

**Final Exam**  
**IAP Part A: Sustainable Energy**  
**10.391J/22.811J/ESD166J/11.371J/1.818J/3.564J/2.65J**

**Part 1(in class): due Thursday, January 25, 2007 at 4:30pm**  
**Part 2 (take home): must be turned in electronically by noon on Saturday, January 27, 2007**

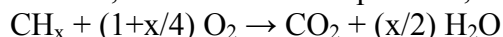
**Note that each part of the exam is worth 100 points making the total 200 points. You must work independently on both parts with no collaboration with others. However, use of the class textbook is permitted for part 1 (in class). For Part 2 (take home) use of all written and electronic materials including the web is permitted. Please use one blue book per question.**

**Part 1: In class analytical problems -- 100 points total**

**1. (60 points)** Renewable energy sources are often viewed as inexhaustible, non-depletable and essentially “emissions-free” and therefore very attractive as alternatives to fossil and nuclear energy. Let’s consider a possible hydropower solution to meet long-term U.S. electricity supply needs. As a replacement for coal-fired base load capacity, assume that U.S. hydro capacity could grow to provide 500 GWe from its current level of about 70 GWe.

- (a) How many tons of carbon dioxide emissions would be offset annually?
- (b) Assuming reservoirs 50 ft deep on average with an average elevation gain of 500 ft could be constructed to provide this increased capacity, what volume of water would need to be stored annually for the new hydropower capacity?
- (c) How much land area in square kilometers would be needed for these reservoirs?
- (d) Given average rainfall rates for the U.S. of 20 inches per year, estimate the land area of watershed that would be required to provide total recharge of the hydro system.
- (e) Describe any environmental or sustainability issues that may be need to be resolved before proceeding with such an ambitious scheme.

*Supplied information* -- The C/H ratio of coal is on average about 0.9. You can assume that inert materials and other organic components in coal are negligible. In practice using “state-of-the-art” hydroturbines, 90% conversion efficiency from kinetic energy to electricity can be achieved. The average rainfall in the U.S. is approximately 20 inches per year. For reference, the land area of Texas is 695,622 km<sup>2</sup>. For this problem, assume that coal combustion is as follows:



**2. (40 points)** Consider a nuclear power plant having an initial Operating License duration of 40 years. During that interval the cost of electricity is 0.04 \$/kWeh, divided into cost components of capital (50%), fuel (20%), and operations and maintenance (30%). Assume that the capital cost of the plant is amortized over the initial 40-year operational interval, and that the latter two cost components are constant at these values at all times. The plant obtains an Operating License extension for an additional 20 years of operation. What is the initial (i.e. with evaluation at time=0) net present value of the cost of electricity over:

- the first 40 years of operation, and
- the next 20 years of operation?

The annual monetary discount rate is 3%.

**Note -- For both problems please remember to state and justify any assumptions you make. Use of the class textbook is permitted.**

## **Part 2: Essay question -- 100 points total**

**Write a short essay (about 1000-1500 words – pithy is better than verbose!!) addressing the following issues. Please submit the essay electronically in MS Word or PDF format to Gregg Beckham.**

**3. (100 points)** A recent article (see attachment) in Environmental Protection magazine discusses corporate roles in sustainable development – some of which are just “green washing.” Suppose that you are a strategic planner for Ford Motor Company and that you were asked by the CEO to develop a better longer term corporate strategy along the lines suggested by MacLean in the article.

First, you need to assess the article and decide whether it is on track or not. Are there parts of it that apply to Ford?

If you don't know specifics of Ford's business strategy at present, see what you can find easily or make assumptions. State what your impression of Ford's image and practices are and how you might wish to change that. Does the green wash label apply at present? Consider future partners, product features, advertising, public messages, etc. A new car takes about 4 years to produce if the technology is not too radical. What is your vision for a new corporate philosophy and do you think it might be successful over a ten year time frame?

**Note – You may use any resource on this essay except another human. Please cite your sources.**