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Electricity Markets
1. Exercise Sheet

Exercise 1. Electricity consumption in your household (*)

1. *First, check your households contract for electricity. What is your basic charge (per year), what is your kilowatt-hour rate?*

2. *Using your kettle, how long does it take to boil one liter of water? With the power consumption of your kettle (it should be written on it), what is the corresponding amount of electrical energy in kWh? Given your kilowatt-hour rate, what is the corresponding cost of electricity?*

3. *Check the power consumption of the light bulbs in the lamps in your living room. If you assume that you have the lights on 4 hours each day – given your kilowatt-hour rate, what would be the cost with respect to the electrical energy consumed per year?*

Exercise 2. Basic demand side management of private households

The electricity consumption of private households in Germany in 2013 was around 138 TWh (Source: Umweltbundesamt), of which approximately 12.4% were used for washing, drying and dish washing (Source: BDEW, data for 2011). In the following, we abbreviate these activities with "washing".

1. *Estimate the amount of electrical energy yearly used in Frankfurt for washing in private households (population of Germany: ≈81 million, population of Frankfurt: ≈0.716 million).*

2. *For households with a suitable electricity meter, a large Frankfurt electricity supplier offers a tariff with a kilowatt-hour rate of 28.64 ct/KWh during daytime, and 24.15 ct/KWh at nighttime (between 10 p.m. and 6 a.m.). If everyone in Frankfurt would use this tariff, what would be the total annual cost saving by shifting 60% of washing from daytime to nighttime?*

3. *The basic rate for this tariff is 93.31 EUR/year. Comparing with the standard tariff (basic rate 71.4EUR/year, fixed kilowatt-hour rate 28.64 ct/KWh with no distinction between day and night), for which electricity consumption at nighttime per year a household should use which tariff?*

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Exercise 3. Energy conversion *For simplicity assume that the marginal costs of power generation from lignite, hard coal and gas are given by the fuel costs plus the CO_2 costs due to the EU Emissions Trading Scheme. For answering the following questions use the numbers given in the lecture slides.*

1. *Estimate the price per tonne in EUR for lignite, hard coal and gas.*
2. *For which CO_2 price are the marginal costs of electricity generation from lignite and hard coal the same?*
3. *For which CO_2 price are the marginal costs of electricity generation from lignite and gas the same?*

Exercise 4. Some basic microeconomics *Suppose that the utility function for the consumption of electricity of an industrial company is given by*

$$U(q) = 70q - 3q^2[EUR/h] \quad , \quad q_{min} = 2 \leq q \leq q_{max} = 10,$$

where q is the demand in MWh and q_{min}, q_{max} are the minimum and maximum demand.

1. *Determine the inverse demand function $D^{-1}(q)$ in the range $[q_{min}, q_{max}]$.*
2. *What is the range of prices π, in which the company adjusts its electricity consumption? Determine the demand function $D(\pi)$ and the price elasticity of demand in this range.*
3. *Determine the net consumers' surplus as a function depending on the quantity q in the range $[q_{min}, q_{max}]$.*
4. *Determine the net consumers' surplus as a function depending on the price π. What is the maximum surplus? At which price the company might consider to shut down the factory?*