Development of Strategies for Sustainable Energy Efficient Building Codes in Nigeria

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Abstract- The promotion of Energy efficiency in buildings has gained prominence worldwide as a result of several issues ranging from high level energy demand for buildings to high cost of the energy at construction and post-construction stages. There exist a serious concern regarding problems of energy supply and consumption. Studies have shown that buildings approximately use 39% of the total energy consumed globally. In view of this environmental issue, increasing cost of energy and the current economic challenges; building energy efficiency is a key component of sound public policy. It is evident that preaching energy efficiency through incentives and disincentives alone may not be the only solution to these environmental challenges. A radical approach need to be employed through provision of rules and regulations in the form of codes to reduce the effect of these monumental environmental problems in developing countries most of which are in the tropics. This paper seeks to highlight several public policy efforts made locally and internationally on the ways to militate against this menace. It illustrates the role of government in setting and enforcing energy codes and standards. The study suggests strategies towards effective energy code development, implementation and compliance at all levels of government in Nigeria and concludes with recommendations on how best to achieve the said goals.

Index Terms- Compliance, Energy Codes, Energy Efficiency, Enforcement, Sustainability

I. INTRODUCTION

Energy efficiency in buildings and sustainability is relatively young but rapidly developing phenomenon (Legislative Research Commission, 2008) which is gaining prominence in global affairs due to high energy demand in most sectors of the economy and infrastructural development to which the building industry accounts for about 40% of the global energy consumption (IEA, 2008). Research has proved that energy efficiency of new buildings determine the building sector's energy consumption to a large extent than the end-use components. It is pertinent to note that energy issues are not of continuing policy concern, due to the crucial role played by energy in various aspects of life such as environmental quality, economy and national security (Building and Energy Efficiency, 1992).

In emerging developing nations energy consumption has been on the increase due to recent economic growth and development. The quest for more buildings and infrastructure (Joseph and Abraham, 2010) as a result of this high energy demand lead to serious environmental problems such as global warming, air pollution and acid rain. In view of the above emerging facts, there is radical shift to the use of building energy standards and codes to minimize building energy consumption in developed countries to achieve a more sustainable and energy efficient buildings. The situation however is not the same with developing countries like Nigeria as argued by Deringer, Iyer and Yu Jo Huang (2004), that where these codes and standards exists in these countries, they are often on paper only without implementation and enforcement due to corruption and other related problems.

With all the global euphoria on energy efficiency, there seem to be little or no policy directly geared towards control in energy consumptions. It is however pertinent to note that Nigeria as a nation has been in energy generation crisis for decades, the energy generating capacity as at 2007 estimates stands at 5,898mw (EIA, 2010) within estimated population of more than 160 million when compared to other African countries like South Africa with generating capacity of 43,000mw in 2008 and a projection of 77,000mw by 2017 and a population of 49.9 million; or even Egypt with a capacity of 23,400mw and a population of 80.4 million (PRB, 2010 and Energy information Administration, 2010).

It can be said that devising ways to conserve energy or being energy conscious cannot be over emphasized. The National Energy Policy promulgated in April 2003 by Energy Commission of Nigeria is principally centred on these aspects of energy consumption namely: Industries, Agriculture and Transportation with no specific reference to energy consumption in the building sector. In 2010, effort was made by the establishment of National Centre for Energy Efficiency and Conservation at University of Lagos. While the National Building Code which was evolved in with the aim of setting minimum standards on building pre-design, design, construction and post-construction stages (National Building Code, 2006) with the view to ensuring quality, safety and proficiency in the building industry made no reference to energy efficiency in buildings. Bearing these issues in mind, it certainly became imperative to propose a strategy for energy code development and ways to implement and enforce these codes.

Table 1. Electricity Production and Consumption 2007

Country	Population (2010 est.)	Generating Capacity (MW)	Electricity Production (KWh)	Electricity Consumption (KWh)
Egypt	80.4 million	23,400	118.4 Billion	104.1 Billion
South Africa	49.9 million	43,000	240 Billion	215 Billion
Nigeria	160 million	5,898	21.92 Billion	19.21 Billion

Source: EIA, 2010; World Fact Book, 2010

II. ENERGY EFFICIENCY IN BUILDINGS

2.1 ENERGY CONSUMPTION IN BUILDINGS

Energy is used in buildings for various purposes ranging from heating, ventilation, cooling and lighting etc. In residential and commercial building, there seem to be no clear distinction between fixed and fluctuating demands for energy (IEA, 2008).

Emphasis was only given on total amount consumed by whole building. With this difficulty in subdividing energy requirements, most analysis examined energy use in building as defined by the end-use (operational phase of the building).

Table 2. Energy Consumption Comparison

Building	Location	Gross Floor Area (Sqm)	Height (m)	No. of Lifts	No. of Light Fittings	Energy Consumption (kWh/m2.a)
Ji Mao Tower	Shanghai	292,475	420	79	N/A	215
Petronas Towers	Kuala Lumpur	980,000	450	76	60,000	N/A
CBN HQ	Abuja	72,000	70	18	11,200	121

Source: Emporis Corporation., CBN website and Wikipedia, 2011

Based on the superficial study of the above table in addition to lack of sufficient energy in Nigeria; it can be agreed that there is urgent need for energy conservation mechanism to reduce the effect of these impending crisis.

2.2 DEVELOPMENT IN BUILDING ENERGY EFFICIENCY.

World business council for sustainable development (2007) defines energy efficiency as a process of reducing energy consumption to acceptable level of comfort, air quality and other occupancy requirement, including the energy used in manufacturing building material and in construction. There have been developments globally in promotion of energy efficiency in the privet building construction sectors. Most energy efficiency requirement in building codes followed some form of traditions with the past decade showing a trend in borderless collaboration to develop international energy efficiency standard (International Energy Conservation Code, 2004). The overall argument for improved energy efficiency in building as put forward by European Alliance of Companies for Energy Efficiency in Buildings (EACEE, 2007) centers primarily on the following;

- Reduction in cost of energy to consumers and improved comfort.
- Ruction over- dependences on energy.
- Minimize greenhouse gas emission (GHG)
- Contribute to the objective of sustainable development.

2.3 RATING FOR ENERGY EFFICIENCY

There exist various rating system for energy efficiency as described by (Prucnal-Ogunsote; Okwoh and Udeh,2010) which include the building research establishment environmental assessment method (BREAM) in the United kingdom, the Green

Star in Australia, Haute Qualite Environmental (HQE), also establish are the LEED, ASHRAE and green global rating system in the United States some of which the authors below.

2.3.1 LEED: Leadership in the Energy and Environment Design as stated in Wikipedia, (2009) is an international recognized green building certification system proved third party verification, that a building or community was designed and built using strategies intended to improve performance in metrics such as energy saving, water efficiency water efficiency, greenhouse gas emission, indoor quality etc. This system was development by US green building council established in 1998 intended to provide building owners and operators a concise framework for identify and implementing practical and measurable green building design. This certification is after submission is obtained after submission of application documenting compliances with the rating system. The outlined advantages of LEED certification among others are:

- Save up 25-30 % more energy efficiency.
- Better ventilation and Effective temperature control.
- Improve indoor quality.
- Add economic value to properties (where owners charges 2-3% higher (if their properties are LEED certified).

2.3.2 ASHRAE: American Society of Heating Refrigerating and Air-conditioning Engineers is a professional organization based in the united state which was founded in 1894 that provides certification and standards for design of high energy performance buildings. Originally its interest is in the area of heating, ventilation, air-condition and refrigeration (HVAC&R), but in 2006 it adopted the concept of sustainability and demonstrated so by renovating its headquarters to be highly energy efficient and there by obtaining a LEED Platinum rating (Wikipedia, 2009).

2.3.3 GREEN GLOBE: Another energy rating system based upon agenda 2 of the United Nation Sustainable Development Strategy endorsed by 182 countries at the Earth Summit held at Rio de Janeiro in 1992.

The challenges evolving as a result of this certification include:-

- Raising cost of initial design and construction
- Requiring in-depth research for the design team to fully understand complex matrix of sustainable construction principle which result in delays
- Pursuing LEED certification is also an additional cost.
- Lack of available manufactured building component which meet the certification.

2.4 MITIGATION MEASURES TO ENERGY CONSUMPTION

In other developed nations such as the United State, tax incentives and rebate programmes were introduced as a popular tool to encourage people to embrace energy efficiency in buildings. These incentives programme which encourage private investment in the energy industry have been successful when offered at level sufficient financial risk. Studies have shown that major challenge with offering such as programme will be funding (IEA, 2008).

The data base of American Institute of Architects (AIA) has information on the following types of alternative green building initiatives among others.

- Discount or cash rebate for energy efficient appliances and operating systems.
- Technical guidance for efficient and sustainable designs.
- Reduction of permit and zone fees in return for achieving specific levels of efficiency certification by LEED or similar rating system.
- Expedited and streamlined permit for green building and development.

III. ENERGY CODES AN STANDARDS FOR EFFICIENCY

3.1 CODE CLASSIFICATION SYSTEM

Basically the classification of coding system is based on several forms. But the major classification is based on the following three broad based categories: Basic requirement, the Prescriptive and Performances base. Other forms code formulations do exist but for the purpose of this study, emphasis will be on the prescriptive and based codes. Other forms of code formulation do exist but for the purpose of this study, emphasis will be on the prescriptive and performance based codes.

The building or part of the building that will be subjected to code shall meet some basic requirements which include fundamental issue such as insulation, power quality, lift performance or other energy efficient item such as luminous efficiency etc., which are usually related to measures that cannot be accurately modelled. Assumptions made in this regard shall be based on appropriate professional judgment.

3.1.1 PRESCRIPTIVE BASED CODES

This method as outlined in the IEA, 2008 set separate energy efficiency requirement for each building. That is to say individual components such as walls, windows, frames etc., must achieve compliance with their specific targets. When setting codes or regulations using prescriptive method, energy efficiency requirement are set for each component as described above such as U-values, thermal conductivity for windows, roof etc. Prescriptive method can also include efficiency value for technical installations, ventilation, building orientation, solar gains, window size and quantity to which each part of the building component must meet these set values or code for energy efficient building.

3.1.2 PERFORMANCE BASED CODES

In performance based regulation as described by Joseph and Abraham, 2010, those requirements are based on building overall consumptions energy or the implied building emission of green house gases. This method involves setting a total energy requirement for the building based on supply of energy or resulting environmental impact. This method requires an extensive and comprehensives method for calculating the energy performance of a building with standard values for climate and

use of the different categories of buildings. The use of advance computer simulation model is implored for the calculation using building energy software programmes such as DOE-2, Energy plus, ENERGY-10, e-QUEST etc. Resultant values for energy performance are set based on overall value, consumption per square meter or a combination of both for different types of buildings.

The other forms which are briefly going to be mentioned include: the trade-off, which set values for each part of the building some of which could be more or less to strike a balance in the overall values; the model building approach which also set value as in trade-off but with a model building with same shape calculated with those values.

IV. STRATEGIES FOR CODE DEVELOPMENT IN NIGERIA (FIVE-STEPS)

At present the codes and regulations relating to building in Nigeria make little or no reference to energy as such the below mentioned strategies could be adopted in evolving a sustainable energy efficient building code which will work side by side with the existing National Building Code. The steps are as follows:

STEP 1: INITIATION

Convening stakeholders' forum involving policy makers, all professionals in the building industry, representative from the energy sectors of economy, manufacturers of appliances and equipment, environmentalists, educator, planning authorities to brainstorm on the issue of energy situation in Nigeria with the following objectives:

- Create more awareness in the area of energy efficiency.
- Take stock of the current state of energy consumption in Nigeria.
- The need and effort of manufacturers of building components, appliances and equipment in manufacturing products that are energy conscious.
- Provision of legal and macro economic frame work for energy efficient technology.

STEP 2: FORMULATION

This involves constituting a Building Energy Conservation Council to be chaired by an astute building professional under Energy Commission of Nigeria (ECN) possiblly as a sub division of recently established National Centre for Energy Efficiency and Conservation with the sole aim of achieving the under listed objectives

- Give more emphasis on creating awareness on the environmental, economics and social benefits of building energy conservation.
- Formulate a policy on modalities to manufacturers of energy conscious building products, design professionals and developers with energy conscious approach to design and construction.
- Develop a procedure for evolving energy code for buildings.
- Outline measures for compliance and enforcement of these codes.
- Fashion out other options for enforcement of these codes.

STEP 3: THE CODE STRUCTURE

The structural format and arrangement of the code can be based on the existing International Energy Conservation Code 2009 edition with some slight modifications to be compatible with the current situation and make it akin with the existing National Building Code for ease of reference. The modifications should be in the areas of climatic zone, design and construction process. The format is categorized as follows:

- General administration and definitions: which will deal with the general administrative provisions in the code, issue of enforcement, scope and definition of terms as stated in the body of the code.
- Material requirements.
- Energy efficiency in residential buildings.
- Energy efficiency in commercial buildings.
- Reference standards.

STEP 4: CODE COMPLIANCE INFRASTRUCTURE

The challenge for code compliance and enforcement in Nigeria has been an issue under debate, while the national building code came into existence five years ago. There appeared to be a fundamental challenge of poor compliance and enforcement. This may be as a result of several factors which include government policy on implementation, lacking the political will to enforce these codes, insufficient information to fully understand and assess the situation among others. The need for sufficient information on the cost implications, overall benefit of energy efficient building codes as well as other energy policy enforcement and lack of knowledge over the real impact is in itself symptomatic to lack of attention; adequate compliance and evaluation procedures. The consequences of which will lead to a gap between intended goals of energy efficient building codes and its actual outcomes. This paper intended to provide strategies that could be explored to achieve effective code compliance which are itemized as follows:

- Capacity building for professionals in development control authorities, building professionals developers on energy code interpretations and application.
- Development of product labels and thermal insulation rating systems.
- Upgrading research laboratories in tertiary institutions to carry out certification process.
- Issuance of Energy Performance Certificate (EPC) after practical completion of building and subsequently when the property is about to be leased or sold out.
- Formulating an inspection, monitoring and evaluation team possibly through out-sourcing of the inspection to the private professional entities to ensure effective compliance and also reduce the burden of work for the planning authorities. Capacity building in the aspect of energy efficiency is inevitable to acquaint them with energy efficient strategies.

STEPS 5: CODE ENFORCEMENT STRATEGIES

For any meaningful achievements to the issue of code enforcement, various roles and responsibilities of those saddled with responsibility of energy code enforcement must be unambiguously spelt out and separated according to the enforcement elements.

4.1 APPLICATION TO DESIGN, CONSTRUCTION AND OCCUPATION STAGES

4.1.1 DESIGN STAGE:

This stage involves the project inception stage, feasibility, brief formulation, preliminary design stages, detailed designs and specifications. At this stage the role of those saddled with the responsibilities are as follows:

(A) PLANNING AUTHORITY

- The planning authorities at all level of government shall be statutorily saddled with the power of energy code enforcement.
- Determine the level of special building plans for third party involvement for review and inspection.
- They shall be empowered to appoint third party known as Professional Plan Examination Firms (PPEF) to perform function of plan examination and review based on complexity of the project.
- Issue building permit based on the recommendation of the approved PPEF.
- Issue final approval for construction based on PPEF reports.

(B) DEVELOPER

- Shall also be referred to as the applicant.
- Shall be responsible for meeting all the requirements specified in the energy code.
- Must obtain a copy of the code or extract of the code relevant to his/her proposed submission.
- Supply complete and accurate drawing to planning authority for onward submission to appointed PPEF.
- Responsible for payments to PPEF based on the direction of the planning authority on government approved fees schedule.

(C) PROFESSIONAL PLAN EXAMINATION (PPEF)

- Preferably an Architect who attend or have requisite knowledge of energy conservation principles and shall be certified by the proposed energy certification/rating systems.
- The planning authority shall approve the PPEF to perform the function of drawing reviews for energy conservation.
- Checks plans for energy codes compliance of the following categories: Building envelope (insulation, glazing, shell etc).
- Notifies the developer in case of compliance deficiencies.
- Approves plans/drawing when they must have satisfied relevant energy code compliance.
- Provide access of approved plans/drawings to planning authorities when required.

4.1.2 CONSTRUCTIONS STAGE

The construction stage commences when the plans/drawings must have successfully passed the initial design stage and obtained necessary planning approval to mobilize to site for actual constructions. At this stage the role and duties of the parties are:

(A) PLANNING AUTHORITY

- Responsible for the normal site inspection.
- Appoints a professional site inspection firm (PSIF) preferably an Architect as the third party to carry out periodic site inspection to ensure strict compliance on the design stage recommendations by the PPEF on energy conservation modes.
- Issuance of a periodic permit at stage levels of the construction stage.
- The power to issue stop work notification order if energy compliance are deficient as recommended by the PSIF.

(B) DEVELOPER

- Responsible for maintaining on-site repository for records which shall be availed to planning authority and the PSIF as warranted.
- Provides direct access to all inspection area and components.
- Request for PSIF inspection at an appropriate time.
- Responsible for payment of PSIF fees as directed by the planning authorities based on approved government fee schedule.

(C) PROFESSIONAL SITE INSPECTION FIRM (PSIF).

- Appointed by the planning authorities.
- Conduct site inspection for energy code compliance to all building categories such as building envelope (insulation, glazing, shell etc).
- Resend to developers request for inspection.
- Prepare documents regarding compliances or approval.
- Provide access to these documents when required.

4.1.3 POST CONSTRUCTION STAGE

This stage indicates the practical completion of the building and its eventual habitation, the role of each party at this final stage of building cycle is:

(A) PLANNING AUTHORITY

- Authorize the PSIF to issue certificate of compliance to energy conservation code.
- Responsible for the provision of directory where all buildings certified to be energy efficient are documented reference purposes.

(B) DEVELOPER

- Upon completion shall notify the authorities for final checks for compliance with all relevant energy code prescribed.
- Shall receive a certificate of energy code compliance form the PSIF.
- May have a property with higher economic value compared to when energy measures are not considered.

(C) PROFESSIONAL SITE INSPECTION FIRM (PSIF)

- Will be responsible for undertaking final checks for compliance with energy codes.

- Issue a certificate of code compliance to the developer having satisfied all conditions on the direction of the planning authority.
- Preparation and documentation of reports for official gazetting and referencing.

V. CONCLUSION

Information and public awareness are the key elements to achieving success in terms of changing Nigeria into a more energy efficient society. This study suggests that training and education will be helpful as a starting point in convincing the stakeholders and design professionals in the building industry the importance of building energy conscious design. Without appropriate educational programmes and implementation mechanism for the industry, a well designed mandatory standard will not save energy.

The strategy proffered also covered some technical and policy details of meeting energy targets through codes compliance. Mandatory inspection by the planning authorities, and or through third party professionals, building energy certificate and labelling programmes as suggested may be good tools for achieving the stated goals.

VI. RECOMMENDATIONS

The authors strongly believe that building energy efficient design through code development, compliance and enforcement is an undisputable fact which could be effectively achieved through the following recommendations;

- Critical review of government policies and reforms in the area of procurement procedures to capture energy conscious building measures.
- Organize a stakeholders forum which will include all multidisciplinary professions to brainstorm among others the energy situation in the country and in particular the building sector, the present and future scenario, possibility of energy code development etc.
- Constitute an efficient energy certification and award system to supplement the efforts in energy mitigation.
- Establishment of energy efficient research laboratories nationwide or alternatively upgrading the existing laboratories in the nation's tertiary institutions to sufficiently undertake such researches.
- Upon successful development of the codes, government must lead by example, which means by a demonstration of energy efficient public buildings projects through the application of the energy code.
- Further research and development (R&D) to be undertaken in building for developing an intelligent and highly energy efficient buildings.
- Introduction of energy efficient curricula in schools of Architecture and Design as a foundation for training Architects in energy conservation in buildings.
- Professional Architects should be encouraged to specialize in intelligent building designs that minimize energy consumption.
- Professional body of Architects- the Nigerian Institute of Architects (NIA) and the regulating body; Architects Registration Council of Nigeria (ARCON) should include energy efficiency as a module in their Mandatory Continuing Professional Development Programme (MCPDP).

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