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A Power Saving opportunity – DC Power Distribution System

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Abstract- High demand for electrical power increases a pressure on the throughout energy supply and efficiency of the power system. In India where the electrical distribution infrastructure is not well extended in rural areas so it's a very challenging task to be accomplish. With the advanced development in the power electronics switching and control devices now it is possible to replace a existing AC power distribution network with the DC power supply for better energy efficiency. In this paper the DC distribution system types, and the energy efficiency of existing AC network with the DC network is compared. For this case study actual load data is taken from the site survey of academic building of Matoshri College of Engineering, Nashik. From the energy efficiency analysis on different loads it is found that if existing AC power distribution network is replace by DC distribution network then considerable amount of energy can be saved.
Keywords-DCdistribution system; Energy efficiency; Conversion Efficiency; Energy saving.

1. INTRODUCTION

Electrical power distribution system at the end of 19th century was based on the DC technology. Edisons DC distribution system having disadvantaged that power generating plants feeding heavy distribution conductors and consumer loads tapped of them. This system operates at a same voltage level throughout. But to have a better option three wire system is also used now to save copper conductor cost. The three wires were at +110 volts, 0 volts and −110 volts relative potential. 100-volt lamps could be operated between either the +110 or −110 volt legs of the system and the 0-volt "neutral" conductor, which carried only the unbalanced current between the + and − sources. In the fast and growing power electronics development now days it is possible to completely replace the existing AC distribution network with the DC distribution network as a need of today's power system scenario at the distribution side. Most of the loads on the distribution side are of DC types and unfortunately they all are feed by AC type of supply distribution system by using number of energy conversion stages. In case of AC there should be source synchronization which is not required in case of DC, and can drawn upon solar, wind, and the grid as each source is available. Harmonic issues, phase balancing problem are not present in DC system.[1].DC offers a lower cost of ownership in building wiring, copper and connectors along with an increase in efficiency of 8 to 10 % that is truly significant[2].

A proper distribution system offers higher efficiency and potential to extract power from multiple available sources. There are also benefits which are not as immediately apparent. Most backup energy sources such as batteries and flywheels are inherently DC. Further telecom and server loads

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run on DC, so there is fewer intermediate efficiency robbing stages, along with greater reliability due to fewer potential points of failure with a DC approach [3]. According to CEA (Central Electricity Authority) India is running a shortage of around 11% peak demand and more than 24% as T &D losses [4]. In rural area electricity is not available more than 8 hours in a day so it is necessary to move towards energy efficient techniques with renewable energy support.
In this paper firstly DC distribution system topologies were discussed. Then analysis of energy efficiency of different loads is done for existing AC supply system and DC supply system. For this work electrical load on academic building of Matoshri College of Engineering, Nashik is taken as a case study. And finally it is concluded that DC supply distribution system is advantageous than that of the AC power distribution system.

II. LOW VOLTAGE DC DISTRIBUTION SYSTEM TOPOLOGIES

LVDC system is of two types accordingly to the conductor polarities.

2.1 Unipolar LVDC system

In this type of distribution system voltage level throughout the system is same. Two conductor system has one conductor at positive polarity and other at zero or neutral polarity. The entire load on the distribution system connected at this voltage level only, as shown in figure 1.

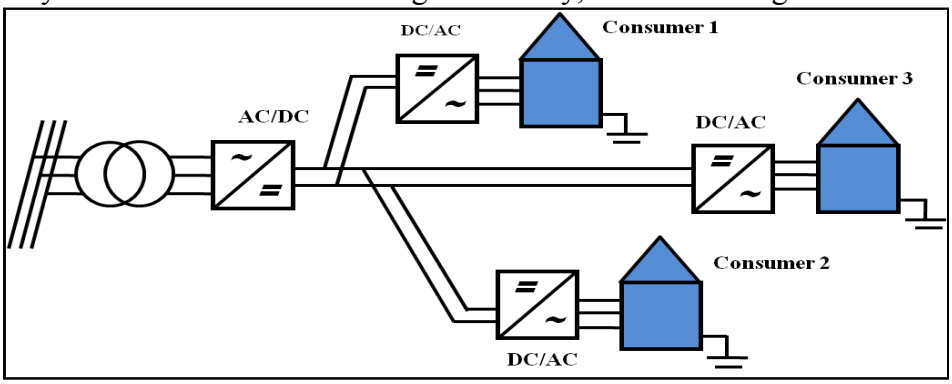

Figure 1. An unipolar LVDC distribution system

2.2 Bipolar LVDC System

Basically bipolar LVDC system is the combination of two series connected unipolar system. Now here it is the choice of customer to connect to the appropriate voltage level as the choices are,
1. Positive polarity to Neutral
2. Negative polarity to neutral
3. Positive to Negative Polarity
4. Positive to Negative polarity with neutral connection

In following figure 2 it is shown that possible alternatives for the consumer connection. The customer connections 1 and 2 can lead unsymmetrical loading situation between DC poles in system. The possible overvoltage can be restricted with cable cross section selection. The connections 1 and 2 are chosen to be used in studied ± 750 VDC bipolar system. The main lines of system contain all three conductors but customer connections are2-wire cablesconnected between positive or negative pole. Therefore customer supply voltage is either + 750 VDC or -750 VDC.

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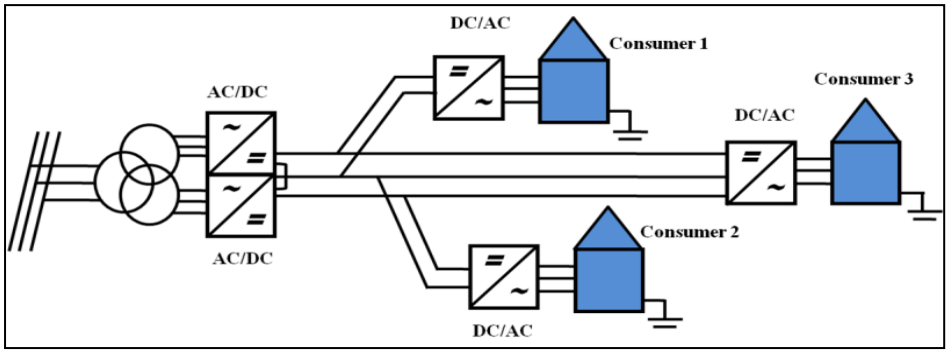

Figure 2. Bipolar LVDC distribution system with different customer connection alternatives

III. ENERGY EFFICIENCY ANALYSIS OF AC/DC, DC/DC, AND DC/AC CONVERSIONS

According to the survey of different products in market by [2] here are some conversion efficiencies for different wattage ratings are given which further use for the calculation.

Table 1. Conversion efficiencies of different electrical equipments by wattage.

Power Rating(W)	10	100	1000	10000	100000	1000000
The Conversion						
AC/DC	69%	75%	81%	87%	93%	99%
DC/DC	86%	90%	92%	96%	97%	99%
DC/AC	90%	92%	92%	95%	95%	98%

IV. EENERGY EFFICIENCY ANALYSIS OF MATOSHRI COLLEGE OF ENGINEERING , NASHIK ACADEMIC BUILDING

4.1 Loads in the building

Academic building consists of the different connected loads broadly mentioned in the table 2 with their wattage rating. From table 1 it is clear that according to the wattage rating, conversion efficiency of every electrical equipment is different.

Now to calculate the total energy consumed by each equipment a site survey is done. According to the site survey total electricity consumed by particular load is mentioned in the table 2.

4.2 The power supplies of the loads in the building

From the above mentioned data of the connected load for the building, now by using the conversion efficiency formulas for the different loads as follows;

4.2.1 Desktop Computers

Efficiency for desktop computers on existing AC supply is given by,

$$\eta_{ac} = \eta_{UPS} * \eta_T * \eta_{AC/DC} * \eta_{DC/DC} * \eta_{Feeder} \quad (1)$$

If the same used to supply by DC power system, so the power efficiency is,

$$\eta_{dc} = \eta_{UPS} * \eta_{DC/DC} * \eta_{Feeder} \quad (2)$$

Where η_{UPS} is the power efficiency of UPS it is 75% taken here by measurement, η_T is the power efficiency of transformer, $\eta_{AC/DC}$ is the power efficiency of AC/DC, DC/DC power efficiency is $\eta_{DC/DC}$, η_{Feeder} is the power efficiency of feeder which is 100%.

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4.2.2 Other loads

Like the desktop computers for all the other loads it is possible to calculate the power conversion efficiency for AC and DC supply.

Fluorescent Lamp:

$\eta_{ac} = \eta_{Feeder}$ (3)

$\eta_{dc} = \eta_{DC/DC} * \eta_{Feeder}$ (4)

Printers and IT Devices:These efficiencies are calculated using equation (1) and (2)

LED lights and Photocopy Machine,

$\eta_{ac} = \eta_{AC/DC} * \eta_{DC/DC} * \eta_{Feeder}$ (5)

$\eta_{dc} = \eta_{DC/DC} * \eta_{Feeder}$ (6)

Similarly it can be calculated for the all the load and summarized the calculated values in the following table 3.

Table 2. Statistics of load in the academic building of MCOE & RC Nashik

Sr.No.	Loads	Power(W)	Quantity	Total(W)
1	Fluorescent Lamps	40	419	16760
2	Fans	80	842	67360
3	Desktop Computers	150	548	82200
4	Printers	40	48	1920
5	IT Devices	20	27	540
6	Photocopy Machines	200	04	800
7	Water Coolers	1000	08	8000
8	Water pumps	2332	02	4664
9	LED Lights	68	20	1360

Table No. 3 Comparisons for efficiencies of AC and DC with individual load

Sr. No.	Loads	Total kWh/day	Energy loss by AC(kWh)	Energy loss by DC(kWh)	% Efficiency by AC	%Efficiency by DC
1	Fluorescent Lamp	48	00	7.2	100	85
2	Fans	228	00	20.52	100	91
3	Computers	300	99	9	67	97
4	Printers	2.8	1.064	0.112	62	96
5	IT Devices	4.86	2.187	0.388	55	92
6	Photocopy Machine	1.2	0.312	0.096	74	92
7	Water Coolers	32	6.72	1.6	79	95
8	Water Pumps	18.65	00	0.9325	100	95
9	LED Lights	3.264	0.8486	0.2611	74	92

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It is clear from the above analysis that in the environment of distribution system where most of the loads are of dc types, dc distribution system works very efficiently. Also the effective energy saving of 18% is possible, in this case of academic building of Matoshri college of Engineering & Research Center, Nashik.

V. CONCLUSIONS

In this paper calculations of energy conversion efficiency of a building have been established for various loads. During the conversion from AC/DC, DC/AC and DC/DC power losses are calculated with efficiency for AC and DC supply with the proper comparison. Compared to the AC distribution system, DC distribution system has 18% more efficiency. Thus DC distribution system with bipolar DC feeder has a great future in the distribution section in India.

REFERENCES

[1] R.K. Chauhan, B.S. Rajpurohit, N.M. Pindoriya, "DC power Distribution System for Rural Applications".Synergy & Energy magazine AMAAhmadabad, p.108- 112, 2012.
[2] Zifa Liu, Mengyu Li, "Research on Energy efficiency of Energy Distribution System".2nd Conference on Power and Energy of AASRI, China, p.68-74, 2014.
[3] Stephen Oliver, "High voltage DC distribution is the key to increased system efficiency and renewable energy opportunities". VICOR Power Bench Magazine, P.1-7, 2012.
[4] STARKE M, LI F X, TOLBERT L M, et al, "AC vs. DC distribution: maximum transfer capability", Proceedings of IEEE Power and Energy Society General Meeting-Conversion and Delivery of Electrical Energy in the 21st Century, July 201-24, Pittsburgh, PA, USA: p.1-6. 2008.
[5] HAMMERSTROM D J, "AC versus DC distribution systems-did we get it right", Proceedings of IEEE Power Engineering Society General Meeting, June 24-28, Tampa, FL, USA: 1-5.Wu, J.K. (1994) Two Problems of Computer Mechanics Program System.Proceedings of Finite Element Analysis andCAD, Peking University Press, Beijing, p.9-15, 2007.

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