

Re-Exam Energy Analysis
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. Heat pumps

The COP of a heat pump is 4. The heat pump is driven by electricity. The heat pump heats water from 10° – 65° C. Electricity is generated in a coal fired power plant with an efficiency of 40%

- a. How much primary energy is needed to supply 100 J of heat with the heat pump?
- b. What is the energy and exergy efficiency of the heat pump based on primary energy?
- c. The heat pump is compared with a gas fired boiler (efficiency 90%). How much primary energy is saved per unit of supplied heat if a household installs the heat pump in stead of the boiler?
- d. Why do households still buy a traditional boiler in stead of a heat pump?

2. Policy Instruments

There are three distinct mechanisms that play a role in influencing human behaviour. Argue which mechanisms play a role in the following policy instruments.

- a. Emission trading
- b. Voluntary agreements

3. Structure and volume

In the industry that processes fruit and vegetables, the following products can be distinguished (in parenthesis the typical value for the specific energy consumption around the year 2000 is given for each of the product groups):

- canned fruit and vegetables (2 MJ/kg)
- frozen fruit and vegetables (8 MJ/kg)
- dried fruit and vegetables (15 MJ/kg)

In the following table some information is given about the fruit and vegetables processing industry in three countries.

	Canned fruit and vegetables production (ktonnes in 2002)	Frozen fruit and vegetables production (ktonnes in 2002)	Dried fruit and vegetables production (ktonnes in 2002)	Primary energy use for fruit and vegetables production (TJ)
Germany	800	300	0	4,400
Netherlands	600	250	0	3,700
France	300	300	100	6,300

- a. Give an expression to calculate the energy-efficiency index
- b. Which of the three countries quoted in the table is most energy-efficient, based on the information that you have? Provide the calculation.
- c. Give two reasons why your conclusion drawn in (b) might be wrong.

4. Energy savings in households

A home uses 100 GJ of natural gas per year. For that home three different types of energy conservation measures are considered: wall insulation, roof insulation and window insulation. The investments for each of these options are 20, 30 and 200 Euro per m². The relevant areas are 40, 60 and 10 m². The annual natural gas savings are 20, 10 and 30 m³ natural gas per m² respectively. The natural gas price is 15 Euro per GJ. Use a discount rate of 10% and a depreciation period of 30 years. Operation and maintenance costs can be neglected.

- a. Can you explain why the saving per m² of insulated area is less for roof insulation than for wall insulation (insulation thickness and material are the same)?
- b. Construct an energy conservation cost supply curve for the home
- c. Can you explain why window insulation is often the measure that is taken first by households?

In addition, a condensing boiler is added to the package of options. A condensing boiler has an additional investment of 1500 Euro and saves 15% of the natural gas demand. The additional operation and maintenance costs are 30 Euro per year.

- d. If no insulation measures had taken, what would be the simple pay-back time and the net present value of the condensing boiler?
- e. Construct an energy conservation cost supply curve in which the three options mentioned above and the condensing boiler are included.

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