Design of a solar PV power plant for Living Love Ministries Children's home

Living Love Ministries

SOLAR PV

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Our Team

The solar photovoltaics (PV) team (Fig. 1) designs and installs solar panel systems in developing countries where power is either unreliable or non-existent. Lack of reliable electricity significantly hinders the mission of our clients and, in the case of our current client, prevents them from furthering their mission of caring for orphaned children in Kenya.

This poster describes the steps performed to design a solar PV system for Living Love Ministries (LLM) Children's Home in Kenya and explains the current layout chosen for the system.

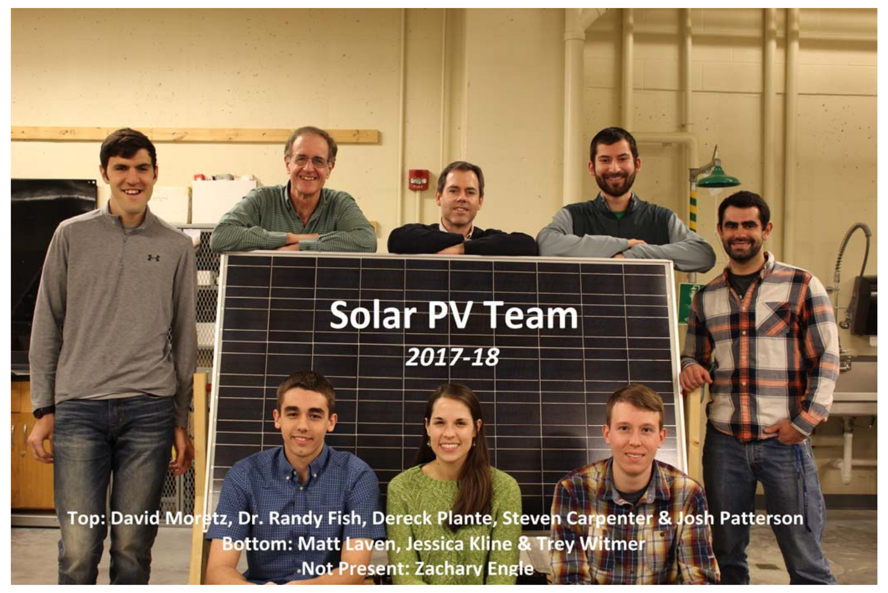

Figure 1: The Solar PV Team in Spring 2018

Our Partner

The Living Love Ministries (LLM) Children's Home (Fig. 2) is located in Ol Kalou, Kenya (Fig. 3). LLM ministers to 36 children who are orphaned and provides food, clothing, living expenses, and an education at a nearby Christian school, among other things. LLM's goals for the Home include adding a new dining hall/multipurpose building (to be completed by May '18), adding a primary school (5-10 years) and reducing reliance on outside agents by becoming more self-sufficient. The lack of consistent electricity has hindered progress toward these goals in recent years.

Figure 2: LLM's Children

Figure 3: Children's Home Location

Our Partner's Need

LLM Children's Home is connected to the local electricity grid. Unfortunately, the grid is unreliable and often shuts off unexpectedly, remaining off for an unknown amount of time—sometimes up to a week. This has interrupted refrigeration, causing food to be lost, and continues to limit the children's ability to finish homework in the evenings when the power is out. To mitigate LLM's energy concerns, the solar team has designed a solar panel system to power key appliances.

Design Methodology

In order to design a viable solar PV system, certain steps were followed. A simplified version of these steps are outlined below:

♦ First, the size of the system was determined by analyzing power usage. LLM provided a list of equipment they want to power. This information was used to perform a load analysis in order to calculate the required energy production the system would need to meet, measured in kilowatt-hours per day (kWh/day).

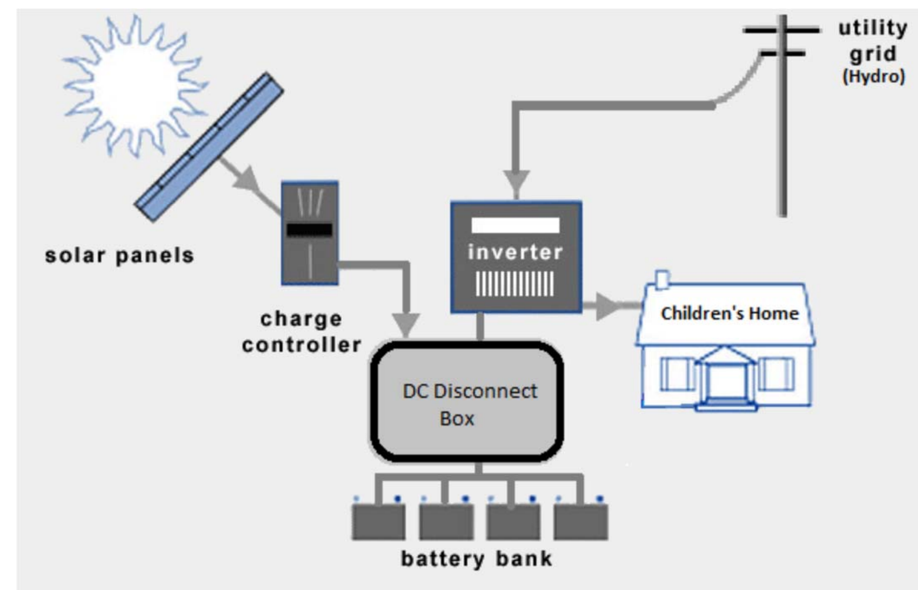

Figure 4: LLM Solar PV System Schematic

♦ Then, the client's budget was considered. The solar team estimated a system of the size desired would cost $12,000—18,000. LLM identified they would prefer to keep the cost under $15,000.

♦ Next, the availability of in-country distributors of solar equipment was investigated. The solar team inquired of many companies in the area near the Home. Ultimately, the choice of distributor was made based on availability of equipment, quality of customer service, professionalism and demonstration of technical competency.

♦ Then, the specific system components were selected based on the distributor's selection and the size of the system. These components include: solar panels, panel mounting, batteries, an inverter, a charge controller, an energy monitoring system, breakers, wiring, conduit, etc. (Fig. 4). A location for the equipment was also selected. A new building, currently in construction, called Pamajo Hall, will house the panels and necessary components (Fig. 5).

Figure 5: Pamajo Hall Being Constructed (Feb. '18)

♦ The system is designed to supplement LLM's electricity usage at the Home. Thus, during sun-sync hours, solar energy is treated as the primary energy source for the loads connected to the system. However, when the batteries hit a predetermined state of charge in the late afternoon, the system prioritizes the hydro energy from the local grid, if available (otherwise it switches back to the solar).

♦ This hierarchy of prioritization of energy source is intended to preserve the life of the batteries. The batteries are the most expensive part of the system (nearly 45% of the total cost). In this design, they are intended to last 7-10 years.

System Layout

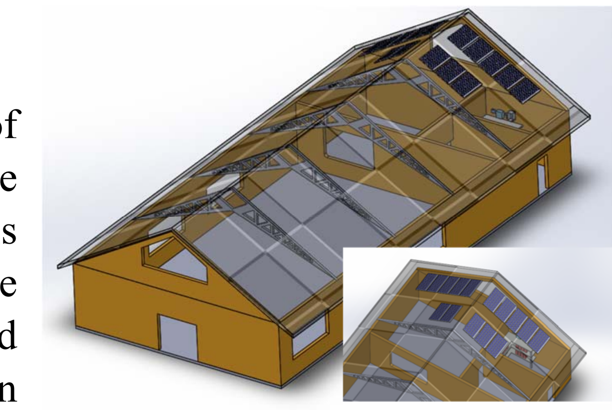

Figure 6: Panel Layout on Pamajo Hall

Fifteen 255 watt solar panels will be placed on the roof of Pamajo Hall to form a 3.8kW array (Fig. 6). The panels will be wired in five strings of three panels each. The building is currently under construction, but it is scheduled to be completed by the end of May 2018. The Home is located nearly directly on the equator, so panels could be placed on either side of the roof for essentially equivalent overall energy production over the course of a whole day. However, the building is oriented northwest to southeast, so half of the panels will be shaded by the peak of the roof during the first and last hours of each day. Therefore, the solar team decided to place half of the panels on each side of the roof to even-out the power production throughout the entire day. Wiring will be added between buildings to reach the necessary loads (Fig. 7). Lastly, the location of the batteries and other electrical components was chosen based on the partner's desired location inside Pamajo Hall (Fig. 8).

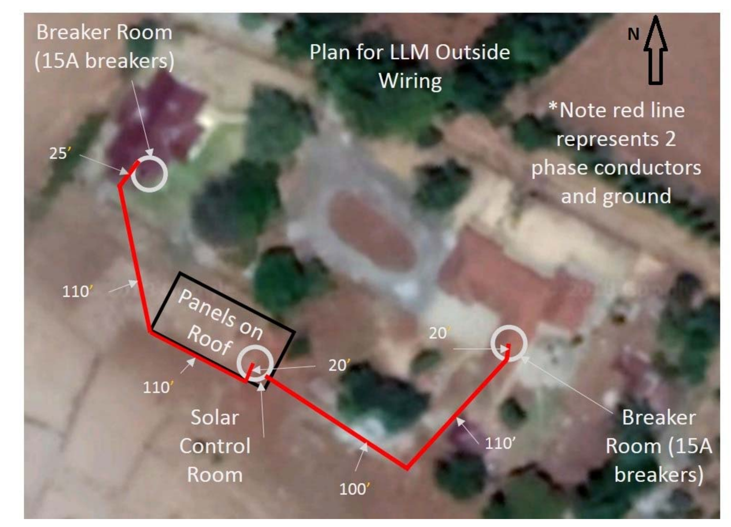

Figure 7: In-Between Building Wiring Plan

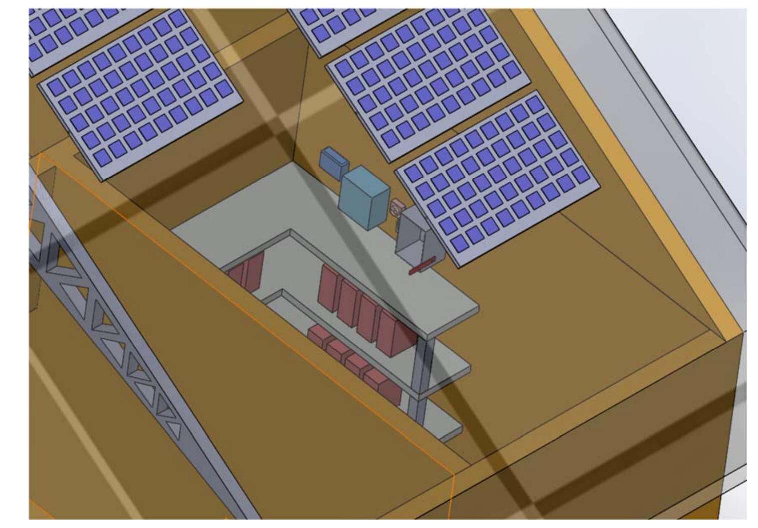

Figure 8: Batteries and Electrical Components Location

Conclusions

The solar team looks forward to traveling to Kenya in May-June 2018 to install the system and interact with the staff, children and families of the LLM Children's Home. The Collaboratory hopes to continue to foster a relationship with LLM as a new water pump project and an athletic fields development project begin next semester. The Collaboratory desires to help support LLM as it fulfills its mission to care for orphans in Kenya and reach them with the gospel of Jesus Christ.

Acknowledgements

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