Analysing the challenges of designing Nearly Zero Energy Buildings and retrofitting of the existing housing stuck in Nigeria: A study of South-Eastern Nigeria.

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Abstract: In recent times the aim of building has gone beyond providing shelter and security to being more sustainable and responsive. The net Zero Energy Building (nZEB) concept has recently gained prominence worldwide, however, it is still at a nascent stage in Nigeria. Use of conventional energy sources in Nigeria, such as gasoline electric power generator among others encourages nZEBs design in Nigeria to limit the effects from use of dirty energy sources. Its large scale adoption and implementation will potentially contribute greatly to greening of the building sector in Nigeria and the world at large. Notwithstanding the great need for nZEBs in Nigerian, designing and retrofitting of the existing housing stuck has been stalled by a lot of challenges. The main objective of this research is to analyse the challenges of achieving perfect nZEBs in Nigeria. Data was sourced through questionnaires administered to designers and the built environment professionals. The finding of the paper is that there is a very strong correlation at 0.000 between training on nZEBs as a professional and consideration of energy consumption in building in the study area. The paper concludes, after analysing data collected, by recommending Passive building energy strategy as a viable solution to reduce high energy use in buildings in the study area in the event where other strategies to achieve nZEBs failed. The paper also recommend that the Nigerian University Commission should as a matter of urgency include in her curriculum Nearly Zero Energy Building courses or program to increase awareness and improve quality of design professionals graduates.

Keywords: Nearly Zero Energy Building, energy sources, designing and retrofitting, solar passive, renewable energy.

1. Introduction

It is evident that buildings consume approximately 40 percent of the world’s energy. Considering this fact, energy performance of buildings and supply is a very important issue in the context of scarcity of energy resources, climate change and reduction of global energy consumption. A wide array of measures have been adopted and implemented to actively promote a better energy performance of buildings. Nearly Zero Energy Building (nZEB) idea is one of the measures that could change the rate of energy consumption in the building sector, and significantly contribute to the reduction of the global energy use. nZEB is a building that consume slightly more energy than the amount of renewable energy they produce. nZEB is a viable way of reducing energy use in buildings, in order to alleviate the current worldwide energy challenges of rising prices, climate change, and security of supply (Marszal, Heiselberg, Bourrelle et al., 2011). Nearly Zero Energy Buildings are built with significant energy...
saving features. These features vary, depending on climate zones in which the construction occurs. According to Banerjee, (2015) the heating and cooling loads are lowered by using high efficiency equipment, added insulation, high efficiency windows, natural ventilation, and other techniques. These buildings make use of heat energy that conventional buildings may exhaust outside. The nearly zero energy idea is viewed as a means to reduce carbon emissions and reduce building dependence on fossil fuels energy generation.

Various scholars such as Sharma (2013); Cassandra et al (2013); Shubhangi et al (2017) among others have defined and reviewed the Nearly Zero Energy Building concept and saw its adoption as vital, based on its advantages. So, by the concept of nZEB we can use the renewable sources like sun, wind etcetera to reduce the use of non-renewable sources. Optimization of renewable energy is a relatively recent area of development, however, the ability to fully exploit sources of energy such as solar, wind, geothermal, and hydroelectric will be a learning process for Building Teams for years to come.

The rising problems of energy shortages and environmental concerns have encouraged the development of the nZEBs. As a consequence of the expected widespread development of nZEBs, there is an urgent need to improve the available skills for design and operation of the systems to realize energy savings, environmental protection, and economical operation.

2. Statement of the problem
Buildings are the Largest Energy Consumer in the world, consuming about 40 percent of primary energy, 72 percent of electricity, and 55 percent of natural gas (Bhavin, Jayeshkumar and Bhavnaben, 2013). Buildings are using all the non-renewable sources of energy and this situation is not different in the study area. The energy used by the building sector in South Eastern Nigeria will continues to increase because new buildings are constructed faster and in great quantity than the old ones are retired.

Notwithstanding the great advantages of nZEB, a lot of Nigerian factors have stalled designing nZEBs and retrofitting of the existing housing stuck in Nigeria. Such factors include; building materials factor, Political, Design culture factor, financial factor, Technological factor, Educational factor, Policy (codes) factor among others. Based on the foregoing, Energy consumption in the building sector will continue to increase in the study area until buildings can be designed to produce enough energy to run itself. In view of this, there is an urgent need to create the technology and knowledge base for cost-effective nearly zero-energy buildings in South Eastern Nigeria.

3. Study Area
South eastern Nigeria is one of the five geo political zones of the country with a land mass of 40,000km². a population size of 40 million and density of 400/km². The region is made up of six states namely; Abia, Anambra, Ebonyi, Enugu and Imo State. The region is rich in oil and forms the commercial nerve centre of the country. The south eastern Nigeria is known to have the highest number of high rise building in the country as well as total number of buildings than any other region of the country.
4. **Research Methodology**
A set of 500 questionnaires were prepared and were randomly administered to the design professionals across the five states that makes of South Eastern Nigeria namely: Abia State, Imo State, Enugu State, Anambra State and Ebonyi State. Out of the 500 questionnaires successfully administered, 479 questionnaires were retrieved, representing a response rate of 95.8%.

5. **Research Findings and Discussion**
Some variables that will help to understand the position of nZEBs in the study area have been analysed and presented below.

**Table 1.** During your training as a designer/Environmental professional, were you thought Nearly Zero Energy Buildings design or construction as a course in universities in Nigeria?

| S/N | Variables       | Frequency | Percentage |
|-----|-----------------|-----------|------------|
| 1.  | Yes             | 0         | 0.0        |
| 2.  | No              | 479       | 100        |
|     | Total           | 479       | 100        |

Source: Author’s field work, August to October, 2018.

**Table 2.** Have you gone for any training on Nearly Zero Energy Building as a professional either at home or abroad?

| S/N | Variables       | Frequency | Percentage |
|-----|-----------------|-----------|------------|
| 1.  | Yes             | 68        | 14.2       |
| 2.  | No              | 411       | 85.8       |
|     | Total           | 479       | 100        |

Source: Author’s field work, August to October, 2018.

The Data in Table 1 shows that during the training of the designers and the environmental professionals in the study area, they were not thought about nZEBs, the reason why it has been difficult to design nZEBs in the study area. However some of the design professionals in the study area have undergone professional training on nZEBs, though the Data in Table 2 established that only sixty eight (68) respondents out of four hundred and seventy nine (479) respondents, representing 14.2 percent of the
respondents have undergone the training. This percentage is minimal regards to the population of the south eastern Nigeria and the rate of housing construction in the area.

**Table 3.** Have you considered building energy consumption in design or retrofitting of existing buildings before?

| S/N | Variables | Frequency | Percentage |
|-----|-----------|-----------|------------|
| 1.  | Yes       | 62        | 12.9       |
| 2.  | No        | 417       | 87.1       |
| Total |          | 479       | 100        |

Source: Author’s field work, August to October, 2018.

**Table 4.** What is your reason for not considering energy consumption in designing and retrofitting of existing buildings?

| S/N | Variables                              | Frequency | Percentage |
|-----|----------------------------------------|-----------|------------|
| 1.  | Lack of technology                     | 215       | 44.9       |
| 2.  | Initial cost                           | 103       | 21.5       |
| 3.  | Lack of nZEB Education/Manpower        | 161       | 33.6       |
| Total |                                      | 479       | 100        |

Source: Author’s field work, August to October, 2018.

Table 3 established that only 12.9 percent of the respondents have considered energy consumption in designing and retrofitting of existing buildings in the study area. This is as a result of not receiving formal training on nZEBs during their training in the universities while only 14.2 percent of the respondents according to Table 3 have gone for a professional training. Considering the number of respondents that have gone for a training on nZEBs (14.4%) and those who consider energy consumption in there design and retrofitting of existing buildings (12.9%), this indicates that not all of the professionals who have undergone the training are considering energy consumption in practice.

From the survey, 44.9 percent of the respondents agreed that lack of technology is the major reason for not considering energy consumption in the design and retrofitting of existing buildings. According to Gandhi, Daniel, Peter, Alec, Riadh and Will (2014), realization of nZEBs requires a wide range of technologies, systems, and solutions with varying degrees of complexity and sophistication, depending upon the location and environmental conditions. While 33.6 percent of the respondents says that the reason was lack of education/manpower on nZEBs, 21.5 percent attribute the non-consideration of energy consumption in design and retrofitting of existing buildings to the initial cost of construction.

**Table 5.** Is there need to embrace nZEB construction in the South Eastern Nigeria?

| S/N | Variables | Frequency | Percentage |
|-----|-----------|-----------|------------|
| 1.  | Yes       | 381       | 79.5       |
| 2.  | No        | 98        | 20.5       |
| Total |           | 479       | 100        |

Source: Author’s field work, August to October, 2018.

**Table 6.** How do people of the south eastern Nigeria view Nearly Zero Energy Buildings?

| S/N | Variables | Frequency | Percentage |
|-----|-----------|-----------|------------|
| 1.  | Costly    | 92        | 19.2       |
| 2.  | Western   | 281       | 58.7       |
| 3.  | Unnecessary | 106      | 22.1       |
| Total |          | 479       | 100        |

Source: Author’s field work, August to October, 2018.
Table 7. Does any government policy exist in the south eastern Nigerian, demanding to embrace Nearly Zero Energy Building design and construction in the zone?

| S/N | Variables | Frequency | Percentage |
|-----|-----------|-----------|------------|
| 1.  | Yes       | 0         | 0.0        |
| 2.  | No        | 479       | 100        |
| Total |           |           | 100        |

Source: Author’s field work, August to October, 2018.

Considering the benefits of nZEBs such as reduced total net monthly cost of living, increased comfort, isolation from energy price increase among others, Table 5 established that 79.5 percent of the respondent indicated that there is need to embrace nZEB construction in the south eastern Nigeria, while 20.5 percent of the respondents did not see need to embrace nZEB construction in the study area, reason why according to Data in Table 6, 22.1 percent view nZEBs as unnecessary and 58.7 percent view it as western culture. From the survey it also 19.2 percent that see nZEBs as costly, which is not a problem considering the fact that the study area is the oil rich region of the country.

Some years back, policymakers globally have come around to view energy codes as an opportunity to effect wide-ranging changes in energy use. Government agencies have also identified nZEBs as the greatest goal for reducing energy use in buildings and building footprint on the planet earth. The Data in Table 7 confirms that in the study area that there is no government policy existing or existed that is demanding that in design, construction and retrofitting of existing buildings that N Design concepts should be embraced.

6. Summary of Findings

From the survey, nZEB design strategy is not known in the study area. It was confirmed that none of the Universities in the study area have nZEB Design in their curriculum, reason why the design professional do not know about it apart from those who have attended seminars and workshops on nZEBs abroad.

Table 8: Correlations.

|                      | WERE YOU though nZEB Design AS A STUDENT? | HAVE YOU GONE FOR TRAINING ON nZEB AS A PROFESSIONAL? | HAVE YOU CONSIDERED BUILDING ENERGY CONSUMPTION IN YOUR DESIGN? | IS THERE NEED TO EMBRACE nZEB DESIGN? |
|----------------------|----------------------------------------|-----------------------------------------------------|---------------------------------------------------------------|--------------------------------------|
| WERE YOU though nZEB Design AS A STUDENT? | Pearson Correlation                    | .ª                                                    | .ª                                                            | .ª                                   |
| Sig. (2-tailed)      |                                        |                                                     |                                                                |                                      |
| N                    | 479                                    | 479                                                 | 479                                                           | 479                                  |
| HAVE YOU GONE FOR TRAINING ON nZEB AS A PROFESSIONAL? | Pearson Correlation                    | .ª                                                    | 1                                                              | .948**                               |
| Sig. (2-tailed)      |                                        |                                                     |                                                                | .206**                               |
| N                    | 479                                    | 479                                                 | 479                                                           | 479                                  |

Note: *Correlation is significant at the 0.05 level (2-tailed).**Correlation is significant at the 0.01 level (2-tailed).
In the study area, energy consumption in building design and retrofitting of existing buildings is not a major consideration because of mainly lack of technology and manpower. However, the design professionals in the study area have seen the need to embrace the Nearly Zero Energy Buildings concept based on the advantages. Data in Table 8 indicates that there is a strong correlation between training the design professionals on nZEB design and consideration of energy consumption in buildings and embracing nZEB design in the study area. This indicates that for the design professionals in the study area to start considering energy consumption in building during design and retrofitting, there is a great need for them to be trained on nZEB design.

7. Conclusion and Recommendation
Considering the global energy need, its challenges, emission as a result of dirty energy sources and global acceptance of nZEBs, it is vital that energy consumption in buildings be considered in the study area. The paper concludes by recommending that the Nigerian University Commission (NUC) should as a matter of urgency include in her curriculum nZEB courses in her program. Government should endeavour to organise training and retraining for all the players in the design and built environment professionals, this will enable them to quickly cue in the world best practices and change the face of design thinking in the study area. This will promote a paradigm shift in design idea in the study area as contend by Sharma (2013), that nZEB has gained a worldwide attention and now seen as the future building concept.

Government should also remove border barriers, if possible grant tax exemption for importing technologies and materials that will help the players in the south eastern Nigeria to cue in effectively. Acceptance of nZEB technology may require government incentives or building code regulations. Therefore, Nigerian government through its legislative arm should make a policy that will encourage adoption of nZEB design concept and enforce its application as this is not contained in the Nigerian building code.

Passive building energy strategies are viable solution to the problems of energy crisis and environmental pollution, passive building designs are therefore recommended as a means to cut the dependence on dirty energy sources. In the event where other strategies to achieve nZEBs in the study area failed, passive building strategy is strongly recommended, which Riadh and Will (2014) argued that its realization is depending upon the location and environmental conditions, which the study area has a great advantage because of its location in the tropics.

If these challenges are addressed as recommended, it will go a long way in improving the technological base of the south eastern Nigeria as regards nZEBs and reduce energy consumption in new buildings and retrofitting of existing buildings, which amount to about 40 percent of the total energy consumption of the world.
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