

Homework 2 Solar Power Africa
Due Tuesday September 8, 2020

Medical services in rural Ethiopia and over much of Africa is poor. For instance, in the DRC there are two “medical professionals” per 100,000 people. There are more physicians of Ghanaian origin in Chicago than there are in Ghana which is a relatively rich country in West Africa. Things in Ethiopia have improved in the past 15 years. For most regions there are visiting nurses who serve as the sole contact with health services. Since there are fewer nurses than the need and since the nurses require certain facilities to perform their tasks, village visits by nurses are limited to villages that have clinics with refrigeration and electricity. This is to store vaccines and other medicines and to run medical equipment. Several European NGOs have funded construction of clinics in Ethiopia. However, due to the lack of grid electricity few of these clinics are electrified so they are, for the most part vacant. There is limited interest in donations of solar electrification for clinics built by other NGOs. This homework involves a rough design for a solar system to power such a clinic and to equip the clinic with a refrigerator, lighting and some other equipment.

- 1) Make a table with items, cost and power requirement as well as a plot of the expected power consumption over a 24hour period for a clinic in rural Ethiopia. The clinic will need a vaccine refrigerator, fan, 10 LED lights, a laptop computer, cell phone charging system, a radio, and a kettle to boil water. All of this equipment will need to be purchased. The cost in Ethiopia is twice the price on the European market. Your table should list the items, give operation power, W, number, average hours of use per day, average Watt-hours per day, cost for the item purchased new in Ethiopia. Compare the Average Wh/day with what you can garner from your usage plot (the plot should result in a lower Wh/day that is a more reasonable value). You are only interested in the peak power usage for instance, if you won't use the kettle and computer at the same time their power consumption shouldn't be directly added.
- 2) From the internet find the peak sun hours per day in Harar Ethiopia (Dire Dawa or Djibouti could substitute) It should be about 12. Assume a system efficiency of 60%. Calculate the rated peak power of the solar panel array that you need based on the Wh/day from part 1 and these numbers.
- 3) Using the specification from part 2 search on the internet for PV modules with the necessary peak power and find their price. Find a price for deep cycle 12V batteries rated at about 175 Ah each. Calculate the number of batteries required to power the clinic for two days from your estimates of total power requirement. Price a charge controller and inverter for this system. Give a total price for the system in the US and multiply by two to get the price in Ethiopia.
- 4) Comment on how you would go about implementing this on the ground in Ethiopia if you had a two-week trip in December to accomplish this project.