Implications of Building Energy Standard for Energy Conservation in Developing Countries

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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. Energy consumption of buildings in developed countries comprises 20–40% of total energy use in EU and USA while most of these developed countries are implementing building energy standards rapidly to reduce building energy consumption. The position of developing countries in respect to energy standard implementation is either poorly documented or not documented at all. In addition, there is a 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 investigates the progress of building energy standard in developing countries and its implication for energy conservation. The present status of building energy standards in 60 developing countries around the world, were analyzed through survey of building energy standards. The study uses using online survey. Hence, this study revealed the present progress made on building energy standard, implementation and compliance at the same time the study recommends possible solutions to the barriers facing building energy standard implementation in developing world.

Keywords: Energy, Standard, building, implementation, developing and 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, 2009) and (Janda and Busch, 1994) 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 (Hui, 2000). In view of these facts, there is a pragmatic shift to the use of building energy standard and code to reduce building energy consumption in developed countries. Building energy standards can be used to address the energy use of an entire building or building systems such as heating or air conditioning (Birner and Martinot, 2002). Energy standard is one of the most frequently used instruments for energy efficiency improvements in buildings and can play an important role in enhancing energy efficiency in buildings (OECD, 2003). This paper investigates the progress of building energy standard in developing countries and its implication for energy conservation. The paper reviews the present status of building energy standard in 60 developing countries around the world through survey of building energy standard using online survey. It also discusses the implication for energy conservation, challenges, and barriers.

1.1 Buildings Standards in Developing Countries

While building energy efficiency codes exist in almost all developed countries more and more developing countries are currently introducing such legislation (UNEP, 2009; Deringer et.al, 2004). The latter are often introducing voluntary standards first. There are two types of building energy codes: prescriptive codes 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 codes, prescribing only an annual energy consumption level or energy cost budget, usually provide more incentives for innovation (Gann *et al,* 1998). 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 (UNEP, 2009). Deringer *et al.* (2004) 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. (2009) 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 (2009) and Laussen (2008), 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 (Moisan, 2005). Furthermore, Janda (2009) 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 standard, 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.

2. 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 organizations 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 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 (2010a) 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 (IMF, 2010b). In consideration of the above definitions, this study further classified developing countries as emerging and developing countries (IMF 2010a) and Graduated developing Countries also known as newly industrialized countries (NIC). NIC is a category between developed and developing countries. (IMF, 2010a; Pawel, 2006; Mauro et al, 2003; Waugh 2000; Mankiw, 2007). 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 and compliance. These investigation variables and the question asked in the survey were derived from literature review (Janda, 2009; RIC, 2009; UNEP, 2009).

3. DATA ANALYSIS AND DISCUSSION

3.1 Overview of Regional Energy Standard performance For Developing Countries

In the sample surveyed, a total of 97 responses were received from 60 different countries. According to survey, 62% of the countries that responded to this survey were from emerging developing countries while 38% percent were from graduated/NIC developing countries. Building energy standards are starting to appear in the Africa, Latin America and Middle East regions, 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, 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 (RIC, 2009).

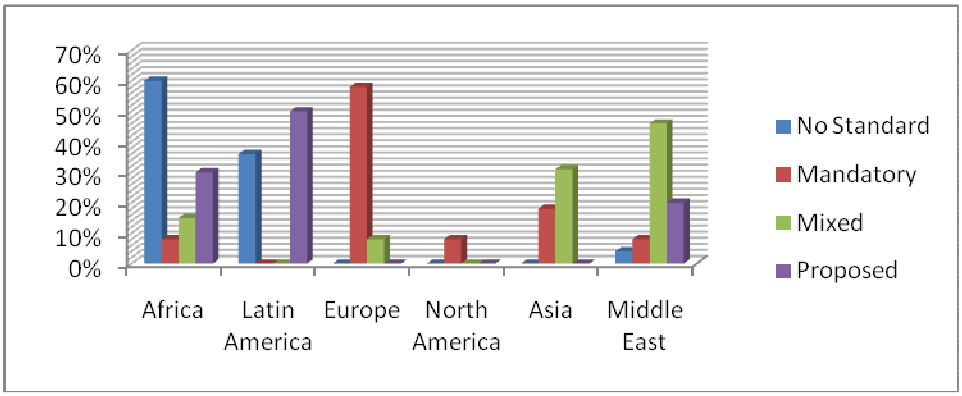

Figure 1. Regional Energy Standard performance For Developing Countries

In figure 1.0, 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 fig 1.0.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 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 (RIC, 2009). 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 (RIC, 2009). 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 (Anon, 2005; Huang et al. 2003).

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,). Enforcement seems to be robust in, Singapore and Taiwan going by the level of energy standard activities and performance as shown above, but a recent study by the United Nations Development Programme has suggested that elsewhere a lack of resources has compromised compliance (RIC, 2009). 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 compliance. Enforcement is unclear (Hong and Chiang, 2007; Huang, 2006). In Middle East, some progress has been made on building energy standard development and adoption as shown in figure 1. 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. However, lack of an established regulatory infrastructure is a significant barrier to practical application of building energy standard (RIC, 2009).

3.2 **Building Energy Standards Development, Implementation and Compliance.**

3.2.1 Development:

This section analyses the development performance of building energy standards in these stated regions. In figure 2, 78% of the countries surveyed for Europe indicated that energy standards in their countries are scheduled for review and revision (SRR) while only 40% in Africa and 15% from Latin America indicated that their energy standards are scheduled for review and revision (SRR).The high percentage recorded from Europe and North America shows their level of energy standard development, progress and regular upgrading of their standards compare to other regions where development is still at infant stage such as Latin America. In line with this view, 58% of respondent countries from Europe, 100% from North America and 42% from Africa indicated that computer simulations were used to attain compliance (CSC) their energy standard development. This also indicates the high level of activities being undertaken to develop their energy standards. In support of the above views,78% of the countries surveyed from Europe, 100% North America and 64% Africa confirmed that energy standards from a different country(ESD) was used to develop their standards[including proposed standards].

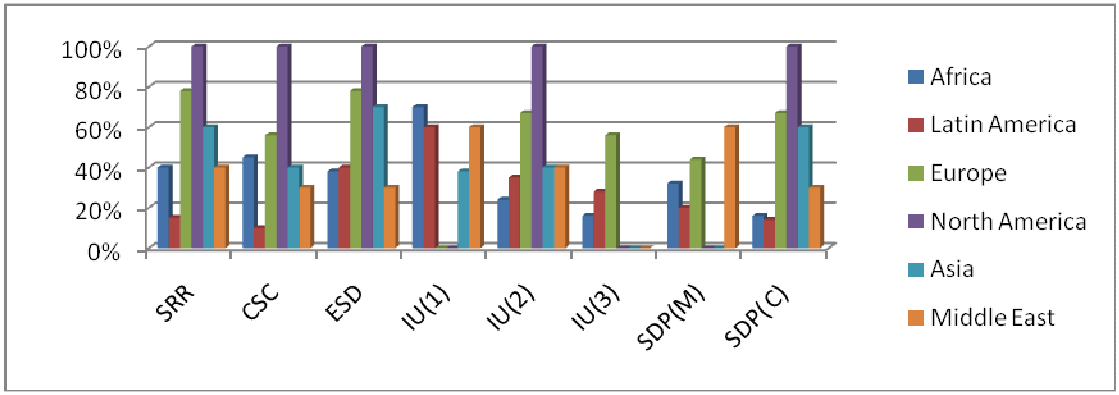

Fig 2. Regional Building Energy Standard Development Performance

On the types of information that was used (UI) to developed energy standards in their countries, 64% of respondents from Africa, 60% from Latin America and 60% from Middle East indicated lack of information [UI (1)] in developing their energy standards. Moreover, 62% from Europe, 100% from North America, 40% from Asia and Middle East indicated using professional judgments [UI (2)] to develop their energy standards while only 22% of Latin America and 18% of Africa indicated gathering information through audits and surveys[UI(3)] for the purpose of developing their standards. On the standard development process (SDP), 62% of respondents from Europe, 60% from Asia and 100% from North America indicated consensus decision [SDP(C)] while 25% from Africa, 18% from Latin America and 60% from Middle East showed support for mandate decision [SDP (M)].This analysis suggests that countries surveyed from Europe, North America and Asia which are mainly graduated/NIC developing countries are more prone to integrated and consensus approach. Thus suggests their high level of energy standard usage, progress and development in these regions. On the other hand, Africa, Latin America and Middle East which are mainly emerging countries are more prone to mandate approach in making decision and developmental policies as they recorded lower percentages consensus approach (SDP(C)].Thus suggests that all decision making regarding energy standard are still from government only with little or no input

from non-governmental entities. As a result, there is lower energy standard development recorded in these regions compared to regions with integrated approach.

3.2.2 Implementation and Compliance

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 3,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 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 show high level of energy standard implementation in these areas as confirmed their high performance in developing energy standard as shown in figure 2 above.

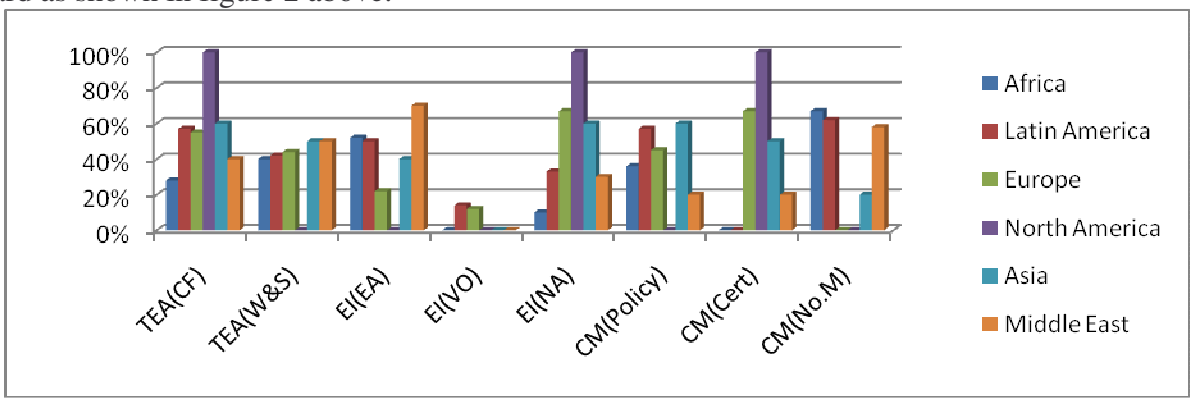

Figure 3. Regional Energy standard Implementation and compliance performance

However, the general response on the sole dependence on voluntary organizations [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 compliance mechanism while 62% from Europe,100% from North America and 45% from Asia confirmed the used of certification approach[CM(Cert)] as their compliance mechanism. On the other hand, 62% respondents from Africa, 60% from Latin America and 58% from Middle East indicated that no compliance mechanisms [CM(No.M)] were in place. Thus, indicates low level of compliance in these regions. In general, in spites of low compliance 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 development and 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.

4. IMPLICATION OF BUILDING ENERGY STANDARD FOR ENERGY CONSERVATION

Building energy standards and regulations are policy measures widely used to control energy consumption in buildings (Janda and Busch, 1994). It can help overcome some of the significant market barriers and ensure that

cost-effective energy efficiency opportunities are incorporated into new buildings. This is especially important in developing countries where the number of new buildings is growing rapidly and the energy prices and market often do not encourage the use of efficient technologies (Hui, 2000). Despites this situation, some parts of developing countries are making progress on the adoption, development, implementation and compliance of building energy standards as indicated in the above analysis from figure 1 to 3. However, the implementation and application of energy standard to conservation energy in building is still far behind compared to developed countries (WBDG, 2009; UNEP, 2009; Deringer et al 2004). Building energy standards are one of the most frequently used instruments for energy efficiency improvements in buildings and can play an important role in improving energy conservation in buildings (OECD, 2003). 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 (HKU, 2009). Also, energy standards allow the use of innovative approaches and techniques to achieve effective utilization 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 (EMSD 2010). Therefore, energy standards generally dictate the requirements for building's envelope, mechanical, and lighting requirements as well as window requirements. All these measures are incorporated in building energy standards and lead to significant reduction in building energy consumption and enhance energy conservation in building WBDG (2009).

5. BARRIERS AND CHALLENGES FACING BUILDING ENERGY STANDARD APPLICATION IN DEVELOPING COUNTRIES.

The present position in which 42% of developing countries surveyed do not have building energy could be attributed to some implementation barriers (Evander *et al*. 2004; Deringer *et al*. 2004). The numerous barriers presented explain why implementation of building energy standard towards energy conservation and energy efficiency improvements usually requires special impetus through governmental action. The number of barriers is enormous and according to some estimates, it is higher in the buildings sector than in any other sector. These barriers includes: economic/financial barriers, lack of appropriate production technologies (LAPT), behavioural and organizational constraints, political and structural barriers, information barriers and limited policy framework (LPF). (IPCC, 2007; Wang et al.2008; UNEP, 2009)

5.1.1 Economic/financial barriers

Purchasing more efficient equipment as stipulated in building energy standards usually involves higher costs which many Consumers do not want to spend and low-income consumers cannot afford because they have limited capital (Carbon Trust, 2009). This is one of the most important barriers facing the application of energy standard in developing countries as a result of lack of funding. As it is now, the energy prices and market often do not encourage the use of energy standards involving efficient technologies (Hui 2000). Although it is an efficient way or technique to apply high technology and equipment to save energy in buildings, but cost consideration is a prime challenge. The high cost has hindered the utilization of building energy standard, because the technical level of most developing countries lags behind some developed countries (INTEESA, 2009). Therefore, it is impossible to carry out the energy-saving strategies involving building energy standard if there is no financing guarantee either from government or private organizations.

5.1.2 Lack of appropriate production technologies (LAPT)

LAPT is a crucial barrier to building energy standard because most developing countries lack production capability to produce energy efficient and cost effective products in line with energy standards stipulation, implementation and compliance. As a result, developing were unable to properly enforce building energy standards which would have create market and encourage the development of local skills in all areas of building energy standard such as energy standard implementation, compliance, development, energy conservation and efficiency. This makes the implementation of energy standards in building abound in technical bottlenecks which waste energy and pollute environment. And it is important to recognize that they are not large on a per capita

basis. The small size of per capita fossil fuel reserves restricts for developing countries and China's capacity to follow Western-style industrialization. Accordingly, developing countries needs to find their own ways of production which best suit their national conditions and improve their production capacity for them to execute building energy standard effectively and according to their economic capacity.

5.1.3 Behavioural and organizational constraints

Behavioural characteristics of individuals and organizational do hinder energy standard practices. Small but easy opportunities and strategies for energy standards implementation are often ignored and changing in behavior or lifestyle is very difficult (Shove, 2003; Chappell's and Shove, 2005). This phenomenon can be described as "bounded rationality" according to Simon (1960), who argues that human beings act and decide only partly on a rational basis. In developing countries, energy expenditure represents a much larger share of the disposable income, but energy subsidies often lower the energy price artificially, which does not encourage the practice of building energy standards. Actually, energy subsidies are frequently considered as one of the most important barriers for energy standard practice in developing countries (Alam, 1998). This is because most of the findings that are suppose to be expended on energy saving programme such subsidizing the implementation and proper enforcement of building energy standard are being spent on energy subsidy for short term benefits.

5.1.4 Information barriers

Lack of information about the potentials of building energy standard as energy efficiency solutions is a major barrier in developing countries and therefore mentioned as a separate barrier category here (Evander *et al*. 2004; Deringer *et al*. 2004). Very often, provision of energy services or provision of access to the national grid is considered a priority without recognizing the advantages of always combining these with application of building energy standard for energy efficiency in order to reduce the electricity required. Even in Germany and most European as well as other developed countries many architects don't know. Therefore, inadequate data and information (IDI) is a serious barrier faced by developing countries in the process of energy standard implementation

5.2 Possible solutions to these barriers

In order to overcome these barriers the following remedies are being proposed:

5.2.1. **Addressing the economic and financial barriers by investing in building energy standard measures now and gain the benefit later**. The options involved in this approach are:

- The use of economic and market based regulatory instruments: economic regulatory instruments help to reduce transaction costs such as EPC. Energy performance contracting (EPC) means that a contractor, typically an energy service company (ESCO), guarantees certain energy savings for a location over a specified period; implements the appropriate energy efficiency improvements; and is paid from the estimated energy cost reductions achieved through the building energy standard measure applications(UNEP 2009). EPC and ESCOs therefore serve as vehicles or agents for implementing and financing building energy standards. The other three economic instruments presented are: cooperative procurement, energy efficiency certificate schemes and Kyoto flexibility mechanisms.
- *Fiscal instruments and incentives:* Capital subsidies, grants, subsidized loans and rebates are one of the most frequently used instruments for increasing energy efficiency in buildings. Subsidies are very commonly used to overcome the major barrier of high first costs (ECS 2002). They are used to finance better insulation such as roof insulation in the UK, more efficient equipment such as refrigerators in Germany, CFLs or energy audits as in France. Subsidized loans are used for example in Austria to support ESCOs.

5.2.2 .**Information barrier: information policy instrument can be applied for information barrier**.

This instrument can will be very effective if combine with regulatory measures. Public information campaigns can be described as policy instruments designed by government agencies with the intention to change individual behaviors, attitudes, values, or knowledge (Bender *et al*. 2004). Program types include counseling, consumption feedback, elementary school programs, and mass media motivational campaigns on energy standard can be effectively implemented. Also, creating local energy information centers, establishing good information systems, strengthen data collection networks.

5.2.3 Lack of appropriate production technologies: technology subsidies can be help to facilitate the introduction of new technologies and enable especially poor households to engage in energy efficiency investments and implementation of energy standard measures. For this reason, they are especially useful in developing countries where financial limitations constitute one of the major barriers for energy standards implementation. This will create market for cost effective, energy efficient building components and encourage local skills. Also it will enhance better enforcement of building energy standard development and implementation.

5.2.4. Behavioral and organizational constraints: voluntary policy instruments and regulatory measures can be implemented to confront this barrier. These approaches involved voluntary agreement, certification, public leadership programs, and detailed billing. These are the regulatory measures that can ensure compliance and adequate enforcement of building energy standard on the organization. In order to ensure compliance, combine regulatory measure can be exploit such as voluntary agreements with a threat of regulation, industrial agreements and energy audits, industrial agreements and tax exemptions .Also, complete elimination of energy subsidy should be considered as this will facilitate the availability of cost effective technologies.

6. CONCLUSION

The progress of building energy standard in developing countries and the implication for energy conservation was considered in this paper. There are elements of progress on energy standard activities in Africa, Latin America and Middle East in view of higher number energy standard proposal recorded in these regions. However, they are still far behind in building energy standard development, implementation and compliance when compared to developed nations as indicated by Janda (2009). 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 adopted and implemented for energy conservation. Also, there is a progressive increase in the government involvement in energy standard development and implementation as indicated by high percentage of government agencies involvements and percentage of developing countries now using mandate decision approach. Besides, 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% have proposed standards. In general, building energy standard activities are still at infant stage in some in developing countries despites continuous increase in building energy demand. Therefore, there needs to further promote the use of building energy standard for energy conservation in developing countries through international partnership.

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8. AUTHORISATION AND DISCLAIMER

The content of this paper is authorized by Joseph Iwaro and Abrahams Mwasha.The content and information is intended to promote energy research and the use building energy standards for energy conservation and

efficiency. Effort has been made to ensure that the content of this paper is accurate and up to date. However, if you do find any error or objectionable area, please contact the authors to discuss any change.

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