Bringing Electricity to Rural Households in India and Kenya

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ENERGY INSTITUTE AT HAAS

tier

Two countries and two technologies

Kenya: subsidized grid connections

India: Smart microgrids

Major economic and policy questions

- What are the main barriers to getting electricity service to more people?
- In what ways does electricity service influence a household's well-being?
- What are the environmental impacts (local and global) of different electricity connection technologies? Of an electricity connection relative to the alternative?

Connectivity challenges in India

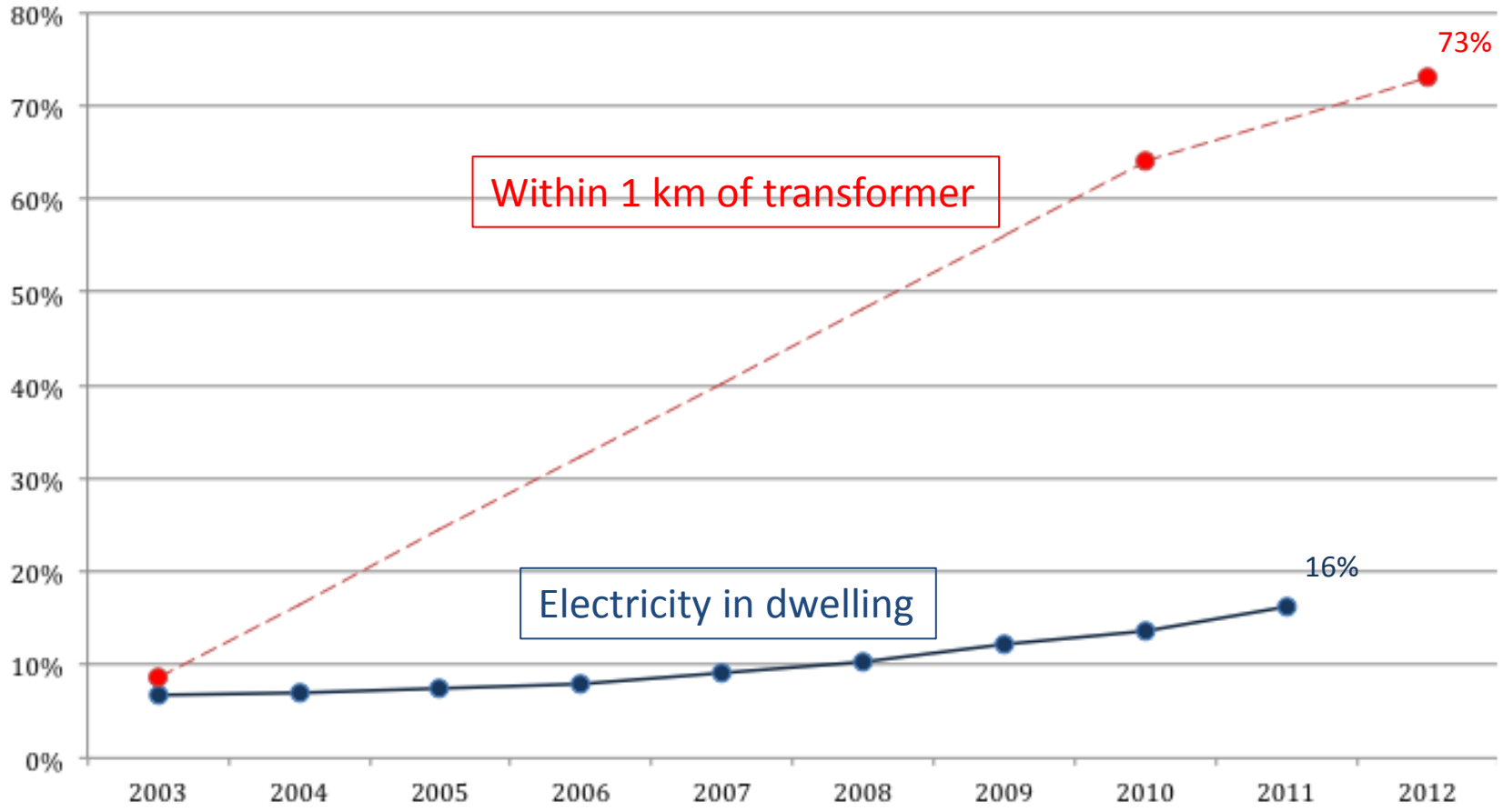
- Approximately 30% of the households in India live without access to electricity
- Those with grid connections get very cheap, and often free, electricity
  - Subsidies to electricity sector equal two percent of Indian GDP
- Electricity is unreliable, grid build-out is slow

Smart microgrids in India

Objectives

1. Build out smart microgrids in 40 villages in Uttar Pradesh and Rajasthan
   - Villages randomly selected from at least 80 eligible villages, currently without an electricity connection
   - Surveys at treatment and control villages
2. Evaluate household-level impact of electricity
3. Offer rebates on energy efficient and inefficient appliances
   - Rebates vary randomly

Connectivity vs. “Access to electricity” in Kenya

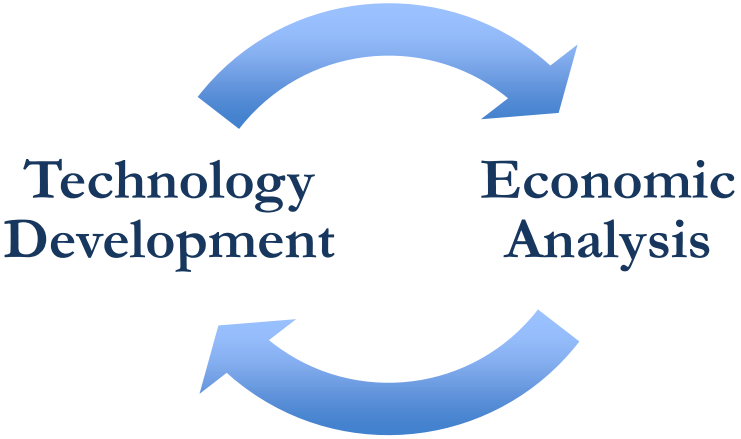


- “Access to Electricity” based on REA press releases
- “Connectivity” based on KPLC Annual Reports (e.g. residential customers * 2009 average household size / population)

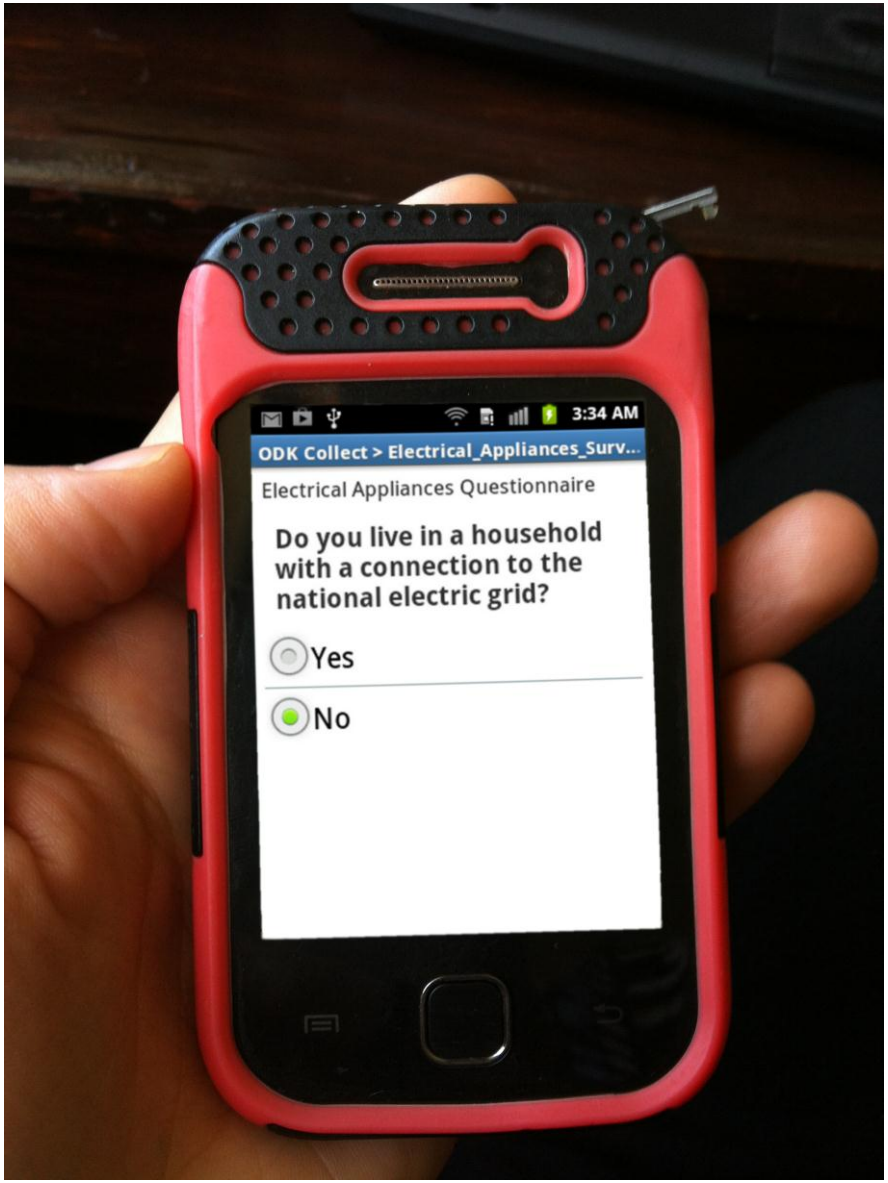
Kenyan grid connection study

Objectives

1. Offer unconnected households close to randomly selected transformers subsidies of different levels to connect to the grid
   - Current costs are ~$400, about half of average annual income
   - REA is offering 50% discount, financed over 10 years
2. Study drivers of subsidy take-up, like discount rates, neighbors
3. Evaluate household-level impact of grid electricity
   - Couple with careful measurement, and potentially, enhancement of reliability



Open Data Kit survey device



Preliminary survey results

Figure 1: Rural Households

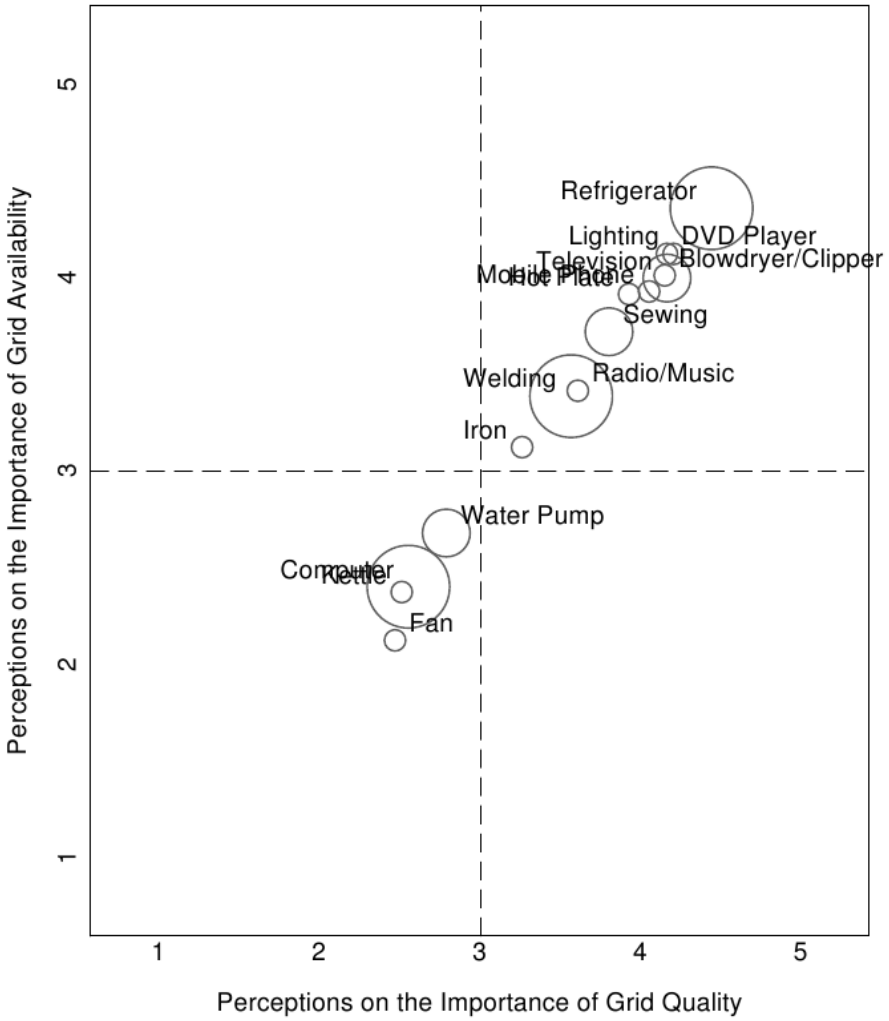
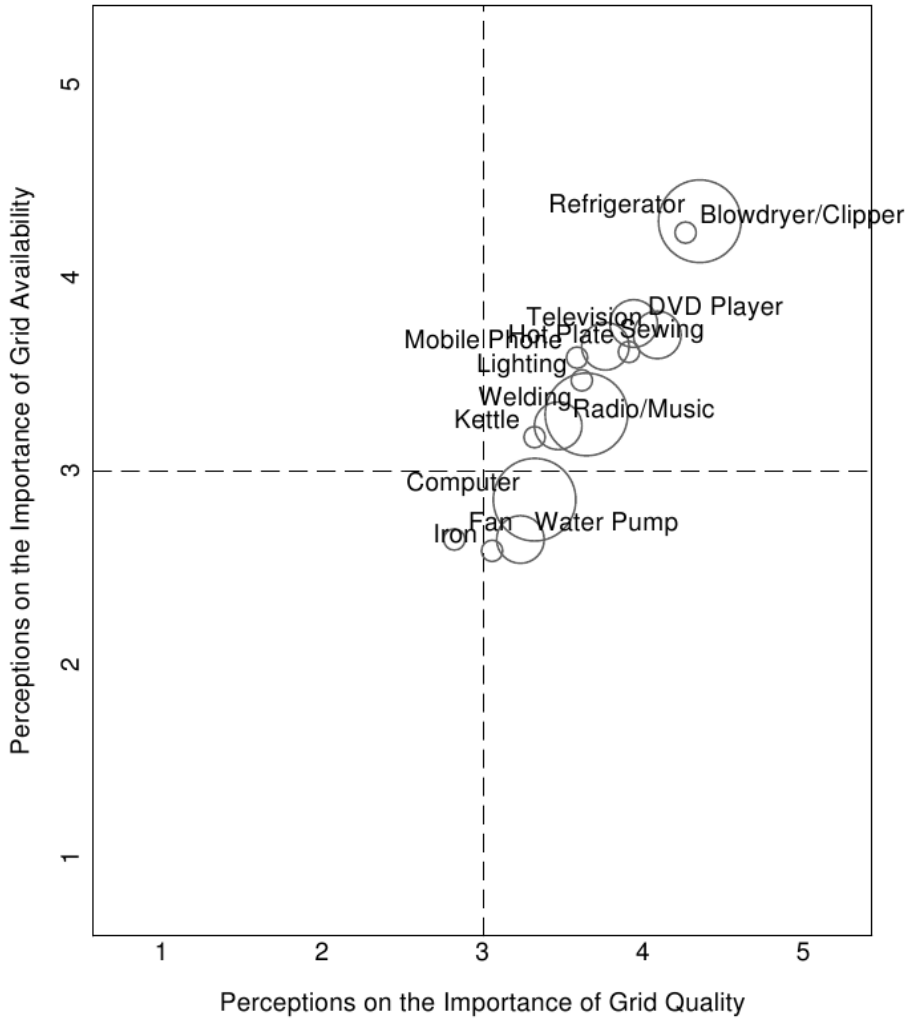
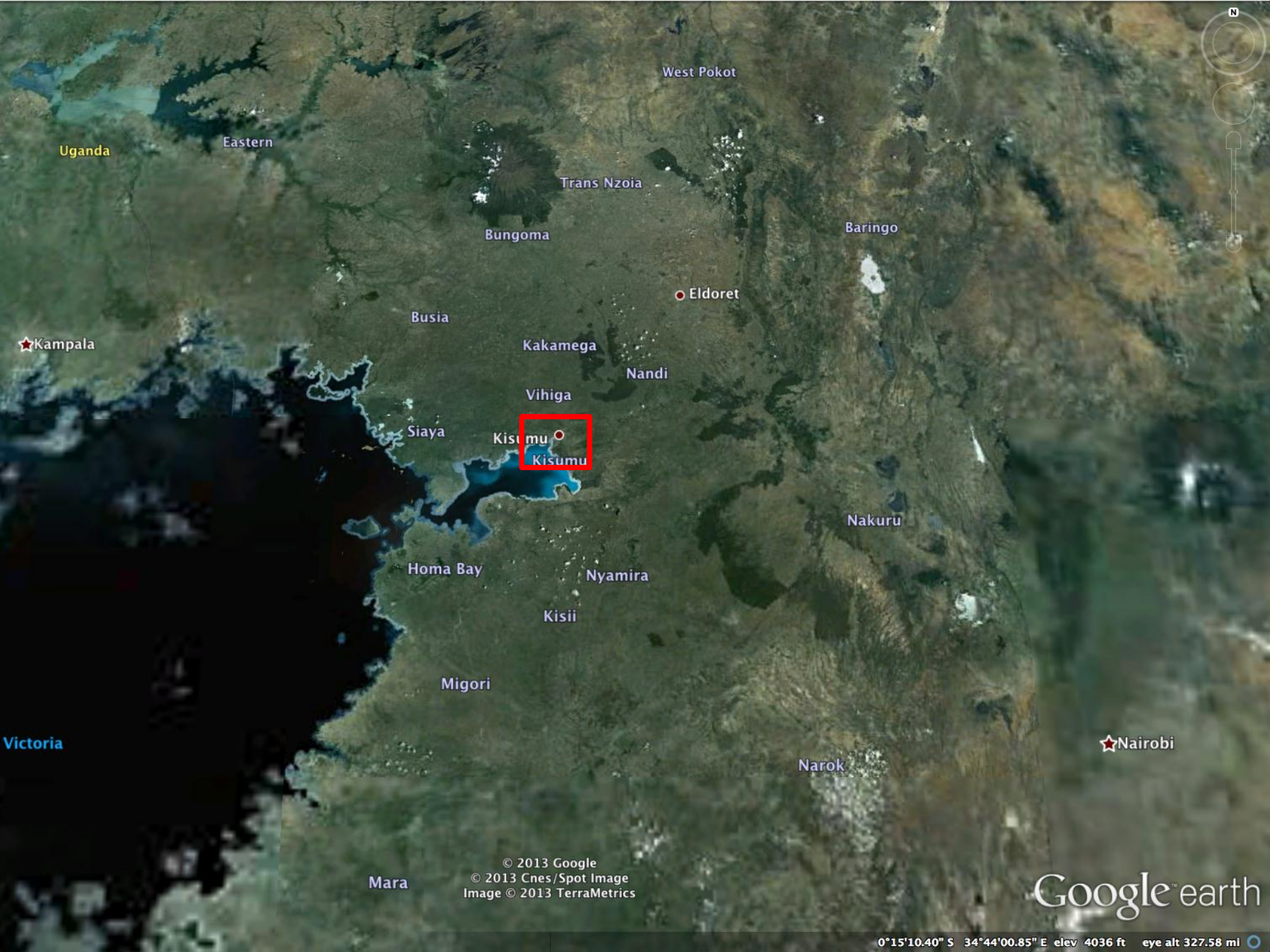


Figure 2: Urban Households

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Homa Bay
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Google earth
0°15'10.40" S 34°44'00.85" E elev 4036 ft eye alt 327.58 mi


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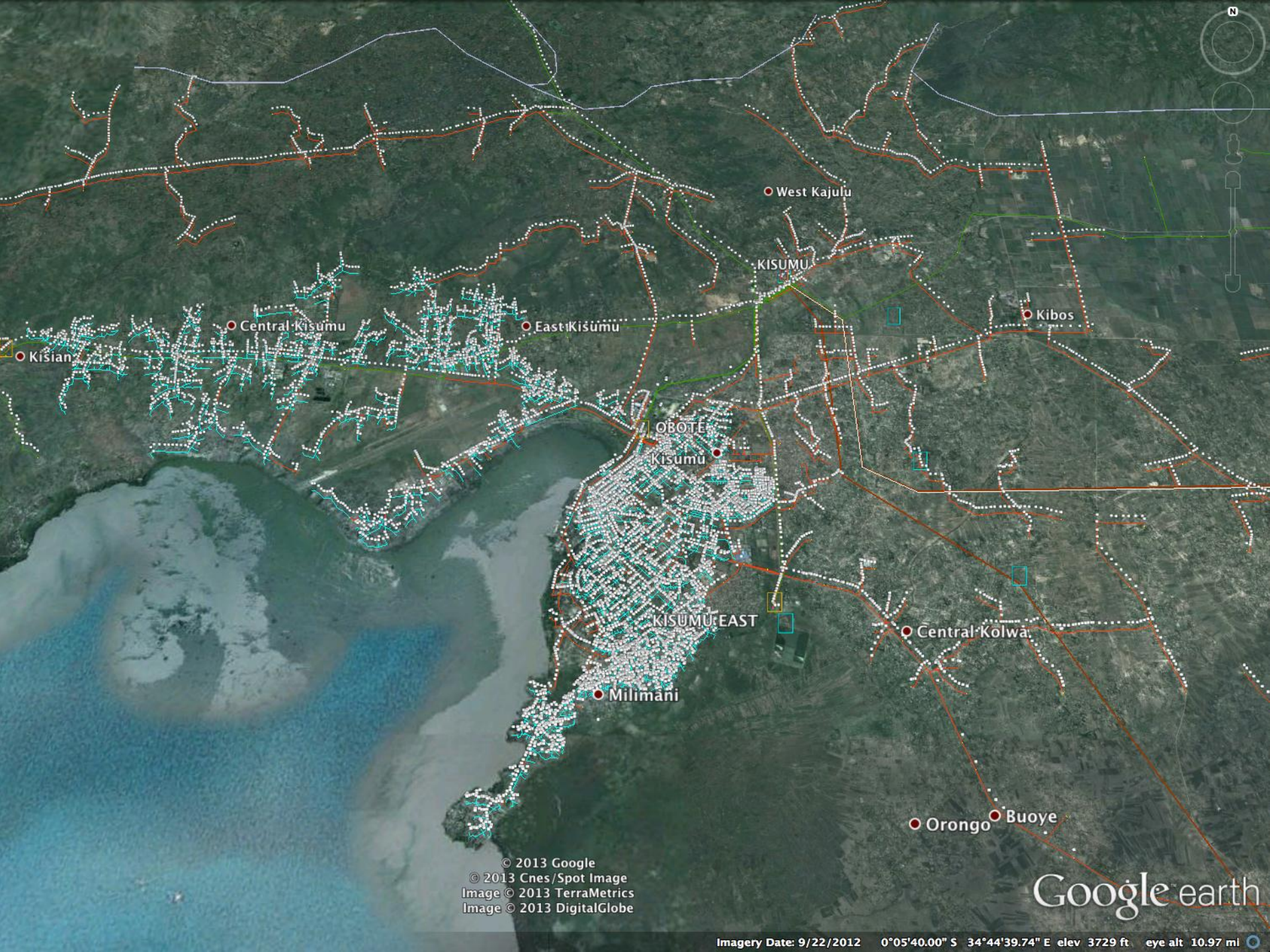
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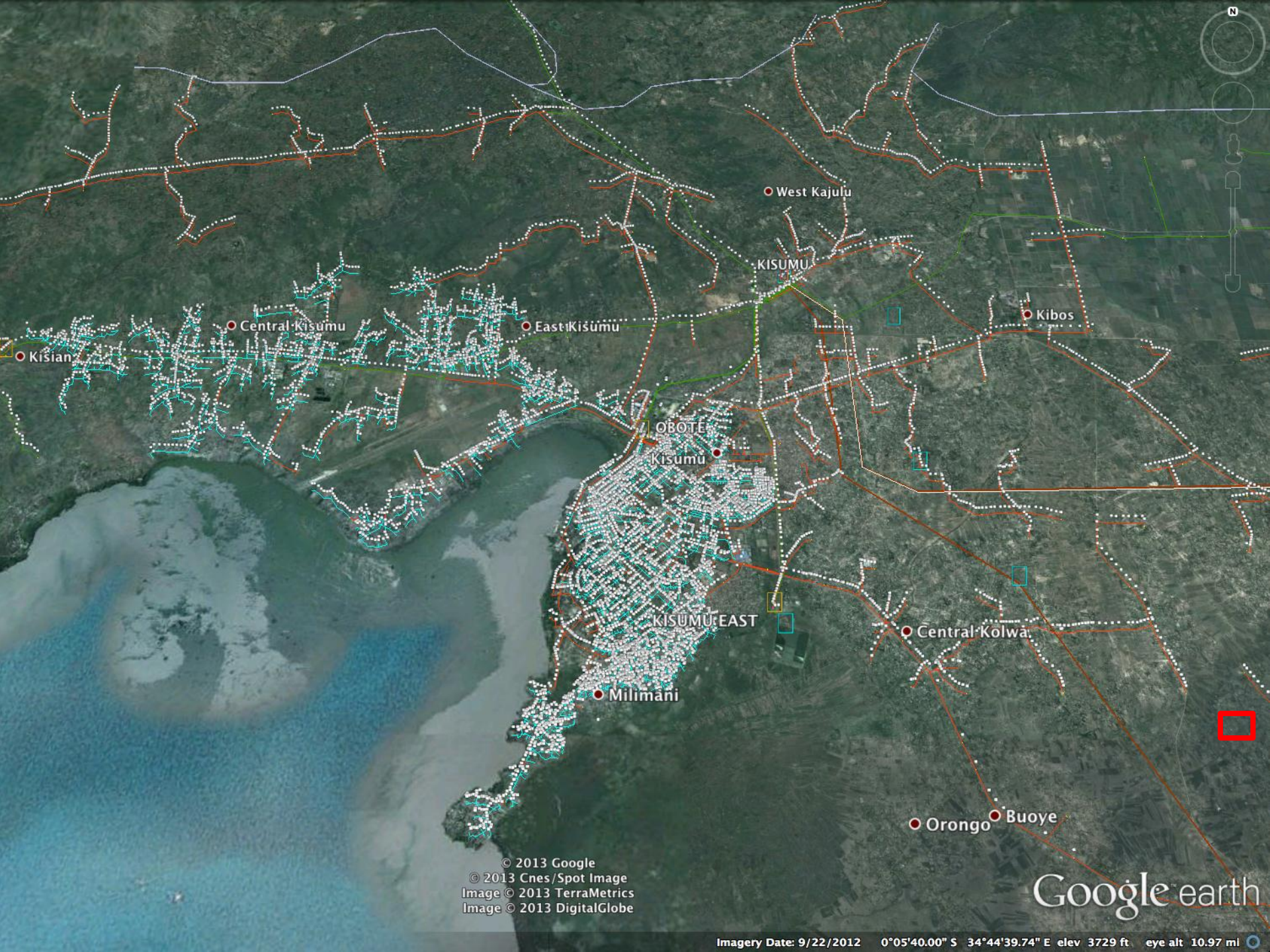
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Osure Dam
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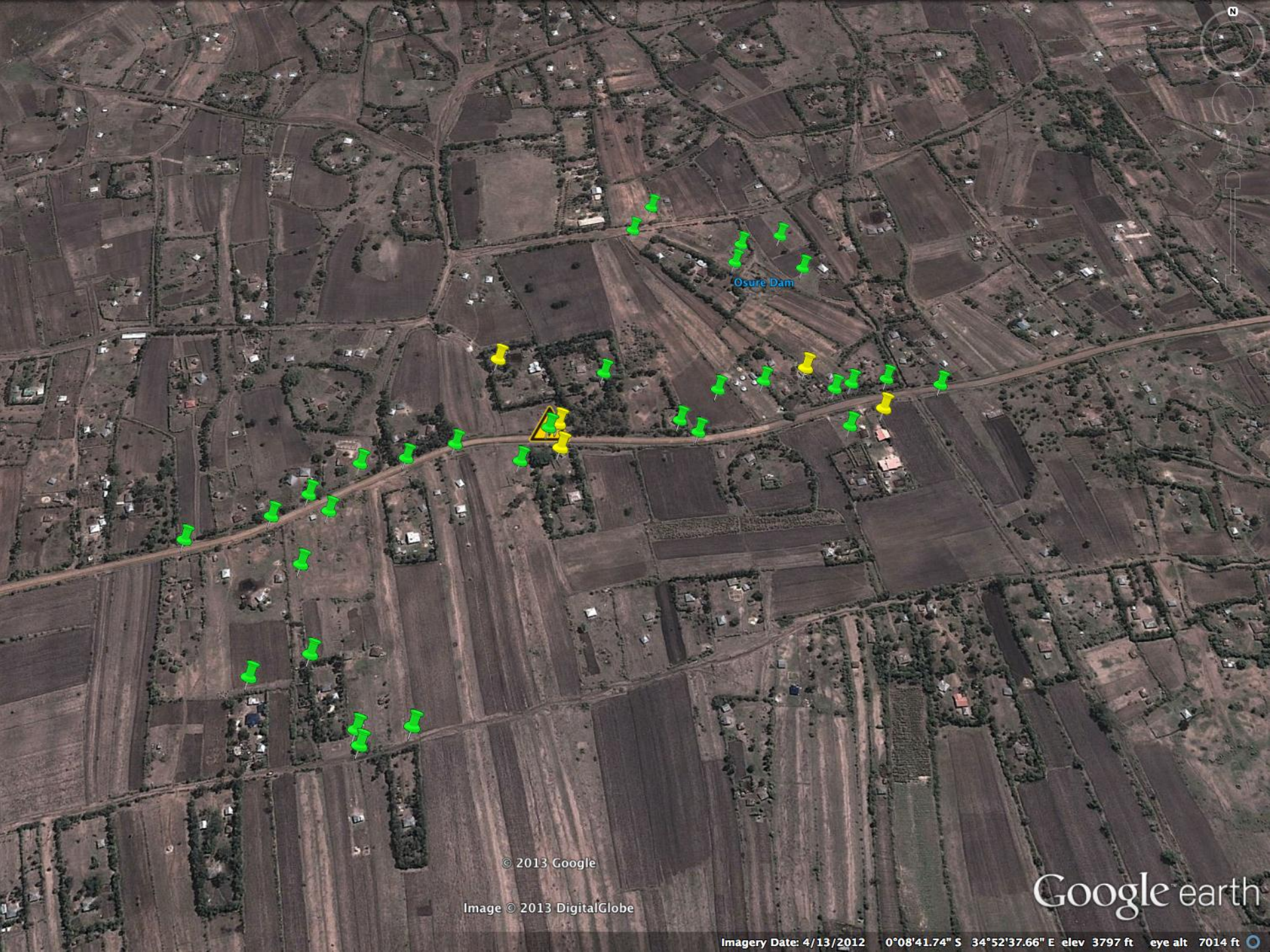
Imagery Date: 4/13/2012 0°08'41.74" S 34°52'37.66" E elev 3797 ft eye alt 7014 ft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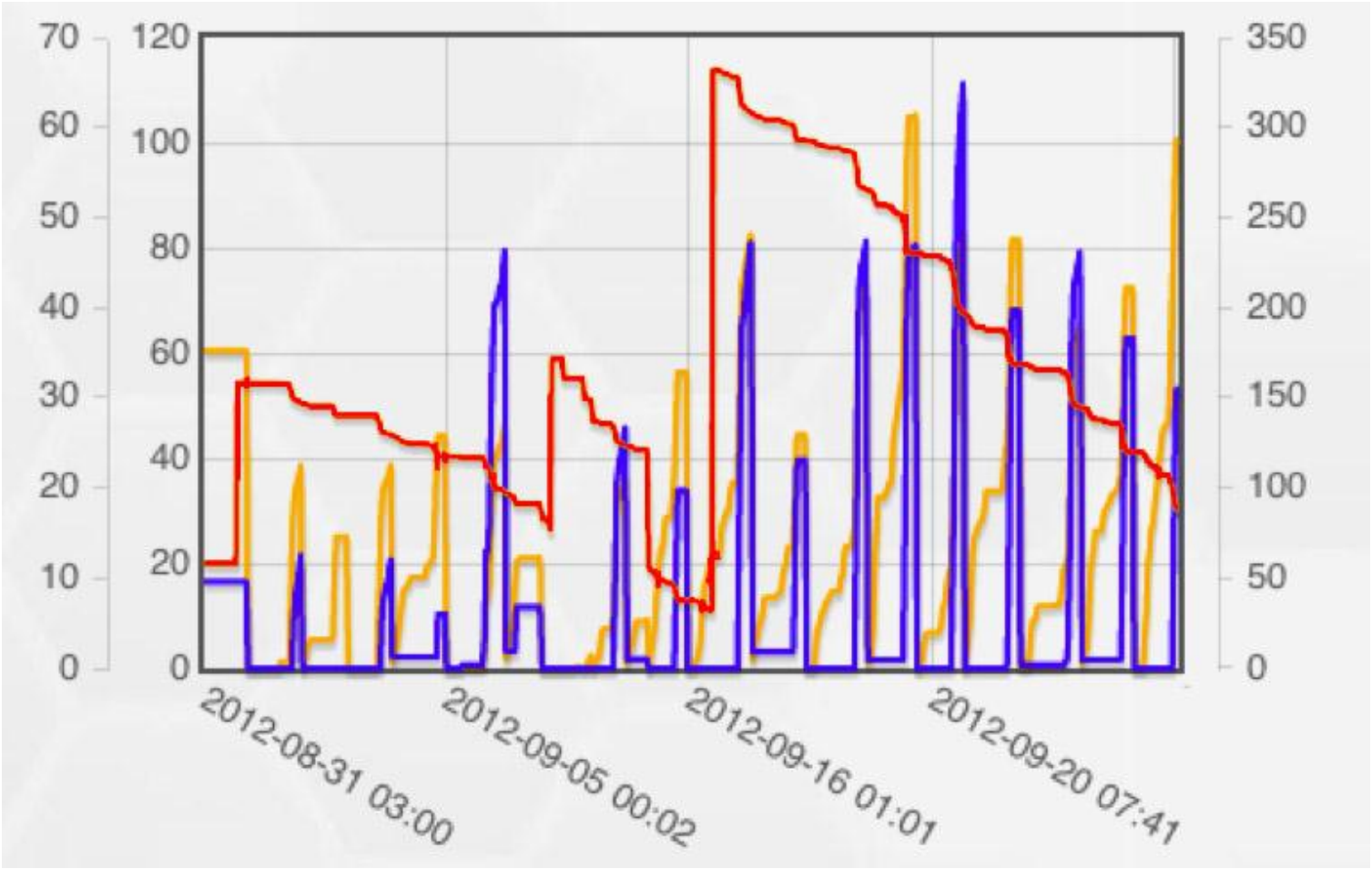
Microgrid Innovations

- Usage-based payment
  - Need ultra low-cost metering (and shut off)
  - Need pre-paid approach
- Higher-quality power
  - Grid has low-quality power
    - Bad for LED lighting, cell phones
  - Grid is unavailable
    - Solution: small battery in the house
- Also exploring DC instead of AC

Multi-house meter

Hourly electricity usage (Kenya)



Mezuri: Data Platform

- Goal: high-quality data for pilots and RCTs
  - ODK for surveys
    - Real-time updates, geo-coding
  - Fine-grain sensor data
    - Microgrid meter data
  - Data is in the “cloud”
    - Visualization tools such as maps
    - Access control
    - Tools for data processing
  - Provenance for data
    - How was this data calculated/acquired