

GEOSPATIAL PORTFOLIO PLANNING

MINI GRIDS FOR HALF A BILLION PEOPLE



WORLD BANK GROUP
Energy & Extractives

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10 building blocks to deploy mini grids at scale

Where We Are Today

47 million people connected to **19,000 mini grids**, mostly hydro and diesel-powered, at an investment cost of **\$28 billion**. Plus: 7,500 mini grids planned, mostly in Africa, mostly solar-hybrid, connecting more than 27 million people at an investment cost of \$12 billion.

Where We Want to Be to Reach Universal Access by 2030

490 million people served at least cost by **210,000 mini grids**, mostly solar-hybrids, requiring an investment of **\$220 billion**.

10 Building Blocks need to be addressed in countries to deploy mini grids at scale: (i) solar-hybrid technology and costing, (ii) **geospatial portfolio planning**, (iii) income-generating uses of electricity, (iv) community engagement, (v) local and international industry, (vi) access to finance, (vii) training and skills-building, (viii) institutional framework, (ix) workable regulations, and (x) enabling business environments.

Why geospatial planning, why now?

- Technological advances and cost reductions in satellite imaging and machine learning
- Increased sophistication of algorithms and analytical software
- Proliferation of global positioning system (GPS) devices and Web-based and mobile technologies
- Availability of high-quality open-source software
- Accessibility of big data and cloud-based computing

National Least-Cost Electrification Planning



Typical Least-Cost Electrification Planning Sequence



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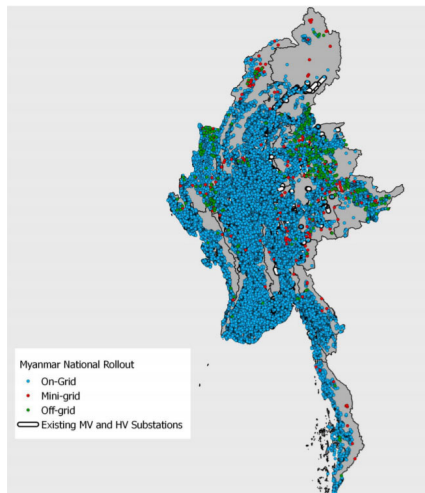
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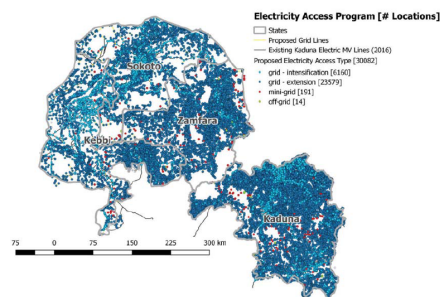
Even though these national plans for the first time in history include all options for electrification—grid extension, mini grids, and off-grid—they still rely to some extent on chosen input assumptions that can result in a more advantaged position of one solution over the other. It is important that, during the preparation of these plans, the different stakeholders are carefully consulted so that the ultimate outcome is carried out by as many stakeholders as possible. Countries using advanced geospatial analysis to develop national electrification plans include Ethiopia, Kenya, Myanmar, Nigeria, and Rwanda.

National Least-Cost Electrification Planning Outputs

Myanmar



Nigeria (4 states)



Source: Myanmar National Electrification Program (NEP) Roadmap and Investment Prospectus, Castalia, 2014; Achieving Universal Access in the Kaduna Electric service area, World Bank, 2015

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Countries are using geospatial analysis to develop national electrification plans that clearly delineate areas for mini grids (figure ES.5). Through a geospatial approach to national electrification planning, the

existing grid network is mapped and its attributes are digitalized. The supply of and demand for electricity are geo-located and overlaid with supporting data, including demographic (population density and growth

patterns); social infrastructure (schools, health centers, churches, administrative offices); and economic (household income, poverty, commercial activities, willingness to pay) data. Spatial modeling then delivers a

least-cost plan that identifies the optimal grid or off-grid technology—technology that is tailored to local circumstances, technically feasible, and economically viable.

National Least-Cost Electrification Planning in Africa



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Mini Grid Portfolio Planning



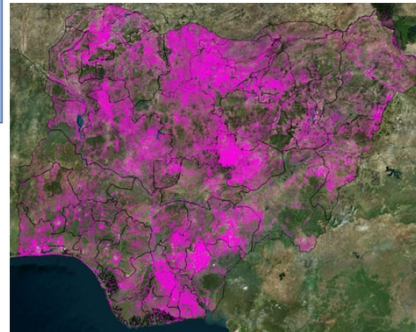
Mini Grid Portfolio Planning



Site Identification and Prioritization

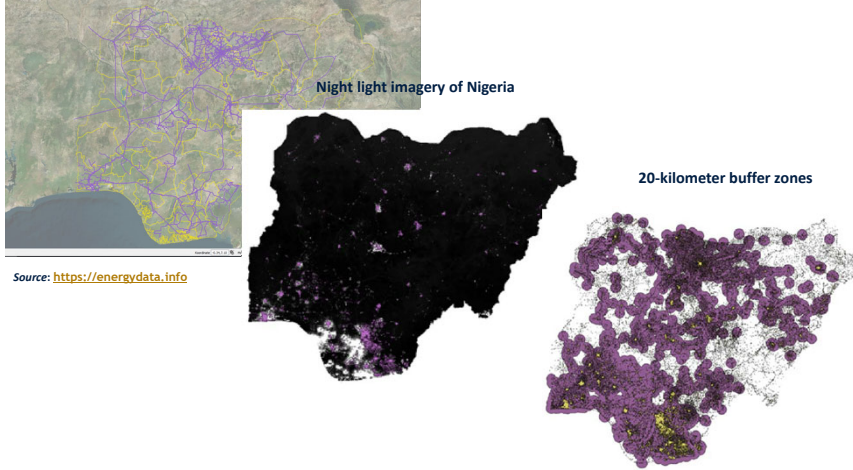
| Input Data | Processing | Result |
|---|---|--|
| Build-up raster data Pixels with presence of build-up structures are depicted in light colors | Vectorizing, Buffering & Dissolving in order to indicate precise settlement boundaries | Settlement Clusters Outline of settlement structures result from merging the three input data types. |
| OSM Land use Land use types are colored individually (residential in red, industrial in blue) | Filtering, Buffering & Dissolve Extracting residential landuse and reducing polygon count |  |
| OSM Buildings Open source mapped polygons ... | Clipping & Clustering Finding additional buildings not covered in other data sets and clustering them | |

Source: RLI and Integration



Site Identification and Prioritization

Map of available geospatial grid data coverage in Nigeria



Site Identification and Prioritization

Additional socio-economic data available for entire Nigeria are number of schools, health facilities and telecom towers currently relying on diesel generators.

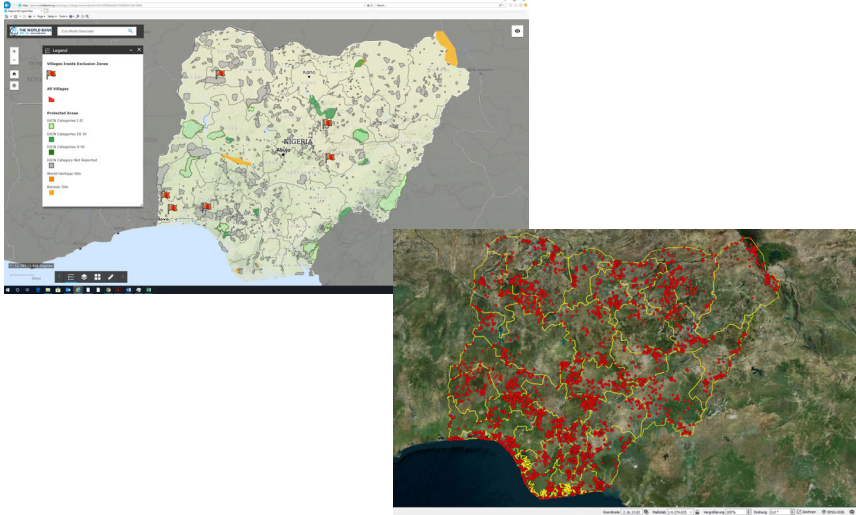
Exclusion Criteria:

- Exclusion of sites with distance to grid <5km
- Exclusion of sites with population < 1,000
- Exclusion of sites that fall within protected areas, national parks and other ecologically sensitive zones

Prioritization Criteria:

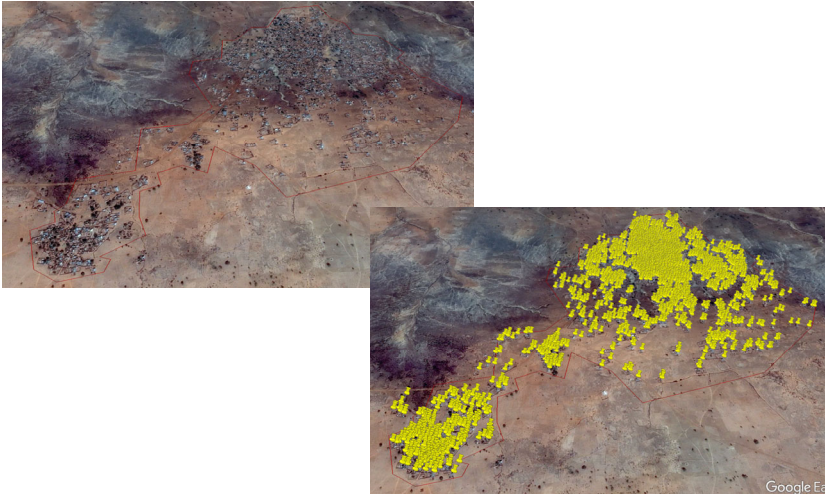
- Ranking of sites based on population, density, schools, health facilities, distance to grid, anchor customers.

Site Identification and Prioritization

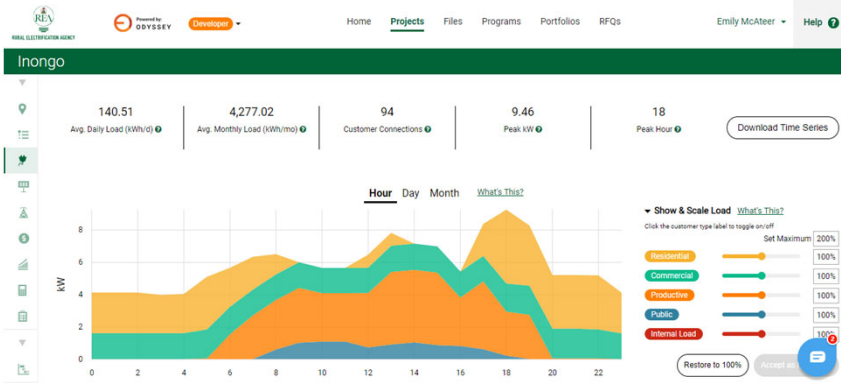


Source: RLI and Integration

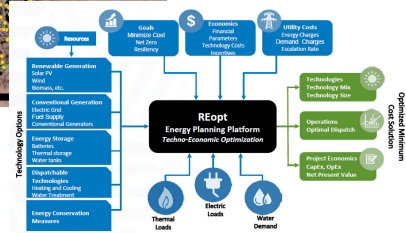
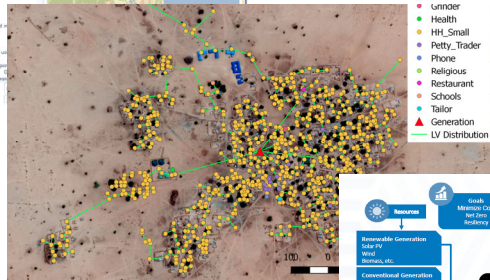
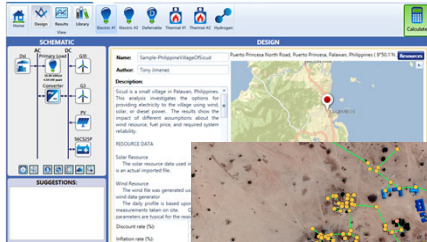
Customer Mapping



Survey Data Collection and Load Modeling



System Optimization



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Online Platform

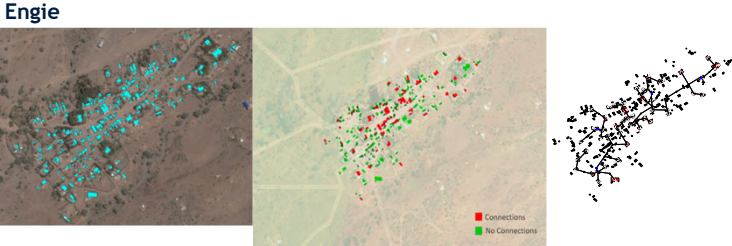
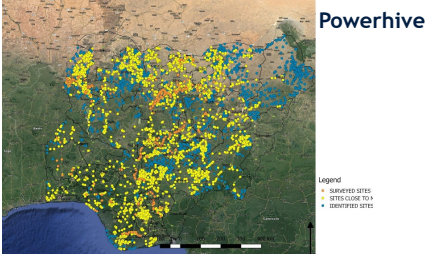
The screenshot displays a complex web-based interface for energy project design. It includes several key components:

- Map View:** A satellite map showing project locations with red and blue markers.
- Table 1: Generation Design Data**

| Name | Source | Sub-PTV | Generator | Storage | Load Met | Renewable Fraction | CAPEX | OPEX |
|------------|--------|----------------|----------------|------------------------|----------------|--------------------|----------------|----------------|
| Category 1 | HOMER | 50 kW | Diesel, 40 kW | 201 (210kWh) Lead Acid | 100% | 40.0% | \$19,024.14/kW | \$148,473.45 |
| Category 2 | HOMER | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated |
| Category 3 | HOMER | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated |
| Category 4 | HOMER | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated | Not Calculated |
- Table 2: Customer Connections**

| Type # | Details # | Quantity # | Unit Cost # | Unit # | Total Cost # | |
|--------|--|---|-------------|----------|--------------|----------|
| 1 | Single-phase Meter & Customer Connect... | 88 | \$70.00 | customer | \$6,160.00 | |
| 2 | Metering | Three-phase Meter & Customer Connect... | 3 | \$125.00 | customer | \$375.00 |
- Diagram:** A schematic diagram of a power system showing a generator, a substation, a transformer, and a load.

Private Developer Initiatives



Conclusions

Impact of Geospatial and Digital Tools

- Significant **reduction in pre-investment costs** associated with mini grid development
- **Unprecedented scale** possible because of the low costs involved
- **Swifter speed** compared to traditional approaches that require the deployment of multi-disciplinary teams at considerable expense
- Experience from Nigeria suggests mini grid portfolio planning already feasible at a cost of approximately \$2300 per site, with scope for further cost reduction

Thank You

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