

Midterm #3.

1. Wind power. I'm considering buying a wind turbine. Turbine A is bigger than Turbine B but costs way more. So, I could buy lots of Turbine B or just one Turbine A. Turbine A has three times the radius of turbine B and it is also taller, so the effective wind speed for A is twice that of turbine B.
 - a) If I decide to go with Turbine B, how many will I need to buy in order to get as much power as one Turbine A?

2. Lighting. Consider each of the three lighting technologies: Incandescent, Fluorescent, LED. Light Emitting Diodes work by the magic of solid state semiconductors. Briefly describe the mechanisms for fluorescent and incandescent lights and compare their efficiency to that of the LED along with the supporting underlying principle.

a) Incandescent

- How does it produce light?
- How does the efficiency compare to an LED and why?

b) Fluorescent

- How does it produce light?
- How does the efficiency compare to an LED... you don't have to state why.

3. You live in Alaska by a lake and keep my house at $30\text{ }^{\circ}\text{C}$. Only the top 1m freezes in the winter, so I have year-round access to water at the freezing point! I decide to heat my house with heat from the lake.
- With a quick drawing, *briefly* explain how I could use a heat pump to heat my house with water from the lake.
 - If I buy a 200 W_E (electrical wattage) heat pump, estimate the maximum possible rate of thermal heat delivery to my house at $30\text{ }^{\circ}\text{C}$.
 - I worry that the coils in the water may accumulate ice. Is this something I should be concerned about? Why or why not?

4. Efficiency: A closed in parking lot is lit with a hundred 200W fluorescent light fixtures 24-7 even though most of the time, there's no one there. I recommend a \$30,000 sensor system whereby only the immediate lights are turned on when motion is sensed. We estimate this will cut the electricity use in half.
- a) Calculate the annual cost savings and the simple payback time.
 - b) We take out a 7% loan annual interest loan for over the 30-year expected lifetime of the parking structure. Please estimate the cost of conserved energy. CRP for 7% 30 year is about 8%.
 - c) Please make a financially based recommendation to the company – should they make this \$30,000 investment. Support your answer.

5. The company is also environmentally motivated, and are also concerned about potential forthcoming carbon taxes.
- d) We want to calculate the reduction in CO₂ emissions. Please identify the carbon(dioxide) intensity (in kg_{CO2}/kWh_E) that you will use for the marginal electricity.
- e) Please describe what it means to be marginal electricity, and why don't you just use the weighted average carbon intensity of all the electricity generating technologies on the California Grid.
- f) Calculate the annual reduction of CO₂ from the investment.
- g) Please estimate the cost of abated carbon. Will there need to be a carbon tax in order to motivate this efficiency upgrade? If not why? If so, how much of a carbon tax will be necessary?