EXERCISE 4:

A Battery Pack for a house connected to a Solar Power Plant needs to be sized.

When the sun shines it feeds the electric loads for the house, but when it´s cloudy the Solar Panel will not give energy and in that case the loads need to be feed from an existing Battery Pack.

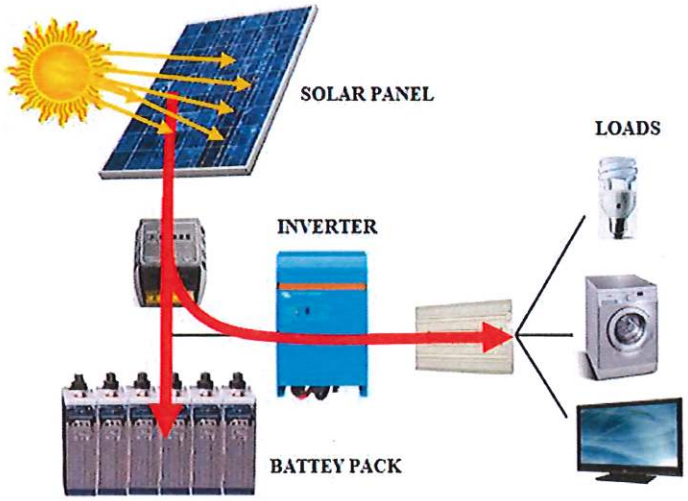


Image 1 Sunny day

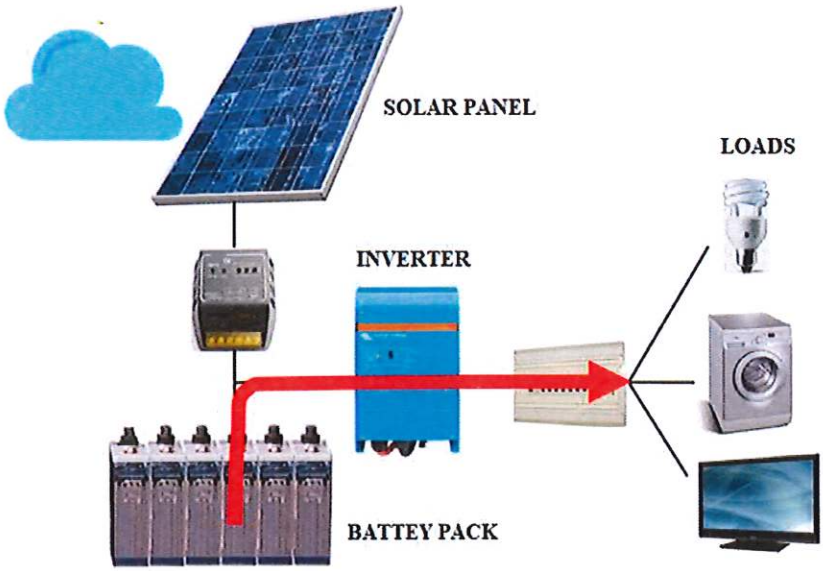


Image 2 Cloudy day

The Battery Pack shall be sized to be able to feed the loads for a period not longer than 2 days.

The table below sows the load consumption during a day:

- Freezer: 1unit x 120W x 7h -> 840Wh/day
- Microwave: 1unit x 800W x 0,1h -> 80Wh/day
- Television: 1unit x 85W x 5h -> 425Wh/day
- Lighting: 6unit x 10W x 6h -> 360Wh/day
- Hydraulic pump: 1unit x 750W x 1h -> 750Wh/day
- Washing machine: 1unit x 550W x 1h -> 550Wh/day

The Battery Pack voltage shall be of 24Vdc.

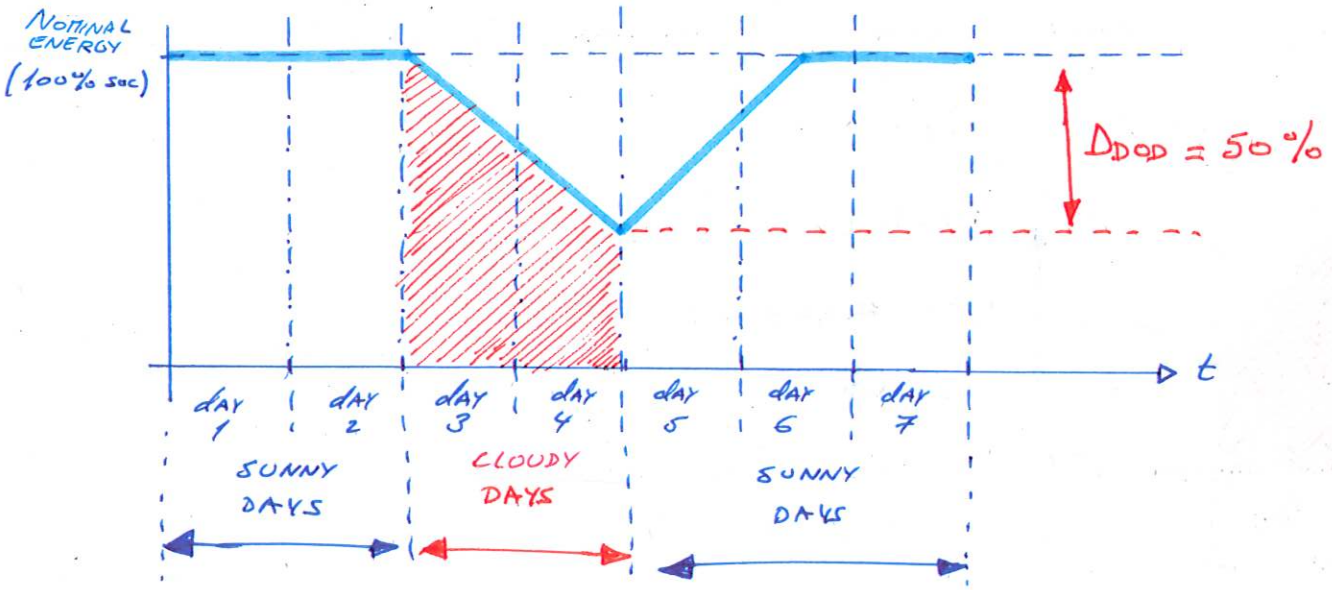
Question 1) ¿How much is the energy discharged from the Battery Pack during those two days?

Question 2) ¿Which shall be the nominal energy of the Battery Pack if during those two cloud days the allowed ΔDOD is limited to 50%?

Question 3) ¿Which is the average discharge current from the Battery Pack for a cloudy day? Give the answer in Amp and in C-rate.

Question 4) In the worst case all the loads can coincide at the same time, ¿which is the current drawn from the Battery pack in that case? Give the answer in Amp and in C-rate.

Question 1)



TOTAL ENERGY DISCHARGED ON CLOUDY DAY → ENERGY (Wh) = 840 wh + 80 wh + 425 wh + 360 wh + 750 wh + 550 wh

ENERGY (Wh) = 3005 wh

TOTAL ENERGY DISCHARGED FROM BATTERY PACK ON THE TWO CLOUDY DAYS → TOTAL ENERGY (Wh) = 3005 wh · 2 = 6010 wh

Question 2)

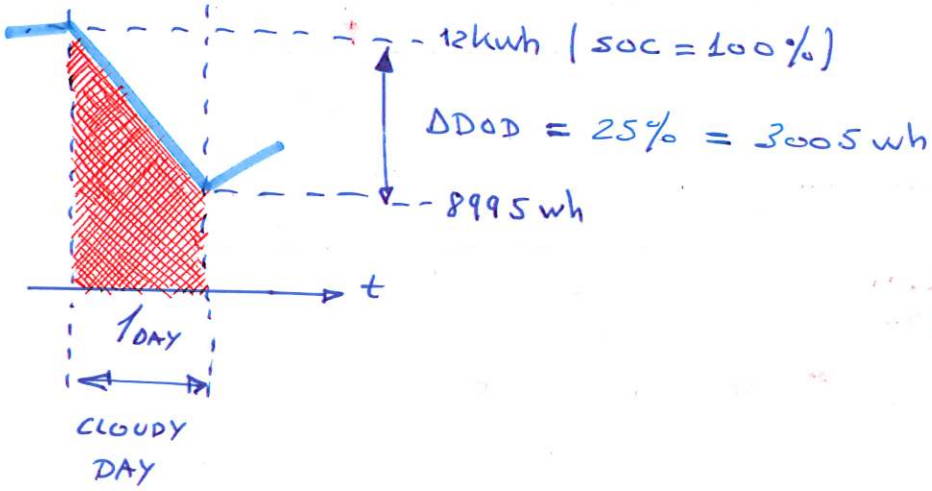
6010 wh — 50 % → OF NOMINAL ENERGY

SO:

$$\text{NOMINAL ENERGY OF BATTERY PACK} = \frac{6010\ \text{wh}}{0{,}5} = 12\ \text{kwh}$$

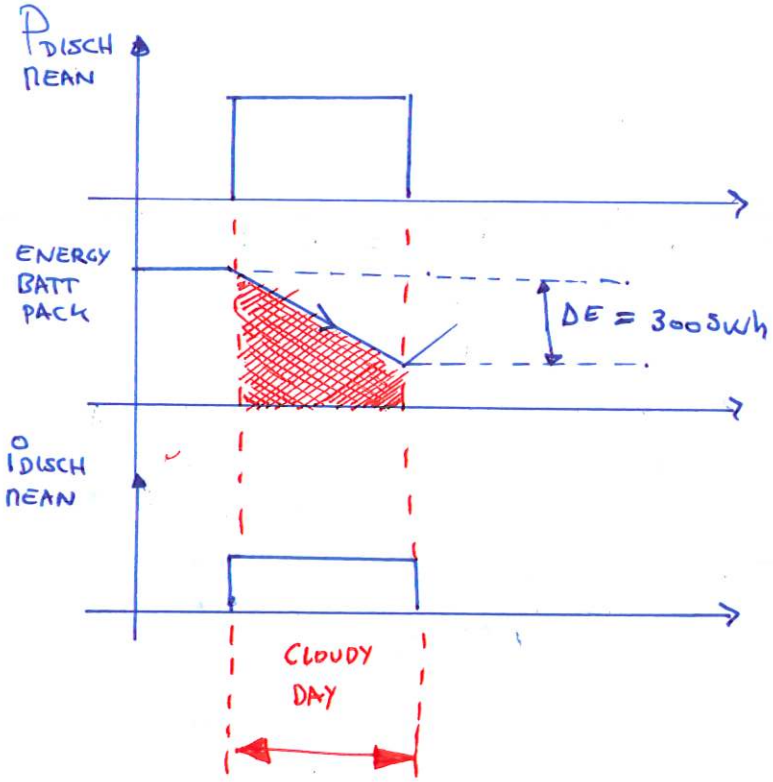
Question 3)

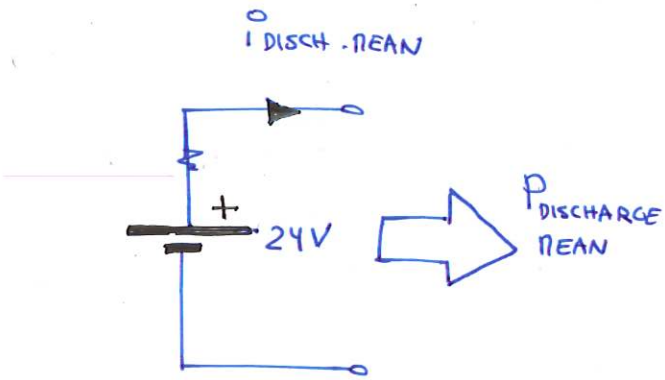
AVERAGE BATTERY PACK DISCHARGING CURRENT DURING CLOUDY DAY:



$$\mathcal{E} = \int p(t) \cdot dt \Rightarrow 3005\,wh = P_{DISCHARGE\ MEAN} \cdot 24h.$$

$$P_{DISCHARGE\ MEAN} = 125'2\,W$$





$$P_{DISCH\ MEAN} = 24V \cdot i_{DISCHARGE\ MEAN}$$

$$i_{DISCHARGE\ MEAN} = \frac{125'2W}{24V} = 5'21\,Amp$$

CURRENT IN C-RATE ?

BATTERY PACK Ah ? → $E_{NOMINAL}^{BATT}$ = 12 000 wh = 24V · C_{NOM} (Ah)
(SOC = 100 %)

$$C_{NOMINAL}^{BATT\ CAPACITY}(Ah) = \frac{12\,000\ wh}{24V} = 500\ Ah$$

$1_C = 500A$

$X \leftarrow 5'21A \longrightarrow \boxed{X = 0'0105C}$

Question 4)

WORST CASE → $P_{DISCHARGE\ (MAX)}$ = 120W + 800W + 85W + 60W
+ 750W + 550W = 2365 W

$$I_{DISCHARGE\ MAX} = \frac{P_{DISCHARGE\ (MAX)}}{BATT\ PACK\ VOLTAGE\ NOMINAL} = \frac{2365\ W}{24V} = 98'5\ A$$

$1_C = 500A$

$X \leftarrow 98'5A \longrightarrow \boxed{X = 0'2C}$