1.1. The blocking diode is in series with the pv modules and it is used to block the flow of current from the batteries at night when there is no voltage generated by PV.

1.2 $\eta = \frac{V_{mpp} I_{mpp}}{G \cdot A}$ assuming $G = 1000 W/m^2 \Rightarrow A = 0,33 m^2$

1.3 In more standard situations since the modules have an $V_{mpp} = 12V$ two modules in series would be enough to provide 24V. However in this case for a DC application working at 24V we must ensure that we don't have voltages below 24 DC at MPP.

So we must consider the situation in the worst case scenario which is 30°C ambient temperature

$$T_{c\,max} = T_{a\,max} + G \frac{NOCT - 20}{20} \Rightarrow T_{c\,max} = 65°C$$

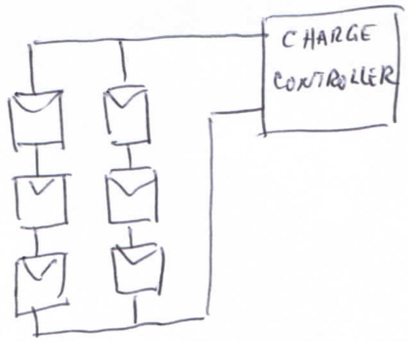
so $V_{mpp} (T_a = 30°C) = 12 * (1 - 0,33\% \times 40) = 10,416\ V$ (40 = ΔT)

So now the number of modules $n_s = \frac{V_{DC}}{V_{mmin}(30°C)} = \frac{24}{10,416} = 2,3 \simeq 3$ modules in series

what current is needed?

$$I = \frac{P_{needed}/PSH}{V_{DC}} = \frac{600W/4}{24} = 6,25\,A \Rightarrow N_p = \frac{6,25}{4,25} = 1,8 \simeq 2 \Rightarrow \text{two modules in parallel}$$

PV Layout



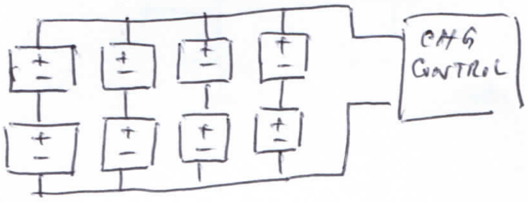
1.4

Assuming $\eta_{inv} = 90\%$ $\eta_{bat} = 80\%$ and $DOD = 0,6\%$ 3 day autonomy

$$C_{bank} = \frac{3 \times \frac{600}{\eta_{inv} * \eta_{bat} * V_{DC}}}{DoD} = 173,6\ Ah$$

so for $N_s = \frac{V_{DC}}{V_{bat}} = \frac{24}{12} = 2$ bat per string

$N_p = \frac{C_{bank}}{C_{bat}} = \frac{173,6}{50} = 3,5 \Rightarrow$ 4 bateries in paralel



1.5 The charge controller handles the current flow from the PV modules to the battery and the load. 1- It must track the MPP to optimize PV power

2 - it must not overcharge the batteries

3 - it must not allow over discharge of the batteries

1.6 We assume the current is only affect by the irradiance

so at 1000 W/m² $I_{max} = 4,5 A$; at 800 W/m² $I_{min} = 3,4 A$

assuming a safety factor of 10% and knowing we have two strings in paralel

$I_{min\,reg} < I_{min} * m_p \times$ safety factor ($= 0,9$)

$I_{min\,reg} < 6,12\ A$

$I_{max\,reg} > I_{sc} \times m_p \times$ safety factor

$I_{max\,reg} > 4,5 \times 2 \times 1,1 = 9,9\ A$

For the voltage

$V_{min\,reg} < V_{min} \times m_s \times$ safety factor

$V_{min\,reg} < 10,416 \times 3 \times 0,9$

$\quad '' \quad < 28,1\ V$

$V_{max\,reg} > V_{oc} \times m_s \times$ safety factor ($T_a = 10°C$)

$V_{max\,reg} > 14,01 \times 3 \times 1,1 = 46,2\ V$