INTERNATIONAL JOURNAL OF
ENERGY AND ENVIRONMENT

Volume 1, Issue 5, 2010 pp.745-756

Journal homepage: www.IJEE.IEEFoundation.org

Implications of building energy standard for sustainable energy efficient design in buildings

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Abstract
The rapid growth of energy use, worldwide, has raised concerns over problems of energy supply, energy sustainability and exhaustion of energy resources. While most of the developed countries are implementing building energy standard rapidly to reduce building energy consumption and moving aggressively to achieve sustainable energy efficient building; the position of developing countries respect to energy standard implementation for this purpose is either poorly documented or not documented at all. Presently, there exists a gap between existing building designs and the increasing demand for sustainable energy efficient building design in developing countries. In that respect, this paper investigates the implementation status of building energy standards in developing countries and its implications for sustainable energy efficient designs in building. The present implementation status of building energy standard in 60 developing countries around the world, were analyzed using online survey. Hence, this study revealed the present implementation status of building energy standards in developing countries, implications for sustainable energy efficient designs in building and how building energy standards can be used to fill the gap between existing building designs and increasing demand for sustainable energy efficient building.

Keywords: Energy, Standard, Building, Developing, Conservation.

1. Introduction

Energy consumption in developing countries has been increasing rapidly due to recent economic growth and development. According to Building Energy Standards (BES), HKU [1] and Janda and Busch [2] this energy consumption has lead to serious environmental problems such as increasing energy demand, global warming, air pollution and acid rain. In developing countries, the number of new buildings is growing rapidly and the energy prices and market often do not encourage the use of efficient technologies [3]. In view of these facts, there is a pragmatic shift to the use of building energy standards and codes to reduce building energy consumption in developed countries order to achieve sustainable energy efficient building. Building energy standards can be used to address the energy use of an entire building or building systems such as heating or air conditioning [4]. Energy standard is one of the most frequently used instruments for energy efficiency improvements and can play an important role in enhancing energy efficient design in buildings [5]. This paper investigates the implementation status of building energy standards in developing countries and its implications for sustainable energy efficient designs in building. The present implementation status of building energy standard in 60 developing

countries around the world, were analyzed using online survey. Hence, this study revealed the present implementation status of building energy standards in developing countries, implications for sustainable energy efficient designs in building and how building energy standards can be used to fill the gap between existing building designs and increasing demand for sustainable energy efficient design.

2. Buildings standards in developing countries

While building energy efficiency standards exist in almost all developed countries more and more developing countries are currently introducing such legislation [6, 7]. There are two types of building energy standards: prescriptive standards that set separate performance levels for major envelope and equipment components, such as minimum thermal resistance of walls, are used more frequently, possibly due to their easier enforcement. On the other hand, overall performance-based standards, prescribing only an annual energy consumption level or energy cost budget, usually provide more incentives for innovation [8]. However, the effectiveness of building energy standards varies significantly from country to country, mainly due to difficulties and resulting differences in compliance and enforcement. In developing countries, building energy standards are often ineffective or much less effective than predicted [6]. Deringer et al [7] argued that while building energy efficiency standards exist in a number of developing countries, they are often only on paper due to insufficient implementation and enforcement, corruption and other problems. Building energy standards in developing countries are usually promoted by and developed with support from international donor agencies, but if this support does not cover the implementation period, prospects are rather negative. Building energy standards are a set of procedures and regulations that prescribe the energy performance of buildings. Energy efficiency standards can be either mandatory or voluntary. Thomsen et al [9] conducted an international comparative study of standards for very low energy buildings in the European Union that usefully describes both governmental and non-governmental activities. Other authors, like Hitchin [10] and Laussen [11] set their work in an international context, but their goal is to assess the utility of energy standards as a policy instrument rather than articulating the content in particular countries. The World Energy Council conducted a survey of 63 countries and found that there were mandatory efficiency standards for new dwellings and buildings in all European countries [12]. Furthermore, Janda [13] identified the worldwide status of energy standards for buildings with more focus on developed countries. Janda conducted a survey of 81 countries and it was found that 61 countries have some form of mandatory and/or voluntary existing standards, eleven countries had proposed standards, and nine countries did not have standards. The limited information about developing countries reflects an information gap surrounding the development, use, and effectiveness of energy standards for building energy conservation.

3. Methodology

To exploit this important area of research, this paper used mail survey to gather detailed information about building energy standards. The investigation assessed the progress made so far on the development, implementation, compliance and usage of building energy standards for energy conservation in developing countries. The survey was sent to approximately 145 contacts in government, research organisations and professionals in 95 countries. Given the survey's length and the need for specific information in several areas, the response rate of 46% (67 surveys from 46 countries) was better than anticipated. However, given the importance of this investigation, more contacts were made for more information. An additional 28 surveys were received from 14 different countries. Hence, a total of 30 surveys were sent to each of the six regions surveyed in this investigation. This was aimed to assess the region equally even though some regions were more economically developed than the others. The regions were: Europe, Africa, Asia, North America, Latin America and Middle East. Moreover, World Bank [14] considers all low- and middle- income countries as developing. Countries with more advanced economies than other developing nations, but which have not yet fully demonstrated the signs of a developed country, are grouped under the term newly industrialized countries(NIC).However, IMF uses a flexible classification system that considers (1) per capita income level, (2) export diversification—so oil exporters that have high per capita GDP would not make the advanced classification because around 70% of its exports are oil, and (3) degree of integration into the global financial system [15]. In consideration of the above definitions, this study further classified developing countries as emerging and developing countries [16] and Graduated developing Countries also known as newly industrialized countries (NIC). NIC is a category between developed and developing countries [16-20]. The

information from survey respondents' countries contained: (1) the status of energy standards for buildings in each country; (2) approaches to standards development (3) implementation. These investigation variables and the question asked in the survey were derived from literature review [13, 21, 6]. Questions such as status: are there any proposed or existing energy standards for buildings in your country? What is the status of energy standards for building at national level in your country (mandatory, mixed/voluntary, proposed and none)? Furthermore, on implementation: What training/educational aids are used for energy standard implementation in your country? And at what stage in the construction process is the compliance mechanisms directed (prior, during, after)? .The next section presents the surveyed data and analysis.

4. Data analysis and discussion

In the sample surveyed, a total of 97 responses were received from 60 different countries. According to Figure 1, 62% of the countries that responded to this survey were from emerging developing countries while 38% percent were from graduated/NIC developing countries. The differences in their response can be attributed to the differences in the level of economic development. Some developing countries have been classified as "Developed countries" such as South Africa, and Turkey by the CIA [16] and Antigua and Barbuda, the Bahamas, Bahrain, Barbados, Equatorial Guinea, Kuwait, Oman, Qatar, Trinidad and Tobago Saudi Arabia by the World Bank [14]. Also newly industrialized countries (NICs) are nations with economies more advanced and developed than those in the developing world, but not yet with the full signs of a developed country [16-20]. NIC is a category between developed and developing countries. It includes Brazil, the People's Republic of China, Malaysia, Mexico, South Africa, Thailand and Turkey. IMF classified advanced economies as Euro area, major advanced economies(G7), newly industrialised Asian economies, European Union, and other advanced economies (excluding G7 and euro area).Also, it classified emerging and developing economies as Africa, Africa- Sub-Sahara, Central and eastern Europe, Commonwealth of Independent States, Developing Asia, ASEAN-5, Middle East, Western Hemisphere The above classification by World Bank, IMF and CIA is based on the level of economic development as they are yet to be recognized as developed countries. Building codes, standards which address the energy use of an entire building or building systems such as heating or air conditioning [4], are one of the most frequently used instruments for energy efficiency improvements in buildings and can play an important role in improving energy efficiency in buildings [5]. While these building energy standards exist in almost all developed countries more and more developing countries such as Thailand are currently introducing such legislation [6].

Presently, energy consumption is experiencing an unprecedented growth of 70 percent in emerging developing countries [22] while energy consumption in other developing regions also grows strongly over the projection period, with projected increases of around 60 percent for the Middle East and for Central and South America and 50 percent for Africa. A smaller increase, about 25 percent, is expected for developing Europe and Eurasia. The energy consumption in developing countries around the world is increasing with increase in economy, population, GDP and modernisation [23-25]. Likewise, the energy consumption in newly industrialised developing countries is also increasing with a rapid urbanization [23, 24, 26]. As such if no building energy conservation actions were carried out as buildings will need large amount of energy supply for their operations in the following years [23]. Therefore**,** the requirements of building energy standards for building energy conservation are considered to be issued in the form of policy or regulation [27]. As a result of this unique problem confronting developing countries at different levels of economic development, the effectiveness of building standards varies significantly from country to country, mainly due to difficulties and resulting differences in economic development, compliance and enforcement [6]. The building energy standards development and adoption as investigated in this research showed that 42% of developing countries surveyed have no energy standard in place, 20% have mandatory, 22% have mixed and 16% proposed. In spites of the fact that, most developed countries have one kind of building energy standard in place either mandatory, mixed or being proposed. However, this survey revealed that some developing countries but classified as developed countries by World Bank [14] such as Trinidad and Tobago and Barbados have no standard in place.

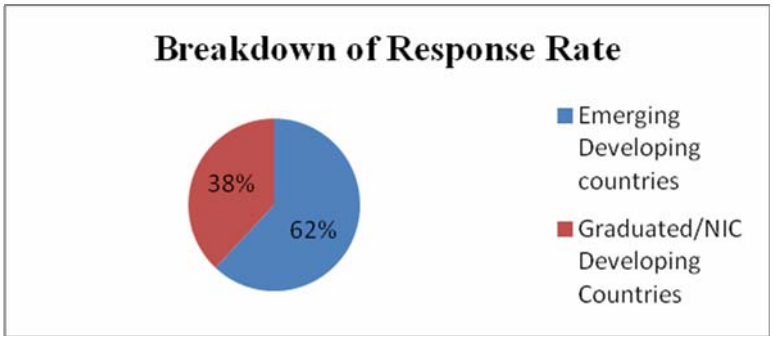

Figure 1. Respondents' response rate

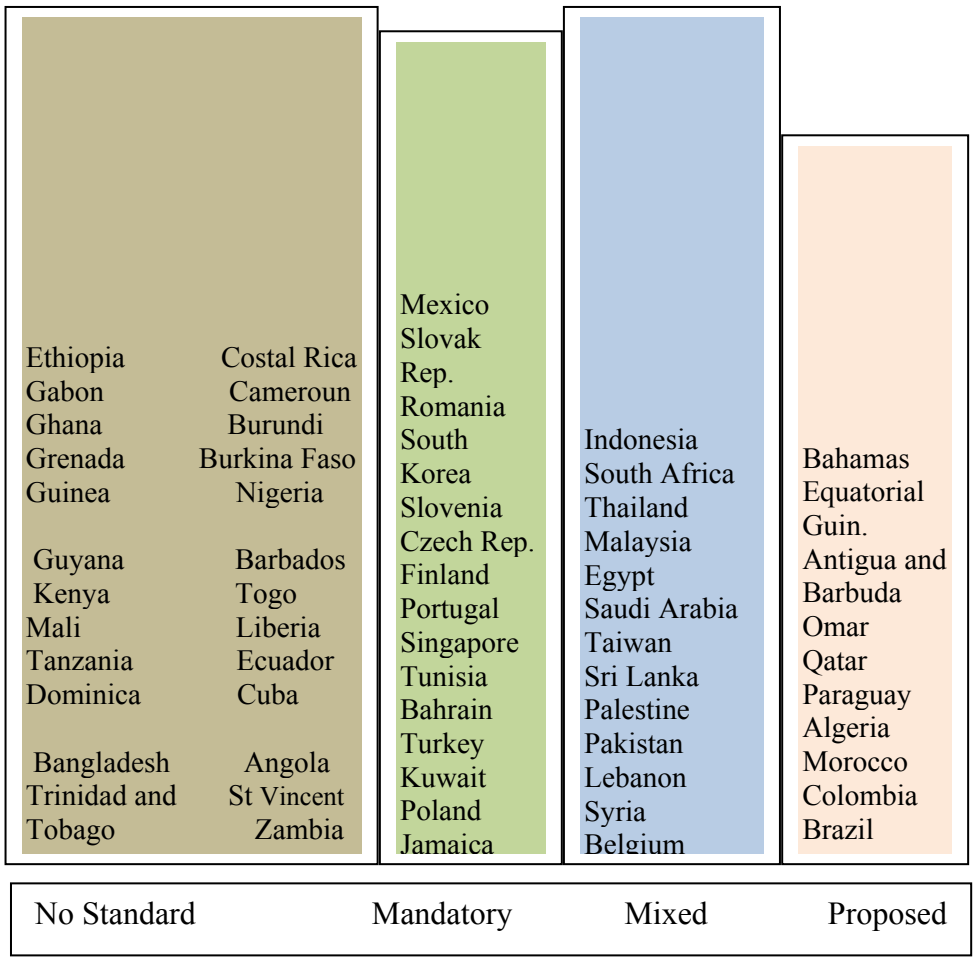

Figure 2. Status of Building Energy Standards implementation status in 60 developing countries (emerging and graduated/NIC), 2010

This position in which 42% of developing countries surveyed have no standard in place could be attributed to lack of building energy policy, government interest in energy conservation and inadequate information about the usefulness of building energy standards for building energy efficient design, building energy consumption, and climate change [28, 7]. Also, it can be a result of corruption, lack of infrastructure and technology as well as inability of some developing countries to implement efficiency measures under building energy standard policy due to low level of economy [29, 32, 6]. The major impediments to implement building energy standards for energy efficiency in the building sector are institutional barriers and market failures rather than technical problems, as pointed out by Nature Publishing Group [30]. Among these, Santamouris [31] includes: lack of owners' awareness of

sustainable design benefits, building energy standards benefits, insufficient awareness and training of property managers, builders and engineers, lack of specialized professionals to ensure implementation.
Based on the above information, the level of implementation of building energy standards in developing countries is still far behind when compared to building energy standard in developed countries. In this study, 25 developing countries out of 60 countries surveyed have no standard compared to Janda [13] finding where only 9 countries were without standard out of 81 countries surveyed. However, some levels of progress have been made according to Figure 2, this study recorded new proposals over the findings from Janda [13]. The countries with proposed standard are: Bahamas, Equatorial Guinea, Antigua and Barbuda, Omar and Qatar. Also, Syria has mixed/voluntary standard compared to Janda [13] where Syria only made a proposal for standard. Countries with no building energy standards are far greater than countries with building energy standards while little proposed standards were recorded. This shows that the levels of building energy standards implementation in developing countries are still at infant level when compared to building energy standard implementation in developed countries. The level of energy reduction recorded is directly linked to their level building energy standard implementation in developed countries. As confirmed in UNEP [6], building standards in the US are estimated to have reduced energy use by 15-16% of the baseline in 2000 (0.57 EJ). According to estimates, new dwellings in the EU built today use on average 60% less energy compared to the building stock built before the first oil shock. This shows the level of building energy standard development and adoption in European countries which also confirmed the findings of this study in Figure 2 above, where most of the euro countries surveyed had mandatory standard in place.

4.1 Overview of regional energy standard implementation performance for developing countries
Building energy standards are starting to appear in the Africa, Latin America and Middle East regions, even though in general, this is a new development. With UNDP and GEF support, a number of codes are being developed in developing countries, and these typically include both elemental and integrated routes to compliance, i. e an elemental method defines the performance requirements of specific building elements. An integrated method, on the other hand, sets a whole-building performance target and provides a calculation mechanism for evaluating whether or not a proposed (or actual) building complies but often only dealing with building envelope issues [21].

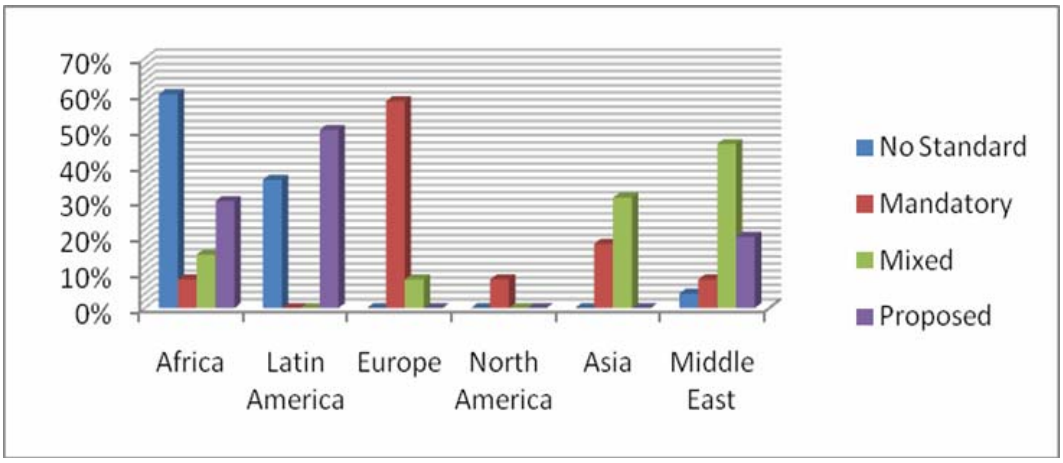

Figure 3. Regional energy standard implementation performance for developing countries

In Figure 3, Africa and Latin America recorded the highest percentage of no standard and at the same time showed the highest percentage of energy standard activities as indicated by the percentage of proposed standards. While Asia and Middle East displaced high level of performance in drive toward achieving energy standard implementation as indicated by the percentage of mixed/voluntary standards recorded in Figure 3. Moreover, the performance of Europe is highly encouraging in respect to energy standard activities. They recorded the highest percentage of mandatory energy standard when compared to other five regions. In Africa, a number of North African countries such Tunisia, Egypt have programmes relating to building energy standards as showed in Figure 2, while Algeria and Morocco are currently proposing to have building energy standard. The Egypt energy standard for housing became

law in 2005. A commercial standard was expected to follow, and the background analysis had already been completed. The standards have elemental and integrated routes and also include minimum performance levels for air-conditioners and other appliances application [21]. A feature of the residential standards is intended to allow natural ventilation to reduce overheating. However, in 2005 enforcement legislation was said to still be needed. Also, Morocco initiated a plan in 2005 to develop thermal energy standards for buildings, focusing on the health, hotel and collective housing sectors. This was expected to be completed in 2010. Tunisia has mandatory standard while Algeria plans for similar standards but need to develop supporting infrastructure and education programmes for effective application [21]. South Africa is presently using mixed/voluntary standard and it is developing a mandatory building energy efficiency standards for residential and commercial buildings as party of its national energy efficiency strategy. The timescale is not entirely clear but appears to be for implementation between 2011 and 2015 [33, 34].

Further more, in Asia, there is a very mixed picture in this region, with some countries having no building energy standards, others having mandatory standards (Singapore) while others have mixed standards (Indonesia, Malaysia, Taiwan, Thailand, Philippines,). Implementation seems to be robust in, Singapore and Taiwan going by the level of energy standard activities and performance as shown in Figure 3 above, but a recent study by the United Nations Development Programme has suggested that elsewhere a lack of resources has compromised implementation [21]. Also, Pakistan introduced a voluntary energy efficiency standard in 1992 and presently using mixed energy standard. India and Sri Lanka have recently developed standards for larger commercial buildings, providing both elemental and trade-off routes to implementation. In Middle East, some progress has been made on building energy standard implementation as shown in Figure 3. Kuwait developed standards in the 1980s, but their current status is mandatory energy standard. Syria, Saudi Arabia and the Palestine Territories have mixed energy standard while Lebanon has mixed standard and a proposals intended to be implemented mandatory standard in 2010.In addition, Qatar and Omar are currently on the process to adopt energy standard as shown in Figure 2. However, lack of an established regulatory infrastructure is a significant barrier to practical application of building energy standard [21]. North America has good energy standard performance [13] as indicated by Mexico energy standard performance with mandatory energy standard in Figure 2, even though the region recorded low performance and participation in this study. In Mexico, a 2001 standard relates to the energy efficiency of non-residential buildings, apparently focusing on limiting heat gains. The country has a substantial number of regulations and standards relating to equipment efficiencies, which may be seen as a higher priority.

The Latin America region appears to be in the early stages of developing building energy standards, albeit with some countries more advanced than others. A number of countries do not appear to have any legal framework to support building energy standards, (Ecuador, Costa Rica, Cuba, Trinidad and Tobago, Dominica, and Guyana) [35]. Besides Colombia, Brazil, Paraguay, Antigua and Barbuda and Bahamas have a proposed standard. The proposed regulation allows both a prescriptive route and a simulation route [21].

4.2 Building energy standards implementation

The implementation levels of building energy standards in developing countries can be assessed by looking at the training and educational aids (TEA) being used. Also, by considering the characteristics of the entities involved (EI) in implementing energy standards in those countries. In Figure 4, Latin Americal,58%,Europe,56%,Asia,60% and North America indicated the used of compliance forms and written guidelines [TEA(CF)] as training /educational aids for energy standard implementation while Africa and Middle east recorded lower percentages in this area. Besides, 42%, Asia and 42%, Middle East indicated the used of workshops and seminars [TEA (W&S)]. Furthermore,62% of respondents from Middle east,45% from Africa and 43% from Latin America indicated that existing government agencies [EI(EA)] such as building agencies, energy agencies are involved in implementing building energy standards in their countries compare to 20% from Europe, 38% from Asia and 0% from North America which indicated the involvement of existing agencies. The used of new/separate agency [EI (NA)] recorded higher percentages from North America, Europe and Asia. This shows high level of energy standard implementation in these areas as confirmed their high performance in implementing of energy standard as shown in Figure 3 above.

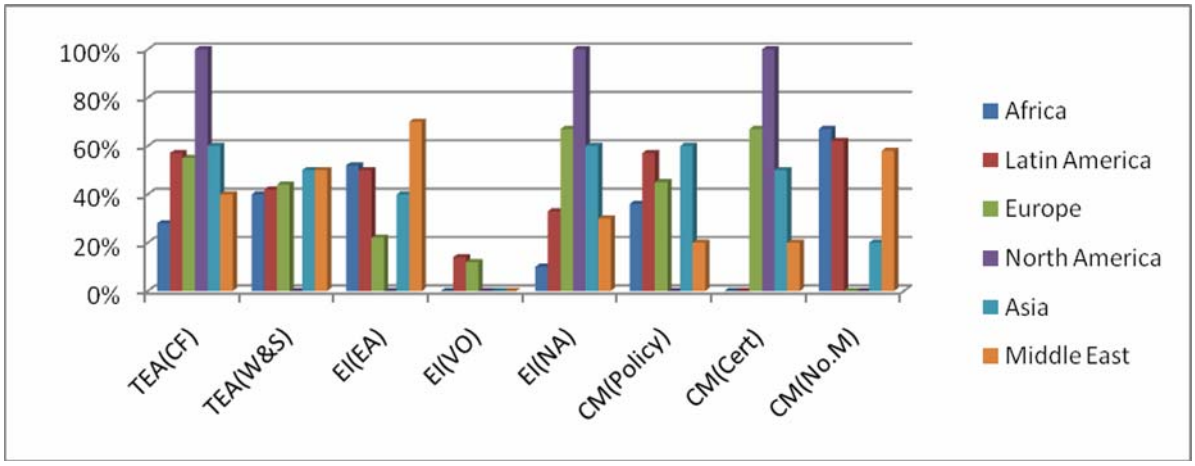

Figure 4. Regional energy standard implementation and compliance performance

However, the general response on the sole dependence on voluntary organisations [EI (VO)] is very low which indicates some level of progress on government interest and involvement in implementing energy standards in these countries. In addition,58% from Asia,40% from Europe and 30% from Latin America confirmed the used of policy approach [CM(Policy)] as their implementation mechanism while 62% from Europe,100% from North America and 45% from Asia confirmed the used of certification approach [CM(Cert)] as their implementation mechanism. On the other hand, 62% respondents from Africa, 60% from Latin America and 58% from Middle East indicated that no implementation mechanisms [CM (No.M)] were in place. Thus, indicates low level of implementation in these regions. In general, in spites of low implementation performance recorded from some regions and countries, some levels of progress have been made in some areas based on this study findings and the analyses such as: increasing government involvement in energy standard implementation, increase number of proposed standards, increasing level of energy standard implementation, especially in part of developing countries (Graduated/NIC countries) and upgrading of some energy standards from proposed to mixed/voluntary, from mixed to mandatory.

5. Implications of building energy standard for sustainable energy efficient design in building

Building energy standards are one of the most frequently used instruments for energy efficient design in buildings [5]. Energy standards provide minimum building requirements that are cost-effective in saving energy in building and provide a degree of control over building design practices and encourage awareness of energy conscious design in building [36]. Also, energy standards allow the use of innovative approaches and techniques to achieve effective utilisation of energy and optimum building performance. Besides, it encourages cost-effective energy use of building components including building envelope, lighting, HVAC, electrical installations, lift and escalator, and other equipment [37].

Hence, a clear understanding of the building energy standard is essential for architects and building designers to achieve optimal energy efficient building design [36]. Energy demand intensity will increase sharply in most developing countries, particularly in Asia. These phenomena require urgent action such as implementation building energy standards, and improved energy efficiency [38]. Low implementation building energy standards as recorded in this study will lead a situation where developing countries will unable to confront increasing building energy consumption. Sustainable Energy efficiency provides services for sustainable energy and helps to protect the environment. When less energy is used, less energy is generated by power plants. Thus reduce energy consumption and production. This in turn reduces emissions and improves the quality of the air. Energy efficiency also helps the economy by saving costs for consumer and businesses [39]. Furthermore, according Whole Building Design [39] implements and enforcing energy standards will result in fewer energy demand, fewer power plants and natural resources being used to provide electricity and natural gas. It also means fewer emissions to the atmosphere. In the U.S. most buildings are constructed to meet minimum energy code requirements [39]. Therefore, energy standards generally dictate the requirements for building's envelope, mechanical, and lighting requirements. In addition, according to WBDG [39], building envelope requirements in energy standards generally include minimum insulation levels for walls, roofs, and floors, as well as window

requirements. These generally vary with climate region, since more insulation is cost-effective in cold or extremely hot regions. Mechanical system requirements include minimum equipment efficiency requirements, insulation requirements for ducts and piping, and controls for off-hours and dead bands i.e. temperature control mechanism. Commercial building requirements for lighting include total building wattage requirements for interior and exterior lighting. Controls are generally required to assure lighting is turned off when facilities are unoccupied. This can be achieved through programmable controls and energy conscious design. Inability to incorporate all these measures in building will lead to significant increase in building energy consumption. According to World Energy [40] primary energy demand in developing countries is expected to triple and form up to two third of total global demand by 2050. This means that if building energy standards are not being implemented and enforced in these regions as it is being done in developed countries, increasing energy demand and increasing demand for sustainable energy efficient designs in building will be a major problem for these regions. More importantly, economic development will be affected while there will be depletion of natural energy resources.

In existing research on energy consumption, buildings, worldwide, account for as much as 45% of primary energy resources and that makes building the biggest single contributor to total energy consumption [30]. Energy uses in office buildings is about70–300kWh/m2 per annum, 10–2 times that of residential buildings [41]. The rapid growth of energy use, worldwide, has already raised concerns over problems of supply, the exhaustion of energy resources and severe environmental impacts (ozone layer depletion, global warning, climate change, etc [42]. The growth in population, increasing pressure for building services, and enhanced comfort levels, together with the rise in times spent inside buildings, assured upward trend in energy demand will continue in the future. For this reason, energy efficient design in building is today a prime objective for energy policy makers at regional, national, and international levels [42, 43]. According to Saidus [42] building sector consumes 8–50% of the total energy used in EU, USA, Saudi Arabia, Hongkong, Iran, China, Thailand, Bahrain, Spain and UK [44, 45, 41, 46, 43, 47] . Also, building energy consumption in the EU was 37% of total energy of the total energy used while industry recorded (28%), transport (32%) and others, 3%. Furthermore, building sector recorded higher share than transport and industrial sector of the total energy consumption in Malaysia and Thailand with higher percentage coming from commercial sector as result of their energy used pattern [48]. The Bahrain's energy consumption indicates that the installed capacity, energy demand and the annual energy use are growing substantially [49]. It is clear from the above information that buildings, particularly those in the commercial and residential sector, will have substantial impact on economic growth due to higher percentage of energy used and increasing energy demand [48]. In Lombard et al [43], high economic growth in Malaysia has led to a dramatic increase in energy consumption in recent years, particularly electrical energy use in commercial and residential buildings, with the residential and commercial sector consuming almost half of total electricity generated. In view of the low implementation of energy standards recorded in this study especially from emerging developing countries, there exist a sustainability gap between the existing buildings and increasing demand for sustainable energy efficient buildings. It is therefore essential to start promoting the use of building energy standard for sustainable energy efficient design in buildings in developing countries.

6. Recommended ways to address the challenges of the sustainability gap in developing countries

6.1 Effective implementation of building energy standard measures in building

The implementation of this standard will provide the criteria and the minimum standards for energy efficiency in the design. The standard will allow the use of innovative approaches and techniques to achieve effective utilisation of energy and optimum building performance. Also, it encourages cost-effective energy use of building components including building envelope, lighting, HVAC, electrical installations, lift and escalator, and other equipment.

6.2 Establishment of policy framework for building energy standards

The practice of building energy standard for energy saving and sustainable energy efficient design in building is a complex system, involving many different interest departments, such as finance, resources, industry, tax, environment, etc., and needs coordination among administrative departments. This approach will help to implement building energy standard measures for sustainable energy efficient designs in buildings and projects with adequate support of the relevant policy framework.

6.3 Establishment of innovative financial schemes

These schemes will help to finance, implement and enforce building energy standard measures at a cheaper and cost effective ways. These schemes will involve grants/financial support, capital subsidies, audits schemes, tax incentives, soft loans, etc., at the national level and at the international level. Also, these measures will enhance energy standards implementation capability and help to bridge this sustainability gap.

6.4 Instituting technical assistance and training

Capacity-building and training are indispensable for developing countries example, lack of knowledge on energy saving construction techniques among architects has been identified as a major barrier to energy efficient design, even in most developed countries in Europe [50, 29]. Sustainable construction, design and know-how needs to be introduced into the base curriculum of architects, engineers and other construction-related professions all over the world. This is very important for developing countries because of the often much more dynamic new construction designs. As the training of countries' own nationals will take some time, technical assistance through international consultants and organisations can be engaged in order to bridge this sustainability gap.

6.5 Establishment of regulatory measures by government

At the government disposal are a variety of administrative, regulatory, and financing tools that can help building professionals to design, develop and operate buildings in a sustainable manner. Governments can create policies for procurement, contract specifications, building performance, and building codes regulating community standards; enact resolutions, training and education programs, and ordinances that focus attention on sustainable development and energy efficient design in building. Also they can create community boards and commissions to study local sustainable issues and provide economic incentives for sustainable development in building.

7. Recommended sustainable energy efficient building initiatives

Sustainable energy efficient building initiatives, as well as sustainable development activities, can offer many opportunities to governments and communities in these developing countries. The key to success for governments in these regions is to take the first step toward achieving sustainable energy efficiency in building through the implementation of building energy standards ; is to start with the implementing the following sustainable energy efficient building initiatives:

1. Examine government policies and procurement procedures for inclusion of sustainable energy efficient building measures.
2. Develop a demonstration sustainable energy efficient building project or sustainable building design through application building energy standards
3. Require that government building projects incorporate sustainable energy efficient systems, indoor-air-quality guidelines, and waste and water-efficiency measures.
4. Survey and review other countries with sustainable energy efficient building projects, programs, and standards.
5. Assemble a multidisciplinary team within the communities to discuss the possibility of developing a sustainable energy efficient building program.
6. Develop a sustainable energy efficient building awards program; co-sponsor the program with the local utility and local chapters of design, engineering, and property-management societies.
7. Survey and publish the community's sustainable energy efficient building and building energy standard resources.
8. Initiate a conference or series of lectures on sustainable energy efficient building issues.
9. Assemble a sustainable energy efficient building and energy standard resource library within an existing libraries or municipal offices.
10. Publish case studies of sustainable energy efficient building projects achieve through energy standards.

8. Conclusion and recommendations

Building energy standard plays a significant role in reducing building energy consumption. Besides, it is a widely used instrument in most developed countries for sustainable energy efficient design in building. However, the position of building energy standards in developing countries in respect to energy standard

implementation toward sustainable energy efficiency is not known. In addition, there exist a sustainability gap between the existing building and increasing demand for sustainable energy efficient building .Moreover, the lack of consistent data which makes it difficult to understand the underlying changes that affect energy standard implementation in developing countries. In that respect, this paper investigated the implementation status of building energy standards in developing countries and the implication for sustainable energy efficient design in buildings. Even though there are elements of progress on energy standard activities in Africa, Latin America and Middle East in view of higher number energy standard proposals recorded in these regions (see Figure 3). However, they are still far behind in building energy standard implementation when compared to developed nations [13]. Further more, there is a steady progress on energy standard implementation in Europe, North America and Asia with highest number of building energy standard being implemented as shown in this study (see Figure 3). In general, the performance of building implementation in developing countries is still at infant stage especially in the emerging developing countries. As a result, this study presents the implications of this phenomenon for sustainable energy efficient design in buildings. The study recommended ways to address the challenges of the sustainability Gap that exist due to this phenomenon in Developing Countries and recommended sustainable energy efficient building Initiatives that can be implemented.

Acknowledgement
The author acknowledges the contribution of United Nation Environment Programme Report UNEP [6] and Kathryn Janda [13] whom their reports have served as a major reference in this study.

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