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Energy management key practices: A proposed list for Malaysian universities

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Abstract
This study embarks to propose a list of energy management key practices for Malaysian Universities. Energy management is beneficial for Malaysian university that confront expensive energy bill, for it have large build up areas, comprehensive facilities as well as large numbers of building users. The proposed list of energy management key practices is a complement to their existing practices and, to guide them in achieving energy sustainability. A non-experimental, quantitative, and survey research design was used. Questionnaire survey was performed in Malaysian public and private universities to obtain energy coordinators' perspective on the importance of proposed energy management key practices. This study suggests a total of 47 key practices are vital to manage energy in university, they were grouped into three major phases: "Planning", "Implementing", and "Monitoring and Evaluation". The results show that key practices pertain to involvement, measurement and verification, budget allocation, energy goals and objectives were considered very important by university energy coordinators. Although technology approach seems impressive, result shows it is not their prior choice. Also, some of the soft energy management key practices, such as "develop education plan" and "advice on energy matters" are not considered important by the energy coordinators. The paper confirms the importance of the proposed list of energy management key practices, the list would be applicable to university to monitor and measure their energy performance.

Keywords: Energy management; Key practices; Malaysian universities.

1. Introduction

Developed and developing nations depend on energy for it is the important driver for economic growth and country development. The World Energy Outlook [1] projected the world primary energy demand grows by 1.6% per year on average from 2006-2030. In developing nations, energy usage is expected to increase rapidly due to expansion of their economies [2]. The ever rising of energy demand will exhaust the limited energy resources sooner or later. The rapidly increased oil price and environmental degradation in recent years had attracts global concern and leads to a call for better use of energy. A long term programs aimed at making the use of energy more efficient is needed [3]. One of the possible solutions is through energy management. Energy management is known as the effective use of energy to maximize profits and to enhance competitive positions [4]. It is regarded as a long-term method of stretching limited energy resources. As according to [5], consistent energy savings can be achieved by

implementing consistent energy management practices as well as proper measurement verification procedures.

2. The needs of energy management key practices for Malaysian universities

In year 2007, The Malaysia Ministry of Education has urged all education centres to save energy for expensive monthly electricity bill had became the concerns for many parties. This was concurrent with The Ministry of Energy, Water, and Communications that embarking on a conservation program in Government department to reduce electricity consumption by 10 percent [6]. Indeed, the increases of electricity tariff in peninsular of Malaysia by an average of 12% since Jun 2006 has a domino effect on operational costs for university, for it have large build up area and large community.

Energy management provides considerable opportunities in assisting large public institutions (universities, hospitals, government office buildings, etc) and high energy consumption private operations cut costs considerably [7]. The typical energy bill in the education sector is approximately 5 percent of the total expenditure and saving of 20 percent of the energy bill is possible with simple improvements [8]. In fact, an energy cost savings of 5-15 percent is usually obtained quickly with little to no required capital expenditure when an aggressive energy management program is launched [9].

A comprehensive list of energy management key practices is important for local university, for it will reveal the significant practices to be focused. This help university to plan, review, benchmark and allocate resources better, to put it simply, it can be understood as "what" are the best to be done to achieve energy saving goal. Key practices mean the fundamental policies, procedures, and activities that contribute most to the effective implementation of a key process area [10]. The term 'key practices' is well described in the Capability Maturity Model (CMM) developed by the Software Engineering Institute at Carnegie-Mellon University. It is understand as the elements which contribute most effectively to the implementation of the key process areas. This study embarks to identify and propose a list of energy management key practices for Malaysian Universities.

3. Phases and key practices of energy management

Comprehensive literature search was done to identify relevant energy management key practices, the sources of reference was based on secondary data, including journals, books, thesis, reports and conference papers. These include [4, 9, 11- 29].

We have identified 47 key practices that grouped into three phases: 'Planning', 'Implementing', and 'Monitoring and Evaluation'. Each phase is associated with a list of key practices.

"Planning" is known as "delineating goals and ways of achieving them" [30]. Planning provides a starting point for initiating energy management efforts in any activity and is essential to any successful energy management program [17, 21]. It is crucial for the allocation of scarce resources, whether those resources be people, money, or energy. In general, "planning" is the process of deciding on advance what is to be done, how is it to be done, where is it to be done, when to be done, who should get it done, and how to achieve the pre-determined organizational goals. In energy management, "planning" is beginning from designing to the organizing of the whole process until monitoring and evaluating of the energy management process. It is looking ahead, energy manager or management committee need to anticipating the future and deciding the course of action to be taken during this phase. It requires imagination, foresight, and sound judgement throughout this phase. The literature search had confirmed that there are 16 key practices fall under this phase. See Table 1.

The phase two "Implementing" is to execute or take action of what management team had planned in the planning phase [31]. "Implementing" phase is the heart of many energy management programmes. For that, it is vitally important to incorporate appropriate leadership and sufficient supervision in this phase to ensure the energy management can be implemented as in plan. During "Implementing" phase, the management shall set their goals, capital investments, application of energy management principles, and then follow through the program according to the plan [12]. Besides that, the energy management committee or practitioner needs to determine where and how energy is being used. The literature search had confirms 17 key practices connected to this phase. See Table 2.

Phase three is "Monitoring and Evaluation", it is to direct, control, and evaluate the particular action taken are matching as what the management had designed and planned. This is the final phase in the energy management process by which goals and objectives are transformed from planning information into completed programs [17]. Now, the energy coordinator should make sure the program is carried out according to the plan, if any changes is needed, what different directions should be taken and so evaluate

the outcome as well [24]. Literature search reveals that there are 14 key practices connected to this phase. See Table 3.

Table 1. Energy management key practices for planning phase

Key Practice	Description
P_1. Appoint energy management manager	Assign or appoint someone as energy manager to plan, lead and manage energy in university
P_2. Budget allocation	Provide dedicated and sufficient capital budget for energy management purpose
P_3. Determine capital investment and priorities	Weight the return and risk of energy conservation related investment opportunities
P_4. Develop contingency plan	Prepare emergency plan for minimize the impact of unexpected disruption happened
P_5. Develop educational plan	Improve stakeholder's energy knowledge through relevant training and education programme
P_6. Develop master plan	Summarize conditions and set appropriate operational parameters, including potential savings, maintenance functions and needs of resources
P_7. Develop strategy plan	Set short term and long term strategies to achieve the pre-determined energy conservation objectives/missions/visions
P_8. Establish database	Establish a database which is sufficiently comprehensive to show the present and historical energy-usage trends, as well as to develop a uniform energy record, report, and account system
P_9. Establish energy goals and objectives	Set energy goal and objective, the principle of Specific, Measurable, Accurate, Reality and in the Time Frame (SMART) must be well considered
P_{10}. Establish energy policy	Establish concise energy policy which may consist of the following: vision, mission, objective, and approach to update the policy
P_{11}. Establish procedures	Establish procedures for energy data collection, analysis, measurement and reporting purpose
P_{12}. Formulate energy management committee	Form energy management committee who will become key players to implement energy management practices in an organization
P_{13}. Gain top management commitment	Pursue and gain top management commitment in supporting energy management programme
P_{14}. Provide guidelines	Provide comprehensive guidelines such as user manual or standard for energy related matters
P_{15}. Provides sufficient tools	Equip staff with appropriate energy conservation and measurement tools such as walt-hour meter and portable digital meter for trouble shooting, detect energy defects and other energy conservation purposes
P_{16}. Visibility start-up	Have high visibility start-up to ensure stakeholders understand the purpose of the energy program and how it relevant to their job and income, for example: releasing of medias, memos, newspapers, posters, films, etc

Table 2. Energy management key practices for implementing phase

Key Practice	Description
I_1. All level employee involvement	Involve all level of staff in the process of generating and implementing energy saving ideas, make them "own the problem" rather than just direct them to do something
I_2. Communicate to Employee	Communicate periodically to employees regarding cost and progress of energy management for enlisting employee support and participation
I_3. Conduct energy audit	Conduct energy audit to review existing practices, investigate energy usage and provide insight into particular inefficient operations
I_4. Conduct energy walk-through survey	Conduct walkthrough assessment in classroom, office, utilities plant, lab etc to investigate and analyze building energy usage
I_5. Conduct periodic meetings between energy management committee and coordinator	Organize periodic meeting to assure stakeholders understands the energy management task and agrees on the proposed approaches in solving identified energy problems
I_6. Conduct program to stimulate and sustain interest	Organize program regularly to create and sustain interest among stakeholders to conserve energy
I_7. Educate and train all staff	Educate all employees on various energy issues and energy saving opportunities through training, seminar or workshop
I_8. Establish uniform record keeping system	Develop a uniform record keeping system to document the energy consumption, energy saving, improved actions etc.
I_9. Establish uniform reporting system	Develop standard reporting procedures to monitor energy management progress, the report shall be regularly submit to top management and other interest party regarding what actual energy savings have resulted from the expenditure of resources and funds
I_{10}. Identify energy conservation opportunities	Prepare a list of energy conserving opportunities of common interest range from no or low cost investment (e.g. monitor room temperature and provide better building insulation) to expensive investment (e.g. install Building Energy Management System)
I_{11}. Inform of the reasons-Need	Inform and justify the needs of energy conservation to employees and public
I_{12}. Implement automatic Control	Optimize efficient operation through automatic energy management control system
I_{13}. Improve energy Efficiency electrical Appliances system	Improve efficiency of appliances, such as lighting, heater, air-conditioning system, computer, fan, etc
I_{14}. Promote awareness	Raise energy awareness through appropriate awareness development process, example: energy awareness stimulus, transference method, regulation of behaviour and follow up
I_{15}. Motivation	Recognize and reward outstanding individual or group for their contribution in conserving energy
I_{16}. Perform maintenance	Perform regular proactive and reactive maintenance on energy relevant facilities
I_{17}. Use sophisticated technical innovation	Install or use sophisticated and advance equipments to aid energy management, for example: solar technology, biomass technology, advance motion sensor etc.

Table 3. Energy management key practices for monitoring and evaluation phase

Key Practice	Description
M_1. Advise on energy matters	Seek experts advise on energy management
M_2. Attention the detail of use and costs	Study the details of energy consumption pattern and costs for potential improvement
M_3. Conduct economic analysis	Conduct economic analysis on selected energy management options, such as life cycle cost, rate of return and cost-benefit ratio
M_4. Conduct energy forecasting	Forecast future energy consumption and determine whether the actual performance is better or worse than expected
M_5. Conduct energy usage and performance analysis	Conduct energy usage and performance analysis on different areas so that appropriate improvement can be took
M_6. Demand control	Conduct demand control, for example: sub metering energy account centre and identify devices or appliances to be turned off when it is not in use
M_7. Ensure regulations always met	Ensure energy management activities are always compliance with statute, regulation and contractual requirements
M_8. Keeping abreast of latest development	Keep abreast of latest energy management development
M_9. Maintain good relations with other department	Keep a good working relationship with other departments on energy management matters
M_{10}. Measure and verify	Conduct measurement and verification on the effectiveness of organisation's policy in conserving energy
M_{11}. Perform follow-up tasks	Collect and analyze energy use information to determine when and why energy consumption is deviating from an establish pattern
M_{12}. Periodic review and evaluation of overall program	Conduct periodic review and evaluation on whether energy management program has been properly implemented, also, identify opportunities for continuous improvement
M_{13}. Review of drawing, data sheet, and equipment specification	Review and update building drawings, energy data sheets, and energy measurement and saving equipments
M_{14}. Tracking and targeting	Track and forecast energy usage for major group and then, set energy saving target for them

4. Method

4.1 Current study

In order to identify the key practices of energy management, a questionnaire survey was conducted in Malaysian Universities. This study is significant in exploring what are the key practices appreciated by energy coordinators in Malaysian Universities.

4.2 Procedures and measures

The 'typical' itinerary of a research consisted of three important stages, begins with the theory runs through the phases of data collection and analysis and returns to the theory [32]. In previous stage, we have identified and categorized a list of key practices from the literatures. Anyhow, the list is doubt to be accepted by the practitioners as it was merely theoretical review. Therefore, a survey is needed to be done to mitigate the gap between theoretical review and practitioner's needs [33].

Literature search indicated that there are no relevant questionnaire is available. To confirm the proposed list of energy management key practices, we prepared a closed-ended questionnaire survey sheet that consists of two sections. Section A intended to obtain the information about respondent background and Section B intended to obtain the opinions of respondents towards the reviewed list.

The issue of measurement is one of the major concerns in instrument designation. In this research, researcher adapted the Likert scale proposed by psychometrician Rensis Likert. The Likert scores

adopted were from 1 "very unimportant" to 5 "very important". Energy coordinators were enquired to rate energy management key practices according to their significance.

The respondents consisted of energy management coordinators from Malaysian public and private universities. Questionnaires were distributed through electronic mail. Then, follow-up calls were made every week until the third week from the date the instrument was sent. From the disseminated questionnaires, 14 out of 29 sets of completed questionnaires were returned, the response rate is 48.30%.

Collected data was subjected to descriptive analysis, including analysis of mean and standard deviation. Analysis of mean is to measure the central of tendency or identify the arithmetic average across the distribution of the data set. It is designed to indicate the "middle" or "most typical" point (e.g. category or score) in a distribution [34]. It is a norm to use this technique for ranking purpose [35, 36]. In this research, the mean scores are more specific known as average Likert Score. It were calculated by summing up the score from all the respondents and then divided by the number of respondents. The formula is given as:

$$\text{Average Likert Score} = \sum x \big/ n \tag{1}$$

where x is the summation of all respondent Likert score, n is the total number of respondent.

Standard deviation is computed to measure the dispersion of observations around the mean. It measure how much all the scores in a group differ on average from the mean score [37]. Standard deviation is the positive square root of the variance which is commonly used in explaining how widely the values in a data set are spread or are clustered together around the mean [38]. It is more interpretable than variance because it is in the correct unit of measurement [39]. The greater the variability around the mean of a distribution, the larger the standard distribution is. The formula is given as:

$$\text{Standard Deviation} = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \bar{x})^2}{N-1}} \tag{2}$$

where $\bar{x}$ is the value of mean, N is the total number of respondent, and X_i represents each data value from i= 1 to i = N.

5. Findings and discussion

Table 4 shows key practices that energy management coordinators considered important at planning phase. The key practices are presented according to their degree of importance in descending order with its standard deviation.

Table 4. Planning phase

No	Key Practice	Average Likert Score	Standard Deviation
1.	Gain top management commitment	4.86	0.36
2.	Establish energy goals and objectives	4.71	0.47
3.	Budget allocation	4.71	0.73
4.	Establish procedures	4.57	0.51
5.	Develop a master plan	4.57	0.76
6.	Establish data base	4.43	0.51
7.	Establish energy policy	4.43	0.51
8.	Provides sufficient tools	4.43	0.85
9.	Develop strategy plan	4.43	0.76
10.	Provide guidelines	4.36	0.50
11.	Determine capital investment and priorities	4.29	0.73
12.	Visibility start-up	4.21	0.58
13.	Formulate energy management committee	4.14	1.03
14.	Appoint energy management manager	3.93	0.73
15.	Develop contingency plan	3.86	0.66
16.	Develop educational plan	3.79	0.43

The average Likert Scores for all key practices in planning phase is 3.79 and above. The ranking suggest that the practitioners are satisfied with the proposed key practices. All the key practices have standard

deviation with positive value and score less than 1.00, this except key practice "formulate energy management committee" which its standard deviation (1.03) is slightly higher.

In overview, the key practice "gain top management commitment" have the highest average Likert score. Without full and sincere commitment from top management, the energy program will not able to go far and perhaps, confronted difficulties in gaining support from staffs. Therefore, it is not surprise to see it was ranked as the most significant key practices. This was followed by establishing energy goals and objective and budget allocation. The results suggest that the energy coordinators in Malaysian University are well aware and concern about the budget issue. As without substantial budget, it is difficult for them to invest in energy conservation activities. Key practices, namely "establish database", "establish energy policy", "provides sufficient tools" and "develop strategy plan" share a same average likert score, which is 4.43. Respondents considered appoint energy manager to be the least important key practices, to some extent this can be attributed to many energy management activities in Malaysian universities are done by other related professions such as facility manager or property manager rather than energy manager. The bottom two are "develop contingency plan" and "develop education plan", both are not the core function of an energy management programme.

Table 5 shows the average Likert score for key practices distributed under the implementation phase. Most of the key practices obtained mean value higher than 4.00. The standard deviation for all the key practices under this phase are less than 1.00, indicating they were not distributed far from central tendency.

Table 5. Implementing phase

No	Key Practice	Average Likert Score	Standard Deviation
1.	Conduct energy audit	4.64	0.50
2.	Communicate to employee	4.57	0.65
3.	Promote awareness	4.36	0.74
4.	Efficiency improvements in electrical appliance system	4.29	0.47
5.	Conduct energy walk-through survey	4.21	0.70
6.	All level employee involvement	4.21	0.80
7.	Educate and train all staff	4.21	0.70
8.	Establish uniform record keeping system	4.21	0.70
9.	Identify energy conservation opportunities	4.21	0.43
10.	Perform maintenance	4.21	0.43
11.	Motivation	4.14	0.77
12.	Periodic meetings between energy management committee and coordinator	4.14	0.66
13.	Establish uniform reporting system	4.00	0.55
14.	Inform of the reasons-need	4.00	0.55
15.	Automatic control	3.93	0.62
16.	Conduct program to stimulate and sustain interest	3.86	0.36
17.	Use sophisticated technical innovation	3.71	0.61

Respondents placed the "conduct energy audit" with highest average Likert score, suggests that it is the most important key practices in the implementation phase. May there be internal or external, energy audit can reveals energy performance in a university, and it is recommended to be performed to identify opportunity for improvement. "Communicate to employee" is at the second whereas "promote awareness" is at the third, this suggest respondents felt that it is important to gain support from the employees in saving energy. Both practices are very relevant for no improvement can be expected unless people know what to do and realized how importance of energy saving. There were total of six key practices gained same average Likert score of 4.21, including "conduct energy walk through survey", "all employee involvement", "educate and training of all staff", "establish uniform record keeping system or documentation", "identify energy conservation opportunities", and "perform maintenance". For the key practices automatic control and using sophisticated technical innovation, both of them was ranked as number 15 and 17. The results implied that although using technological approach may seem impressive and attractive, it is not always the favourite solution in energy conservation. Then, key practice "conduct

program to stimulate and sustain interest" was ranked as number 16. The result suggests that the practitioners felt embracing key practices such as "promote awareness" and "motivating" are good enough, key practices such as "conduct program to stimulate and sustain interest" seems to repeat what others key practices have done.

Table 6 shows average Likert scores for 14 key practices in "Monitoring and Evaluation" phase. Standard deviation is ranging from 0.83 to 0.43, indicating scores is near to the mean value.

Table 6. Monitoring and evaluation phase

No	Key Practice	Average Likert Score	Standard Deviation
1.	Conduct energy use and performance analysis	4.64	0.50
2.	Measurement and verification	4.64	0.50
3.	Periodic review and evaluation of overall program	4.50	0.52
4.	Ensure regulations always met	4.50	0.52
5.	Conduct economic analysis	4.43	0.51
6.	Demand control	4.43	0.51
7.	Keeping abreast of latest development	4.43	0.51
8.	Attention the detail of use and costs	4.36	0.74
9.	Perform follow-up tasks	4.29	0.47
10.	Conduct energy management forecasting	4.21	0.43
11.	Tracking and targeting	4.07	0.83
12.	Review of drawing, data sheet, and equipment specification	4.00	0.55
13.	Maintain good relations with other department	4.00	0.68
14.	Advice on energy matters	3.71	0.47

Again, key practices regarding to assessment such as "conduct energy use and performance analysis" and "measurement and verification", is placed at the most significant, both of them gained highest Likert mean score of 4.64. To some extends, this can be attributed to lack of efficient energy performance measurement system in Malaysian universities. For something cannot be measured, it is difficult to be managed. Subsequently, this is followed by "periodic review and evaluation of overall program", suggests that respondents believed evaluation shall be conducted from time to time to monitor programme performance properly. Respondents also show the key practice "ensure regulations always met" is important, for it has been rated as number four, indicating respondent are well aware about the needs to comply with energy legislation, for examples, Efficient Management of Electrical Energy Regulations, Occupational Safety and Health Act, Electricity Supply Act 1990 and other legislation relevant to energy management. Three key practices received same average Likert scores, including "conduct economic analysis", "demand control" and "keeping abreast of latest development". Results shows respondents rank key practices: "review of drawing, data sheet, and equipment specification" and "maintain good relations with other department" at number 13 and 14, implies that it is not the main focus in the monitoring and evaluation phase. Also, respondents rate the key practice: "advise on energy matters" as the lowest, suggest they might found it is not a necessary to gain experts advises on energy management matters.

6. Conclusion

The study has identified a list of energy management key practices for Malaysian universities and ranked according to their average Likert score. We have grouped them into three phases, namely "planning phase", "implementing phase" and "monitoring and evaluation phase". The list is a complement to guide energy coordinators to implement effective energy management system in Malaysian university.

Most of the top ranked energy key practices such as "gain top management commitment", "promote awareness" and "communicate to employee" are intends to gain people involvement in the energy management project. Key practices "budget allocation" which regarding resource gathering and management also have high Likert mean score. For key practices related to measurement and reviews, including "measurement and verification", "periodic review and evaluation of overall program" and "conduct energy audit" also received high Likert mean score. The results shows key practice "establish

energy goals and objectives" is very important for it will drive university to success in energy management and sustainability.

On the other hand, some of the soft energy management key practices such as "develop education plan", "maintain good relationships with other department" and "advise on energy matters" have relatively low Likert mean score. Also, key practices related to technology such as "automatic control" and "use sophisticated technical innovation" have relatively low Likert mean score, these results suggest that technology approach is not always the prior choice in energy conservation.

The survey is somewhat limited, for the sample size is small and it is the summary of opinions towards the importance of predetermined key practices. It is felt that the list of key practices can still be extended through open ended survey. In the future, a focus group study could be done to develop a more updated and comprehensive list of key practices. Also, we feel it is worthwhile to measure the current practices of energy management in Malaysian Universities. Therefore, it is recommended that an assessment matrix to be developed based on the identified list of key practices.

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