Energy & the Env't Hwk #8

Ch. 21: 34, 35, 38, 40
Ch. 22: 32, 33, 36
Ch. 23: 33
Ch. 25: 36, 37

} 100 points total

(21.34) $f = 23000\ Hz$, $\lambda = ?$

$C = \lambda f$, $C = 330\ m/s$

$$\lambda = C/f = \frac{330\ m/s}{23{,}000\ 1/s}$$

$\lambda = 1.43 \times 10^{-2}\ m$ | $\lambda = 14.3\ mm$

(21.35) Cost of facility $= \$300/kW_e/yr$

Maint & Op Cost $= \$0.017/kWH$

Array size $= 10{,}000\ m^2$

a) 20% cloudy, Amt power produced?
use $150\ W/m^2$, p. 466

$$\text{Power Production} = (1-.2)\left(12\ \frac{h}{d}\right)\left(365\ \frac{d}{yr}\right)\left(150\ \frac{W}{m^2}\right)\left(\frac{10^4\ m^2}{10^3\ W/kW}\right)$$

$$\text{Power Prod.} = 5.256 \times 10^6\ \frac{kWh}{yr}$$

b) $\text{Cost} = \text{Facility Cost} + \text{O \& M Cost}$

$$= \frac{\$300}{kW}\left(\frac{150(10^4)}{1000}kW\right) + (.017)(5.256\times10^6\ kWh)$$

$$= \$450{,}000 + \$89{,}352$$

$$\boxed{\text{Cost} = \$539{,}352.00}$$

c) $\text{Electricity Cost}\left(\frac{\$}{kWh}\right) = \frac{\$539{,}352\ /yr}{5.256\times10^6\ kWh/yr}$

$$= \frac{\$0.1026}{kWh}$$

@ 10.3¢/kWh probably would not make money off peak, as other sources are less than this. On peak, could make money

(38) $\lambda_{blue} = 400\,nm$, $\lambda_{red} = 630\,nm$

$E = \frac{hc}{\lambda}$ blue has more energy, since λ is

$$\boxed{E_{blue}/E_{red} = \lambda_{red}/\lambda_{blue} = \frac{630}{400} = 1.57}$$

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(21.40) 1 GW = 10^9 Watts

Find photovoltaic area

use 150 W/m² for $\frac{Power}{Area}$

$$\text{Collector Area} = \frac{\text{Power}}{\text{Power/Area}}$$

$$= \frac{10^9 \text{ watts}}{150 \text{ W/m}^2}$$

$$\text{Collector Area} = 6.7 \times 10^6 \text{ m}^2 = 6.7 \text{ km}^2$$

(22.32)

$$\text{Energy Stored} = \rho A g \Delta h^2 / 2$$

$$(J)\ \text{Energy Stored} = (5.72\text{m})^2 (9.8 \tfrac{m}{s^2})(32.1 \times 10^6 \text{m}^2)(1030 \tfrac{kg}{m^3}) / 2$$

$$= 5.31 \times 10^{12} \text{ J}$$

This energy stored occurs over 12 hrs

$$P = \frac{\text{Energy}}{\Delta t} = \frac{5.31 \times 10^{12} \text{ J}}{(43,200)\text{sec}\,(1000 \frac{W}{KW})}$$

$$\text{Power Produced} = 1.23 \times 10^5 \text{ KW} = 123 \text{ MW}$$

(22.36) Given Input power Flux = 550 W/m²

$\Delta T = 10°C$, $T_{high} = 25°C$

Output power = 500 kW

Find Area needed

Find efficiency $E = \frac{10\ K}{298\ K}$

$= .0336$

$P_{in} = \frac{P_{out}}{E} = \frac{500 \times 10^3\ W}{.0336}$

$P_{in} = 1.49 \times 10^7\ W$

$\text{Lake Area} = \frac{P_{in}}{\text{Input Power Flux}}$

$= \frac{1.49 \times 10^7\ W}{550\ W/m^2}$

Lake Area $= 2.71 \times 10^4\ m^2$

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(22.33) Given: Power Density = 60 kW/m

Find Energy production cost

Use eqn. p.485

$$\left(\frac{\$}{kWh}\right) Cost = \frac{\$\,1.129\,/kWh}{\left(\text{Power density } kW/m\right)^{.64}}$$

$$= \frac{\$\,1.129}{60^{.64}} = .0822$$

Cost = 8.2 ¢/kWh

(23.33) Given 25 MW electrical generator

a) 5 t/ha/yr
b) 12 t/ha/yr
c) 17.5 t/ha/yr

From Tab. 6.1, p.93

Pine Energy Content = 5.1 kWh/kg

Assume 90% operation, Assume efficiency = 33%

$$\text{Input Power} = \frac{\text{Output Power}}{E} = \frac{25}{.33}$$

$$= 75 \text{ MW}$$

Total Wood Energy Need $= 75\ MW \times .9 \times 365 \times 24\ \frac{h}{d} \times 1000$

$= 5.913 \times 10^{8}\ \frac{kWh}{yr}$

$\left(\frac{kg}{yr}\right)$ Mass Wood Needed $= \frac{5.913 \times 10^{8}\ kWh/yr}{5.1\ kWh/kg} = 1.159 \times 10^{8}\ \frac{kg}{yr}$

Tons Wood Needed $= \frac{\left(1.159 \times 10^{8}\ \frac{kg}{yr}\right)(2.2)}{2000}$

Amt Wood Needed $= 1.27 \times 10^{5}$ tons/yr

Area Needed (ha)

a	1.27×10^{5}	$/5$	$= 2.55 \times 10^{4}$ ha
b	↓	$/12$	$= 1.06 \times 10^{4}$ ha
c	↓	$/17.5$	$= 7.29 \times 10^{3}$ ha

(25.36) Given latent heat $= 106\ \frac{kJ}{kg}$

Energy Available $= \left(106\ \frac{kJ}{kg}\right)(500\ kg)$

Energy Available $= 5.3 \times 10^{4}$ kJ

(25.37) 2.0 mw stored for 6 hrs

$$\text{Energy Stored} = \left(2\times10^{6}\,\frac{J}{s}\right)(6\,h)\left(3600\,\frac{sec}{hr}\right)$$

$$\boxed{\text{Energy Stored} = 4.32\times10^{10}\,J}$$

$$\text{Amt Stannic Bromide} = \frac{\text{Energy}}{LH_oF}$$

$$= \frac{4.32\times10^{10}\,J}{(106\,J/g)(1000\,g/kg)}$$

$$\boxed{\text{Amt. Stannic Bromide} = 4.075\times10^{5}\,kg}$$