

Final Exam Energy Analysis
26-01-2006

- You can use the reader and books like BINAS and Key World Energy Statistics.
- The answers of the exercises and your notes may **not** be used.
- You can use a calculator.
- The answers can be provided either in English or Dutch.
- Provide your name and student number on each separate sheet of paper.

1. Burning wet biomass waste

A biomass waste stream has a water content of 80%. The combustion value (HHV) of the dry matter in the biomass is 20 MJ/kg.

- a. Calculate the energy content of the biomass waste stream, both on a higher and a lower heating value.

The lower heating value (calorific value) is often considered as the amount of useful heat that can be extracted from the biomass through a regular combustion process.

- b. Describe an adapted combustion process through which more than the lower heating value can be extracted and utilized.

2. Wind Energy

The installation costs of a 0,5 MW wind turbine are 500.000 euros. The scale factor is 0,7. The lifetime of the wind turbine is 20 years. The discount rate is 7%. The annual operation and maintenance costs are 3% of the installation costs. The load factor is 22%

- a. What are the installation costs of a 2MW wind turbine?
- b. What are the avoided CO₂ emissions per year of the 2MW turbine?
- c. Calculate the production costs of electricity in euro/Kwh of the 2 MW turbine.
- d. At what size of the wind turbine will the production cost will become lower than 0,03 euro/Kwh

3. High oil prices

Due to the high oil prices, the price of gasoline is increased from 1.00 Euro to 1.20 Euro. For the short-term the price elasticity of gasoline is -0.1; for the long-term this is -0.3

- a. How much will the gasoline consumption decrease immediately due to higher oil prices? And how much will the decreasing effect on gasoline consumption be if the oil prices remain high for many years?
- b. Why is the long-term price elasticity different from the short-term price elasticity?

4. Structure

In the pulp and paper industry in a certain country, the following products are made: News print paper, writing paper, sanitary paper and packaging paper. The SEC in 1990 for those products are 6, 12, 11 and 8,8 GJ/ton.

	1990 ktonne	1995 ktonne	2000 ktonne
Newsprint paper	300	361	376
Writing paper	819	818	892
Sanitary paper	167	161	144
Packaging paper	1484	1627	1844
Total Energy Use (PJ)	26,5	26,6	27,2

- 2770 2967
- Calculate the Physical Production Index (PPI) and the Energy Efficiency Index (EEI) for both 1995 and 2000 (1990=100).
 - What is the relative difference between 1990 and 2000 with regard to volume, structure and energy use?
 - Make a graph of the decomposition of these three effects as calculated in question B, analogous to Figure 10.6, page 153 ("Influence of activity changes..") from the reader.
 - Is it a problem that the SEC values are only known for 1990?

5. Stimulation of energy-efficient lighting

In Finland compact fluorescent lamps (CFLs) are sold for 5 Euro. A compact fluorescent lamp of 15 W replaces an incandescent lamp of 60 W. Nowadays Finnish households on average have 20 lamps: 5 are on during 1500 hours per year, 5 are on for 800 hours per year, 5 are on for 300 hours per year and 5 for 100 hours per year. The lamps last for 10,000 hours.

Finnish households have the (implicit) requirement that investments in energy conservation are paid back within 4 years.

Power plants in Finland have an energy conversion efficiency of 40%. Electricity costs Euro 0.10 for households.

- Determine the pay-back times of the CFLs, for the various hours per year they are on.
- Construct a cost-supply curve for energy conservation through CFLs for an average Finnish household (in terms of conserved primary energy). Use a discount rate of 10%.
- The Finnish government wants to stimulate the use of CFLs by giving a subsidy of 2 Euro per CFL. Determine how much subsidy will be paid per household and which part of this subsidy can be considered a free-rider effect.
- Do you expect that in Finland rebound-effects will occur through the application of the subsidy scheme? How can this be prevented.
- The Finnish government falls and a new government comes in that does not want to spend money for energy subsidies. However, they still want to stimulate the use of CFLs. Propose an alternative policy instrument and make an estimate of the effectiveness of this instrument.

Neglect in all calculations the operation and maintenance costs of CFLs and the costs saved through the fact that no incandescent lamps need to be purchased.