MIT Department of Architecture **FALL '08**

Fundamentals of Energy in Buildings **1.044J, 2.45J, 4.42J**

Homework Set # 1

---

1. The average energy used for heating a single family home in 1978 was 80 x 10^6 BTU in a climate similar to Boston or Madison, Wisconsin. Heating is mainly needed for the six coldest months. Use the enclosed table of daily solar radiation, taken from ASHRAE Handbook of Fundamentals 1997, to estimate, to within 15 to 20 percent accuracy, the size of a solar collector needed, in ft,or m^2, to supply one-half of the heating energy for the house for the six winter months. Assume the energy collected on the collector is 50% of the total solar radiation incident on the collector.

2. Assume the house is a simple two story design with 1500 square feet total floor area overall. Sketch a preliminary design of the appropriate sized collector integrated into the roof.

3. A solar collector costs roughly $\$25/ft^2$ of collector area for the entire system. A gallon of fuel oil can supply roughly 140,000 BTU, 158 x 10^6 J, and costs ?? dollars. Compare the economics of a one square foot collector versus heating with oil. Consider how to compare building cost versus operating cost. What other alternatives should be considered?

4 .How big must the solar collector be to supply all of the heating energy if no back up system is included?

5 On same consistent basis, e.g. J, Kw-hr, or BTU compare the costs of energy supplied by electricity, and by burning natural gas and heating oil. Use average consumer prices for one area, such as Boston. Obtain prices directly from utilities or from reference sources. Is there a disparity in energy prices? If so, is this a consumer rip off or is there some justification? This problem is fundamental to many energy considerations.

6. You have been recently hired by MIT to perform a partial energy audit of one of the new luxury dorm rooms just built on campus. Each room comes with quite a bit of pre-installed equipment for the students. Your task is to estimate the electricity usage of one of these rooms. Among other items in the room are: a room air conditioner, full-size refrigerator, microwave oven, coffee maker, toaster, iron, hair dryer, TV and VCR, PC, monitor and laser printer. Assume the electrical lighting is the same as in your own room.

Now assume that the student has everything running at full blast at one time. How much electrical power does this room need to be supplied with (in Watts)? Make some assumptions about how long each appliance is used on a certain day. How many kilowatt-hours of electricity are used by this room in one day? Based on your response to Problem 5, how much does electricity cost for one day?

Submit a table with the following information for each appliance:

Appliance 1	350W	2 hours/day	700 kWh/day	Name of Source

7. For your living group at MIT, list two or three strategies to make it more energy efficient.

Your sources may include: info on the backs of appliances, local department stores (Sears...), and 2 books placed on Reserve in the Rotch Library. (Note that these books aren't entirely up to date!) The books are: *Planning and Building the Minimum Energy Dwelling*, Burt Hill and Associates; *The Home Energy Audit*, Richard Montgomery. Of course, any other sources you can find are great, too.

Table from ASHRAE Handbook of Fundamentals

Solar Heat Gain Through a Single Sheet of Clear Glass 40 N Latitude

Clear sky

Month	**Horizontal Daily (W h/m2)**	**Vertical South Facing (W h/m2)**
Jan	2234	5130
Feb	3458	5180
Mar	4818	4380
Apr	6036	3076
May	6828	2256
Jun	7100	1990
Jul	6790	2220
Aug	5964	2990
Sep	4658	4238
Oct	3408	4986
Nov	2230	5030
Dec	1782	4890

4.42J / 1.044J / 2.66J Fundamentals of Energy in Buildings
Fall 2008