

Homework 5 Solar Power Africa
Due Tuesday September 27, 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) 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.
- d) Give an example of where a super-capacitor might be used rather than a battery as a power source.
- e) Max presented a new method to produce porous silicon electrodes using silica which is treated at 650°C via magnesiothermic reduction. The traditional method is through silicon boule which is produced at 1500°C .
 - a. Assume that the heat used for both processes is generated from a coal-fired plant on site. What is the cost savings per kilogram of silicon using magnesiothermic reduction? State your assumptions. Cite your sources.
 - b. Due to the low temperature, an electric furnace can be used to run the magnesiothermic reduction. How much would this change the cost savings?
 - c. What are the associated carbon emissions for each process?