DEVELOPMENT OF NZEB AND GREENER BUILDINGS IN BUCHAREST – SOLUTIONS FOR URBAN PROBLEMS

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Abstract- The purpose of this paper is to present an urban proposal for the current problems in Bucharest. The proposal promotes the development of a certain type of buildings that would improve the air quality in the European capital. This type of buildings combines the concept of NZEB (Net/Nearly Zero Energy Building) with the one of green buildings and therefore, implementing it would provide the advantages of both concepts. The proposal is based especially on the author's professional experience as a coordinator of major urban and architecture design projects. The article's originality is supported by the novelty of the urban concept proposed.

Keywords- Green Building, Nzeb, Solution, Urban Concept.

I. INTRODUCTION

The article presents an urban concept for solving the present problems related to air quality in Bucharest.
The first chapter explores the literature review carried out regarding successful urban solutions implemented in other countries.

The second chapter describes the present situation in Bucharest referring to the air pollution and lack of green projects.
The next chapter suggests the new urban concept proposed by the author in order to improve the current situation in the European capital.

II. LITERATURE REVIEW – URBAN CONCEPTS

The literature review carried out was focused on the urban concepts of NZEB and green buildings.
According to [1],[2], urbanisation is one of the main health problems of the 21st century as cities are becoming the generators of chronic physical and mental diseases. [1], [3].
Buildings are responsible for aproximately 40% of the global energy use and 24% of greenhouse gas emissions. The need for new buildings' growth is proportional to the world population increase. Therefore, the energy efficiency and the use of renewable sources are essential to face the climate change [4].

Commercial building development support the economic development of a country [5], [6].
This development led these countries to become the highest emission generators as EU is producing 22,3%, USA 13,4% and China 9,3% of the world's total emissions [5], [7].
To face the urbanization problems, one of the urban solutions implemented worldwide is the concept of NZEB.
The concept of NZEB has flourished in developed countries, respectively EU countries, USA and Canada [8].

The European Union has started to impose the urban concept of NZEB through Directive 2010/31/EU on the energy performance of buildings states that Member States must have all new buildings nearly zero energy by 31 December 2020 and since 31 December 2018 all new public buildings have to be nearly zero-energy [9].

Consequently, France has set as a target for 2020 that all new buildings will be producing more energy than the energy they consume [10].
Brussels (Belgium) has proposed that since 2015 all new public and residential buildings will have an energy demand performance in accordance to the PassivHaus standard [10], [11].

On the other hand, in the Southern countries of Europe, the progress related to NZEB objectives is very slow. For example, Romania and Portugal encounter problems such as: lack of expertise about design and execution of NZEBs, lack of local high standard construction materials and lack of locally manufactured HVAC equipment to reach high energy performance [10], [12]-[14].

One purpose of zero energy buildings is to diminish the climate change [15].
Besides the global need to improve energy performance, by the end of the 21st century, the global temperature is gradually increasing and, therefore, the buildings have to be more energy efficient and sustainable.

A correct selection of the building concept should take into consideration the main heating source. In Nordic

countries it is represented by ground source heat pumps. Therefore, in Norway and Finland the passive building design principles can lead to the nearly zero energy buildings. Moving to South, in Sweden and Estonia it is necessary to implement solar technology in order to reach the same requirements. However, in order to reach the Net Zero Energy target in the Northern countries, further research on the innovative solutions have to be carried on [16].

An example of such an innovative solution is presented in [17] which demonstrates the possibility to develop a net zero energy building in Bergen.
Analyzing the situation of NZEB development in other countries, the study of [18] revealed that China has a greater potential to reach the net-zero requirements and USA, whereas Germany surmounted the other two.

Despite the numerous benefits of NZEB, there are certain problems encountered in this building concept, such as overheating due to poor estimations of the cooling potential [19].

A complete building concept have to be based on social, economic and environmental aspects and also take into consideration the issues implied related to resource conservation, comfort, safety and health, also known as the green building concept [5], [20], [21].
One way to improve the concept of NZEB is to combine it with the green building concept.

In order to increase the green building implementation projects in Indonesia, Wimala et al. (2016) suggested that education programs should be organized, green building related practices should be included in the school curricula, grants, rewards, premium costs reduced and regulation detailing should be provided [5].

Another important discovery made on green building concept is represented by the green walls covered by vegetation which helps to increase the green areas, to limit the heat island effect, to limit loads for summer cooling and to ameliorate air quality [22].
The success of green buildings depends on various factors such as: cost economies, financial incentives and increased gains.

In the initial stage of developing a green building, the costs are higher than the ones implied by a non-green building [23],[24].

In conclusion, the urban concepts of NZEB and green building would certainly improve the present situation related to energy performance, environment and quality of life in cities worldwide.

III. NZEB GOAL IN ROMANIA

As a EU Member State Romania must accomplish the objectives imposed by the EU Directive 2010/31/EU on the energy performance of buildings and, as a result, the number of NZEB has to be increased.
Another commitment that Romania made is the reduction of toxic emissions through Directive 2016/2284.
The objectives Romania established are hard to reach as integrated urban strategies are missing. The analysis conducted by Buildings Performance Institute Europe (BPIE) entitled "The NZEB implementation in Romania" highlights the following estimated effects of NZEB implementation since 2020 to 2050 [26]:

Table 1 – Effects of NZEB implementation [26]

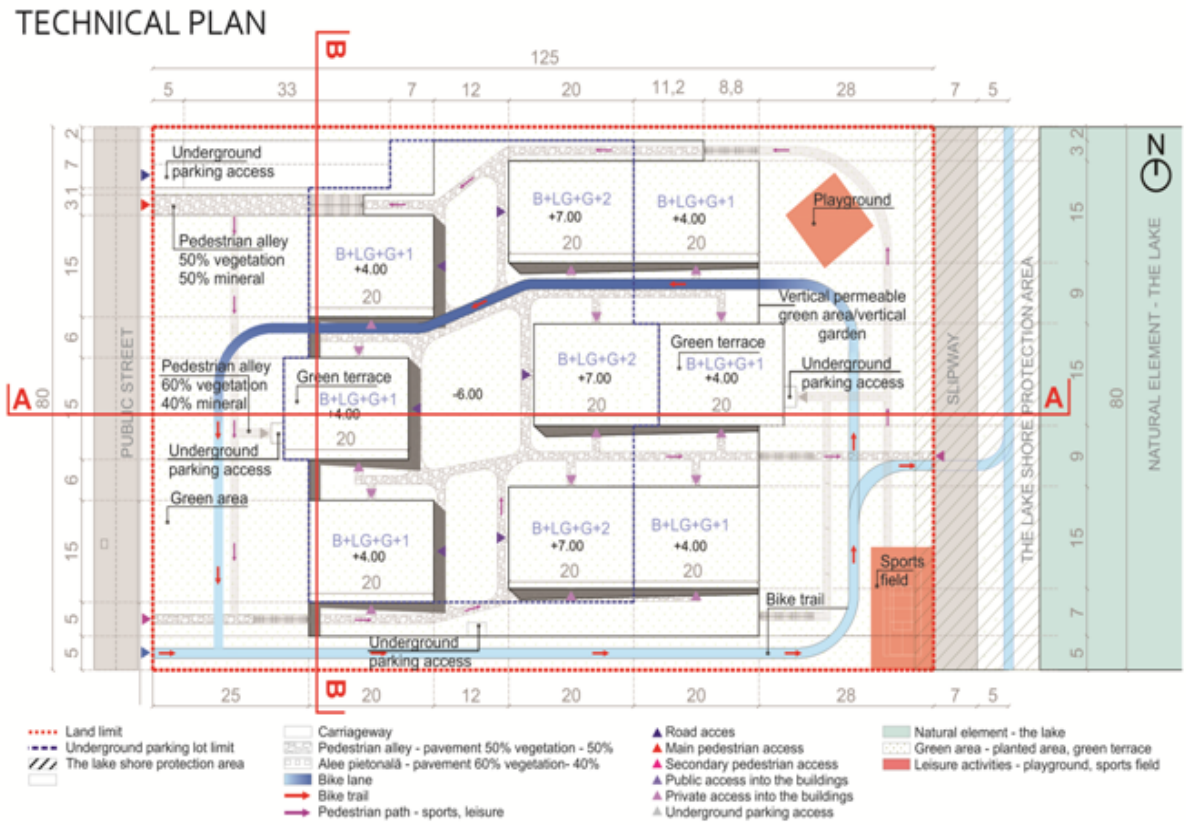
Indicator	Reduction of CO2 emissions	Economy of energy	Annual additional investments	Number of new jobs
Effect	6,8 Mil. t	40 TWh	82-130 Mil €	1.390 - 2.203 fulltime jobs

The expected effects of NZEB include the improvement of the economic, social and environmental situation in Romania.
Among the most significant advantages of implementing NZEB, the BPIE analysis suggests: the improvement of the quality of life due to the better thermal comfort, a superior air quality, protection against the outside noise. Another advantage would be the environmental benefits as the amount of energy demand would be reduced. Social benefits would be enabled through the lack of combustible dependence. The inhabitants would benefit from healthier conditions due to the air improvement and thermal comfort. In addition, the NZEB implementation would empower economic advantages such as: new jobs creation, efficient and innovative new technologies.
However, the benefits illustrated above can be achieved only if applicable integrated policies and strategies are implemented. The following chapter illustrates an example of practical urban concept to face the Romanian urban problems.

IV. URBAN CONCEPT PROPOSED

The new urban concept proposed represents a new stage in the NZEB standard implementation and it combines the NZEB standard with the green building concept.
A nearly zero energy building is a type of building that consumes the same amount of energy it produces. The proposed NZEB is an integrated part of the landscape. As it can be observed in the following figure 1, the new type of building cannot be seen from above, as it is partially below the ground level. It has from 1 to 3 facades opened to an underground courtyard that provides light and air ventilation of the building.

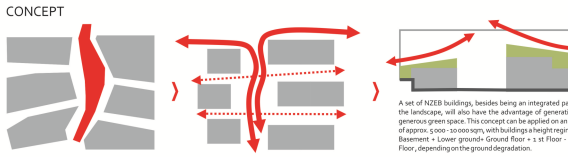
Figure 1 – Technical plan for the new type of building (own contribution)



The most important advantage of this type of building is that it does not reduce the surface of green space. In addition, the possibility of creating walls or facades covered with vegetation which would increase the green surface.

This concept can be implemented in a residential complex of 5.000 to 10.000 square meters having a height regime of Underground + Ground-floor+ 1 Floor/2 Floors, having one or more basements and a semi-basement depending on the unevenness of the ground the next figure 2 shows:

Figure 2 – The new type of building part of the landscape (own contribution)



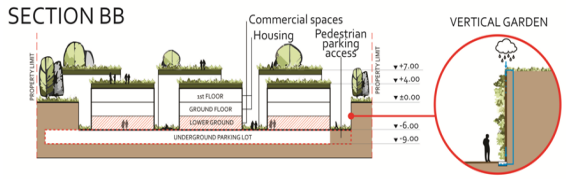
Besides being an integrated part of the landscape, the new type of building would contribute to create a considerable green space as a private park providing numerous leisure facilities for the inhabitants.

An example of space planning for such a residential complex would include an entrance directly to the underground parking in order not avoid the car traffic inside the green space.

Among the numerous advantages of choosing to build this type of building it can be mentioned: the large green space next to the inhabitants' houses which provide leisure and sport facilities; organization of outdoor pedestrian traffic through slopes and / or stairs, thus enabling you to make physical exercise even in the park. These would ensure the inhabitants a healthy lifestyle.

The playgrounds would be safe and would offer the possibility for children to grow and develop in a community. The complementary functions as educational units, fitness center, spa, dance, dance room, beauty salons, car wash would be situated in the buildings' underground, not consuming the urbanistic indicators, as illustrated in the next figure 3:

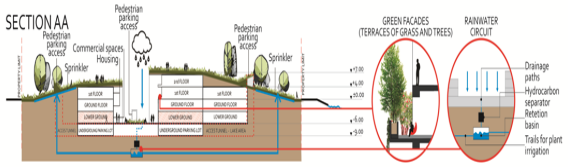
Figure 3 – Complementary functions underground (own contribution)



The water accumulated on the buildings can circulate and remain at the ground level whilst the water accumulated in the underground courtyards would be stored in water tanks and subsequently used to irrigate the green space of the complex. The following figure 4

presents the rainwater circuit in the complex:

Figure 4 – Rainwater circuit in the complex (own contribution)



The concept of green building is applied through the green space provided by this type of residential complex and also through planting trees which offer a wide range of benefits being more effective than green spaces. The trees occupy small land surfaces, approximately 1 square meter per tree. However, their crowns cover large diameters; for example the linden's crown diameter reaches 25 meters and the crown's sphere volume reaches approximately *8177.083 m3.*

In the following table, there is illustrated the calculation of the volume of the crown's sphere, observed from above:

Table 2 – Calculation of the crown's sphere volume *(Source for the applied formulas: https://www.math.hmc.edu/funfacts/ffiles/20004.2-3.shtml)*

	Formula		*Value*	*Unit*
Diameter	2 r		25	m
Radius	r		12.5	m
Circle Area	πr^2	≈	490.625	mp
Sphere Area (A)	$4\pi r^2$	≈	1962.5	mp
Sphere volume (V)	$4\pi r^3/3$	≈	*8177.083*	m^3

In order to propose certain species of trees to be planted inside the residential complex, the author analyzed the specialty literature. One of the most important references was the Salisbury and Ross Plant Physiology. [27]

The selection of trees species took into consideration the capacity of absorbing toxic emissions, the level of allergenic risk for sensitive inhabitants and the climate conditions in Romania.

Therefore, in the following figure 5 presents an illustration of trees species planted through the residential complex in order to improve the air quality:

Figure 5 – illustration of trees species (own contribution)



The author recommends the harmonization of the specific urban legislation in order to introduce new modern urban concepts, similar to the one proposed in the present paper. In this way, green projects could be implemented also on the plots regulated as green spaces. Due to the fact that some plots are regulated as green spaces, the present regulation does not permit the construction of buildings on them. However, the urban concept proposed would increase the green space and the tree planting. Therefore, the new urban concept would contribute to the creation and enlargement of green spaces instead of jeopardizing them, as it happens in the present with the classic residential complexes. Consequently a legislative update would be necessary to clarify the situation of new urban green concept and the possibility of implementing them on green spaces.

Due to the fact that NZEB and green buildings tend to be more expensive in the initial stage but also in the operation and maintenance stage, convenient legislative mechanisms are necessary in order to increase their attractiveness for private investors.

These legislative initiatives would promote energy efficiency and economic incentives such as: reduced taxes, exemption from notarial taxes, access to funds dedicated to individual and also to the legal entities.

V. METHODS AND PRINCIPLES

The first method the author used was the literature review of over 100 scientific publications available on the Web of Science database related to NZEB implementation worldwide and green buildings concept.

The second important method applied was the observation from a scientific point of view. As a coordinator of major urban design projects, the author could understand the current urban problems in Romania and could offer the appropriate solutions.

In addition, the author extrapolated benchmarking, usually applied in business related activities to scientific research. Therefore, through benchmarking the existing national policies and strategies connected with the urban design planning were evaluated in comparison with the ones applied in developed countries, in order to propose an appropriate solution to improve the current situation in Romania.

The principle of sustainable development was taken into consideration when proposing the new concept for urban buildings, as it promotes "a better quality of life, now and for generations to come" [28]. It brings in an image of "progress that integrates immediate and longer-term objectives" [28].

CONCLUSION

The new urban concept was developed taking into consideration NZEB standard and green building concept.

The innovative solution can be implemented in any European country in order to achieve the NZEB requirements. In addition, the implementation of the concept would contribute to the improvement of air quality, toxic emissions reduction and inhabitants' lifestyle.

The green space created through the residential complex proposed would provide the perfect place for communities to develop. These communities would be similar to the ones found in the traditional ancestral Romanian village in which collectivism and the care for the public goods were cultivated.

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