Power Quality and Consumption Analysis Using Power Quality Analyzer

Siddharth Rautela
Department Of Electrical Engineering
Dehradun Institute Of Technology, Makkawala, P.O. Bhagwantpur
Mussoorie Diversion Road, Dehradun-248009
Uttarakhand, INDIA
siddharthrautela@gmail.com

Dr. Gagan Singh
HOD Department Of Electrical Engineering
Dehradun Institute Of Technology, Makkawala, P.O. Bhagwantpur
Mussoorie Diversion Road, Dehradun-248009
Uttarakhand, INDIA
gagunus@gmail.com

Abstract

The paper presents a quality analysis of the power of Dehradun Institute of Technology. Aspects such as magnitudes and phases of voltages and currents of all phases, power factor, voltage and current harmonic content, dips and swells, frequency stability, and inrush current were taken into account. These electrical parameters were measured with a power quality analyzer.

1. Introduction

Initially the power consumption of organization was less which is increased. Not only that the number of hostels, computers, machines in lab and other power consuming equipments have also increased. . With the increase in power consumption the cost of electricity consumption also increases. Now for large organizations, the power quality becomes an important issue. The main aim of the paper is to calculate power consumption and the power quality. It is growing day by day it becomes necessary to maintain the good power quality in order to avoid the excessive power consumption and hence reduce the cost of power consumed. So by this we can analyses the power quality and gives suggestions for maintaining good power quality in upcoming years.

2.1 *Power quality definition*

Power quality is simply the interaction of electrical power with electrical equipment. If electrical equipment operates correctly and reliably without being damaged or stressed, we would say that the electrical power is of good quality. On the other hand, if the electrical equipment malfunctions, is unreliable, or is damaged during normal usage, we would suspect that the power quality is poor.

As a general statement, any deviation from normal of a voltage source (either DC or AC) can be classified as a power quality issue. Power quality issues can be very high-speed events such as voltage impulses / transients, high frequency noise, wave shape faults, voltage swells and sags and total power loss. Each type of electrical equipment will be affected differently by power quality issues. By analyzing the electrical power and evaluating the equipment or load, we can determine if a power quality problem exists. We can verify the power quality by installing a special type of high-speed recording test equipment to monitor the electrical power. This type of test equipment will provide information used in evaluating if the electrical power is of sufficient quality to reliably operate the equipment. The process is similar to a doctor using a heart monitor to record the electrical signals for your heart. Monitoring will provide us with valuable data; however the data needs to be interpreted and applied to the type of equipment being powered.

2.2 *The reasons for interest in power quality*

(i) **Metering:** Poor power quality can affect the accuracy of utility metering.
(ii) **Protective relays:** Poor power quality can cause protective relays to malfunction.
(iii) **Downtime:** Poor power quality can result in equipment downtime and/or damage, resulting in a loss of productivity.
(iv) **Cost:** Poor power quality can result in increased costs due to the preceding effects.
(v) **Electromagnetic compatibility:** Poor power quality can result in problems with electromagnetic compatibility and noise

2.3 *Factors affecting power quality*

(i) Voltage sag
(ii) Voltage swell
(iii) Voltage imbalance
(iv) Harmonics
(v) Flickering
(vi) Unbalancing
(vii) Transient
(viii) Inrush

2.4 *Benefits of improved power quality*

(i) Higher power factor reduces current draw and allows more computers to be operated on the same branch circuit without the need for costly electric infrastructure upgrades.
(ii) Lower triple harmonics place less stress on neutrals and increase the life of distribution transformers.
(iii) Cost reduces.

2.5 *Outline of paper*

The major steps involved in carrying out the purposed work are as follows-

(i) Collecting data from organization.
(ii) Collecting data from UPCL (Uttaranchal Power Corporation limited).
(iii) Taking readings with the help of Power Quality Analyzer.
(iv) Evaluate connected load and maximum load.
(v) Evaluate the causes of generation of harmonics and give their reduction methods.
(vi) Generating a comparative statement from the above analysis.
(vii) Calculate the cost which organization can save in a day.

3.1 *Power demand graph*

This is the graph (figure 1) of kW unit per year demand. in starting period the demand is very low because hostels are small, labs and rooms are few. But with the passage of time its demand increases. Around 2004 its demand is approx 125kw.in 2008 new construction are done like new building etc. and the demand reaches to 250kw

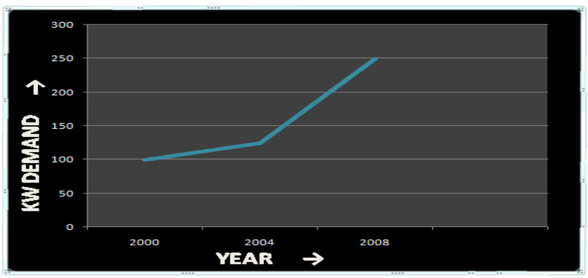


Figure 1 Power demand graph

3.2 *Unit consumed*

Figure 2 shoes the unit consumed per year. in this the unit consumed is maximum in July and august because of the of fans, ac, labs and class rooms are running. While the unit consumed is minimum in may because in this month lab and class rooms are closed

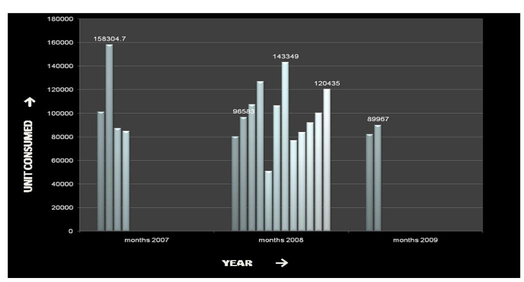


Figure 2 Unit consumed

3.3 *Power factor in organization*

Figure 3 shows the power factor. The power factor is Good. It is one in April to June because use labs and class rooms are almost closed. While it is not good in September October.

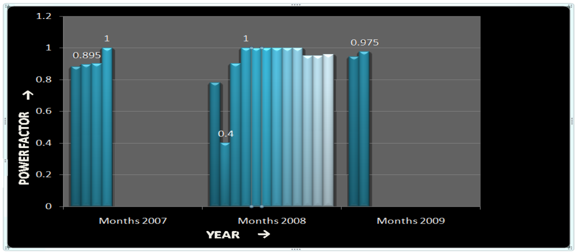


Figure 3 Power factor in organization

3.4 *Load factor*

Figure 4 shows the load factor per year. Load factor is highest in December and February. It is minimum in June and January.

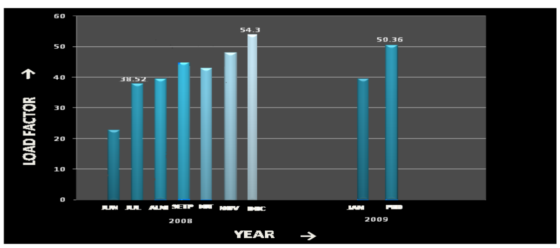
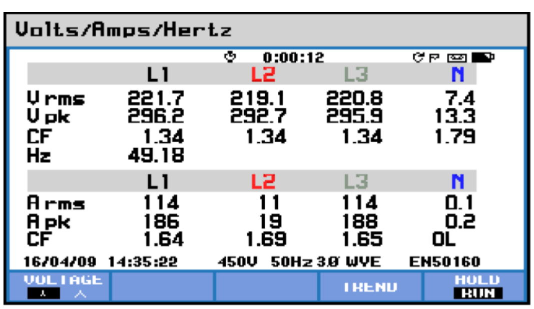


Figure 4 Load factor

4. Analyses of electrical department

4.1 *Voltage and current*

Figure 5 the rms and peak values of current and voltage of three phases and neutral cf means the correction factor. cf shows the deviation from original value.

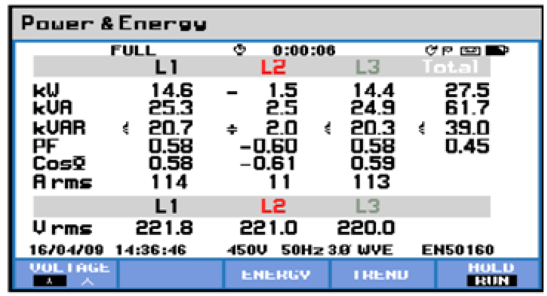


VOLTAGE AND CURRENT

Figure 5 Voltage and current

4.2 *Power and energy under load*

Figure 6 kw(actual power),kva(active power) and kvar (reactive power).+ve power indicates inductive load and –ve shows capacitive load. pf means power factor which is inductive.

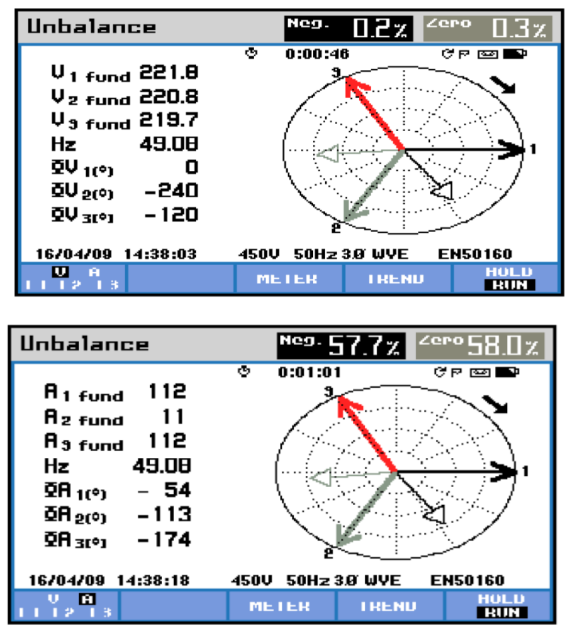


POWER AND ENERGY UNDER LOAD

Figure 6 Power and energy under load

4.3 *Phasor diagram of voltage and current*

Figure 7 shows the unbalancing in both the voltage and current.figure shows that magnitude and phase difference of line voltages is same. but fot current magnitude and phases are not same.

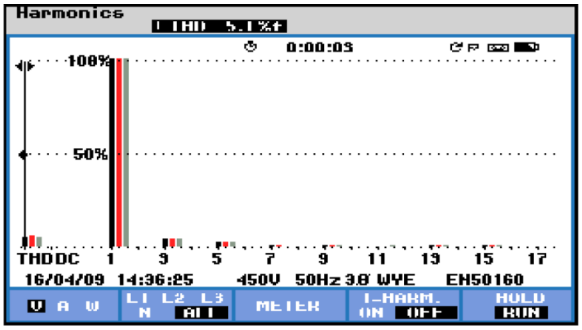


UNBALANCE IN CURRENT

Figure 7 Phasor diagram of voltage and current

4.4 *Harmonics*

Figure 8 shows harmonics in the voltage.There are 1,3 5,7,9,13,15th harmonics present in the voltage.



HARMONICS IN VOLTAGE UNDER LOAD

Figure 8 Harmonics

4.5 *Dips and swells*

Figure 9 shows dips and swell in the line voltage and neutral. dip means magnitude fall, swell means magnitude rise

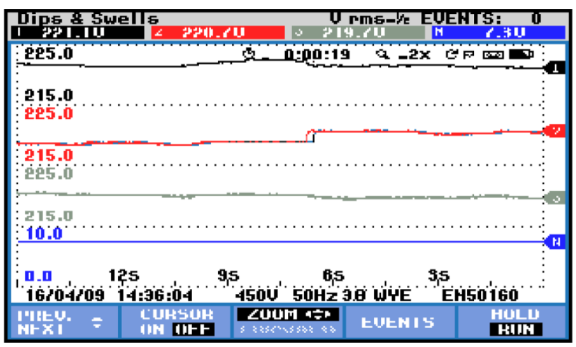


Figure 9 Dips and swells

4.6 *Harmonics in current*

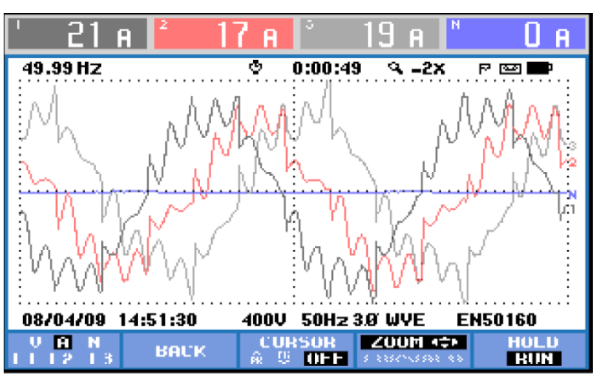
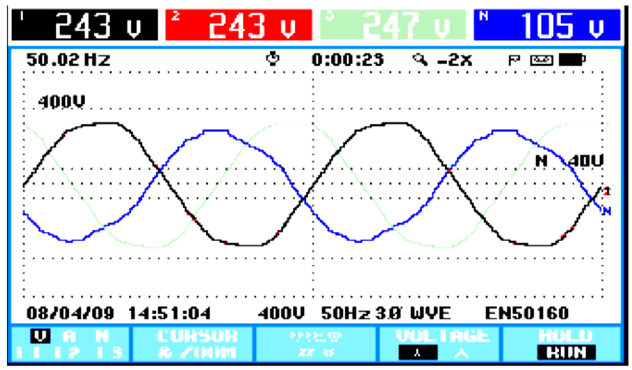


Figure 10 Harmonics in current

Figure 10 shows the harmonics pattren in the line current. That waveform is not purely sinusoidal

4.7 *Transients*

Figure 11 shows transients in the voltage. the waveform is not pure sinusoidal because of harmonics.

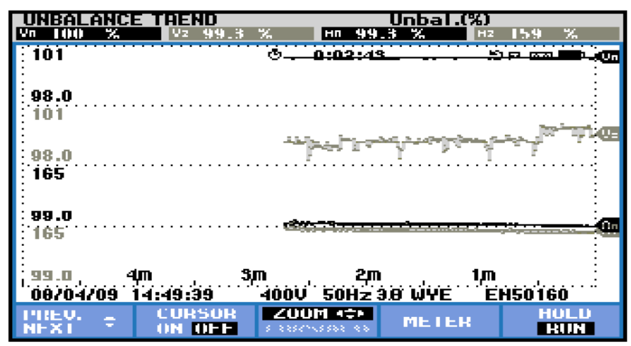


TRANSIENT IN VOLTAGE

Figure 11 Transients

4.8 *Unbalance trand*

Figure 12 shows the unbalancing trand of the voltage and current. it shows that how much current and voltage deviates from its original value.



UNBALANCE TAEND

Figure 12 Unbalance trand

5. Result The results are shown in the table 1 given below:

5.1 ***Table 1 Showing power consumption***

BLOCKS	CONNECTED LOAD	ACTUAL LOAD in peak hrs	HARMONICS	REMARK
OLD BUILDING (WITHOUT LAB)	87.992 KW	33.45	CURRENT-3,5,7,9,13,15,17 VOLTAGE-3,5,7,9,13	LOAD VERY HIGH HARMONICS POWER FACTOR= -
BOYS HOSTEL	140.33	76.3	CURRENT-3,5,7,9,13 VOLTAGE-3,5,7,9	HIGH HARMONICS POWER
GIRLS HOSTEL	51.396	33.1	CURRENT-3,5,7,9,13,15 VOLTAGE-3,5,7,9	CAPACITIVE LOAD POWER FACTOR= - 0.38
NEW BUILDING	26.360(CLASS ROOMS)	83.5	CURRENT-3,5,7,9,11,13 VOLTAGE-5	POWER FACTOR=- 0.58 CF OF
OFFICE	21.247	16.3	CURRENT-3,5,7,9,13,15,17 VOLTAGE-3,5,7,9,13	LOAD HIGH HARMONICS POWERT FACTOR= -
CANTEEN	11.256	1.5	CURRENT-3,5 VOLTAGE-3,5	VE LOAD LESS HARMONICS POWER
ELECTRICAL DEPTT.	125.692	28.92	CURRENT-3,5,7,9,13,15 VOLTAGE-3,5,7,9,13	HIGH HARMONICS HIGH DIPS AND SWELLS
AREC. AND PHARMACY	47.156	21.23	CURRENT- 5,7 VOLTAGE-3,5,7	FACTOR=0 .47 CF OF CURRENT = 1.53
EC DEPTT.	12.453	65.145	CURRENT-3,5,7,9,13,15 VOLTAGE-3,5,7,9,13	CAPACITIVE LOAD HIGH HARMONICS POWER FACTOR= -0.41 CF OF CURRENT= 1.5 CF OF VOLTAGE= 1.39
CSE DEPTT.	81.968	163.87		
MECHANICAL DEPTT.	48.452			
IT DEPTT.	33.45			

5.2 *Conclusion*

From the above analysis we find out following conclusion –

The input power supply is= 250 KW.

The total connected load is =574.752 KW

The actual power consumed in peak hours is = 360.14 KW

Academic blocks = 250.045 KW

Hostels (boys +girls) = 109.4 KW

Street lights = 0.7 KW

If there is a off day of students, money Saving in academic blocks (assuming only light, fans and few computers are working) =Load * Unit rate *working hours

= 145 KW * 3(Rs. /UNIT)* 8 Hr.

= Rs. 3480 per day

"Hence money saving = Rs. 3480 per day"

5.3 *For power quality*

The 1,3 5,7,9,13,15th harmonics are present in the voltage.

The variation in load 5% is due to the following factors-

(i) weather conditions
(ii) summer and winter seasons
(iii) consumption of electricity in different time duration
(iv) power cut

6. References

1. www.fluke.com
2. www.upcl.ac.in
3. Nagrath I.S. / Kothari D.P. Modern Power System Analysis, 2nd Edition. (Tata McGraw Hill New Delhi,2001)
4. R.K. Rajput, Utilization Of Power Quality, 3rd Edition (Laxmi Publications 2008)
5. Prabha Kundur, Power System Stability and Control, 1st Edition (Tata McGraw Hill New Delhi,2006)
6. D. Das, Electrical Power Systems, 1st Edition (New Age Publication 2006)
7. C. L. Wadhwa, Electrical Power System, 6th Edition (New Age Publication,2010)