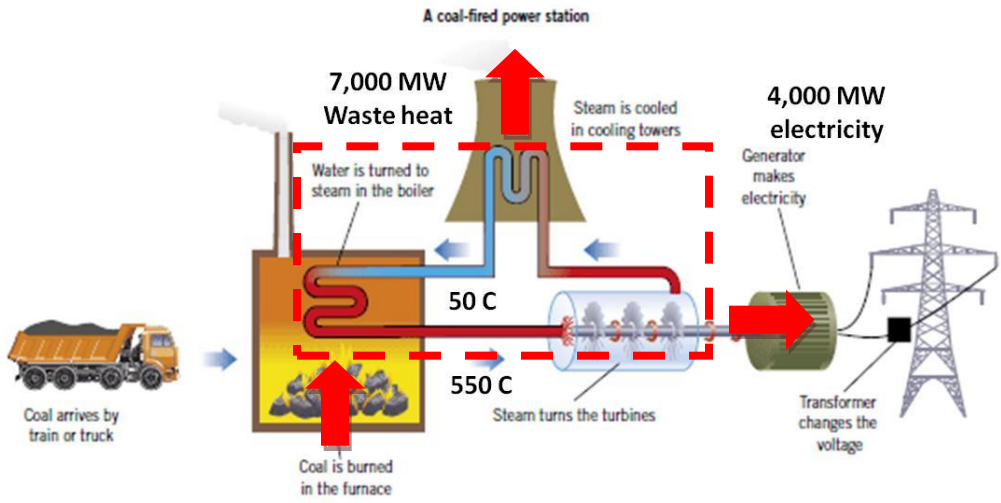
PRACTICE SET 1: ENERGY TRENDS, DEVELOPMENT, AND THERMO

Energy and the built environment CRP 570.004/470.004

Total Points: 25 pts
Due Date: 2/11, 12 pm, in class.
Grading: Most of the problems are worth 2 points: 1 point for completion, 1 point for clearly showing all steps of your work. Every number should have a unit next to it (unless they it is unitless, like efficiency).

1. Energy and development (8)
    a. Define energy poverty (2)
        - Energy poverty involves not having access to a variety of energy services that can improve the range of health, safety, and livelihood choices that a person can make.
    b. Explain how energy poverty impacts women and children more than men (2)
        - Women and children are adversely impacted by inadequate energy services. Cooking with unimproved cookstoves produces substantial indoor pollution leading to respiratory diseases. Women and children spend significant amounts of time in kitchens cooking, as well as collecting wood. Many household tasks, such as cleaning and cooking, are done at nighttime by women under poor lighting. Nighttime insecurity due to poor lighting on streets also impacts women. Children might also do their school work under poor lighting at night.
    c. A typical car battery has 500 Wh of energy. Only 250 Wh can be used without damaging the battery. If a rural household charges their battery every day with a solar panel and they have three 6W light bulbs, how many hours can they use the three lights for each night? (2)
        - Total household load = 3 x 6W = 18W. Time = 250Wh/18W = 14 hours
2. Power plant. The diagram below shows a coal burning power plant. (9)
    a. Draw a boundary for a closed system for analysis. (1)
    b. Draw arrows showing all transfer of work or heat across your system boundary.
    c. Using your knowledge of the 1st law of thermodynamics, calculate the rate of heat input (MW) to your system.(2)
        - Qin = Qwaste + Wnet. Putting it in terms of rates: 4,000MW + 7,000 MW = 11,000 MW
    d. Calculate the thermal efficiency (first law efficiency) of the system. (2)
        - 4000 MW/11000MW = 0.36
    e. Calculate the carnot efficiency of the system (remember to convert temperatures to Kelvin). (2)
        - η_C=1- (50+273) / (550+273) = 1 – 323/823 = 0.61
    f. Calculate the 2nd law efficiency (thermal efficiency/carnot efficiency). (2)
        - $\eta_{II} = \frac{\eta_I}{\eta_C}$ =0.36/0.60 = 0.59



3. Combustion (8)
    a. Write the equation for the combustion of ethane in pure oxygen and balance the equation. (2)
        - $C_2H_6 + 3.5O_2 \rightarrow 2CO_2 + 3H_2O$
    b. What is the molar mass of ethane? (2)
        - 2x12 + 6x1 = 30 g/mol
    c. Use this to calculate the total mols in a metric ton of ethane. (2)
        - $\frac{30g}{mol} x \frac{1kg}{1000g} x \frac{1\ ton}{1000kg} = \frac{3}{100000} ton/mol$ → 3e4 mols/ton
    d. What is the mol ratio of ethane to carbon dioxide? The mol ratio is the number of ethane molecules to the number of carbon dioxide molecules in the balanced equation. (2)
        - 1:2