

1. The average energy used for heating a 1980's single family home is roughly  $84 \times 10^6$  kJ,  $80 \times 10^6$  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 75% 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 typical US home with 2000 square feet total floor area overall. Sketch a preliminary design of the appropriate sized collector integrated into the roof. The design and orientation is your choice. What if the long axis of the house is N-S?
3. A solar collector costs roughly  $\$25/\text{ft}^2$  of collector area for the entire system. A gallon of fuel oil can supply roughly 140,000 BTU,  $158 \times 10^6$  J, and costs 2.5 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. Use the kill a watt meters we will supply to make your measurements. Don't forget the energy used by power supplies and other items in standby mode.

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
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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, the internet, and your own measurements.

Table from ASHRAE Handbook of Fundamentals

**Daily Solar Heat Gain Through a Single Sheet of Clear Glass at 40 N Latitude  
With a Clear sky**

<b>Month</b>	<b>Horizontal Daily (W h/m<sup>2</sup>)</b>	<b>Vertical South Facing</b>	<b>Vertical East Facing</b>
Jan	2234	5130	1621
Feb	3458	5180	2311
Mar	4818	4380	2983
Apr	6036	3076	3085
May	6828	2256	3781
Jun	7100	1990	3866
Jul	6790	2220	3752
Aug	5964	2990	3424
Sep	4658	4238	2859
Oct	3408	4986	2233
Nov	2230	5030	1601
Dec	1782	4890	1347

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4.42J / 1.044J / 2.45J Fundamentals of Energy in Buildings  
Fall 2010

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