ECE2795 Homework Assignment #2

Due date: 02/12/2015 at 6 pm.

For all questions elaborate some few conclusions or comments about the results. For all questions with simulations include a graph with the used model. State all the assumptions considered in the analysis. You are free to do as many assumptions or simplifactions you consider appropriate.

1) Consider that you are the new proud owner of a house in Pittsburgh, which has a roof with a 20^{o} tilt and with a 200^{o} azimuth. Assume a typical load for your new home and make the necessary reasonable assumptions in terms of roof size and loads in your home. Using this information, browse the Internet and select some suitable PV modules and calculate their cost. If the power electronics plus the installation cost equals that of the PV part, what is the total absolute cost? What is the relative costs with respect to its capacity in kW and its average energy production in kWh? How does this compares with the average electricity residential cost in Pennsylvania found at http://www.eia.doe.gov/cneaf/electricity/epm/table5_6_b.html? How much of this initial cost is reduced if you consider Duquesne Light rebates and tax incentives? Is there any difference if you are instead in Penn Power or West Penn Power service area?

2) Let's compare the performance of wind turbines, spark ignition engines, and microturbines at different elevations. As a reference, consider that the atmospheric pressure in Miami (sea level) is 101 kPa and the atmospheric pressure in Denver (1600 m over sea level) is 83 kPa. You can assume that for the microturbine the pressure, P_2, at the output of the compressor is held constant regardless of the elevation. Likewise, some operational characteristics of the wind turbine such as wind speed are assumed to be equal regardless of the elevation. For the spark ignition engine consider that the compression is considered to be a reversible adiabatic (i.e. isentropic) process. Also, consider that the specific heat ratio of air+fuel γ remains unchanged at about 1.38 despite the change in temperature at different heights (you would need a more significant temperature difference in order to notice a difference in the specific heat ratio). For the microturbine, the spark ignition engine and the wind turbine plot relative efficiency vs. elevation. Which of the three DG technologies see its efficiency changing the most when comparing Denver and Miami?
Note #1: You will need to do some little research to find how air pressure, temperature and density change with elevation.
Note #2: Relative efficiency means that you need to assign a relative efficiency of 1 to the elevation where you expect to observe the maximum efficiency which will correspond to a given absolute efficiency which is, of course, less than 1.