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BENEFIT ASSESSMENT OF PASSIVE HOUSE IN BULGARIA IN SUSTAINABILITY CONTEXT

Yavor STOYANOV

University of National and World Economy, Students city, 1700, Sofia, Bulgaria, Phone: +359887306556, E-mail: j.stojanov@mail.bg

Corresponding author: j.stojanov@mail.bg

Abstract

Demand for cost-effective and environmental friendly building solutions as well as the continued implementation of eco-innovation in construction sector leads to an increase of research interest in passive house. The aim of the paper is to assess the benefits of passive house in Bulgaria which influence on environment, economy and society. On this basis are made general conclusions and recommendations related to benefits of passive house for achieving sustainable housing, their assessment for economy, society and environment and evaluation of factors for increasing the benefits of passive house.

Key words**:** *benefit, passive house, sustainability*

INTRODUCTION

The building of houses related to the concept of sustainable development and the achievement of a sustainable and energy-efficient construction sector requires a study of the benefits of passive house in economic, environmental and social contexts.

The benefits of building passive house in ecological aspect could be related to achieving energy efficiency, water conservation, reduction of greenhouse gas emissions, material efficiency, pollution prevention. They could be analysed in economic aspect mostly related to cost efficiency over time, adaptability with minimal cost, long life cycle of systems. Benefits of passive house could be assessed according their possibility to achieve social sustainability. The benefits could be both 1) for the people living in these buildings - healthy indoor environment, comfort in use, safety (personal, household), provision of recreational amenity, and 2) benefits to society as a whole - job creation, safety (environmental), creating ecological thinking and attitudes to move to energy-efficient buildings.

According some authors [2][4], ecological benefits of passive house are related to energy efficiency and internal comfort. They define passive house as an "energy-efficient home in which a comfortable interior climate can be maintained without active heating and cooling systems". The potential for energy savings in the passive house is up to 90% compared to traditional building depending on design [3]. A view of other authors [7] confirms this statement and they consider that passive house improves energy efficiency through energy savings. The passive house is the logical development of the low-energy house: improving comfort and reducing energy demand through "passive" building and technical measures that ensure avoidance of unnecessary heat loss and optimal use of free heat flows [9].

The view of some authors [5] reflects the economic and environmental benefits of passive buildings. They consider that more and more efforts are being made to develop passive and environmental friendly houses as a result of energy and environmental strategies to reduce energy consumption and polluting emissions. Together with a certain reduction in energy consumption, they will reduce the negative impact on the environment by using more environmental friendly materials.

Passive house offers the opportunity to achieve very low energy consumption with quality and less expensive solutions. Low maintenance costs of passive house create

benefits for the environment and the economy, while additional maintenance for conventional buildings requires more materials and capital than additional costs needed for the improved components of passive house [9].

In regard to the social benefits of a passive house, it is one of the highest standards in terms of achieving inner comfort. In this connection its founders define the main characteristics of passive house such as: 1) the use of post-heating or post-cooling of the fresh air mass to achieve thermal comfort 2) sufficient indoor air quality conditions 3) –no additional recirculation of air [6].

A research related to passive house regions [7] states that these buildings also have another very important function of providing training and knowhow. Their implementation increases the capacity of designers, builders, local government and educational institutions. They found out that passive house has social benefits in terms of improved public services and quality of living. Furthermore other authors [10]consider that ecological projects provide more competitive services in the sectors and better efficiency and quality in service provision. This could become a driving force for enhancing competitiveness through implementation of approaches for sustainable growth [10]. At the same time research [8] shows that benefits of passive house derive from longer-term relationships with clients and the low energy outcome brings higher quality design and greater robustness.

In research some authors [1] use six environmental themes of sustainability that can be used to analyse sustainable housing in general and passive house in particular. They are related to 1) energy, because passive house reduce the demand of energy and use renewable resources 2) materials: more efficient use of materials, reducing waste 3) water: reducing water usage, preventing land drying up, and protecting water quality 4) indoor environment connected with air quality, thermal comfort, and reducing noise levels 5) surrounding environment: impact on bio-diversity, reduce noise, wind etc 6) miscellaneous: flexibility and safety. These themes could be considered as benefits of sustainable housing in social, economic and ecological aspect.

MATERIALS AND METHODS

The aim of the paper is to assess the benefits of passive house in Bulgaria which influence on environment, economy and society. On this basis are made general conclusions and recommendations for implementations of passive house standard in Bulgaria.

The following tasks have been set out to achieve the aim of the paper:

(i)Literature review of benefits of passive house and achievement of sustainability;

(ii)Assessment of total benefits (social, ecological, economic) of passive house and evaluation of factors for increasing the benefits of passive house;

(iii)On the basis of analyzed information will be offered recommendations and general conclusions.

The benefits to the economy, society and the environment of passive house have been assessed in detail. They are classified as benefits for achieving social, environmental and economic sustainability (Fig. 1).

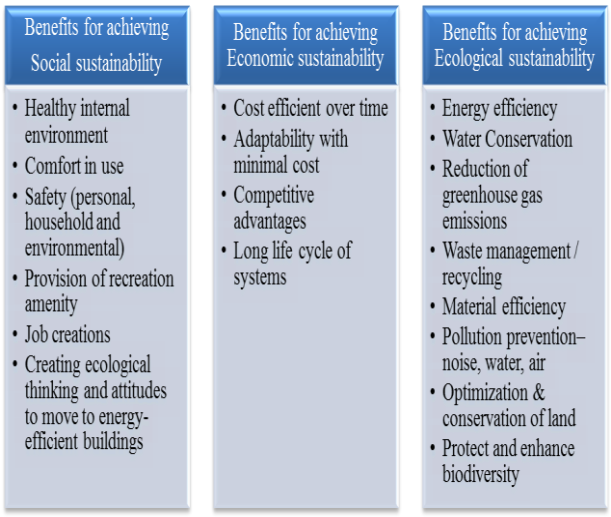

Fig. 1. Benefits for achieving sustainability in construction sector
Source: Own findings.

Findings and conclusions in the paper are based on structured interviews with 48 experts from construction sector involved in the implementation of energy-efficient

construction and passive house standard. The survey was conducted in June 2017.The distribution of respondents according to the participation in the construction process is as follows: 52% are managers of the construction company, chief engineers and technical managers (construction contractors), 31% are building engineers and architects (building designers) and the other 17% are traders of systems for energy-efficient construction (Fig. 2). The majority of respondents – 83 % are men and 17% are women. This could be explained by the sector in which the survey was conducted. The age range of respondents is between 30 and 60 years. 25% of them are between 30 and 40 years, 60 % are between 41 and 50 years, and the other 15 % are between 51 and 60 years.

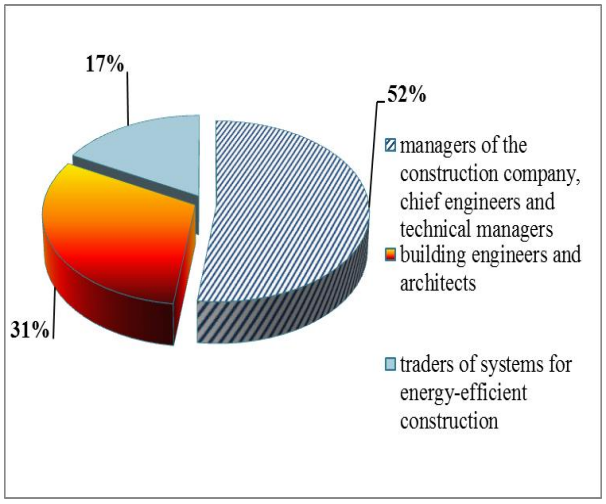

Fig. 2. Distribution of the respondents according to the participation in the construction process, %
Source: own findings

RESULTS AND DISCUSSIONS

Experts assessed the total benefits (social, ecological and economic) of passive house (Fig. 3). Most of the respondents (75 %) state that total benefits of passive house have very large range. 13 % consider that the benefits have large range. The response "intermediate range of benefits" and "small range of benefits" have been given by respectively 6% from the experts.

The assessment of benefits of a passive house in temporal aspect (Fig.4) shows that 69 % of experts consider that there are benefits in long –turn aspect and 31 % of them share the opinion that they are both in long turn and short-turn aspect. None of the experts consider that the benefits of building passive house are only in short-turn aspect.

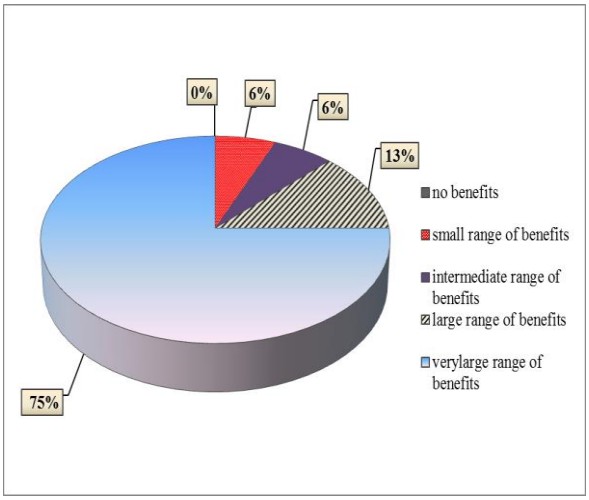

Fig. 3. Assessment of total benefits (social, ecological, economic) of building passive house, %
Source: Own findings.

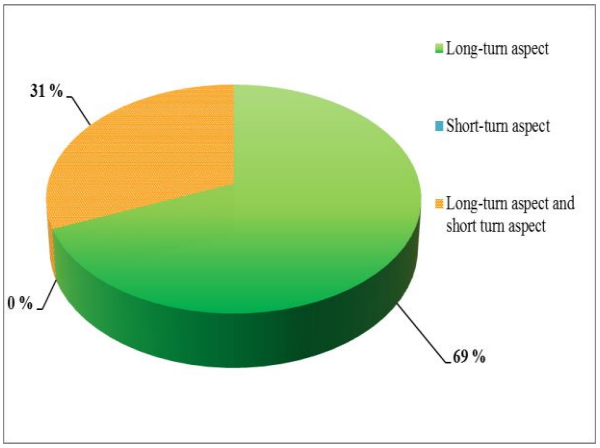

Fig. 4. Benefits of building a passive house in temporal aspect, %
Source: own findings

According respondents opinion for the share of economic, social and ecologic benefits of a passive house the highest share receive environmental (39%) and economic (38%) benefits (Fig. 5).

The similar share of economic and ecological benefits are related to the respondents' opinion that there are benefits for both the environment by reduction of greenhouse gas emissions, use of renewable resources, development of eco-innovation, but there are economic benefits by reducing energy consumption of systems and heat loss.

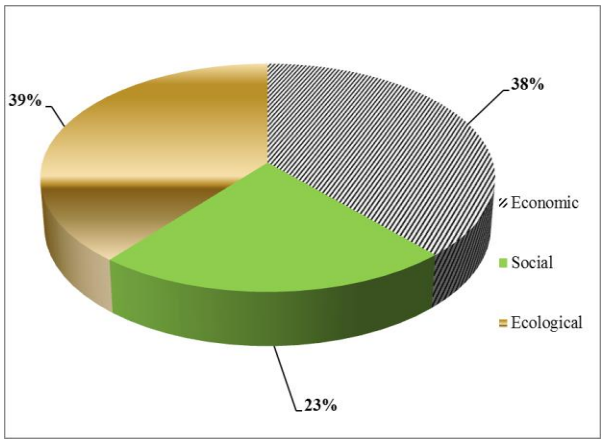

Fig. 5. Share of economic, social and ecologic benefits of passive house, %
Source: own findings

The lowest share receives social benefits - 23%. This could be explained with not so well developed research area of benefits in social aspect.

Table 1 presents assessment of benefits for achieving ecological, social and economic sustainability. Experts consider that "Creating ecological thinking and attitudes to move to energy-efficient buildings" has very large range of benefits for achieving social sustainability, followed by "Healthy internal environment" (63%), "Safety" and "Provision of recreation amenity" (56%).

Table 1. Benefit assessment for economy, society and environment of passive house, %

Benefits for achieving :	**No benefits**	**Small range of benefits**	**Intermediate range of benefits**	**Large range of benefits**	**Very large range of benefits**
Social Sustainability					
Healthy internal environment	0	0	19	19	63
Comfort in use	19	13	0	25	44
Safety (personal, household and environmental)	6	19	0	19	56
Provision of recreation amenity	13	6	6	19	56
Job creations	0	13	38	13	38
Creating ecological attitudes to move to energy-efficient buildings	0	0	13	13	75
Economic sustainability					
Cost efficient over time	0	0	0	19	81
Adaptability with min. cost	0	13	6	19	63
Competitive advantages	6	19	19	25	31
Long life cycle of systems	0	6	19	25	50
Ecological sustainability					
Energy efficiency	0	0	0	6	94
Water Conservation	13	0	6	19	63
Reduction of greenhouse gas emissions	0	0	6	6	88
Waste management / recycling	6	0	31	19	44
Material efficiency	0	13	6	31	50
Pollution prevention – noise, water, air	0	0	13	13	75
Conservation of land	0	0	19	25	56
Protect and enhance biodiversity	13	13	25	25	25

Source: Own findings.

Factors that may contribute to increasing the benefits of passive house are evaluated on Fig. 6.

The highest support have factors "Best practice of companies with similar activity successful in passive house projects" (69%), "Increasing social activity of society in environmental terms" (63%), followed by "Innovation and innovative policy, know-how" (63%).(Fig. 6).

Half of the respondents feel that very important are factors such as the "Labor market" and the "Availability of qualified personnel", "Training and increasing the awareness of the standard "passive house"", "Increasing qualification and improving the image of firms".

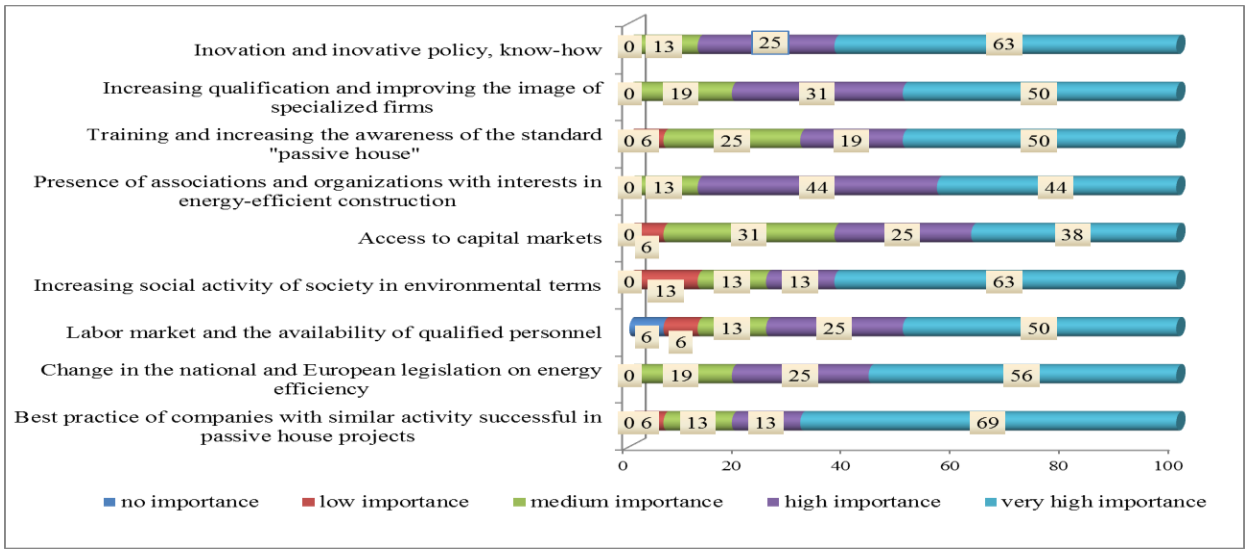

Fig.6. Evaluation of factors for increasing the benefits of passive house, %
Source: Own findings.

CONCLUSIONS

Based on the literature review of benefits of passive house and their benefit assessment could be made conclusions and recommendations as follows:

-The literature review of the benefits of passive house shows they are related to reducing energy consumption of systems, the use of non-renewable resources, providing and generating comfort in the building, reducing negative impact on the environment and preserving natural ecosystems .

-Respondents' view shows that there is large range of social, economic and ecological benefits of passive house. The highest share receives the benefits for environment and economy. Social benefits receive lowest share because the social aspect of passive house is the least studied.

-According to the expert view the holistic approach is applied in passive house projects in Bulgaria and therefore the focus is placed on the benefits in the long-term perspective.

-Assessed factors receive high evaluations in terms of its importance for the building of passive house. More than 80% consider that evaluated factors have a high or very high importance. "Creating ecological thinking and attitudes to move to energy-efficient buildings" and "Healthy internal environment" are the most significant factors for achieving social sustainability. "Cost efficiency over time" and "Long life cycle of systems" have very large range of benefits for achieving economic sustainability and most of the evaluated factors as "Energy efficiency", "Water Conservation", "Reduction of greenhouse gas emissions" etc. have very large range of benefits for achieving ecological sustainability.

-The highest evaluation received by factor "Best practice of companies with similar activity successful in passive house projects" shows that is necessary to disseminate the good practices of the other countries related to the sustainable innovations and passive house standard as this type of sustainable constructions in Bulgaria is still not well developed. This will help for better implementation of the Standard and will lead to improvement of quality of the project realization.

-Factors with very high assessments for increasing the benefits of passive house are "Training and increasing the awareness of the standard "passive house"" and "Increasing qualification and improving the image of specialized firms". This requires being encouraged and undertaken specific programs supporting investors and contractors of the passive house standard in order to increase the professional capacity and their qualification related to its implementation. It is necessary to organize information campaigns and training of investors, contractors, owners,

architects, specialists, experts, policy makers for increasing the awareness of the standard "passive house". This will increase the awareness for the benefits of low-energy buildings, but will also contribute to the implementation of innovative solutions in construction sector and lead to implementation of new policies supporting the transition to sustainable green energy.

-The very high importance of the factor "Interests and participation of municipalities in energy-efficient construction/projects" shows that respondents consider local authorities have an significant active role in implementation the passive house standard and development national policies and measures to support the energy efficient sector. In this regard, municipalities could create programs for financial support related to investors and owners. The advisory function of municipalities is also very important and they could provide consultations on issues related to energy efficiency.

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