Consider a standalone home that has a 10kW-hour/day load, with a peak usage of 2kW of power.

1.) Find the price of petrol/diesel in your hometown, on a per-volume basis. Assuming that diesel has 44MJ/kg and a density of 0.85kg/L. Using the internet, price out the cost of a backup diesel generator to match this power demand, and the expected lifetime of such a generator. When factoring in equipment and fuel costs, what is the per-day cost of powering this home?

2.) Price out the cost of purchasing solar equipment necessary to achieve this same power demand and the lifetime of this equipment. What is the per-day operating cost to power this home using this setup?

3.) What would the per-volume price of diesel need to be in order to have the same per-day cost of operation as the proposed solar system?

Read "Comparison of different lead-acid battery lifetime prediction models for use in simulation of stand-alone PV systems" by Dufo-López et. al., (2014) on Courseworks. The paper discusses several methods of calculating the effective lifetime of a lead-acid battery. While a straightforward calculation dividing the full capacity of a battery by the energy requirements over a given timeframe will give a rough estimate of how long it will last, this type of calculation does not factor in several phenomena that will lower a battery's effective usable lifetime. For example, the extent to which a battery is discharged before being charged again will affect how many cycles can be actually performed before failure.

The lifetime of the battery can be described in terms of these variable depths of discharge (DoD, defined as 1 – SoC), using a ‘rainflow cycle counting’ method:

\[
\text{Lifetime} = \frac{1}{\sum_i Z_i CF_i}
\]

For a given bin of DoD \(i\), the actual system has undergone \(Z_i\) cycles in that DoD bin over one year, out of a possible \(CF_i\) cycles before failure. The relationship between \(Z_i\) and \(CF_i\) is also specific to battery models and can be interpolated from empirical data.

4.) In one year, a battery undergoes 100 cycles at 20% DoD, 100 cycles at 30% DoD, and 200 cycles at 50% DoD. Use Figure 5 in Dufo-López et al. to infer the lifetime of this battery based on this performance.

5.) If this same battery instead undergoes 400 cycles to 50% DoD over one year, how long is the effective lifetime of this battery?

6.) Dufo-López mentions that both of the previously mentioned conventional predictions tend to overpredict actual effective battery lifetimes. What other phenomena can occur that will cause losses?