



## 1.818J/2.65J/3.564J/10.391J/11.371J/22.811J/ESD166J

## SUSTAINABLE ENERGY

Spring 2005

## PROBLEM SET #6

*Due April 7, 2005*

*In reference to the topics covered in Chapter 10 of our text:*

1. **Managing forests for bioenergy.** The United States has a lot of federally owned land. Unfortunately, uncontrolled natural forest fires destroy large areas in the Western US every summer. Last year alone about 1,000,000 acres of standing timber in National forests were consumed. Some consideration is being given to improved management practices that could produce electric power from residual forest thinnings. Estimate the lost energy content of burned US forests during 2002. Assuming the US average electricity demand load is about 300,000 MWe, how much forested land would be needed to produce all the country's power? Is this a sustainable alternative? A few facts to consider:

(i) the total forested area on US Federal lands in the lower 48 states is about 600 million acres with a standing stock density of about 100 dry metric tonnes of wood per acre

(ii) woody plants and trees capture solar energy via photosynthesis at an average rate of about  $0.8 \text{ W/m}^2$  which corresponds to producing about 5 to 10 dry tons of biomass per acre annually with an average heating value of 8000 BTU/dry lb. Note that  $1 \text{ acre} = 43,560 \text{ ft}^2 = 0.405 \text{ hectare} = 4047 \text{ m}^2$

(iii) the average heat to work conversion efficiency of a biomass-fired electric power plant is about 35%

2. **Replacing imported oil with biofuels.** An alternative utilization scheme to what is proposed in Problem 1 would be to convert the lignin cellulosic matter in wood to a liquid fuel such as ethanol.

(a) Estimate how much forested land would be required to offset our current daily quota of imported oil – about 10 million bbl per day. Is this sustainable?

(b) If we used all the biomass available in the US annually from agricultural and forest wastes, food wastes, MSW, and municipal and industrial sludges as a feedstock to a new set of US-based biorefineries could we meet the current imported oil quota? Explain.