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Analytical Study of Power System in MLA Hostel for Power Performance Improvement

(Case study and commercial Building by Solar Energy)

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Abstract —*from the point of significance in power system to meet the growing energy demands of industries, corporate sector and domestic places, the present power system needs to be improved. The detailed study of electrical power system is a key element of many curricula industrial technology. Proper utilization of energy is one of the main important points for Generated energy. As there is huge cost of generation of energy so we would utilize energy in proper manner. In this project we have suggested some existing and best possible methodologies for reducing cost of tariff to desired level so that it will save Indian Economy. In this project there is planning to implement Solar Power panels in MLA Hostel, Nagpur. In this project we have concentrated on three R i.e. Reduce, Recycle and Reuse. There are many ways for reducing cost of tariff rate such as by using LED lights in place of regular tube lights, solar water heater at Bathroom, etc In present scenario there are many loads which are inductive which are responsible for lagging power factor from unity. Use of capacitor bank for power factor improvement will be beneficial of reducing tariff cost. Energy conservation and Energy efficiency are the different concepts but related concepts. Energy conservation is achieved when energy consumption is reduced, measured in physical terms energy conservation can therefore is the result of several processes or developments such as productivity increases or technical progress.*

Keywords- *KWhr Electricity Consumption; Load curve; Load Calculation; Solar system Design; Solar Parameters; Solar Panels.*

I. INTRODUCTION

Industrial development around the globe and continuously changing policies to balance the development and environment has made the industries to adopt sustainable measures. Nowadays it is not only the profit margins which make the industries sustainable but it is also conserving the essential resources which are playing an important part. Electrical Energy is one of the most important parts of the industries. Depleting the energy resources and increasing the energy prices has made the industries to think on the sustainable efforts to increase the electrical energy securities as well as to have control over the incurred.

The Electrical Energy requirement of MLA Hostel, Nagpur has been carried out by as a part of our project work. The present project emphasis about checking the levels of energy efficiency at MLA Hostel. Subsequently, it also tries to explore the possibilities of conserving energy through the better operating practices and employment of newer technology. India has a vast population of more than 1.26 billion out of which nearly 70% are living in rural areas. In order to make sustainable growth rate, it is necessary to have sufficient energy for sustainable development in various sectors. Energy sectors have received top priority in all five year plans. [1]. Power Sector in India has made rapid progress. Both in the installed generating capacity and transmission and distribution system since independence. The total power generating capacity of (utilities & non utilities) has increased from meager 1362 MW in 1947 to 223344 MW at the end of March, 2013. [2]

The proven reserve of fossil fuel in India is not very large. A major share of scarce foreign currency is earmarked for importing petroleum products. The bill of which is continuously increasing. The coal reserve is likely to be exhausted by the middle of the century. Thus new alternatives and new strategies should be adopted for energy conservation. Time has came that India has to adopt a plan of its own strategies in energy sectors based on available resources, funds, requirements and past experience. The planners have adopted the western model of centralized energy system without necessary modification to suit Indian conditions.

In future the energy conservation would assume more significance globally on the basis of the effect of burning fossil fuel on environment, particularly the global warming, rather than the depletion of the fossil fuel reserve and other consideration

1.1. Present Power Scenario in MLA Hostel

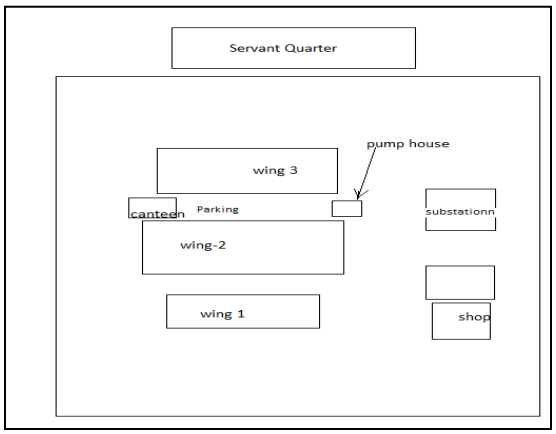
MLA Hostel, Nagpur, has total three sub-divisions including wing – 1, Wing – 2 and wing – 3. There are total three transformers , (10 MVA) 3 No. . The area distribution of the MLA hostels Buildings are shown below :

TABLE I. MLA HOSTEL AREA DISCREPTION

Sr. no.	Building Wing	Area in Sq.-m.
1	Wing-1	7972 m^2
2	Wing-2	12774 m^2
3	Wing-3	5826 m^2

Major consumption of electrical energy is maximum at wing – 2. This has been provided with the 10 MVA capacity of large transformer for handling large power Capacity. There are Geysers which is the major electricity consuming equipment present at the site.

Figure 1. Map layout of MLA Hostel, Nagpur



The layout of MLA Hostel Nagpur, as shown above. MLA hostel mainly includes three buildings viz., wing-1, wing-2, wing-3, canteen, Garment shop, pump house, servant quarter and substation. The major portion of electricity gets consumed at wing – 2 and pump house. At substation three main transformers has been provided for different buildings at MLA hostel is huge commercial building where assembly events takes place.

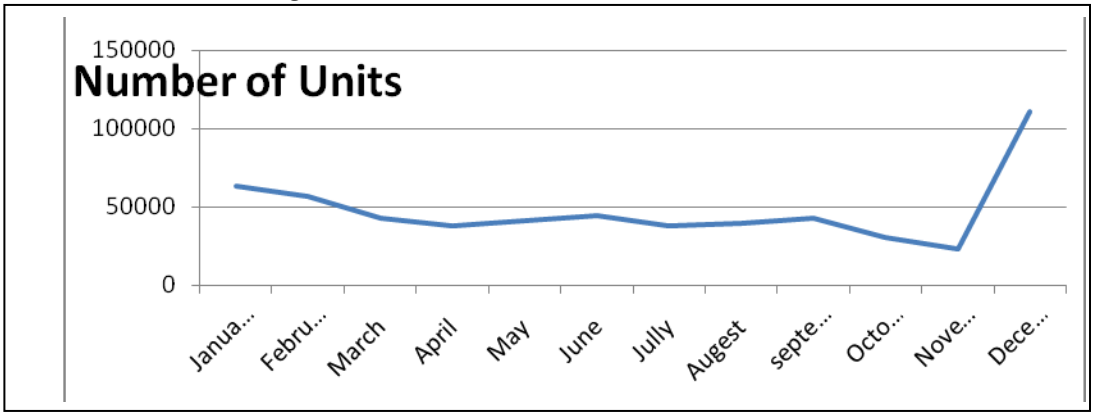
II. ENERGY SCENAIO AT MLA HOSTEL

Sr. no	Table of various load at MLA load for 400 rooms		
	Objects/ Equipments	***Count***	***Load Wattage***
1	Fans	2/room	60Watt/fan
2	Tubelight	4/Room	100Watt/light
3	CFL Light	3/rooms	23 Watt/Room
4	Geaser	1Rooms	1.5KWatt
5	Induction Motor Drive	6	5.595 KW/Drive
6	Kkitchen Appliances (e.g. Oven, Mixer, fridge, etc.)	-	10KW

2.1. Annual load curve

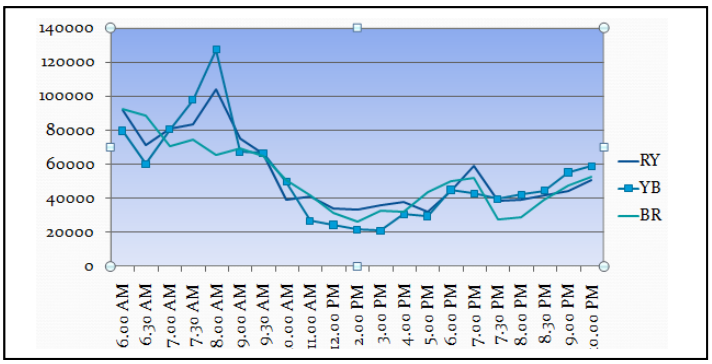
A curve showing the load demand variation of consumer with respect to time is known as Daily Load curve. Similarly a curve plotted between No. of units consumed with month of annum is known as annual load curve. Fig. 2 shown below signifies the total annual consumption of electricity in units with respect to month. The maximum demand of electricity can be observed on the month December, January and February because of winter assembly.

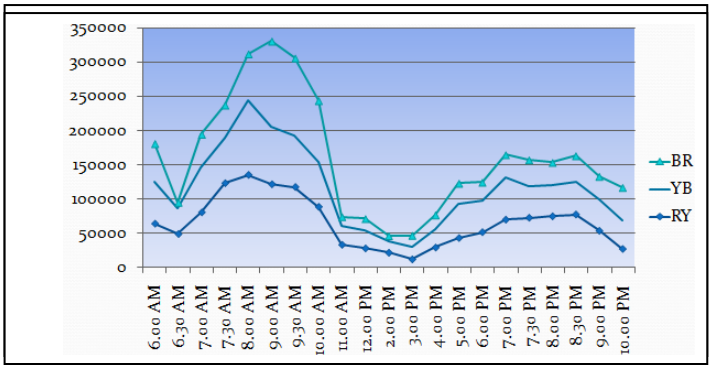
Figure 2. Annual Load Curve of MLA Hostel, Nagpur



2.2. Daily load Curve

The Daily load consumption can be clearly seen that the maximum demand of electrical energy is in between

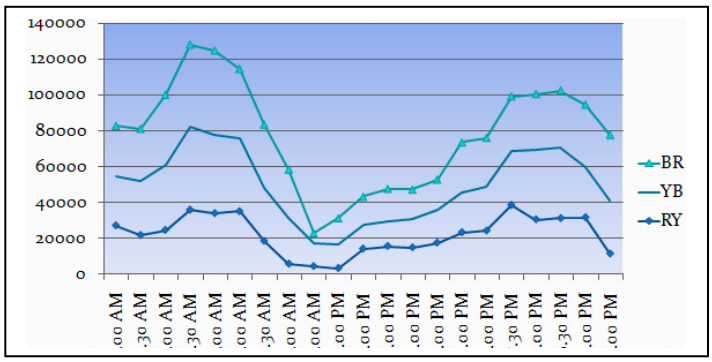




6.30AM to 9 AM because of use of Water heater (Geyser), water pump, electric iron, freezer, light load, etc. Daily Load Curve Transformer 1 Date – 9-12 2014

Figure 4. Daily Load Curve Transformer 1 Date – 9-12 2014

Figure 5. Daily Load curve of Transformer – 3 Dated -9-12-2014



. Fig 3, 4,and 5 shows the daily load curves of the transformer 1,2 and 3 which supplies energy to Wing 1, Wing – 2 And wing – 3 from which maximum electricity consumption done by Wing – 2 then secondly come wing -1 and in comparison among these three wings consumes less energy as compared to other wings.

2.3. Load Scenario at MLA Hostel,Nagpur

The total connected load is given by the product of count and Equipment wattage rating.

$$Connected\ Load = Count \times equipment \quad \ldots\ldots\ldots (1)$$

2.4. Electricity bill calculation

2.4.1. Energy consumption calculation

The energy E in kilowatt-hours (kWh) per day is equal to the power P in watts (W) times' number of usage hours per day t divided by 1000 watts per kilowatt:

$$E_{(kWh/day)} = P_{(W)} \times t_{(h/day)} / 1000_{(W/kW)} \ldots\ldots\ldots\ldots (2)$$

$$Cost_{(Rs/day)} = P_{(kWh/day)} \times Cost_{(Rs/kWh)}$$

E.g. if there are total 9 fans in count each rated 100watt then total connected load is given by and runs for 8 hrs for entire night. And runs in daytime nearly for 2 Hrs so total hrs are 11hrs and

$$E_{(kWh/day)} = P_{(W)} \times t_{(h/day)} / 1000_{(W/kW)}$$

$$= 900 \times 11 / 1000_{(W/kW)}$$

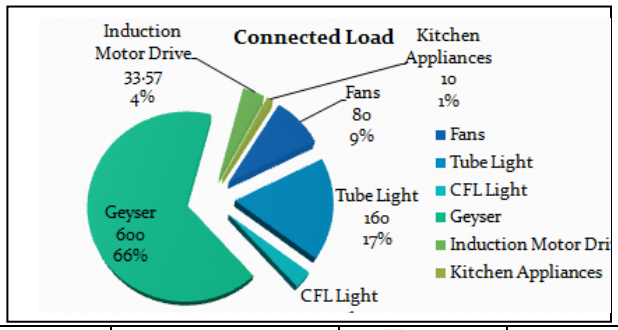
$$= 9.9\ kWh/day$$

The data specified below is as per the instructions given by the respective authorities of MLA Hostel, Nagpur.

Sr. No.		Connected Load		
	Equipment	***Count***	Load Watt/ Appliance	***Total in KW***

Sr. No.	Connected Load			
	Equipment	***Count***	Load Watt/ Appliance	***Total in KW***
1	Fans	2/Room	100Watt/Fan	80 KW
2	Tube Light	4/Rooms	100Watt/Light	160KW
3	CFL Light	3/Room	23Watt/light	27.6KW
4	Geyser	1/Room	1.5KW	600KW
5	Induction Motor Drive	6	5.95/Drive	33.57KW
6	Kitchen Appliances	-	10KW	10 KW
			Total	911.17KW

Figure 3. Daily Load Curve Transformer 1 Date – 9-12 2014



Appliance	*Count * 400*	Wattage (VxA) Mult. * 1.5 for AC	***Hrs per Days***	***Days per week/7***	***Average Watt Hours per Day***
Fans	2/Room	100*1.5	14	6	1440KW
Tube Light	4/Rooms	100*1.5	12	7	2880KW
CFL Light	3/Room	23*1.5	12	7	500KW
Geyser	1/Room	1.5KW	0.5Hr	7	450KW
Induction Motor Drive	6	5.95/Drive	4	7	215KW
Kitchen Appliances	-	10KW	4	7	15KW

Largest AC Load in Watts	Total Wattage used at one time :		Total Watt HRs Per Day:
Total Watt Hrs Per Day:	÷ 14	=	
5905480.00Watts	÷ 7677124 watts	=	7677124 watts

Total Watt-hour per day = 5905480.00Watts
Watt-hour assuming inherent Efficiency losses = 7677124Watts

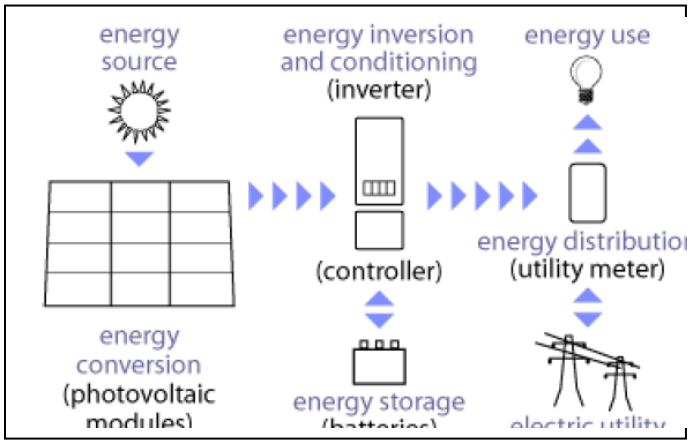
III. COMPONENT OF SOLAR PV SYSTEM

Solar PV system includes different components depended on your system type, site location and applications. The major component of the solar PV system as shown in below:

3.1. Major Components of PV System.

1. PV Module.
2. Solar Charge Controller.
3. Inverter.
4. Battery Bank.
5. Load.

Figure 4. Different components of PV system [5]



Latitude (degree)	Optimum Tilt angle (degree)
9	15
10-20	Latitude +5
21-45	Latitude +10
46-65	Latitude +15
66-75	80

TABLE II. LOAD OF MLA HOSTEL, NAGPR (ALL WINGS)

1	Total KW	911.17KW
2	Total Lighting load	187.6KW

IV. SOLAR PV SYSTEM SIZING

As shown in fig below MLA hostel comes Under Zone-3. This means that MLA hostel's solar equipment can be charged up to 5 Hours/Day during entire year excluding Manson season.

Figure 5. Sum Hours/Day Zone Map [9]

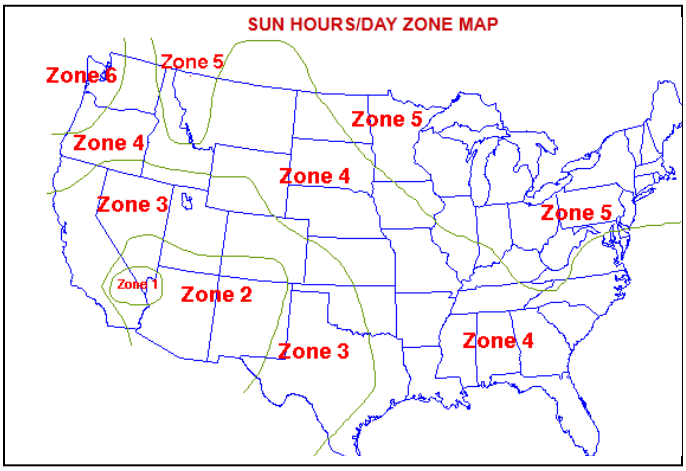


TABLE III. RATING OF DIFFERENT EQUIPMENT USED [5]

	Single Battery Specifications of Battery Bank	
1	Voltage	12V

2	Ampere Hours	200Ah
3	Depth of Discharge	0.8
4	Efficiency	0.9
	Solar Panel (Nano) Specifications	
2	Peak Power	170KW
3.	Peak Power Voltage	28.7V
4	Peak Power Current	4.3A
4	Open Circuit Voltage	41.1V
5	Short Circuit Current	5.7A
6	Maxi,um System Voltage	1500V
7	Series Fuse Rating	25A

TABLE IV. CALCULATION OF PV SYSTEM (NANO SOLAR CELL)

Sr. No.		**Calculation of PV System (Nano Solar Cell)**		
1	Battery Bank Ampere Hr	(Avg Wh/day × day of autonomy)/battery voltage	$=\frac{3380000*7}{220}$	107545.4545
2	Final Battery Bank capacity Ah	Battery bank Amp hr/DOD	$\frac{107545.45}{0.8}$	134431.818
3	Batteries in series	System voltage /battery voltage	220/12	18
4	Batteries in Parallel	Ah of battery bank/Ah of battery	134431.818/200	672
	Total NO. of Baatteries	**3*4**	18*672	12096
5	Array peak amp	Battery bank Ah capacity / (battery efficiency× peak sun shine)	134431.818/(.9*5)	29873.737
6	modules in parallel	Array peak amp/peak amp per module	29873.737/4.3	6947.38
7	modules in parallel	Battery bank voltage/nominal module voltage	220/27	9
	Total PV module	**6*7**		62523

But if we use 200Watt and fulfilling the total lighting load of the MLA Hostel. Total load Watt hour comes 3380KWhr which can be compensated by Nano solar panel. If we go for online solar parameter calculator then it shows following results:

Total Watt Hours per Day	5905480.00Watts
Watt Hours assuming Inherent energy losses	7677124 watts
Minimum system size	315837 Watts
Approximate solar panel Wattage	200 Watts

Minimum system size: 315837Watt
Approximate solar panel Wattage: 200 Watts
Approximate Number of solar panels Needed: 1580

V. COST ANALYSIS OF NANO SPV SYSTEM

Sr No.			
1		Total load of system(Wh)	269331.8
2		Total load of system (W)	911.17KW
3	4	Required number of modules /panels	1580

Sr No.			
4		Required numbers of batteries	12096
5		Cost of different components of required PV system:	
	a.	Cost of each module	10800/-
	b.	Cost of total modules (3×a)	17064000/-
	c.	Cost of each battery	11000/-
	d.	Cost of total batteries (4×c)	13305600/-
	e.	Cost of inverter 246000/- 8558400/-	24600/-
	.	Total (b +d + e)	30394200/-
	f.	Cost of wiring + installation(2% of Total)	5424084/-
	g.	Total Capital cost (Total+f)	35818284/-
	h.	Calculation of Salvage value for depreciation of PV equipments	
	h 1.	module at 60% of initial cost (60% of b)	10238400/-
	h 2.	Inverter at 20% of initial cost (20% of e)	4920/-
		Total salvage value against initial cost (h1 + h2)	10287600/-
	i.	Total cost on PV system installation to be borne by NTPC organization is calculated as follows[	
		Depreciation on battery cost (20% of d)(considering life of 5 year)	2661120/-
	j.	Depreciated value on balance equipment of cost	10% Per Year
	k.	(d-g) and (h1+h2) @8% after 25 years	2335692/-
	l	Depreciation on total cost @ 4% (4% of k)	93427.68/-
	m.	Maintenance cost of PV system @ 0.5% (0.5% of g)	17906.42/-
6		Total cost on PV system installation (g+i+l+m)	35929618.1+j./-
7		Subsidy on capital cost (30%) =	10778885.43+30%%of j.
8		**Cost to be borne by MLA Hostel, Nagpur (6-7)**	34851728.57+j*0.7/-

.. (j = Depreciated Value)

VI. RESULT AND DISCUSSION

1.	Total Watt Hours per Day	5905480.00Watts
2	Watt Hours assuming Inherent energy losses	7677124 watts
3	Minimum system size	315837 Watts
4	Approximate solar panel Wattage	200 Watts
5	Total KW	911.17KW
6	Total Lighting load	187.6KW
	Total cost	34851728.57+j*0.7/-

	Total solar pannel required	1580

(j = Depreciated Value)

The results obtained from the analysis of the cost of nano SPV system for a commercial building. The present power equipment and the tools, load using are costly and power consuming so that they should be energy efficient equipment and other necessary components. In present scenario electrical power is the most demanding and important factor for each and every field so that there is a huge future scope on energy audit and energy conservation.

It is observed that there is significant electrical load for lighting.etc, during the day for hostel facility. Sufficient area is available for the installation of Solar PV system. It is proposed to install solar PV cell system for generation of electricity during the day. The electricity generated will be fed to the local grid and utilized for the day loads in the office. Life of the solar PV system is more than 24 years and hence its benefits are achieved over the very long time after payback periods. Depreciation of 80% is available in the 1st year for the solar and all other efficiency equipment.

VII. CONCLUSION

In this paper application of renewable energy sources, particularly solar energy, for commercial load demand has been explored in view of the merits of solar energy over other types for such application. From the results it can be concluded that nano SPV system designed for single phase load of MLA Hostel, Nagpur building. The nano SPV system is conventional. This makes the consumer independent of paying the recurrent cost to the grid and in turn, also reduces the burden on the electricity grid. A part of the total connected load especially single phase load of the MLA Hostel, Nagpur building has been considered for analysis purpose, because nano SPV system cannot be utilized for high power load on account of its low conversion efficiency. Such high power loads are still supplied by grid system.

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