

Physics of Human Energy Use
Assignment 1

Due September 8, 2010

- 1) Suppose that your car gets 30 miles per gallon when travelling at 60 miles per hour. What is its fuel-energy consumption rate in Watts?
- 2) Look up on the web (choose a reputable source!) the energy intensity and energy used per capita for the following countries: US, Canada, Switzerland, Russia, Bahrein, Turkey, Paraguay, and Kenya. Is there a broader range in energy intensity or in energy per capita? What might account for the relative magnitudes of this quantity found in these countries?
- 3) Look up the population density of Manhattan. Assuming that per capita energy usage of New Yorkers (all forms, including non-residential use) is the same as the national average (in fact, they use rather less), estimate the mean power used on the island. Next estimate the mean power delivered to Manhattan by sunlight, first assuming that the Sun is directly overhead during the daytime. Then correct this estimate by assuming that the mean angle of the Sun from the zenith during daytime is 60° . How does the human power consumption per unit area compare to the rate at which solar power arrives?
- 4) Imagine that you're building a new skyscraper, 300 m tall (that's roughly Empire State Building height). Compare the energy it takes to lift its materials to the top with the energy it would take to raise their temperature from ambient to room temperature on a cold winter day (-10 C). Assume that the mean mass per atom is that of concrete ($N \text{ CaO} + \text{SiO}_2$), where $N \simeq 2-3$.
- 5) Imagine a box that you can put a number of hard balls into and shake. As you do work on the box by shaking it, the balls acquire energy by collisions with the walls of the box. Would you describe the balls' energy as organized kinetic energy or heat? Does your choice depend on the number of balls in the box?