Prepare an engineering PV based power supply working layout diagram (Indicating size of PV modules/array, size of rechargeable battery/batteries, wire sizes fuses, etc.) to meet the following requirements for a remote area school:

- **Light load: 5 no of 15 W LED lamps for 5 different rooms**
- **Computer Load: 50 desk top computers (Ten 80-Watt computers per room in 5 different rooms)**
- **System Voltage: 220 VAC, 50 Hz**
- **Solar Insolation Value: Min 4 kWh/m2/day (for 8 months); Max: 5.5 kWh/m2/day for 4 months**
- **Efficiency of DC to AC inverter:90? Assume other data as required**

Ans:

Here,

Total bulbs power consumption (P1) = no. of rooms * bulb per room * power per bulb
= 5 * 15
= 75 W

Total computer power consumption (P2) = no. of computer * power per computer
= 50 * 80
= 4000 W

Total Power Consumption (P) = P1 + P2
= 75 + 4000
= 4075

For dealing with the given power requirement objectives, let us assume following points:

- The devices are operated 10 hrs a day.
- The battery size is aimed to have a full day backup capacity.
- The unit battery pack is of 12V.
- The peak sun time is 4 hrs.

The total energy requirement per day (E) = power * operating time
= 4075 * 10
= 40.75 KWh/day

Since the system is operating around the year, the case for minimum Solar Insolation Value is to be considered, so considering the PV module efficiency,

Obtained Energy per m^2 per day (E1) = 0.2 * 4 = 0.8KWh/m^2/day

Since the AC converter has power loss, actual energy required in battery (C1) = E/efficiency
= 40.75/0.9
= 45.27 KWh

As per ELDORA VSP.72.AAA.03 PV module Spec:

Peak Power (W_p) = 300W

We have,

Total energy per day = power per panel * no. of panel * peak sun time
or, 45270 = 300 * no of panel * 4
or, no of panel = 45270/300/4
so, no of panel = ~38 panels

The size of the battery in terms of Ah (S1) = C1/V

= 45.27/12

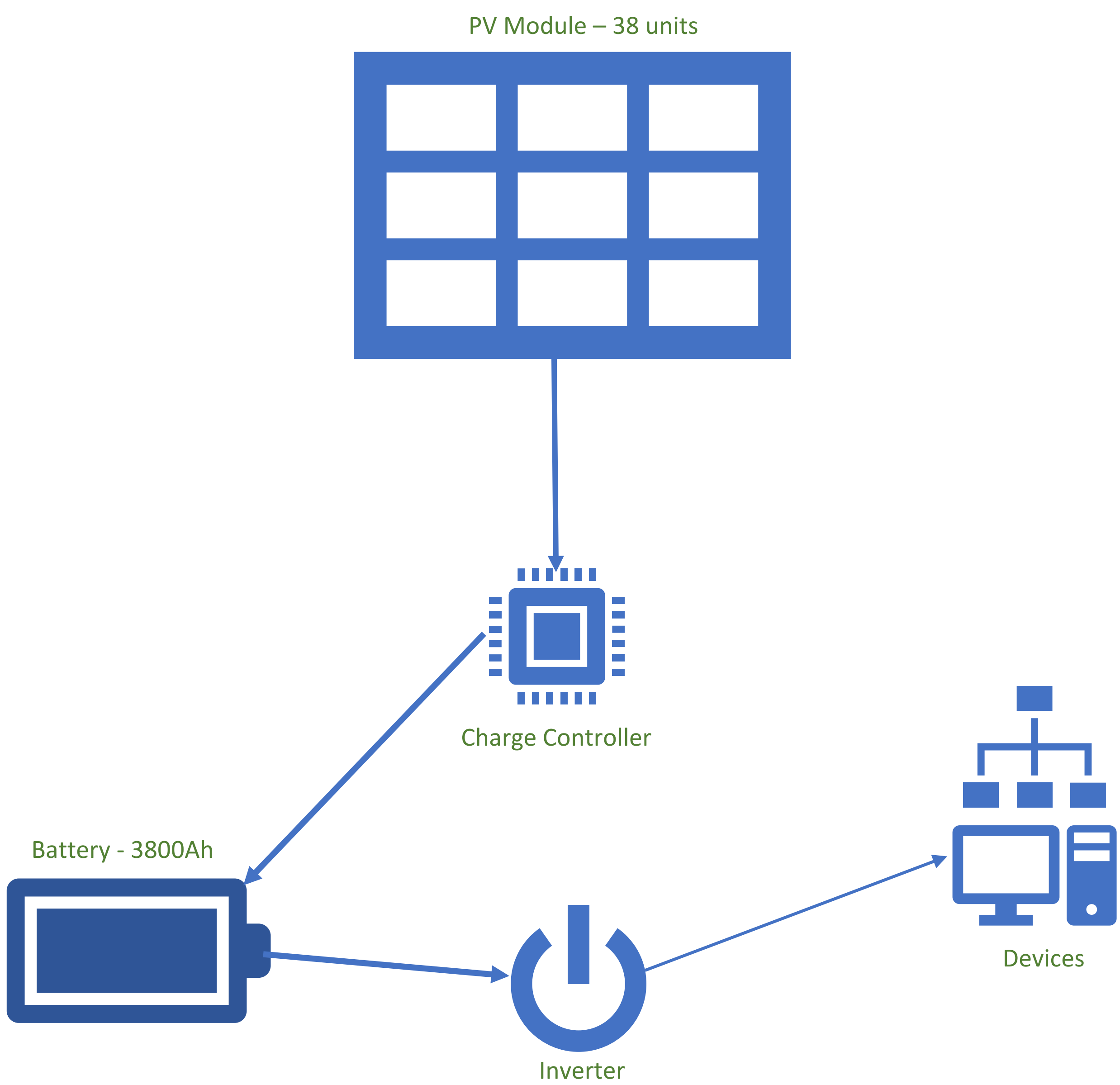
= 3.77 KAh = 3772Ah

As per 6LMS200L battery Spec:

Energy capacity (E_c) = 200Ah

So minimum no of batteries required = 3772/200

= ~19



Per Room power consumption (P') = P/no. of rooms
= 4075/5
= 815

So, current through room mains = P'/220
= 3.7A

The rooms mains must have wire gauge that can handle at least of ~4 Amps, thus 1/18 Size Wire is suggested.

Following assumption are done for Diesel Equivalency

- Cost per liter of diesel (C) = Rs. 108
- Energy generated per liter (E2) = 3KWh/L
- CO_2 emission per liter (P) = 2.5 Kg/L
- Total operational day in a year (T) = 280 days

Per day equivalent diesel usage (V) = E/E2
= 40.75/3
= ~13.6L

Cost of Diesel per day (C2) = V*C
= 13.6*108
= Rs. 1469

Cost of Diesel per year (C3) = C2*T
= 1469*280
= Rs. 411320

CO_2 emission per day (P1) = P*V
= 2.5*13.6
= 34Kg/day

Benefits due to CER of CO_2 (B1) = 0.034*$20*T
= $190.4/year
= ~Rs. 22617/year

Total equipment expenditure (X) = Cost of PV module + Cost of Battery + Cost of Inverter
= 50*38*300 + 150*3800 + 20*4075
= Rs. 1221500

Total Cost Savings per Year (X1) = C3 + B1
= 411320 + 22617
= Rs. 433937

Total payback Period (T) = X/X1
= 1221500/433937
= <3 Years

For 3-day Backup Calculation following assumption is made:

- The 3-day battery backup charging from 0-100 takes 6 full active usage days

Size of Battey module for 3 full day backup (S2) = S1*3
= 3772*3
= 11316Ah

As per 6LMS200L battery Spec:

Energy capacity (E_c) = 200Ah

So minimum no of batteries required = $S2/E_c$

= 11316/200

= ~57

As per the assumption made

Total energy required in 6 days (E2) = Active usage energy + Full battery energy

= C1*6 + C1*3

= 45.27*9

= 407.43KWh

Energy production per day (E3) = E2/6

= 407.43/6

= 67.91KWh

As per ELDORA VSP.72.AAA.03 PV module Spec:

Peak Power (W_p) = 300W

We have,

Total energy per day (E3) = power per panel * no. of panel * peak sun time

or, 67910 = 300 * no of panel * 4

or, no of panel = 67910/300/4

so, no of panel = ~57 panels

A BTS (Base Transceiver Station) is being planned to install at a remote area without INPS (Integrated National Power System). During active mode from 0600 hours to 2300 hours, required current to operate the relevant equipment is 37 A and during sleep mode from 2300 hours to next day 0600 hours, required current is 10 A. The operating voltage is 48 V DC with negative grounding.

Design PV based power system along with deep cycle battery bank with 50% DOD (depth of discharge) for number of autonomy days considered as two. The average peak sun can be considered as 4 hours.

Ans:

Total energy in a day cycle (E1) = (37*17 + 10*7)*48
= 33552Wh
= 33.552 KWh

Since the total autonomy day is 2,

Total energy consumption in 2 days (E2) = E1*2
= 33.552*2
= 67.104 KWh

Since DOD is 50%,

Total Energy Capacity of the battery is (E3) = E2/0.5
= 67.104/0.5
= 134.208 KWh

As per 6LMS200L battery Spec:

Energy capacity (E_c) = 200Ah
Voltage (V1) = 12V

So, the size of the battery is (S1) = E3/V1
= 134.208/12
= 11.184 KAh
= 11184 Ah

So minimum no of batteries required = S1/E_c
= 11184/200
= ~56

As the operating voltage is 48V, system requires 4 units in series and its multiple in parallel to increase the energy capacity. Here, 56 is a multiple of 4 and so no extra battery must be added to attain 48V serial packs.

As per ELDORA VSP.72.AAA.03 PV module Spec:

Peak Power (W_p) = 300W

We have,

Total energy per day = power per panel * no. of panel * peak sun time
or, 33552 = 300 * no of panel * 4
or, no of panel = 33552/300/4
so, no of panel = ~28 panels in parallel