An Evaluation of Sustainable Campus Guidelines in Energy Management Context

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ABSTRACT Campus Sustainability can be defined as the integration of sustainable environmental practices into higher education institutional practices. The involvement of the university community, including administration, academic departments (faculty and students), researchers, and the local community, is required for an effective transition to a sustainable campus. After UI GreenMetric was published in 2010 and revised in 2015, most institutions released sustainable campus guidance. However, implementation toward sustainable campus status is still low because some factors such as lack of relevant managerial experience in implementing sustainable campus initiatives and lack of funding were obstacles to achieving sustainable campus development. Furthermore, energy has a significant effect on sustainability since it impacts both the social economy and the environment. Thus, campus sustainability requires an emphasis on energy sustainability due to campus operations and activities that have significant energy consumption depending on the size of the campus, including its buildings and infrastructures. This paper identifies critical energy management needs by extracting energy elements from the green building's framework and highlighting sustainable campuses toward proposing the energy sustainability maturity framework for Malaysian universities.

KEYWORDS: Sustainable Campus Guidelines/Frameworks; Sustainable Energy Management Guidelines; Sustainable Building Guidelines; Energy Efficiency
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Review Article

INTRODUCTION

Nowadays, energy is one of the key issues in achieving a sustainable campus status. Energy consumption has the largest environmental impact on a sustainable campus which led to an increase carbon and greenhouse gas emissions. Every year, the number of students enrolled in universities grows, resulting in increased electricity consumption. This increase drives the construction of new buildings. The use of electricity in a campus area is highly affected by the buildings. In Malaysia, the building consumes of a total 48% of energy generated by the country (Hassan *et al.*, 2014). According (Ma & Yu, 2020), building sector consumes about 20% to 60% of the total energy in the different region of the world. Chenari *et al*. (2016) investigated that heating, ventilation and air conditioning (HVAC) systems significantly affect energy use in buildings. Brunelli *et al*. (2015) concluded that increasing use of electricity in campus has led many researchers to seek assessments or guidelines to reduce the energy usage.

A university can be regarded as a 'small cities' which have a large-sized population. Various activities particularly in energy consumption in campuses cause a serious or indirect impact on the environmental, economic and social aspects. The environmental pollution and degradation caused by those activities on campus lead to the sustainability issue. Furthermore, universities as a center to promote education makes a significant contribution to the development of society, thus it has special responsibility for youth training and public awareness about sustainability. Therefore, universities, comprised of students (learning and living environments) and administrative staff (working environments) which use a number of equipment and facilities have to make a conscious effort to conserve energy to overcome this issue. Brundtland Report defined sustainable development as a process that aims at meeting the needs of the present generation without harming the ability of future generations to meet their needs (Brundtland, 1987) and to achieve sustainable development

overall energy consumption pattern must be changed (Krajnc *et al*., 2008). Sustainable energy management can be described as a necessity for sustainable economic development, but energy utilization should not cause adverse effects on the environment (Matiasi, 2006). Gyberg and Palm (2009) also stated that the world must reduce its energy consumption to build a sustainable society. At the same time, energy conservation can be described in general as using less energy service and thus saving the energy required to provide it (Brundtland, 1987). This shows that energy efficiency and energy conservation is key to a long-term energy future through sustainable energy management.

Addressing energy conservation in large organizations that incur multi-level energy consumption is particularly important (Scherbaum *et al*., 2008). In general, efforts from all stakeholders from multi-level energy consumers play an important role in energy conservation. The top management of the university as decision-maker is responsible for approving the budget for energy sustainable efforts, while the support staff is the driving force behind the planned program or project (Ramísio *et al*., 2019). Students, on the other hand, are responsible for implementing the guidelines that have been outlined. Table 1 presents the role of stakeholders in the university involved in energy sustainability efforts.

Table 1. Multi-Level Energy Consumer in Campus and Their Responsibility in Energy Sustainability

Stakeholders	Responsibility	References
Top University Management	As decision-maker Approve funding allocation for energy conservative effort/energy efficiency program	(Shrouf *et al*., 2017)
Staff (Administrator) /Academicians	Driving force behind the planned program	(Garrido-Yserte & Gallo-Rivera, 2020)
Student	Implementing guidelines outlined	(Mohamad *et al*., 2020)

Though sustainable campus practices are gradually being implemented in developed countries, it is still not widely practiced (Yahya *et al*., 2016) due to lack of relevant managerial experience in implementing sustainable campus initiatives and lack of university's funding (Gomez & Yin Yin, 2019). In terms of energy management, universities face several challenges due to shrinking budgets and rising energy costs to implement energy efficiency and conservation energy (Fonseca *et al*., 2017). Thus, a more detailed study on energy management is essential towards achieving sustainable campus status to overcome these issues. The previous studies related to energy management are by Saleh *et al*. (2015) which investigated critical success factors for sustainable university from the energy management view's framework, Abu Bakar *et al*. (2013) study about sustainable energy management and its effect on energy efficiency index in university buildings and Choong *et al*. (2012) study for the implementation of energy management key practices for Malaysia universities. This study supports sustainable energy management as the best step to achieve the target of reducing energy consumption for a sustainable campus.

APPROACHES FOR ENERGY MANAGEMENT IN SUSTAINABILITY CAMPUS

Sustainable Campus Elements

CSAF (Campus Sustainability Assessment Framework) from Canada (Fadzil *et al*., 2020) and **STARS** (Sustainability Tracking Assessment and Rating System) from the United States *(Findler et al*., 2019) are among the earliest sustainable campus guidelines and most widely used in the world.

Designing of sustainable campus framework in different countries are largely based on these earlier sustainable frameworks. Table 2.0 shows the list of sustainable campus elements for CSAF and STAR. Energy is one of the important elements to be evaluated in sustainable campus status.

Table 2. Sustainable Campus Elements

Sustainable Campus Guidelines	Elements/Criteria
Campus Sustainability Assessment Framework (CSAF)	Health and Wellbeing, Community, Knowledge, Governance, Economy and Wealth, Water, Materials, Air, Energy and Land.
Sustainability Tracking Assessment and Rating System (STAR)	Three (3) main areas Education and Research, Operations and Planning and Management and Communication. In Operations and Planning Elements – Building, Climate, Dining Services, Energy, Purchasing, Transportation, Waste, Water and Grounds

Table 3 presents the lists of some of the existing sustainable campus frameworks that have been identified as having energy elements with elucidates on the framework's year establishment, the organization or individual responsible for its development, and the country of origin.

Table 3. Existing Sustainable Campus Frameworks with Energy Elements

Sustainability assessment tool	Year	Organization/ individual for development	Country/ states origin	References
British Research Establishment Environmental Assessment Method (BREEAM)	1990	BRE Global Ltd	United Kingdom	(Fekry *et al.*, 2014)
Auditing Instrument for Sustainability in Higher Education (AISHE)	2001	Dutch Committee on Sustainable Higher Education (CDHO)	United Kingdom	(Shriberg, 2002)
Campus Sustainability Assessment Framework (CSAF)	2003	Lindsay Cole	Canada	(Fadzil *et al.*, 2020)
Sustainability Tracking, Assessment and Rating System (STARS) for Colleges and Universities	2006	Association for the Advancement of Sustainability in Higher Education (AASHE)	Pennsylvania, U.States	(Lauder *et al.*, 2015)
UI GREENMETRIC	2010	Universitas Indonesia	Indonesia	(University of Indonesia, 2021a)

Based on data screened, the most frequently applied are AISHE, BREEAM, CSAF, STAR, UI GreenMetric, CASBEE-UD, GBI Township, Green Mark, GREENSHIP and LEED-ND. According to the findings of the review, many sustainable guidelines were developed from around the world from 1990 to 2010. Most of the guidelines were created based on the results obtained from the publication of "Our Common Future" reported by the Brundtland Commission in 1987 which sustainability was emphasized and was seen as a crucial issue (Ramísio *et al.*, 2019). A brief description and comparative framework in terms of energy elements are provided as below:

British Research Establishment Environmental Assessment Method (BREEAM)

BREEAM is the most broadly used for building environmental assessment and rating schemes in

the U.K and it is a voluntary standard. The energy assessment in BREEAM is referred to as Sustainable Use of Natural Resources and the Reduction of Carbon Emission with a weighting of 21.6%.

Auditing Instrument for Sustainability in Higher Education (AISHE)

AISHE was developed as a strategic tool for developing an Education for Sustainable Development (ESD) policy. AISHE is mainly used in Europe and has been applied to about 30 countries. For energy elements in AISHE are included in physical structure assessment without a score weighting. The campus is evaluated to see if it meets the state of the art of the AISHE's requirements.

Campus Sustainability Assessment Framework (CSAF)

CSAF is focusing on assessing sustainability performance in Canadian Universities. CSAF is not run by any institution and has been applied freely by Higher Education Institutions (HEIs). Energy is an element of the Ecosystems subsystem in CSAF and it is further separated into three sub-elements which are Source, Management and Intensity of Use.

Sustainability Tracking, Assessment and Rating System (STARS) for Colleges and Universities

STARS for Colleges and Universities is a sustainability benchmarking tool that includes a voluntary self-reporting framework and an online reporting platform. It originated in North America and is applied to Canada, Mexico, Europe, and Asian HEIs as well. It is a simple, explicit and effective assessment tool. It has three main categories and covers 67 indicators. Its energy element is under the operation category and further broken down to two sub-elements which are Building Energy Efficiency and Clean and Renewable Energy with a score weighing 10 points.

UI GreenMetric

UI GreenMetric was initiated by the University of Indonesia. The UI GreenMetric is an annual international ranking of universities' sustainability performance and it has been widely applied in the world especially in Southeast Asia to benchmark and do continuous improvement in the area of sustainability (Atici *et al*., 2021). For Energy element in the UI Green Metric, it's more comprehensive which included Energy Efficient Appliances Usage, Smart Building Implementation, Number of Renewable Energy Sources In Campus, The Total Electricity Usage Divided By Total Campus Population (Kwh Per Person), The Ratio of Renewable Energy Produced Towards Energy Usage, Elements of Green Building Implementation as Reflected in all Construction and Renovation Policy, Greenhouse Gas Emission Reductions Program and The Ratio of Total Carbon Footprint Divided to Campus Population (University of Indonesia, 2021b).

After 2010, most institution established their own guideline or framework for them to achieve or to comply with established guidelines such as UI GreenMetric as their institutional ranking in the world. Considering the diversity in climate and geography, as well as the imbalanced developments between campuses, UI GreenMetric is suitable and relevant for the local circumstances in Malaysia, concentrating on its context and allowing cross-institution assessments in the region with similar climate and geography characteristics. However, all the frameworks only point toward sustainability, without providing a strategy for implementation. There is a gap between the existing framework and its application in practice. If the existing framework had addressed the leading and guiding functions, it would have had a greater practical impact (Lu *et al*., 2020).

As shown in Table 4, the following is the list of some of the sustainable and green building assessment frameworks that are still in use today. Several sustainable building guidelines have been

formed in ASEAN since 2005, including Green Mark developed by Singapore's Building and Construction Authority (BCA), GREENSHIP developed by Indonesia's Building Council (GBCI), GBI from Malaysia, and CASBEE from Japan. For assessment, each guideline has its energy management elements respectively.

Table 4. Existing Sustainable/Green Building Assessment/Framework/Guidelines

Sustainability Assessment Tool	Year	Organization/Individual for Development	Country/ States Origin	References
Green Mark	2005	Building and Construction Authority (BCA)	Singapore	(Al-Sakkaf *et al*., 2020)
GREENSHIP	2008	Building Council of Indonesia (GBCI)	Indonesia	(Sihite & Simanjuntak, 2015)
LEED for Neighborhood Development	2008	U.S Green Building Council	U. S	(Szibbo, 2016)
GBI- Green Building Index for New Residential Development and Township	2011	Malaysian Institute of Architects	Malaysia	(GBI, 2011)
CASBEE - Comprehensive Assessment System for Build Council	2014	Japan Green Build Council (JaGBC) Japan Sustainable Building Consortium (JSBC)	Japan	(Kaur & Garg, 2019)

ENERGY MANAGEMENT IN SUSTAINABLE CAMPUS ELEMENTS

Since energy is a subset to the sustainable campus elements and has an impact on achieving a sustainable campus status, a guideline or a framework need to be created in managing the energy consumption on campuses. A comprehensive sustainable campus guideline or framework can assist universities to fully understand where the institution stands with regards to the sustainability goals and a conceptual model can assist in identifying and organizing issues after they have been assessed. A sustainability framework will help to identify areas for improvement and develop strategies for improving an institution's sustainability performance, as well as help focus and clarify what to calculate, what to expect from that measurement, and what kind of indicators to use to assess the campus sustainability of higher education institutions.

Elements of Energy Management

According to Turner *et al*. (2020) there are six elements for energy management which are Organisational Structure, Energy Policy, Planning, Audit, Reporting and Awareness. While in technical element Mohd-Rahim *et al*. (2017) and (Abu Bakar et al., 2013) added one element which is retrofitting and it was a crucial element to reduce the energy consumption based on case study at Universiti Teknologi Malaysia (UTM), Malaysia. In addition, Ali & Al Nsairat (2009) explained another four technical elements which were Building Envelope, Efficiency Equipment, Mechanical Systems, and Renewable Energy.

Management Aspect

Organizational Structure

The energy management structure, referred to as the energy team has been set up to implement an energy management program on campus. The energy team is comprised of the Energy Manager or Representative and their team. A minimum of three members including and Energy Manager. For larger organizations, the energy team should consider including personnel from a variety of divisions

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including operations and maintenance, purchasing, engineering, public affairs, utilities, buildings and facilities management, administration, human resources and environmental, health, and safety department. The Energy Team works with the Energy Manager in supporting energy management and energy performance improvement activities. Top management also authorizes the energy team by assuring that its members have the resources necessary to conduct the required activities and participate without compromising their regular job. These resources may include energy management training, adequate funding for energy team activities and space for energy team meetings and working sessions.

Energy Policy

An energy management policy includes the organization's aims and goals concerning energy use and management and it appears in documents or on an institution's website. A formal written energy policy serves as a public statement of the institution's commitment to energy management as well as a working document that guides energy management activities and ensures consistency. The policy should be presented in two sections. Part 1, which includes an expression of commitment and a summary of general principles, is intended for publishing and distribution. Part 2, which contains the comprehensive operational policy, may collect commercially sensitive information intended for internal distribution.

Planning

Planning for energy management revolved around collecting data for identifying, conducting and evaluating the results of energy projects. Planning includes developing an energy management program focused on a continuous approach to implementing energy projects and sustaining the energy savings achieved. The planning step begins with gaining a better understanding of the different types of energy campus uses and how these energy types are used. Once the energy team understands these key issues, they will be able to identify and prioritize possible energy performance improvement opportunities, and then develop project action plans to implement prioritized opportunities.

a) Audit

Tracking and analyzing energy data as part of an energy audit provides insight into the impact of operations on energy usage and consumption. The energy usage and cost analysis must be documented in a way that is beneficial and understandable to individuals at all levels of the company. It could be as basic as graphs of energy usage or as complex as statistical models that identify the important variables. The study of energy consumption and expenses should be updated on a regular basis using the most recent energy data. The energy team created a fundamental method to data analysis for foundational energy management, which includes an energy review as a key component in the strategy and responsibilities for energy data analysis. In addition to previous and current energy use and consumption, the energy review will require analyzing data related to the significant energy consumption and energy performance improvement opportunities.

e) Reporting

Reports must be issued to the relevant managers as the final principle which allows for continual monitoring of energy use, achievement of targets and verification of savings. This in turn allows decision-making and actions to be taken to achieve the targets, as well as confirmation or denial that the targets have been reached. Reporting and monitoring the performance of the institution regularly to check that they are making progress toward their energy-saving targets. Procedures are set in place to ensure that systems continue to operate efficiently and make savings in the future.

Awareness

Energy awareness is the understanding of energy consumption. Raise awareness of the practical benefits achieved by utilizing more efficient technologies to motivate change. The university's overall energy efficiency objectives are supported and reinforced through a comprehensive awareness program. Engaging all stakeholders on campus and improving energy use- behavior among students and staff, can improve the campus's energy efficiency and lower costs. These savings can be reinvested into areas such as research and development (R&D), training or building improvements. Encourage the implementation of efficient behavior among campus residents, through standardization and everyday practices.

Technical

Retrofitting

The addition of new technologies or functionality to outdated systems is known as retrofitting. Retrofitting refers to building energy retrofit with improving existing buildings with energy-efficient equipment as well as lighting with use the daylight, HVAC and lighting maximized based on the tasks and functions of the occupied space. Alternatives to heating and air conditioning include natural ventilation and fresh air. Solar shading systems for windows can lead to reduce energy usage or replacing existing windows with insulated ones. In locations with a lot of noise, insulated windows are a good idea. The cost of retrofitting a structure is typically less than the cost of constructing a new one. The building will be less costly to operate, increase in value, endure longer, and contribute to a better and more productive working environment if the design objectives are met.

Building Envelope

External wall insulation, window glazing type, solar shading and airtightness are some of the essentials utilized in the building envelope to reduce energy consumption. Some of the building's envelope features can be retrofitted to improve comfort needs including thermal, visual and acoustical, without compromising functionality.

Efficiency Equipment

Effective lighting and daylighting system design and controls can add significant energy savings. In terms of energy-efficient through retrofitting strategies are the lighting (previously mostly based on T8 lamps with conventional magnetic ballast) was gradually replaced by LEDs. Several efficient types of equipment used to reduce energy consumption are eco chargers, smart sockets, programmable thermostats, energy monitors and solar panels.

Mechanical Systems

Mechanical systems including HVAC (Heating, Ventilation, and Air-conditioning) systems are by far the largest users of energy in campus buildings (Afroz *et al.*, 2018). Designers need to consider designing efficient HVAC systems, particularly efficient water or air-based systems, in order to optimize energy use. Additionally, installation or retrofitting a new efficient HVAC system which involves the installation of new or tailored parts to an already existing system essentially allowing it to function optimally also to a cost-effective alternative. Hot water distribution systems, which are pipe layouts of the heating system relative to points of use to minimize total heat loss, and motor-driven system components such as pumps and air handlers, which can significantly increase the efficiency of the total motor system, are also included in mechanical systems.

Renewable Energy

Campuses are ideal places to implement programs and technologies that will create clean energy technology and expedite the transition to a future powered entirely by clean, renewable energy exhaustible elements since campuses are hotspots of innovation and technical expertise. Different types of renewable energy sources are on-campus solar energy and on-campus wind energy. Sustainable energy such as sunlight and wind energy does not need to be restored because they can never be depleted. These renewable energy sources are important because they provide reliable power supplies and fuel diversification. These help to improve energy security, the environment and conserve natural resources and habitats. They also reduce the need for costly fuel imports and accidents such as the Deepwater Horizon oil spill in 2010, which claimed the lives of 11 rig employees and millions of marine creatures including mammals, birds, and fish (Omene, 2019).

Four (4) frameworks were selected from the sustainable campus framework and green building framework in order to understand the similarities and differences in their energy elements as to analyze in detail for identifying the gaps in the existing sustainable assessment tools. It is shown in Table 5 below:

Table 5. Comparison of Energy Elements For STAR, GREENMARK, UI GREENMETRIC and GBI

Guidelines and Elements	STARS	GREENMARK	UI GREENMETRIC	GBI
a) Management				
Organizational Structure/Energy Team	X	-	X	-
Energy Policy	X	X	X	-
Planning	X	-	-	-
Audit	-	-	X	-
Reporting	-	X	-	-
Awareness	X	X	X	-
b) Technical				
Retrofitting	-	-	-	-
Building Envelope	-	-	X	X
Efficiency Equipment	X	X	X	X
Mechanical Systems	-	-	-	X
Renewable Energy	X	X	X	X

Note: X indicates the element is addressed in the framework and - indicates the element not addressed.

Table 5 shows that the energy elements in STARS, Green Mark and UI GreenMetric can be seen were focused on both aspects but not covered all elements. However, the GBI was more focused only on the technical aspect. There is no framework that includes retrofitting elements in their assessment tools. Retrofitting the existing buildings can be more cost-effective than constructing new green infrastructure. According to empirical evidence, retrofitting is a crucial factor in achieving the success of green building aims (Bruce *et al*., 2015). In most of retrofit projects, energy-efficient retrofit strategies are not applied due to a lack of knowledge about the amount of investment required and the efficiency of the potential energy-saving strategies (Gooding *et al*., 2021). The complexity of retrofitting and finance is also the barrier to intervention and implementation (Alam *et al*., 2016).

Based on Table 5, to develop a comprehensive framework for achieving a sustainable campus, integration of both a sustainable campus framework and a green building assessment tool is required to fulfill all the energy elements by balancing both management and technical aspects. When these elements are met and incorporated into the existing sustainable framework, the effectiveness of

achieving a sustainable campus becomes more holistic in terms of assessment and practicality. Energy sustainability in campus neutrality requires engagement from every member of the community (students, faculty, and staff) in research opportunities, multidisciplinary teaching and living laboratory projects. According to the literature analysis, UI GreenMetric made a significant improvement began 2015 by adding several energy elements. In 2010, UI GreenMetric has used 23 indicators within the five criteria to calculate ranking scores. In 2011, it added 11 new indicators in 5 categories and add Education as a category in 2012 (Lauder et al., 2015). In the year 2012, 33 indications were used to evaluate green campus and one indicator was excluded which is a smoke-free and drug-free environment. By the year 2015, UI GreenMetric has established the energy element as the highest merit among the other elements namely Energy and Climate Change (21% weight) including focusing on carbon footprint and a more systematic data collection to focus the activity. This addition shows that energy management is important in achieving a sustainable campus. Table 6 show that summarized the improvement of guideline and energy elements in UI GreenMetric. At the early part of the UI GreenMetric release in 2010, only a few energy elements were covered and since 2015, UI GreenMetric has improved as its covered almost all energy elements with included building envelope and renewable energy elements. This shows that the integration between Sustainable Campus Guidelines and Sustainable/Green Building Guidelines in the energy element is relevant to achieve Sustainable Campus Status.

Table 6. Improvement Guidelines and Energy Elements in UI GreenMetric

Elements/Year	2010-2014	2015-2021
a) Management		
Organisational Structure/Energy Team	X	X
Energy Policy	X	X
Planning	-	-
Audit	X	X
Reporting	-	-
Awareness	X	X
b) Technical		
Retrofitting	-	-
Building Envelope	-	X
Efficiency Equipment	X	X
Mechanical Systems	-	-
Renewable Energy	-	X

Note: X indicates the element is addressed in the framework and - indicates the element not addressed.

CONCLUSIONS

This paper provided a better understanding of prominent sustainability assessment tools in the energy management context implemented in different countries. From the general overview, it was found that UI GreenMetric was highly concerned with the management and technical aspects that covered elements and it was used globally. STAR and Green Mark were found to cover some elements both in management and technical aspects while GBI only concentrated on the technical aspects. Eleven (11) elements identified as important elements contribute to energy management namely: (1) Management Aspects, which are Organizational Structure/Energy Manager, Energy Policy, Planning, Audit and Awareness and (2) Technical Aspects, which are Efficiency Equipment, Mechanical System, Renewable Energy, Building Envelope and Retrofitting.

From this study, it is shown that the energy management aspect integrated with the technical aspect as a sustainable campus framework can solve the sustainability energy issue because the combination can help the organization in reducing expenses especially in terms of operational and maintenance costs and also to reduce the carbon footprint on campus. This study might aid in developing a new sustainability campus framework and/or modifying the existing guidelines to make these more comprehensive, reflecting a better or more holistic understanding of sustainability toward proposing the energy sustainability maturity framework for Malaysian universities in the future.

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