



Figure by MIT OCW.

1.818J/2.65J//3.564J10.391J/11.371J/22.811J/ESD166J SUSTAINABLE ENERGY

Spring 2007

HOMework: NUCLEAR POWER MODULE

Due Thursday, April 19, 2007

QUESTION #1

As fossil fuel prices have risen so has speculation in nuclear fuels (the price of U_3O_8 recently has exceeded \$70/lb). For the case below, what relative change in uranium price would be allowed while still maintaining the same competitive position of coal vs. nuclear energy if an emissions tax of \$50/Tonne- CO_2 were to be imposed upon coal-fired power plants?

Assumptions:

Total cost of electricity from a coal and a nuclear plant is the same for each at 6.0¢ per kWhr. Cost contributions are distributed as follows:

Technology	Capital	Operations & Maintenance	Fuel
Coal	40%	20%	40%
Nuclear	65%	20%	15%

Other Factors:

Technology	Thermal Efficiency	Duty Factor (i.e., Operational Availability)
Coal	0.40	0.95
Nuclear	0.33	0.90

- Coal composition: $CH_{2.2}$
- Nuclear fuel enrichment: 3%
- Nuclear fuel burnup in reactor: 60,000 MWd-t/Tonne
- Monetary interest rate = 7% annually
- Discount rate = 5% annually
- Inflation rate = 0% annually

For any other factors needed in your analysis, make reasonable assumptions and state what you have done.

QUESTION #2

In the current U.S. government initiative to slow the spread of nuclear weapons, it is proposed that only the current major nuclear weapons states (i.e., China, USA, Russia, France, UK) would possess and operate nuclear fuel cycle facilities providing new nuclear fuel and talking back used nuclear fuel to the other countries upon a commercial basis. Provide a critique of this proposal (be sure to state your evaluation criteria and major factors of uncertainty).

QUESTION #3

Consider that breeder reactors are to be built using ^{233}U (obtained from ^{232}Th) and ^{239}Pu , respectively. Note that the Table of nuclear data shown in class has a typographical error showing data for thermal neutrons involving ^{233}U as being that for ^{239}U . What is the maximum conversion ratio that could be achieved in principle with each fuel? (Assume that the reactor consists of pure fuel and that no neutrons escape from it.)

QUESTION #4

In class we have noted that public participation in nuclear power plant licensing processes has led to costly delays, and that such participation is justified by some, partially upon the basis that alternative fora for de-facto determination of the effective national energy policies are largely unavailable within the U.S. political system. If public participation in licensing were to be eliminated, it might be wise to create such fora. Propose two such methods for determination of national energy policies and provide a critique contrasting them. (Hint, you might examine how other countries do this.)