

Interim examination Energy Analysis

19 December 2006

14:00 -16:00

- This examination has 3 questions with weights 20, 40 and 40% respectively.
- You can use the book, a dictionary and Key World Energy Statistics.
- The answers of the exercises 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. IEA Energy Balance 2003 (text book)

- a) Explain the difference between the Total Primary Energy Supply and Total Final Consumption.
Show with a calculation on the European Union energy balance that your definitions are correct.
What is the average primary energy conversion efficiency in the EU?
- b) Which definition is the best indicator for the energy use of a country/region?
- c) Calculate the share of the aviation sector in the total consumption of petroleum products of the EU economy.

2. CHP

Utrecht University utilizes a number of gas engines in a combined heat and power plant. The thermal capacity of the gas engines in total is 6.25 MW; they run for 4000 hours per year. 40% of the energy content of the natural gas input (lower heating value) is converted to electricity and 50% to heat (hot water, heated from 60 to 110 °C).

If Utrecht University would not apply combined heat and power, the electricity would be generated in power plants with an energy conversion efficiency of 50% and the heat in boilers with an energy conversion efficiency of 90%.

- a. How much primary energy does Utrecht University save per year by applying CHP instead of separate production?
- b. What is the exergy of the heat produced with this CHP plant.
- c. We want to allocate the natural gas input to the two products heat and electricity. How much natural gas is allocated to heat and electricity if the allocation is done either on an energy basis or an exergy basis?
- d. Which allocation method do you prefer? Explain.

3. Anotherstan

The electricity production system of the country of Anotherstan consists of 1000 MW hydropower, 1800 MW coal fired, and 3000 MW natural-gas fired electric capacity. All plants have an availability of 80%. All year round, the electricity demand is 4500 MW during daytime (7.00 - 23.00) and 2500 MW during night time (23.00 - 7.00).

Power source	Capacity (MW)	Fixed cost (€/kW/yr)	Fuel cost €/kWh
Hydropower	1000	250	-
Coal-fired	1800	165	0.018
Natural gas-fired	2190	90	0.036

- a. Calculate and draw the way the power sources are dispatched to achieve the lowest possible costs.
- b. Calculate the average load factor of the natural gas-fired plants.
- c. Calculate the price per kWh for the different energy sources.
- d. Calculate the average kWh price in the base load and the intermediate load.