THE DEVELOPMENT OF CRITERIA AND INDICATORS IN ENERGY MANAGEMENT OF EDUCATIONAL INSTITUTIONS USING THE ENERGY MANAGEMENT SYSTEM STANDARD

การพัฒนาเกณฑ์และตัวชี้วัดการจัดการด้านพลังงานในสถานศึกษา โดยการประยุกต์ใช้ระบบมาตรฐานการจัดการพลังงาน

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ABSTRACT

Improving energy efficiency in school buildings provides environmental, economical, and educational benefits. It is therefore important for school administrators to achieve energy efficiency through effective energy management. The objectives of this research were to develop the criteria and indicators used as the guidelines for school administrators in energy management and conservation, and to assess their energy performances. In doing so, 12 experts were surveyed for their opinions in energy management and the results were applied to develop the criteria and indicators. A training course was conducted for the representatives of small, medium and large-sized schools and the assessment was conducted by energy auditors from agencies accredited by the ISO 50001. The results were composed of nine criteria and 25 indicators. The assessment results on the efficiency of quality management by the auditors revealed that the energy management efficiency of the three institutions was at a high level and could be incorporated in other projects and their electricity consumption was reduced. The reduction was 35.40 %, 24.17 % and 6.05 % in large, medium and small schools respectively. The satisfaction assessment results of the schools on the implementation of the criteria and indicators were at a high level. From developing the energy management criteria and indicators for the schools to use as a systematic and evaluable guideline, the findings are discussed as the efficiency

evaluation results of the criteria and indicators in the 3 participating schools revealed that electricity consumption decreased, which was in line with the 20–year energy conservation plan, a state policy to reduce electricity consumption and to promote the 30 percent use of renewable energy.

The major role of administrators is for their respective schools to conduct energy management with optimal efficiency. Thus, it is recommended that they implement the PDCA Cycle by collaboratively establishing the practical guidelines, analyzing school's needs, problems and their causes in an attempt to formulate operational strategies, encouraging personnel to share and seek new knowledge related to their performances, and revising and improving their operations. Although operational policies and guidelines have been formulated, changes are perpetual and inevitable due to an annual transfer of administrators as well as non–centralized and non-binding policies. Additionally, the vision of each administrator is different, leading to the policies being non–continual. As a consequence, it is recommended that policies be continuously implemented by schools and personnel be encouraged to seek new knowledge about as well as to have awareness on energy consumption. Furthermore, budget and necessary technology should be allocated and provided to energy management programs for their sustainability. Some schools did not have sufficient equipment for and did not correctly understand energy management. Administrators should promote career advancement on the performance–oriented basis and improve job performances with the acceptance of concerned individuals. Good awareness and values should be cultivated through activities or a routine practical guideline in order to create a state of continuity. Some schools were awarded on energy management, but stopped to practice or improve further. Additionally, some awarding agencies did not follow up on a regular basis.

Keywords: School Energy Management , Criteria and Indicator, Energy Audit, Energy Efficiency

หัวข้อวิทยานิพนธ์ : การพัฒนาเกณฑ์และตัวชี้วัดการจัดการด้านพลังงานในสถานศึกษาโดยการประยุกต์ใช้ระบบมาตรฐานการจัดการพลังงาน

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บทคัดย่อ

การปรับปรุงประสิทธิภาพการใช้พลังงานในอาคารเรียน เพื่อให้เกิดผลกระทบด้านสิ่งแวดล้อมด้านพลังงานโดยให้มีการประหยัด และการศึกษาถึงประโยชน์ในการใช้พลังงาน ผู้บริหารสถานศึกษา จึงจำเป็นต้องมีการบริหารจัดการในใช้พลังงานอย่างมีประสิทธิภาพ การวิจัยครั้งนี้มีวัตถุประสงค์ เพื่อพัฒนาเกณฑ์และตัวชี้วัดที่ใช้เป็นแนวทางสำหรับผู้บริหารสถานศึกษาในการจัดการและอนุรักษ์พลังงาน และเพื่อประเมินประสิทธิภาพการใช้พลังงาน โดยได้มีการสำรวจความคิดเห็นของผู้เชี่ยวชาญในด้านการจัดการพลังงาน 12 คน และทำการคำนวณทางสถิติของความคิดเห็น เพื่อนำไปพัฒนาเกณฑ์และตัวชี้วัด และมีการจัดหลักสูตรฝึกอบรมสำหรับตัวแทนของโรงเรียนขนาดเล็ก ขนาดกลาง และขนาดใหญ่ ซึ่งเป็นตัวแทนของคณะทำงาน ประกอบด้วย ครู บุคลากรและนักเรียน จากนั้น มีการประเมินผลดำเนินการจากผู้ตรวจสอบพลังงานจากหน่วยงานที่ได้รับการรับรองมาตรฐาน ISO 50001 ผลที่ได้จากการวิจัย ประกอบด้วย เกณฑ์ 9 ข้อ และตัวชี้วัด 25 ข้อ ผลการประเมินประสิทธิภาพการจัดการคุณภาพโดยผู้ตรวจสอบ พบว่าประสิทธิภาพการจัดการพลังงานของทั้งสถานศึกษาทั้ง 3 แห่ง อยู่ในระดับสูง และสามารถนำไปต่อยอดโครงการอื่น ๆ ด้านการจัดการพลังงานได้ รวมทั้งมีการใช้ไฟฟ้าในอัตราที่ลดลง คิดเป็นร้อยละ 35.40, 24.17 และ 6.05 ในสถานศึกษาที่เป็นโรงเรียนขนาดใหญ่ ขนาดกลาง และขนาดเล็กตามลำดับ นอกจากนี้ ผลการประเมินความพึงพอใจของตัวแทนสถานศึกษาทั้ง 3 แห่งในการดำเนินการตามเกณฑ์และตัวชี้วัดด้านการจัดการพลังงานโดยเฉลี่ยอยู่ในระดับสูง และจากการ

พัฒนาเกณฑ์และตัวชี้วัดการจัดการพลังงานเพื่อให้สถานศึกษาใช้เป็นแนวทางอย่างเป็นระบบและประเมินผลได้ แสดงให้เห็นว่าผลการประเมินประสิทธิภาพของเกณฑ์และตัวชี้วัดในสถานศึกษาที่เข้าร่วม 3 แห่งนี้ พบว่า ปริมาณการใช้ไฟฟ้าลดลง ซึ่งสอดคล้องกับแผนอนุรักษ์พลังงาน 20 ปี คือ นโยบายรัฐลดการใช้ไฟฟ้าและส่งเสริมการใช้พลังงานหมุนเวียนร้อยละ 30

บทบาทหลักของผู้บริหาร คือ ให้สถานศึกษาของตนดำเนินการจัดการด้านพลังงานได้อย่างมีประสิทธิภาพสูงสุด ดังนั้น จึงควรนำวงจร PDCA มาใช้บริหาร โดยมีการร่วมกันกับคณะทำงาน เพื่อกำหนดแนวทางปฏิบัติ วิเคราะห์ความต้องการ ปัญหาและสาเหตุของสถานศึกษา เพื่อกำหนดกลยุทธ์ในการดำเนินงาน ส่งเสริมให้บุคลากรแบ่งปันและแสวงหาความรู้ใหม่ที่เกี่ยวข้องกับการปฏิบัติงานด้านพลังงาน ตลอดจนแก้ไขและปรับปรุงการดำเนินงานของคณะทำงาน แม้ว่าจะมีการกำหนดนโยบายและแนวปฏิบัติด้านการปฏิบัติงานแล้ว แต่จะต้องมีการปรับเปลี่ยนไปตามการเปลี่ยนแปลงที่อาจจะเกิดขึ้นได้ เนื่องจากการโยกย้ายผู้บริหารประจำปี ทำให้วิสัยทัศน์แตกต่างกันและนโยบายไม่ต่อเนื่องด้วยการเปลี่ยนแปลงของนโยบายที่ถูกกำหนดขึ้นใหม่

ดังนั้น จึงแนะนำให้สถานศึกษาและบุคลากรดำเนินการตามนโยบายอย่างต่อเนื่อง และมีการส่งเสริมการแสวงหาความรู้ใหม่ ๆ รวมทั้งมีความตระหนักในการใช้พลังงาน ควรมีการจัดสรรงบประมาณและเทคโนโลยีที่จำเป็นให้กับโครงการจัดการด้านพลังงาน เพื่อความยั่งยืน ถึงแม้ว่าบางสถานศึกษาไม่มีอุปกรณ์เพียงพอและไม่เข้าใจการจัดการด้านพลังงานอย่างถูกต้อง ผู้บริหารควรส่งเสริมความก้าวหน้าโดยเน้นที่ผลการปฏิบัติงานและปรับปรุงผลการปฏิบัติงานด้วยการยอมรับจากบุคคลที่เกี่ยวข้อง ควรปลูกฝังจิตสำนึกและค่านิยมที่ดีผ่านกิจกรรมหรือแนวทางปฏิบัติที่เป็นกิจวัตรเพื่อสร้างความต่อเนื่อง ซึ่งบางสถานศึกษาเมื่อได้รับรางวัลการจัดการพลังงานแล้วจะหยุดปฏิบัติหรือปรับปรุงเพิ่มเติม หรือไม่ได้มีการติดตามผลเป็นประจำ ทำให้การพัฒนาการจัดการด้านพลังงานของสถานศึกษาหยุดชะงักลง

คำสำคัญ : การจัดการพลังงานของโรงเรียน, เกณฑ์และตัวชี้วัด, การตรวจสอบการใช้พลังงาน ประสิทธิภาพการใช้พลังงาน

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CHAPTER 1

INTRODUCTION

Background and Rationale

Energy consumption crisis is an issue of global concern as energy consumption is increasing in accordance with economic growths, and energy costs are steadily increasing nowadays. Furthermore, there is a tendency that energy is depleting. Most of the energy is derived from fossil fuels in the forms of crude oil, coal, and natural gas. These types of energy are non – renewable and could bring about shortages and great negative impacts on all population sectors. Additionally, energy consumption is a cause of carbon-dioxide production, causing global warming. From the above–mentioned problems, the government issued the 1992 Energy Conservation Act in an attempt to monitor and promote efficient use of energy in buildings and factories, as well as to use energy for optimal benefits and to cultivate awareness in personnel. Individuals in charge of energy have been appointed and an energy management system has been formulated (Announcement of Energy Ministry, 2009). The system is similar to the ISO 50001 regulations, except the latter having more practical details. Moreover, renewable energy has been used to alleviate energy crisis problems. However, using renewable energy *per se* has not been the solution to the problems. It is thus imperative to collectively reduce energy consumption, which is a way to decrease energy costs. For this to be sustainable, the practice must be systematic.

Electricity consumption rates in school buildings in 2014 were steadily increasing to 6 % (1,120 gigawatt hours) of the electricity consumption volumes in the industry sector at 18,374 gigawatt hours, an increase of 2.4 % (Office of Energy Policy and Planning, 2014). From the projection of the Ministry of Energy to formulate a 20–year energy conservation plan (2011 – 2030), it was revealed that, in 2030, if economic structures and energy needs were unchanged, school buildings are projected to require energy use as high as 12,947 gigawatt hours, the highest of all,

followed by office buildings (11,211 gigawatt hours) and shopping malls (8,466 gigawatt hours) (Ministry of Energy, 2014). This is indicated that energy saving efficiency in school buildings has been relatively low, while, in the industry sector, electricity consumption rate was 73,782 gigawatt hours, increasing just 1.7 % from the previous year (Office of Energy Policy and Planning, 2014). This was because of better energy control and management measures, e.g., legal controls and regulations or accreditation of energy management system (ISO 50001) for commercial benefits (Ministry of Industry, 2012).

From the above – mentioned energy problems, various state and private agencies as well as students have been made aware of the crisis of energy shortages in the future. School buildings have consumed electricity at a relatively high level. It is thus imperative to implement energy management system guidelines by using simple but efficient indicators and criteria. Energy management and control should be assessable. Additionally, an analysis on electrical leakages and wasteful expenditure should be conducted, and electricity consumption behavior of school personnel should be changed for optimal cost – effectiveness and efficiency. Another important reason is that the changes would be a model to understand and learn about energy consumption, to raise awareness on reasonable electricity saving for students and educational personnel.

From the national energy strategies, Ministry of Energy has issued the 4.0 energy goals to alleviate and develop more cost – effective and efficient energy consumption by integrating clean energy consumption with environmental conservation for energy saving, cost – effectiveness without negative environmental impacts in order to alleviate the quality of public life. The core of the 4.0 energy policy is to save the energy as much as possible (Ministry of Energy, 2017). Moreover, the ministry has formulated the 2018 – 2037 alternative and renewable energy development plan with an aim to increase the ratio of the energy use in the forms of electrical, thermal and biomass energy to the ultimate energy consumption at 30 % in 2037. The plan is also meant to cultivate better understanding and awareness on renewable energy by improving the potential of personnel on renewable energy production and by creating collective understanding and collaboration at the community level. This attempt is expected to reduce energy import, strengthen community energy security, and create

new knowledge that could lead to research and development on energy technology, as well as to reduce global warming and to increase sustainable environmental conservation (Department of Alternative Energy Development and Efficiency, 2020).

Most schools have carried out practices that are in line with energy conservation programs by using energy conservation devices, launching campaigns and cultivating awareness on energy conservation into teaching and learning processes. However, what needs to be fulfilled is continuous inspection, monitoring, assessment, and development in order to achieve sustainable conservation. If a school has implemented these practical guidelines, the operation will be systematic and complete, making activities suitable for the school contexts. Energy consumption with incorrect management may be derived from unclear energy management policies and goals as well as a lack of inadequate training on energy management for personnel. These may bring about weak awareness on energy consumption for optimal efficiency. If the inspection and/or monitoring is not on a regular basis, energy management efficiency will not be fully developed.

The Ministry of Education has thus formulated six strategies in response to the 4.0 national strategies. Section 5 states about the growth of environmentally friendly life quality which is related to energy conservation. As a consequence, announcements on energy conservation policies, measures, and practices have been formulated and issued for schools. Some schools have undertaken more than what the announcements require by promoting and enhancing energy efficiency by installing technologies and innovations in school buildings, such as solar cells. It is indicated that efficiency of energy saving in school buildings has not been at a high level (Ratha, 2003). Therefore, it is recommended that there be the guidelines for an energy management system with simple, efficient and assessable criteria and indicators for energy control and management. Additionally, an analysis on wasteful energy consumption and behavioral changes of school personnel and students should be conducted for cost – effective and optimally efficient energy consumption. Another significant reason is that the practices could be a model for society to understand and learn as well as to cultivate awareness on electricity saving among school personnel and students. Furthermore, there has been collaboration between Ministry of Energy and Ministry of Education to integrate energy

knowledge into classroom learning and teaching in the energy in educational institution courses (Office of the Permanent Secretary, 2017).

For successful and sustainable energy management mechanisms, it is imperative to consider efficiency and effectiveness of energy consumption. The implementation of carefully revised energy management criteria could lead to continuous improvement of efficacy, efficiency and conservation of energy as well as energy provision, assessment, reporting, purchase, and practical designs of equipment use. This includes energy consumption process and system in this research with the ISO 50001 standard indicators and criteria as well as the criteria for energy competition projects in order for them to be suitable for schools, reduce complexity and ease of implementation, so that they could become a foundation for other projects concerning with energy management. However, there must be strong determination with administrators issuing clear policies and goals as well as providing full personnel and budgetary support in an attempt to efficiently reduce energy costs. It is also expected to bring about energy conservation and reduction of greenhouse gas emission and environmental impacts.

Research Objectives

1. To investigate and develop the criteria and indicators used as the quality management guidelines on energy management and conservation in schools.
2. To assess the operation results after the implementation of the criteria and indicators as well as the satisfaction with the criteria and indicators of the schools.
3. To propose a policy to encourage the schools to implement the criteria and indicators.

Expected Results

1. The appropriate and efficient criteria and indicators for school implementation are constructed.
2. School operation achievement and the criteria and indicator development achievement are realized.
3. Opinions on energy management systems of the participating schools are obtained and they could be used to revise and improve the criteria and indicators.

4. Knowledge on energy conservation is formulated and energy conservation attempts of schools are promoted.

Research Scope

In this research, the researcher used examining and developing the criteria and indicators for use as a guideline for quality management of energy management to promote energy conservation in educational institutions. This is a documentary research on energy management criteria and related articles and concepts. The findings were applied to create the questions in the questionnaire for developing the criteria and indicators. After that, school operations were assessed with the following scope.

Scope of population and sample group

1. There were 12 informants for developing the criteria and indicators, consisting of three experts from agencies with the ISO 50001 accreditation, three experts from Ministry of Energy, and six representatives from the three schools (each with two representatives) which used to participate in the Energy Mind Awards competition. The congregating opinions from 12 experts through the iterative questionnaires for 3 rounds in order to find their consensus of energy management criteria and indicators. An interview was used for the first round and the questionnaire was administered for the second and third rounds. The questionnaire was assessed for its index of item – objective congruence (IOC). The IOC was used to find the content validity from 3 experts prior to the survey being conducted. The acceptable value of IOC for each questionnaire question was between 0.67 – 1.00. In this process, the experts were asked to respond to the questionnaire several times and, each time, their answers were considered as the feedbacks. The data were analyzed for mean, median, and standard deviation. To accept the consensus of the 12 experts, the mean must be more than 3.50, the median must be ≥ 4, and the standard deviation must be ≤ 1.25.

2. Three schools were selected to assess their operation achievements, divided into one small – sized, one medium – sized, and one large – sized.

3. The school informants were six individuals (two from each school) who were in charge of school energy management.

4. Three school assessment committee members were selected, who were specialized in energy management system accreditation with an aim to assess school energy management operations according to the criteria and indicators.

5. Eighteen respondents (six from each school) were selected to answer the satisfaction questionnaire. They were school administrators and/or teachers in charge of school energy management.

Scope of contents

An investigation on the criteria and indicators of the ISO 50001, Thailand Energy Awards, Energy Mind Awards, and policies of the Ministry of Energy (Green buildings, energy saving buildings) was conducted in order to develop the criteria and indicators for implementing in the schools.

Scope of time

The development and implementation of the criteria and indicators took one year based on the reference of energy management standards, information about energy management and standards, relevant laws and policies, and criteria of the project competition. Questionnaires were used to collect the data for further analysis was applied to process, assess and summarize the study results.

Scope of place

The research was conducted in Bangkok with three schools in the service areas under the Office of the Basic Education Commission. Each school has different physical locations, environment, community neighborhoods, and limitations in the operations of energy management, for instance, budget, readiness of personnel, or building designs and aspects. This was to obtain the data and assessment results from the sample groups that represented small, medium and large – sized schools, so that the results could be properly applied in other schools in accordance with national energy management policies and plans.

Definition of Operational Terms

Criteria refer to the constructed five – point rating standard to assess energy management achievements of the schools and the acceptable standard scores are average at 3.5.

Indicators refer to the entities showing the operational results based on nine aspects of energy management criteria, consisting of administrators; personnel; administration; purchase, provision and procurement; communication; inspection, testing, assessment and follow up; correction and prevention; social and community responsibility; and participation.

Energy management system is the international energy management system (ISO 50001) for schools to continuously and systematically improve their energy capabilities in an attempt to reduce their energy costs and emission of greenhouse gases that are detrimental to the environment.

Energy management standards refer to the constructed standards based on the ISO 50001 and the criteria of the Energy Mind and TEA Awards in order to formulate the practical guidelines on school energy management.

Office of the Basic Education Commission (OBEC) refers to the Secretariat Office of OBEC under the supervision of the Office of the Permanent Secretary of the Ministry of Education in charge of basic educational management from pre – school to high school levels. There are regional coordination centers nationwide and secondary schools are under their supervision catering educational services from Mathayom Suksa 1 to 6. The size of the schools is based on the number of students based on the school size criteria of OBEC.

Educational institutions are legal agencies with the aim or in charge of educational management in both state and private sectors, such as, schools, colleges, universities, or other educational agencies. They are divided into three sizes.

Large educational institutions refer to secondary schools under OBEC in Bangkok with the number of students from 1,500 to 2,499.

Medium educational institutions refer to secondary schools under OBEC in Bangkok with the number of students from 500 to 1,499.

Small educational institutions refer to secondary schools under OBEC in Bangkok with the number of students from 1 to 499.

School representatives refer to main personnel or leaders involved in school energy management.

Experts refer to professionals specialized in the core contents of the energy management standards and their efficient implementation from planning, preparation

to formulation of practical guidelines which could be applied to both technical and technological activities in accordance with energy objectives and goals. They must be representatives from ISO 50001 – accredited agencies, specialists from Ministry of Energy, and representatives from schools having participated in the Energy Mind Awards.

Conceptual Framework

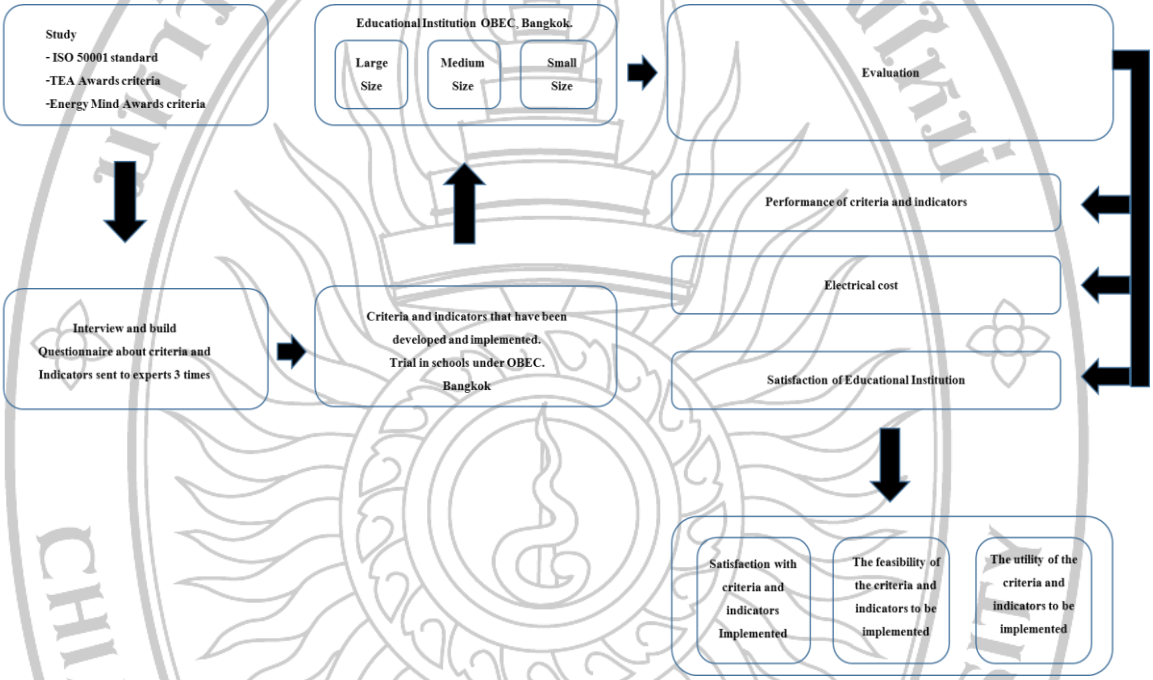

Figure 1.1 Conceptual Framework

CHAPTER 2

LITERATURE REVIEW

The electricity consumption in educational institutions tends to increase continuously (Office of Energy Policy and Planning, 2014). It is found that the education institutions have expanded their school buildings and added more facilities. Some school buildings are in the Control Building Act, while others have not had energy consumption control or energy conservation. This research was conducted to formulate the criteria and indicators which are suitable for educational institutions. As a consequence, concepts and theories about energy management as well as related literature are reviewed as follows.

1. Domestic and international energy situations
2. Policies of the Ministry of Energy
3. ISO 50001: 2018
4. Concept about school energy management system
5. Criteria for school energy management project competition
6. Concepts and theories about school energy management and behavior for sustainability
7. Related Studies

Domestic and International Energy Situations

Domestic situations

At present, population growth has been increasing exponentially, with the expansion of living space and urbanization that influence economic, social, and industrial development relentlessly. The production of goods has changed from household level to industrial level in order to catch up with rising demands of the population, making transportation to play a major role. Furthermore, it affects the use of natural energy for some activities. For example, apart from living, energy can

facilitate humans in terms of transportation, industry, and agriculture. Commercial and residential buildings also make use of energy especially electricity energy. The use of energy to conduct human activities has a tendency to increase continually from the past to the future. The highest demand is crude oil, followed by coal which is a cheap and huge source of energy. Energy from fossil fuel is considered as an important source of energy, such as, crude oil, coal, and natural gas. They are essential for humans these days and are going to be needed in the future.

Thailand's energy consumption in 2015

Oil. The amount of oil used was 33,067 thousand tons of oil equivalent to a 3 % increase from the previous year or 57.6 % of all commercial energy consumption. It was used for transportation the most (70.8 %), followed by agriculture (11.1 %), manufacture industry (8.3 %), residence (6.1), commercial businesses (3.3 %), and construction (0.4 %).

Natural gas. The amount of natural gas used was 4,485 thousand tons compared to crude oil equivalent to 508 million standard cubic feet per day. It increased 19.0 % from the previous year or 7.8 % of all commercial energy consumption. It was used for manufacture industry the most (54.6 %), and the rest (45.4 %) was used for transportation and commercial businesses.

Coal. The amount of coal used was 7,201 thousand tons compared to crude oil equivalent to a 12.6 % decrease from the previous year or 12.5 % of all commercial energy consumption. Coal was all used for manufacture industry.

Electricity. The amount of electricity used was 12,671 thousand tons compared to crude oil equivalent to a 4.2 % decrease from the previous year or 22.1% of all commercial energy consumption. It was used for industry the most (41.8%), followed by commercial businesses (34.9 %), residence (22.1%), and others (1.2%) respectively.

It could be seen that energy is needed for various aspects in Thailand as well as other countries. Energy used in Thailand comes from various sources. Most of them are from nature and could be exhaustible. The more population increases, the higher demand for energy consumption would be likewise. The majority of energy in Thailand is utilized for industry and transportation. People's lives are all involved with

transportation which comes from natural energy (Department of Alternative Energy Development and Efficiency, 2015).

International energy situations

US Energy Information Administration (EIA) released International Energy Outlook Report 2017, which projected that the world would use 28 % more energy from 2015 to 2040. The report showed energy consumption prediction of sixteen regions all over the world. They could be divided into two groups which were Organization for Economic Cooperation and Development (OECD) member countries and non–member countries. OECD non–member countries (developing countries, e.g., India and China) had used 84 % more energy of all the increasing energy consumption of the world. Asia continent had the most rising demand of energy consumption. Natural gas would have had the most growing demand until 2040, an increase of 43 %, while the demand of petroleum and other liquid fuel would be increasing to 18 %. The demand for coal had still been steady, approximately 160,000 trillion BTU. The demand of coal decreased in China, but it increased in India.

Renewable energy

Renewable energy (water, wind, solar, or geothermal) is the energy resource which has the greatest growing demand. Wind, sunlight, and natural gas are all together the energy resources used to produce electricity the most. In 2040, renewable energy is expected to be an equal proportion as coal at 31 %. Furthermore, of all the renewable energy, water energy will be the biggest resource of electricity production at 53 %. In 2040, the world will use energy from fossil fuel (petroleum and other liquid fuel, natural gas, and coal) and nuclear the most at 83 %. Additionally, renewable energy (wind, solar, water and geothermal) would be used at 9 % and 8 % respectively (Electricity Generating Authority of Thailand, 2018).

Energy consumption in buildings

Thailand has the production capability measured from gross domestic products which can earn about five thousand trillion baht per year. Expansion rate is at 5 – 6 %. Approximately 63 million of the population need to spend around nine hundred billion baht per year for energy consumption. Of this energy demand, it is the demand for electric energy at 1,800 kWh per person and its rate is increasing at 6 to 8 %. Energy has to be imported around five to six hundred billion baht per year. Moreover,

the expansion rate of energy demand is increasing to 14 % which is considered as the highest expansion rate of energy demand in Asia. Agricultural products can be exported just only around three thousand to three thousand and five hundred million baht per year. Furthermore, Thailand relies on energy from other countries for 70 %, and cannot find energy resources which have high potential enough to produce energy. The energy reserves most discovered in Thailand is only 2,188 million barrels, while Thai people need to use natural gas for 147 million barrels. This natural gas can be utilized for less than 15 years which may cause energy crisis to the country, so it is necessary for Thai people to have awareness and consciousness on using energy (Department of Alternative Energy Development and Efficiency, 2006). In 2007, the highest demand for electricity in the country was on April 27, 2007 which was equal to 22,586.1 MW. It is higher than the highest demand for electricity in 2006 which was 1,522.1 MW or a 7.22 % increase. The electricity needs during eleven months (January – November) was equal to 134,873.8 million units increasing from the same period in 2006 to 3,987.2 million units or a 3.05 % increase. Power generation capacity in Thailand at the end of November, 2007 was 28,530.3 MW in total (Electricity Generating Authority of Thailand, 2007). According to the 2006 Provincial Electricity Authority's annual report, it was founded that the authority distributed electric power at 83,203.0 million units, higher than the previous year for 5,089.3 million units or a 6.5 % increase. It can be divided into several types of power distribution unit including residence at 17,762.2 million units or 21.4 %, businesses at 59,516.0 million units or 71.5 %, and others at 5,924.8 million units or 7.1 % (Provincial Electricity Authority, 2006).

Policies of the Ministry of Energy

The issue of energy to meet increasing demand reflects the fact that energy consumption is a global issue due to an increase in energy consumption, economic growth, and rising energy production costs. There is a tendency that energy volumes are dwindling, which may bring about energy shortages that greatly affect all sectors of the population. Energy security has become a warning sign for policy makers of leading production and exporting countries. It is thus imperative to establish collaboration among domestic and international state and private sectors in an attempt to assist and

strengthen energy security (Phanjit, 2016). As a consequence, the Ministry of Energy has formulated energy management policies by examining and collecting the data from the following sources.

The 20–year energy conservation plan (2015 – 2036)

The ministry has issued the building standard criteria in order to implement ministerial regulations to specify building types or sizes and design methods for energy conservation (2009 Building Energy Code: BEC) for new buildings with an area of over 2,000 square meters. Currently, the regulations can still not be fully enforced because they have not been approved by the Building Control Commission. During this waiting period, the regulations are being piloted for new buildings of state and state enterprise sectors by requesting their cooperation for their new buildings to pass the energy conservation standards. The Budget Bureau has implemented these standards for building budget approval since 2013. The incentives to promote building images include issuing an energy conservation building seal, granting loans with low interest rates, encouraging the use of highly efficient equipment, and promoting new buildings to be certified from international standards like LEED or TREES of the Thai Green Building Institute. If the operation is carried out according to the 20–year energy conservation plan, it is expected that over 1,166 Ktoe could be saved in 2036.

Relevant laws

The 1932 Energy Conservation Promotion Act took effect on April 2, 1992. The target is controlled buildings and factories with efficient energy consumption and systematic energy conservation. Therefore, business owners and administrators are required to be aware of their responsibilities, practical steps, and state – sponsored services in order for them to abide by the laws.

Using energy in machinery or devices and their quality for energy conservation instead of officers in order to catch up with socio – economic changes.

The 2007 Energy Conservation Promotion Act (2nd edition) was issued and enforced. The act was announced in the Royal Gazette on December 4, 2007 and was effective on June 1, 2008 (Energy Conservation Promotion Act, 2007).

Controlled buildings or factories are those which are obliged to implement energy conservation regulations stated in the 1992 Energy Conservation Promotion Act. They must have one of the following aspects:

1. Those approved by energy distributors to use one or more electricity generators with the capacity of 1,000 kilowatts or 1,175 kilowatt amperes and over, *or*

2. Those using the electricity systems from thermal energy or non–renewable energy distributors or oneself with the total electricity capacity of over 20 million megajoule.

Energy consumption and management guidelines. The 2011 renewable energy report of the Department of Alternative Energy Development and Efficiency revealed that Thailand has paid more attention to renewable energy due to having a clear renewable energy policy. Furthermore, community energy development has been promoted, making all sectors to pay more attention to renewable energy. In addition, the country wants to reduce the use of fossil fuels in order to decrease environmental problems and more expensive fuel import.

Investment in renewable energy

There has been a drive to use renewable energy on a continuous basis from the state. It was revealed in 2011 that renewable energy investment from the state and private sectors was worth 44,936 million baht. The investment in solar energy was the highest at 24,472 million baht, followed by 13,901 million baht in biomass energy, 3,757 million baht in bio–gas, 2,264 million baht in waste energy, 330 million baht in hydro–energy, 139 million baht in wind energy, and 73 million baht in bio–fuel respectively (Department of Alternative Energy Development and Efficiency, 2011).

For the alternative and renewable energy plan to become successful, the department has formulated six issues of the alternative and renewable energy promotion strategies as follows.

1. Encouraging communities to participate in renewable energy production and consumption widely

2. Adjusting incentive measures for private investors in accordance with circumstances

3. Amending laws and regulations that are impeding renewable energy development

4. Improving the infrastructure system, e.g., distributing cable systems and development of smart grid

5. Publicizing and raising awareness and knowledge of the public

6. Promoting the research as a tool for developing a complete renewable energy industry

The focus of the drive is on solar, wind, hydro, waste and biomass energies. Other less untapped renewable energy sources are geothermal, wave and current, and hydrogen. Furthermore, the public are encouraged to participate in energy production and knowledge should be provided to them in order for energy sustainability in the community (Ministry of Energy, 2011).

Energy saving and conservation

Due to rapidly increasing demands for energy as a result of population growth and rapid technological and economic development, it is crucial to consume energy most efficiently and cost–effectively. Thus, energy saving and conservation must be carried out by producing and using energy efficiently. Apart from reducing energy consumption, conservation can reduce environmental problems derived from energy production and consumption sources.

The principles of energy conservation consist of changing energy consumption behaviors with efficiency and more conservation, accelerating electricity management promotion and adjusting the roles of concerned organizations, improving and amending relevant laws and regulations to promote efficient use of energy, improving the traffic and transportation systems to save energy and reduce pollution problems, promoting the research and development on energy conservation and production technology, increasing the efficiency of energy production and consumption, and reducing energy losses in the steps of energy consumption (Onphlee, 2011).

Energy saving and green buildings

Green buildings are those constructed by using natural resources efficiently and cost–effectively with social and environmental responsibilities throughout the life cycle of the buildings. It involves the steps of location selection, design, construction, care, maintenance, and destruction. The ultimate goal is to reduce the impacts of built environment that may affect human health and natural environment. The assessment criteria are the Leadership in Energy & Environmental Design (LEED) by the U.S. Green Building Council. The criteria are the Thai's Rating of Energy and Environmental Sustainability (TREES) by Thailand Green Building Institute,

which certified energy saving and environmentally friendly buildings with a focus on new buildings or buildings with major renovations.

The focus of green buildings is on three aspects: efficiency of water, energy and natural resource consumption, health protection and promotion of working abilities of people in buildings, and reduction of waste, pollution and environmental destruction. Currently, there are four awards of green buildings: certified, silver, gold, and platinum. Nowadays, almost all buildings aim to become green buildings, because it is a sustainable investment since such buildings are able to save more energy and are environmentally friendly (Thai Green Building Institute, 2015).

ISO 50001: 2018

In the current national and global circumstances, energy and climate change problems are important and related. Energy is an important basic factor in response to the basic needs of the public as well as the business and industry sectors. However, energy consumption has affected the environment and is a root cause of climate change. In the past, it was revealed that most entrepreneurs focused on technical improvement and technological exploitation, but there was discontinuity of the implementation. That is, there is a lack of continuous improvement mechanisms and clear strategies on energy management plans, resulting in the operations being not so successful. The Department of Alternative Energy Development and Efficiency, which is in charge of supervising–controlled buildings and factories, perceived the importance in updating and modernizing the operational processes of energy conservation. The department thus issued the second edition of the 2007 Energy Conservation and Promotion Act with the focus on energy management implementation. The guidelines were formulated based on the energy management standards, criteria and methods for controlled buildings and factories in 2009. Eight energy management steps are specified for these buildings and factories, which are able to be developed for the ISO 50001 certification. Therefore, the certification is regarded as an important step to drive the energy improvement process on a regular basis, based on the PDCA cycle. This attempt could bring about continuous energy potential improvement, changes of corporate culture, and systematic and efficient improvement of personnel. Apart from a long-term reduction of energy costs,

it could lessen the impact of trade barriers from Western countries as well as climate change and global warming.

ISO stands for International Organization for Standardization. It was founded in 1947 with its headquarters in Geneva, Switzerland. The aim is to promote international standardization and related activities in order to develop industries and economies, to eliminate trade barriers, and to promote international collaboration on academics, sciences, and technology. If an organization is certified with the ISO standard, it means that its products, services or management systems are acceptable at the international standards. The standards cover quality management, environmental management, or energy management.

ISO 50001 specifies terms for organizations to implement, maintain and improve their energy management systems in order to improve the capability, efficiency, manners and volumes of energy consumption. They can be adopted for documentation, report, inspection, design, energy–related appliance purchase, personnel in charge of energy management, and factors affecting energy capacity that can be monitored by the organizations.

The standard also emphasizes a documentation system for organizations to formulate, implement and maintain. The documents include an energy management manual, a procedure manual, work instructions, and other forms to record energy management activities (Office of the National Policy Commission, 2009).

Terms of the ISO 50001

There must be the boundary and scope of energy management system suitable for an organization. The executives appoint energy management representatives, and the representatives select a working committee. After that, the organization plan, do, check and act accordingly with the following details (ISO 50001: 2018, 2018).

1. Plan. Energy consumption data are inspected and analyzed for a significant energy use of an organization, energy baseline, energy performance indicators, and energy performance. This is to indicate an opportunity to improve energy performance of an organization by formulating objectives, goals, and energy operation plans in accordance with energy policies, laws, and relevant regulations.

2. Do. This is the implementation of the operation plans that cover other aspects to facilitate sustainable energy management systems. They include competence training and awareness, internal and external and machinery design and purchase.

3. Check. This is a monitoring process to ensure that the system is in existence and in a good performance. A monitoring and follow–up plan should be formulated to inspect energy performance and achievement of objectives and goals by using reliable and valid assessment instruments. Additionally, internal audit should be carried out on an annual basis to prevent and correct any problems or shortcomings.

4. Act. Organizational administration must be revised annually by executives to ensure continuous improvement and development of the energy management system.

Concept about School Energy Management System

Circumstances of energy consumption in schools

Educational institutions are one of the sectors that consume large volumes of energy. Due to increasing temperatures, air–conditioners have been installed in offices and classrooms for comfort during instructional periods. Over 60 % of the electricity is for the air–conditioning system and about 15 – 20 % is for classroom instruction and offices. Large–sized schools have used electricity over the legal limits. Schools are categorized as controlled buildings and are required to manage electricity use more efficiently in order to reduce imported energy and monthly electricity bills (Namhomchain, 2017).

Administration of green schools

The establishment of the green classroom by the Electricity Generating Authoring of Thailand is a milestone of collaboration to develop learning and teaching activities in primary and secondary schools. The aim is to cultivate energy saving and environmental conservation habits in students by doing it by themselves in order to cultivate an attitude toward efficient electricity consumption. The green classrooms were alleviated into the green schools in an attempt to create an energy and environmental conservation network as well as to expand the idea to other schools and communities. It is to encourage schools to carry out energy saving activities continuously as well as to permanently cultivate such attitude and habits in the future.

This concept will be expanded to schools in the new age of the Ministry of Education, that is, a good *tambon* school with an emphasis on green environment and congruence with community lifestyle. If possible, it would be an important part in collectively conserving the environment, promoting energy–saving community lifestyle, and designating communities as a learning resource. The new age classrooms and schools are expected to be prepared for important changes of the learning process in an attempt for students to become developed in all aspects and manners (Metropolitan Electricity Authority, 2015).

Eco–schools

Eco–schools are aimed at promoting the environmental study process of schools, which are another step of the provincial environmental study center project (1995 – 2005). It is the second phase of center for educational management for sustainable development with a focus on the whole school approach as a driving force. It starts from school policies, learning management with local issues, school environment management to collaboration. Others, such as, school personnel being able to participate in activities of the department and its networks at the national and ASEAN levels.

Criteria for School Energy Management Project Competition

The criteria for the Thailand Energy Award and Energy Mind Award are applied to judge energy conservation project competitions initiated by the Department of Alternative Energy Development and Efficiency for the business/industry sectors to implement in order to conserve and develop energy of the organization. Personnel at all levels in any organization are encouraged to participate in order to raise their awareness on energy conservation and development of alternative/renewable energy. The complete criteria are divided into five aspects, but this investigation focuses on those for educational institutions.

Competition criteria for the Energy Mind Award

The Metropolitan Electricity Authority, in collaboration with Mahidol University and the Environmental Quality Development Association, initiated the Energy Mind Award. The objective of the award is to promote and support the schools under the service areas of the authority in Bangkok, Samut Prakan, and Nonthaburi

provinces to concretely and sustainably carry out environmental and energy conservation work by taking into consideration cost–effective energy consumption in order to conserve the environment. This could increase school capabilities to cultivate awareness on environmental and energy conservation in their students as well as to promote school participation in environmental conservation by using energy effectively and reducing wastes in the environment. This could create a model school for conservation by integrating the conservation into the school administration system. Educational personnel are selected for the Energy Master Award and student leaders for the Young Master Award. They are expected to play an important role in driving the conservation in their respective schools (Environmental Development Association, 2015).

The creation of the environmentally friendly learning process and life skills in all social sectors, particularly among the youths, is a mission that the country and society wish to see it to become reality by cultivating the awareness in the youths and students through classroom instruction and extracurricular activities. There have been attempts to integrate the conservation contents into eight learning strands or local curricula or learners' development activities. Nevertheless, the follow–up of these attempts revealed that the cultivation achievement was still far from the target. In general, most of them did not perceive the importance of what was learned and there did not exist the conservation awareness in them.

Therefore, the competition criteria are used for scoring environmental and energy conservation projects. They are also utilized for specifying, developing and inspecting the standard of energy consumption management/operations of participating schools in order to confer them e–mind certificates (1 – 5 levels) according to their performances with the standard creation process for outstanding energy school projects. Participating schools would have an opportunity to learn and practice resource and energy conservation systematically and integratively. Students and personnel would be able to learn about the conservation and participate in activities simultaneously.

Green School Standard

The Electricity Generating Authority of Thailand (EGAT) has initiated the Green Learning Room Project for schools nationwide since 1998. The main objective is to cultivate the youths on efficient electricity consumption and environmental

conservation through the green classroom instruction process and extracurricular activities until the habit is formed and the results are expanded to families and communities. Currently, there are 414 schools nationwide participating in the project. This is to expand the operation results to school's environmental and energy conservation management by encouraging schools to integrate the conservation knowledge into instruction and school management. To assess and monitor performances of the participating schools, EGAT has raised the project onto the Green School Project in an attempt to establish an energy conservation network with the Office of Basic Education Commission, Ministry of Education. The conservation performances of the schools are assessed to formulate a guideline for other schools to implement (Metropolitan Electricity Authority, 2015).

A comparison of the energy management standard and the competition criteria was conducted in order to incorporate them into the criterial and indicators for schools, as shown in Table 2.1.

Table 2.1 Comparison of the energy management standard and the competition criteria

PDCA	ISO 50001	Thailand Energy Award	Energy Mind Award
Plan	- Preliminary assessment of contexts to formulate an energy management system - Responsibilities of executives - Policy formulation - Reference energy database - Related laws and terms - Formulation of objectives, goals and plans	- Academic and technological support and promotion - Responsibilities of executives - Policy formulation - Formulation of objectives, goals and plans	- Responsibilities of executives - Policy formulation - Formulation of plans & projects - Formulation of building data - Formulation of data on electricity meters & consumption

Table 2.1 (Cont.)

PDCA	ISO 50001	Thailand Energy Award	Energy Mind Award
Do	- Ability, training & awareness - Communication - Documentation - Operational control - Building design - Equipment purchase and procurement - Implementation of plans	- Activity promotion & support - Training - Media construction, public relations - School activities - Extracurricular activity	- School participation promotion - Expansion of energy projects - Energy consumption management - Electrical appliance purchase and procurement
Check	- Assessment inspection & analysis - Assessment of terms and legal congruence - Assessment of energy management system - Monitoring and record - Incongruence, correction & prevention	- Assessment of indicators in the competition criteria	
Act	Revision by administrators		

Source : ISO 50001 Energy management system requirements with guidance for use (2018), Department of Alternative Energy Development and Efficiency (2015)

Concepts and Theories about School Energy Management and Behavior for Sustainability

Management is defined as efficient operations and performances. Energy management is efficient energy production and consumption with optimal benefits. In reality, the industry sector has a better and more efficient energy management than communities and localities, because it has a clear policy framework and operation plans, with individuals correctly understanding energy management in accordance with practices of such an industry. For sustainable energy management according to the Sufficiency Economy Philosophy, the management should be at the local and community levels. This is because energy use at the household and community levels is fundamental to the cultivation of awareness on and attitude toward energy consumption according to the philosophy. Energy planning at the community level could facilitate energy saving and conservation. Additionally, local and community management is a narrow one, enabling them to perceive the overall problems and planning. The major aim of energy management is to reduce expenditure and increase benefits and service quality. It is also to improve a working condition, promote the conservation behavior and local participation, and reduce negative impacts on the environment and health (Kraiyapak, 2010).

Three important principles of energy management are energy purchase at the lowest price, maximal use of energy, and most appropriate technological exploitation and control (Rithikroekrai, 2003). Good energy management should be as follows.

1. Energy policy. This is to make energy management policy successful in order to express real intentions.

2. Energy management structure. This is to clearly specify energy responsibilities.

3. Investment and investment sources. There are three levels of energy management investment: without investment, low investment, and high investment. Investment and investment sources could contribute to efficient management.

For sustainable energy management with the integration of the Sufficiency Economy Philosophy, it is required to know how much and whether local resources are sufficient for self–reliant energy production. It must be taken into consideration local potential, appropriateness and wisdom to support the attempt. If the community is able

to produce small–scale energy for use with responsible individuals and member participation, it will make energy planning, management and conservation efficiently. If community energy is self–sufficient, the country can save the costs of the cable system construction, reduce fuel technology import for energy production, and bring about sustainable energy production that would result in economic stability and energy security (Rithikroekrai, 2003).

From Figure 1.1, the conceptual framework was based on related theories and literature in connection with the development of the criteria and indicators for educational institutions. The results were integrated into the preliminary data for the survey and interview in order to construct the questionnaire. The instruments were implemented in the three schools. The assessment was conducted based on the quality management guidelines on school energy management according to the criteria and indicators. Satisfaction on the implementation of the criteria and indicators was also evaluated. Additionally, a policy would be proposed as a result expansion for schools to put the criteria and indicators into practice.

Related Studies

This section focuses on previous related studies on energy conservation and management in order to formulate the guidelines, criteria and indicators in this study.

Niloh (2012) examined and compared the congruence of the terms between energy management ministerial regulations, standards, criteria and methods in controlled buildings and factories and the ISO 50001: 2011. It was revealed that the principles and objectives are the same, which is to reduce the volumes of energy consumption. Some of those of the ISO 50001 were enforced to organizations for efficient use of energy. The focus was to collect the data on energy management measures, so that they could be implemented more easily and conveniently. However, those of the ISO 50001 were more complete because they were more systematic, with planning, implementation, inspection, and follow up.

Khanmeesri (2021) investigated three large private controlled buildings by applying the terms and steps of the ISO 50001 in order to compare operational restrictions and difficulties that might affect the energy management system of controlled buildings based on the 1992 Act. It was found that the implementation was

still problematic and needed to be improved. However, the standards were developed according to the PDCA cycle.

Saichumdee (2013) described relatively high energy consumption of frozen seafood industry for export, which required the temperatures of –60 to –80 degrees Celsius. Additionally, the production process by boiling and steaming required high temperatures. It was therefore to apply the ISO 50001 energy management system to the industry for efficient energy consumption. It was expected that the practice would be implemented in other industries in an attempt to reduce energy import and to conserve national energy.

Willaert (2014) examined the application for ISO 50001 certification and tax exemption. Aside from saving energy, expenditure for energy use can be reduced. Appropriate measures could accelerate continuous improvement and efficiency of energy consumption. In the initial stage, about 20 – 25 % were certified but efficient responses to technological and appliance investment increased. The certification has various advantages and governments reward monetary incentives to organizations with efficient energy management systems.

Pakbin (2014) investigate the ISO 50001 certification of the food industry and it was found that efficient energy use took place during the production process by incorporating the PDCA cycle. Pepsi Co., was the first company to implement the ISO 50001 standard.

Amatawanit & Wirunrat (2017) investigated the criteria for renewable energy projects and the overview of the Thailand Energy Awards. It was revealed that international criteria were used to consider such projects and more projects were submitted for consideration every year. Nevertheless, during the past five years, fewer projects were awarded. Further investigation revealed that sources of energy production and marketing, economic and technical criteria should not be in the same category. Additionally, project data were not complete due to the misunderstanding that they were confidential to organizations. Preparation time was insufficient, resulting in incomplete data. Access to the project was not wide because of inadequate public relations. Finally, more rewards should be given to innovative alternative energy development to boost motivation on national alternative energy development.

Environmental Quality Development Association (2016) states about programs to publicize environmental and energy conservation in schools as well as to define, develop and inspect energy consumption standards of participating schools, so that the practices could be systematic and integrative. The Metropolitan Electricity Authority in collaboration with Mahidol University and the association initiated the Energy Mind Award, so that schools are able to increase their potential to cultivate awareness on environmental and energy conservation among students and personnel.

Khrongyuti, Rakhwamsuk & Kubaha (2014) investigated conservation of lighting energy and development of energy management systems in public buildings by using the SWOT analysis. It was found that using highly efficient lamps could reduce electricity expenditure, and communication strategies should be adopted by organization in order for personnel to have a shared understanding and participate in energy conservation activities.

Suwanasang & Thongsopit (2015) examined a downward trend of solar energy costs in the past several years. It was revealed that solar energy investment in the ten selected buildings was cost–effective. The current net value and internal return were positive and duration of investment return was short. Thus, installing solar cells on roof tops is another alternative to reduce energy expenses.

Mujeebu & Alshamrani (2006) examined the overview of energy management and conservation in buildings in Saudi Arabia. It was revealed that there should be supporting policies on research and public awareness to use resources cost–effectively. Campaigns on energy conservation should be launched. Building designs should be carried out by those knowledgeable in and aware of energy conservation.

Ratakul, Banjerdrit & Sriherun (2014) investigated the effectiveness of and factors affecting renewable energy management in Thailand. It was found that the effectiveness was derived from state policies due to overall energy problems. The Ministry of Energy was authorized to formulate renewable energy strategic plans and to become a coordinating agency. The focus is on research and development, public awareness on the issue, and support from administrators as a major factor. Moreover, social interest, resource management and attitude of the public contribute to the success of renewable energy management of the country.

Phujinda (2012) examined renewable energy management guidelines at household and community levels to solve fuel consumption problems. It was revealed that the management was still not successful due to discontinuous operations and lack of raw material selection and analysis, unsuitable production resources and technology, and knowledge in energy production for domestic consumption.

Zhang, Dong & Augenbroe (2015) conducted an energy comparative study before and after the installation of energy conservation measures in buildings. It was found that the change–point regression model was suitable for measuring energy in buildings and it could project energy consumption in the future. Additionally, building use behavior could potentially affect the measurement in certain cases.

Fedoruk, Robinson & Cayuela (2015) investigated failed efficiency of energy consumption by examining the gap between building design and energy use. It was found that the failure was from resistance against conventional practices. Therefore, awareness on inspecting, utilizing and understanding building design and analysis would be able to solve the problem.

Jiramakorn (2007) investigated energy saving behavior of personnel and students in Buriram Rajabhat University. It was found that, on using cars or motorcycles, 36.7 % of the personnel and 39.9 % of the students practiced the behavior. On reusing paper, 42.4 % of the personnel and 39% of the students practiced the behavior. It was also revealed that gender was not related to the behavior, whereas age was. Faculties of the students were related to the behavior.

Vlek & Steg (2007) examined energy consumption behavior which was essential for sustainable environment as well as trends of resource utilization and improvement of human wellbeing. It was revealed that overconsumption of fuels brings about global warming, resulting in environmental, social and personal problems. It was recommended to issue policies impacting the environment and to specify decision–making criteria to solve future problems. An important environmental conservation factor was the maintenance of fundamental resources. Having sustainable environment could solve social problems like conflicts in the contestation of resources, which might be detrimental to national peace and security.

Goldensor (1984) stated that behavior is an action or response to psychological action of individuals. It is in response to internal or external stimuli. It is purposeful, noticeable, premeditated, or subconscious.

Leavitt (1964) stated that human behavior was under three related assumptions: behavior is caused, behavior is motivated, and behavior is goal-directed. The three components exist in humans of all ages and cultures.

Khongnui & Khruahong (2014) investigated electricity consumption behavior of students at Suwanabhumi Rajamangala Technology University. It was summarized that correct knowledge about electricity saving and situations of male and female students was not significantly different. Gender was not related to their knowledge, attitude, and energy saving behavior. The research results could be used as fundamental information for campaigns to raise their awareness on constructive electricity consumption and social responsibility.

Revel (2014) reported the estimates of environmental impacts on energy-saving houses in London, which attempted to reduce carbon–dioxide emission and water use. There were measures to install small energy–saving appliances and to change materials affecting energy use as well as to provide advice on how to change energy consumption behavior. The estimates revealed that carbon-dioxide emission was reduced but the behavior could not be changed.

Prathumthin (2010) constructed a cultural tourism management model for a Tai Yai community at Ban Tham Lot in Pang Ma Pha district, Mae Hong Son province. The research involved 15 experts to provide three rounds of information by means of interview and a questionnaire. The participatory rural appraisal was utilized with 42 villagers by an open–ended interview. It was revealed that the experts agreed on four components of the model which included community, concerned agencies, policies, and entrepreneurs. The Sufficiency Economy Philosophy consisted of integrity, sufficiency, good immunity, knowledge, and ethics. The interview results revealed that the villagers wanted their community to become a cultural tourist attraction.

Pankham (2016) developed a consensus measurement of experts and applied the measurement results to information technological and communicative competencies of future teachers in Bangkok (2016–2025). The results revealed that the competencies comprised six aspects and 32 indicators. They included fundamental knowledge on

information technology and communication, classroom learning design and planning, integration of instructional technology, fundamental knowledge about learning measurement and evaluation, professional learning, and social and ethical values.

Phuphat (2018) conducted a study on learning management framework and efficiency of primary schools with different contexts. The study described the indicators based on the contexts, constructed assessment criteria and instruments, and developed an assessment and measurement manual. The results revealed that the framework and efficiency consisted of three competencies with eight components and 21 indicators. Schools were able to use them to alleviate their educational quality and learning management in accordance with educational promotion policies. The framework and efficiency were regarded as a tool to raise the quality of citizens in an attempt to drive and develop the country forward.

CHAPTER 3

RESEARCH METHODOLOGY

Research Design

This research was aimed at investigating and developing the criteria and indicators for energy management as well as assessing the operational results of the quality administration on energy management of the participating schools. The energy management standards, the judgement criteria for Thailand Energy and Energy Mind Awards, and energy – related laws and regulations were examined as the fundamental data to develop the criteria and indicators.

The Investigation and Development of the Criteria and Indicators as the Energy Management Guidelines to Promote Energy Conservation in the Schools

Population and sample group

There were 12 informants consisting of three specialists from the ISO 50001 accredited agencies, three specialists from the Ministry of Energy, and six representatives from three schools having participated in the Energy Mind Awards. The consensus of the specialists' opinions was conducted. In this process, they were required to respond to three rounds of questionnaire. An interview was used for the first round and the questionnaire was administered for the second and third rounds. The questionnaire was assessed for its index of item–objective congruence (IOC). The answers for each round were statistically analyzed for mean, median, and standard deviation as a means to derive their feedbacks and reliability.

Data and data sources

To construct the criteria and indicators, documents and revision or specifications of domestic and international energy management were investigated and conducted, e.g., ISO 50001 and EnMs, which are based on pre-conceived management systems and they are implemented by various organizations with the co–implementation of the Deming Cycle (PDCA). This is meant to provide organizations a guideline to

develop their energy management systems systematically. The eight mandatory regulations must be implemented in order to plan and improve relevant measures.

The criteria of Thailand Energy Awards are derived from the energy conservation competition program that the Department of Alternative Energy Development and Efficiency encourages the business/industry sector to implement. It includes factories and buildings regulated by the 1992 Energy Conservation Promotion Act, and others with high energy consumption and a large number of involved personnel including entrepreneurs, administrators, engineers, employees, and organizations in charge of promoting alternative energy development and conservation, e.g., educational institutes, associations, or the mass media. To conserve energy and develop more alternative energy, personnel at all levels should be encouraged to have awareness and to participate in the attempt. The awards are categorized into five aspects and, for this investigation, only the criteria on energy conservation and institutional alternative energy were the main focus.

The criteria and indicators of the Energy Mind Awards were developed by the Metropolitan Electricity Authority with the aim of publicizing knowledge about energy and environmental conservation to schools. The authority also specified, developed and inspected energy management and operation standards of participating schools. E-mind certificates were given to participating schools whose energy conservation performances were ranked from one to five levels through the process of creating and standardizing outstanding energy conservation programs. The participating schools would be able to learn about and practice resource and energy conservation systematically and integratively. Students and other school personnel were able to learn about energy and environmental conservation as well as to participate in the program activities.

Policies of the Ministry of Energy consist of the energy management policies and the 2018 – 2020 national energy management strategic plan. The third strategy is about environmentally friendly and sustainable energy development. The aim is for the country to use energy efficiently by promoting energy saving devices, training personnel on energy conservation, and issuing public relations measures to raise public awareness.

Green buildings are buildings that put an importance on increasing efficiency of resource use, e.g., construction materials, water use, and energy consumption. At the same time, health impacts of building users and the environment are reduced throughout the time span of the buildings. These can be achieved by better selecting the building location, planning, design, material selection, management during construction, utilization, and maintenance.

Energy saving buildings are those designed by the Ministry of Energy. The Department of Alternative Energy Development and Efficiency issued regulations about building types or sizes, regulation standards, and methods for designing energy conservation buildings in 2009 based on Article 19 of the 1992 Energy Conservation Promotion Act (Amendment in 2007) in order to increase efficiency of energy consumption in buildings. It starts from building designs with heat resistance to selection of environmentally friendly and efficient construction materials and devices, generally known as Building Energy Code (BEC).

Relevant laws and energy management guidelines consist of energy–related laws, particularly the 1992 Energy Conservation Promotion Act. The act basically promotes domestic energy conservation with the same criteria and standards. The promotion is concerned with both technical and financial issues for operational individuals to follow in accordance with socio–economic changes. It is imperative to formulate the act in order to specify measures in directing, supervising, promoting and helping energy consumption regarding energy conservation policies, goals, planning, inspection, analysis, and practical guidelines. Other specified measures include energy use levels in tools and machinery, establishment of an energy conservation fund to support and assist in energy conservation, prevention and solving of environmental problems due to energy use, and energy-related research. Additionally, other measures are meant to promote energy conservation activities or to produce highly efficient machinery, equipment or materials for energy conservation.

Literature review related to the implementation of energy management criteria was also conducted. For instance, a comparative investigation was conducted on the congruence between ministerial regulations, standards and the 2009 energy management methods in controlled factories and buildings, and the ISO 50001: 2011 standards. The ISO 50001 regulations and steps were compared to find out practical

limitations and difficulties that might affect energy management systems of controlled buildings. It was also found that ISO 50001 accreditation in some countries can result in tax exemption, e.g., collection on alternative energy or electricity energy tax. In addition to saving energy, the cost of energy consumption control can be reduced. The ISO 50001 can be applied to food factories that can be a successful driving force in efficient energy management in the industry sector. It is expected that this practical guideline can be adopted in other industries in an attempt to conserve more energy in the industry sector, reduce imported energy, and conserve national energy. Moreover, communication strategies can be adopted in organizations, enabling personnel to share the same understanding and to participate in energy conservation activities. In the past several years, the cost of solar energy has been reduced substantially. This type of energy is used to reduce energy cost. However, solar energy has not been exploited widely. In some countries, there are policies to support research and raise public awareness on the cost-effectiveness of energy consumption as well as being examples on energy conservation. When alternative energy technology is exploited and efficient energy consumption policies are implemented, building designs must be conducted by those with efficient energy consumption knowledge. The public sector must be provided with knowledge about and awareness on energy conservation. Furthermore, energy saving buildings should be accredited and research studies on materials for energy saving buildings as well as efficient energy consumption behaviors should be carried out.

Data collection instruments and methods

The research instruments are divided into two parts as follows.

1. Instruments for qualitative data collection

Step 1 was about construction the questionnaire from the first round of interview and survey. The questionnaire was a five-point rating scale: strongly agree, agree, moderately agree, disagree, and strongly disagree. The questionnaire was assessed and verified by the experts for its accuracy on contents, language, and the relationship between the question items and the research objectives. The IOC of the statement items were assessed and the results were used to improve the questionnaire.

Step 2 involved the calculation for the median and standard deviation of the statement items from Step 1. The questionnaire was improved by using the results

from Step 1 and the experts were asked to assess the revised version of the questionnaire.

Step 3 was concerned with the calculation for the median and standard deviation of the statement items from Step 2. The purpose was for the experts to realize their answers in the previous steps and to revise them accordingly.

2. Electricity consumption data (electricity consumption units) and the electricity expenditure of the participating schools in order to compare the trends and expenditure in the same period of the previous years

The data collection was conducted as follows.

1. The administrators of the participating schools were coordinated to examine fundamental information of their respective schools. The experts were contacted before submitting the questionnaire for them to evaluate.

2. The questionnaire was mailed individually to the experts and they were allowed five days to respond to and complete the questionnaire.

Data analysis

Two aspects of the data were analyzed as follows.

1. Analysis of the criteria and indicators was divided into two parts. The content analysis was adopted to analyze the energy management standards and criteria and indicators for Thailand Energy Awards, Energy Mind Awards, and relevant laws and policies in order to select the most suitable and congruent criteria and indicators for the participating schools. The data from the three rounds of the questionnaire were statistically analyzed to examine the propriety and feasibility of the constructed criteria and indicators. The results from analyzing the data from the three rounds were used to revise the questionnaire, so that their answers could be most reliable.

2. Analysis of the school's electricity consumption records to obtain the trends of and factors affecting their electricity consumption.

Mean

$$\overline{X} = \frac{\sum x}{n}$$

where $\overline{X}$ is the mean scores of the sample group

$\sum x$ is the scores of each class

N is all data numbers of the sample group

Standard deviation

$$S.D. = \sqrt{\frac{N\sum x^2 - (\sum x)^2}{N(N-1)}}$$

where S.D. is standard deviation

x is scores of each class

$\sum$ is total results

N is all data numbers of the sample group

From the five – point rating scale questionnaire, the standard deviation of each statement item was calculated and interpreted as follows:

More than	1.75	as highly different
	1.25 – 1.75	as relatively highly different
Less than	1.25	as slightly different or relatively similar

Median

$$\text{Median} = L + \left[\frac{\frac{n}{2} - \sum f_1}{f_s}\right] c$$

where

L is lower class boundary of the median class

f_1 is collected frequency of minimum data before lowering median class

f_s is frequency of the class for median calculation

c is class interval

n is total number of data

From the five – point rating scale questionnaire, the answer of each statement item is calculated and interpreted as follows (Best, 1970).

4.50 and over	means the experts agree with the statement at the highest level.
3.50 – 4.49	means the experts agree with the statement at a high level.
2.50 – 3.489	means the experts agree with the statement at a moderate level.

1.50 – 2.49	means the experts agree with the statement at a low level.
Lower than 1.50	means the experts agree with the statement at the lowest level.

Steps in constructing the questionnaire for the development of the criteria and indicators

1. Components and steps of constructing the criteria and indicators were explored.

2. The criteria and indicators were constructed and developed, based on the Likert rating scales. The five – point rating scales to measure the satisfaction levels are interpreted as follows.

5	highest level
4	high level
3	moderate level
2	low level
1	lowest level

The mean score ranges of the satisfaction are interpreted as follows.

4.51 – 5.00	highest level
3.51 – 4.50	high level
2.51 – 3.50	moderate level
1.51 – 2.50	low level
1.00 – 1.50	lowest level

3. The constructed questionnaire was assessed and verified by three experts for content accuracy and language appropriateness, as well as to assess the Index of Item – Objective Congruence (IOC) of the statements. The scores are +1 or 0 or –1, with the interpretation as follows.

+1	Congruent
0	Questionable
–1	Incongruent

The statements with the scores lower than 0.5 were revised, while those with the scores equal to or higher than 0.5 were accepted.

4. After the revision and improvement, the final draft of the questionnaire was formulated in order to develop the criteria and indicators.

Assessment of the Criteria and Indicator Implementation as well as Satisfaction with the Criteria and Indicators

The assessment involved three aspects as follows.

1. Assessment of the criteria and indicator implementation in the participating schools

2. Assessment of the electricity expenditure before and after the implementation of the criteria and indicators

3. Assessment of the three satisfaction aspects of those having implemented the criteria and indicators

Population and sample group

The population and sample group consisted of secondary schools (OBEC). The purposive random sampling method was applied to select three schools with each one representing small, medium and large – sized schools in the Educational Service Area 2. Due to the contexts of the schools, the main variable was the acceptance of school administrators. Each selected school had different locations, physical environment, community aspects, and limitations in implementing energy management, such as, budget, readiness of personnel, or building designs. The data of the schools and their representatives used in this study are shown in the following tables.

Table 3.1 Number of Secondary Schools Under the OBEC by Educational Service Areas in the 2019 Academic Year

Educational Service	Number of Secondary Schools		
	Large	Medium	Small
Area 1	18	14	17
Area 2	21	5	2

Source: Office of the Basic Education Commission, 2019

Table 3.2 Number of Personnel and Students in the Sample Group Schools in 2019

School	Service Areas	No. of Personnel	No. of Mathayom Suksa 1-6 Students					
			M.1	M.2	M.3	M.4	M.5	M.6
Rithiyawanalai 2	2	144	457	401	428	382	364	325
Kunonthithuratharam Withayakhom	2	54	107	134	108	150	147	115
Watnoinophakhun	1	49	88	102	125	84	45	51

Source: Office of the Basic Education Commission, 2019

The informants for assessment were six individuals (two from each school) who were in charge of school energy management.

Data and data sources

The data from implementing the criteria and indicators were as follows. The efficiency results of the criteria and indicators would reveal at what levels they could further be implemented and incorporated into energy management project competitions or energy conservation projects of various agencies or an application for the ISO 50001 accreditation. What aspects should be improved or supported based on the assessment of the three satisfaction aspects of the schools. The reduction of energy consumption expenditure of the participating schools included their electricity bills, and the cost of reinstallation of long-life instruments by comparing the data before and after the implementation of the criteria and indicators due to maintenance.

Data collection instruments and methods

1. An assessment checklist with the criteria and indicators energy management quality administration in schools. The checklist was assessed and verified by the experts from the ISO 50001 accreditation agencies.

2. A satisfaction assessment and three aspects of the indicators of the schools.

Data analysis

1. The efficiency assessment results of the quality administration should be in accordance with the criteria and indicators at a good level, and should be ready for furthering other projects. The full scores were 5 (100 %) at the highest level, 4 (80 %) at a high level; and the standard scores should be 3.5 (75 %) at a moderate level. The scores lower than 3.5 must be improved and revised.

2. Energy expenditure must be reduced and awareness on energy use and conservation among school personnel must be raised. The implementation of the criteria as well as improvement of equipment and technology must be sustainable.

3. Satisfaction of the participating schools that implemented the criteria should be at a high level.

The data were assessed and analyzed as follows.

Mean $\overline{x}$

$$\overline{X} = \frac{\sum x}{n}$$

where $\overline{x}$ is the mean scores of the sample group

$\sum x$ is the scores of each class

N is all data numbers of the sample group

Table 3.3 An Example of the Energy Management Evaluation Rubric

0	1. Administrators	2. Personnel	3. Management
5	Formulating practical guidelines, regulations, rules, and performance results in accordance with the goals and objectives. Having continuous practices and development for sustainable energy management of the school.	Assessing their practices to achieve the project's goals and objectives. Reporting performance results of each project to the administrators.	Operations are connected and systematic with personnel understanding about energy management system. Activities could be thoroughly examined and revised.

Table 3.3 (Cont.)

0	1. Administrators	2. Personnel	3. Management
4	Having a policy for concrete implementation, regulations, rules, and practices that are in line with some goals and objectives. There is a tendency for development and practices on a regular basis, which could result in sustainable energy management of the school.	Assessing their practices to achieve the goals and objectives of some projects. Reporting performance results of each project to the administrators.	Some operations are connected and systematic with personnel understanding about energy management system. Activities could be thoroughly examined and revised.
3	Formulating practical guidelines, regulations, rules, and performance results in accordance with some goals and objectives, but practices are not on a continuous basis, which may affect sustainable energy management of the school.	Practices are not correct and are not in line with the goals and objectives of each project. Reporting performance results of each project to the administrators.	Few operations are connected and systematic with personnel understanding about energy management system. Few activities could be thoroughly examined and revised.

A Policy Proposal for the Schools to Implement the Energy Management Criteria and Indicators

Population and sample group

There were two groups to assess the participating schools. They included three experts specialized in energy management accreditation to assess the operation results of the schools in implementing the constructed criteria and indicators, and 18 questionnaire respondents (six from each school) who were the administrators and those in charge of energy management of the participating schools.

Data and data sources

The data were from efficiency assessment results by the experts and the results must be at a high level, which could be further incorporated into other projects. The other one was from the satisfaction assessment results of the participating schools with the implementation of the criteria and indicators. The data would be proposed to the OBE C and the Ministry of Energy to formulate school energy management policies in order for the operation to become systematic and sustainable.

Data Collection Instruments and Methods

For the formulation of the satisfaction questionnaire, the steps were taken as follows.

1. The question statements were created in correspondence with the main issues and objectives of the research.

2. The constructed questionnaire was submitted to the experts to assess and verify on the content and language accuracy. After that, the questionnaire was revised accordingly.

3. The revised questionnaire was resubmitted to the three experts to assess the index of item – objective congruence (IOC) of each question statement with the following criteria:

+1	Congruent
0	Questionable
–1	Incongruent

For the statements to be acceptable, the IOC value must be equal to or higher than 0.05.

4. The final draft of the questionnaire was obtained.

Data analysis

After assessing the efficiency of energy management system administration and satisfaction with the implementation of the criteria, the content analysis was used to analyze the propriety of the results in order to propose them to the OBEC and the Ministry of Energy for their policy formulation.

1. The efficiency assessment results must be congruent with the criteria and indicators at a high level. The full scores were 5 (100 %) at the highest level, 4 (80 %)

at a high level, and 3.5 (75 %) at a moderate level. Those with the scores lower than 3.5 must be revised and improved.

2. Energy expenditure must be reduced and awareness on energy consumption and conservation among school personnel must be raised. The implementation of the criteria as well as improvement of equipment and technology must be sustainable.

3. Satisfaction of the participating schools that implemented the criteria should be at a high level.

The statistics for data analysis was as follows.

Mean $\overline{x}$

$$\overline{X} = \frac{\sum x}{n}$$

where $\overline{x}$ is the mean scores of the sample group

$\sum x$ is the scores of each class

N is all data numbers of the sample group

The statistics for analyzing the instrument quality.

For the content validity of the questionnaire, the Index of Item – Objective Congruence (IOC) was conducted and the results were analyzed by using the following formula.

$$IOC = \frac{\sum R}{N}$$

where

IOC represents the congruence between the questionnaire and the research objectives.

$\sum R$ represents total scores of the experts' opinions

N represents the number of experts

CHAPTER 4

RESULTS AND DISCUSSION

The objective of this research is to develop criteria and indicators for use as a guideline for energy management and conservation in educational institutions. It also evaluates the performance in accordance with the quality management guidelines for energy management in educational institutions. The congregating opinions from 12 experts through the iterative questionnaires for 3 rounds in order to find their consensus of energy management criteria and indicators. An interview was used for the first round and the questionnaire was administered for the second and third rounds. The result from this technique leads to the development of 9 criteria and 25 indicators. The representatives of from educational institutions will be trained by the auditors of the standards system from the Certified Organization Providing ISO 50001 certification. Then, the auditors will evaluate the results of applying criteria and indicators implemented. The results of the evaluation of the quality management efficiency from the certification body, found that, all 3 educational institutions are at a good level, and ready to continue in other projects on the 4 following parts.

Part 1 The results of the development of criteria and indicators for energy management and energy conservation in educational institutions.

Part 2 The results of performance evaluation according to the guidelines for energy management quality management in educational institutions.

Part 3 The results of the electricity consumption of educational institutions before and after applying the criteria and indicators.

Part 4 Evaluation of satisfaction and opinions on criteria and indicators from educational institutions.

Part 1 The Results of the Development of Criteria and Indicators for Energy Management and Energy Conservation in Educational Institutions.

By developing the criteria and indicators related to energy management in educational institutions, the congregating opinions from 12 experts through the iterative questionnaires for 3 rounds in order to find their consensus of energy management criteria and indicators. An interview was used for the first round and the questionnaire was administered for the second and third rounds. These experts were the representatives from the ISO 50001 agencies, Ministry of Energy, and three educational institutions that have participated in the Energy Mind Awards Contest. The questionnaire was a 5-point rating scale designed to collect their opinions and consensus on the criteria and indicators. The statistics used were Mean greater than or equal to 3.5, Median greater than or equal to 4, and Standard Deviation less than or equal to 1.25 would be acceptable the by the 12 experts. The details of the experts were classified by gender, educational background, and age as shown in Table 4.1.

Table 4.1 Number of Informants to Develop Criteria and Indicators by Gender, Education, Age

		Number (People)
Gender	Male	9
	Female	3
	Total	12
Education	Bachelor's Degree	4
	Master's Degree	6
	Ph.D.	2
	Total	12
Age	25 – 40	5
	Over 40	7
	Total	12

From Table 4.1, it shows that 75 % of the respondents were male, 50 % were with educational level of master's degree. And the majority of over 40 years old was at 58.3 %.

The researcher has developed the criteria and indicators of school energy management and conservation, with a total of 9 criteria and 30 indicators for the first time as shown in Table 4.2. The opinions of 12 experts regarding to the 9 criteria and 30 indicators for energy management of educational institutions. These criteria and indicators were developed based on the literature review. However, the expert consensus was not achieved on 5 indicators, i.e., indicator number 5, 8, 10, 21, and 27 respectively. Therefore, there remained 9 criteria and 25 indicators.

Table 4.2 The Opinions of the Experts on the Criteria and Indicators.

Criteria and Indicators	Mean	Median	S.D.
Administrators			
1. Formulating energy management policies or directions suitable for the school	4.33	4	0.49
2. Designating responsibilities of personnel for monitoring energy management in the school	4.2	4	0.62
3. Providing resources for energy management in the school	4.3	4.5	0.78
4. Formulating follow – up measures or methods and evaluation on the implementation of the energy management policies	4.2	4	0.72
5. Considering restrictions on energy management operations	4.2	2.5	0.78
6. Supervising the operations systematically and developing other related programs	4.2	4.5	0.67

Table 4.2 (Cont.)

Criteria and indicators	Mean	Median	S.D.
Personnel			
1. Being knowledgeable and understanding the energy management quality system in order to implement the policies	4.17	4	0.72
2. Those supervising or carrying out the energy management are required to understand their roles and responsibilities.	2.67	3	0.65
Management			
1. An energy management training plan should be formulated in order to provide relevant knowledge to school personnel.	4.67	5	0.62
2. The school database on buildings, facilities, equipment, electrical appliances and system should be constructed.	4.58	5	0.51
3. Energy management documents and their filing system should be systematic.	3	3	0.95
4. Assessment on energy consumption problems is conducted.	4.67	5	0.49
5. There are energy management plans/projects with clear goals and objectives.	4.75	5	0.45
6. Energy management controlling guidelines and operation measures are formulated.	4.75	5	0.45
7. There are evaluation and guidelines in response to possible emergencies in school.	4.23	4	0.62
8. There are practical guidelines for maintaining school equipment, appliances, and electrical system.	4.42	4.5	0.67
9. Energy management knowledge and projects are incorporated in classroom instruction and learning process.	4.67	5	0.49

Table 4.2 (Cont.)

Criteria and indicators	Mean	Median	S.D.
Purchase, provision, and procurement			
1. There are surveys on conditions of electrical equipment, appliances, and consumption system in order to incorporate into the annual purchase, provision and procurement plan.	4.33	4	0.98
2. There is coordination with internal and external agencies and communities.	4.33	4	0.96
Communication			
1. Communication methods are specified.	3.83	4	0.71
2. What to communicate and communication media are created.	3.25	3.5	0.87
3. There is coordination with internal and external agencies and communities.	3.92	4	0.79
Inspection, testing, evaluation, and follow up			
1. A guideline for inspecting the conditions of electrical equipment, appliances and system is designated.	4.33	4	0.65
2. There is operational follow up of energy – related plans or projects.	4.25	4	0.65
3. There is consumption follow up after the school has had an energy management system.	4.42	4	0.51
Correction and prevention			
There are correction guidelines for aberrant policies, plans, projects, objectives, or aberration or damage to electrical equipment, appliances and system. There are preventive measures to prevent those problems from happening again.	4.42	4	0.51

Table 4.2 (Cont.)

Criteria and indicators	Mean	Median	S.D.
Community/social responsibility			
1. Community/social voices are listened to on the impacts of school operations.	3.33	3.5	0.75
2. Community/social collaboration or problem solving is sought.	3.75	4	0.97
Participation			
1. There is activity participation within and outside of the school.	4.08	4	0.67
2. An opportunity is provided to external individuals to participate in analyzing and revising the congruence between project performances and policies of the school and of the Ministry of Energy.	4.08	4	0.52

From the second and third times of surveying 12 experts regarding to the criteria and indicators, it was found that all experts insisted on maintaining the 9 criteria and 25 indicators. After that, the 3 energy auditors were interviewed and the performance consideration methods were developed, as shown in Table 4.3

Table 4.3 Details of the Energy Management Criteria and Indicators in the School

Criteria	Indicators	Performance Consideration Methods
1. Administrators	1. Defining energy management policies or directions suitable for the school	• Having policies and their concrete implementation
	2. Specifying roles and responsibilities of personnel in charge of	• Convening meetings with the energy management working

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	energy management in the school	committee to inform them about the policies and appoint those in charge of energy management
	3. Providing resources for school energy management and considering limitations of energy management operations	• Considering the feasibility of the projects and plans in order to approve operational budgets
	4. Designating measures or monitoring methods and evaluation of the implementation of energy management policies systematically	• Formulating the meeting agenda to monitor the operations
	5. Supervising and developing other programs as well as implementing on a regular basis	• Participating in activities or being a part of the projects to ensure that the activities or projects are actually carried out
2. Personnel	1. Those involved in energy management supervision or operation must understand their roles	• Being evaluated from correct operations and achieving objectives and goals of each project with evidence

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	and responsibilities. They must be trained to have knowledge and skills about energy management.	supporting involved individuals to get training
3. Management	1. There is an energy management training plan for school personnel.	• There is an annual plan for energy management training.
	2. There is a filing system/database about buildings, equipment, appliances, electrical system, and energy consumption.	• There is a printed and electronic filing system.
	3. There is an assessment on energy consumption problems of the school.	• There are results of energy problem evaluation.
	4. There is an energy management plan/project with clear practical guidelines, objectives, and goals.	• There are plans or projects to correct or eliminate energy-related problems with clear practical guidelines.
	5. There are guidelines and measures to monitor energy management.	• There is an operation report and manual or operation methods.

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	6. There are an assessment and guidelines in response to possible emergencies in the school.	• There are emergency assessment results and plans in response to emergencies.
	7. There are practical guidelines to maintain the electrical equipment, appliances, and system of the school.	• There are maintenance plans and their execution.
	8. There is incorporation of energy management knowledge and projects into the learning process in classroom.	• There are lesson plans with an incorporation of energy management contents, e.g., academic contents, activities, or projects.
4. Purchase, provision, and procurement	1. There is a survey on the suitability of electrical equipment, appliances, and electricity consumption system to incorporate the data into the annual purchase, provision and procurement plan.	• There is a purchase, provision and procurement plan for budget allocation.

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	2. There is a systematic guideline for purchase, provision and procurement.	• Price comparison and seller evaluation must be conducted prior to the purchase and procurement.
5. Communication	1. Defining communication methods, what to communicate, and media production.	• Records or evidence of media production
	2. Coordinating with internal and external agencies, as well as surrounding communities.	• Evidence of reception or message reception internally and externally
6. Inspection, testing, evaluation, and follow up	1. There are corrective guidelines for things not in accordance with policies, plans, projects, or objectives, as well as irregularities or damage to equipment, appliances and electrical system of the school. There are also guidelines to	• Operation reports and summary of electrical equipment and appliances in good condition

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	prevent problems from happening again.	
	2. There is a follow up of the plan or project operations on energy of the school.	• Operation results of projects in line with objectives and goals
	3. There is a follow up of expenditure after having the energy management system.	• Declining expenditure compared with the data in the same period of the previous year
7. Correction and prevention	1. There are corrective guidelines for things not in accordance with policies, plans, projects, or objectives, as well as irregularities or damage to equipment, appliances and electrical system of the school. There are also guidelines to prevent problems from happening again.	• Problems solved, with regular meetings of the working committee to monitor performances. Irregularities are recorded in meeting reports and follow up is conducted.
8.Community/social responsibilities	1. Problems of community/society are listened to about the impacts from the operations of the	• There is no complaint from communities.

Table 4.3 (Cont.)

Criteria	Indicators	Performance Consideration Methods
	school. Collaboration or problem solving is conducted with community/society.	
9. Participation	1. Participating in activities in school and with external agencies 2. Providing school personnel an opportunity to take part in analyzing and revising the congruence of project operation results with school policies and policies of the Ministry of Energy.	• Acceptance of activity participation • Meeting reports of administrators and working committee

According to the Table 4.3, the 12 experts continued insisting on maintaining the criteria and indicators after the second and third time. Once again, the researcher interviewed three energy auditors, and developed the performance consideration methods of 9 criteria and 25 indicators. Each indicator had a weight of 4 %, totaling 100 %. For this matter, the researcher has given the most significance to the criteria 1 (Administrators) and the criteria 3 (Management) as they are keys to success in the energy management and conservation in educational institutions. Not only the administrators must have the full potentiality, but they must also have effective management to make the personnel in educational institutions realize the importance and cooperate in driving the project to be successful. But at the same time, when the

criteria are applied in different educational institutions in different contexts, it may be possible to exclude some indicators which are activities that some schools cannot perform. Hence, increasing the weight in terms of administration and management should be focused instead.

Due to the criteria and indicators of energy management in educational institutions, school administrators can be seen as a key to success in implementing and improving energy efficiency in schools. They must be a driving force to the successful implementation of energy management criteria and indicators. Everyone in the school and related persons also have duties and responsibilities to perform the energy efficiency as shown in Figure 4.1.

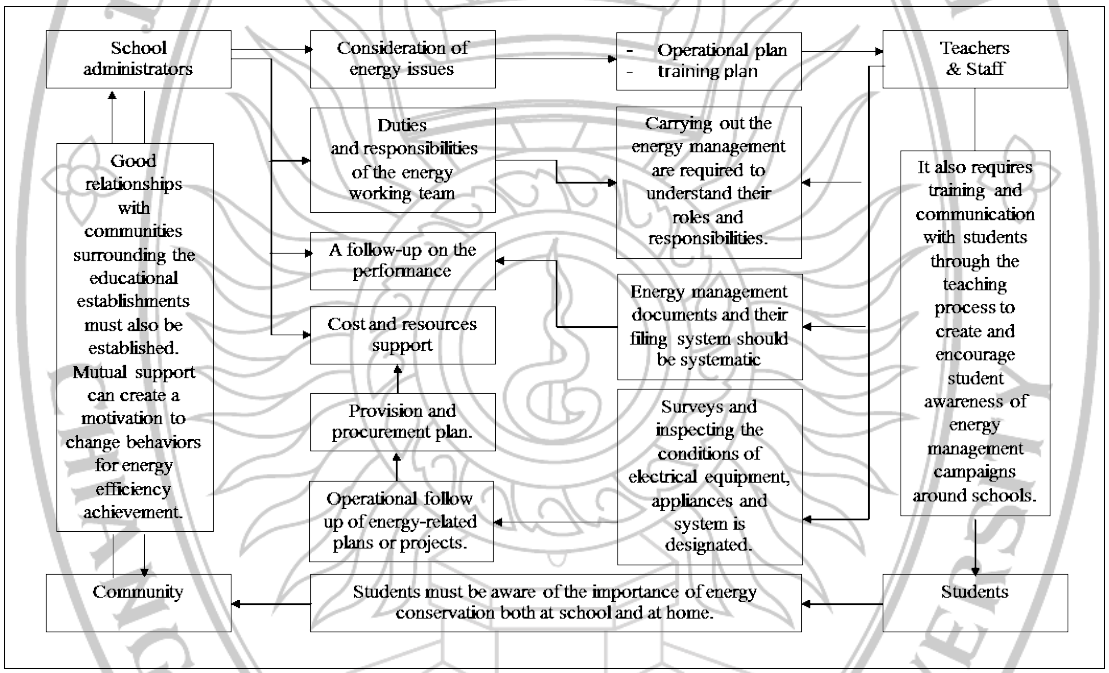

Figure 4.1: Relation of Energy Management Criteria and Indicators to be used as Practice Guideline

School administrators: School administrators are the most dominant mechanism for successful and sustainable energy management. They are committed to drive and support related projects along with the personnel working group, parents, and the community, through systematic practices to reduce energy costs effectively using

systematic criteria and indicators. In planning, the goals and objectives must be clearly understood and in accordance with the policies, visions and missions to create a consistent development throughout the school. Also, there must be a consideration of energy issues, an operational plan, and training plan. The duties and responsibilities of the energy working group must be clearly defined. A follow – up on the performance, as well as giving advice on solving any problems and various constraints in implementing energy management, must be also highly regarded. Cost and resources support is very necessary. Good relationships with communities surrounding the educational establishments must also be established.

Teachers and staff: Teachers and staff are highly significant to the success of energy management. They must work together and participate in the implementation of the policy, duties, and responsibilities assigned. It also requires training and communication with students through the teaching process to create and encourage student awareness of energy management campaigns around schools.

Students: Students must be aware of and understand the importance of energy and energy conservation. After being trained, acknowledged, and implemented by the school's plans, students will raise awareness of the importance of energy consumption both at school and at home.

Community: Community also have to share responsibility for raising awareness of energy management. Community and parent involvement can be an important part of effective energy management. Mutual support can create a motivation to change behaviors for energy efficiency achievement.

Then again, the researcher interviewed three Energy Auditors with over 5 years of experience in auditing from ISO 50001 certification to develop a method for determining performance according to Criteria and indicators. Including the scoring method for the evaluation of the success indicator of the criteria and indicators of the school's energy management, the method of scoring for the evaluation of the success indicator of the criteria and the indicators is shown in Table 4.4. Indications for energy management of educational institutions from the interview with the 3 energy auditors, were divided into 5 levels ranking, was ranging from poor, need to improve, moderate, good and very good improvement.

Table 4.4 Success Indicator Assessment Criteria on the Implementation of the Energy Management Criteria and Indicators

Score range	Level	Interpretation
4.51 – 5.00	Highest	School has high potential to implement the criteria and indicators and should receive budgetary and technological support for continuous development
3.51 – 4.50	High	School has potential to implement the criteria and indicators and should receive budgetary and technological support to improve its performance.
2.51 – 3.50	Moderate	School has potential to implement the criteria and indicators, but should focus more on the missing indicators.
1.51 – 2.50	Need to improve	School does not have sufficient potential to implement the criteria and indicators. However, it requires support for the missing indicators to initiate the adoption of the criteria and indicators to formulate the practical guidelines.
0.00 – 1.50	Poor	Schools lack of the capacity to implement energy management criteria and indicators, and requires urgent development and improvement. They need immediate support for missing indicators to initiate the adoption of the criteria and indicators in setting up guidelines in schools.

From the interviews with the 3 auditors for the standards system, the criteria for assessing the indicators of success in the energy management in educational institutions can be divided into 5 levels as follows: Score 4.51 – 5.00 is very good, score 3.51 – 4.50 is good, score 2.51 – 3.50 is moderate, meets the standard and score

1.51 – 2.5 is in need of improvement and 0.00 – 1.50 needs urgent improvement. For this matter, the determination of the criteria for assessing the indicators of success in the use of energy management criteria and indicators for educational institutions is based on the same principles as the criteria for assessing educational quality assurance in determining the level of the assessment score range.

The results of the application of criteria and indicators for energy management in educational institutions has been taken to conducting a training course to 18 representatives from 3 secondary schools in Bangkok Metropolitan. The 5–year experienced in energy auditors, will be training to the representatives of the energy working group of 3 educational institutions, including executives, teachers and staffs, and student representatives. In this training, the trained teachers, communicate through instruction to students. School personnel are communicated through media, public relations, and various projects, creating a knowledge on energy management thorough out the schools. As a result, the objectives of implementing energy management criteria and indicators will be understood before implementation and can properly operate

The objective of the training is to enable the participants to understand the criteria and indicators before being implemented and to implement them correctly. The training representatives were from 3 secondary school under the Office of the Basic Education Commission (OBEC) were 1) Rittiyawannalai 2, a large – sized school, 2) Kunnatheerutharam Wittayakhom, a medium – sized school, and 3) Watnoinoppakhun, a small – sized school. The schools were purposively selected in order to obtain the data and evaluation results from the schools of three sizes, physical environment, community aspects, and different energy management operations, such as, budget, readiness of personnel, or building designs.

Part 2 The Results of Performance Evaluation According to the Guidelines for Energy Management Quality Management in Educational Institutions.

The researcher, in collaboration with the Energy Auditors, has evaluated the performance in accordance with the quality management guidelines for energy management in schools. After 9 months of training the criteria and indicators for educational institutions, each school has implemented the criteria and indicators and keep and record relevant information. The researcher has identified the areas used in

the study and conducted the research, which is, the sample group of educational institutions in Bangkok under the Office of the Basic Education Commission (OBEC) selected from 2 school districts. The determined area in the study was used in order to obtain information and evaluation results from the sample representative of educational institutions of all sizes, ranging from small, medium and large. This preparation of the criteria and indicators will, eventually, be applied in other educational institutions in accordance with the national energy management plans and policies. The location and details of the school are as follows.

1. Rittiyawannalai 2 School, located at 119 Moo 1, Sai Mai District, Bangkok 10220, is a large school under OBEC District 2.

2. Kunnatheerutharam Wittayakhom School, located at 199 Ratchadaphisek Road, Din Daeng District, Bangkok. 10400 is a medium – sized school under OBEC District 2

3. Watnoinoppakhun School located at 2/1 Rama 5 Road, Nakhon Chai Si Subdistrict, Dusit District, Bangkok 10300, is a small school under OBEC District 1.

The tool used in the assessment is the evaluation form for the implementation of the criteria and indicators on energy management in education, which details the consideration of the assessment methods according to the 5–point scale corresponding to the criteria and indicators for quality management in energy management in educational institutions. The assessment was conducted by the 3 energy auditors, and it was done through documents, interviews, observations, and evidence of actual implementation. Each criterion and indicator was scored from 1 to 5. The assessment results revealed that the performance of the three schools was at a high level and the mean scores were 4.4, 4.0, and 4.2 for Rittiyawannalai 2, Kunnatheerutharam Wittayakhom, and Watnoinoppakhun schools respectively. The implementation of the criteria and indicators was acceptable and reflected the success of the implementation, and can be used to extend various energy projects in the future. Nevertheless, each school has encountered its own limitations and different facilitating factors, as shown in Table 4.5

Table 4.5 Assessment Results on the Implementation of School's Energy Management Criteria and Indicators

Criteria	Rithiyawanalai 2	Kunnatheerutharam	Watnoinophakhun
1. Administrators	5	4	4
2. Personnel	4	4	4
3. Administration	4	3	4
4. Purchase and	5	5	5
procurement	5	4	5
5. Communication	4	4	3
6. Inspection			
7. Correction and	4	3	3
prevention			
8. Community/social	5	5	5
responsibility			
9. Participation	4	4	5
	4.4	**4.0**	**4.2**

According to Table 4.5, it can be seen that when applying energy management criteria and indicators in the educational institutions selected as a sample group, there were different evaluation results as follows. Rittiyawannalai 2 School had an average assessment score of 4.4 points. They received a perfect score of 5 for the criteria on Administrator, Purchase & Procurement, Communication, and Social & Community Responsibility. The possibility is that Rittiyawannalai 2 School is a large school with readiness and transparency in administrative system. There is inspection in the need for procurement. The relationship between the school and the surrounding community, and external agencies is at a very good level. The criteria that received a score of 4 were the Personnel, Administration, inspection, Correction and Prevention. Assembly, the lack of some personnel's capability to perform in accordance with the objectives was the cause of partially achieved goals in the project.

For Kunnatheerutharam Wittayakhom School, classified as a medium – sized school, acquired an assessment average of 4.0 points. From the result, Kunnatheerutharam Wittayakhom School was unable to manage projects as well as it should. And in terms of prevention and correction, it had to wait for consideration from the administration, due to the changes in management during the research process. Consequently, the project implementation was not as smooth as it should be.

A small school like Watnoinoppakhun, on the other hand, was found that the criteria in terms of procurement was transparent, as there was always examination on the need for procurement and outsourcing. The communication between the school and the surrounding community and other agencies was at a very good level. On the other hand, the performance report summary shows the unreadiness of devices & electrical appliances used in the school. Hence, the objectives and goals of the implementation on many projects can only be partially achieved. Nevertheless, Watnoinoppakhun School had an average rating of 4.2 points, which was, higher than Kunnatheerutharam Wittayakhom School.

Part 3 The Results of the Electricity Consumption of Educational Institutions Before and After Applying the Criteria and Indicators.

Thai educational institutes operate on a two-semester basis. The first semester starts from May to October and the second semester from November to March. The data for this investigation were collected in 2019 after the implementation of the criteria and indicators. The data were then compared to those before the implementation in the same period of 2017 and 2018 academic years, as shown in Figure 4.2 – 4.4.

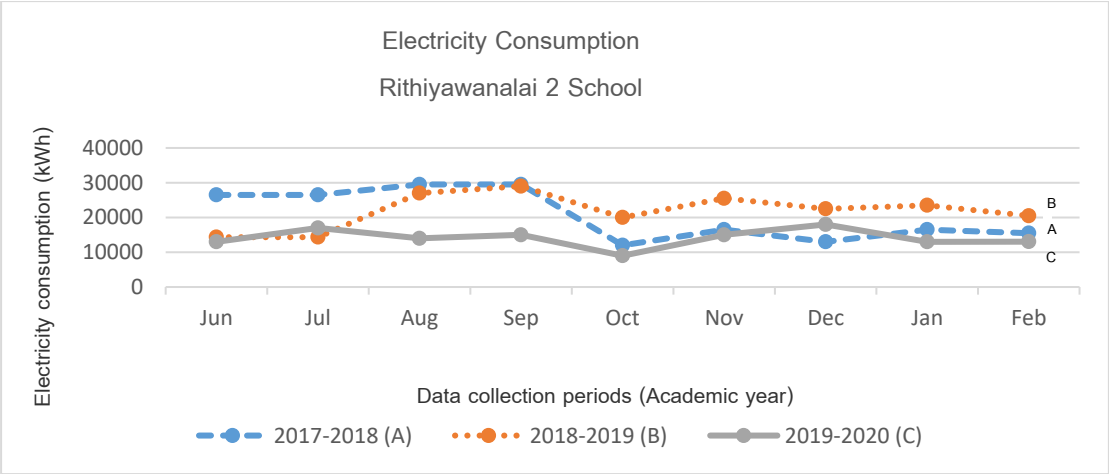

Figure 4.2: Comparison of Electricity Consumption in the Same Period of 2017, 2018 and 2019 Academic Years of Rithiyawanalai 2 School

Figure 4.2 shows the comparison of electricity consumption of Rittiyawannalai 2 School between the academic years of 2017 – 2019 during the same period of time based on the basic information of the school. As a large educational institution under OBEC District 2 located in Sai Mai. Bangkok, there are buildings and classrooms and a spacious overall area of the school. A large number of personnel has been carrying out a variety of activities within the school, such as, a language student exchange program, a scientific innovation and invention contest program, or an energy conservation and saving program. The comparison of electricity consumption in the three academic years revealed that the average electricity consumption was 20,611.11 kW/h in 2017 and 21,851.78 kW/h in 2018, which was relatively high due to the construction of a new building. In 2019, after the implementation of the criteria and indicators, electricity consumption has reduced to 14,116.67 kW/h. When comparing the energy consumption in 2019 to two previous academic years (2017 and 2018), the reduction was by 31.31 % and 35.40 % respectively. In addition, the graph shows that the electricity consumption of the schools was high in June, when the first semester started, and tended to rise in August to September. The electricity consumption has dropped down during October, at the ended of semester, and the amount of electricity demand has decreased. Also, during the months of November to February, the electricity

consumption tends to decrease slightly. The assessment results of the criteria and indicator efficiency reveals that Rittiyawannalai 2 School score was at 4 or high level, indicating the congruence of the assessment results and the implementation of the school. As for being a large educational institution, they received the budget to support activities for improving the efficiency of the electrical system and increasing the efficiency of the energy management system in the school. They were capable of setting up a project for replacing electrical equipment, such as, electric lamps, air conditioners, solar cell panel installation, etc. The school has also launched a campaign to raise personnel's awareness on saving electricity. Furthermore, the school has prepared to participate in the energy conservation program of the Ministry of Energy. Thus, the criteria and indicators of energy management have been adopted by the school as practical guideline for further practice.

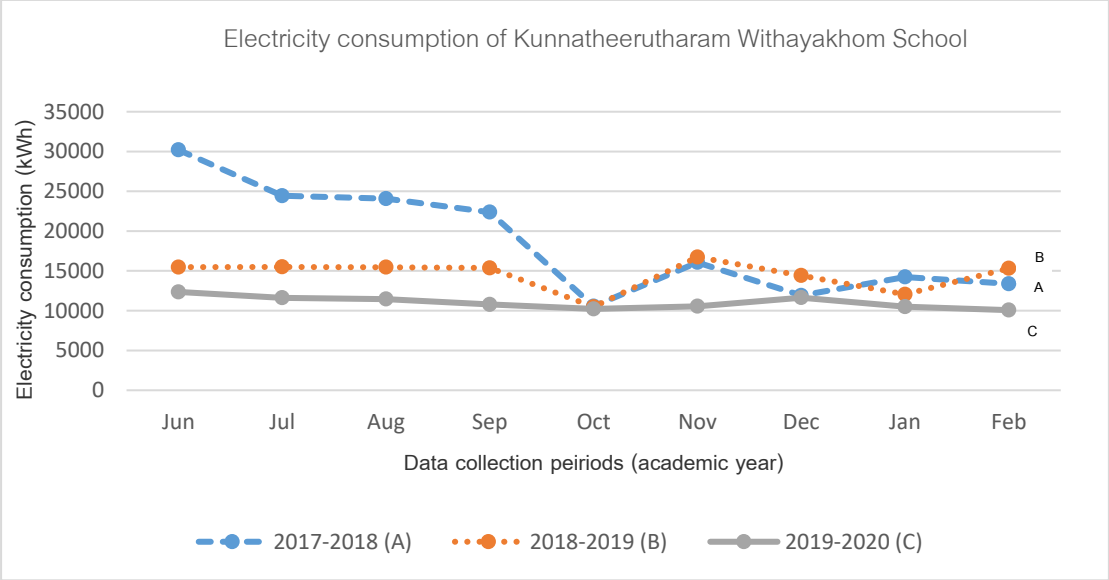

Figure 4.3: Comparison of Electricity Consumption of Kunnatheerutharam Withayakhom School in the Same Period of 2017, 2018 and 2019 Academic Years

Figure 4.3 shows the electricity consumption of the medium–sized Kunnatheerutharam Wittayakhom School in Din Daeng district. The comparison of electricity consumption in the three academic years revealed that the average consumption was 18,577.78 kW/h in 2017, 14,530.11 kW/h in 2018, and 11,018.22 kW/h

in 2019. The above data of the 3 years of study shows the trend of electricity consumption that was declining in continuity. The school used to be categorized as a large – sized school reduced into a medium – size. Urbanization and parent relocation caused the number of students to decrease. The downsizing of the school led to personnel reduction, partially closed down buildings, and reduction of activities. As a result, the trend of electricity consumption has decreased. When comparing the energy consumption in 2019 to two previous academic years (2017 and 2018), the reduction was by 40.78 % and 24.17 % respectively. In addition, the electricity the consumption increased in November, when the second semester started, and dropped to the lowest in October, at the end of the semester. During the month of the opening of semesters, the electricity consumption was quite stable. The assessment results of the criteria and indicators efficiency reveals that the score was at the 4 or high level, indicating the congruence of the assessment results and the implementation of the school. But since this school is a medium – sized institution without affluent budget support, it may result in slow improvement and development related to the efficiency of the power system and energy. Some modifications of electrical equipment to increase the efficiency of the electrical system and power may be delayed. Fortunately, the school has received cooperation from personnel within to create awareness on saving electricity. An energy conservation project has been initiated within the school, by using the criteria and indicators as a guideline to create more activities.

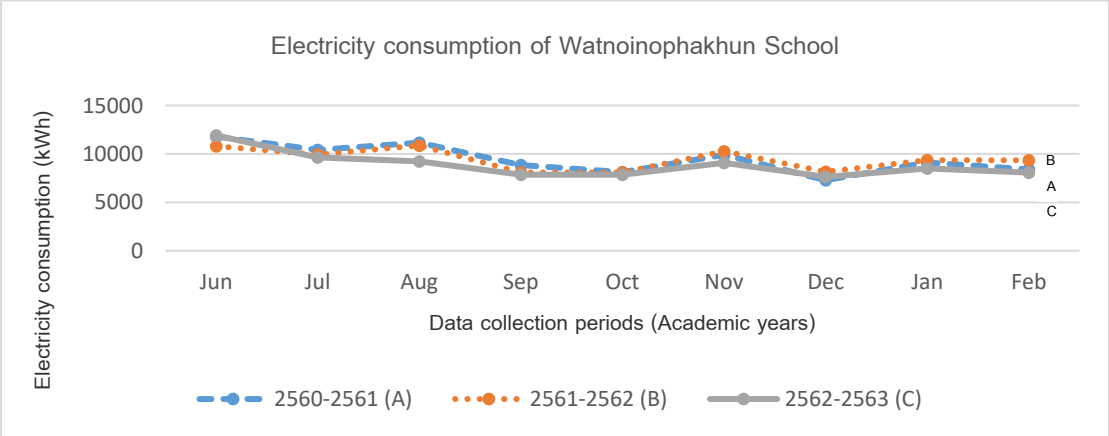

Figure 4.4: Comparison of Electricity Consumption of Watnoinophakhun School in the Same Period of 2017, 2018 and 2019 Academic Years

Figure 4.4 shows the electricity consumption of the small–sized Watnoinophakhun School in Dusit district. The comparison of electricity consumption in the three academic years reveals that the average consumption was 9,449.33 kW/h in 2017, 9,443.89 kW/h in 2018, and 8,861.56 kW/h in 2019. It also shows that the electricity consumption was quite high during the month of the semester, and dropped down during the semester break just like other schools. Watnoinoppakhun used to be a medium-sized school. But due to the urbanization, relocation of parents, and more educational alternatives for students, a number of personnel has been reduced and buildings were partially closed. As the school required less area for activities, the amount of electricity consumption has decreased continuously from the academic year 2017 – 2019. When comparing the energy consumption in 2019 to two previous academic years (2017 and 2018), the reduction was by 6.22 % and 6.05 % respectively. The difference may not seem significant because it is a small school, and the budget for changing electrical equipment is not so affluent. Therefore, energy saving strategies had to be changed by specifying some measures or organizing small contest programs in the school. On the contrary, since Watnoinoppakhun School has been in a good relationship with the surrounding community, they are able to receive well cooperation for any activities from the community.

The assessment results of the criteria and indicator efficiency reveals that the school score was at the 4 or high level, indicating the congruence of the assessment results and the implementation of the school. The school has regularly organized energy conservation programs and the activities. The smaller size of the school made activities possible thoroughly, with good collaboration from communities and external agencies. Additionally, the school has launched campaigns to raise awareness on cooperation in electricity saving among its personnel and families of students. It has established an internal energy conservation program by using the criteria and indicators to create a practical guideline to construct a quality control system.

Part 4 Evaluation of Satisfaction and Opinions on Criteria and Indicators from Educational Institutions.

The details of the respondents who has answered the satisfaction questionnaire classified by sex, age, and status are shown in Table 4.6.

Table 4.6 Number of Respondents in the Satisfaction Questionnaire, Classified by Gender, Educational Background, Age

	Variable	Number	Percentage
Gender	Male	10	56
	Female	8	44
	Total	18	100
Age	Under 20	6	33.3
	21 – 40	6	33.3
	Over 40	6	33.3
	Total	18	100
Background	Personnel	12	66.7
	Student	6	33.3
	Total	18	100

From Table 4.6, the majority of respondents were male at 56 % at age under 20 to over 40, and most of the respondents in the satisfaction survey were personnel accounted for 66.7 percent.

The 18 representatives of educational institutions, who are in energy management working group, were asked to rate their opinions on the criteria and indicators in three aspects: satisfaction, feasibility and utility. From Table 4.7, the average satisfaction of the representatives was at a high level with the mean of 3.77. When the issues were taken into consideration, it was found that the highest level was “the specified energy management policies suitable for the school to implement” with the mean of 4.67. The rest of the issues were at a high level with the mean of 3.56 equally.

Table 4.7 Satisfaction Levels of the Representatives on the Energy Management Criteria and Indicators

Description	Mean	SD	Level
1. The specified energy management policies are suitable for the school to implement.	4.67	.50	Highest
2. Communication methods of the energy management committee about energy management are interesting.	3.56	.52	High
3. Electricity equipment and appliances are in good condition.	3.56	.52	High
4. School administrators are open to problems and solutions related to energy management from the committee or personnel.	3.56	.52	High
5. School is satisfied with the energy management criteria and indicators, and implement them in order to realize energy conservation in practical terms, e.g., reduction of electricity consumption or awareness of personnel on the issue.	3.56	.52	High
Total	**3.77**	**.50**	**High**

When the opinions on the feasibility of the criteria and indicators of the school were taken into consideration, the total score was found at the mean of 4.55. The items that were taken into consideration at the highest level, with the mean of 5.00, were "the school mandating the times for turning on the air – conditioners" and "launching a campaign to exercise by walking up and down the stairs instead of using the lift." Additionally, the feasibility at the second highest level with the mean of 4.56 were "the school launching a campaign on cleaning up air conditioners once a year and maintaining them on a regular basis" and "encouraging students and personnel to participate in informing the facilities division about damaged appliances and not using them until they are repaired." The opinions on the feasibility at the least mean level of 3.67 was on the launching a campaign to encourage students and personnel to strictly save electricity in buildings. The details are shown in Table 4.8

Table 4.8 Opinion Levels on the Feasibility of Energy Management Criteria and Indicators of the School (N=18)

	Feasibility	Mean	SD	Level
1.	School mandates the times for turning on air conditioners.	5	.00	Highest
2.	School encourages the facilities division to clean up air conditioners once a year and to maintain them on a regular basis.	4.56	.52	Highest
3.	Students and personnel are encouraged to inform the facilities division about damaged appliances and not to use them until they are repaired.	4.56	.52	Highest
4.	Students and personnel are encouraged to save electricity in buildings strictly.	3.67	.50	High
5.	School encourages students and personnel to exercise more by walking up and down the stairs instead of using a lift.	5.00	.00	Highest
	Total	**4.55**	**.16**	**Highest**

The opinions of the representatives on the utility of the criteria and indicators were at a high level with the mean of 4.11. When the items were considered, the opinions at the highest level with the mean of 5.00 and 4.67 were about “the school participating in energy management activities organized by external agencies” and “administrators or teachers providing support to energy management programs.” The opinions at the secondary level with the mean of 4.00 and 3.78 were “the school having a good relationship with communities and collectively solving problems arise” and “administrators or teachers providing students and personnel knowledge about saving electricity on a regular basis.” Finally, the opinions at a moderate level with the mean of 3.11 was about the energy management committee reporting the status of their operations to school personnel. The details are shown in Table 4.9

Table 4.9 Opinion Levels on the Utility of the Energy Management Criteria and Indicators of the School (N=18)

Utility	Mean	SD	Level
1. Administrators or teachers support energy management – related programs.	4.67	.50	Highest
2. Administrators or teachers provide students and personnel knowledge about electricity saving in buildings regularly.	3.78	.83	High
3. Energy management committee inform school personnel about operational status.	3.11	.782	Moderate
4. School has a good relationship with communities and collectively solve problems.	4.00	.707	High
5. School participates in energy management activities with external agencies.	5.00	.00	Highest
Total	**4.11**	**.52**	**High**

As mentioned, an important mechanism for successful and sustainable energy management is that school administrators are determined to be driving and supporting related programs with systematic practices. They must be able to systematically implement the criteria and indicators in order to achieve efficient reduction of energy costs.

Responsibilities of school administrators for implementing the criteria and indicators

For successful and continuous implementation of the criteria and indicators, administrators are required to seriously support the implementation in collaboration with the working committee, personnel, parents, and communities according to the PDCA Cycle as follows.

Plan. Administrators formulate energy management plans or directions appropriate to school contexts.

Do. Administrators assign responsibilities of personnel in charge of energy management by providing them relevant training, supporting sufficient budget,

resources and necessary technology. They are obliged to revise curricula in accordance with energy management needs and contents. Also, they must create the environment and learning resources conducive to knowledge inquisitiveness. Yet, they are required to investigate any operational restrictions of energy management.

Check. Administrators are required to issue measurement, or monitoring and evaluation methods on implementing the energy management policies.

Act. Administrators supervise the improvement and revision of the plans as well as drive other energy management programs to ensure their actual and continuous implementation.

Discussion

From developing the energy management criteria and indicators for the schools to use as a systematic and evaluable guideline, the findings are discussed as follows

1. The nine criteria and 25 indicators were congruently implemented in a complete quality control system, and they were practically suitable for the schools because they were convenient and easy to understand. The nine criteria were composed of the following aspects: administrators as leaders in formulating policies suitable for school contexts; personnel; management; purchase and procurement; communication; inspection, testing, evaluation and follow up; correction and prevention; community and social responsibility; and participation in revising and improving. The developed energy management criteria and indicators are correlating with existing management system standards. Also, comprehensive and systematic actions such as ISO 50001, Thailand Energy Awards, and Energy Mind Award have been implemented.

2. The efficiency evaluation results of the criteria and indicators in the three participating schools revealed that electricity consumption decreased. This result was congruent with the 20–year energy conservation plan, a state policy to reduce electricity consumption and to promote the 30 percent use of renewable energy. (Energy Policy and Planning Office, 2017)

3. The role of administrators is to ensure that educational institutions perform the most efficient energy management. They should jointly define operational guidelines by analyzing demand conditions, problems, causes, and necessity of educational institutions to formulate strategies operation. Personnel should be

encouraged to increase their knowledge by exchanging new information and awareness of energy use to eliminate operational defects. Although operational policies and guidelines have been formulated, changes are perpetual and inevitable due to an annual transfer of administrators as well as non–centralized and non-binding policies. Additionally, vision of each administrator is different, leading to the policies being non–continual. As a consequence, it is recommended that policies be continuously implemented by schools, and personnel be encouraged to seek new knowledge about as well as to have awareness on energy consumption. Furthermore, budget and necessary technology should be allocated and provided to energy management programs for their sustainability. Some schools do not have sufficient equipment and do not correctly understand about energy management. Administrators should promote career advancement on the performance – oriented basis and improve job performances with the acceptance of concerned individuals. Good awareness and values should be cultivated through activities or a routine practical guideline in order to create a state of continuity. Some schools were awarded on energy management, but discontinued to practice or improve further. Additionally, some awarding agencies did not follow up on a regular basis. (Luanpasitsakul, 2019).

According to the announcement of the Energy Conservation Policy of the Ministry of Education, administrators must play the key role in the managing effective energy conservation to be sustainable. It is necessary to establish the system for proper operation and continuously operate with intention, understanding, interest, and cooperation from all parties. Administrators will set policies and goals and assign tasks to responsible persons, as well as defining plan to achieve the long – term objectives. The effective management requires project responsible persons who have true knowledge and understanding of energy conservation, and be able to transfer knowledge and attitudes to every other person in the organization. The conservation of energy, however, is not for any one person to act, but it is a common duty of everyone in that organization. If there is a lack of proper understanding and serious cooperation, the objectives will be difficult to achieve.

An ample theoretical knowledge in various fields of energy applicable for energy conservation is significantly required. In addition, knowing how to implement it properly and at the right opportunity is important as well. Therefore, it is necessary

that the committee or the person responsible for the project must find a way, alliances, and tools to transfer knowledge and understanding of the operation. They are required to make everyone understands and cooperates to the practices properly, and create a good conscience to carry on the continued operation. Furthermore, the continuous energy conservation management must be ready and flexible in order to change or improve oneself or those involved, in order to enhance the mechanism of global energy influence. Due to the world resources that become critical based on time or world events. It may be necessary to conserve certain form of energy in a certain time, and other forms of energy at different times. As energy conservation involves humans, in addition to being a scientific matter, it must also be artistic. The art of motivation, so called, is necessary to make change and improvement as well.

Energy Management is a necessary task to perform as a team in an organization. Everyone is obliged to be involved and actively cooperate. The benefits will certainly occur to the organization and the people involved, nevertheless, some people or groups may encounter different impacts or difficulties, more or less. But of course, the benefit from the energy conservation management would be ‘cost saving’ for the organization.

Energy conservation management is not only beneficial to the organization. It is also beneficial for the country because energy is an important variable for the nation's economy. Energy is an expense or the country's trade balance sheet. Power generation or raw materials used to convert into various energy are high expenses that nation has to spend. Therefore, the use of energy without its full benefit is considered a waste in vain. The production cost of energy is not recoverable. Yet, some energy must be purchased and imported from abroad.

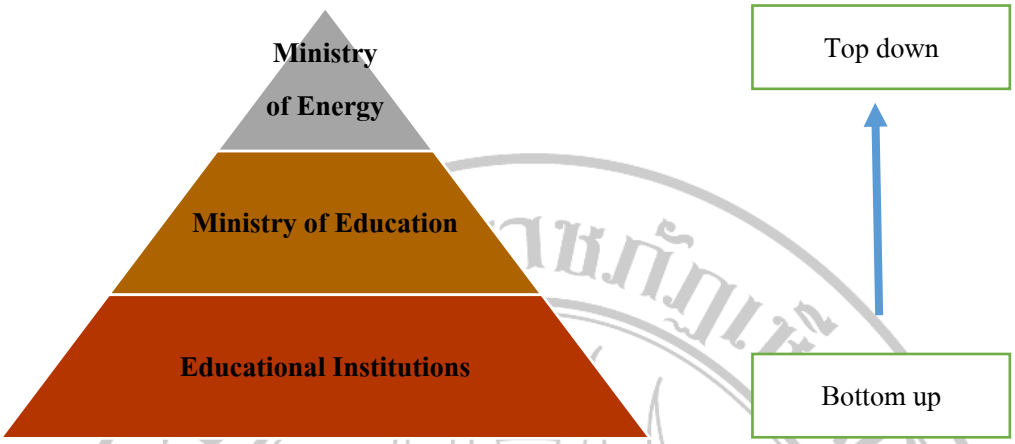

Figure 4.5: Proposal of Policies Supporting Educational Institutions in Implementing Energy Management Criteria and Indicators

According to the energy policy of the Ministry of Energy, the Energy 4.0 targets have been set to help upgrade and develop more efficient and cost – effective use of energy by using energy in conjunction with environmental protection, that is, 'clean energy'. In addition, the Ministry of Energy has developed plan using 'renewable energy' and 'alternative energy.' They are supporting the creation of understanding and awareness of renewable energy among personnel, and creating understanding and cooperation at the community level.

As for the energy policy of the Ministry of Education, energy management policies have been formulated in response in congruence with the National Strategy 4.0, in which, consisting of 6 educational strategies. Section 5 discusses for National Strategy Quality of life & Environmentally, which is about conservation of energy. An energy conservation policy has been announced and set out as measures and guidelines for educational institutions. Nevertheless, in order for the educational institution to successfully implement the policy, the school administrators must play important role in bringing and driving the policy into practice.

There are, somehow, differences in the policy from the energy policy of the Ministry of Energy and the Ministry of Education. The Ministry of Energy's policy focuses on upgrading and improving energy efficiency and use energy efficiently from renewable energy, including supporting understanding and cooperation from personnel

and the community. The policy of the Ministry of Education focuses on the determination of educational institutions from the policies of the administrators. From the policies of both the Ministry of Energy and the Ministry of Education, there is a consistency with this research, namely, the research conducted to obtain criteria and indicators for energy management in educational institutions. When applying such criteria and indicators to the educational institutions as guidelines for practice, it is assessable whether each school has the potential and readiness to expand on various energy management projects. And also, what they need for further supported, such as, the opportunities to learn new technologies, the campaign activities to save electricity, etc., in order to create continuity and sustainability in energy management in educational institutions.

CHAPTER 5

CONCLUSION, DISCUSSION AND RECOMMENDATIONS

Conclusion

Energy consumption is a global issue as it is increasing in accordance with economic growths. Energy production costs are rising nowadays and there is a tendency that energy will be depleted, greatly affecting the population in all sectors. In Thailand, energy consumption in school buildings has continuously been rising and the national energy strategies have been formulated. The Ministry of Energy has thus formulated the 4.0 energy goals in order for efficient and cost – effective energy consumption by integrating clean energy use with environmental conservation. The aim is to use energy efficiently and cost – effectively without negative environmental impacts, and to raise the quality of life of the public. For successful and sustainable energy management, it is imperative to consider the efficiency and effectiveness of energy consumption. The criteria and indicators are used as the guideline for schools to efficiently implement. All schools should be aware of and know about these criteria and indicators with collaboration in energy management in their respective premises. School administrators should be aware of energy security by formulating clear policies and goals and providing full support on personnel and budget. These attempts would enable them to reduce energy cost efficiently with environmental conservation and reduction of environmental impacts.

Discussion

The discussion is conducted according to the objectives of the research as follows.

1. To investigate and develop the criteria and indicators as a guideline for the participating schools to implement on their energy management and conservation.

To develop the criteria and indicators as a guideline for energy management and conservation in schools and to assess the operation results of the implementation of the criteria and indicators. The findings were applied to create the questions in the questionnaire for developing the criteria and indicators. Congregating opinions from 12 experts through the iterative questionnaires for 3 times in order to find their consensus of energy management criteria and indicators. They were then incorporated into the criteria and indicators which were implemented in the participating schools systematically. The results revealed that there were nine criteria and 25 indicators as follows.

1. Administrators with five indicators
2. Personnel with one indicator
3. Administration with eight indicators
4. Purchase / provision / procurement with two indicators
5. Communication with two indicators
6. Inspection / testing / assessment/follow up with three indicators
7. Correction and prevention with one indicator
8. Community and social responsibility with one indicator
9. Participation with two indicators

Training of the representatives from the three participating schools was conducted in order to enable them to understand the criteria and indicators and their implementation, so that the data and assessment results from the sample group could be applied to other schools in accordance with the national energy management policies and planning. Success indicators of the implementation results were conducted by energy auditors from the ISO 50001 accreditation agencies. The assessment results from the three schools were found to be at a high level. The assessment results from the three energy auditors were based on relevant documents, interviews, observations, and implementation evidence. The criteria and indicators were then scored, and the results revealed that the implementation results of the three schools were at a high level. The mean scores of Rithiyawannalai 2, Kunonthreerutharam Withayakhom and Watnoinophakhun were 1.4, 4.0, and 4.2 respectively. It could be concluded that the assessment results were acceptable, reflecting the success of the implementation and enabling the criteria and indicators to be incorporated into other projects. Nevertheless,

each school has its own limitations, different facilitating factors, and strengths or weaknesses in certain criteria.

2. To assess the implementation results and satisfaction with the criteria and indicators of the participating schools;

The assessment results were based on comparing electricity consumption volumes in 2019 with those in 2018 in the same period before the implementation of the criteria and indicators. It was revealed that the volumes were reduced 35.40 % for Rithiyawannalai 2, 24.17 % for Kunontheerutharam Withayakhom, and 6.22 for Watnoinophakhun respectively. The decrease was probably due to other factors, e.g., changes of light bulbs and electrical devices, or campaigns on saving electricity.

The satisfaction assessment results on the three aspects of the criteria and indicators of the schools, which included satisfaction, feasibility and utility, are summarized as follows.

2.1 The overall satisfaction with the criteria and indicators was at a high level, with the mean of 3.77. When each statement item was taken into consideration, it was revealed as follows.

The satisfaction with the energy management policies of the school was at the highest level, with the mean of 4.67.

The satisfaction with communication channels of the energy management committee was at a high level, with the mean of 3.56.

The satisfaction with electrical appliances in response to the needs was at a high level, with the mean of 3.56.

The satisfaction with the administrators listening to problems and solutions of energy management was at a high level, with the mean of 3.56.

The satisfaction with the criteria and indicators as well as their implementation results to bring about energy conservation was at a high level, with the mean of 3.56.

2.2 The feasibility of the criteria and indicators was found to be at the highest level, with the mean of 4.55. When each statement item was taken into consideration, it was revealed as follows.

The opinions on specifying the periods for turning on air conditioners, e.g., 9.30 – 11.30 and 13.30 – 16.00, were at the highest level, with the mean of 5.0.

The opinions on the campaign to use stairs instead of elevators as a way for physical exercise were at the highest level, with the mean of 5.0.

The opinions on the campaign to clean air conditioners once a year with regular maintenance were at the highest level, with the mean of 4.56.

The opinions on the campaign for students and personnel to participate in the inspection and report of the conditions of electrical devices and appliances were at the highest level, with the mean of 4.56.

The opinions on the campaign for students and personnel to control and save electricity in buildings were at a high level, with the mean of 3.67.

2.3 The utility of the criteria and indicators for the schools was found to be at a high level, with the mean of 4.11. When each statement item was taken into consideration, it was revealed as follows.

The satisfaction with the school participating in energy management activities with external agencies was at the highest level, with the mean of 5.00.

The satisfaction with the administrators or teachers supporting energy management projects was at the highest level, with the mean of 4.67.

The satisfaction with the school collaborating and solving problems with or assisting neighboring communities was at a high level, with the mean of 4.00.

The satisfaction with the administrators or teachers regularly providing knowledge about electricity saving in buildings to students and personnel was at a high level, with the mean of 3.78.

The satisfaction with the working committee formulating and publicizing operation results was at a high level, with the mean of 3.11.

3. To propose a policy for schools to implement the criteria and indicators. The research findings revealed that the criteria and indicators were suitable and efficient for implementation. The implementation brought about the success and opinions of school administrators and teachers involved in energy management, enabling them to realize their potential, readiness for integrating in other energy saving projects, and what additional actions should be further taken, e.g., learning new technology, changing

energy saving light bulbs and appliances, or launching energy saving campaigns, in order to attain sustainable and continuous energy management in their respective schools. This is in line with the Ministry of Education's energy policy and the Ministry of Energy's energy policy. Accordance in order to develop Thailand to achieve success with the national strategic plan of energy.

Recommendations

The recommendations from the research results are as follows.

1. For more benefits of energy management projects, schools are advised to examine and understand the constructed criteria and indicators in order that their projects could cover all dimensions of energy management, which could affect the success of those projects.

2. The criteria and indicators should be revised to suit each school context, which could become fundamental knowledge about energy conservation of the school on a regular basis.

3. The criteria and indicators could be used to formulate school energy management policies in accordance with national strategies and policies, which could ultimately result in energy consumption reduction, the use of alternative energy, and reduction of global warming.

4. Energy consumption inspection should be conducted on a regular basis. The inspection would raise more awareness of school personnel on energy saving.

5. Training on energy saving and management should be conducted on a regular basis because students and school personnel come and go all the time, so that new comers could have clear and correct information about energy conservation.

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APPENDICES

Appendix A

Questionnaire

The Opinions of Criteria and Indicators in Energy Management of Educational Institutions # 1

Directions:

1. This questionnaire is a part of doctoral thesis in Community Energy and Environment, Asian Development College for Community Economy and Technology, Chiang Mai Rajabhat University.

   Thesis Title: The Development of Criteria and Indicators in Energy Management for Educational Institution Using the Energy Management System Standard.

2. The questionnaire is separated into 3 sections in 3 pages as follows; Section 1 General information. Section 2 Criteria and Indicators. Section 3 Suggest or other relevant information

The Opinions of Criteria and Indicators in Energy Management of Educational Institutions # 2

Directions:

1. This questionnaire is a part of doctoral thesis in Community Energy and Environment, Asian Development College for Community Economy and Technology, Chiang Mai Rajabhat University.

   Thesis Title: The Development of Criteria and Indicators in Energy Management for Educational Institution Using the Energy Management System Standard.

2. The questionnaire is separated into 3 sections in 3 pages as follows; Section 1 General information. Section 2 Criteria and Indicators. Section 3 Suggest or other relevant information

The opinions of Criteria and Indicators in Energy Management of Educational Institutions # 3

Directions:

1. This questionnaire is a part of doctoral thesis in Community Energy and Environment, Asian Development College for Community Economy and Technology, Chiang Mai Rajabhat University.

   Thesis Title: The Development of Criteria and Indicators in Energy Management for Educational Institution Using the Energy Management System Standard.

2. The questionnaire is separated into 3 sections in 3 pages as follows; Section 1 General information. Section 2 Criteria and Indicators. Section 3 Suggest or other relevant information

Appendix B

Questionnaire

The Opinions on the Criteria and Indicators in 3 Aspects: Satisfaction, Feasibility and Utility

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Directions:

1. This questionnaire is a part of doctoral thesis in Community Energy and Environment, Asian Development College for Community Economy and Technology, Chiang Mai Rajabhat University.

   Thesis Title: The Development of Criteria and Indicators in Energy Management for Educational Institution Using the Energy Management System Standard.

2. The questionnaire is separated into 3 sections in 2 pages as follows; Section 1 General information. Section 2 Criteria and Indicators. Section 3 Suggest or other relevant information

Appendix C

Energy Management Evaluation

Energy Management Evaluation

School .....

Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
5	The policy is leading to practices, such as various projects. There is determination	Being evaluated from correct operations and achieving objectives and goals of each project with	There is a link in the operation systematically. Personnel with knowledge understanding	There is a purchase, provision and procurement plan for budget allocation. Price comparison and seller	The result of the relationship with the surrounding community and external agencies at a	The operation reports and summary of electrical equipment and appliances in good condition. The operation results of	All problems have been resolved and to be considered for further remedial action.	There is no complaint from community.	Acceptance of activity participation and there are meeting reports of administrators and

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Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	of regulations, including the practical results that are consistent with the objectives. The goal is achieved and also a tendency to lead to development and continuous	evidence supporting involved individuals to get training. Every project has a report to the management.	of energy management systems and can be checked and verify the activities completely.	evaluation must be conducted prior to the purchase and procurement.	very good level.	projects in line with objectives and goals. Declining expenditure compared with the data in the same period of the previous year.			working committee.

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Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	practice improvement.								
4	The policy is leading to practices, such as various projects. There is determination of regulations, including the practical results that are consistent with the	Being evaluated from correct operations and achieving objectives and goals of each project with evidence supporting involved individuals to get training. Some project	There is a link in the operation systematically. Personnel with knowledge understanding of energy management systems and can be checked and verify the	There is a purchase, provision, and procurement plan for budget allocation. Price comparison and seller evaluation must be conducted prior to the purchase and procurement some item.	The result of the relationship with the surrounding community and external agencies at a good level.	The operation reports and summary of electrical equipment and appliances in good condition. The operation results of projects in line with some objectives and goals. Declining expenditure compared with the	Some problems have been resolved and to be considered for further remedial action.	There are some complaints from the community. There was considered to corrected and improveme nt	Acceptance of some activity participatio n and there are meeting reports of administrat ors and working committee.

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Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	objectives. The goal has been defined in some parts, and also a tendency to lead to development and continuous practice improvement.	has a report to the management.	activities partly.			data in the same period of the previous year.			
v3	The policy is leading to practices, such as	Being evaluated from incorrect operations	There is a link in the operation systematically	There is a purchase, provision and procurement	The result of the relationship with the	The operation reports and summary of electrical	Some problems have been resolved but	There are some complaints from the	Acceptance of a few activities participatio

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Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	various projects. There is determination of regulations, including the practical results that are consistent with the objectives. The goal has been defined in some parts, but there is not	and not achieving objectives and goals of each project with evidence supporting involved individuals to get training.	. Personnel with knowledge understanding of energy management systems and can be checked and verify the few activities.	plan for budget allocation. Price comparison and seller evaluation must be conducted prior to the purchase and procurement a few item.	surrounding community and external agencies at a moderate level.	equipment and appliances in good condition. The operation results of projects in line with some objectives and goals. Slightly decline expenditure compared with the data in the same period of the previous year.	to be considered for further action.	community and that is in the process to correct.	n and there are meeting reports of administrat ors and working committee.

Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	continuous practice.								
2	The policy is leading to practices, such as various projects. There is determination of regulations, there is a few practices that are consistent with the objectives.	Being evaluated from incorrect operations and not achieving objectives and goals of each project with evidence supporting involved. There aren't reported or	There isn't a link in the operation systematically. Personnel with knowledge understanding of energy management systems and can be checked and verify the	There isn't a purchase, provision and procurement plan for budget allocation. Price comparison and seller evaluation must be conducted prior to the purchase and procurement some item.	The result of the relationship with the surrounding community and external agencies at a low level.	The operation reports and summary of electrical equipment and appliances in good condition. The operation results of projects in line with some objectives and goals. Very slightly decline expenditure	The problems have been fixed some issues but not considered to continue to resolve.	There are many complaints from the community. But there has not been corrected.	Acceptance of a few activities participatio n and there are some meeting reports of administrat ors and working committee.

Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
		problems to the management.	activities partly.			compared with the data in the same period of the previous year.			
1	The policy is leading to practices, such as various projects. There is determination as rules, practical results are rarely	Not achieving objectives and goals of each project with evidence supporting involved. There aren't reported or problems to the management.	There isn't a link in the operation systematically. Personnel with knowledge understanding of energy management systems and cannot be	There isn't a purchase, provision and procurement plan for budget allocation. Price comparison and seller evaluation must be conducted prior to the purchase and	No result of the relationship with the surrounding community and external agencies.	The operation reports and summary of electrical equipment and appliances in good condition. The operation results of projects did not achieve objectives and goals. Very	Very few issues have been fixed.	There were many complaints from the community. But there has not yet been considered for correct and	Unacceptan ce of activity participatio n and there aren't meeting reports of administrat ors and working committee.

Score range	1. Administrators	2. Personnel	3. Management	4. Purchase, provision, and procurement	5. Communication	6. Inspection, testing, evaluation, and follow up	7. Correct-ion and prevention	8. Community/ social responsibility	9. Participation
	consistent with the objectives.		checked and verify the activities partly.	procurement a few items.		slightly decline expenditure compared with the data in the same period of the previous year.		improve-ment.	

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Appendix D

Satisfaction Questionnaire

The Questionnaire for the Opinions on the Criteria and Indicators in 3 Aspects: Satisfaction, Feasibility and Utility

Statement of Questionnaire

1. To allow the researcher an opportunity to acknowledge the performance of energy management of educational institutions. And for the benefit of improving and determining the energy consumption guidelines for more efficiency.
2. Please indicate your level of agreement or disagreement with each of these statements in part 2 place an 'X' mark in the box of your answer.

Part 1: General Information

1. Gender □ Male □ Female
2. Status □ Staff □ Student
3. Age □ Under 25 □ 25 – 40 □ Over 41

Part 2: Question for Satisfaction to promote energy saving behavior of staffs and students

Description of 3 aspects	The level of opinion				
	Very High (5)	High (4)	Moderate (3)	Poor (2)	Very Poor (1)
Satisfaction					
1. The specified energy management policies are suitable for the school to implement.					
2. Communication methods of the energy management committee about					

Description of 3 aspects	The level of opinion				
	Very High (5)	High (4)	Moderate (3)	Poor (2)	Very Poor (1)
3. Electricity equipment and appliances are in good condition.					
4. School administrators are open to problems and solutions related to energy management from the committee or personnel.					
5. School is satisfied with the energy management criteria and indicators and implement them in order to realize energy conservation in practical terms, e.g., reduction of electricity consumption or awareness of personnel on the issue.					
Feasibility					
6. School mandates the times for turning on air conditioners.					
7. School encourages the facilities division to clean up air conditioners once a year and to maintain them on a regular basis.					
8. Students and personnel are encouraged to inform the facilities division about damaged appliances and not to use them until they are repaired.					
9. Students and personnel are encouraged to save electricity in buildings strictly.					

Description of 3 aspects	The level of opinion				
	Very High (5)	High (4)	Moderate (3)	Poor (2)	Very Poor (1)
10. School encourages students and personnel to exercise more by walking up and down the stairs instead of using a lift.					
Utility					
11. Administrators or teachers support energy management – related programs.					
12. Administrators or teachers provide students and personnel knowledge about electricity saving in buildings regularly.					
13. Energy management committee inform school personnel about operational status.					
14. School has a good relationship with communities and collectively solve problems.					
15. School participates in energy management activities with external agencies.					

Part 3: Please suggest or other relevant information

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Thank you for your opinion.

Appendix E

Questionnaire

The Questionnaire to Develop Criteria and Indicators for Energy Management of Educational Institutions

This questionnaire is a surveyed for opinions in energy management and the results were applied to develop the criteria and indicators. To obtain information from energy management experts that will be useful in developing criteria and indicators for energy management in educational institutions. It is recommended that they implement the practical as a guideline for implementation in accordance with the policy and the energy strategy of the Ministry of Energy.

Statement of Questionnaire

1. To enable the researcher to develop criteria and indicators for the implementation of energy management of educational institutions and for the benefit of more efficient energy use guidelines. The researcher defined 9 criteria and 25 indicators.

2. Please indicate your level of agreement or disagreement with each of these statements in part 2 place an "X" mark in the box of your answer for criteria and indicators.

Part 1: General Information

1. Gender □ Male □ Female
2. Age □ Under 25 □ 25 – 40 □ Over 41
3. Education □ Bachelor’s degree □ Master’s degree □ Doctor

Part 2: Question for Criteria and Indicators

Criteria and Indicators	The level of opinion				
	Very High (5)	**High (4)**	**Moderate (3)**	**Poor (2)**	**Very Poor (1)**
Administrators					
1. Formulating energy management policies or directions suitable for the school.					
2. Designating responsibilities of personnel for monitoring energy management in the school.					
3. Providing resources for energy management in the school and considering restrictions on energy management operations.					
4. Formulating follow – up measures or methods and evaluation on the implementation of the energy management policies to operate in a systematic.					
5. Supervising the operations systematically and developing other related programs continuously.					
Personnel					
6. Those involved must understand the roles and duties and responsibility. They must be trained to have knowledge and skills about energy management to implement the policy correctly according to the objectives and achieve the goals.					

Management					
7. An energy management training plan should be formulated in order to provide relevant knowledge to school personnel.					
8. The school database on buildings, facilities, equipment, electrical appliances and system should be constructed. Energy management documents and their filing system should be systematic.					
9. Assessment on energy consumption problems is conducted.					
10. There are energy management plans/projects with clear goals and objectives.					
11. Energy management controlling guidelines and operation measures are formulated.					
12. There are evaluation and guidelines in response to possible emergencies in school.					
13. There are practical guidelines for maintaining school equipment, appliances, and electrical system.					
14. Energy management knowledge and projects are incorporated in classroom instruction and learning process.					

Purchase, provision, and procurement					
15. There are surveys on conditions of electrical equipment, appliances, and consumption system in order to incorporate into the annual purchase, provision and procurement plan.					
16. There is coordination with internal and external agencies and communities.					
Communication					
17. Communication methods are specified and setting the content to communicate, and communication media are created.					
18. There is coordination with internal and external agencies and communities.					
Inspection, testing, evaluation, and follow up					
19. A guideline for inspecting the conditions of electrical equipment, appliances and system is designated.					
20. There is operational follow up of energy – related plans or projects.					
21. There is consumption follow up after the school has had an energy management system.					
Correction and prevention					

22. There are correction guidelines for aberrant policies, plans, projects, objectives, or aberration or damage to electrical equipment, appliances, and system. There are preventive measures to prevent those problems from happening.					
Community/social responsibility					
23. Community/social voices are listened to on the impacts of school operations and collaboration or problem solving is sought.					
Participation					
24. There is activity participation within and outside of the school.					
25. An opportunity is provided to external individuals to participate in analyzing and revising the congruence between project performances and policies of the school and of the Ministry of					

Part 3: Please suggest or other relevant information.

Do you think the criteria or indicators which should be used in schools to manage energy? Other than what was stated in this questionnaire.

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Thank you for your opinion.

CURRICULUM VITAE

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Educational Background

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1988 – 1992	Degree Bachelor's Degree of Science
	Program in Geography
	Srinakharinwirot University (Prasarnmit)

Work Experience

2013 – 2015	Head of Quality Assurance
	Department of Education
	Chitralada Technology College
	Bangkok, Thailand
2006 – 2013	Head of Department of Management System Standards
	Central Pattana Company Limited
	Bangkok, Thailand
2004 – 2006	Head of the management system standards
	TCL Television (Thailand) Company Limited
	Pathum Thani, Thailand