Homework #2 (group) – due Tuesday, 1/30 by 4:00 pm
5290 Exercises (individual) – due Thursday, 2/1 by 4:00 pm

Readings for this homework assignment and upcoming lectures

1. Read lecture notes:
   - Part 1. Introduction to Energy
   - Part 2. Energy Perspectives
   - Part 3. Growth Rate and Hubbert's Peak
   - Weston Chapter 1. Fundamentals of Energy Conversion
2. Watch the sequence of videos on Prof. Bartlett's lecture on Arithmetic, Population, and Energy; the link to the videos is on the course website and on Canvas.

   link to Prof. Bartlett's Lectures
3. Readings for the 5290 assignment (note the extended due date):
   - Part 4. Energy Economics

Homework Submission Requirements

- For this assignment, the regular exercises are to be **worked individually**, but only one set submitted by a single person from your group, either in class or by dropping off at my office.
- The 5290 Exercises are to be worked individually.
- If you use EES or Matlab for this assignment, then print out your file and solution and include this with your solution set.
- At the end of each problem, rank your confidence in the answer from 1 to 5; 5 being very confident and 1 being 'a guess'.

Correspondence

- PLEASE include the course number (MEEM4200 -or- MEEM5290) in the subject line of any email correspondence.

Office Hours

- Tue, Thu 9:30-11:30 MEEM 905, or by appointment

Homework #2 (group) – Tuesday, 1/30 by 4:00 pm

1. Estimate the power required in the United States during the year 2050, in GW, and the energy consumed, in GJ, from the year 2010 to 2050 if the average consumption rate increases at an average rate of 3.2 percent/year. Start with the 1980 annual consumption. [cite your sources of information]

2. Determine the average rate of increase for the total annual energy consumption in the United States from 1963 to 1983 and from 1983 to 2016. [cite your sources of information]

3. The total solar insolation on the continental United States is estimated to be 1.87×10^{15} W. A typical solar cell has a conversion efficiency of 10 percent. Using the 1990 consumption rate of electricity per year, determine how long it would be before the entire surface of the continental United States were covered with solar cells if all of the electricity were produced this way. Assume a constant electrical energy consumption growth rate of 3 percent per year.

4. Based on the data presented by M. K. Hubbert in his 1956 paper, the 1920 estimate of Texas crude oil production is 100 million barrels per year. The 1951 estimate is 1000 million barrels of oil per year.
   (a) What is the annual growth rate and doubling time for this period?
   (b) If this production had continued to grow at this rate, what would the rate of oil production been in 1980? How does this compare to the actual production rate in 1980?

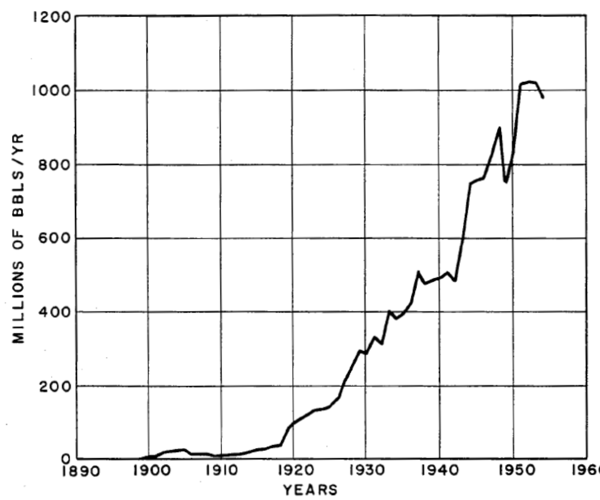

Figure 7 – Texas production of crude oil.

5. A 2007 magazine article states that consumption of fossil fuels will increase by 48% by 2030 due to increasing demand by China and India. What is the assumed annual growth rate from 2005 to 2030 used to generate this percentage increase? How does this compare to the Department of Energy projection?

6. The cost of mining and transporting coal are roughly independent of the heating value of the coal. Consider that the coal in the ground is valued at 50 cents per million kJ, that mining costs are $9/ton and that transportation costs are 8 cents per ton-mile. If the price of other delivered coals are 200 cents/million kJ, find:
   (a) The radius from the mine, in miles, that a coal of 32,560 kJ/kg can be delivered and sold for zero profit or less.
   (b) The same radius for a coal with a heating value of 23,200 kJ/kg.
   (c) The minimum heating value of a coal that could be used locally.

Homework #2 (group) – 5290 only
5290 problems - due Thursday, 2/1 by class time

7. If the capital cost of a 70-MW_e gas-turbine power system is \$200/kW_e, determine the total cost of energy (capital cost plus fuel costs) in \$/kWh. The plant has a capacity factor of 30 percent and a plant life of 15 years with a salvage value of 35 percent of the original cost. The annual percentage rate for investment and payments is 6.5 percent per year, compounded daily. The plant efficiency is 35% and the fuel costs are \$5.50 per million kJ.

8. A person pays \$8000 for a solar heating system instead of investing the money in money-market certificates that pay an average of 6 percent/year, compounded semi-annually. The system is designed to operate for 20 years with an estimated salvage value of \$3000 at that time. Determine the annual fuel savings required during the first, tenth and twentieth years that must be achieved in order for the system to break even over the twenty year period. Assume that the annual fuel cost savings will increase at a rate of 2% per year. Also, assume that the fuel cost savings realized each year could be invested at an annual interest rate of 7%, compounded daily.

9. A power plant has a nominal construction cost of \$1,000 per kW_e and a construction period of 9 years. Payments for the construction are made monthly and escalate at 6 percent per year. The anticipated capacity factor is 70 percent and the price for selling power will not escalate. The discount rate on construction funds and power payments is 9% APR, compounded daily. The operational life of the plant is 40 years and the salvage value negligible.[1]
   (a) Determine the future value/kWh at the end of construction.
   (b) Determine the future value/kWh at the end of life.
   (c) Determine the levelized capital cost in \$/kWh.

[1] There are 8766 hours in a year.