Solar Energy test 2020/21

① cf Fenix

② PV ARRAY?

a)

Demand: $5\ kW \times 24\ h/day = 120\ kWh/day$

worst month: $6.11\ kWh/m^2/day$ (irradiation) → $6.11\ kWh/kWp/day$ (PV generation)

installed power:

$$P = \frac{120\ kWh/day}{6.11\ kWh/kWp/day} = 19.6\ kWp$$

($\div$ 150 Wp/module) ~ 130 modules

$V_{DC} = 250\ V$

$V_m = 34\ V$

$$N_S = \frac{V_{DC}}{V_m} = \frac{250}{34} = 7.3 \rightarrow 7 \text{ modules per string}$$

$$N_P = \frac{130}{7} = 18.5 \rightarrow 19 \text{ strings}$$

PV array is 7×19 modules (= 133, or 19.9 kWp)

b) BATTERY?

$$\frac{5\ days \times 120\ kWh/day}{DoD\ (=0.7)} = 850\ kWh$$

$$\left(\text{or } \frac{850\ kWh}{250\ V} = 3.4\ kAh\right)$$

c) input current range?

$I_{max} = 1.25 \times I_{sc} \times N_p = \dots$

$I_{min} = 0.50 \times I_m \times N_p = \dots$

d) input voltage range?

$V_{max} = V_{oc}\ (@\ T_{min}) \times N_s$

$V_{min} = V_m\ (@\ T_{max}) \times N_s$

$T_{min} = -40°C \equiv T_{c\,min}$ ← usually we would use T_{cell} (using NOCT) but here we should be pessimistic (i.e. the greatest difference to STC 25°C!)

$\frac{\Delta V}{V} = -0.33\ \%/°C \cdot \Delta T$

$\frac{\Delta V}{V} = 21\ \%$

$V_{oc\,max} = 1.21 \times V_{oc} = \underline{\underline{51.8\ V}}$

$T_{max} = 10°C$

$T_{cell} = T_a + \frac{NOCT - 20}{800} G = 10 + 48 - 20 = 38$

(being conservative we can use $G = 800\ W/m^2$, it is probably less)

$\frac{\Delta V}{V} = -0.33\ \%/°C \times (38 - 25) = -4.2\%$

$V_{m\,min} = (1 - 0.042) \times 34 = \underline{\underline{32.5\ V}}$

V RANGE:

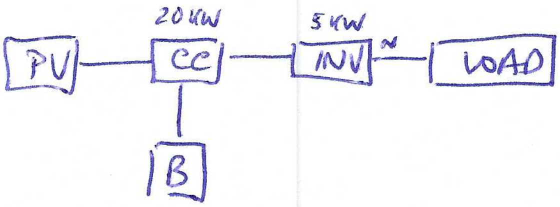
$7 \times 32.5 \rightarrow 7 \times 51.8\ V$

$\boxed{227\ V \rightarrow 362\ V}$

e) inverter power?

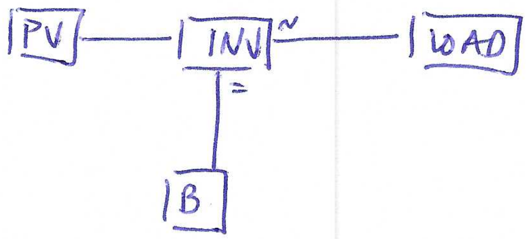
it depends on the system configuration.

if the snow melter is the only load:



then the charge controller should be 20 KW whilst the inverter is 5KW (because of the load)

if the charge controller is included in the inverter (allowing for "higher" loads):



then it should be ~ 20 KW.

Due to low irradiance, the system would have higher efficiency if the inverter was sub sizede: about 18 KW.

f) issues ?

- maintenance difficult & expensive (remote area)
- ice on modules reduces performance and may lead to faster degradation (may be consider local heating)
- PV system requires tracking; with so much ice and cold, mechanical maintenance also complicated
- shadowing between rows is a challenge (due to low solar height) requiring wider distance between strings (thus longer cables ≡ more expensive)