CENTRE FOR ENERGY STUDIES

ESL750 ECONOMICS AND PLANNING OF ENERGY SYSTEMS

Max. Marks: 35 Major Test (II Semester, 2009-2010) Time: Two Hours

Note: Please answer all questions. Maximum marks assigned to each question for the purpose of evaluation are indicated within square brackets at the end of each question. Please note that the marks scored would be normalized for a total of 35 maximum marks for the Major Test.

1. Please explain the reason(s) for
   (a) Scarcity rent being included in the price of depletable fuels.
   (b) Unsuitability of time trend based long term forecasts of energy demand.
   (c) Value of a_{ii} in an input-output coefficient matrix being less than unity.
   (d) Differences in the expected future variation of the marginal cost of energy supply with non-renewable and renewable sources of energy.
   (e) Input-Output technique not being able to consider any economy of scale in production.
   (f) All inter-industry transactions in an input–output table being expressed in monetary units.
   (g) Providing financial/fiscal incentives for development and dissemination of renewable energy technologies.
   (h) A lower value of energy GDP elasticity of a country being desirable.
   (i) Undertaking sensitivity analysis as a part of financial/economic evaluation of renewable energy technologies.
   (j) Global willingness and initiatives for mitigation of carbon dioxide emissions.
   (k) Interest of Annex-I countries in investing in renewable energy and energy efficiency projects in Non Annex-I countries.
   (l) Different possible objectives / goals of energy demand supply balancing exercise.
   (m) Large scale use of Simple Payback Period for appraisal of investments in projects. **[26]**
2. Why relative pricing of fuels needs to be done carefully? Explain possible reasons for pricing petrol at a higher rate as compared to diesel in India. Why electricity should have time of use pricing? Explain the relevance of factors that are to be considered while pricing petroleum fuels. **[10]**
3. The capital cost ($C_{0,iph}$) of low temperature solar industrial process heating system can be expressed in terms of solar collection area (A_{sc}) as
   $C_{0,iph} = 8000\ A_{sc}^{0.95} + 16000$ (In Rupees)
   The expected useful life of the system is 25 years with 5% of the capital cost as the annual cost of operation and maintenance of the system. On an average, 1 m^2 of solar collection area can heat 50 kg of water from 10° C to 60° C. The salvage value of the system is expected to be 10% of the capital cost. The system is expected to have an annual capacity utilization of 85%. Calculate the unit cost of useful thermal energy delivered by a system of daily water heating capacity of 50,000 kg if the discount rate is 10% and the specific heat of water is 4.2 kJ/kg/ °C. **[7]**
4. The government of a developing country is providing 20% capital subsidy on a photovoltaic pump and 80% of the balance amount as soft loan at 4% annual rate of interest. The loan is to be paid back in 10 equal annual repayment instalments. Determine the total effective present value cost of the pump to the user if the market price of the photovoltaic pump is Rs. 400,000 and the discount rate is 8%. Also determine the total present value cost of the incentives given by the government to the user if the market rate of interest on loans is 11%. **[7]**
5. Proposed use of a paraboloid concentrator solar cooker by a 5 member household is expected to save 70% of the per capita daily useful energy requirement of 2.5 MJ for cooking. For meeting the cooking energy demand the household presently uses LPG (butane, C_4H_{10}, with a calorific value of 44 MJ/kg) in a burner with efficiency of utilization of 60%. Determine the annual amount of carbon dioxide likely to be mitigated with the use of the paraboloid concentrator solar cooker if it can be used on 300 days of the year. If the capital cost of the solar cooker with an expected useful life of 5 years is Rs. 8000 and the annual cost of maintenance is Rs. 200, determine the unit cost of carbon dioxide mitigation for an LPG price of Rs. 25 per kg. Assume a discount rate of 10% and also that the salvage value as well as carbon dioxide emissions embodied in the solar cooker are negligibly small. If the present value of one tonne of carbon dioxide mitigated is Rs. 600 and it is expected to remain the same for next five years, estimate the cumulative present value of the carbon mitigations benefits during the useful life of the solar cooker. **[10]**

   OR

   A country uses 6 million electric pumps of 3 kW rating with an average efficiency of electricity utilization of 70%. Transmission and distribution losses of electricity in the country are estimated at 15%. Electricity is produced in coal thermal power plants with an average coal utilization efficiency of 30%. The coal used in the thermal power plants has a calorific value of 22MJ/kg, a carbon fraction of 0.60 and an ash content of 32%. The electric pumps are used for 1800 hours during a year. Estimate the amount of coal likely to be saved and the amount of carbon dioxide mitigated annually if the efficiency of an electric pump is increased to 75%. If an electric pump is replaced by a PV pump providing the same amount of water, estimate the savings of electricity and coal as well as the amount of carbon dioxide likely to be mitigated ignoring the carbon dioxide emissions embodied in the PV pump. If the number of electric pumps is expected to increase by 5% in a year, estimate the corresponding increase in the requirement of coal. **[10]**
6. An economy has only two producing sectors – Agriculture and Electronics. The agriculture sector consumes 400 units of its own output and 200 units of output from the electronics sector. The electronics sector consumes 600 units of its own output and 100 units worth output of agriculture sector. If the final demand of agriculture and electronics sectors is 1500 and 3200 units respectively, prepare the input-output coefficient matrix for the economy. Also, if the final demand for the agriculture and electronics sectors is expected to increase to 2000 and 4200 units respectively, determine the new required gross outputs of the two producing sectors. **[10]**