Assignment 2: ENVS/ENGR 119 Energy and the Environment (Prof. Ben)

You must show all of your work for full credit. The MIT Conversion Sheet is the best resource for working on unit conversions and energy transformations (Do not Google the conversion as you may end-up with different rounding). Please write your calculation by hand or type it if you know how to deal with equations on your Word processing software and return this assignment sheet completed in .PDF format. All numbers must be labelled with proper units, rounded to the closest digit (no decimal), use a coma to separate the thousands.

Part 1. Energy: In assign#1. We calculated that a large majority of energy currently used by a California average household comes from fossil fuels in the form of 2 therms/day of natural gas and 5 gallons per day of gasoline. How much electricity would we need if we would convert our vehicles and house heating appliances in all electric households? Reply to the following questions to find out.

1. Convert 2 therms / day (average CA home natural gas use per day) into kBtu. Calculate the annual total, and the equivalent kWh of electricity (assuming gas appliances and electric appliances have almost the same efficiency factor).

2. Convert 5 gallons of gasoline per day. Calculate the annual total in kBtu. Assuming an electric engine has a 90% efficiency and a gasoline engine has 30% efficiency, calculate the annual electricity needed if the gasoline cars are replaced by the electric cars.

3. Calculate the electricity a CA household would need in kWh per year, if the 2 fossil fuels sources were replaced by electricity. Reminder: Current electricity use is 560 kWh per month don't forget to add this to the sum of electricity replacing nat. gas and gasoline.

4. By what percentage the electricity use of a typical household would increase?

Part 2. Budget: In assign. #1 we calculated that an average CA household would spend per year $1,142 in electricity, $1,022 in natural gas and $6,387 in gasoline for a total of $8,543 per year as energy budget. How much would it be if this household was 100% electrified? Reply to the following questions to find out.

5. Given average electricity price is $.17 per kWh, calculate the annual budget in dollar for the electricity that would be used replacing the natural gas (see question 1).

6. Of the old natural gas budget, what is the increase in dollar spend per year and in % if all the natural gas appliances (boilers, water heater and stoves) are converted to electricity?
   a) Increase in $ spent

   b) Percent of $ increase

7. Given most utilities have a special EV rate for electricity price at $.09 per kWh if the electric cars are charged at night (midnight to 7am), and assuming all charging will occur at night, calculate the annual budget in dollar for the electricity that would be used replacing gasoline (see question 2).

8. Of the old gasoline budget, what is the decrease in dollar spend per year and in % if all the vehicles are changed to EV?
   a) Decrease in $ spent

   b) Percent of $

9. Finally, what would the total annual energy budget (all electric) for the future California average home, in dollar, assuming the price of electricity stay stable? How much will be saved per year?

Essay question: Earlier studies estimate the carbon footprint of electricity produced from solar utility farm and wind farm with battery storage between 70 g CO_2-eq/kWh and 300 g CO_2-eq/kWh GHG emissions (https://www.forbes.com/sites/rrapier/2020/02/16/estimating-the-carbon-footprint-of-utility-scale-battery-storage/#749347a07adb). Assuming an average of 100 g CO_2-eq/kWh and 100% of the electricity produced in CA use this technology. What would be the annual carbon footprint of the future average CA household using only electricity? Compare this number to the results from question 8 in assignment #1 (47,546 lbs of CO_2 per year per household). What can be deducted?