Energy Audit in Faculty of Mechanical Engineering UiTM Shah Alam

Ahmad Fauzi Sharif
Department of Power
Faculty of Electrical Engineering
UniversitiTeknologi MARA Malaysia
40450 Shah Alam, Selangor, Malaysia
e-mail: ahmad_fauzi1718@yahoo.com.my

Abstract— **People nowadays are more concerned about energy efficiency and conservation. One of the focal points of such concern is on energy consumption in buildings. An energy audit is considered as one of the comprehensive methods in checking energy usage and wastage in buildings. This paper addresses the implementation method of energy saving in Faculty of Mechanical Engineering (FKM) at UniversitiTeknologi MARA (UiTM) Shah Alam, Malaysia. In this paper, energy saving concept and purpose is analyzed. By analyzing current utilization situation of energy in FKM building, the significance of energy saving in FKM building to produce improvement in operation efficiency and cost saving initiatives due to high monthly electrical consumption and penalty charge due to low power factor operation by the supply utility. Power quality, harmonic and power factor issues are successfully identified and recommendation for improvement is highlighted.**

Keywords-energy consumption; energy saving; harmonic; power factor

I. INTRODUCTION

This energy crisis and greenhouse effect are the impetus behind energy saving. The energy audit is used to "diagnose" the weak points of the building energy-usage system, tap latent power and to build up energy-saving responsibility. The Energy audit focuses mainly on total energy consumption of the equipments, especially on air- conditioning system, electronically equipments, lighting, and elevators, etc. By conducting a survey on the energy use, the equipment load in the building is gathered for the analysis. Some measures to increase energy efficiency are put forwards [1].

The energy process is an organized approach to identify energy waste in a facility, determining how this waste can be eliminated at a reasonable cost with a suitable time frame. Energy audit is widely used and many have different meaning depending on energy service companies. Energy auditing of a building can range from a short a walkthrough of the facility to a detailed analysis. It is not only serves to identify energy use among the various services and to identify opportunities for energy conservation but it is also a crucial first step in establishing an energy management program. The audit will produce the data on which such a program is based [2].

Energy audit, similar to financial accounting process, is a process of examining an energy account, checking the way energy is used and identify areas where wastage can be minimized. Energy audit cannot be successfully carried out without the commitment from the top management. Management must be firstly convinced of the necessity of implementing energy management and hence energy audits [3].

This energy analysis contains valuable information such as energy consumption patterns of the building and the identification of high energy intense equipments, possible energy saving measures and cost benefit analysis of energy saving measures.

The audit discusses in this paper is carried out in aim of analyzing and identifying possible energy saving measures, which can be implemented in a FKM building. This effort will help the FKM building to reduce their monthly electrical energy consumption thus reducing the cost of production. The total energy survey is conducted by means of onsite inspections, measurements, questions and discussions with the maintenance staff. Energy consumption data have been logged over a period of time at the main supply and in identified main equipments in the FKM building.

II. ENERGY SAVING

The Energy saving focuses mainly on total energy consumption of the equipments such as voltage and current trend, total harmonic distortion (THD) voltage and current and power factor for the FKM building.

For this project, Reliable Power Meter (RPM) Fluke 1750 is use as power quality recorder. These RPM will be installed in Main Switch Board (MSB) room and automatically record every power quality parameters such as voltage, current, power and harmonic on the week.

The data logger will be analyzed by using the Fluke Power Analyze software and convert to Microsoft Excel format to facilitate our readers. Lastly, additional work to prove the wastage of lamp application had been done to give a recommendation for wastage energy.

III. METHODOLOGY

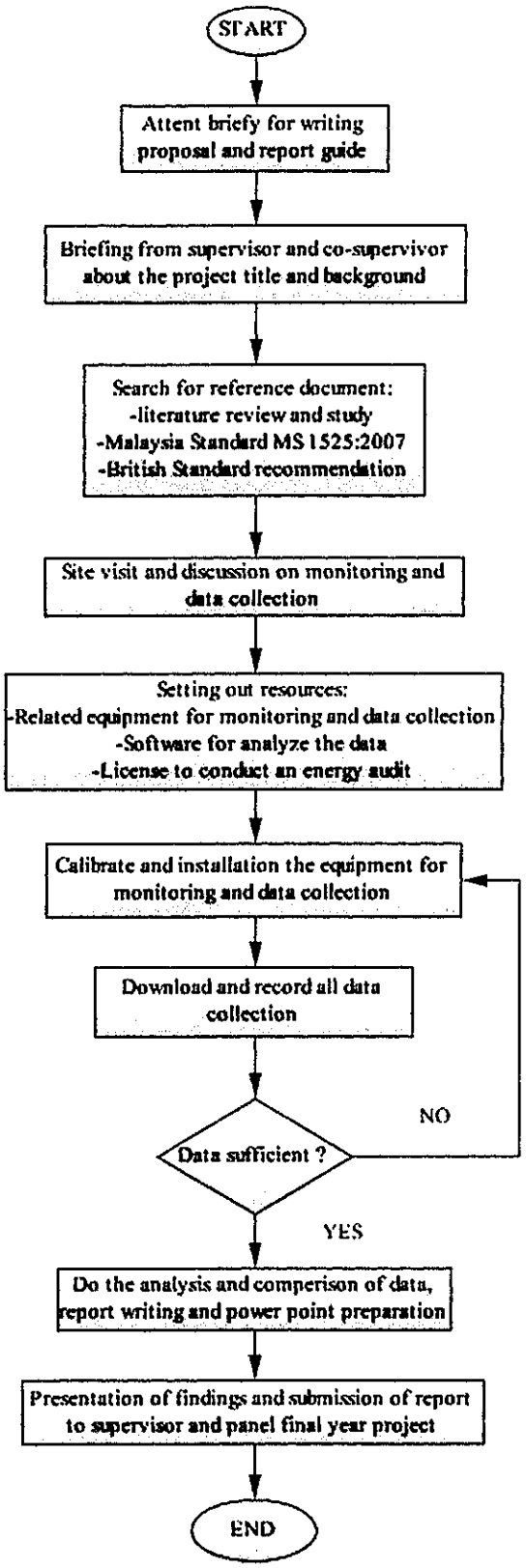

Figure 1: Flow Chart of Energy Audit in Faculty of Mechanical Engineering UiTM, Shah Alam

IV. IEEE STD 519-1992

According to IEEE 519, harmonic voltage distortion on power systems 69 kV and below is limited to 5.0% total harmonic distortion (THD) with each individual harmonic limited to 3%. The current harmonic limits vary based on the short circuit strength of the system they are being injected into. Essentially, the more the system is able to handle harmonic currents, the more the customer is allowed to inject [7].

TABLE 1. *IEEE Std 519-1992 Harmonic Voltage Limits*

Voltage Distortion Limits

Bus Voltage at PCC	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001 kV through 161 kV	1.5	2.5
161.001 kV and above	1.0	1.5
NOTE: High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.		

TABLE 2. *IEEE Std 519-1992 Harmonic Current Limits*

Current Distortion Limits for General Distribution Systems (120 V Through 69000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
Individual Harmonic Order (Odd Harmonics)						
I_{sc}/I_L	<11	11≤*h* <17	17≤*h* <23	23≤*h* <35	35≤*h*	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0
Even harmonics are limited to 25% of the odd harmonic limits above.						
Current distortions that result in a dc offset, e.g. half-wave converters, are not allowed.						
All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.						
e						
I_{sc}	ximum short-circuit current at PCC.					
I_L	ximum demand load current (fundamental frequency component) at PCC.					
TDD	Total demand distortion (RSS), harmonic current distortion in % of maximum demand load current (15 or 30 min demand).					
PCC	nt of common coupling.					

Table 1 shows the IEEE 519 harmonic voltage limits while Table 2 shows the harmonic current limits. The harmonic current limits specify the maximum amount of harmonic current that the customer can inject into the utility system. The utility is responsible for providing a clean (low distortion)

voltage to the customer. The utility can only be fairly judged, however, when the customer meets the harmonic current limits. Otherwise, the customer may be guilty of causing the voltage distortion himself.

V. ANALYSIS DATA COLLECTION

The power quality data of FKM building will be analyze by using Microsoft Excel. Analysis data collection included voltage trend, current trend, THD of voltage, THD of current and power factor. The period of study is three months.

A. Analysis on Voltage Trend

Figure 1belowshows, that the maximum and the average of voltage trend at FKM building on one week data. The maximum voltage imbalance is around 0.45% below and the minimum voltage imbalance is around 0.25%. The voltage imbalance can be concluded less then 1%, so that comply with IEEE Std 519-1992.

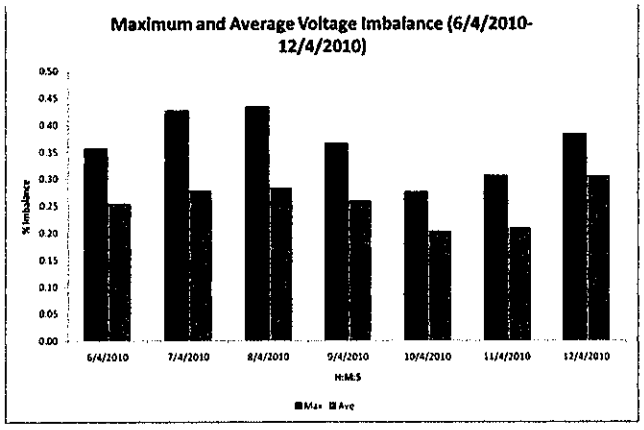

Figure 2: Maximum and average voltage imbalance

B. Analysis on Current Trend

Figure 2 shows, the current trend at Tuesday. Current in phase blue is higher than phase red and yellow. Phase current at this building is not balance. From the analysis, the normal current is 200 amp and the grounding is 150 amp. These current increases around 7 am when classes, offices and air condition start to operate. Around 5 pm to 6 pm, these current start to decreases. At 12 pm to 2 pm, the current drop from 400 amp to 300 amp due to lunch break. No energy usage at that time so that the current drop.

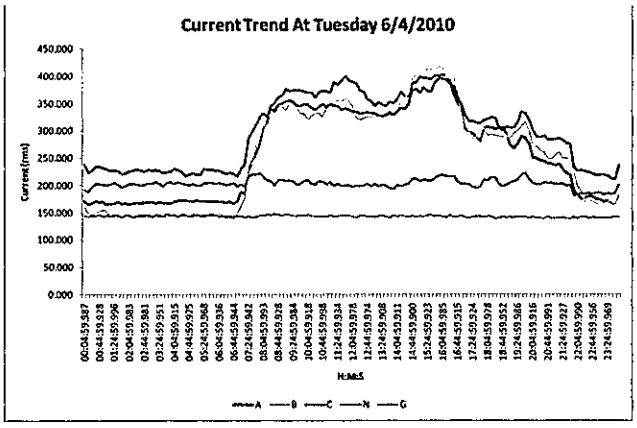

Figure 3: Current trend at Tuesday

C. Analysis on THD Voltage

For THD voltage, the maximum value of one week is 1.1% at Thursday and the minimum value is 0.8%. That means the THD voltage for FKM building complies with IEEE Std 519-1992.

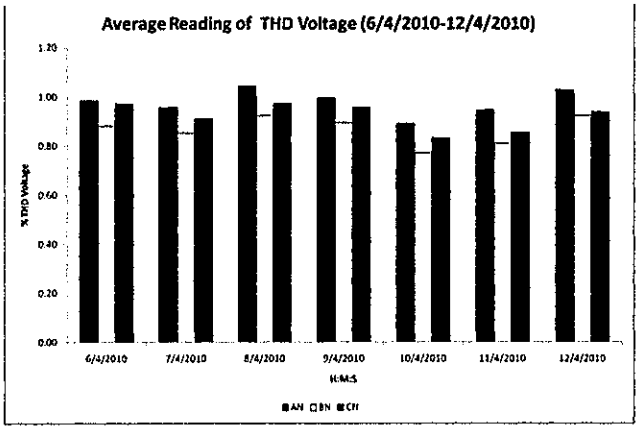

Figure 4: Average THD Voltage

D. Analysis on THD Current

From Figure 4, the maximum THD current for FKM building is around 10% and the minimum is 6%. THD current is not complying with IEC 519(1992) which says that the THD current must less then 4%.These cause nuisances tripping in the connected loads to the supply may damage to equipments connected.

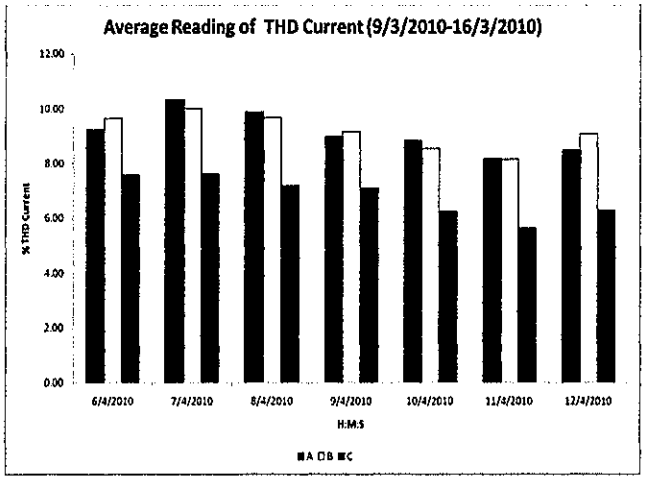

Figure 5: Average THD Current

E. Analysis on power factor

The power factor at FKM building is almost around 0.8 to 0.9.If power factor below that 0.8, penalty charge imposed by (TenagaNasionalBerhad) TNB on monthly electrical consumption.

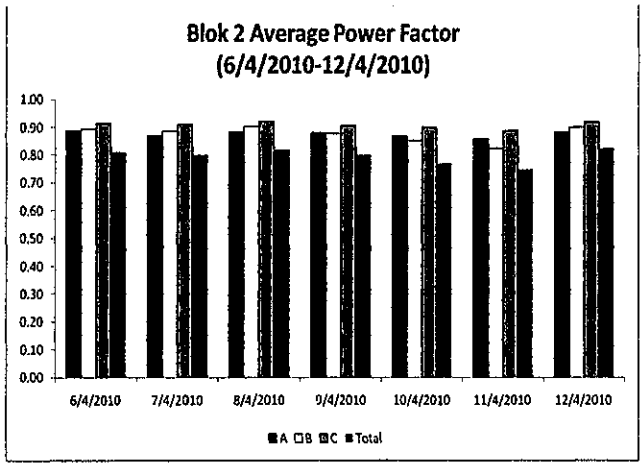

Figure 6: Average power factor

Lighting application in the FKM building is not so efficiently used. The lamps at various floor is switched on during a day at open corridor. The illumination is sufficient on that floor without lighting from the lamps. This is a wastage energy application in the FKM building. So, the lighting painting need to redesign and the reminder sign need to be place at each of the classroom. This effort can reduce the maximum demand at the peak hours and energy consumption of the building.

VI. CONCLUSION

From the analysis made on the findings based on the collected data on the monitoring activities conducted the recommendation and suggestions to solve that problem which occur at FKM building. Imbalance load happen when load at every phases is not balance. It is also caused by high THD contents in the current. The existing loads connected to the respective phases to balance the resultant load current in each phase must rebalance.

Total Harmonic Distortion (THD) is one reason why the electrical consumption high. Harmonic filters will be installed at MSB room to reduce overall THD which occur at the system. Power factor issues would be solve by install capacitor bank. When operating at a higher power factor.

Lighting application in the FKM building is not so efficiently used. The lamps at various floor is switched on during a day at open corridor. The illumination is sufficient on that floor without lighting from the lamps. This is a wastage energy application in the FKM building. So, the lighting painting need to redesign and the reminder sign need to be place at each of the classroom. This effort can reduce the maximum demand at the peak hours and energy consumption of the building.

ACKNOWLEDGMENT

I would like to express my sincere thanks and appreciation to Prof. Dr. Ir. Shah RizamBteMohd Shah Baki, my project supervisor, my co-supervisor Prof. Madya Ir. ZulkefliYaacob, IrRazaliAbdHadi and also En Samsudin, charge man KET and other contributors for their guidance, support and helpful advices to develop the Energy Saving in Faculty of Mechanical Engineering UiTM Shah Alam .

REFERENCES

[1] Xin Wang; Chen Huang; Wuwei Cao; , "Energy Audit of Building: A Case Study of A Commercial Building in Shanghai," Power and Energy Engineering Conference (APPEEC), 2010 Asia-Pacific , pp.1-4, 28-31 March 2010, doi: 10.1109/APPEEC.2010.5448746.

[2] Mendis, N.N.R.; Perera, N.; , "Energy Audit: A Case Study," Information and Automation, 2006. ICIA 2006. International Conference on ,pp.45-50, 15-17 Dec. 2006, doi:10.1109/ICINFA.2006.374149.

[3] Wong, H.K.; Lee, C.K.; , "Application of energy audit in buildings and a case study," Advances in Power System Control, Operation and Management, 1993. APSCOM-93., 2nd International Conference on , pp.977-981 vol.2, 7-10 Dec 1993

[4] Mertens, E.A.; Dias, L.F.S.; Fernandes, E.F.A.; Bonatto, B.D.; Abreu, J.P.G.; Arango, H.; , "Evaluation and trends of power quality indices in distribution system," Electrical Power Quality and Utilisation, 2007. EPQU 2007. 9th International Conference on , pp.1-6, 9-11 Oct. 2007
doi: 10.1109/EPQU.2007.4424212.

[5] Leon-Martinez, V.; Montanana-Romeu, J.; Giner-Garcia, J.; Cazorla-Navarro, A.; Roger-Folch, J.; Grana-Lopez, M.A.; , "Power quality effects on the measurement of reactive power in three-phase power systems in the light of the IEEE Standard 1459-2000.," Electrical Power Quality and Utilisation, 2007. EPQU 2007. 9th International Conference, no., pp.1-6, 9-11 Oct. 2007
doi: 10.1109/EPQU.2007.4424093.

[6] Tongxin Zheng; Makram, E.B.; Girgis, A.A.; , "Evaluating power system unbalance in the presence of harmonic distortion," Power Delivery, IEEE Transactions on , vol.18, no.2, pp. 393- 397, April 2003
doi: 10.1109/TPWRD.2002.807460.

[7] Blooming, T.M.; Carnovale, D.J.; , "Application of IEEE STD 519-1992 Harmonic Limits," Pulp and Paper Industry Technical Conference, 2006. Conference Record of Annual, pp.1-9, 18-23 June 2006