Exam "Energy and Economy", 0EM72

16-04-2013, 14:00-17:00h.

Please carefully read the instructions below before starting. Good luck!

1) Students who are writing a course paper, and who are doing the short version of this exam, should answer 3 out of 5 questions. They may choose which 3 questions they wish to answer.

2) Students who are doing the full exam – without course paper -- should answer all 5 questions.

3) Those students who already attended the course during academic year 2011-12 (or earlier) and *who have already completed a course paper with a pass grade last year*, should answer 4 out of 5 questions. They may choose which 4 questions they wish to answer.

PLEASE INDICATE CLEARLY ON YOUR FIRST ANSWER SHEET WHETHER YOU ARE IN CATEGORY 1, 2, OR 3!

Each question can earn you a maximum of 20 points if all its sub-questions are answered correctly.

Category 1 students can therefore earn a total maximum of 60 pts.

Category 2 students can earn a maximum of 100 pts.

Category 3 students can earn a maximum of 80 pts.

The total pts score for category 1 & 3 students will be normalized as a %, and this sub-grade will then represent 55% of their total course grade.

You may use a calculator. Computers, mobile phones and electronic dictionaries are not allowed during the exam.

This exam consists of 8 pages, including this cover page.

Question 1

Below is given the 2009 Energy Balance for Germany, in thousand tonnes of oil equivalent (ktoe) on a net calorific value basis. Source: IEA. http://www.iea.org/stats/

SUPPLY and CONSUMPTION	Coal and Peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geotherm al, solar. etc	Biofuels & waste	Electri-city	Heat	Total*
Production	45703	3874	0	11113	35164	1605	4769	24861	0	0	127089
Imports	26763	100109	33293	76317	0	0	0	1	3600	0	240083
Exports	-874	-112	-22453	-9047	0	0	0	0	-4655	-6	-37148
International Marine Bunkers**	0	0	-2702	0	0	0	0	0	0	0	-2702
Internat. Aviation Bunkers**	0	0	-7134	0	0	0	0	0	0	0	-7134
Stock Changes	24	397	-255	-1826	0	0	0	0	0	0	-1660
TPES	**71615**	**104268**	**749**	**76557**	**35164**	**1605**	**4769**	**24862**	**-1055**	**-6**	**318529**
Transfers	0	2274	-1645	0	0	0	0	0	0	0	629
Statistical Differences	493	-176	627	-1923	0	0	-9	-1	0	0	-988
Electricity Plants	-53862	0	-1498	-4579	-35164	-1605	-3905	-9441	43807	0	-66248
CHP Plants	-6625	0	-533	-10101	0	0	0	-3244	6625	8198	-5680
Heat Plants	-618	0	-175	-1897	0	0	-50	-1053	0	3039	-755
Gas Works	0	0	0	0	0	0	0	0	0	0	0
Oil Refineries	0	-111574	110000	0	0	0	0	0	0	0	-1574
Coal Transformation	-3098	0	-654	-43	0	0	0	0	0	0	-3795
Liquefaction Plants	0	0	0	0	0	0	0	0	0	0	0
Other Transformation	0	5208	-5321	0	0	0	0	0	0	0	-113
Energy Industry Own Use	-775	0	-6470	-744	0	0	0	-5	-4607	-122	-12722
Losses	-316	0	0	-3	0	0	0	-24	-2150	-872	-3365
TFC	**6813**	**0**	**95081**	**57267**	**0**	**0**	**806**	**11094**	**42619**	**10237**	**223918**
Industry	**5360**	**0**	**3077**	**15159**	**0**	**0**	**0**	**3311**	**17376**	**3625**	**47908**
Transport	**0**	**0**	**49642**	**132**	**0**	**0**	**0**	**2781**	**1367**	**0**	**53923**
Other	1200	0	21975	40229	0	0	806	5002	23876	6611	99701
Residential	960	0	14021	28797	0	0	792	4988	11971	4213	65742
Commercial and Public Services	241	0	7954	7522	0	0	13	14	11165	2398	29307
Agriculture / Forestry	0	0	0	258	0	0	0	0	740	0	997
Fishing	0	0	0	0	0	0	0	0	0	0	0
Non-Specified	0	0	0	3653	0	0	0	0	0	0	3653
Non-Energy Use	**253**	**0**	**20386**	**1747**	**0**	**0**	**0**	**0**	**0**	**0**	**22386**
of which	13	0	16567	1747	0	0	0	0	0	0	18326
petrochemical feedstocks											

a) What is meant by the entry "international marine bunkers" in the table? (3 pt)

b) Assess the domestic energy security situation in Germany, using the data in the table (6 pt)

c) Give your motivated opinion about how Germany is performing with respect to renewables in their energy mix (2 pt).

d) What can you conclude about the level of Germany's nationwide EROEI (Energy Return on Energy Invested) from this energy balance? (3 pt)

e) List two other important energy & economy issues that one can also analyze with this Energy Balance. Indicate for each one which specific data in the above table you would use for this purpose. (6 pt)

Question 2

The text below is taken from a business proposal that was submitted to the Commercial Bank of Zambia in 2012 by a Zambian biofuel company called Z-Jatropha Ltd. All financial data quoted below are in constant US$ of 2012.

Z-Jatropha Ltd. buys Jatropha seeds from over 100,000 Zambian smallholder farmers, who are planting the Jatropha bush as hedges or fences around their food plots. The company buys against a fair cash price and transports the seeds to Lusaka, where it produces straight Jatropha oil (SJO) which is sold domestically to commercial parties who blend the SJO with fossil diesel, e.g. for use in their electricity generators and vehicles. This is financially attractive because fossil diesel is very expensive in land-locked Zambia (at least US$ 1.50/L in Lusaka, and higher in remote rural areas). From the leftover seedcake, the company produces briquettes and pellets which are sold as high-performing firewood & charcoal replacements in household cooking stoves.

The business proposal involves the start of own production of biodiesel from the SJO, by adding a transesterification step to the production process. Currently the SJO is sold at US$ 1.35/L. Current production volume is approx. 100.000 L SJO per year, and this is expected to remain the same in the future. From 1 L SJO, about 0.98L biodiesel can be produced. The biodiesel can be sold locally for minimum price of US$1.50/L. The waste from the process is converted into soap and can be sold on the local market; but the revenues of this are negligible. The cost of a (second hand) transesterification unit is US$ 15,000 in year 0. Tests and training of workers are expected to be US$8,000 in year 0, and US$ 2,000 in year 1. The company will need to employ one extra Zambian employee, who will cost US$ 500 per month. Extra overhead costs, and operational costs such as extra electricity use and costs of chemicals will amount to US$ 416.67 per month. The expected duration of the project is 10 years, this includes the investment year 0. The interest rate quoted by the Commercial Bank of Zambia for a 10-year project loan is 12%, and the average expected inflation rate in Zambia over the project period is estimated at about 8%.

a) Draw up a table containing all the cash flows from non-financial operations (3 pt)

b) Explain the difference between cash flows from non-financial operations and cash flows from financial operations (3 pt).

c) Explain why the cash flows from financial operations are not needed for the estimation of the Pay-Back Period, or profitability indicators such as the Net Present Value and the Internal Rate of Return in the case of this project? (3 pt)

d) The Commercial Bank of Zambia estimates the real Internal Rate of Return of the project at 10%. Assuming the Bank has done its calculations correctly, what does that information tell you about the value of the Net Present Value of this project? (4 t)

e) Calculate the Net Present Value of this project. (4 pt)

f) Would you advise the entrepreneur from Z-Jatropha limited to go ahead with this project, based on the outcomes of your analysis? If yes, why? if no, why not? (3 pt)

Interest rate formula: $(1+i) = (1+r)*(1+p)$, in which i is the commercial interest rate, r = the same rate without inflation, and p is the annual inflation rate. All variables are expressed as proportions.

Question 3

a) Why has the importance of energy demand management increased since the 1980s, in comparison to energy supply management? (3 pt)

b) Briefly discuss two common types of energy demand management (4 pt).

c) Energy demand management policies can have strange impacts in practice. A famous example of this is the Jevons Paradox. What is meant by this? (3pt)

d) In his chapter 6 on Energy Demand Management, Bhattacharyya discusses various tests that can be applied to assess the effectiveness of energy demand management interventions. Briefly discuss two of these tests, and illustrate your discussion with a simple numerical example (10 pts).

Question 4

It has been argued by some policy analysts that liberalized and privatized energy markets often do work out so well – at least in certain respects - due to the prevalence of market failures.

a) What do economists mean by the concept of "market failure"? (2 pt)

b) An "external effect", or "externality", is a specific type of market failure. Use this concept to explain why a fully market-based energy system cannot deal with the problem of greenhouse gas pollution from fossil fuels (4 pt).

c) There are two main types of policy interventions that can be used to address the problems caused by externalities. Which are these, and what is the essential difference between them? (4 pt)

d) Mention two other types of market failure – i.e., in addition to the externalities of question b -, which hinder the widespread adoption of renewable energy technologies in high-income countries with a well-developed fossil-based (and nuclear-based) energy system, like the Netherlands, France, or Germany? (4 pt)

e) There are certain market failures that constitute particularly important barriers to the widespread adoption of renewable energy technologies such as small solar home systems and efficient household cookstoves in low-income developing countries with poorly developed energy systems. Mention two examples of these. (6 pt)

Question 5

a) The "Levelised Bus-Bar cost" method is a well known approach for comparing electricity generation costs of different generating plants using different technologies and having different cost profiles. The essence of the approach is levelisation of costs. What is meant by this? (5 pt)

b) What is meant by the "base load" of an energy using-system? (1 pt)

c) During last year's New Year's reception of the Eindhoven Energy Institute (which is based in the Connector Building on the TU/e campus), several members of the University Board were present. During the festive champagne toast they spoke glowingly about the grand ambitions of the TU/e to become a regional leader in the adoption of energy saving practices. However, after their speech, one of the directors of the Eindhoven Energy Institute made a critical remark, that the Board should perhaps scale down their initial ambitions, given the fact that the base load figures for the TU/e campus are over 80%! In your opinion, what could be two key contributing factor(s) to this extremely high base load? (4 pt)

d) Given this high base load, list two energy-saving strategies that the TU/e should adopt with priority, in your view. Motivate your answer (4 pt).

e) Sometimes, policies to increase energy efficiency are not adopted by companies because they also have the effect of worsening the overall economic efficiency of their operations. Explain the difference between energy efficiency and overall economic efficiency, and illustrate this kind of trade-off situation between the two with a simple example. (6 pt)