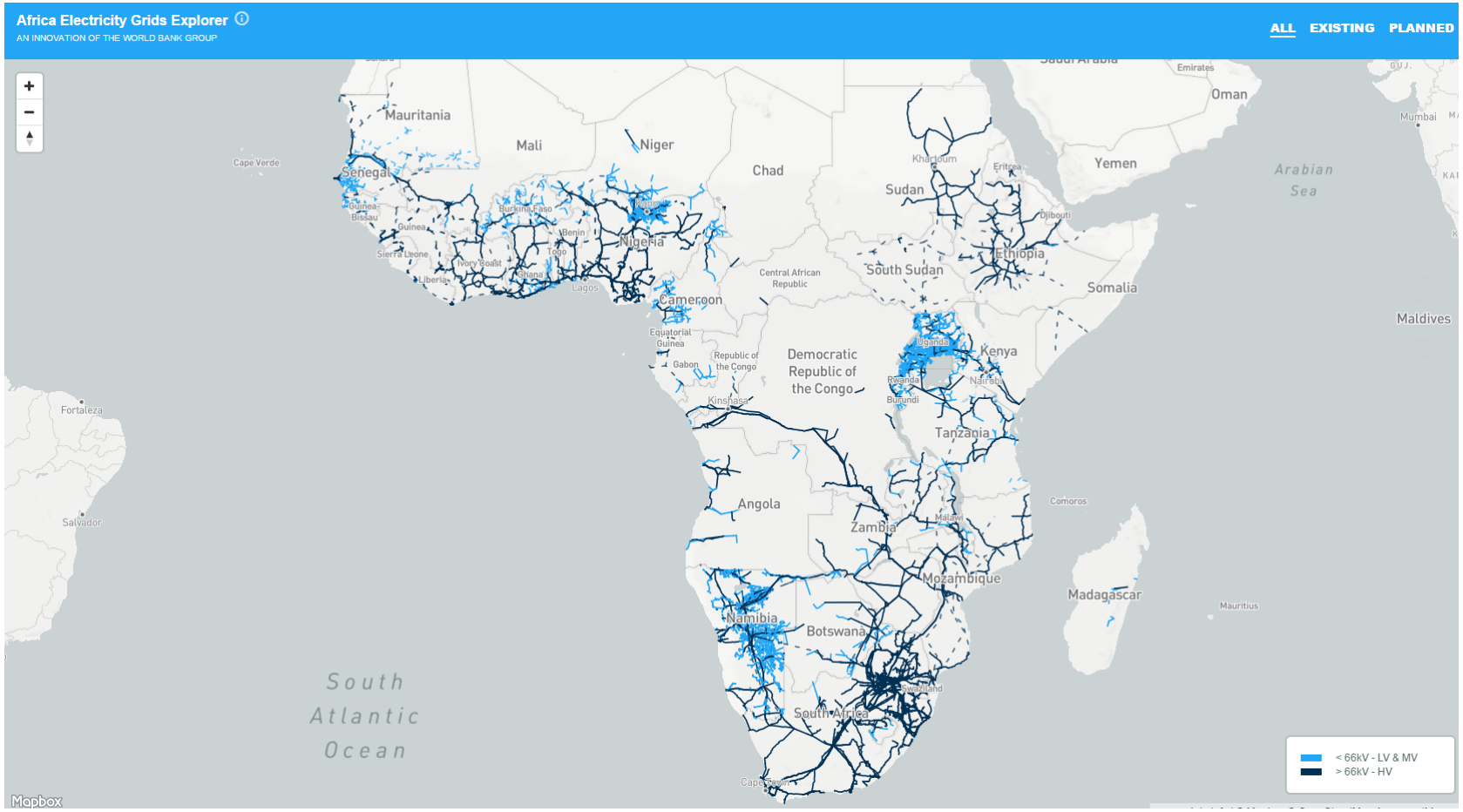
Tool 9: Africa Electricity Grids Explorer (World Bank Group)



Explore the latest data on Sub-Saharan Africa's electricity grids and infrastructure.

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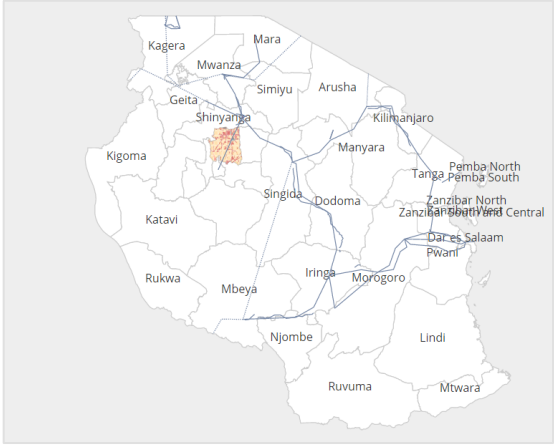
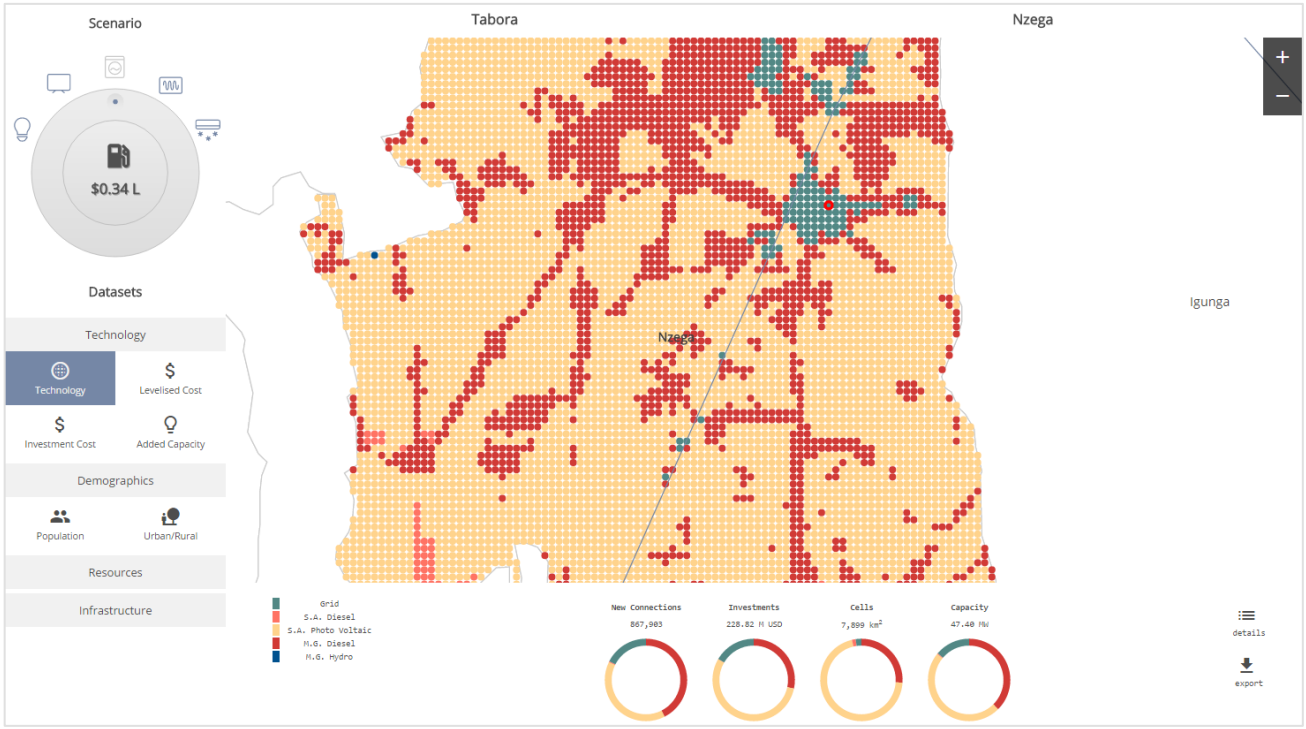
Tool 10: High Definition Least Cost Options Plan (KTH + WB)





	Cells		New Connections		Capacity		Investments	
	7,899 km²		867,903		47,396,205 W		228,815,912 USD	
M.G. Hydro	1 km²	0.01 %	95	0.01 %	3,218 W	0.01 %	37,497 USD	0.02 %
S.A. Diesel	117 km²	1.48 %	3,178	0.37 %	153,378 W	0.32 %	210,513 USD	0.09 %
Grid	177 km²	2.24 %	151,750	17.48 %	6,541,066 W	13.80 %	37,744,659 USD	16.50 %
S.A. Photo Voltaic	5,545 km²	70.20 %	343,790	39.61 %	22,896,100 W	48.31 %	125,928,362 USD	55.03 %
M.G. Diesel	2,059 km²	26.07 %	369,090	42.53 %	17,802,443 W	37.56 %	64,894,881 USD	28.36 %

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CASE STUDY 1:

Case Study 1

Development of Open Source Online Tool for Identifying High Level Off-Grid Market Opportunities (support to IFC)

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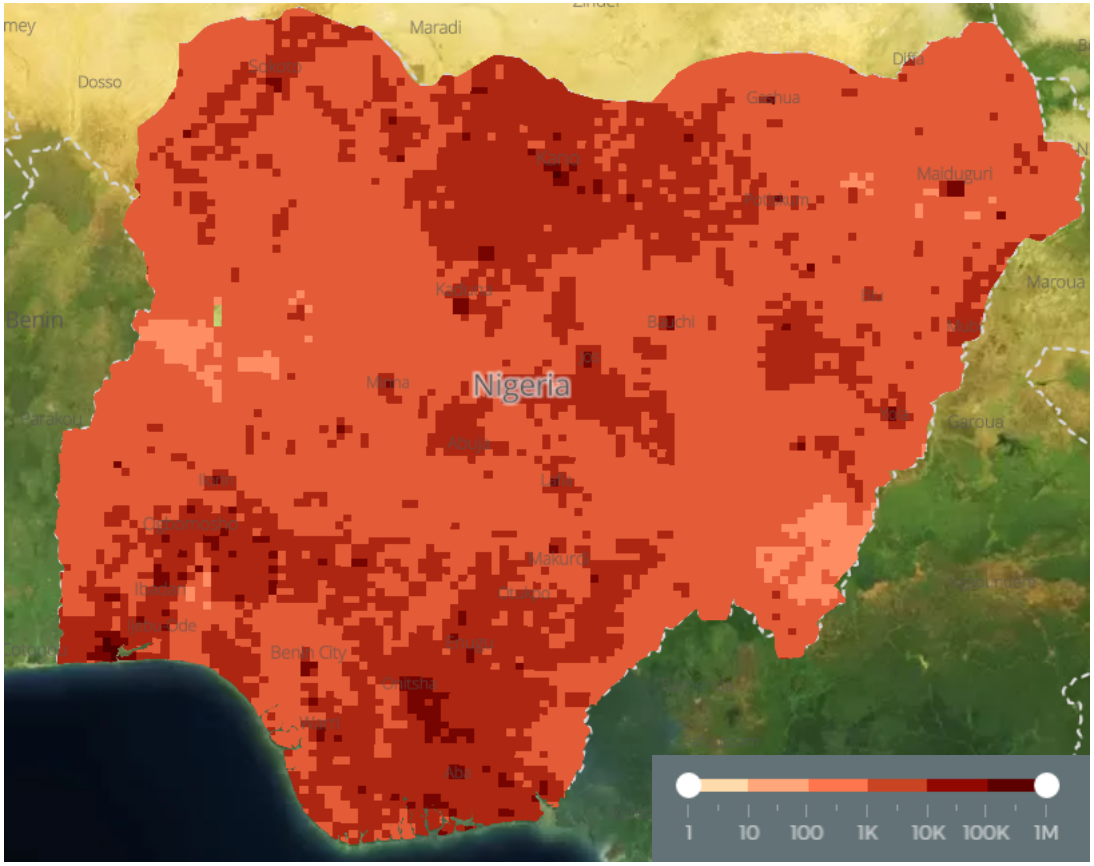
Using GIS Analytics in private sector advisory

- GIS data is of limited use without both visualization and analytics
- Exploiting GIS data often requires specialized skills and software and is a challenge for smaller private sector players
- IFC aims to facilitate energy practitioners' access to GIS based data analytics to address lack of market information
- Off-grid Market Opportunity tool developed to fill 3 main gaps:

1. **Data gap** with making available and leveraging geospatial data in markets where basic data is scarce
2. **Capacity gap** with providing a analytical tool that allows users to get results from data easily
3. **Analytical innovations gap** with developing the tool as open source software

Answering (not so) simple questions

Where are the people?



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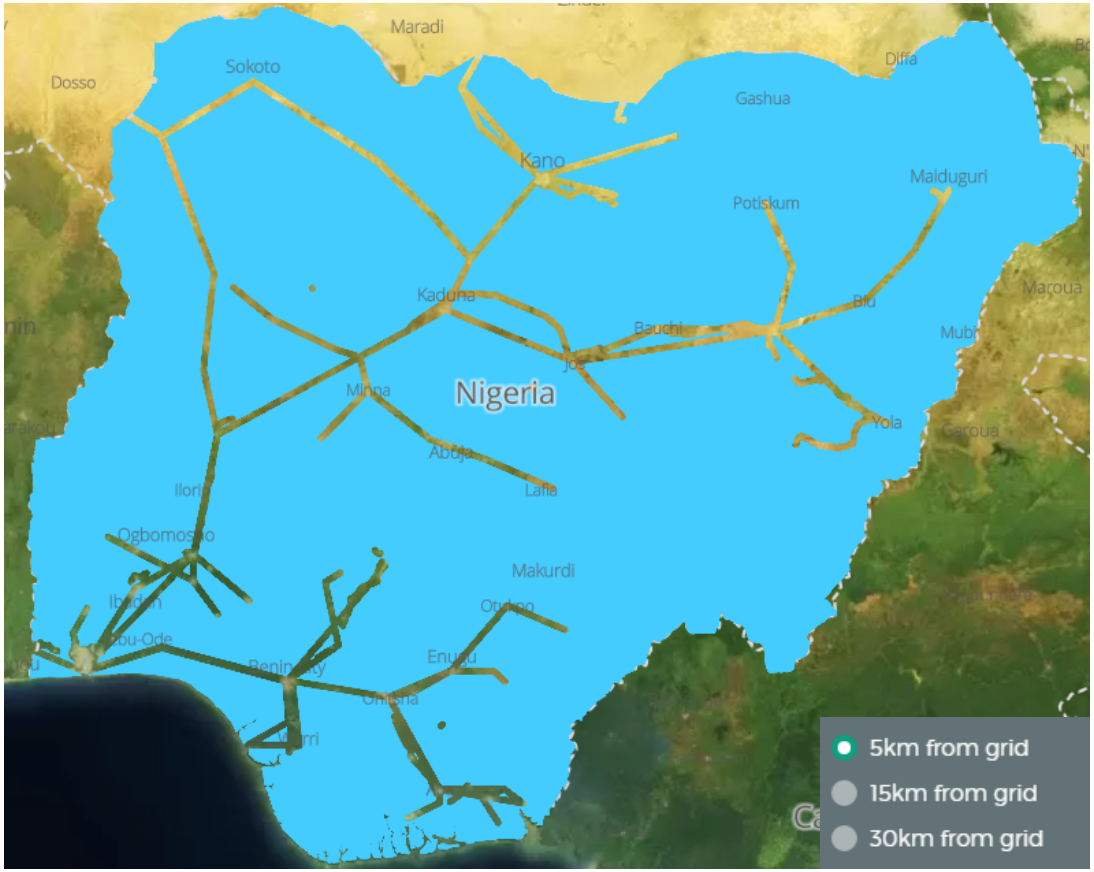
Answering (not so) simple questions

Are they served by the grid?



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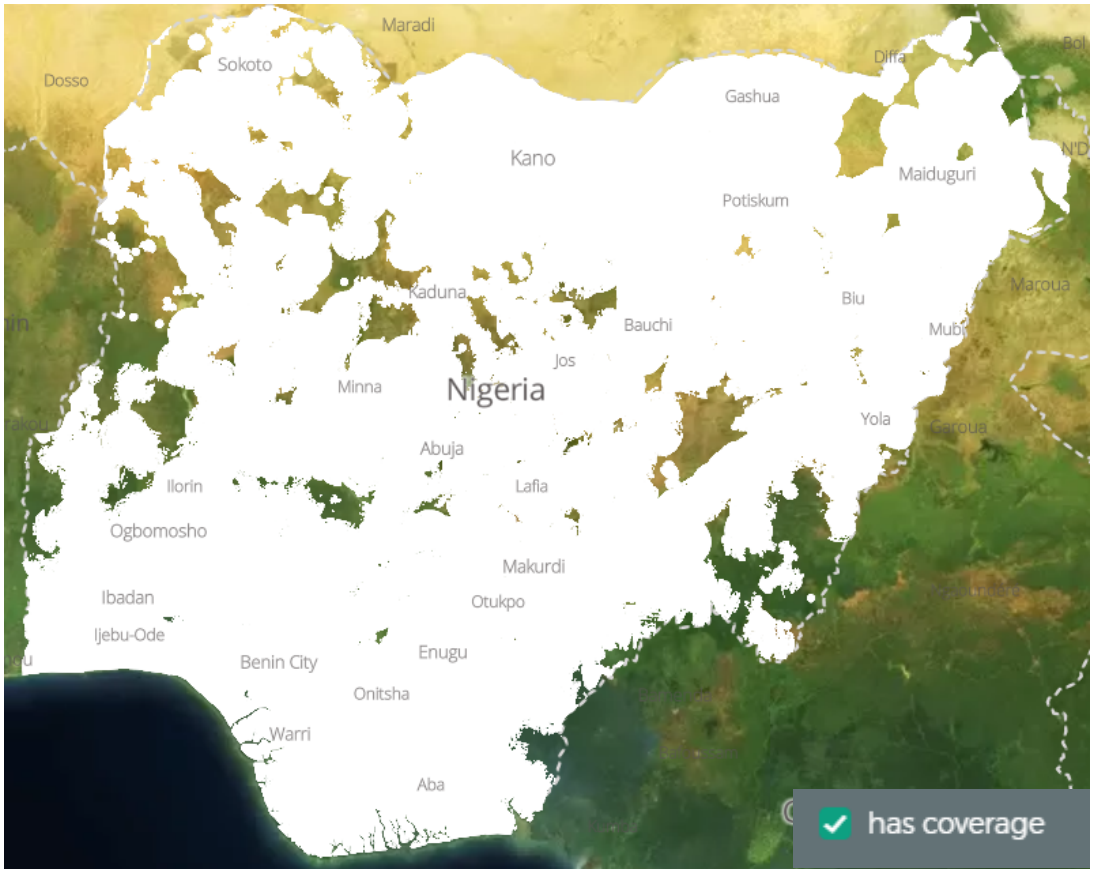
Answering (not so) simple questions

Do they have mobile phone coverage?



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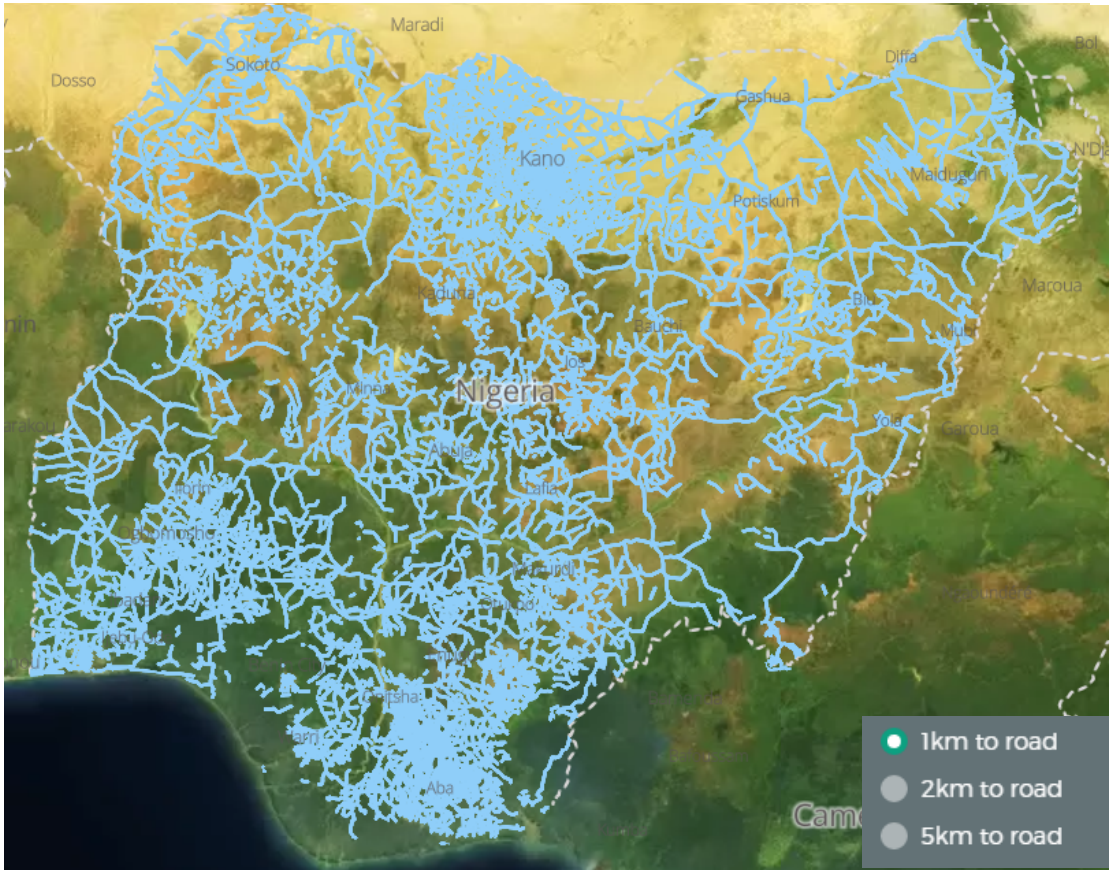
Answering (not so) simple questions

Are they close to an existing road?



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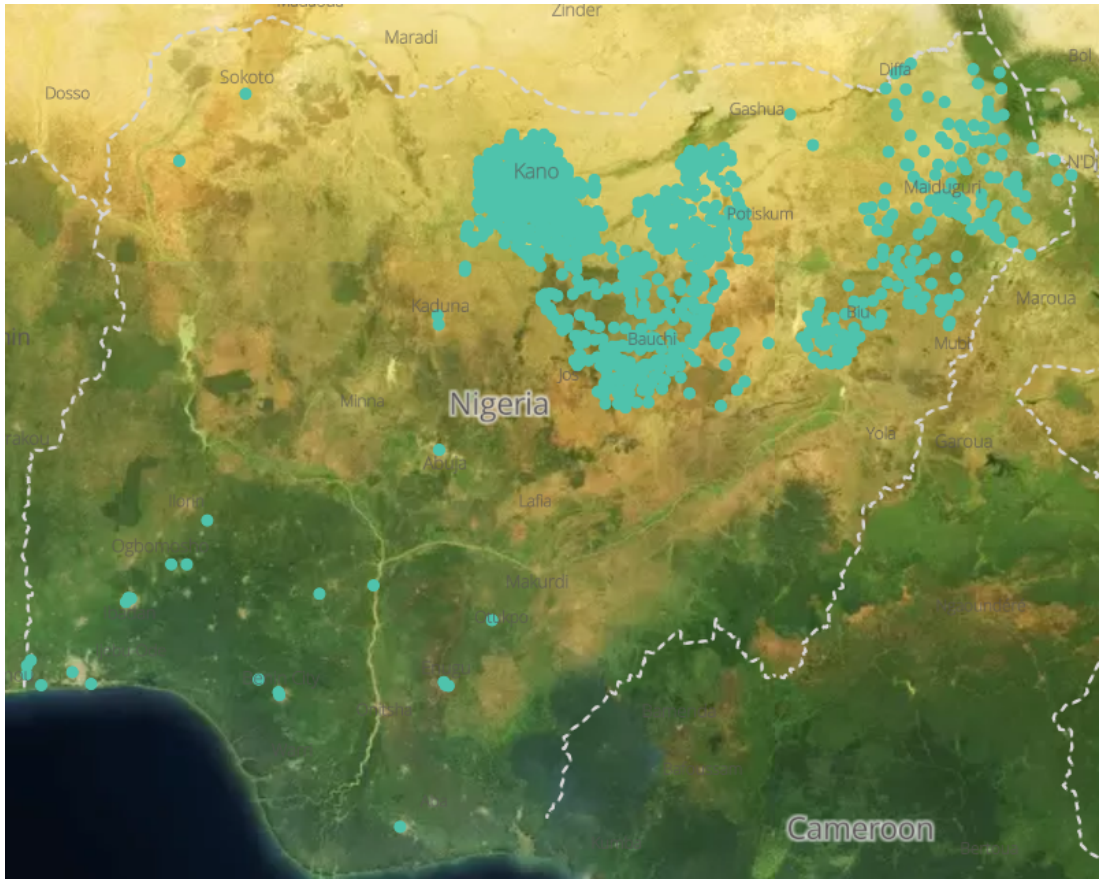
Answering (not so) simple questions

Where are the healthcare facilities?



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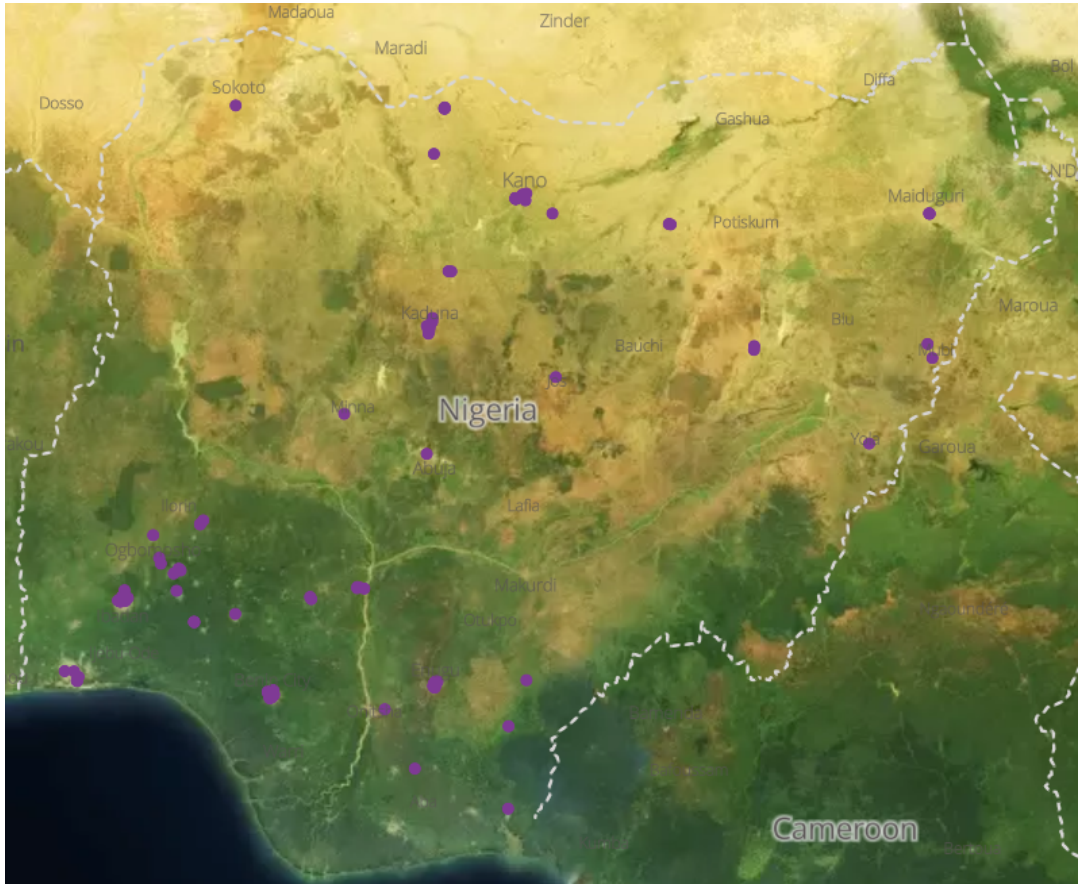
Answering (not so) simple questions

Where are the schools?



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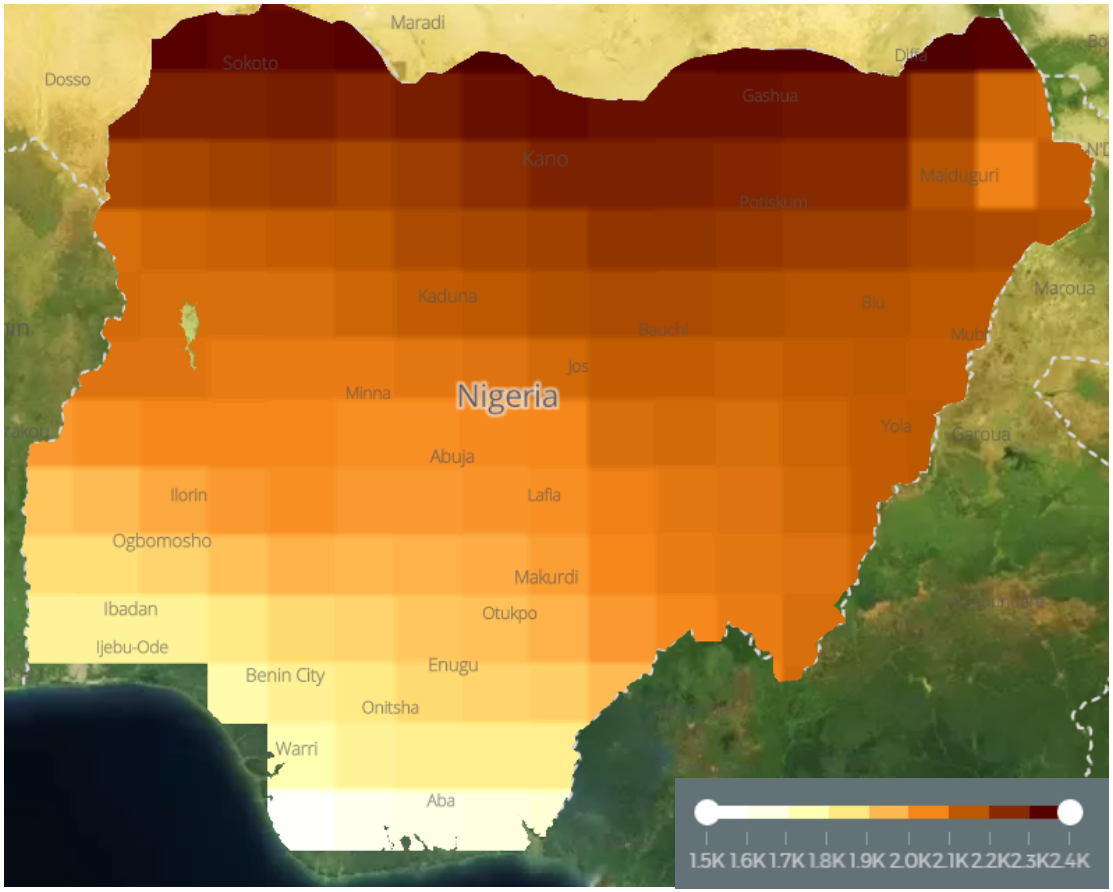
Answering (not so) simple questions

Is the solar resource sufficient?



Answering (not so) simple questions

In Nigeria, how many people live in…

- ✓ Densely populated areas (<1,000 per km2)? **125.91M**
- ✓ At least 5 km away from the grid? **109.17M**
- ✓ Have cellphone coverage? **154.46M**
- ✓ Less than 1 km from an existing road? **84.22M**
- ✓ In areas >2K GHI solar potential? **69.58M**

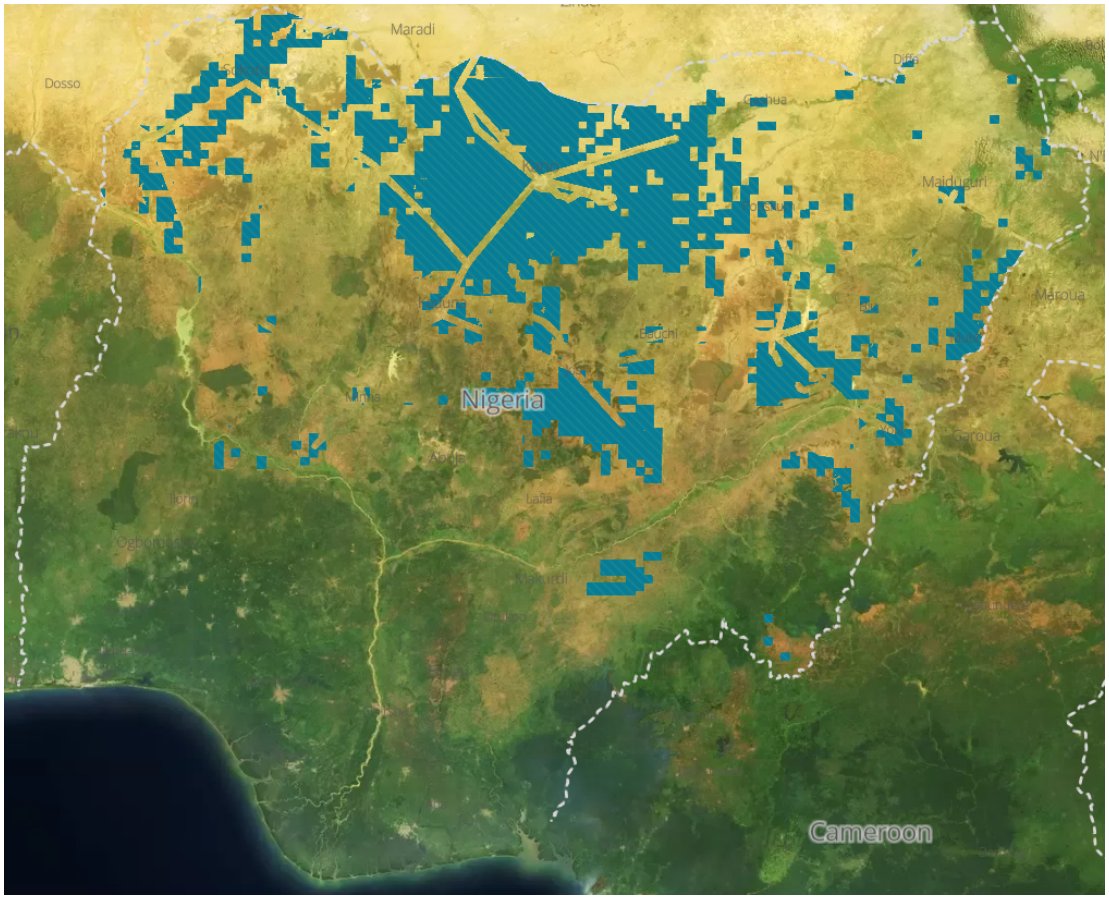
Answering difficult questions

All of these 5 parameters combined? **30.34M**

Where?

What would be my annual revenue with 20% of market at $200 per HH per year?

$ 252.84M / Year



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What do IFC clients say?

"This is a great tool!"

Moya Connelly, Vice President of Deutsche Bank Trust Company Americas

"Congrats on this great new tool! As you know, it will be very helpful for companies like Fenix."

Lyndsay Handler, CEO of Fenix International

"This is amazing! Hats off to the IFC"

Tristan Kochoyan, CEO and Founder of Power:On

"I am interested to explore the scope and opportunity of extending the coverage of the tool to the Caribbean. The intention would be to support energy access initiatives as well as energy transition opportunities"

Glynn Morris, Programme Leader at GIZ

"Thanks so much for this! In fact, this came at the right time when we are developing our own rural electrification planning tool. This surely could contribute to the work we are doing."

Alicia de Guzman, Rural Electrification Administration, Philippines DoE

Caveats, learnings and way forward

- **Results are as good as the data is**
- **Technical limitations due to complex calculations in the background affecting speed**
- **Results can be improved easily with better data and new parameters, as well as new infrastructure**
- **User demonstrations and trainings are key for adoption**

Case Study 2

Project Specific Support - CLSG Regional Interconnection Project with Access Impact (support to WB Africa Team)

Answering (not so) simple operational questions

TEAM REQUEST

We are working actually on an AF for the parent project to increase via a new electrification's component. This component is envisaged in FY18 to finance the electrification of communities near the transmission line and its substations in Liberia and Sierra Leone to further increase the development impact of the CLSG regional transmission line and enhance the social acceptance and protection of the high voltage transmission lines by the local communities.

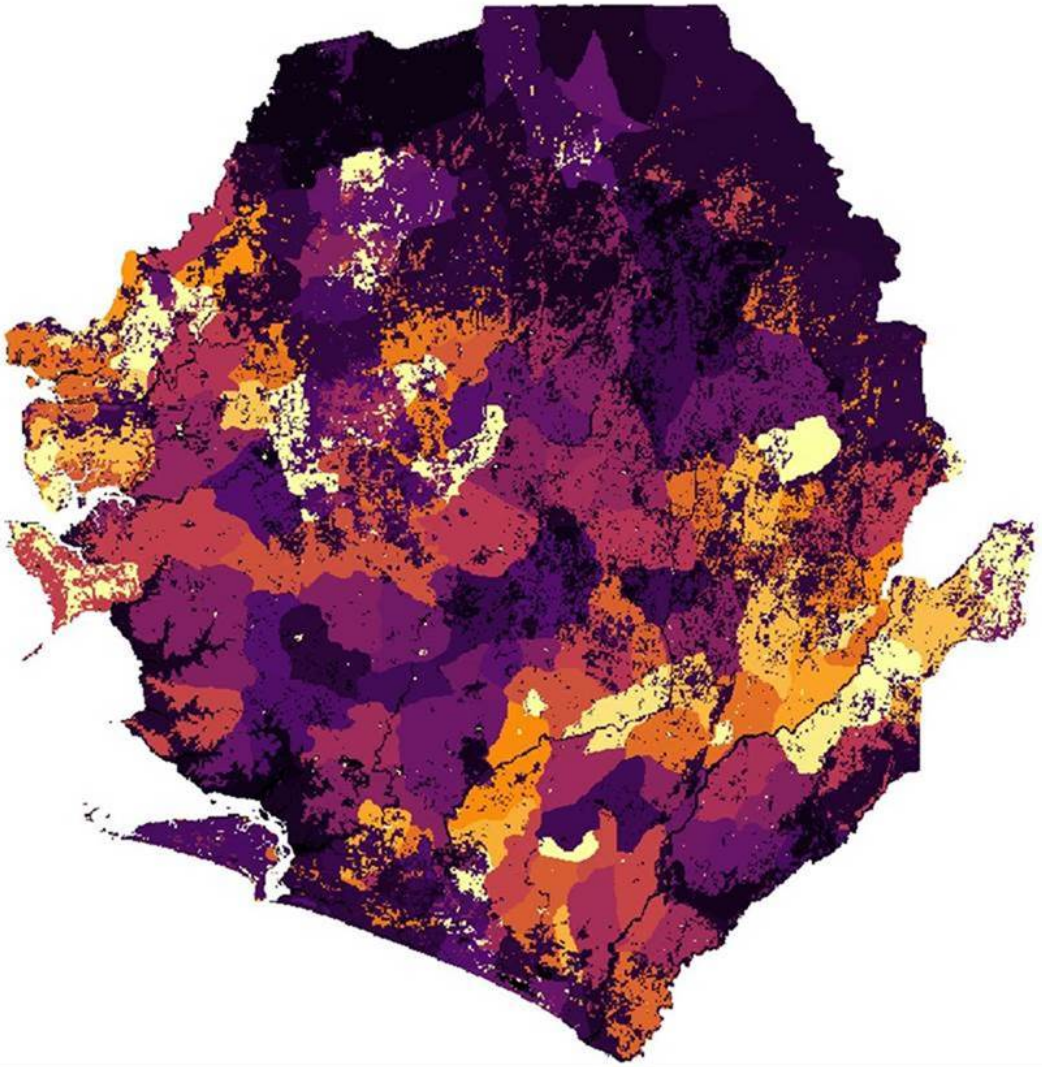
The electrification will be done from (i) the SWS technology (electrification of 3 earthwires) or from (ii) conventional technology from the HV/MV substation.

In order to analyze and determine the best option to feed the village/communities depending the localization of the village/communities and the distance to the future HV/MV substations, I would like to have a map with two layers (i) the population (village/communities) identified along the line (ii) the line routing of the CLSG line.

Answering (not so) simple operational questions

INPUT 1

WorldPop population dataset showing the estimated people number per grid-cells at 100m by 100m resolution



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Answering (not so) simple operational questions

INPUT 2

CLSG Liberia – Sierra Leone – Ivory Coast Transmission Grid GIS Dataset

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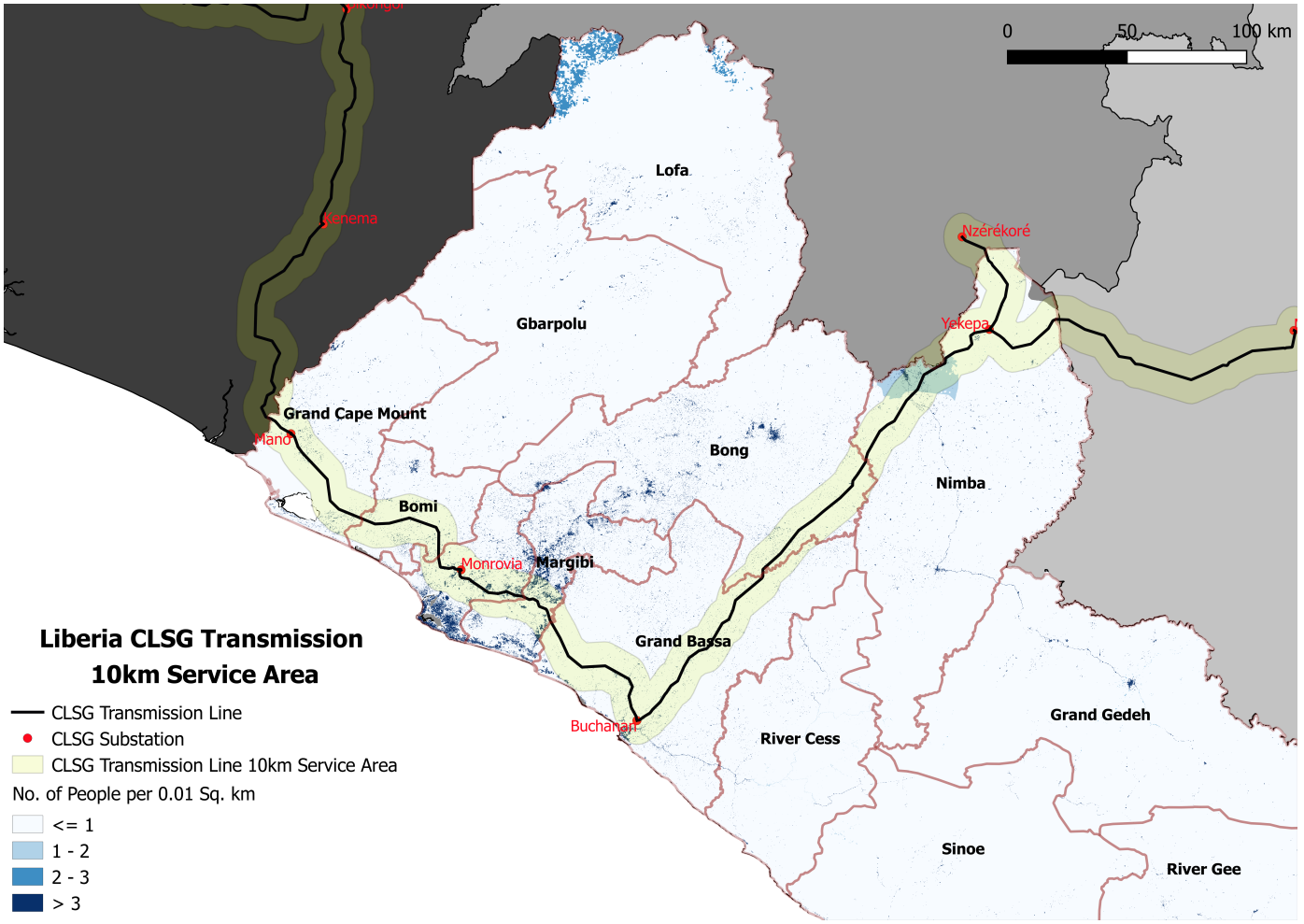
Answering (not so) simple operational questions

OUTPUT 1

Modelisation of 10km service area



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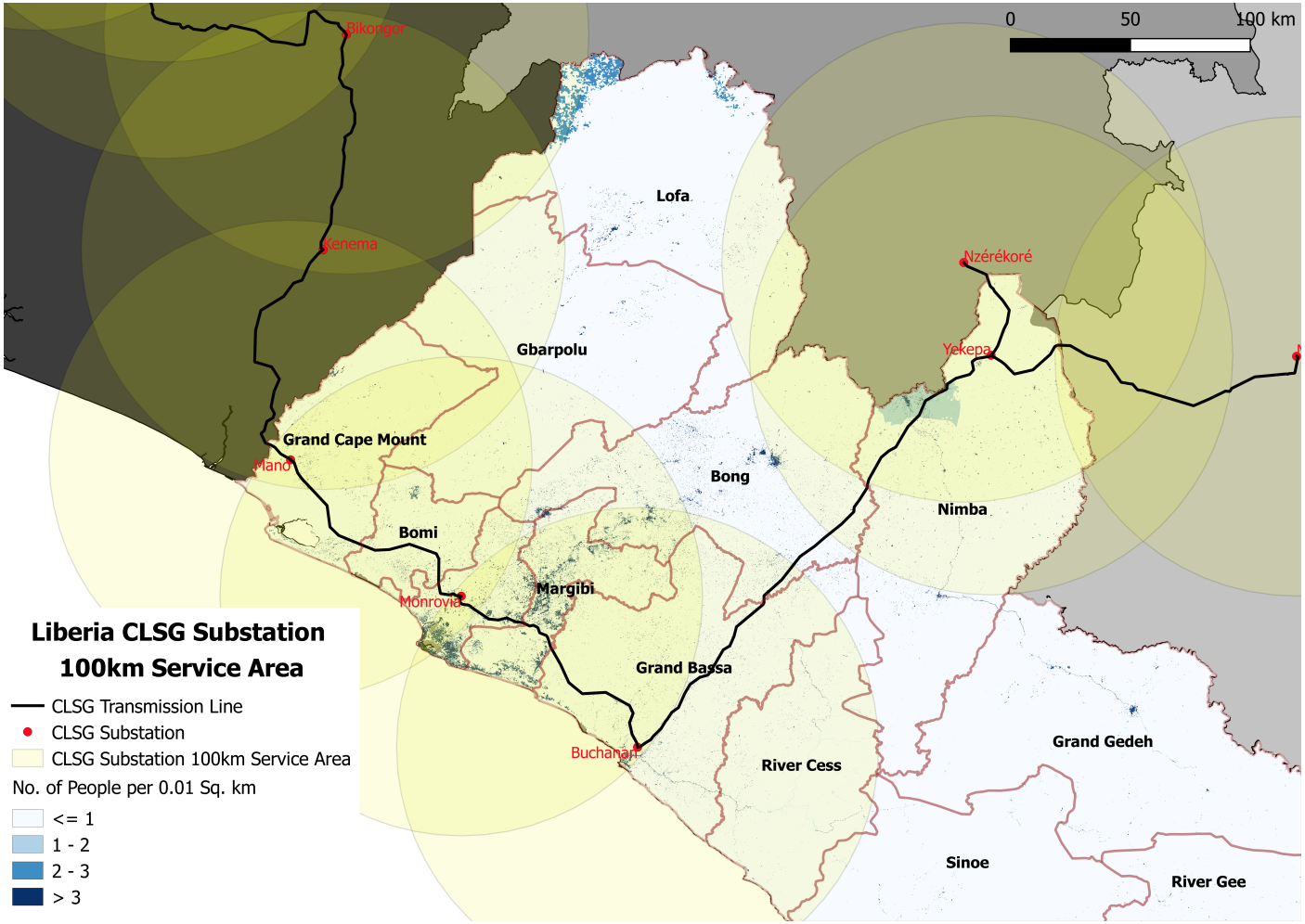
Answering (not so) simple operational questions

OUTPUT 2

Modelisation of 100km substation service area



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Answering (not so) simple operational questions

OUTPUT 3

Detailed results table

	A	B	C	D	E
1	**Country**	**Total Populaiton**	**Buffer Type**	**Pop in Buffer**	**Pop in Buffer Percent**
2	Sierra Leone	6,205,385	10km Line	780,037	12.6%
3	Sierra Leone	6,205,385	100km SS	4,111,362	66.3%
4	Liberia	4,396,869	10km Line	647,292	14.7%
5	Liberia	4,396,869	100km SS	3,307,335	75.2%

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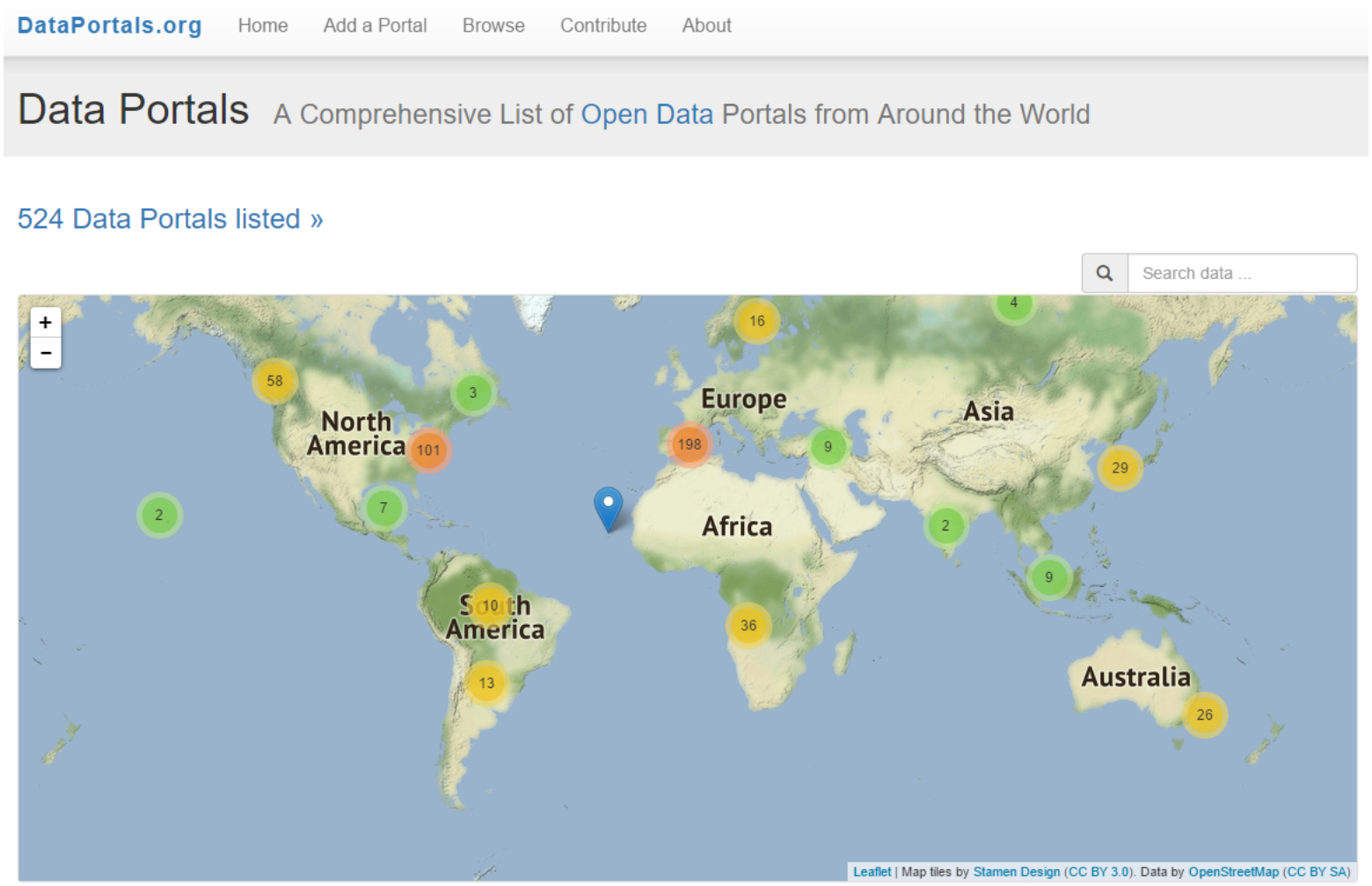
What is Open Data?

Open data and content can be **freely used, modified, and shared** by **anyone** for **any purpose**

- Technically open: accessible online, in open formats, without registration barriers
- Legally open: clear licensing with minimal restrictions on use, re-use or redistribution
- Sufficient metadata and documentation

What is Open Data?



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Why Open Data?

- Open Data increases use/-reuse of data
- Open Data can reduce costs
- Open Data enhance reputation and provide positive appreciation for organization
- Improve data quality

Why are government doing Open Data?

- Openness, Transparency & Accountability
- Improve Public Services
- Innovation & Economic Value
- Public Sector Efficiency

Why are developing countries doing Open Data?

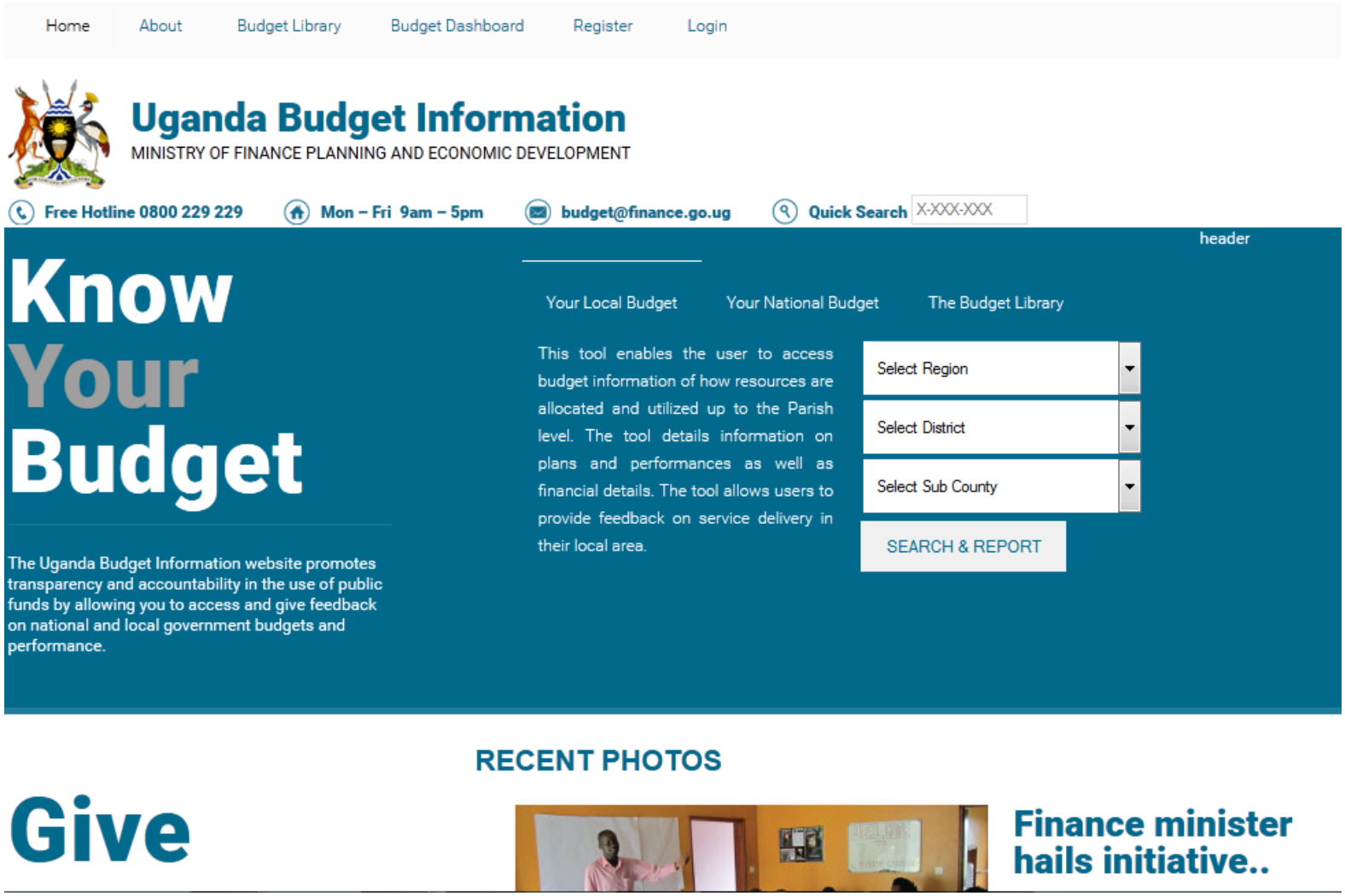
All these:

- Openness, Transparency & Accountability
- Improve Public Services
- Innovation & Economic Value
- Public Sector Efficiency

Plus:

- Support Broader Government Agenda
- Answer Specific Development Questions

Budget transparency & improved service delivery in Uganda



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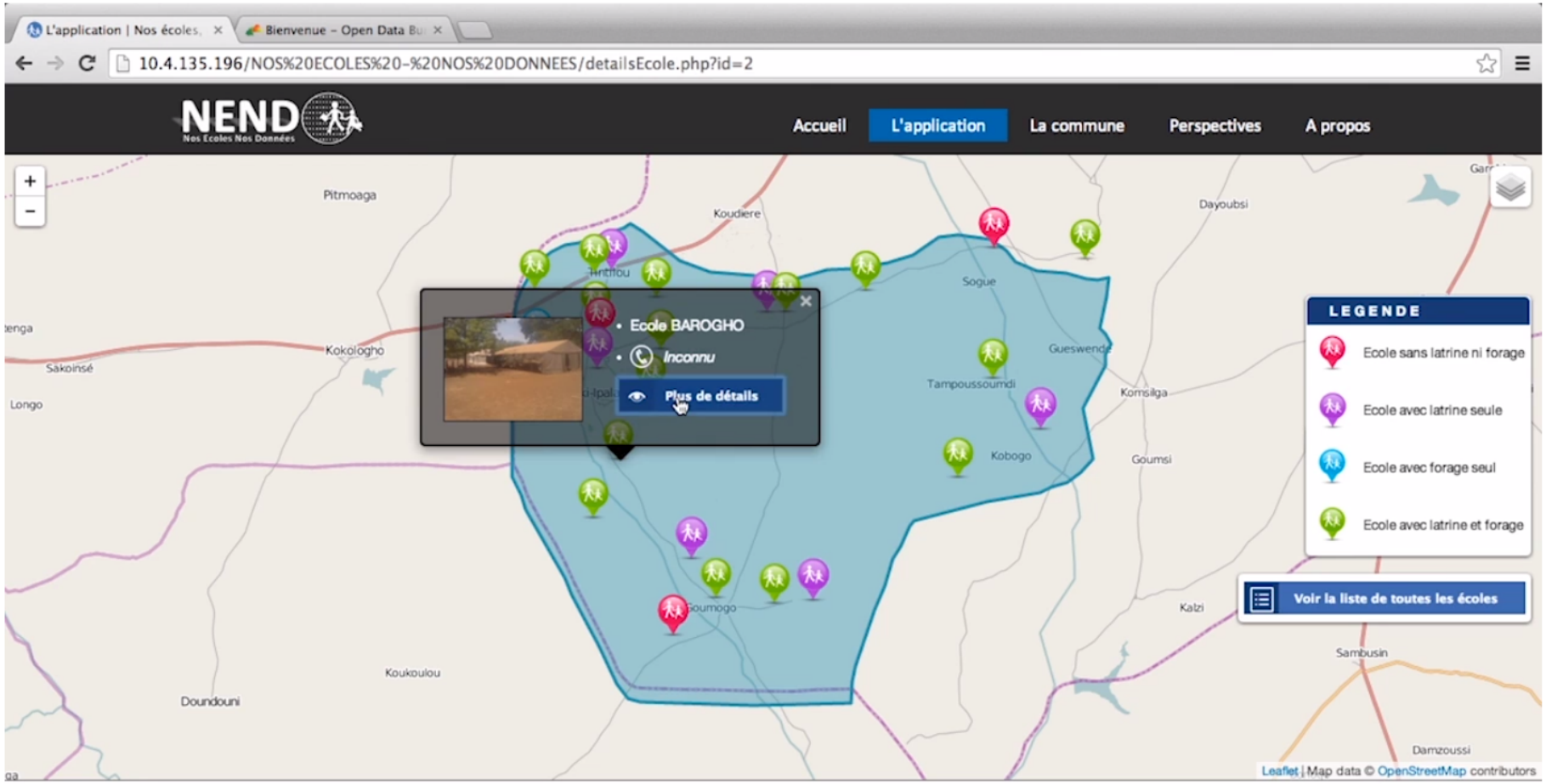
Opening education data in Burkina Faso



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Teacher absenteeism in Nigeria

Location-specific data in Benin City

Select a story from the options below. These visualizations utilize data collected in 2013 and published on the Edo State Open Data Portal.

Maps were made using Tilemill and hosted by Mapbox. You can use both of these tools for free.

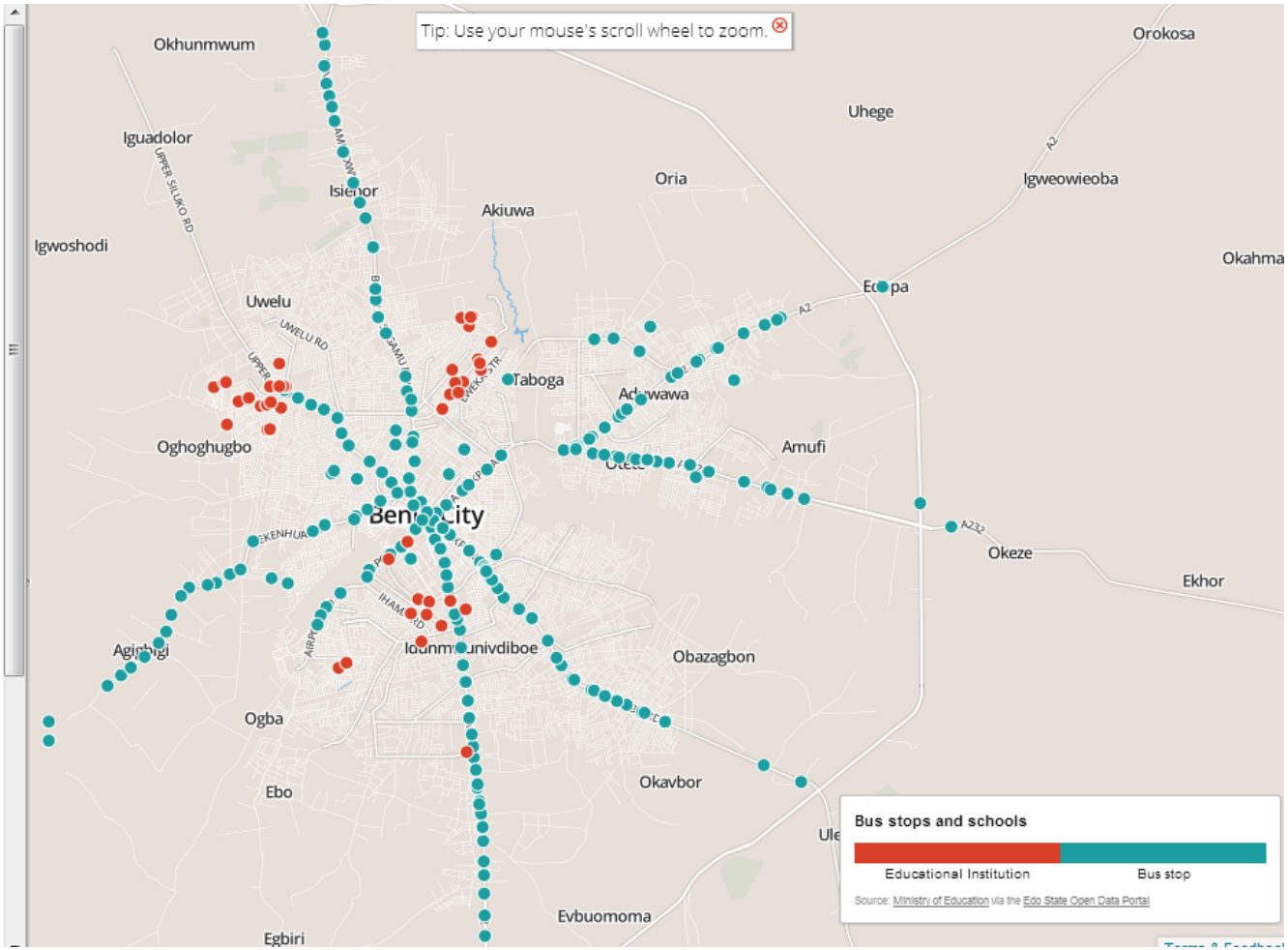
Getting to school
Bus stops and their proximity to selected schools in Benin City.

Tracking illegal waste dumping
Legal and illegal waste dump locations in Benin City.

Churches and shops
Over 70 religious institutions mapped alongside shops and bars in Benin City.

Healthy travel
Selected hotels and health care organizations mapped in Benin City.

This website was made in support of the launch of the Edo State Open Data Portal. The goal of this website is to demonstrate how free and open tools can leverage open data for visual storytelling.



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Official data repository for Edo state - http://data.edostate.gov.ng

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Tools to get started: Open Data Toolkit - http://opendatatoolkit.worldbank.org

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Data

This page in **English** | Français

Open Government Data Toolkit

Welcome to the Open Government Data Toolkit

The **Open Government Data Toolkit** is designed to help governments, Bank staff and users understand the basic precepts of Open Data, then get "up to speed" in planning and implementing an open government data program, while avoiding common pitfalls. We suggest that you begin reading here.

Photo: Tom Perry/World Bank

Getting started with Open Data can be easier than many people think. If you have data in a re-usable electronic form, a publicly accessible online place to put it and an open license, then you're well on your way.

We update the OGD Toolkit frequently with new information. If you have suggestions or corrections, please send us feedback.

Open Government Data Toolkit

- Open Data in 60 Seconds
- Open Data Essentials
- Starting an Open Data Initiative
- Technology Options
- Demand and Engagement
- Supply and Quality of Data
- Readiness Assessment Tool
- Technical Assistance and Funding

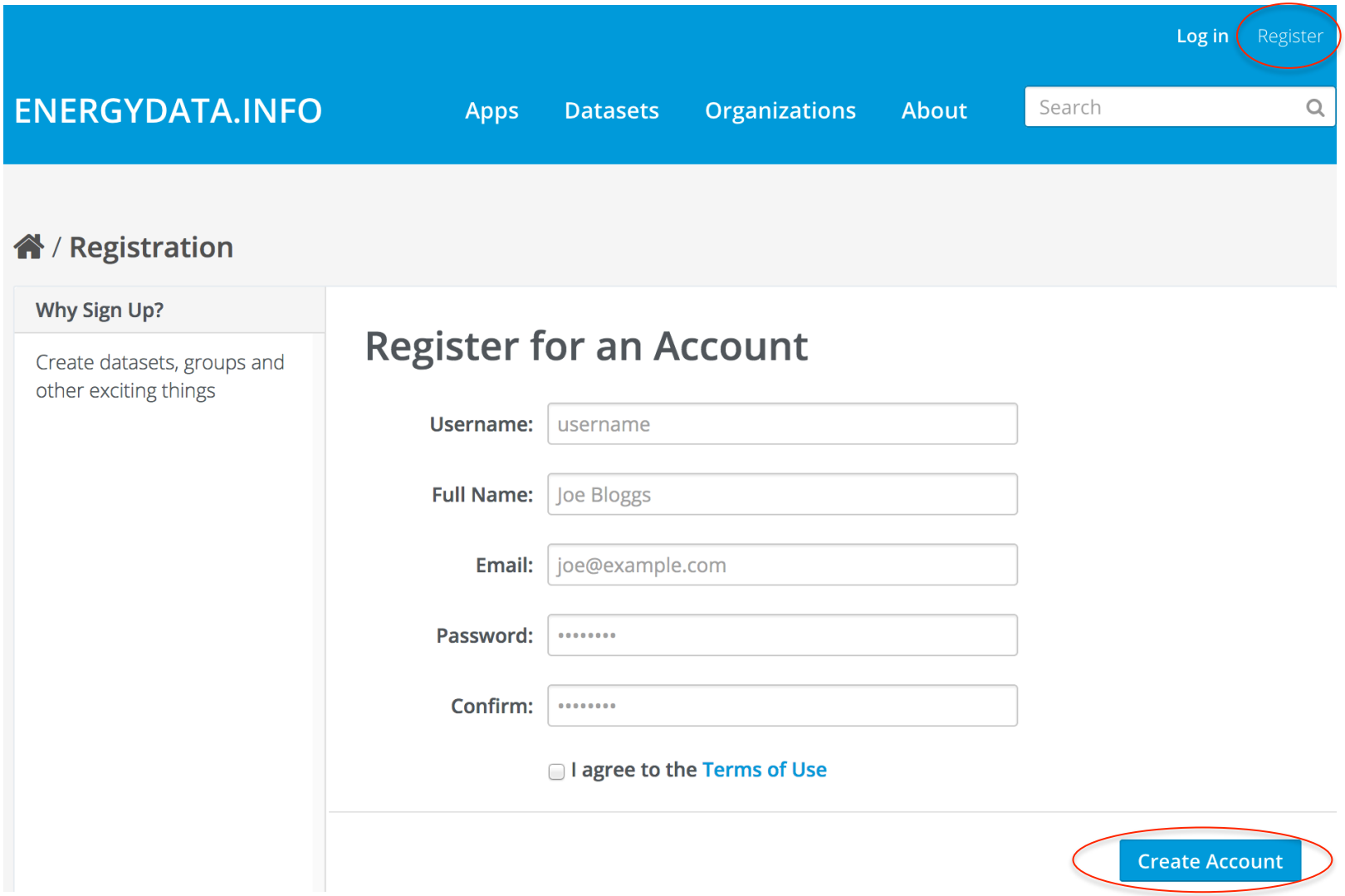
Key lessons for success

- Start small, learn, & grow
- Perfect is the enemy of the good
- Engage the public and civil society

Overview

1. World Bank Group – Open Data and Analytics Program
2. Using Advanced Data Techniques in Energy Planning
3. Why Open Data?
4. Using the ENERGYDATA.INFO Platform
5. Collecting, Improving and Validating Data

Register an account



Organizations, members and access

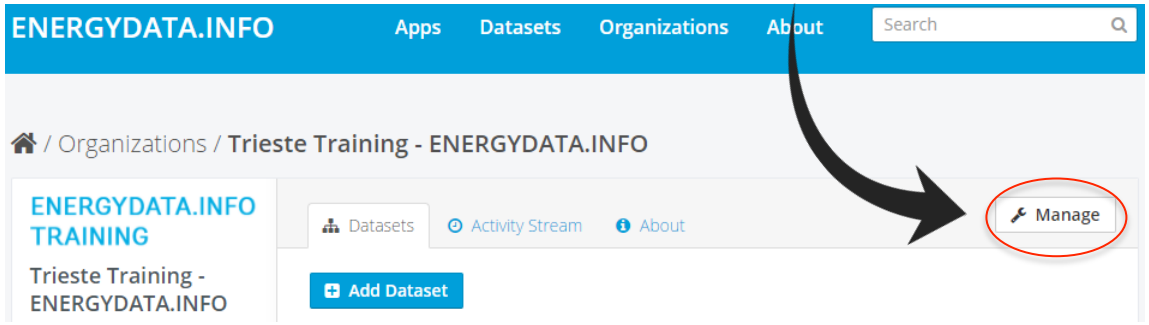
1 ADDING AN ORGANIZATION

- Eligible organizations can be added to energydata.info by submitting a request

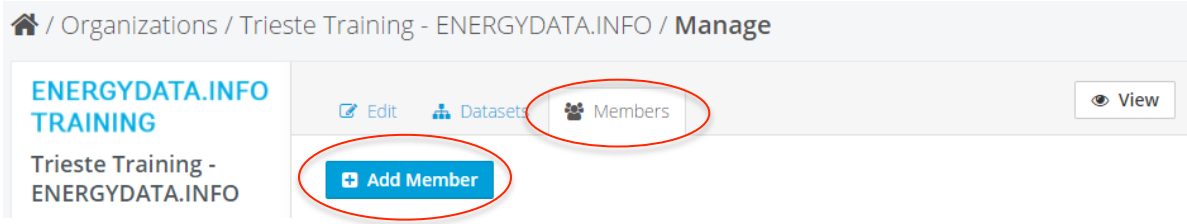
2 ADDING MEMBERS TO AN ORGANIZATION

- Managers of an organization can directly add members to their organization

From the organization page, click Manage



Then “Members” & Add Member



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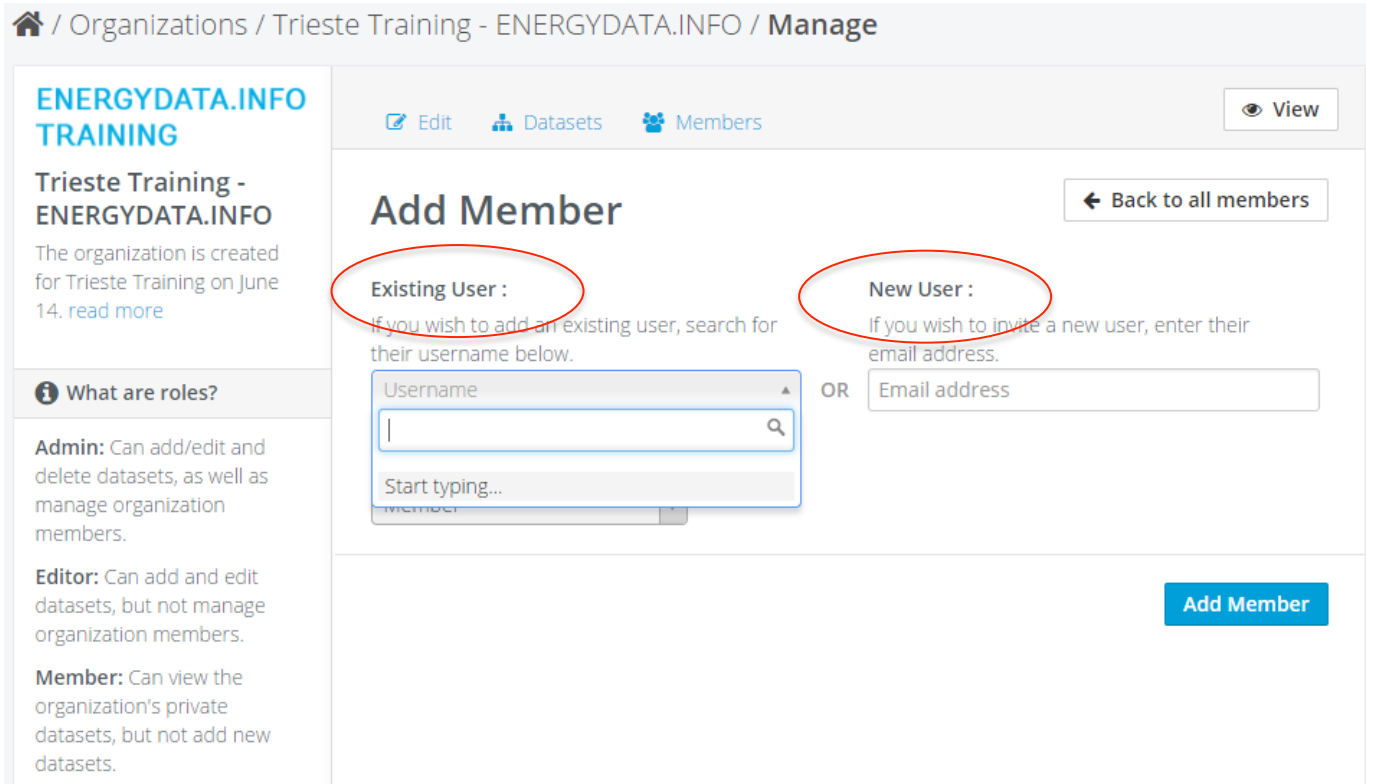
Organizations, members and access

2 ADDING MEMBERS TO AN ORGANIZATION

- Add an existing user by typing user name
- Add a new user by sending an invitation email to the user's email

From the organization page, click Manage and then



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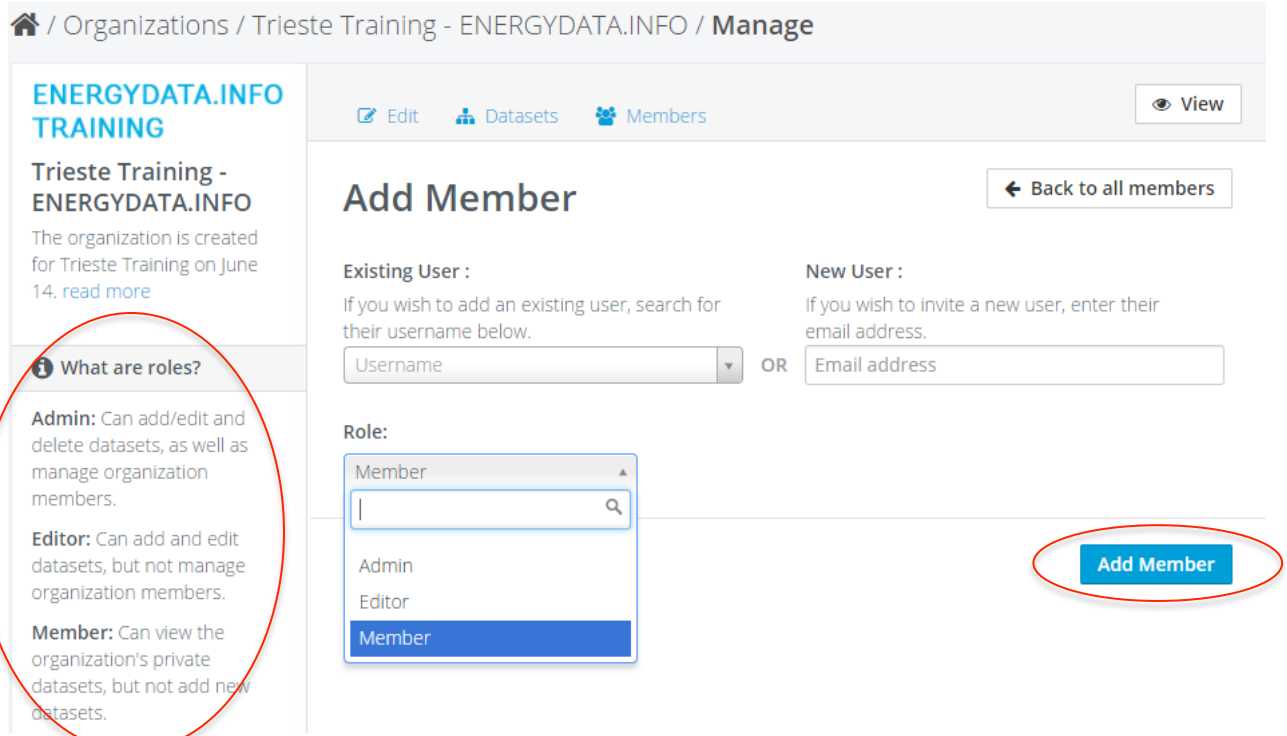
Organizations, members and access

3 ADDING MEMBERS TO AN ORGANIZATION - PERMISSIONS AND ACCESS

Members of an organization can upload datasets within their organization
There are three different types of members:

- **Admin (complete access, add and edit datasets and members)**
- **Editor (add and edit datasets)**
- **Member (view private datasets, but not add or edit)**



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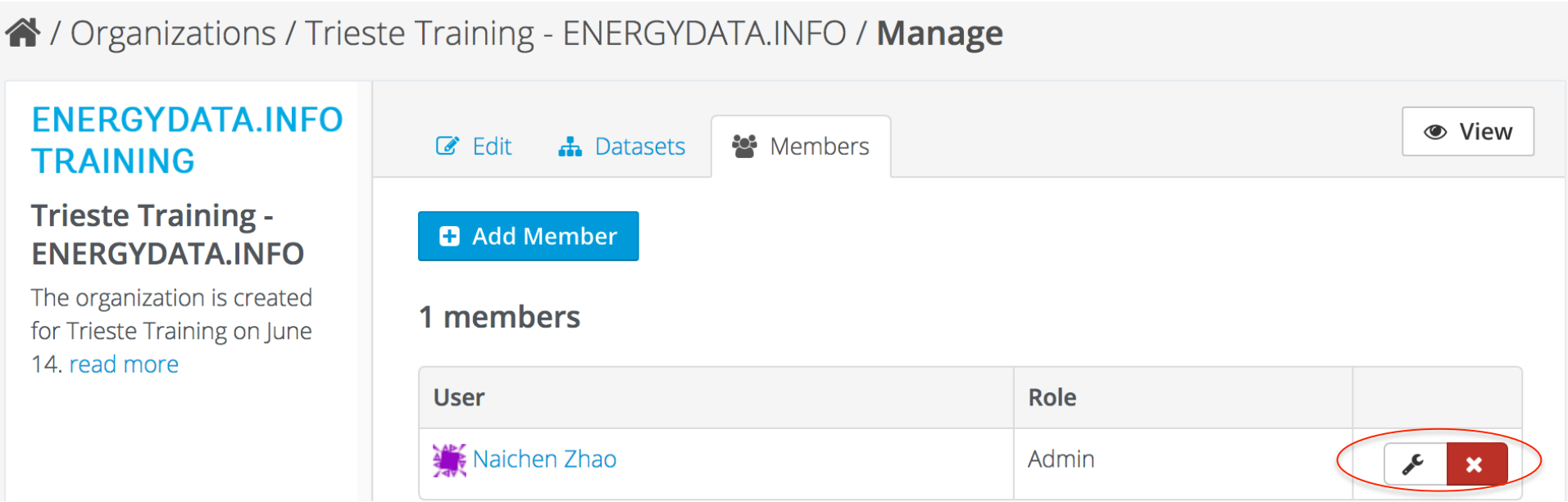
Organizations, members and access

4 CHECK ORGANIZATION MEMBERS

- User list & Role
- Edit & delete member button



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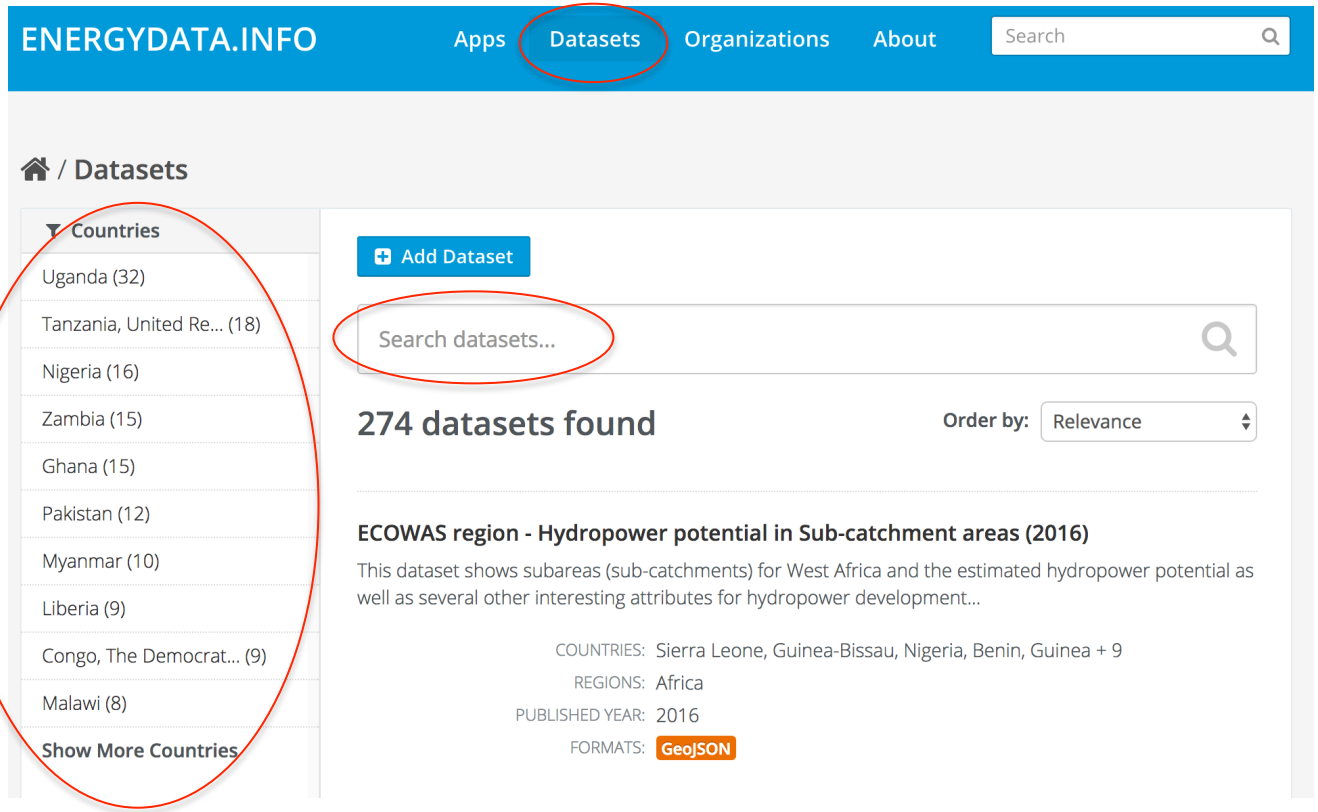
Download datasets

1 FIND THE DATASET OF INTEREST

- Click on “Datasets” button
- Use Search bar, Filtering bar (countries etc.)



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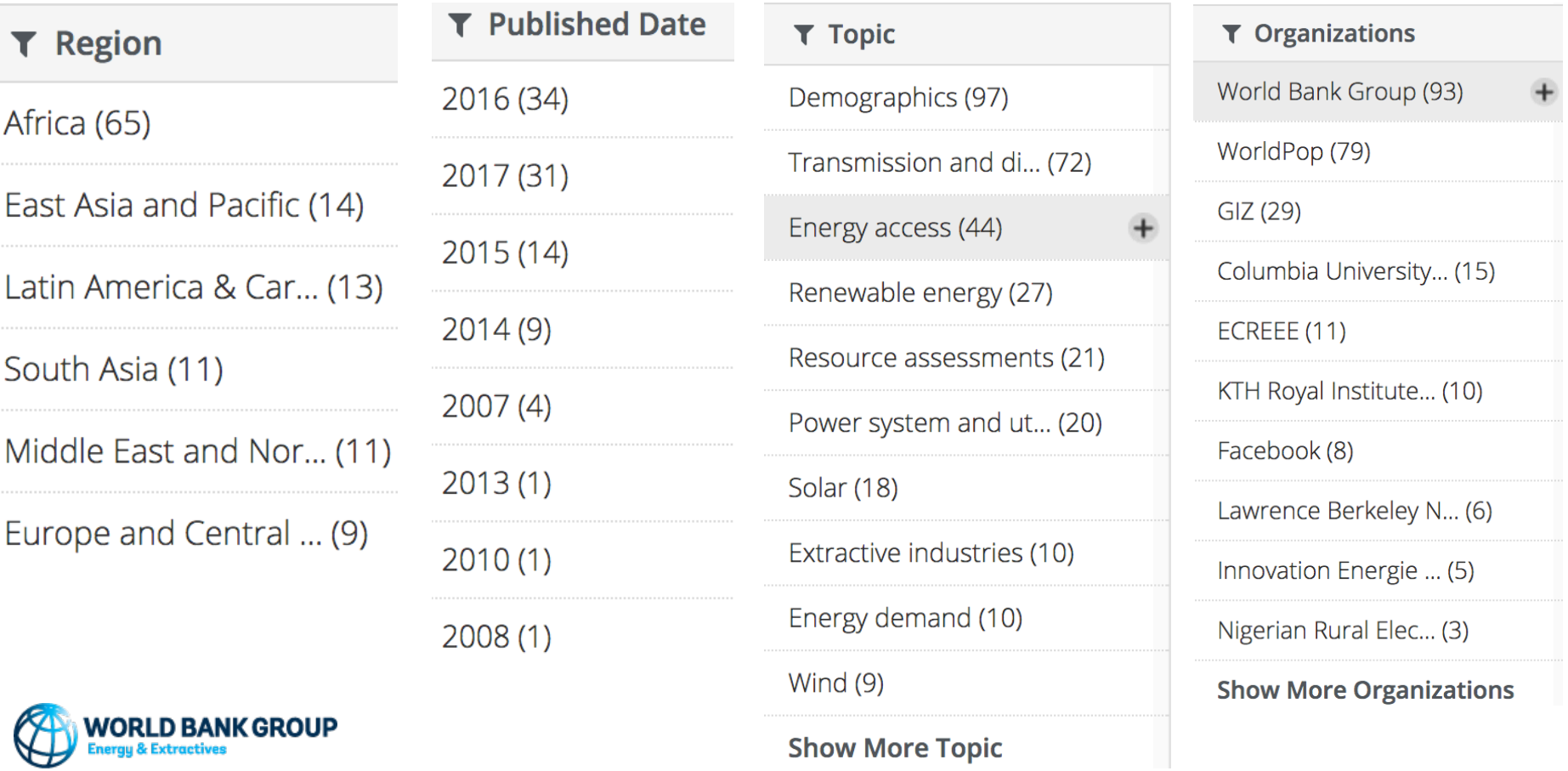
Download datasets

1 FIND THE DATASET OF INTEREST

- **Other Filtering bar - on the left side of the "Dataset" page**



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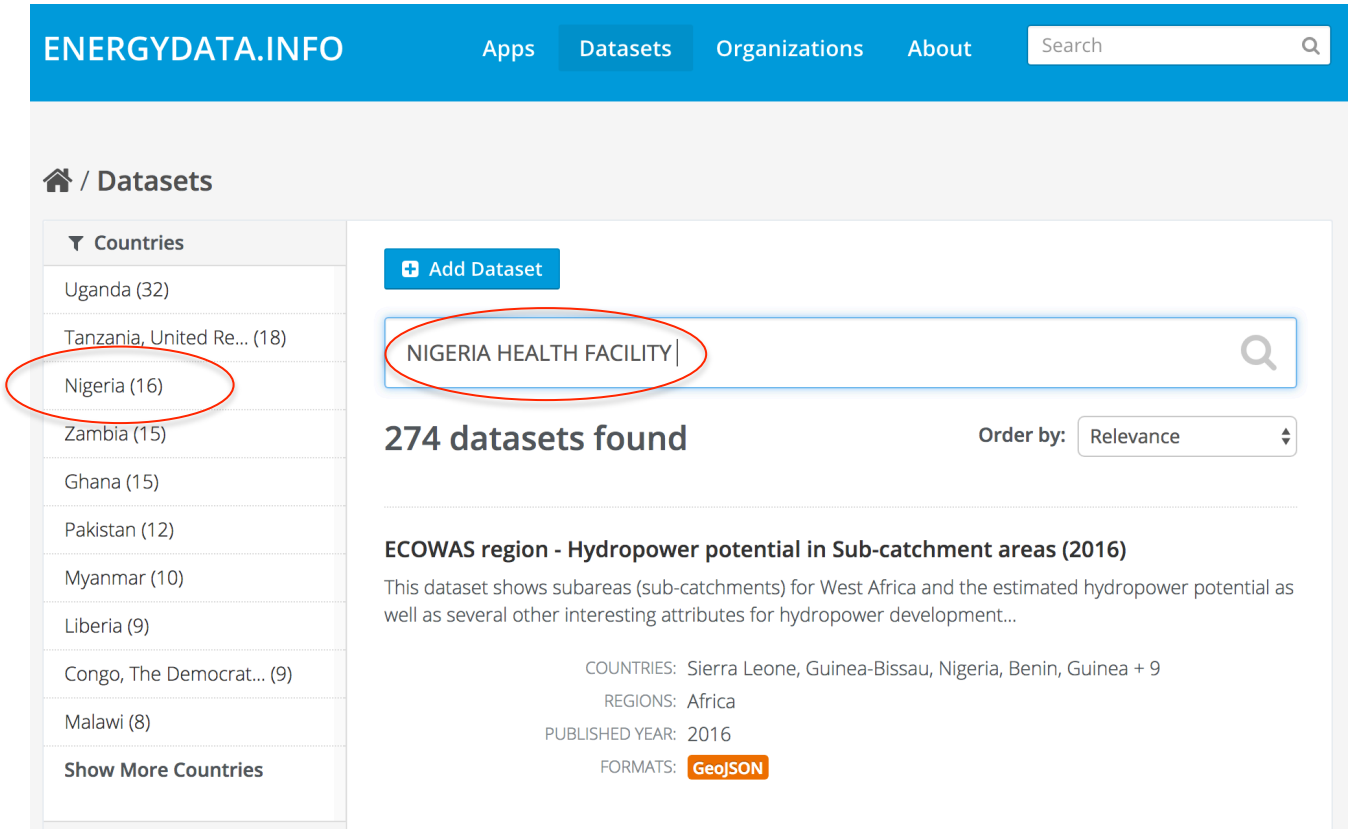
Download datasets

2 CHECK NIGERIA HEALTH FACILITY DATASET

- Click on “Nigeria” in Country filtering bar
- Use Search bar



Download datasets

3

NIGERIA HEALTH FACILITY DATASET PAGE

- Organization
- Description
- Data and Resources
- Additional Info

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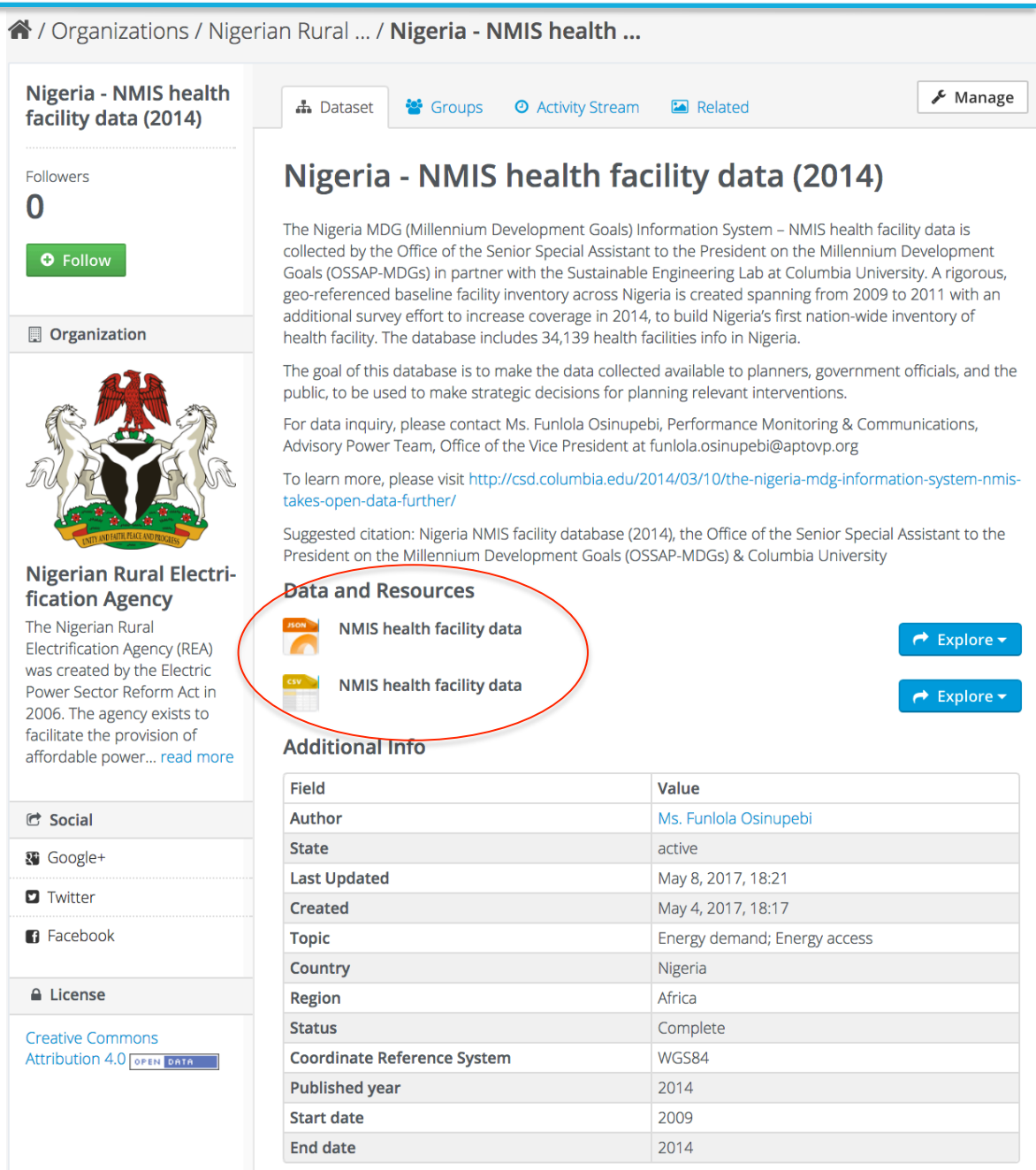


Download datasets

4 PREVIEW AND DOWNLOAD THE DATASET – Explore

- Preview the csv file
- Download the dataset

Process Datasets – Optional Practice

1 SUBSET ALL HEALTH FACILITIES WITH PHCN CONNECTION

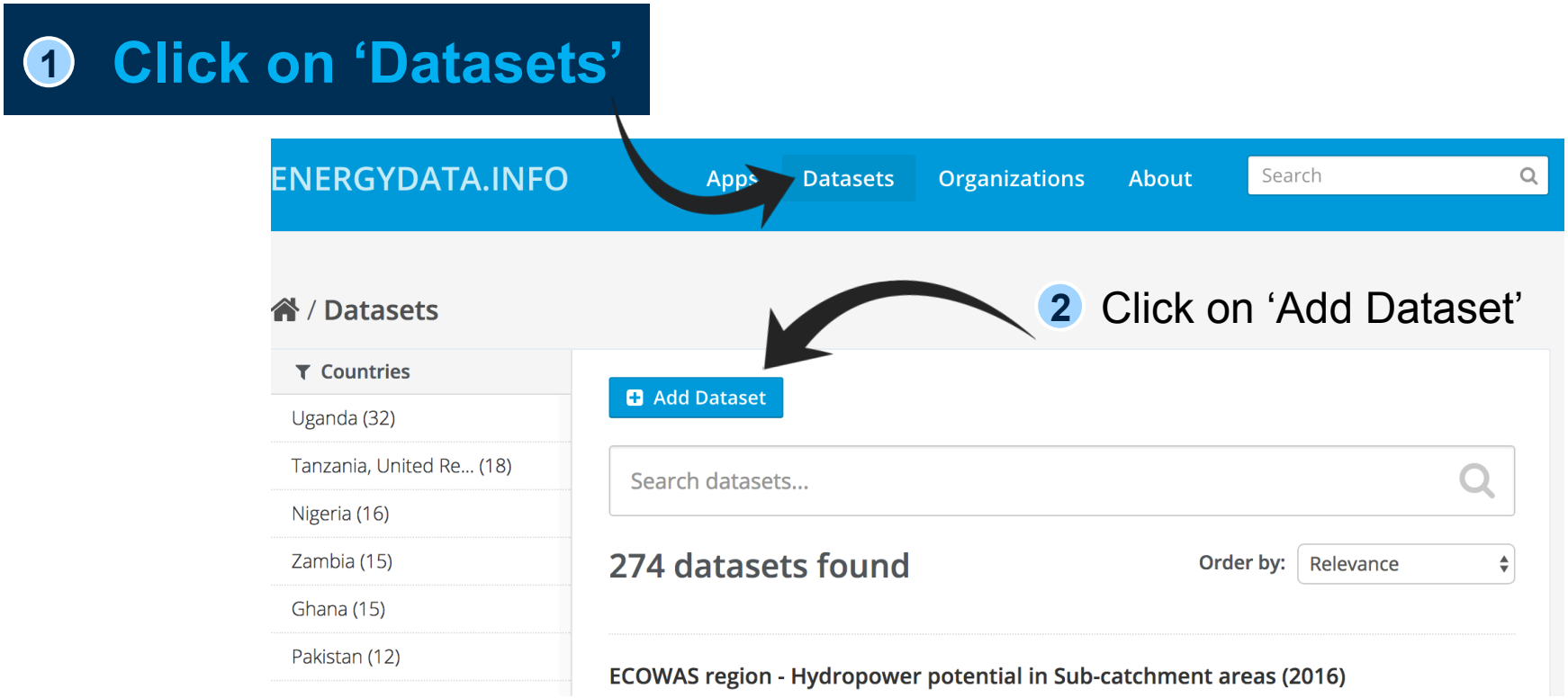
- Use Excel Filter function by column “phcn_electricity”.
- Open csv file in QGIS or ArcGIS to subset

2 Re-SAVE CSV / GEOJSON FILE TO SHAPEFILES

- Use QGIS or ArcGIS

Uploading new datasets

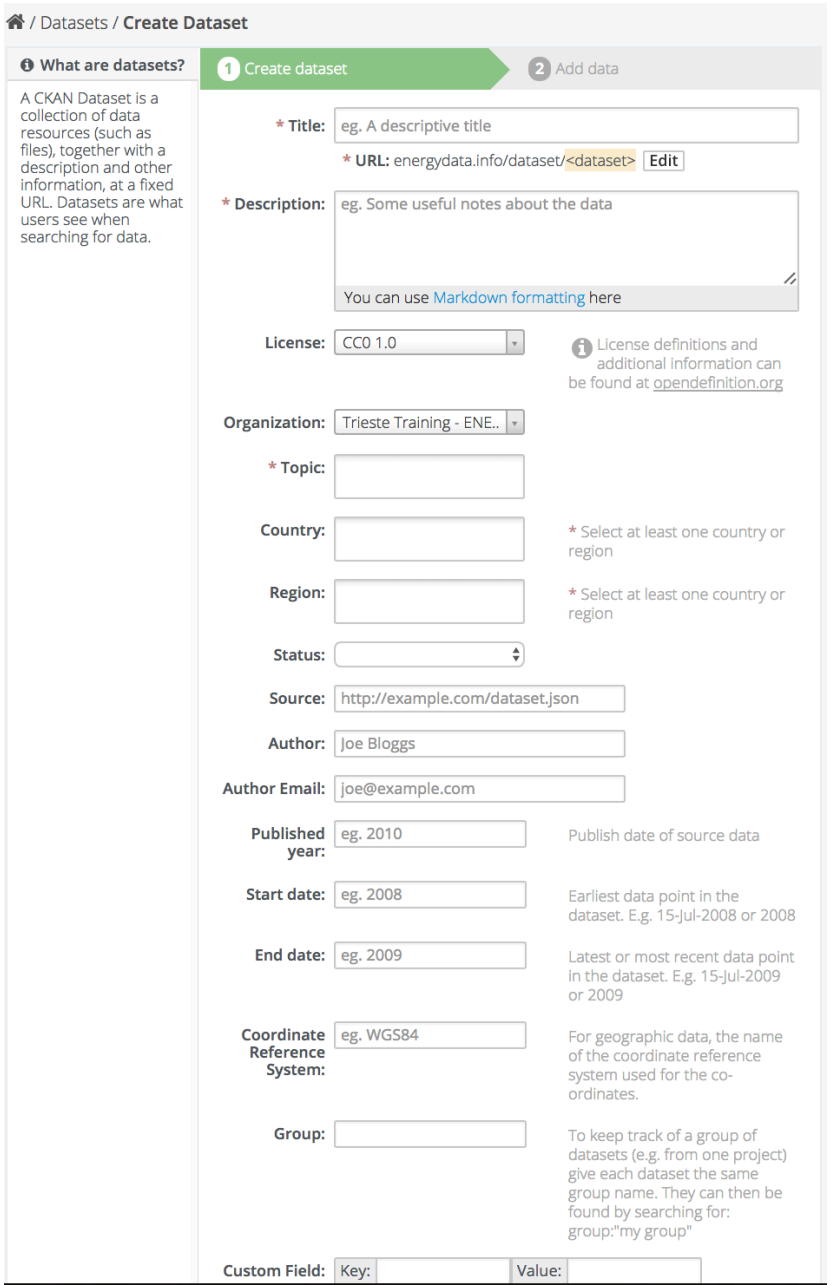
- Users must be either **editors or administrators** to upload new datasets
- In order to add a new dataset, follow these steps:



Uploading new datasets

3 Enter Metadata

- Mandatory fields: the title, description, Topic, Country/ Region, Published years
- Datasets should be named according to the following schema:
  Region/Country - Name (Date)
- Example: Kenya – Electricity Transmission Network (2017)
- Metadata should be added as accurately and completely as possible
- This ensures that data can be traced and the relevant people can be contacted
- Metadata and tags also help to search the database quickly



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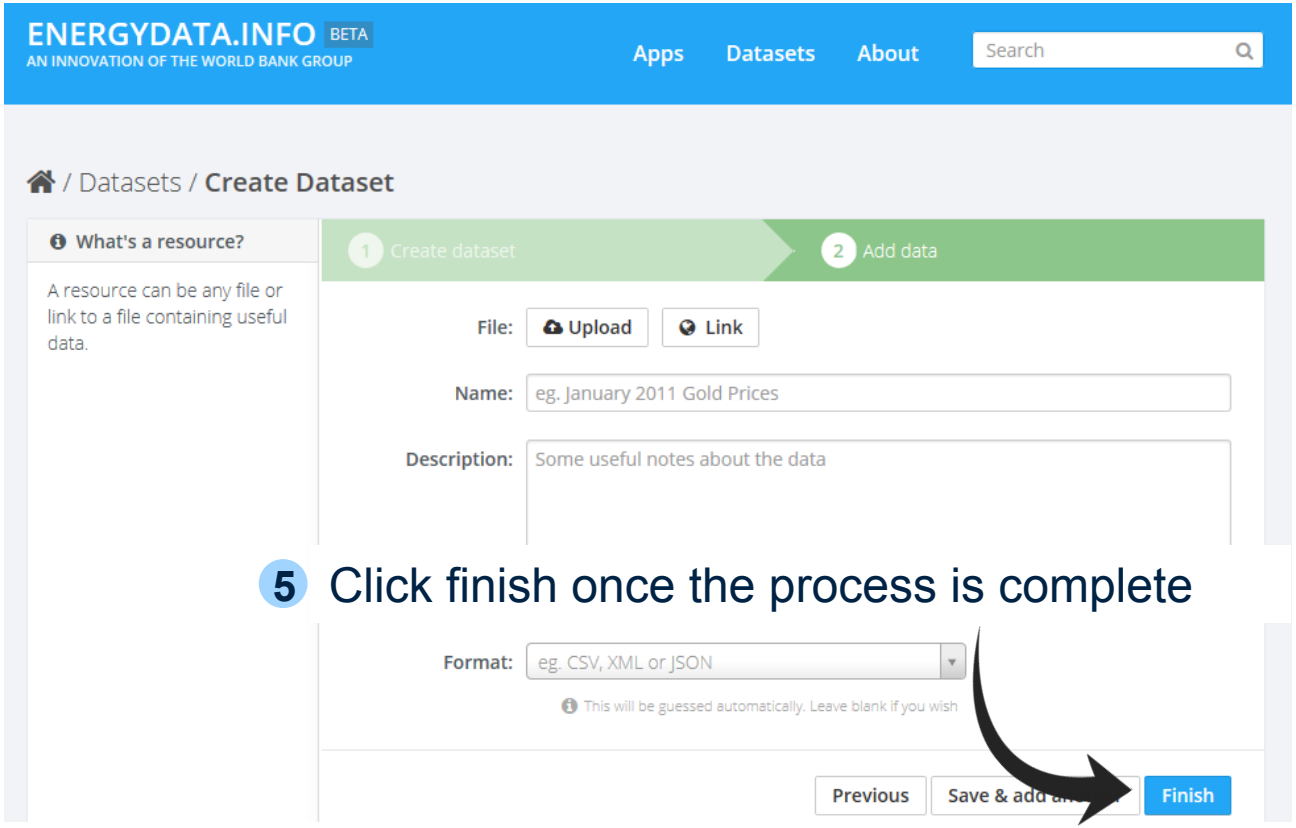
Uploading new datasets

4 **Upload files one by one, giving each a unique name and description, as well as specifying the format**



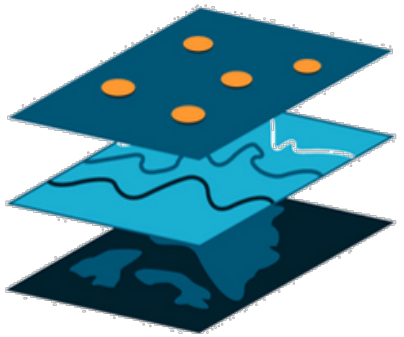
5 Click finish once the process is complete

Preferred formats for **geospatial** data

- Geospatial data is normally used by GIS (**Geographical Information Systems**) software, and is used for data where the geographical aspect is emphasized

- There are two types of geospatial data:
- **Vector data** represents points (e.g. power stations), lines (e.g. power lines) and areas (e.g. water bodies) with geographical coordinates and attributes. It is normally used to represent **categorical data**.
- **Raster data** represents continuous, both **quantitative** (altitude map) and **qualitative** (land use types) in a manner similar to a photograph, using individual pixels to represent data points.

- Vector data should be uploaded as **GeoJSON** (or Shapefile if necessary)
- Raster data should be uploaded as a **GeoTIFF**



Preferred formats for **time-series and other** data

- Time series data is data with a **time-varying element**, representing changes over a time period, such as data from a wind measuring station.

- This data frequently also contains geospatial element (the location of a measuring station), but **may not have precise coordinates**.
- This data emphasizes the time-variation and metadata (location, name, type) associated with it.

- Other data could be any **general energy-related data**, such as electricity prices. This might not have any geospatial element, except for an associated country/region.

- This data is typically stored as a **CSV** or **Excel** file, which can easily be explored with standard software.

Managing, deleting and API links

MANAGING A DATASET

1

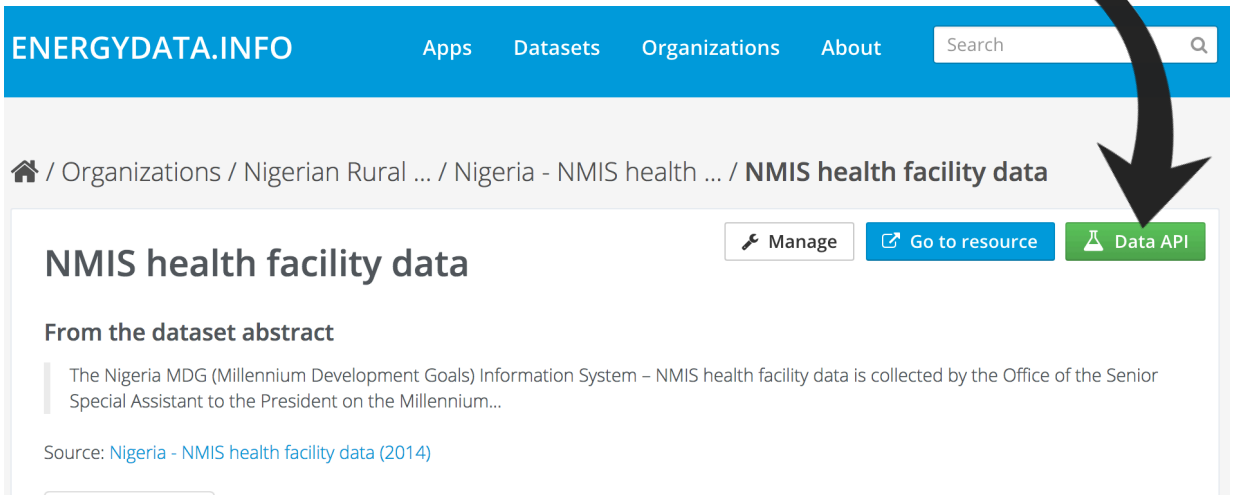
With the required permission you can:

- Modify the information and metadata for a dataset
- Add or update the data resources tied to it
- Re-order the resources (affecting which will be previewed on the main page)
- Delete a dataset

API ACCESS

2

- Certain data types (CSV among others) allow data to be created, updated and queried through API access, allowing automated interaction with datasets.



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Reporting issues and requesting changes on GitHub

- The website source is code is openly available on GitHub at: github.com/energy-data/energydata.info

- By creating a free GitHub account, you can report issues and participate in the development of energydata.info. In order to do so, please follow these steps:

1. Go to github.com/energy-data/energydata.info
2. Click on New issue and describe the issue/change that you would like to see. This message will be publicly visible and you can track the developers' response.

Overview

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1 Geo-located demand load centers

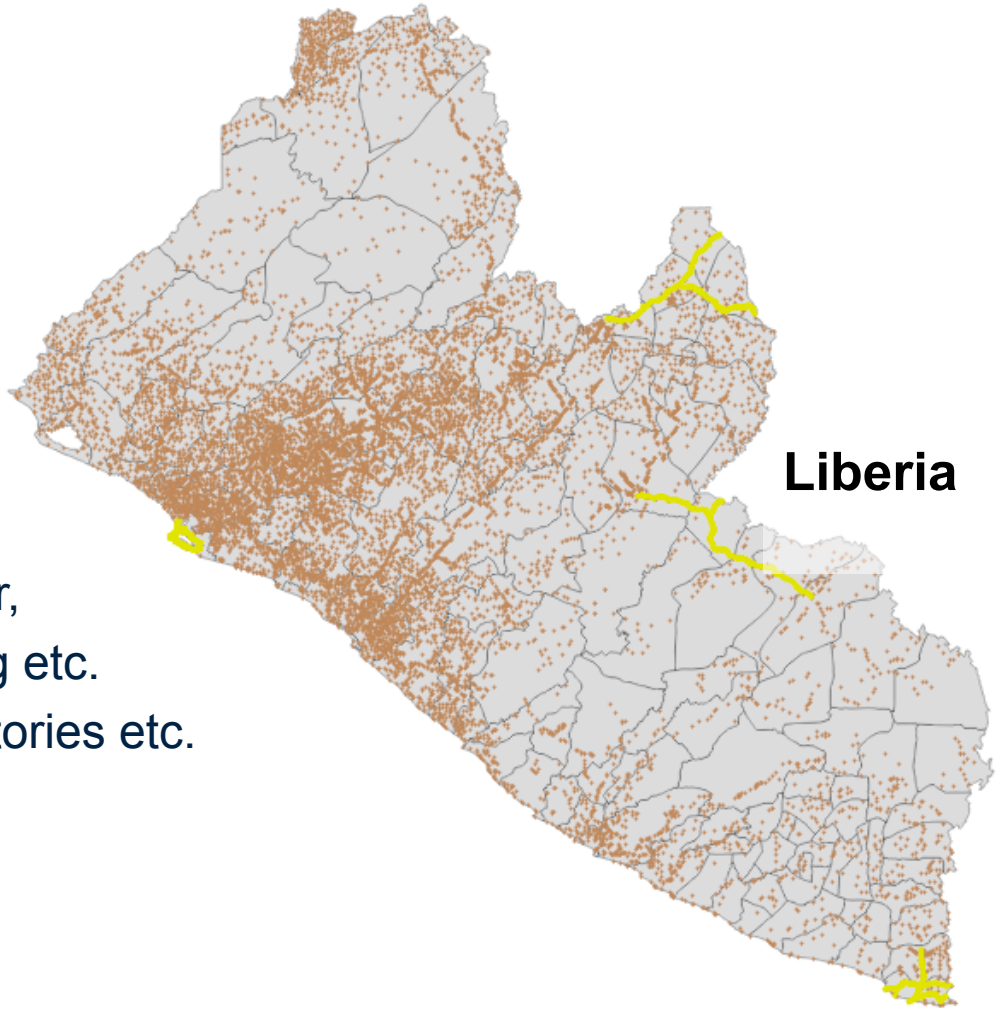
Geo-located demand load centers

- Where do people live – census data (or similar) represented with settlement points(villages, towns, cities) or enumeration areas
- Example – Liberia

  2008 Census:

  Geo-located settlement dataset

  ~13,000 points
- If no census data?



Other demand load centers:

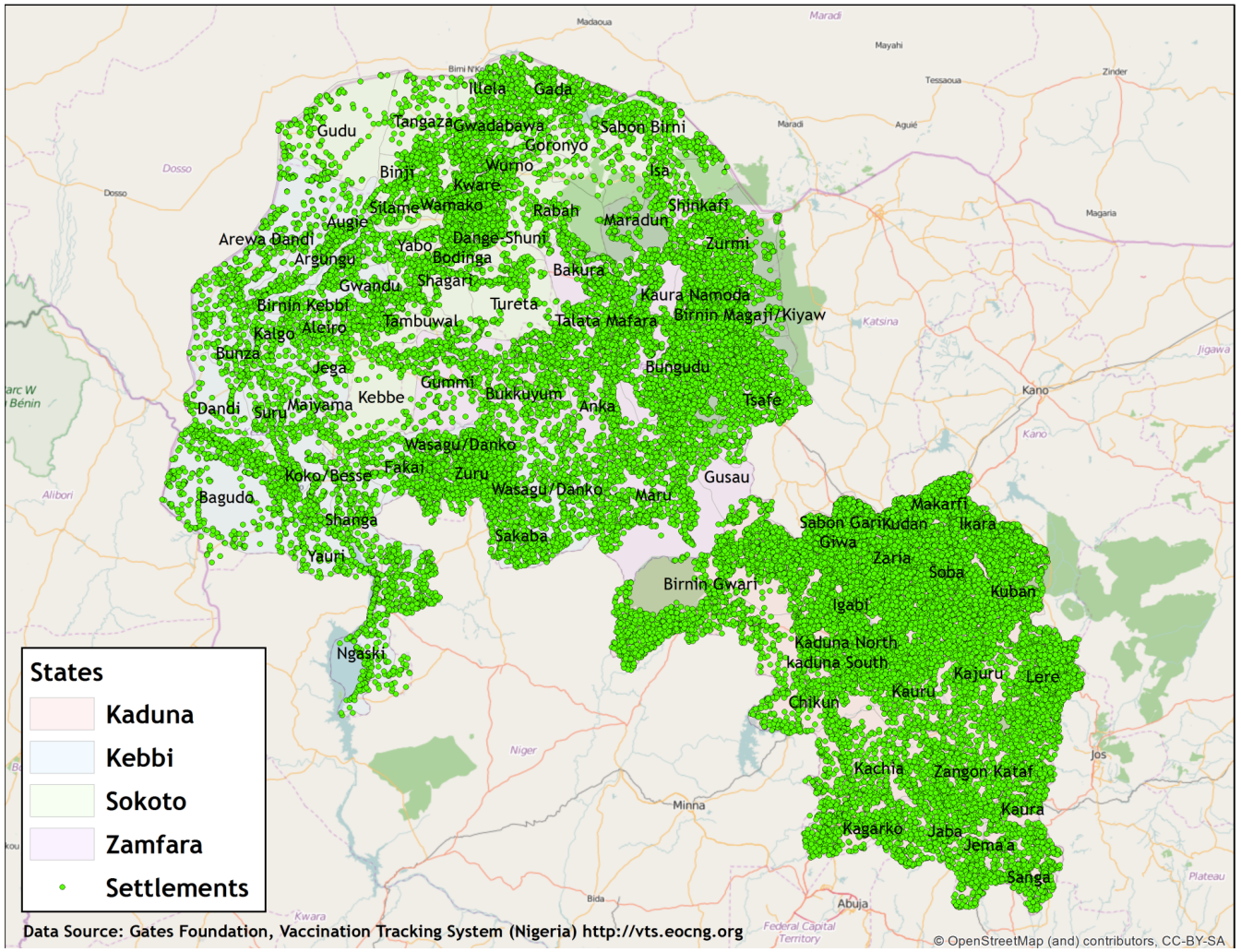
- Social facility demand:

  hospital, school, commercial center,

  public lighting, government building etc.
- Industrial demand: mining site, factories etc.

Geo-located demand load centers – if no census data

Nigeria 4 states - Populated settlements (Gates Foundation Polio Vaccination Project)



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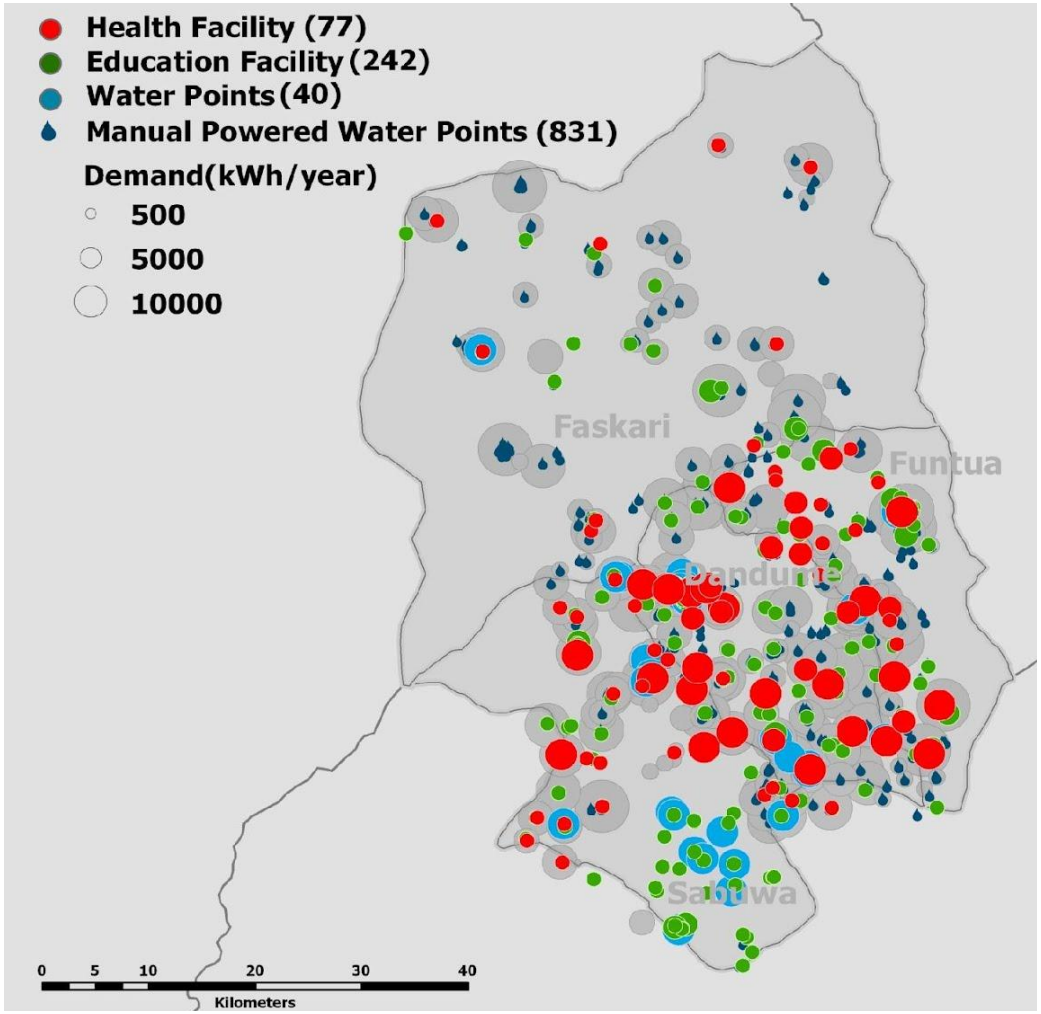
Geo-located demand load centers - Other demand load centers



- Multi-sectorial survey data for electricity planning
- Survey data for 4 LGAs in Nigeria
- Clinics, schools, water points for health & education facility, plus farming irrigation

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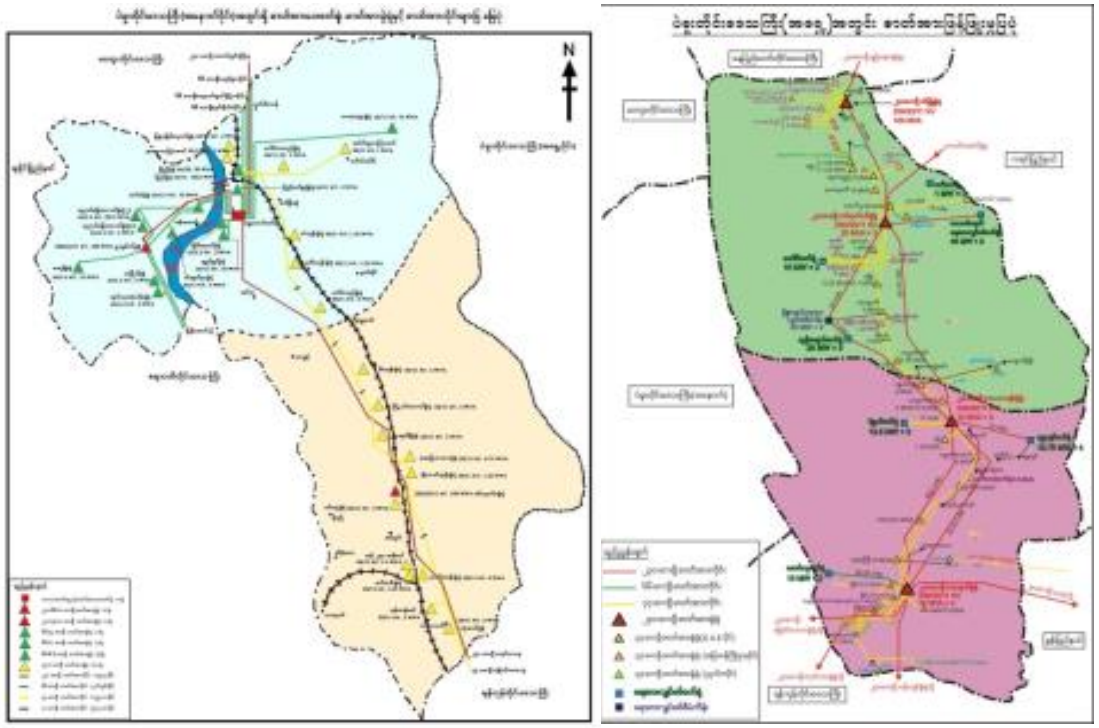
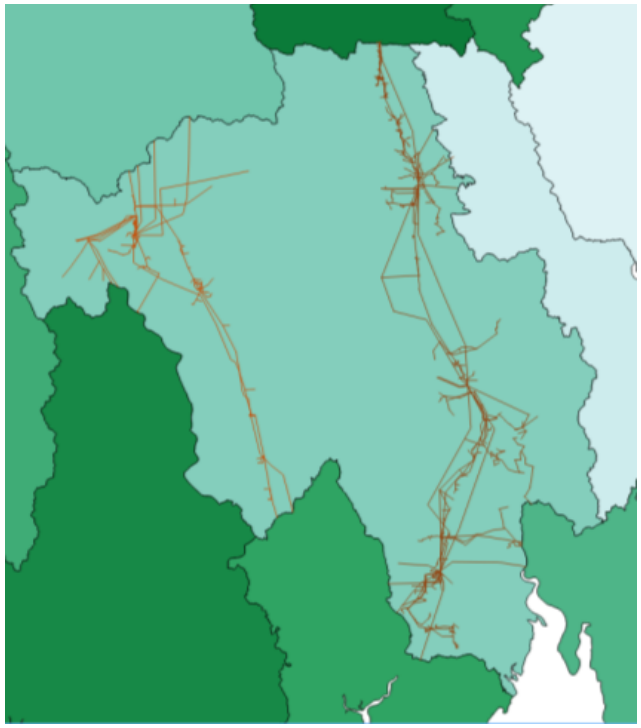
2 Geo-located existing infrastructure

Geo-located existing distribution/medium voltage grid lines – digitizing grid lines in Myanmar





State, district and township level MV line maps. (sample jpegs above for Bago Region)

Geo-reference and digitize to create GIS files.

(Bago Region MV file digitized).

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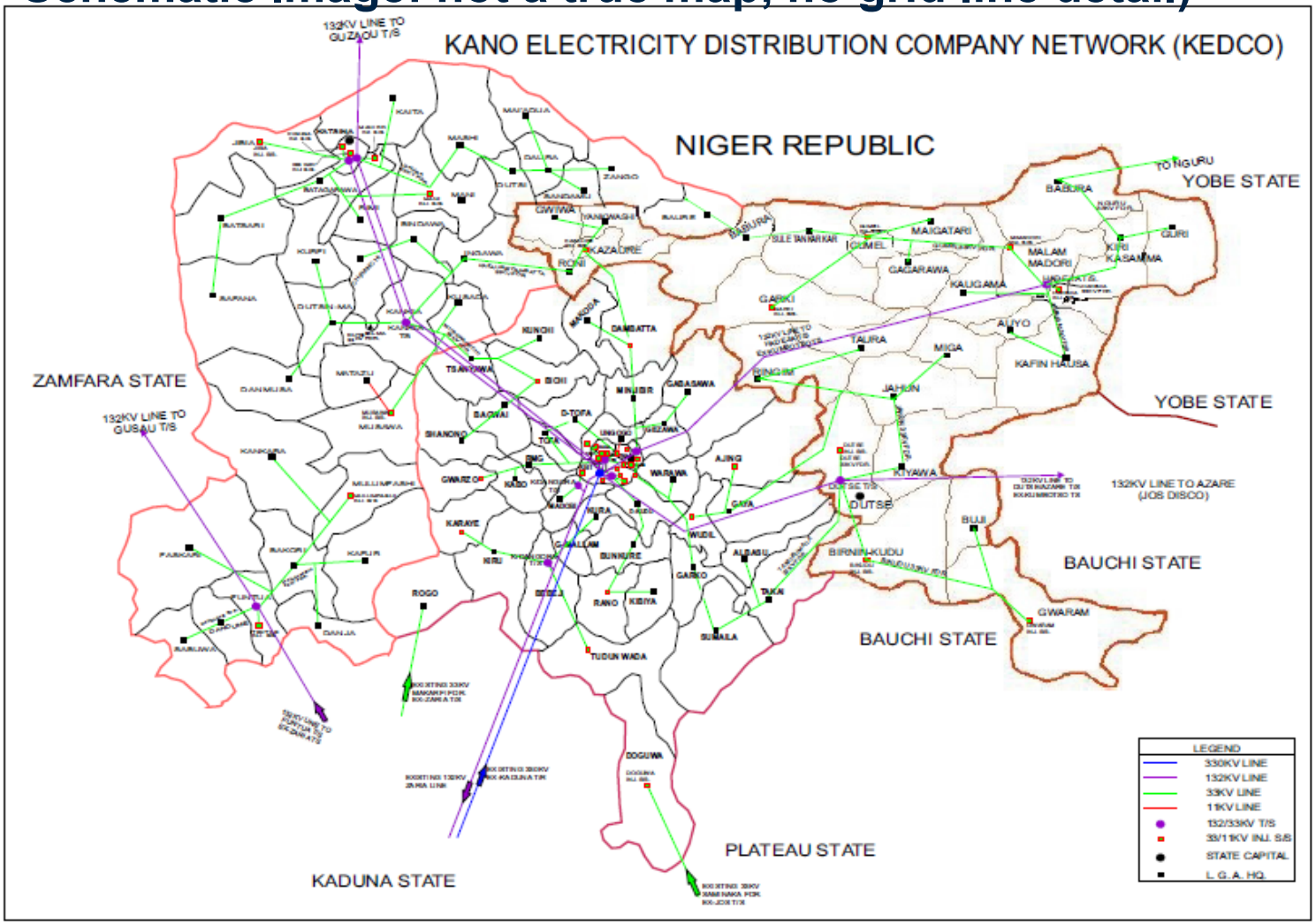
Geo-located existing distribution/medium voltage grid lines – field mapping grid line in Nigeria

Schematic Image: not a true map, no grid line detail)



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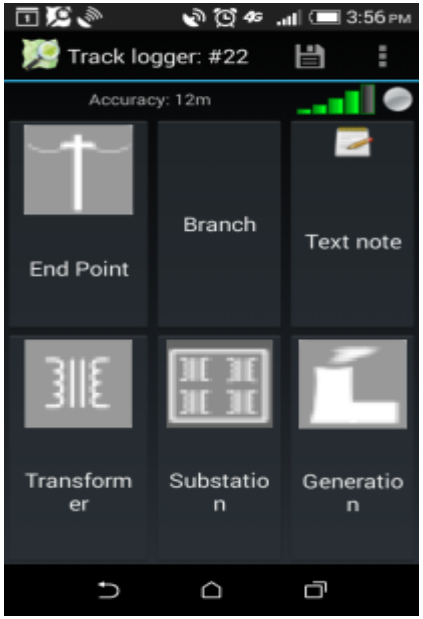
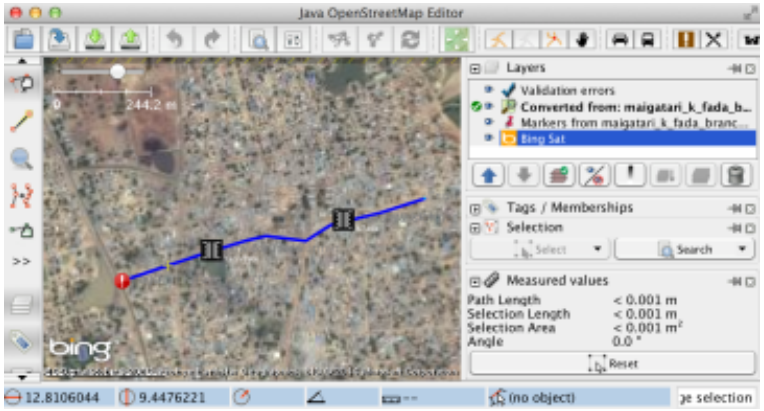
Geo-located existing distribution/medium voltage grid lines – field mapping grid line tools

OSM Tracker



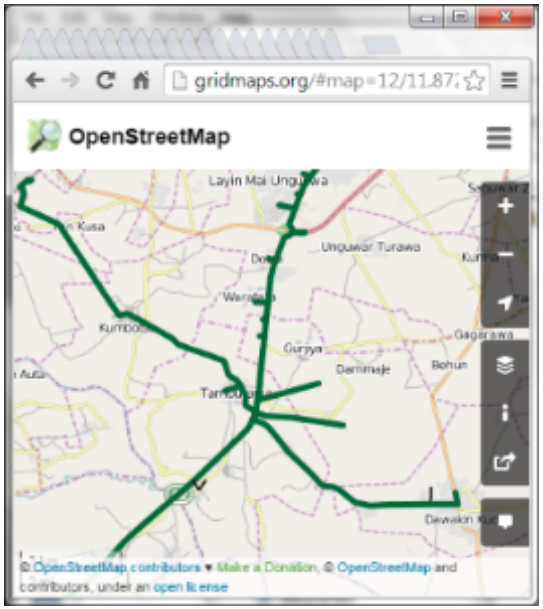
Android smartphone app
Useful for:
tracking lines
recording points

JOSM



- A desktop application
- Useful for:
  - Editing track data to create clean system map
  - Uploading data to server & handling conflicts from multiple users working on the same data

OpenStreetMap



- Online platform established to host mapped grid data
- Accessible by multiple users, password protected
  - technical staff and managers can view mapping progress and see the grid system in detail or as a whole

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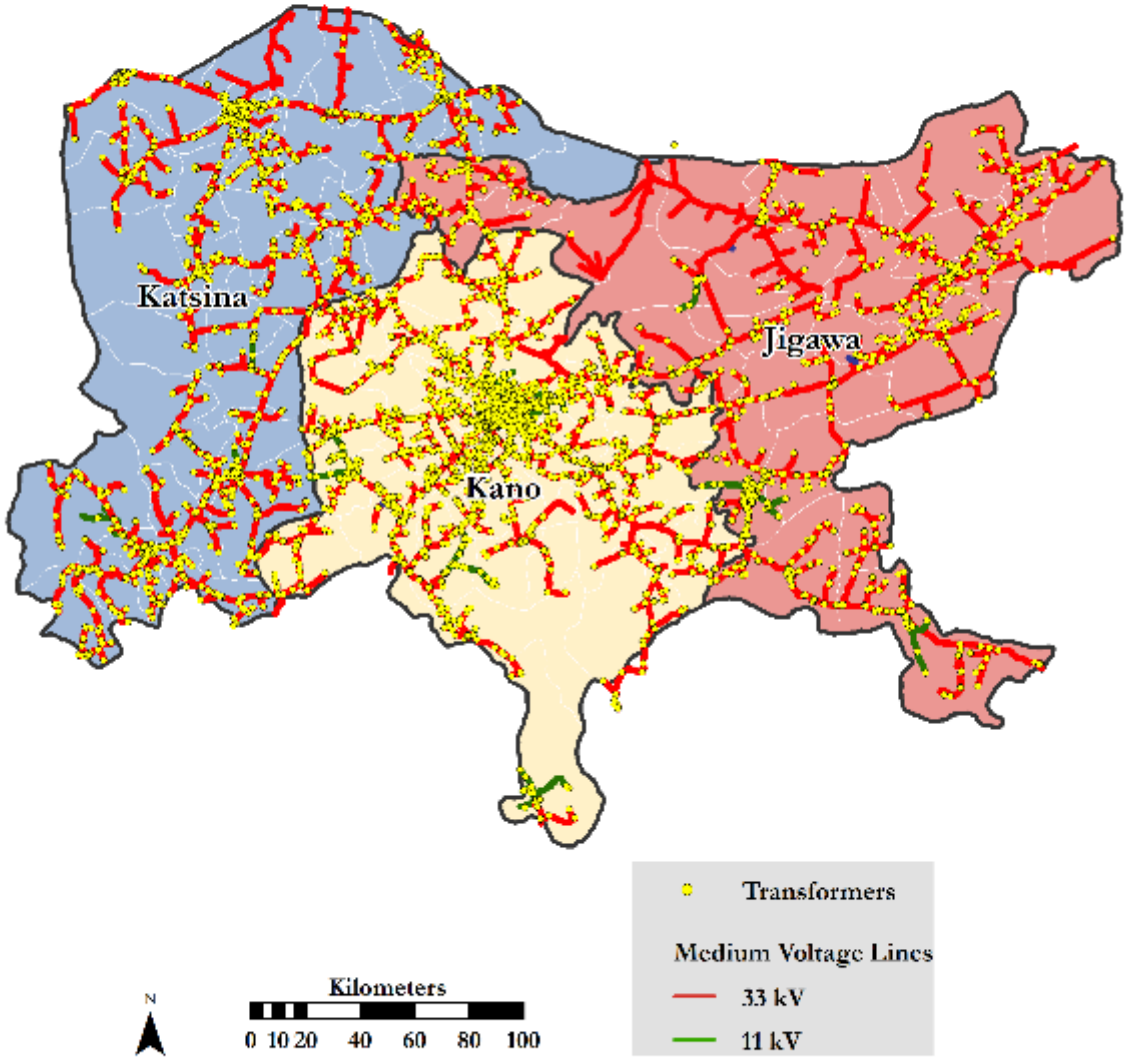
Geo-located existing distribution/medium voltage grid lines – field mapping grid line in Nigeria

- Capture of MV line using OSMTracker in truck
- Editing MV line data and upload to cloud-based system

Geo-located existing distribution/medium voltage grid lines – field mapping grid line in Nigeria results



Covers 3 states:

Kano, Jigawa, Katsina,
total population: ~23 million
total area: ~68,000 sq km

Training:

One week initial training with Android smartphones and open-source editing software
Utility trains its own staff to multiply the mapping workforce

Utility mapping:

~4 months, ~12 teams/vehicles
~10,000 km of MV line mapped
1 vehicle covers 20-100 km per day, depending on urban/rural

Map data includes:

MV line paths
Transformers
Sub-stations
Generation sites

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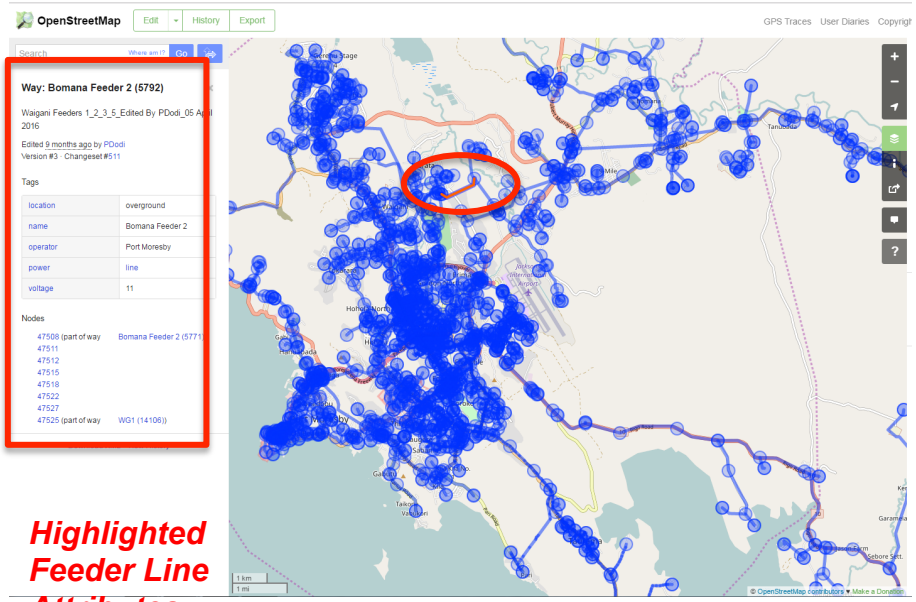
Geo-located existing distribution/medium voltage grid lines – field mapping grid line in Nigeria results

Cloud grid line data platform



Highlighted Feeder Line Attributes (collected in the field)

BENEFITS

- More efficient asset mapping with accurate distance measurement
- Provides inventory of utility assets for O&M and load flow analysis
- Facilitate electrification planning exercises
- Easily use of Open Street Map (free tools) & cellphones
- Easily updatable, available online for future data gathering
- Easily editing online or free desktop software

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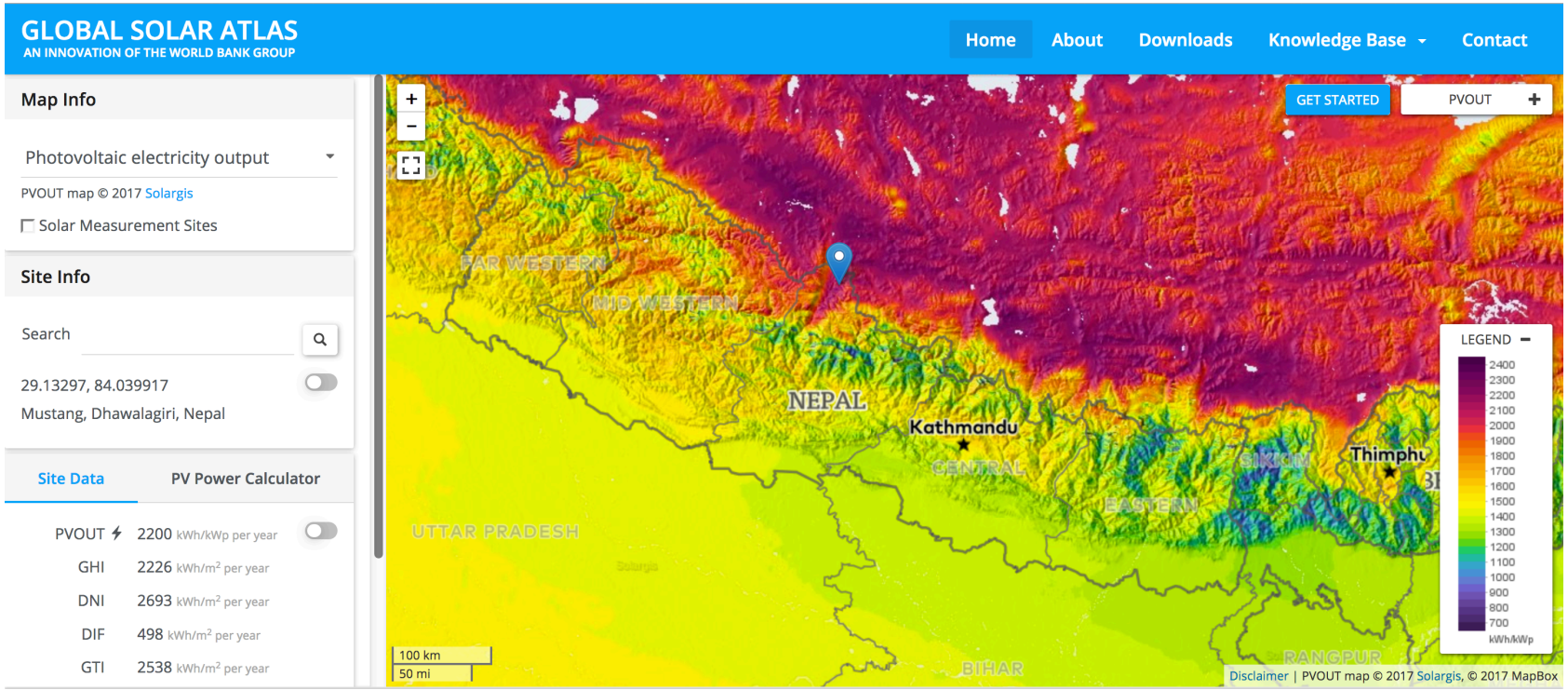
Geo-located existing & potential generation site

- Existing & planned generation sites
- Renewable energy resource mapping and location identification: hydro power for Nepal
- Solar and Wind: Global Solar Atlas <http://globalsolaratlas.info/>



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THE WORLD BANK IBRD • IDA
IFC International Finance Corporation

ESMAP Energy Sector Management Assistance Program
SOLARGIS

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Energy & Extractives

3 Technical & cost & financial parameters

Technical & cost & financial parameters – Household Demand in kilowatt-hours per year (kWh/yr)

Demand level corresponds with appliances

50 kWh/year per HH?

250-500 kWh/year per HH?

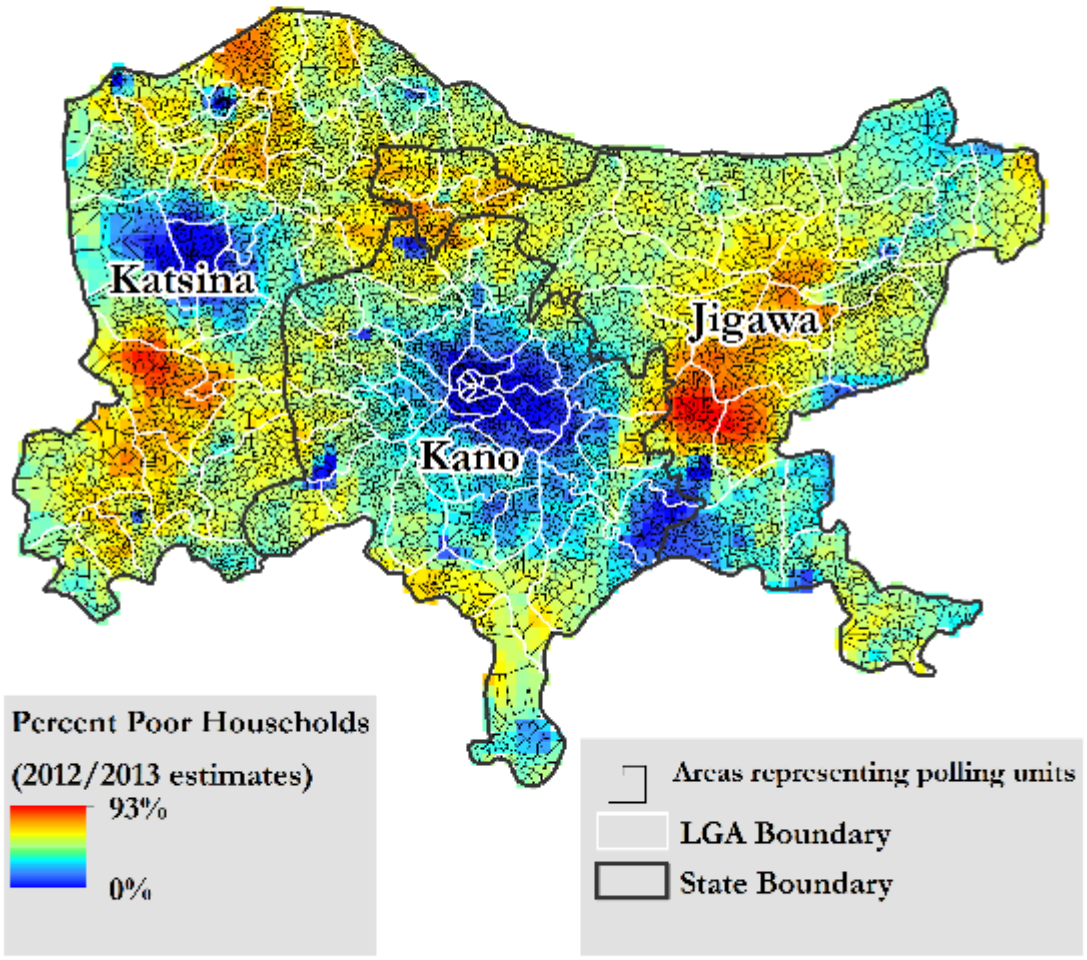
1,000 kWh/year per HH?

Low (~140 Wh/day): lighting, cell phone (lantern? home PV system?)

Med (~1 kWh/day): small TV, fan (solar or hybrid micro grid?)

High (~3 kWh/day): above uses + cooking, refrigeration (micro-grid, grid?)

Technical & cost & financial parameters – Household demand in kilowatt-hours per year (kWh/yr) with poverty rate



- Poverty Study provided percentages for poor vs. non-poor population
- According to utility bills and interviews, obtain household demand in kWh/year for poor and non-poor households
- Combining poverty study percentages and these two demand values, calculate a weighted demand for each populated settlement

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Technical & cost & financial parameters – Other important parameters

- **Technical parameters:**
  - System loss for grid, mini-grid, off-grid including distribution loss & generation loss
  - Available transformer, diesel generator, solar panel sizes in local market
  - Operation & maintenance cost as percent of initial cost
  - Etc…
- **Cost parameters:**
  - Procurement cost for equipment: transformer; diesel generator; distribution line etc.
  - Labor cost: system installation cost
  - Transportation cost
  - Etc…
- **Financial parameters:**
  - Interest rate
  - Project time duration
- **Data collection methods:**
  - Previous procurement documentation
  - Interviewing utility engineer & planning officers
  - Other resources – research organization, NGOs etc.

Thank you!

For additional information, please contact:

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Chris Arderne
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