Achieving net zero status in South Africa

Terblanche R
School of Construction Economics and Management
University of Witwatersrand, 1 Jan Smuts Avenue, Johannesburg, 2000, South Africa
rolien.labuschagne@wits.ac.za

Abstract. The purpose of this research is to determine how net zero buildings in South Africa can achieve net zero status. Net zero buildings are defined as energy efficient buildings with energy supply from renewable sources on-/ or off-site or through offsets. The Green Building Council South Africa launched and certified the first four buildings in South Africa under its Net Zero Pilot Certification scheme in October 2017. Net zero status can be achieved in waste, water, carbon and ecology respectively. The concept of net zero buildings is thus new to South Africa and certain barriers needs to be overcome. A semi-structured questionnaire was sent out to developers in order to establish the perceived barriers by developers. Net zero buildings still needs to be commercially justified in South Africa. Cost and lack of incentives are definite barriers. The National Building Regulations of South Africa is a barrier to the development of net zero buildings as is does not require buildings to aim for net zero status. Requirements from national authorities could greatly impact changes in the approach to developments. There is a knowledge gap in the construction industry of sustainable and net zero buildings in South Africa regarding the benefits, implementation thereof as well as the actual costs.

1. Introduction
The United Nations Environment Programme (UNEP) reports that the built environment contributes approximately 40% to global energy consumption and approximately 36% in greenhouse gas emissions [1]. Recently, developing countries, such as South Africa, has become known for rapid urbanisation. [2]. Urban areas not only see an increase in the carbon dioxide emission but also see a decrease in biodiversity and the effects of the Urban Heat Island effects [3]. Johannesburg, a metropole in South Africa, has been ranked as one of the most polluted cities in the world. This is due the heat island trapping dust from mining and other pollutants. According to the World Health Organisation, Pretoria is the second most polluted city in South Africa, followed by Cape Town and Durban [4]. Internationally, the growth of cities, known as urbanisation, establishes by means of high rises, inward compacting and or outward expansion. [5]. Nonetheless, urbanisation in African cities manifests as uncontrolled spatial expansion, known as urban sprawl. Recent studies on African cities found that urban sprawl subsequently causes unsustainable land use, and often consumes bordering urban areas and converts non-urban land, primarily agricultural lands, into urban developments [6]. As such, it is imperative that African countries, such as South Africa, re-evaluate development strategies by introducing sustainability.

Some sustainability strategies, for example greenery systems, have been around for centuries to reduce and mitigate the negative effects of the built environment on the surrounding environment and
biodiversity [7]. Although they have been around for centuries, green infrastructure systems is relatively new to the South African industry [8], and adaptation to sustainable strategies are slow. The latest sustainable strategy is net zero developments. Understanding if and how net zero developments are introduced in South Africa, and knowing how South Africans can achieve net zero status developments, could inform and encourage the industry. The objectives of this study is thus to define net zero developments, determine the status quo of net zero developments in South Africa, the involvement of building regulations of the latter and to determine the difficulties that South Africans face with the implementation thereof. As such, the main aim is to understand how developments in South Africa can reach net zero status.

2. Building regulations in South Africa
The national building regulations of South Africa does not include any reference to vegetation, greenery or net zero energy usage [9]. As such, it is not compulsory by national regulations to develop sustainable or net zero buildings in South Africa. Nonetheless, South African cities have influence over building energy usage, and thus energy-related emissions, through the building plan approval process, building inspectorate and regulatory functions. Local authorities in South Africa introduce their own by-laws regarding green and sustainable buildings. A range of options regarding the minimising of energy usage by buildings are being explored. These include by-laws that are more stringent than the national building regulations on building energy efficiency. Stringency would increase in order to meet the net zero or low-carbon target by 2030/2050. Incentives for developing more energy efficient buildings are also being considered. Four of South Africa’s metros (Johannesburg, eThekwini, Tshwane and Cape Town) are aiming to implement innovative programmes and certain policies that strive towards net zero carbon emissions from newly-developed buildings by 2050 [10]. The City of Johannesburg has a Built Environment Guideline which will be simplified and reused for awareness-raising. eThekwini (Durban) aims to incentivise green developments. City of Cape Town wants to update their Resource Efficiency Criteria for Development guideline and incorporate low-carbon conditions. The City of Tshwane (Pretoria) requires that all new city-owned buildings must achieve at least a five star Green Star rating and their Green Building By-law document will be updated to incorporate a zero carbon target [11]. In South Africa, the Green Building Council of South Africa (GBCSA) is the main driver of green developing principles [12].

3. Green Building Council South Africa
The GBCSA is a member of the World Green Building Council and was founded in 2007. The aim of the GBCSA is to develop green building solutions to drive the revolution of the South African developing industry towards sustainability. In addition, the GBCSA and focus on green building training and certification. The GBCSA certified the first four buildings in South Africa under its Net Zero Pilot Certification scheme in October 2017 [13]. In the pilot programme, four developments were awarded a net zero certificate. These four developments are the first and only net zero certified buildings in South Africa currently. The developments are the Estuaries Plaza in Century City situated in Cape Town, which received a net zero water certification, the Vodafone Site Solution Innovation Centre in Midrand situated in Johannesburg, which received a net zero certificate in both carbon and ecology, Greenfields Industrial Park in Cape Town and Two Dam Sustainable in Montagu, which both received a net zero carbon certificate [14].

The GBCSA categorizes net zero buildings into the following four categories: carbon, water, waste and ecology. Each categories has its own definition. A net zero carbon building is defined as: “A building that is highly energy-efficient, and the remaining energy use is from renewable energy, preferably on-site but also off-site where absolutely necessary, so that there are zero net carbon emissions on an annual basis.” A net zero water building is defined as: “A building that is designed, constructed and operated to greatly reduce total water consumption, and then use harvested, recycled and reused water such that the amounts of water consumed is the same as the amounts of water that is produced.” A net zero waste building is defined as: “A building that reduces, reuses, and recovers its
waste streams to convert them to valuable resources with zero solid waste sent to landfills over the course of the year.” A net zero ecology building is defined as: “A building that does not reduce the ecological value of the site during development for Greenfield sites [15].”

4. Comparing definitions of net zero across the world
Various definitions and understandings of net zero buildings emerged worldwide. Net zero as defined by Europe, The United States, Brazil and the World Green Building Council will be compared.

4.1 Europe
According to Article 2(2) of the Energy Performance of Buildings Directive (EPBD) of Europe a nearly zero-energy building (NZEB) is defined as “a building that has a very high energy performance, as determined in accordance with Annex I which translates to the nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby”. Each European country, as part of the EPBD recast into national legislation, can adopt a unique national definition of NZEB. Subsequently, variances exist among the NZEB definitions within the European Union, the calculation methods as well as the type and level of requirements [16].

4.2 The United States
The National Institute of Building Sciences in the United States defined “a zero energy building (ZEB) as an energy-efficient building where, on a source energy basis, the actual annual delivered energy is less than or equal to the on-site renewable exported energy” [17].

4.3 Brazil
The Green Building Council of Brazil defines a net zero energy building as a development that proves that the consumer site of the annual operating energy is reset by a combination of high energy efficacy and energy generation from renewable sources [18].

4.4 World Green Building Council
The World Green Building Council (WGBC) defines “a net zero carbon building as a building that is highly energy efficient and fully powered from on-site and/or off-site renewable energy sources”. Canada, Brazil, Australia and South Africa launched the net zero initiatives in 2017 [19].

4.5 Comparison
South Africa is on par with some developed countries regarding the implementation of net zero buildings. It is however, still a fairly new initiation in South Africa. The definitions as given by Europe, United States, Brazil and the Green Building Council all comes down to buildings that are energy efficient and that uses renewable energy resources, where the energy used by the building does not exceed the energy generated by the renewable resources. The GBCSA, however, created four separate categories for net zero status: water, waste, carbon, and ecology. The carbon category relates to the definitions given by Europe, United States, Brazil and the Green Building Council. The water, waste and ecology categories are other means for South African developers to achieve the net zero status.

5. Barriers and solutions to the implementation of net zero buildings in South Africa
Although various benefits have been identified for sustainable buildings, stakeholders, particularly in Africa, have not yet realised the claims as such [20]. Barriers to implement net zero buildings in South Africa includes the perception of costs being higher than it is in reality as well as the lack of incentives [21]. South Africa has a water shortage problem and could be considered a barrier when it comes to developing green buildings, as green building are often seen as rich in vegetation [22]. While African urbanisation has mostly been criticised extensively for its apparent failure to contribute
to a sustainable built environment [23], inadequate guidance is accessible to African governments, policy creators and planning institutions, in respect of how best to deal with these concerns [24].

The average premium cost to build a four star Green Star SA rated building is 5.5% on the total building cost and 6.6% for a five star Green Star SA rated building [25]. The average premium costs for developing a net zero building in either of the four categories given by GBCSA (carbon, water, waste and ecology) has yet to be researched.

If a sustainable industry has not been established, a premium cost exist to overbridge the unknowns and lack of technology available. For example, retrofitting buildings with greenery systems in South Africa. Van der Walt [26] did a cost benefit Analysis for retrofitting an existing building with a green roof system excluding any external incentives or policies i.e. the “do nothing” approach. He found that a retrofitted green roof system will not be feasible in South Africa, as the owner of the building will never be able to recover these expenses. The same cost benefit analysis was done, however incentives and benefits were taken into consideration. The results indicated that a retrofitted building only becomes feasible with the following incentives and policies: if the green roof system reduces the building’s energy consumption by not less than 3%; the municipality subsidise 80% of the green roof’s installation costs and; there is a reduction of property tax by 2% during the green roof’s lifespan. Given these circumstances, a building owner will have a repayment period of 7 years [26]. As such, South African developments are currently relaying on the change of policies and the availability of incentives in order to develop feasible sustainable buildings. That being said, local governments in South Africa are presently dealing with the concept of local economic development (LED), which is perceived as a tool that can support the development of sustainable buildings. LED are progressively becoming a centralised tool while local governments are faced with the challenge of developing sustainable housing that will succeed in improving the quality of lives, economic growth and provision of local needs. [28]. Therefor there is movement towards sustainability in South Africa. The solution provided by Holliday Schmidheiny and Watts is to drive markets in favour of sustainability, leveraging the power of innovation and global markets for the benefits of everyone – including developing countries [29].

The primary reasons for introducing environmentally friendly measures in hotels in South Africa, found by Ismail and Rogerson, were to lessen the hotel’s carbon footprint, to decrease costs and to boost the image of their brand [27]. Hence we see that there are motives for South African developments to follow sustainable strategies.

6. Research Methodology
A mixed method approach was used in order to gather perspectives [28] of developers. A semi-structured questionnaire was emailed to ten developers. The ten developers were selected on a non-probability basis. Five developers responded. The respondents have between 12 and 30 years of experience as developers. Their input is thus deemed as valid and reliable.

7. Analysis of semi-structured questionnaire
The respondents were asked if they have ever developed a net zero building as defined by the GBCSA. None of the respondents have developed a net zero building before. The perceived barriers as set out by the respondents were the following: The 4 Star green star rating is commercially justified; cost, (both the cost of implementation as well as the price sensitivity of the market), scarcity of resources and technology, client's perception of value, lack of incentive/encouragement from the local authorities to promote/include this at the planning phase; completely unfamiliar to net zero developments. The literature review indicated that the barriers of implementing net zero buildings in South Africa includes: lack of incentives; lack of knowledge regarding net zero buildings by the developer, lack of knowledge regarding net zero buildings by the construction professionals; the perception of cost related to the development of net zero buildings; the actual cost for the development of net zero buildings; water shortage in South Africa; maintenance cost and the National Building Regulations. The respondents were asked to rate barriers given on a Likert scale of one to five, where
one is seen as not a barrier at all and five is perceived as a major barrier. The bar graph below shows the extent to which a barrier is involved.

![Barriers to the development of net zero buildings in South Africa.](image)

**Figure 1:** Barriers to overcome in order to achieve net zero status in South Africa

South African developers considers the cost of developing a net zero buildings as the major barrier. Lack of incentives is ranked as the second highest barrier. The third and fourth highest barriers are seen as the lack of knowledge by developers and the perception of costs respectively. The national building regulations and the lack of knowledge by professionals are both perceived as a moderate barriers. Maintenance cost is perceived as small barrier, which means if the design is done correctly, the maintenance could be kept to a minimum. Water shortage in South Africa is not a barrier to the development of net zero buildings in South Africa.

8. **Conclusion**
Cities, especially African cities, are in need of sustainable developments and the net zero criteria is providing the opportunity thereof. The national building regulations of South Africa does not include any reference to vegetation, greener or net zero energy usage, however, local authorities introduce their own by-laws regarding sustainable development. Four of South Africa’s metros (Johannesburg, eThekwini, Cape Town and Tshwane) are working towards the implementation of policies regarding sustainable development. The GBCSA is a members of the World Green Building Council and has awarded the net zero status to four buildings to date. The definitions as given by Europe, United States, Brazil and the Green Building Council all comes down to buildings that are energy efficient
and that uses renewable energy resources, where the energy used by the building does not exceed the energy generated by the renewable resources. The GBCSA, however, created four separate categories for net zero status: carbon, water, waste and ecology. The carbon category relates to the definitions given by Europe, United States, Brazil and the Green Building Council.

Net zero buildings still needs to be commercially justified in South Africa. Cost is a definite barrier for the development of net zero buildings, thus incentives could increase the interest thereof significantly. The National Building Regulations of South Africa is a barrier to the development of net zero buildings as it does not require buildings to aim for net zero status and it is recommended that the National Building Regulations are adjusted accordingly. Requirements from national authorities could greatly impact changes in the approach to developments. The knowledge gap in the construction industry of sustainable and net zero buildings needs to be closed in South Africa regarding the benefits, implementation thereof as well as the actual costs. If installations are done with minimum maintenance in mind, then the maintenance barrier could become redundant. South Africa faces the above mentioned barriers and solutions as a developing country. The same barriers could be issues in other developing countries and the same solutions could be of help to other developing countries.

This research is limited to South Africa and is limited by the small amount of feedback received. It is recommended that more interviews or semi-structured questionnaires are gathered for an in depth and comprehensive conclusion. The research is also limited by the lack of previous research done on net zero buildings in South Africa and further research in this general area in South Africa is recommended. Further research on the premium costs of net zero carbon, water, waste and ecology in South Africa should be done. Future research could also focus on South African credit institutions, fund companies and insurance companies which can possibly acknowledge net zero building developments for sustainable financing instruments, sustainable fund management or insurance offers and support their development with incentives.

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