Prob #1 1) First calc amount of energy to heat the water:

$$(60°C - 15°C) \cdot 100\,l \cdot \frac{4.2\,kJ}{l\,°C} = 19000\,kJ$$

$$19000\,kJ \; \frac{Wh}{3600\,J} = 5.3\,\frac{kWh}{day}$$

Now calc \$ per year:

$$5.3\,\frac{kWh}{day} \; \frac{365\,day}{yr} \; \frac{\$.13}{kWh} = \frac{\$250}{yr}$$

PNM:

$P/A = 0.149$

$$P = \frac{250}{0.149} = \$1680$$

Solar:

$P = \$2000$

PNM is better.

Hw3 Prob 2

Prob 2 From solar table in Albuquerque $6.4 \frac{kwh}{m^2 day}$

at 80% eff this gives $6.4 \frac{kwh}{m^2 day} (0.80) = 5.12 \frac{kwh}{m^2 day}$

we need $\frac{5 kwh}{day}$ so $\frac{5 kwh}{day} \cdot \frac{m^2 day}{5.12 kwh} =$

Solar Thermal $\approx 1 m^2$

using PV $6.4 \frac{kwh}{m^2 day} \cdot (0.15) \approx 1 \frac{kwh}{m^2 day}$

so $\frac{5 kwh}{day} \cdot \frac{m^2 day}{1 kwh} =$ **$5 m^2 = PV$**

$5 m^2$ of PV will be much more expensie than $1 m^2$ of thermal. Silicon cells vs. sheet metal!

Hw 3 Prob 3

Prob 3:

1) $90V \cdot 20A \cdot 4h = 7.2 \frac{kWh}{day}$

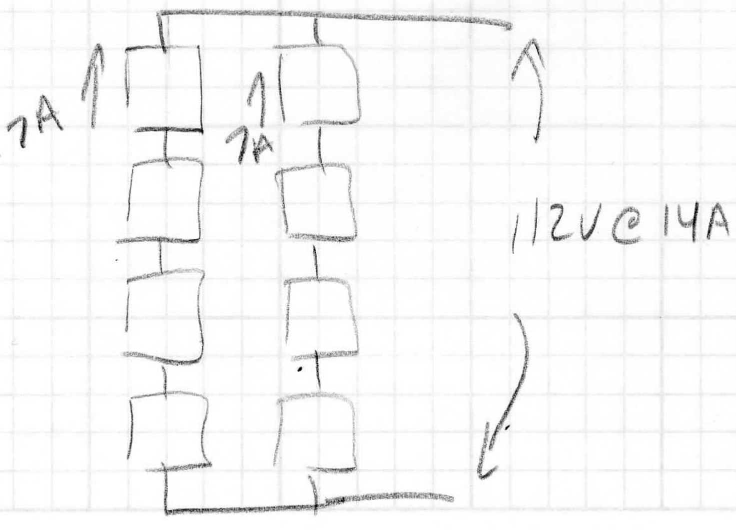
2) If Albuquerque gets $6.4 \frac{kWh}{m^2 day} \times 18\% = 1.15 \frac{kWh}{m^2 day}$

Then I need $\frac{7.2 kWh}{day} \cdot \frac{m^2 day}{1.15 kWh} = 6.3\ m^2$

If 1 panel is $1 m^2$ then I need 7 panels to supply the energy.

3) I need 90V and my panels are 28VDC so I need $\frac{90}{28} = 3.2$ panels which means I need **4 panels in each string**

but I need 7 panels for the energy in answer 2 so I need 2 string of 4 each



HW3 Prob 4

Problem 4

1) from prob 3 we need 8 panels @ $300 each
so $2400 panels + $1000 mount

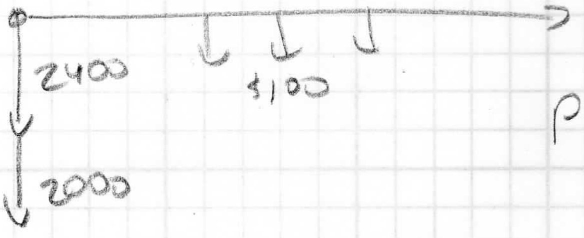
PV = $3400

2) Since a single tracker improves our energy to $8.5 \frac{kWh}{m^2 day}$ (18%) = $1.5 \frac{kWh}{m^2 day}$

going through same calc as prob 3 gives

$7.2 \frac{kWh}{day} \frac{m^2 day}{1.5\,kWh} = 4.8\,m^2 = 4.8\text{ panels} \rightarrow 5\text{ panels}$

but since the panels still need to be in strings of 4 you still need 8 of them! @ $2400



$PV = 2400 + 2000 + \frac{100}{0.1019}$

$= \$5381$

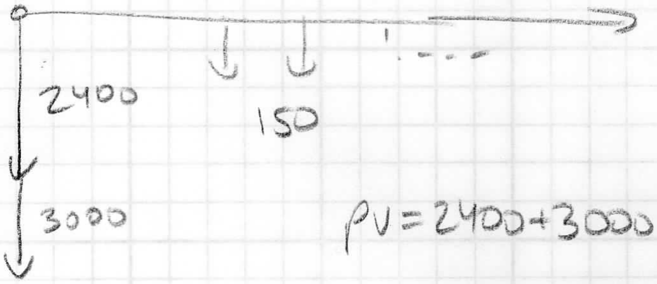
Prob 4

3) Using same analysis as 2.

$$\text{Solar energy} = \frac{8.8\,kwh}{m^2 day}(18\%) = \frac{1.6\,kwh}{m^2 day}$$

$$\frac{7.2\,kwh}{day}\cdot\frac{m^2 day}{1.6\,kwh} = 4.5\,m^2 \Rightarrow 5\text{ panels so}$$

Same as #2



$$PV = 2400 + 3000 + \frac{150}{.1019} = \$6872$$

It is important to note that the need to keep strings of 4 panels forces you to use the same number even with the trackers so it doesn't help meet the minimum need. however the systems will produce different amounts of energy

$$\text{Fixed} = 8\,m^2 \cdot \frac{1.15\,kwh}{m^2 day} = 9.2\,kwh/day$$

$$\text{Single Tracking} = 8\,m^2 \cdot \frac{1.5\,kwh}{m^2 day} = 12\,kwh/day$$

$$\text{dual Tracking} = 8\,m^2 \cdot \frac{1.6\,kwh}{m^2 day} = 12.8\,kwh/day$$