[1]

1) Arbeitspreis : 25,56 Cent / kWh
Grundpreis : 80,97 €/a

2) . boiling of 1l of water : 186s $= 186 \cdot \frac{3600\,s}{3600}$

$= \frac{186}{3600}\,h \approx 0.052\,h$

- power consumption : 2000 - 2400 W

=> I'll take 2.2 kW

=> electrical energy for boiling 1l of water : $0.052\,h \times 2.2\,kW \approx 0.114\,kWh$

=> cost : $0.114\,kWh \times 25.56\,Cent/kWh \approx 2.91\,Cent \approx 3\,Cent$

3) light bulbs in my living room / kitchen

$\left.\begin{array}{l} 2 \times 13W \\ 3 \times 35W \end{array}\right\}$ 131 W = 0.131 kW

electrical energy : $0.131\,kW \cdot 365 \cdot 4\,h = 191.26\,kWh$

cost : $191.26\,kWh \times 0.2556\,€/kWh \approx 48.89\,€$

(replace 3×35W with 3×6W ? => save ≈35.83 €/a)
(5€ each)

1 TWh = 1000 GWh
1 GWh = 1000 MWh
1 MWh = 1000 kWh

1) estimation:

$$138\ \text{TWh} \times 0.124 \times \frac{0.716}{81} = 0.151\ \text{TWh}$$

countries: rank 173, Central ~~Af~~ African Republic, 148.8 GWh (Wikipedia)

2) $r_{day} = 28.64$ ct/kWh
$r_{night} = 24.15$ ct/kWh

saving: $\underbrace{(r_{day} - r_{night})}_{4.49\ \text{ct/kWh}} \cdot 0.6 \cdot 151{,}000{,}000\ \text{kWh}$

≈ 4.07 Million €

3) $b_{kombi} = 93.31$ €/a
$b_{standard} = 71.4$ €/a

$r_{standard} = r_{day}$

$\Rightarrow 1a \cdot b_{kombi} + x \cdot r_{night} < 1a \cdot b_{standard} + x \cdot r_{day}$: use Kombi tariff

" > " : use standard

switch at: $x = \dfrac{b_{kombi} - b_{standard}}{r_{day} - r_{night}}$

$= \dfrac{93.31\ € - 71.4\ €}{4.49\ \text{ct/kWh}}$

$= \dfrac{21.91\ €}{0.0449\ €}\ \text{kWh}$

$\approx 488\ \text{kWh}$

1) given in the slides:

- calorific energy (MWh_{th} / tonne) CE

- cost per thermal (€/ MWh_{th}) C_{th}

$\Rightarrow$ cost per tonne (€/tonne) $C_t = CE \cdot C_{th}$

$\Rightarrow$ lignite: 11.25 €/tonne
hard coal: 67 €/tonne
gas: 354.2 €/tonne

2) marginal costs $mc = C_{el} + C_{CO_2} \cdot e$

mc: €/MWh_{el}; C_{el}: €/MWh_{el}; C_{CO_2}: €/tonne CO_2; e: emissions: tonne/MWh_{el}

$$mc(lig) = C_{el}(lig) + C_{CO_2} \cdot e(lig)$$
$$= mc(h.c.) = C_{el}(h.c.) + C_{CO_2} \cdot e(h.c.)$$

$$\Rightarrow C_{CO_2} = \frac{C_{el}(h.c.) - C_{el}(lig)}{e(lig) - e(h.c.)}$$

$$= \frac{22 \text{ €/MWh} - 11 \text{ €/MWh}}{0.9\ t_{CO_2}/\text{MWh} - 0.8\ t_{CO_2}/\text{MWh}}$$

$$= 110 \text{ €}/t_{CO_2}$$

3) similar:

$$C_{CO_2} = \frac{58 \text{ €/MWh} - 11 \text{ €/MWh}}{0.9\ t_{CO_2}/\text{MWh} - 0.5\ t_{CO_2}/\text{MWh}} = 117.5 \text{ €}/t_{CO_2}$$

[4]

$U(q) = 70q - 3q^2$ [EUR/h] all q in MW.

$q \in [2,10]$

1) maximise net consumers' surplus

$$\max_q \left[U(q) - q \cdot \bar{u}\right] \Rightarrow U'(q^*) = \bar{u}$$

$$D^{-1}(q) = U'(q) = 70 - 6q$$

2) $q_{min} = 2 \;\hat{=}\; \bar{u}_{max} = D^{-1}(2) = 58$ EUR/MWh

$q_{max} = 10 \;\hat{=}\; \bar{u}_{min} = D^{-1}(10) = 10$ EUR/MWh

$D(\bar{u}) = q$

$\bar{u} = 70 - 6D(\bar{u})$

$\Rightarrow D(\bar{u}) = \frac{1}{6}(70 - \bar{u})$ [MW] check: $D(\bar{u}_{min}) = D(10) = 10 = q_{max}$

$D(\bar{u}_{max}) = D(58) = 2 = q_{min}$

price elasticity:

$$\varepsilon = \frac{dq}{q} \Big/ \frac{d\bar{u}}{\bar{u}} = \frac{\bar{u}}{q}\frac{dq}{d\bar{u}} = \frac{\bar{u}}{D(\bar{u})}\frac{d(D(\bar{u}))}{d\bar{u}}$$

$$= \frac{6\bar{u}}{70-\bar{u}}\left(-\frac{1}{6}\right)$$

$$= -\frac{\bar{u}}{70-\bar{u}}$$

3) $U(q) - q\cdot\bar{u} = U(q) - q \cdot D^{-1}(q)$

$= 70q - 3q^2 - q\cdot(70 - 6q)$

$= 3q^2$ for $q \in [2,10]$

check lower bound: $U(2) = 128$

$q \cdot D^{-1}(q) = 2\cdot(70 - 6\cdot 2)$

$= 116$

$\Rightarrow$ n.c.s. $: 12 = 3\cdot(2)^2$

4) $3q^2 = 3(D(\bar{u}))^2$

$$= \frac{3}{36} \times (70-\bar{u})^2$$

$$= \frac{1}{12} \times (70-\bar{u})^2 \quad \text{for } \bar{u} \in [10, 58]$$

check higher bound: $\frac{1}{12} \times (70-58)^2 = \frac{1}{12} \times (12)^2 = 12$

shut down when $U(2) - 2 \cdot \bar{u} < 0$

$$\Rightarrow \bar{u} > \frac{U(2)}{2} = \frac{128}{2} = 64 \quad \text{EUR/MWh}$$