Tutorial Energy & Sustainability

Exercise Sheet 4
–Sketch of Solution–

Exercise 1

Global: $\frac{184\,246\ Mt\ +\ 991\,241\ Mt}{911.5\ Mt/a} = 1\,289.6$ years

D: $\frac{41\,300\ Mt\ +\ 77\,600\ Mt}{179.1\ Mt/a} = 663.87$ years

Exercise 2

$$1.67 \cdot 10^{12}\ kg\ \text{HCU} \cdot \frac{1}{1022 \frac{kg\ \text{HCU}}{t\ \text{hard coal}}} = 1630 \cdot 10^6\ t\ \text{of hard coal}$$

$$728\,436 \cdot 10^6\ t\ \text{of hard coal} = 1630 \cdot 10^6\ t\ \text{of hard coal} \cdot \sum_{t=0}^{m} 1.03^t$$

$$446 = \frac{1.03^{n+1} - 1}{1.03 - 1}$$
$$13.4 = 1.03^{n+1} - 1$$
$$14.4 = 1.03^{n+1}$$
$$n + 1 = log_{1.03} 14.4 = 90 \Rightarrow n = 89 \text{ years}$$

Exercise 3

cf. tutorial

Exercise 4

a) (strongly simplified)

I: $C + S + 2O_2 \rightarrow CO_2 + SO_2$

II: $SO_2 + CaCO_3 + \frac{1}{2}O_2 \rightarrow CaSO_4 + CO_2$

[$CaCO_3$ – calcium carbonate; $CaSO_4$ – calcium sulfate/cement]

b) 25 t sulfur → Change units to mol!

III: amount of substance $n = \frac{mass\ m}{molar\ mass\ M}$

$\frac{25 \cdot 10^6 \cdot g\ S}{32\ g/mol} = 781\,250\ mol = n(S)$

With I and II the following equation olds:

$n(S) = n(SO_2)$ and $n(SO_2) = n(CaCO_3)$

From III follows $m(CaCO_3) = n(CaCO_3) \cdot M(CaCO_3) = 78 \cdot 10^6\ g$

$\approx$ 78 t $CaCO_3$

c) $m(CO_2) = n(CO_2) \cdot M(CO_2) = 34\ t$
(with $n(CO_2) = n(S)$ and $M(CO_2) = 44\ g/mol$)

Exercise 5

a) Depletion in D $= 63\ Mt \cdot\ 0.37 = 23.31\ Mt$

prices on the world market $= 65\ USD/t \cdot \frac{1\ Euro}{1.2\ USD} = 54.17\ Euro/t$

Difference to the german prices $= 85.83\ Euro/t$

Subsidies $= 85.83\ Euro/t \cdot 23.31\ Mt = 2\ 10^9\ Euro$ p.a.

b) approx. 80 000 Euro per employee and year.