

Homework 4 Solar Power Africa

Due Tuesday September 22, 2020

For renewable energy the greatest hurdle is the intermittent nature of the power supply. In some cases the supply matches the demand such as in providing energy for air conditioning in some climates such as Southern California. Also, wind power tends to peak when solar output is at a minimum and vice versa, again, in some climates. More generally, some form of storage is needed, particularly when looking at off grid power for domestic use other than pumping water.

- a) The most popular electrical storage is using deep-cycle lead acid batteries. Give the chemical reaction that occurs at the two electrodes in a lead acid battery and the voltage that each cell generates. How does a car battery differ from a deep cycle battery?
- b) In class you were shown an overview of a plant to manufacture lead acid batteries in the developed world and a low-cost plant in Nepal. What are the problems with introducing low-cost production of deep cycle lead acid batteries in a country like Ethiopia? Do you think that this is a viable industry to introduce to improve economic conditions?
- c) Describe the iron flow battery. Comment on the assembly of iron flow batteries in Ethiopia. Consider supply of materials, technology needed, safety. (All plastic parts must be imported and are about 3 times the cost of similar materials at Home Depot in Cincinnati and generally of much lower quality.)
- d) For a 2 kW electric kettle (tea pot), water has a heat capacity of $\sim 4.3 \text{ J/(g } ^\circ\text{C)}$. What energy is needed to boil a cup (250g) of water? How does this compare with the energy required to charge a cell phone battery with a 3000mAh capacity using a 5V USB charger? Give your answers in Wh and in kJ.
- e) Give an example of where a super-capacitor might be used rather than a battery as a power source.