FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Fachbereich 2
Informatik und Ingenieurwissenschaften

Examination: Energy Economics (Master Renewable Energy)			
Examiner: Schäfer			February 24, 2023
WS 2022/23	student No.:	full name:	signature:

With my signature I confirm that

- I completed the exam on my own and only with the help of the admitted tools listed below,
- I feel healthy and able to take the exam,
- I am aware that the exam is considered to have been taken and will be evaluated once the examination assignments have been received.

- The examination assignments consist of three pages and have to be returned together with the solution!
- Dictionaries and non-programmable calculators are admitted tools.
- The maximum points achievable are 90.
- The examination time amounts to 90 minutes.
- Please write down all steps of calculation! Pure numbers without transparent calculation yield 0 points!

1. Optimal consumption decision and demand

Kristina likes to attend theatre performances and football games. Her annual budget for theatre performances and football games exactly equals 72 €. The price for one theatre performance p_T is 8 €. The local football club only asks for p_F=2 € per game. Kristina's preferences can be described by the following utility function

$$u(x_T, x_F) = x_T^{\frac{2}{3}} \cdot x_F^{\frac{1}{3}}$$

a) Derive Kristina's budget constraint, illustrate it in an appropriate and labeled coordinate system and specify the axis intercepts. *(5 points)*

b) Calculate the marginal utility MU_T and MU_F and the marginal rate of substitution MRS. *(5 points)*

c) Calculate the optimal consumption bundle x_T^*, x_F^* and illustrate it together with an indifference curve in your illustration from subtask a). *(10 points)*

d) Calculate Kristina's demand curve for football games. *(10 points)*

hint: The demand curve describes the relation between quantity and price of a good. Thus, we search for a relation between x_F and p_F. Moreover, the demand curve considers the optimal consumption decision.

Please turn the page

2. **Gas price cap and elasticity**

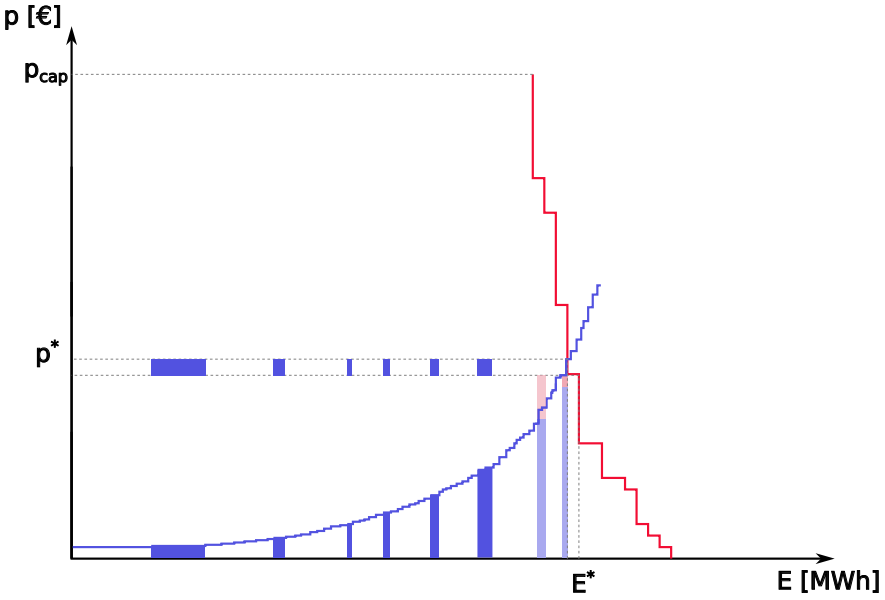
a) Show that the equation $y = A \cdot p^{-\epsilon}$ describes a constant price elasticity of demand. *(5 points)*

b) Assume that demand for natural gas is 950 TWh at a price of 50 €/MWh while it is 750 TWh at a price of 300 €/MWh. Calculate the price elasticity of demand assuming that it is constant. *(7 points)*

c) Interpret the value you calculated in subtask b). Does it seem appropriate to you in the context of gas demand? Give a short explanation also considering different time horizons. *(8 points)*

hint: If you could not solve subtask b), assume ϵ=0.2.

3. **Pricing at the spot market for electricity**



Use the the illustration above to explain

a) how pricing takes place at the spot market for electricity, *(10 points)*

b) what are multi unit bidders, how they can try to increase profits by withholding generation capacity and how the regulator can react. *(10 points)*

Please go to page three

4. **Capacity markets and renewable energy sources**

Assume the following situation for an existing representative base-load and an existing representative peak-load power plant in year t:

capital costs peak-load	$k_{t,peak}$	24,375 €/MW
failure rate peak-load	$X^e_{PER,t,peak}$	0.025
capital costs base-load	$k_{t,base}$	72,500 €/MW
failure rate base-load	$X^e_{IR,t,base}$	0.035
	$X^e_{PER,t,base}$	0.03
$\text{IR}^e_{t,base}$	$(p_{strike} - C_{G,t,base} - C_{E,t,base})d_{t,base}$	50,000 €/MW
PER^e_t	$(p_{cap} - p_{strike})d^e_{spike,t}$	20,000 €/MW

Since $p_{strike} = C_{G,t,peak} + C_{E,t,peak}$, there is no inframarginal rent for the peak-load power plant.

a) Calculate price bids $p_{t,peak}, p_{t,base}$ for the two representative power plants at the capacity market. *(15 points)*

hint: Recall that the calculation of the penalty follows

$$\varrho^e_{t,i} = X^e_{PER,t,i} MM^e_t \Rightarrow \xi_t := \frac{p^*_t}{PER^e_t}$$

b) Is the capacity market in its equilibrium? What is the resulting market price p^*_t at the capacity market? *(5 points)*

hint: If you could not solve subtask a), assume $p_{t,peak} = p_{t,base}$=25,000 €.

Good luck!