

Possible Power Structure for the Entusi Retreat Center and Surrounding Area

1 Overview

1.1 Entusi in Context

The Entusi retreat center is located in southeastern Uganda near the border with Rwanda on the shores of Lake Bunyonyi. Figure 1 shows an overview and an inset map of the lake region.

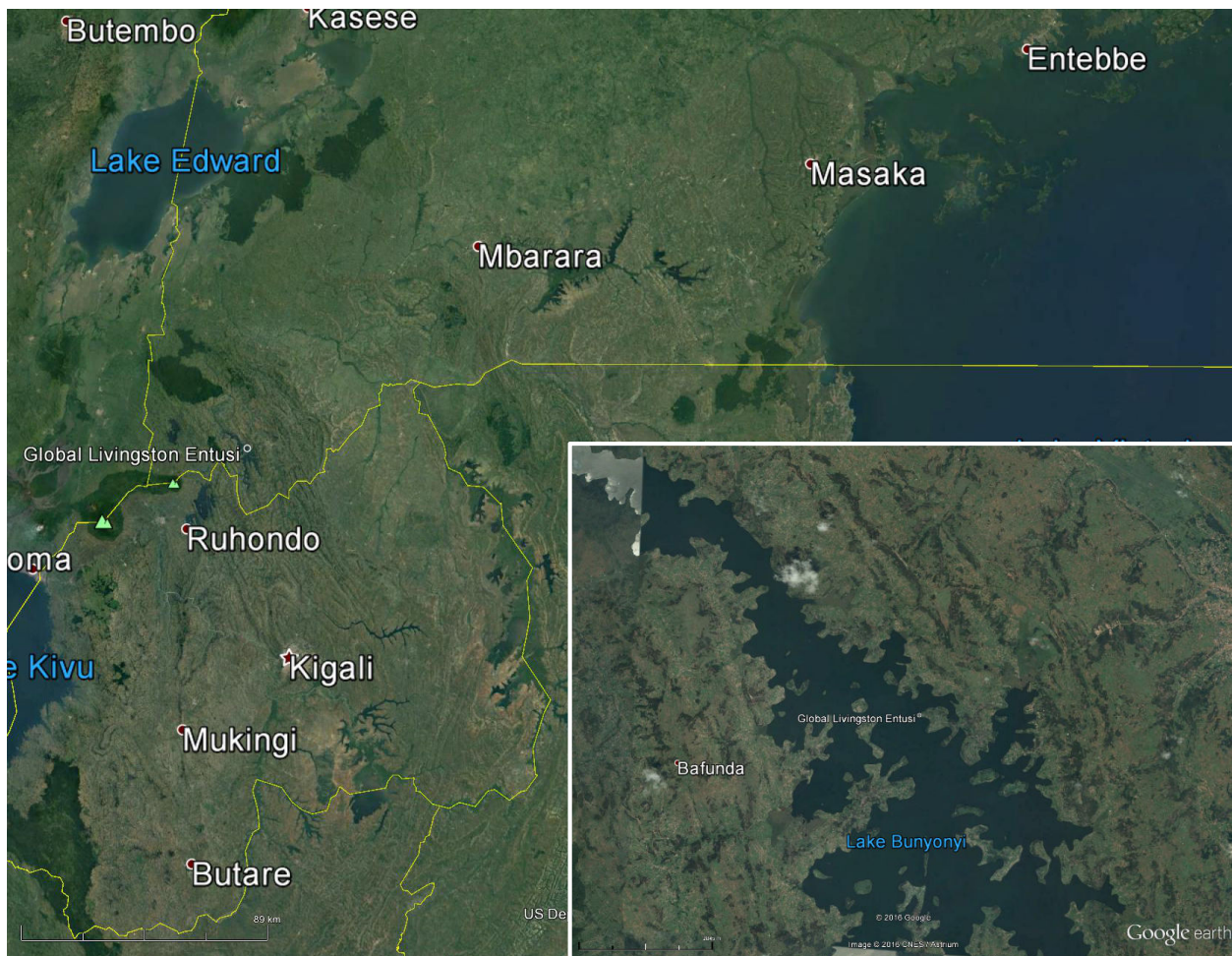


Figure 1: Overview of SE Uganda and location of Entusi

The retreat itself is located on narrow peninsula in the lake (Figure 2). Nearby roads are marked in white. Note scale at bottom of image.



Figure 2: Entusi location and nearby roadways

1.2 First Order Identification of Potential Electricity Customers

The peninsular area is shown in Figure 3, with the road into the facility roughly marked and road distances indicated on the map. The road from the neck of the peninsula to the retreat is about 0.9 km. Nearby structures are marked with pins and grouped into “patches” by proximity. Patch 0 contains the facility itself, Patch a group of 12 nearby structures, and Patch 2 three additional structures some distance away.



Figure 3: Structures proximate to the Entusi Retreat Center

Distances from the retreat to the Patch 1 structures averages approximately 300 meters, with the most distant structure around 500 meters from the facility. Assuming electrical line routing along the road, electrical lines to Patch 2 structures would require about 900 meters of routing.

Further way on the peninsula, Figure 4 roughly identifies areas with clusters of structures on the peninsula and indicates the location of a set of larger buildings, likely a school or similar community structure. The boundary of the analysis area is marked with the green line.

Structures are spread over significant distances and are not grouped into compact village centers. As is common elsewhere in the region, structures in some clusters appear to be placed along roads and trails and a spacing of 30-80 meters. In other clusters, distances between structures within the marked clusters is 30-80 meters. In comparison, a typical suburban neighborhood in Colorado has house spacing of about 30-40 meters.

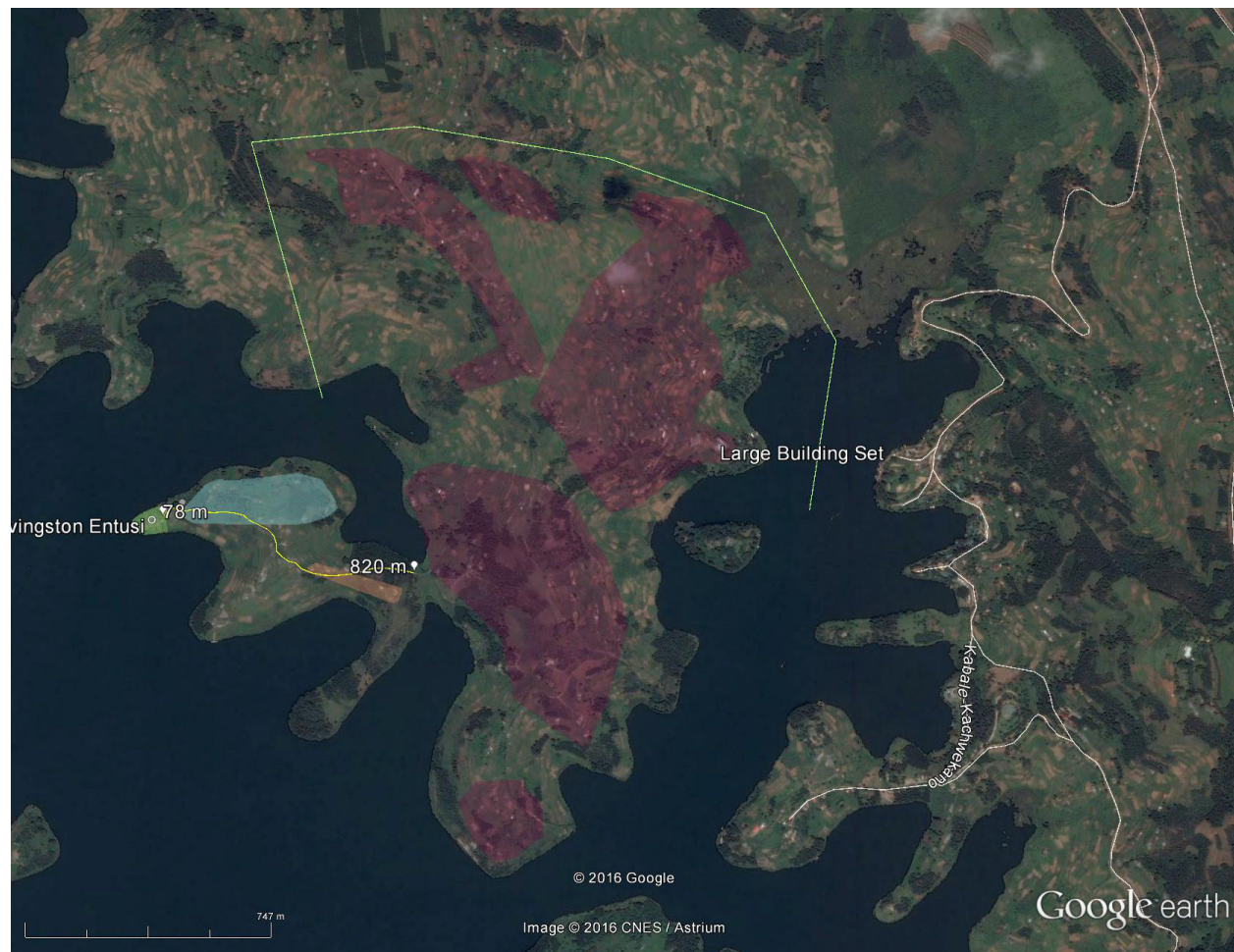


Figure 4: Structure locations near Entusi

The above analysis is based upon spot-checks, and the locations of structures need to be identified more precisely and annotated with the type of structure (residence, store, workshop, etc.), and population in the structure.

1.3 Conclusions

While the above topographical analysis is approximate, several preliminary conclusions can be drawn.

- 1) The distance from Entusi to the houses marked as red in Figure 4 are likely too far from Entusi to warrant the construction of power distribution lines, *unless loads in these areas are larger than residential lighting, cell phone charging or similar*. However, a large anchor tenant in a key location (e.g. the large buildings marked in Figure 4) may make the construction of distribution lines viable by providing sufficient load and power purchase. For these distances, transformers and higher voltage lines (e.g. 2-4 kV) would likely be necessary.
- 2) The structures in Patch 1 in Figure 3 could likely be electrified from the facility. Costs may be higher than desirable, but the extension to nearby houses may be desirable for community reasons. The three structures in Patch 2 are less obviously electrified, as cable lengths could drive significant cost.
- 3) All of the identified structure patches could be electrified with a series of independent distribution systems centered on an appropriately sized power generation system (likely PV) and batteries. Systems could be built in stages, could be interconnected in the future, when load growth justified power sharing between clusters.
- 4) When first installed, a power center at Entusi could provide “benefits of power” to surrounding area by providing “transportable energy products” which could be distributed to all of the surrounding area, including areas reached from Entusi by boat. Examples include:
 - a. Charging batteries, transporting, and swapping them with residents.
 - b. Making ice which could be purchased by surrounding residents.
 - c. Providing local cell phone charging or similar services.

1.4 Next Steps

Working from the above outlined conclusions, the following analysis steps should be completed:

- 1) Identify locations of structures in Entusi area to assess population and economic activity.
 - a. Points initially located by CSU using Google Earth (CSU)
 - b. Points annotated by GLI in a walking survey (GLI)
 - c. Location of stores, community centers, schools, and other major economic activities located (GLI)
- 2) Estimate productive demand for locations in 1c, above. (GLI)
 - a. Type of activity (business, workshop, school, etc.)
 - b. Current energy use – type of energy
 - c. Estimate of possible uses of electricity
- 3) Update conclusions above (CSU lead, GLI support)
 - a. Develop approximate distribution routings for various structure clusters (CSU)
 - b. Estimate equipment required (CSU)
 - c. Acquire local costing for equipment and labor (GLI)
 - d. Identify likely electrification pattern – order and size.

- 4) Solidify multi-stage electrification plan, including energy products and approach (GLI lead, CSU support)

2 Current Power Needs

GLI has provided photos of electrical equipment at Entusi which can be utilized to develop a hybridization plan – moving from diesel-only to hybrid PV/battery/diesel system. A first stage plan would power the retreat center and any nearby residences.

CSU will take the lead developing the hybridization plan, with GLI support. Sule Amadu (PhD student in Systems Engineering) and other students will contribute to the analysis. GLI will support by providing additional data from the current system as the CSU team identifies missing elements.

Plan:

- 1) Verify the size of loads and current interconnection within Entusi.
- 2) Develop a plan to acquire load measurements on the current genset.
- 3) Track down PV irradiance data for the area. Rwanda may have applicable data if Ugandan data cannot be identified.
- 4) Adapt existing CSU models to size PV and battery system.
- 5) Set up sensing at Entusi to collect operational data, if possible.