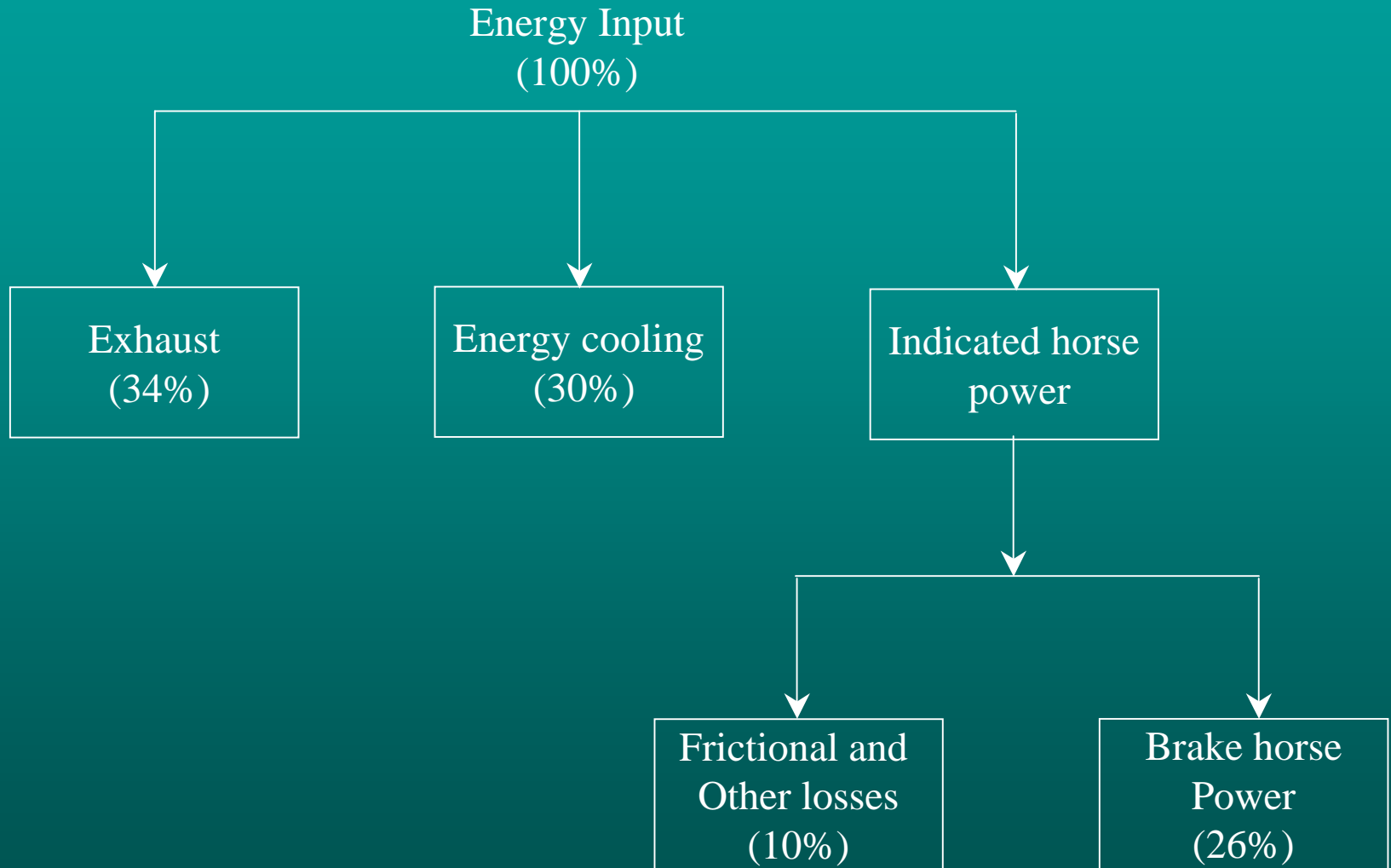


# Solar Photo Voltaic- Mains/ DG Hybrid System

Arbutus Computers & Consultants Pvt. Ltd.  
Pune.

P. Jayakumar

- **Typical energy distribution in an internal combustion engine:**



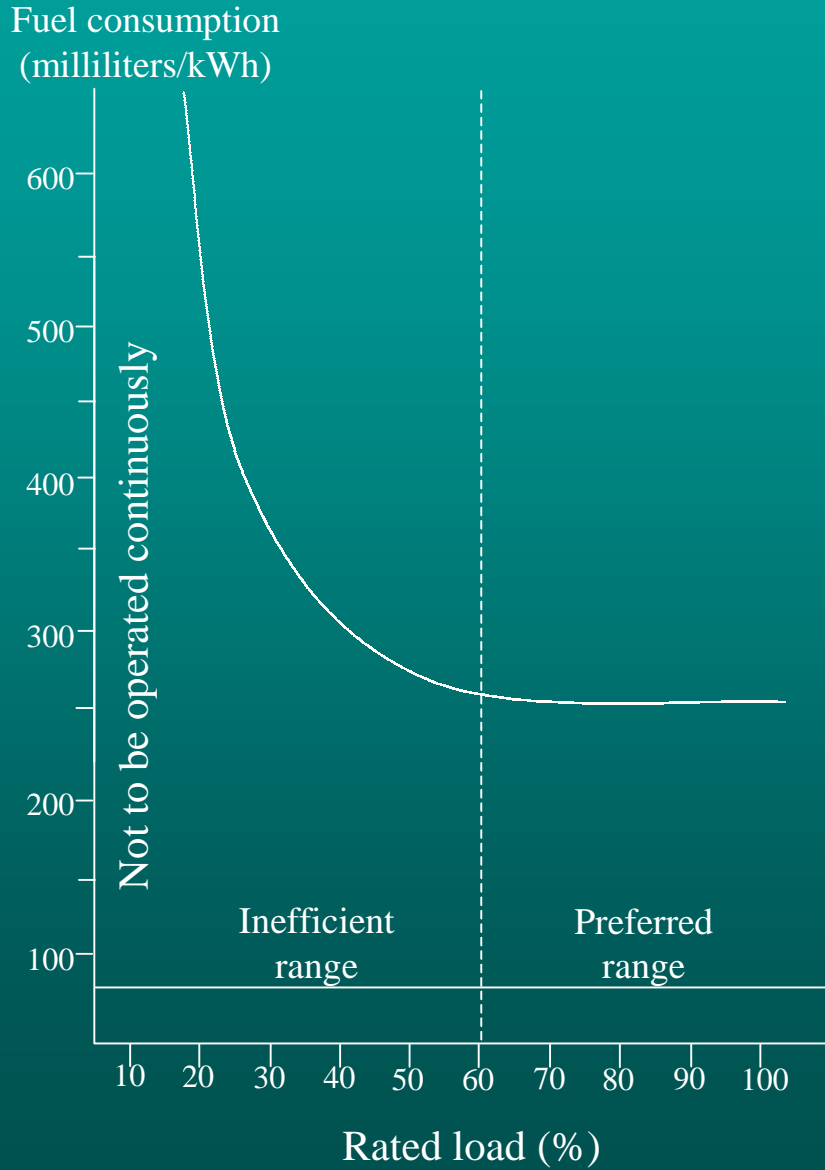
---

Rating (kVA)	<i>Recommended SEGR (kWh/litre)</i>
1450	3.84
1100	3.88
625	3.73
608	3.50
550	3.50
500	3.84
400	3.69
310	3.30
250	3.20
180	3.07
175	3.00
166	3.00
160	3.00
120	3.00

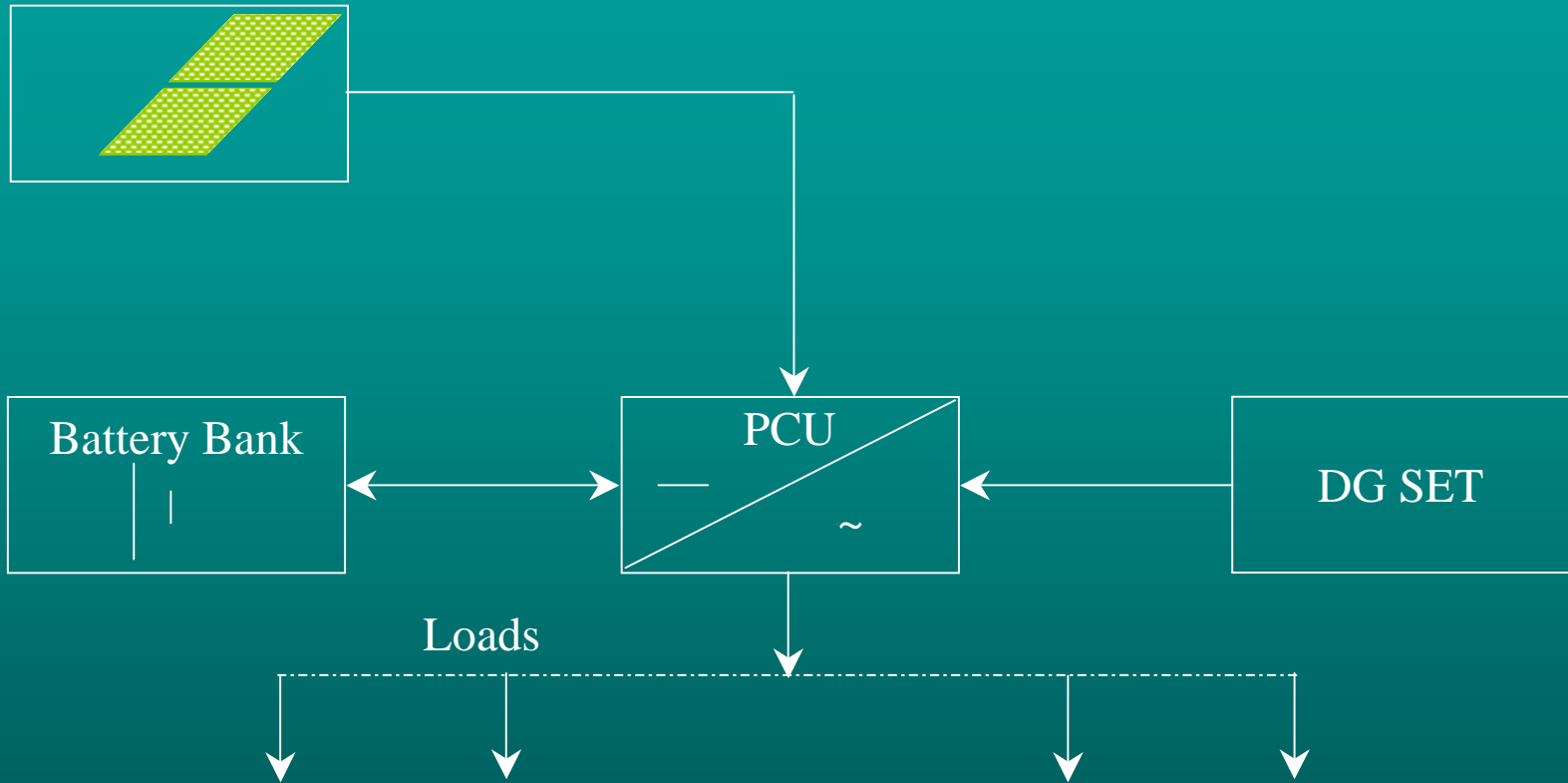
---

Source PCRA (n.d.)

- **Effect of loading on the efficiency of a generator of a diesel generator set**  
Source PCRA (n.d.)



- A typical schematic diagram of Solar PV- DG Hybrid system is given below:



- **Solar PV option**

- λ Hybrid System

- ( Demand for ‘clean’ power has always been on the increase but the pace has been accelerated by the phenomenal growth of the I.T. Industry
- ( Conventional Un-interruptible Power Supply Systems (UPS) has been the response
- ( Appropriate integration of Solar Photovoltaics in to the system can provide more efficient and clean power
- ( A hybrid power system integrates two or more power sources using intelligent controls to manage system operation
- ( A hybrid system - combination of PV and diesel Generator or mains or both is the ideal solution for many situations. The presence of DG eliminates the need to oversize the PV and battery. Diesel operation is limited with corresponding reduction in operating costs

- **Solar PV option**

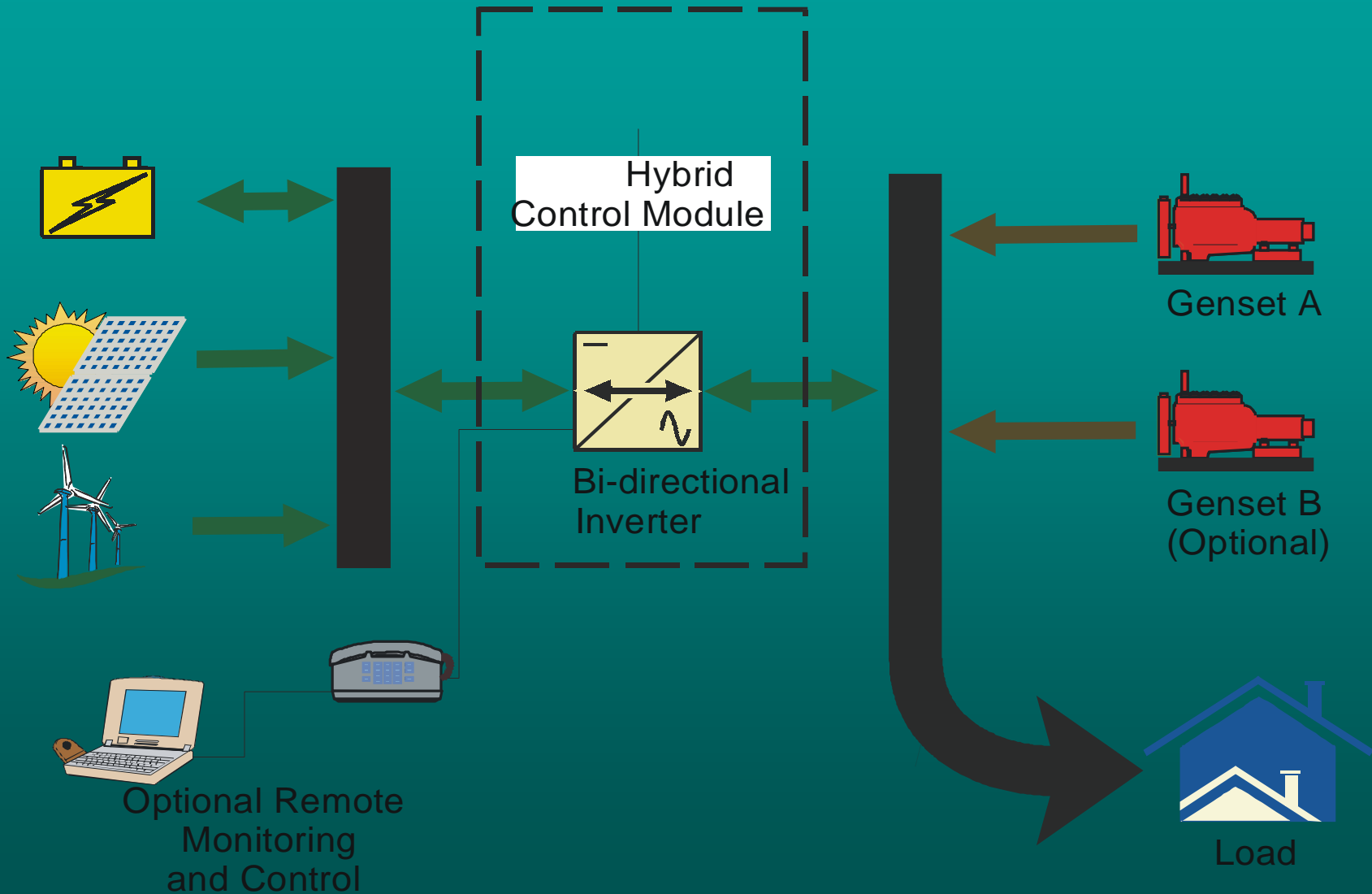
- λ Advantages

- ( Improved energy availability at lower life costs than a conventional diesel or standalone Solar PV System
- ( Higher reliability through back up power sources
- ( Diesel fuel consumption reduced
- ( Reduced maintenance costs
- ( Fuel logistics problems reduced

## λ Some Typical Financials

- ( In a hybrid system the generator can always be programmed to run above 80% of the rated output by which you can take advantage of specific fuel consumption Excess energy is used to charge the batteries and on charging the DG can be turned off. Thus long life and least maintenance is ensured
- ( For a typical DG at 25% load specific fuel consumption goes down to approx. 2 Kwh / litre. At 12% load the engine will only deliver approx 1.2 Kwh / ltr. Hybrid on the other hand can be designed for operation of the engine at 75-95 % of its rated load making those more fuel efficient
- ( Annual fuel consumption for 100% DG operation to provide 3 Kwh/ day =  $3.00 / 1.2$  Kwh / Ltr (at 12% load) 365 days / year = 913 Ltrs.
- ( In a PV Hybrid system assuming PV array supplies 75% of total energy (Diesel only 25%;0.75 units ).The the annual fuel oil consumption will be  $0.75 \times 365 / 3.3$  Kwh /Ltr (at 100%) = 83 Litres

- Hybrid Power Conditioning Systems:



# Solar PV- DG Hybrid System- A Case Study 'MEHRAULI FARM HOUSE'



- 30 Kms from New Delhi; No Grid electricity
- Alternatives considered (i) 100 % DG (ii) Solar PV- DG Hybrid

- Farm House Load Requirement:**

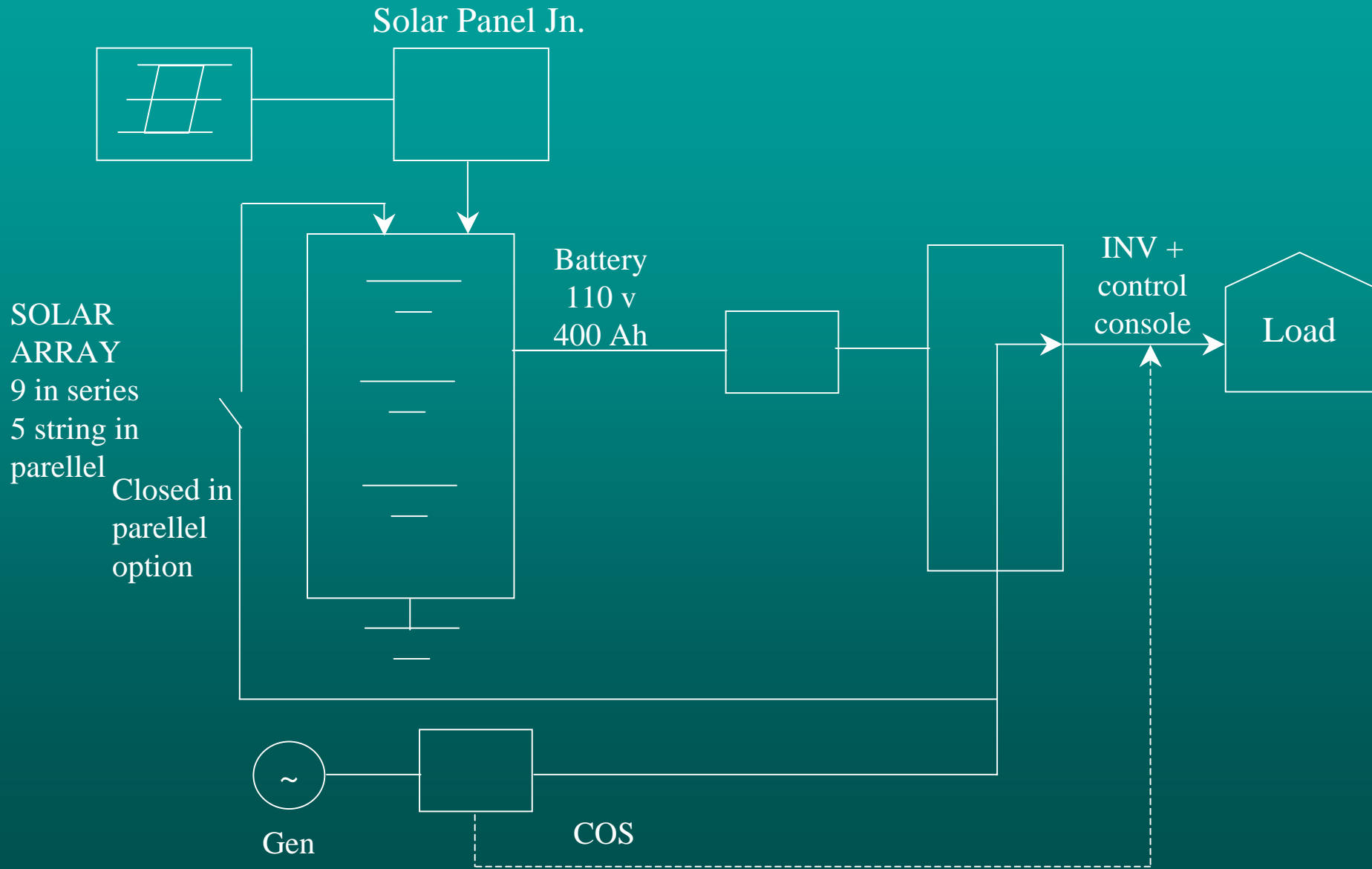
<b>Sr. No.</b>	<b>LOAD</b>	<b>WATTS</b>	<b>QTY (NOS.)</b>	<b>HOURS OF USE PER DAY</b>
1.	Lamp Size	25	4	5
2.	Lamp SL 13	13	22	5
3.	Lamp CFL5	5	28	5
4.	Tube Light (2 x CFL 11)	22	10	5
5.	Music System	100 W	1	3
6.	Cooler/ Heater	150 W	1	12
7.	Ceiling Fans	80 W	14	3
8.	Washing Machine	150 W	1	1
9.	Water Pump	150 W	1	2
10.	Freezers	250 W	2	24
11.	Refrigerator	150 W	1	24

- **Project Cost Details:**

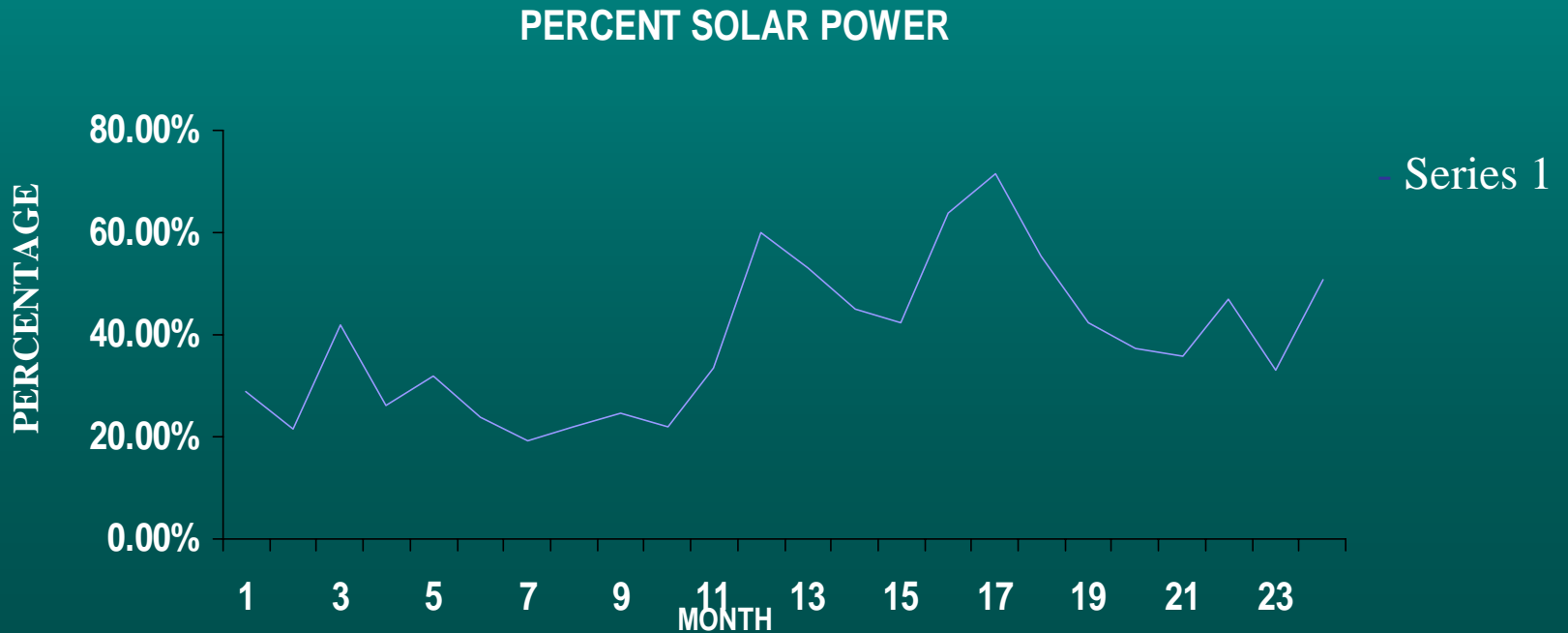
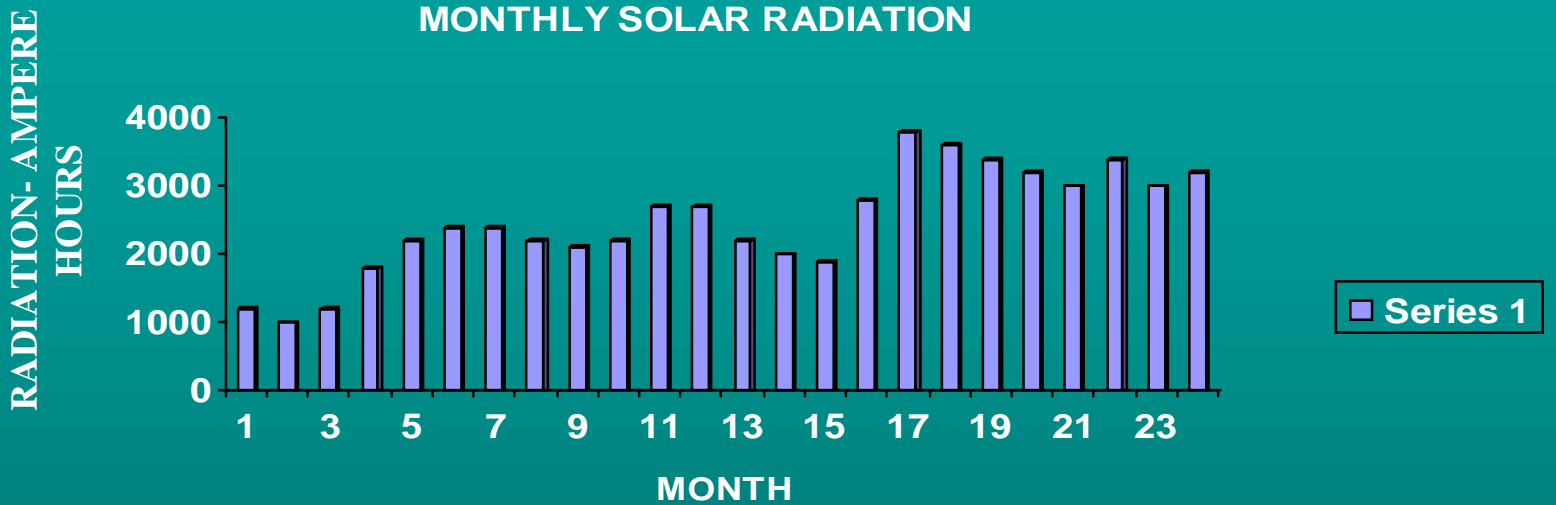
- (i) Total Cost- Rs. 14.5 Lacs

- (ii) Loan availed- Rs. 12.32 Lacs at 4.5 % interest p.a.

- **Solar PV- DG Hybrid System:**



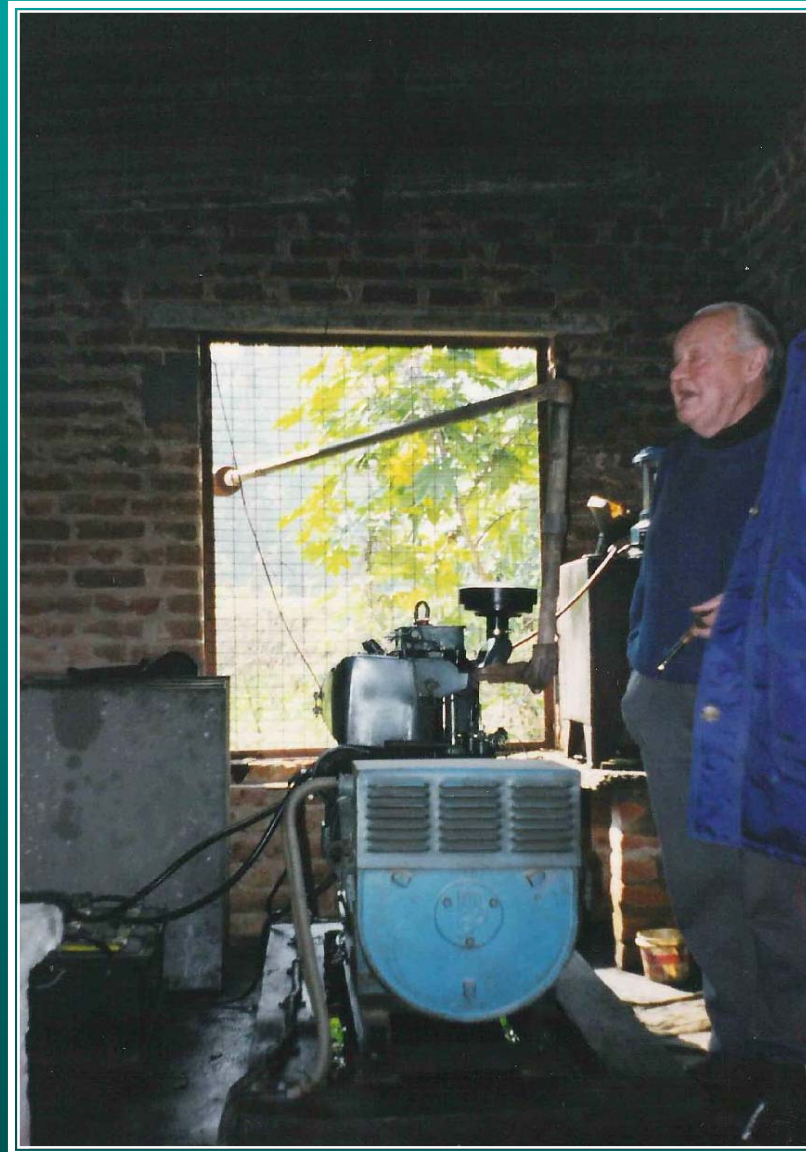
- **Solar PV Energy Production:**



# SPV Energy



# Diesel Generator



- **Energy Generation:**

- (i) 6318 Units from Solar PV

- (ii) 7356 Units from DG

- (iii) 13674 Units Total Energy Consumed

- (iv) Average 18.4 Units per day over 730 days.

- **Cost Analysis : Period of Review- 24 Months**

No.	Item	Hybrid System	Stand alone DG
1	Operation and Maintenance Cost	(2,47,513) (actual)	<sup>1</sup> (1,09,500)
2	Fuel Cost for generation of of 13, 674 units	-	<sup>2</sup> (1,81,632)
3	Financing Cost	<sup>3</sup> (1,64,922)	<sup>4</sup> (51,000)
4	Saving at 12% p.a. on tax saving due to 100% depreciation benefits for 2 years	1,11,360	-
5	Total Cost	3,01,075 (1 + 2 – 3)	3,42,135 (1 + 2 + 3)
6	Energy Cost for 13,674 units.	Rs.22.01/ Kwh	Rs.25.02/ Kwh

- **Notes:**

1. Maintenance Cost of DG for running 17,520 Hrs. (i.e.: 730 x 26)

1.1 Major Overhaul- Every 6000 Hours- 10% Cost of DG Rs. 15,000.

1.2 Short Overhaul- Every 2000 Hours- 5% Cost of DG Rs. 7,500.

1.3 Total Cost =  $(17,520 \times 15,000 / 6000 + 17,520 \times 7,500 / 2000)$

**= Rs. 1,09,500**

2. Fuel Cost for generation of 13,674 units

2.1 Hours of Operation of DG in Hybrid (for 7356 units) = 3257

2.2 Diesel Consumption = 1.5 lit/ hours.

2.3 Cost of Diesel per liter = Rs. 20

2.4 Fuel Cost for 13,674 units =  $3257 \times 1.5 \times 20 \times 13674 / 7356$

**= Rs 1,81,632**

3. Financing Cost of Hybrid (actual) = Rs. 1,64,922

3.1 Interest payment to IREDA

3.2 Notional Cost of 12% p.a. interest payment on 15% contribution by user

4. Financing Cost of Stand alone DG = Rs. 51,000

4.1 Computed at 17 % p.a. interest  
for an investment of Rs. 1.5 Lacs  
for 10 Kva DG and Accessories.

- **The Bottom Line:**



--- in the user's words

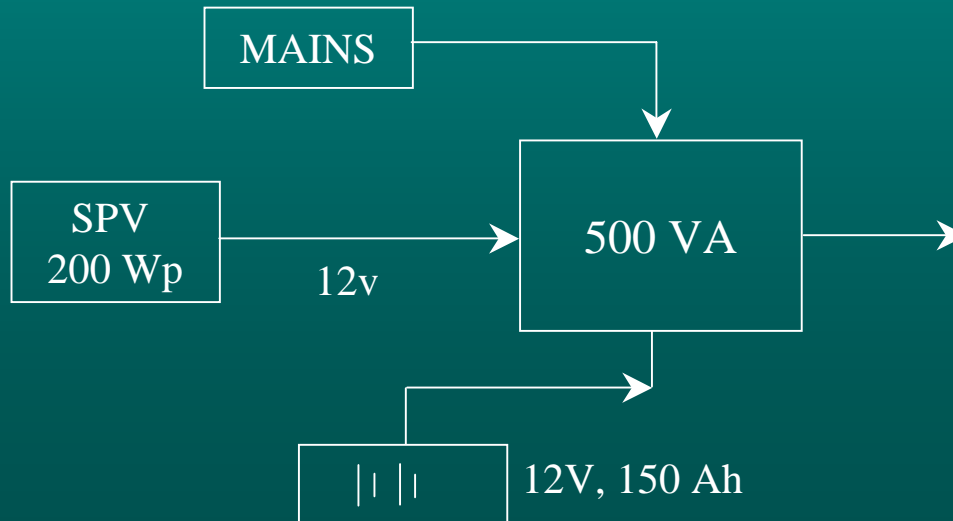
*“ The system has been in continuous operation for more than 30 months, operates satisfactorily and reliably provides the power required to run the house. The generator is required to run from 1 to 4 hours a day to supply heavy loads such as hot- water geysers and to top up the charge on the Battery Bank during periods of wet, cloudy or foggy weather.”*

# • Recommendation for SPV- Mains Hybrid Systems for Housing Complexes:

## 1. Typical Load Details:

Appliance	Rated Watts	Adjusted Watts	Hours	Wh
• Light 5 ≠	150	176	2	352
• Ceiling Fan 3 ≠	135	159	2 ≠ 4 hours	360
• T.V.	200	235	2	470
• Computer	100	118	4	472
			<b>Total</b>	<b>1654</b>

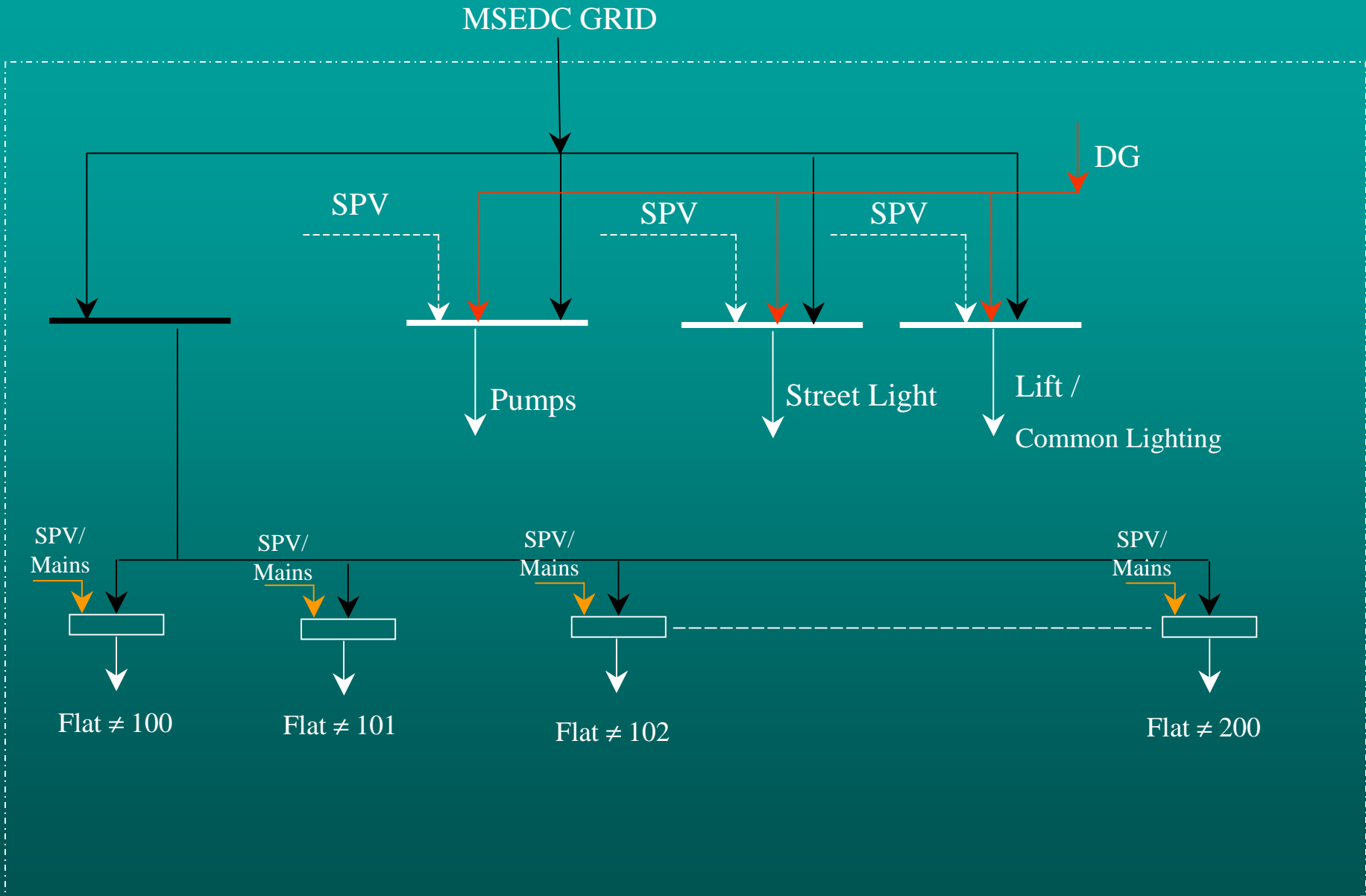
## 2. System Configuration:



- (i) Solar PV - 200 Watts
- (ii) Battery - 12v, 150 Ah
- (iii) Hybrid Controller - 500VA, 12v/ 230v
- ( Charge Regulator +  
Inverter + Battery Charger +  
Load Manager)

**3. Approximate Price - Rs. 1.25 Lacs**

- **Electrical Energy Supply Philosophy ( Suggested):**



Thank You..!