

Sustainable Management and Entrepreneurship in the Field of Green Buildings in the context of the 4th Industrial Revolution

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Abstract: *The sustainable management it is very important, especially nowadays, when progress made as a result of the recent industrial revolutions allow to change the vision and the economic behavior in order to increase the economic efficiency. The sustainable management in the field of the buildings is particularly important because buildings have a major contribution to the greenhouse gas emissions, to the solid municipal wastes and to the water consumption and also because the individuals spend a great part of their time indoors. In recent years, we can observe a worldwide preference for the green buildings, both for new buildings and for converted traditional old buildings, demonstrated by the numerous regulations in financial and legislation fields and thanks to the advantages that they bring to the inhabitants, to the owners, to the developers and entrepreneurs and to the State. Thanks to the last Industrial Revolutions, we are allow to use new equipment and products inside buildings, to transform their appearance or shape, their utility and their functionality, so they are more environmentally friendly and healthier.*

Keywords: sustainable management, green building, energy consumption, modern materials, certification.

JEL Classification: A13, D19, D24, E29, E61, E62, F35, H 21, H 22, I15, I38, O12, O15, O16

1. Introduction

Worldwide, it is considered that the world is now passing through the Fourth Industrial Revolution, which was defined by the prestigious Science and Technology Magazine, in March 2017 as: "It is the digital revolution, characterized by a fusion of technologies that shrinks the boundaries of the world - physical, digital and biological ones. "[4]

Regarding the past progresses of the industrial activities and technologies due to the first three industrial revolutions, besides the many indisputable progress that has led to the economic development and the development of mankind in general, there were also some negative effects that they caused determining several serious environmental crisis as negative externalities resulted from the industrial activities, like the air pollution, the emission of toxic substances, the climate change.

The great technical progress that has been made in recent years due to the 4th Industrial Revolution is the one that allows mankind to use new, more powerful and distinctive new materials and technologies that are more cleaner and more friendly with the environment and the society, are highly economic efficient, allowing for long-term benefits, increasing the revenues and contributing to raising the overall standard of living. New digital technologies will allow unprecedented progresses in medicine, genetics, electronics, robotics, communications, but its most important element remains the energy, especially the renewable one. With the new materials and technologies that the fourth industrial revolution created, it is possible to modernize and, in fact, to change economic activities in all fields so as to have a lower

environmental, social and economic negative impact.

Buildings are important for people because they have a great influence on the daily life and health of the population during their living inside their homes, but also at the work place, by having a great influence on the labor productivity. The buildings are essential for the society because the individuals spend a great part of their time inside the buildings. This part can reach even 90% of the time per day in the developed countries, which demonstrates that the quality of the buildings is an important element for the comfort of the population. So, mankind must change the way to design and construct the new green buildings of the future.

In recent years, we can observe the worldwide preference for the green buildings in terms of both construction of new buildings and adaptation of old buildings in order to convert them in green ones.

The Governments can provide an important example for good practices by locate the State institutions in green or greener buildings. State can also play an important role in raising public awareness, including builders and entrepreneurs awareness, in promoting green buildings and in underlining the benefits that they bring on long term.

In Romania, as in the other European Union States, in recent years, were formulated and passed a series of regulations in financial and legislation fields that encourage the construction of green buildings. It can be observed also the trade market sensitivity in this field, considering that the green buildings bring a multiple advantages, not only to the residents, but also to the owners even if they do not live in those buildings, to the developers and to the State itself.

The main aspects to which the advantages of green buildings are related are: the energy efficiency, which is considered to be the most important; the sustainable water management, which involves the reduction of the water consumption, the increase of its quality and finding new sources of water; using more natural materials for building them and for the interior decoration, which are more environmentally friendly materials and easier to recycle. This allows a significant reduction of the total resource consumption and a more efficient waste management.

2. Literature Review

Because individuals spend a lot of time indoors, it is important for them to have the benefit of the best conditions. The buildings sector has a major importance today also because it is responsible for a significant part of greenhouse gas emissions and consumes a large quantity of material and non-material resources. The green buildings are more energy efficient, consume less water and other materials and are more environmentally friendly and healthier.

„The process of greening buildings and their subsequent use provides a wide range of direct social benefits, including the improved health, productivity and wellbeing of those who live and work in them and the creation of jobs in construction, maintenance and the supply of energy, water and sanitation.” [5]

This sector is very important for all countries and, in particular, for the developing countries where, as population growth and economic growth accelerate, the demand of buildings is growing too, both for residential buildings and commercial or offices. The

construction of the new green buildings is a field which is expected to grow in the future and its importance is demonstrated also by the fact that it is an significant source of the labour demand, leading to an increase in the number of jobs, of which many are green jobs. “If the demand for new buildings that exists in developing countries is considered, the potential to increase the number of green jobs in the sector is still higher. Various studies point to job creation through different types of activities, such as new construction and retrofitting, production of resource-efficient materials and appliances, the expansion of renewable energy sources and services such as recycling and waste management. Greening the building industry also provides an opportunity to engage the informal sector and improve working conditions across the industry, by implementing training programmes targeting new skill requirements and improving inspection approaches.” [5]

The role of the public sector and the leadership regarding the green buildings must be underlined: “Considering, in particular, the hidden costs and market failures that characterise the building industry, regulatory and control measures are likely to be the most effective and cost-efficient in bringing about a green transformation of the sector. These need to be combined with other pricing instruments for greater impact, given realities such as the level of development of the local market and household income-levels. Additionally, government-owned buildings such as public schools, hospitals and social housing units are ideal locations to begin implementing greener building policies, including green public procurement. At the same time, the role of progressive private sector actors organised, for example, through

Green Building Councils can drive the transition to lower carbon and more resource-efficient buildings.” [5]

The decision to build a new green building, the way to actually put it into practice as well as the decision to adapt an old building in order to transform it into a green one depends on the local specificity of each country or area, so the local authorities must adopt their own specific measures appropriate to that area, with all its characteristics. The World Green Building Council underlines: “Any building can be a green building, whether it’s a home, an office, a school, a hospital, a community center, or any other type of structure, provided it includes features listed

above. However, it is worth noting that not all green buildings are – and need to be – the same. Different countries and regions have a variety of characteristics such as distinctive climatic conditions, unique cultures and traditions, diverse building types and ages, or wide-ranging environmental, economic and social priorities – all of which shape their approach to green building.” [6]

„Green building benefits go beyond economics and the environment, and have been shown to bring positive social impacts too. Many of these benefits are around the health and wellbeing of people who work in green offices or live in green homes.” [6]

Developing the preference for the green buildings, mankind have also to answer at some interesting questions, as the authors Francis D.K. Ching and Ian M. Shapiro underlined in their book “Green Building Illustrated”: “Is a green building one that is greener than it could have been? Is a green building one that meets a green building standard? Is a green building one that has low

or zero negative impact on the environment and on human health? Should all buildings be green? Are green buildings a passing fad? Do green buildings stay green over time?” [1]

As the Romanian Green Building Council underlines: „The building sector is one of the major energy consumers (40% of the final energy consumption) and is responsible for a significant amount of CO₂ emissions (36% of the CO₂ emissions). The potential of reduction is very high, especially through measures for increase energy efficiency and energy production from renewable sources. The costs associated with these measures - especially those related to energy efficiency are minimal or even negative. These are not inefficient expenditures, but rather investments returned in the future through the savings of the conventional energy. The price of the energy will continue to grow and the existing subsidy measures, that have the goal to reduce the costs for the citizens, are not sustainable The immediate benefits for citizens would be reducing energy bills, creating new economic opportunities and jobs, increasing comfort at home and office, as well as the living standards.” [7]

“Managers are increasingly required to achieve their carbon footprint targets and the management of scores required by environmental sustainability certifications for individual green buildings or for their entire portfolio.” [8]

Romania applies 4 important systems of certification for the green buildings, LEED, BREAM, DGNB and HQE.

“LEED, or Leadership in Energy and Environmental Design, is an internationally recognized certification system for green buildings, developed by the US Green Building Council (USGBC) in 2000. LEED

certification provides independent, third-party verification that a building, home or community was designed and built using strategies aimed at achieving high performance in key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. LEED certification is the internationally recognized distinction that a building or neighborhood development is environmentally responsible, profitable and a healthy place to live and work. With nearly 9 billion square feet of building space participating in the suite of rating systems and 1.6 million feet certifying per day around the world, LEED is transforming the way built environments are designed, constructed, and operated - from individual buildings and homes, to entire neighborhoods and communities. Comprehensive and flexible, LEED works throughout a building's life cycle." [9]

"BREEAM (Building Research Establishment's Environmental Assessment Method) is an assessment method and rating system for buildings, first launched in 1990 by BRE, the trading name of Building Research Establishment, which sustains expert, impartial research, knowledge and advice for the built environment sector and beyond. BREEAM sets standards for best practice in sustainable building design, construction and operation and has become one of the most comprehensive and widely recognized measures of a building's environmental performance. BREEAM assessment uses recognized measures of performance, which are set against established benchmarks, to evaluate a building's specification, design, construction and use. The measures used represent a broad range of categories

and criteria from energy to ecology. They include aspects related to energy and water use, the internal environment (health and well-being), pollution, transport, materials, waste, ecology and management processes. There are over 200,000 buildings with certified BREEAM assessment ratings and over a million registered for assessment since this rating system was launched. BREEAM sets the standard for best practice in sustainable design and has become the de facto measure used to describe a building's environmental performance. Credits are awarded in ten categories according to performance. These credits are then added together to produce a single overall score on a scale of Pass, Good, Very Good, Excellent and Outstanding." [10]

"The DGNB assesses buildings and urban districts which demonstrate an outstanding commitment to meeting sustainability objectives. The sustainability concept of the DGNB System is broadly based and goes beyond the well-known three-pillar model. The DGNB System covers all of the key aspects of sustainable building: environmental, economic, sociocultural and functional aspects, technology, processes and site. The first four quality sections have equal weight in the assessment. This means that the DGNB System is the only one that gives as much importance to the economic aspect of sustainable building as it does to the ecological criteria. The assessments are always based on the entire life cycle of a building. Of course the focus is always also on the wellbeing of the user." [11]

The HQE certification system (Haute Qualité Environnementale or High Quality Environmental standard) is a French system which can be applied also at the international level. It is based on the principles of the sustainable development. "Underpinned by its

widely acknowledged expertise, HQE™ certification is the best solution to gain objective and credible recognition for:

- Best practice in terms of the sustainable construction and operation of buildings.
- High-quality and sustainable local developments.

HQE™ certification covers the entire lifecycle of a building (construction, renovation and operation): non-residential buildings, residential buildings and detached houses as well as urban planning and development.

It adds value to certified projects thanks to:

- Technical schemes that cover all categories of non-residential buildings (logistics, retail outlets, hotels, etc.).
- The ability to issue certificates worldwide by combining generic criteria, specific criteria, and common indicators, thereby allowing all assets to be compared.
- Full third-party certification, which is the most reliable way to ensure that the high quality nature of a project is recognized." [12]

3. Characteristics of the existing building sector

The technological progress created during the Industrial Revolutions has not only influenced the production activities themselves, but also the way in which individuals have built and arranged their homes. The Industrial Revolutions allowed the use of new equipment and products inside buildings, have greatly transformed their appearance or shape, their utility and their functionality.

Nowadays, the buildings sector accounts for around 10% of the global GDP of the world. In the developed countries it is foreseen that a great part of the currently

used traditional buildings will no longer be used after 2050. This trend is mainly a result of the decreasing trend of the population and the increasing trend of the demand for the new and green buildings. It has been noticed that as a nation and its members become richer, individuals have higher expectations regarding the living conditions, the general living standards, which determines the increase of the demand for buildings with higher standards.

The newest world trends in the social and demographic fields influence the behavior of individuals regarding the buildings. Although they desire to have a higher living standard inside the buildings as the revenues increase, this trend does not always lead to an increase of the energy consumption. At present, it is noted that more and more households are currently formed by a single person, which leads to an increase of the energy consumption for lighting and heating, but causes a decrease of the energy consumption for heating the water. There are significant numerous differences in the energy consumption depending on the local traditions: while in the North of Europe there is a high energy consumption for heating the space, in some Asian countries the highest energy consumption is for heating water.

At the same time, in many countries, especially in the developing ones, there is a significant deficit of buildings, both residential, commercial and for offices, so the trend will be to increase the buildings supply. One of the major factors which conducts to the increase in the demand for buildings in this countries is the rapid increase of the degree of urbanization, as the process of economic development accelerates, by about two to three times more than in developed countries. An

important problem faced by most of the developing countries is that a significant part of the buildings that already exist are informal, low-cost buildings in which people with the lowest income are living. The low-cost buildings in general do not benefit from adequate sanitary conditions, do not have electricity and are placed far away from public transport facilities, which impedes their tenants to access jobs and education. It should be taken into account also the fact that the poor population, even if they want to transform their buildings in greener ones, they do not have the necessary financial possibilities, so the State has an important role by granting them a financial aid.

One of the biggest problems that buildings currently have in all countries is related to the energy consumption. Both residential and commercial buildings together consume over 50% of total global energy consumption. In general, for all types of buildings, the main causes of the energy consumption are lighting, space heating and water heating, using the DVD, TV and PC. An important part of the total energy consumption comes from their construction and also from the demolition. In order to improve the energy consumption, it is essential for the owners of the buildings to be convinced that implementing more energy-efficient systems result much benefits for the whole society, given the fact that if they do not live in those buildings, they do not directly benefit from the inversion of buildings, but the residents who pay lower bills for the energy consumption.

Buildings also contribute with more than 10% to the total water consumption and to the municipal solid waste.

4. Perspectives, modalities and consequences of greening the building sector

Greening the building sector brings a series of long-term benefits both for those individuals that are living inside, for the owners, for the developers and for the States.

For those that are living or working in the green buildings the benefits are the pollution reduction, the lower usage costs and a more pleasant indoor environment, which has positive effects on health and productivity. The green buildings have several advantages also for their owners even if they do not live there because they are easier to rent and with larger amounts, they are more sought after, they have a lower maintenance cost, the relationship between quality and cost is very good and they can be sold much more easily and fast.

The decision to transform a traditional building into a green one must start from the costs that this process implies. In developed countries there is a higher preference for converting old buildings into new buildings since the demand for buildings decreases. In the developing countries, the possibility to build new green buildings is higher due to the significant increase in the buildings demand. In general, the initial cost of a green building is higher than the cost for a traditional building, but the benefits of a green building are much higher. So, at long-term, considering all the costs and benefits, it results that costs are greatly reduced, even until zero.

In the European Union, all the countries aim to reduce the energy consumption of the buildings by about 5% per year, which is set out in the document Energy Performance of Buildings Directive. Although the initial cost

of the green buildings is slightly higher than for the traditional buildings, according to a study conducted in the United States, the perception of the population is very different from this reality, the population believing that the initial costs are even 10 times higher than the real ones, which can turn into a psychological barrier for building green buildings.

In assessing the total cost, it must be taken into consideration not only the cost of building, but also the cost savings, seen as benefits, of that individuals that are living indoors. Although there are very different patterns of energy consumption inside buildings depending on the geographic location, climate, degree of development, and degree of urbanization, can be identified, as solutions, some common elements that lead to reduce the energy consumption inside the buildings: using solar panels and wind turbines; substituting the current lighting system with LEDs; purchasing of systems that are recovering the inside heat; reducing the energy demand for lighting by building larger windows which can allow penetrate the sunlight; using heat pumps and heat storage; making floor holes for the air circulation; evacuating the air through the upper ceiling area; using the natural ventilation in order to reduce the energy consumption for cooling during the warm seasons. There are also some solutions that contributes indirectly at the reduction of the energy consumption inside buildings, such as: the installation of thermal insulation windows; the use of special insulation for exterior walls, made from natural materials such as wool, cotton, cellulose, soybean foam; the construction of roofs with vegetation on top, which ensure a cooler climate inside the building, protecting and favoring also the biodiversity.

Because the greening of the buildings involves to change the behavior patterns of the residents is important to change also the behavior patterns of the investors and the State. Aiming to adjust the energy consumption it is increasingly important to keep informed the households about the energy consumption issues. In order to modify the consumption patterns regarding the energy inside the buildings, the State has an important role in raising awareness among the population, along with other economic subjects such as owners, managers and entrepreneurs, through their voluntary actions of informing and implementing the new techniques and new models of consumption. Concerning the reduction of the energy consumption there are several situations when the political instruments used by the State may have an opposite effect to the desired one. The State can act by providing subsidies to the tenants in terms of energy consumption or by providing subsidies to those that are using the renewable energy. But, when the State decides to provide subsidies to the energy consumers, the effect may be the opposite, if they decide to spend in the future the same amount to pay the bills for the energy consumption, which allows them to increase their energy consumption.

The greener buildings will reduce the greenhouse gas emissions due to the decreasing trend of the energy consumption in all parts of the world less in Asia where the trend is to significantly increase the number of the buildings. Even if these buildings are greener, the foresights show an increase of the greenhouse gas emissions.

Related to the water consumption, which is another important problem of all buildings, in the green ones in order to

reduce the water consumption, they can be implemented various methods of water management such as collecting and storing the rainwater, heating the water by the intermediate of the solar heat, introducing the low-flow water taps, recycling and treating and reusing the gray water. Of course, it must be taken into account the fact that water purification activities are energy-consuming. To solve the general problem of the imbalance between water demand and water supply, the State must encourage the private investors to build smaller local water supply systems and also to find new ways of purchasing water from new sources.

Due to the new discoveries in technology, it can be used better and modern materials in buildings construction, in furniture and in interior decorations, such as reusable and removable components for the constructions, organic paints for the interior, like washable paints with much less or no emissions of toxic substances, wherever possible it can be used those types of wood which have a higher rate of growth and with a fast recovery process, such as bamboo or rattan.

These solutions help also to reduce the problems of the municipal solid waste, given the fact that only the construction and demolition of buildings contribute to about 30% at the municipal solid waste. All the improvements in the materials used in buildings can reduce the consumption of the natural and material resources and can minimize the impact of their extraction on the environment. It can also increase the availability of water and land. By using better and newer modern materials, buildings can be easier to maintain and there is a greater potential for reuse of these materials by recycling them when buildings will be out of use. Nor should we

forget the possibility of finding more efficient transport models related to the building activity.

The consumption of materials is not important only by itself. Within buildings, a wide range of materials such as wood, plastic, metals, with different recycling rates are consumed. In the recycling process, the most difficult to recycle is plastic, but some metals can be recycled with a much lower energy consumption compared to the initial extraction process from the ore. Even if some of the recycled metals no longer retain the original qualities, they can be reused for other activities, the energy savings being extremely important.

Greening the buildings sector has not been considered only from an economic point of view. It is, at the same time, strongly correlated with the social field, the environment and blends with elements of architecture and design. From this point of view, the role of designers becomes very important because they are meant to combine the revolutionary new technologies with aesthetics and functionality elements. These changes do not only relate to the materials used in the construction process, but also to the changes of the traditional form of the buildings. There are two main types of design.

The passive design aims to minimize the effects of the external environment on the building's interior. This design should use the natural elements available in the area, such as sunlight and air currents. According to the passive design, in the warm areas, the greener buildings must have thick walls and small windows and in those areas with high humidity, the greener buildings must use the air currents for ventilation. Many of the principles of the passive design are already being

applied in the traditional buildings in those areas.

The active design is opposed to the passive one because it uses the latest technologies such as renewable energy and new methods to optimize the water consumption and also the most modern artistic elements.

The design should lead to a reduction in the cost with the materials, both for those used to build the buildings, to assure the maintenance of the buildings during their existence and also to favor a better material recycling process when buildings will be disposed of.

Besides the indisputable positive effects that the greening of the building sector has on the household members as residents, there are a number of positive effects on the labor force as well. When the production activities take place in green buildings, it is demonstrated that implies a significant increase in the labor productivity. The increase in labor productivity is primarily due to the fact that people have a more comfortable and pleasant workspace. The quality of the air is better, the natural light can penetrate better, even the natural ventilation can be used, allowing to control the air temperature and also ensures a less pollution, not only for the air, but also related to the noises. Increasing the labor productivity is an important premise for increasing the total profits of the companies. The green elements of a green building for offices may also be related to some elements that influence the climate and health of the population through the social components. For example, there are green buildings where lifts do not stop on each floor, in order to force the workers to make much more movement, by climbing or descending the stairs. The places which are specially set for

a short coffee break are placed outside the building, in green spaces arranged around it, in order to foster the socialization between the working staff and the members of the local community.

Regarding the human resource as production factor, it is obvious that the greening of buildings, by transforming the traditional buildings or by building new ones, contributes to increase the number of many direct and indirect jobs, directly or indirectly linked to the building sector. These jobs refer to the number of people involved in all the activities related to the production and supply of renewable energy, to the procurement and production of the better materials used in buildings, to the transport, to the water treatment and to the waste collection and treatment.

The greening of buildings sector may face many barriers that are not only strictly economical barriers, but also barriers based on people's behavior, financial possibilities or economic policy measures. As the financial projects for the construction of green buildings have, in general, a high degree of uncertainty and high risks, there is a restraint of the financial institutions to provide credits for this purpose.

Among the economic policy measures, the market-based instruments have an important role, such as signing contracts for the energy efficiency or granting energy and materials certificates or cooperating in the field of the public procurements. Regulatory and control mechanisms that State can use have also an significant role, such as monitoring the buildings and doing the audit in this area. The fiscal instruments and incentives are also important, such as tax exemptions or reductions for green buildings, as well as subsidies

or loan guarantees by the State. Together with the general measures which must be taken into consideration in all countries, in the developing countries the issue is more complex because it involves both a stronger information for citizens on the advantages of green buildings including demonstrative projects and, at the same time, ensure the technical and financial assistance and trainings by the developed countries, which have a much greater experience in this area.

The State must encourage the construction of the green buildings or the transformation of the traditional ones into green buildings because that's how it reduces the greenhouse gas emissions, it reduces the dependence on the fossil fuels, it increases the energy security of the country, it makes a better use of the national resources, it can make progress regarding the local utilities by reducing the volume of the municipal solid waste and by a sustainable water use and, last but not least, boosting the local economy by saving resources and gaining extra benefits.

In a report of the Romanian Green Building Council there are illustrated the most important trends on the Romanian market: "Within the recent past, the following trends have converged to create significant opportunity for "green" development - including construction and eco-efficiency - in Romania and the surrounding region:

- increasing competition for existing fossil fuel reserves and falling (or eliminated) energy subsidies and the resulting rising energy prices
- unprecedented international political and business enthusiasm and demand for securing reliable sources of energy, reducing dependence on unstable suppliers of oil and combating climate change.

- scarce natural resources leading to significantly higher prices for a variety of construction inputs

- demonstrated investor interest in green building certification schemes

- mandated green procurement targets currently implemented

- falling prices for eco-efficient building solutions

- significant EU Funding for sustainable development (4.5 Billion Euros allocated between 2007 and 2013 for Environmental initiatives in Romania alone) and a general allocation of 30 Billion Euros to Romania for "Structural Funds" to improve infrastructure, competitiveness, governance, etc.

- relaunch of the suspended "Green Home" initiative providing subsidies for integrating renewable energy solutions into apartments and businesses.

- greater willingness of financial institutions to consider total life-cycle costs in approving project financing

- relatively recent introduction of mortgage lending and other forms of construction financing that makes available more purchasing power when planning and designing homes and buildings for better energy efficiency.

- implementation in Romania and other member states of the mandatory European Energy Performance Building Directive (EPPBD) requiring energy certification for new (2007) and existing (2010) buildings" [13]

As stated by the Romanian Green Building Council, several financial and legislative measures have been taken in our country in order to encourage the greening of the buildings. These financial measures include the co-financing from the Environmental

Fund for those who replace or complement their energy systems with mainly solar, geothermal and wind power energy. It is guaranteed that 80% of the expenditures needed for any eligible projects are non-refundable. There is also the maximum amount that can be granted for this co-financing to the territorial administrative units depending on the number of population. Another financial measure used to increase the energy performance of the buildings is the Multi-annual Thermal Rehabilitation Program, which has the purpose of the thermal insulation of the blocks of flats. The local administrative budgets have an important role in financing those projects. Regarding the legislation, since 2007, the owners of new buildings have been required to obtain energy performance certificates, authorities carry out energy audits and apply the same measures to increase the energy performance in all public procurements. [14]

Among the “Examples of incentives For the promotion of green buildings at central level in the States of the European Union and the United States”, Romania Green Building Council illustrates the main measures in Romania to encourage the development of energy-efficient construction and the main factors that influence the developers in their decision to build sustainable. The results were obtained on the basis of a questionnaire regarding the measures to encourage development of the efficient construction from the point of view of the energy.

From the developers’ point of view, there are illustrated the main factors to encourage the construction of the green and sustainable buildings, the main measures that can be taken as well as the main barriers.

As shown in the graph below, the

determining factors for the developers’ decision to build sustainable are, in order of their importance: the company’s philosophy of building green; concerns about current / future prices; customer requirements; marketing / advertising benefits; lower costs for construction and operation; general demand for green buildings; imposition - by law - of standards; better understanding and information of the public; other factors.

Chart 1: Determining factors for the decision to build sustainable - developers

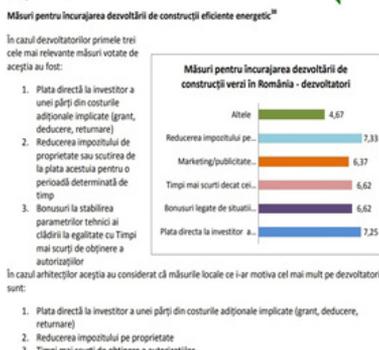


Source:

<http://www.rogbc.org/Downloads/Legislatie/Masuri-pentru-atragerea-de-investitii-in-cladiri-verzi-la-nivel-local.pdf>

As shown in the graph below, the main measures to encourage the development of energy-efficient buildings are, in order of their importance: direct payments to the investors of a portion of the additional costs involved (grant, deduction, return); reduction of property tax or exemption from payment for a fixed period of time; bonuses to establish the technical parameters of the building at the same importance as shorter times to obtain authorizations; marketing / advertising; other.

Chart 2: Measures to encourage the development of energy-efficient buildings

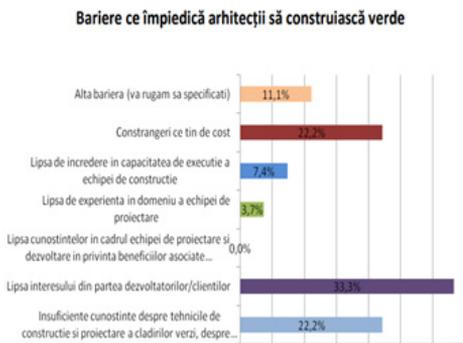


Source:

<http://www.rogbc.org/Downloads/Legislatie/Masuri-pentru-atragerea-de-investitii-in-cladiri-verzi-la-nivel-local.pdf>

As shown in the graph below, the main barriers that prevent architects from building green, in order of their importance are: lack of interest from developers / clients; cost constraints, with the same importance as insufficient knowledge of green building and design techniques; other barriers; lack of confidence in the construction team’s execution capacity; the lack of experience in the field of the design team.

Chart 3: Barriers that prevent architects from building green

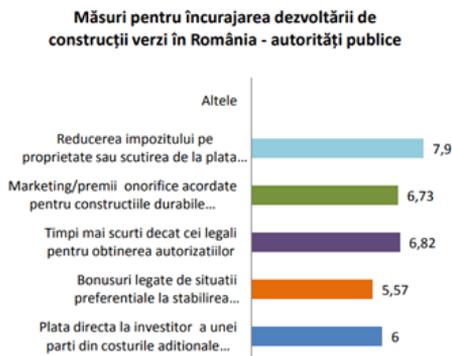


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<http://www.rogbc.org/Downloads/Legislatie/Masuri-pentru-atragerea-de-investitii-in-cladiri-verzi-la-nivel-local.pdf>

From the point of view of the public authorities, the main measures that encourage the development of green building construction in Romania are: reduction of property tax or exemption from payment; shorter times than legal ones for obtaining authorizations; marketing / honors awards for sustainable construction; direct payment to the investor of part of the additional costs; bonuses.

Chart 4: Measures to encourage the development of the green buildings in Romania



Source:

<http://www.rogbc.org/Downloads/Legislatie/Masuri-pentru-atragerea-de-investitii-in-cladiri-verzi-la-nivel-local.pdf>

Among the greenest office buildings in Romania are several buildings in Bucharest, the capital of the country and in the city of Cluj-Napoca

Photo 1: Floreasca Park, Bucharest, Romania



Source:

<https://www.wall-street.ro/articol/Real-Estate/201072/topul-celor-mai-eco-cladiri-de-birouri-din-romania.html>

Photo 2: The Office Cluj, Cluj – Napoca, Romania



Source:

<https://www.wall-street.ro/articol/Real-Estate/201072/topul-celor-mai-eco-cladiri-de-birouri-din-romania.html>

Photo 3: Crystal Tower, Bucharest, Romania



Source:

<https://www.wall-street.ro/articol/Real-Estate/201072/>

topul-celor-mai-eco-cladiri-de-birouri-din-romania.html

Photo 4: Liberty Technology Park Cluj, Cluj – Napoca, Romania



Source:

<https://www.wall-street.ro/articol/Real-Estate/201072/topul-celor-mai-eco-cladiri-de-birouri-din-romania.html>

Photo 5: Green Court, Bucharest, Romania



Source:

https://www.google.ro/search?rlz=1C1AVFC_enRO804RO804&biw=1853&bih=932&tbm=isch&sa=1&ei=iGQBXOuSGNCwadr3t6AD&q=Green+Court+Bucuresti+&oq=Green+Court+Bucuresti+&gs_l=img.3...33922.33922..35432...0.0..0.113.113.0j1....0....1j2..gws-wiz-img.wCLMUTnEV4Y#imgc=mScGpHMdwR8sgM

Although there are not many achievements in the field of private houses as residences in Romania, they can be observed some achievements also in this field. Among

the houses used as residence, the smartest house in our country is located near Bucharest and is called Buhnici House, after the owner's name which is a well-known Romanian journalist. From the available sources, it is the first intelligent house not only in Romania but also in the Southeastern Europe that has the residence destination.

Photo 6: Buhnici House, Ilfov County, Romania



Source:

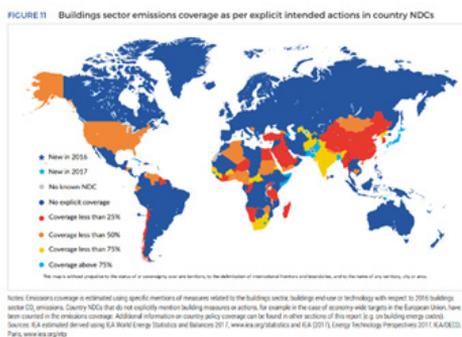
https://www.google.ro/search?q=casa+buhnici&rlz=1C1AVFC_enRO804RO804&source=lnms&tbm=isch&sa=X&ved=0ahUKEwjzoJLbNIHfAhUqxoUKHWzABFYQ_AUIDigB&biw=1853&bih=932#imgrc=I8AiyO88YcSO8M:

This family home is equipped with the latest technology elements is a smart house with minimum energy and water consumption because it is equipped with solar panels, underfloor heating and floor cooling, heat pumps, water tank and smart water taps. There is no need for air conditioning and in the attic there are smart windows, which are automatically opened or closed depending on the climatic conditions. The structure is made of wood and all the materials used inside are sustainable materials. [17]

At the European level, the best known examples are the Bosco Verticale in Milan,

Italy, the roof of Berlin's Parliament in Germany as well as numerous other buildings in different countries of the European Union. In July 2015, the U.S. Green Building Council (USGBC) announces the top 10 Countries outside of the U.S.A. for LEED Green Building: "Canada, India, Brazil, Republic of Korea, Germany, Taiwan, United Arab Emirates, Turkey, Sweden". [15] According to the site green.it, the most famous buildings covered by green in the world in the summer of 2017 were "Rosewood Tower in Brazil, Eco-Luxury Hotel, France and Biodiversity Tower M6B2 in France". [16]

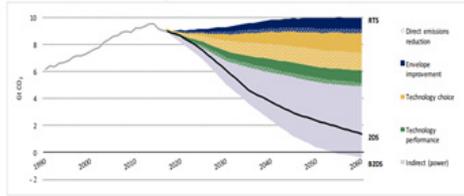
According to "Towards a zero-emission, efficient, and resilient buildings and construction sector, GLOBAL STATUS REPORT 2017", in most countries, are necessary more measures, taken by the authorities, to cover greenhouse gas emissions from buildings.



Source:

https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf

The same publication mentions the main factors that will determine the long-term reduction of carbon dioxide emissions:

FIGURE 13 Key contributions to CO₂ emissions reduction in the global buildings sector to 2060

Notes: "Direct emissions reduction" represents a decrease in emissions from reductions in direct fossil fuel consumption in the buildings sector. "Building improvements" include measures (including deep energy renovations) that improve the energy intensity of the building envelope. "Technology choice" represents shifts from one type of technology and/or fuel to another (e.g. incandescent lamps to LEDs or gas boilers to electric heat pumps). "Technology performance" represents energy technology efficiency improvements (e.g. higher operational performance for heat pumps). "Indirect (power)" emissions reduction is from improved carbon intensities of power generation, where negative emissions are from carbon capture and storage (CCS) technologies.

Source: IEA (2017), Energy Technology Perspectives 2017, EA/DE/20, Paris, www.iea.org/etp

Source:

https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf

8. Conclusions

The transition to a more efficient and environmentally friendly economy, must be a priority of the managers of all levels in all the countries of the world, in order to protect the future generations. The sustainable management is very important, especially nowadays, when progress made as a result of the recent 4th Industrial Revolution allow a change of the vision and of the economic behavior which can lead to increase the economic efficiency.

The sustainable management in the field of buildings is particularly important because they have a major contribution to the greenhouse gas emissions, to the solid municipal wastes and to the water consumption. Another important reason is the fact that individuals spend a great part of their time inside the buildings.

In recent years, we can observe the worldwide preference for the green buildings in terms of both construction of the new buildings and adaptation of the old buildings in order to convert them in green ones.

In the last decades, a series of measures

have been taken to green buildings at both national, European and global levels. There were formulated a series of financial and legislative measures that encourage the construction of green buildings, considering that the green buildings bring multiple advantages, not only to the residents, but also to the owners even if they do not live in those buildings, to the developers and to the State itself.

In developed countries there is a higher preference for converting old buildings into new buildings since the demand for buildings has a decreasing trend. In the developing countries, the possibility to build new green buildings is higher due to the significant increase in the buildings demand. In general, the initial cost of a green building is higher than the cost for the traditional buildings, but the benefits of a green building are much higher. One of the main problems, at the global level, faced by the building sector, is the fact that in most of the developing countries, a large proportion of the population lives in informal houses and their financial possibilities do not afford them even the traditional housing and much less the green ones. But, even if the initial cost is quite high, at long-term, considering all the costs and benefits, it results that costs are greatly reduced, even until zero.

The States must create their own political instruments and measures for greening the building sector, according to the local differences regarding the conditions preferred by the users of the buildings, depending on the area and the region, so on the local traditions and consumption habits.

As there are many green buildings worldwide recognized for their overall performance, it may be necessary to promote

them more intensively so that developers, entrepreneurs, States and the consumers see them as worthy examples.

Given that an important issue worldwide is represented by the scarce financial possibilities, the States should grant more subsidies or tax exemptions to those who want to build new green buildings or to improve the traditional existing buildings and should find effective ways to encourage the financial institutions to give easier and higher amounts as credits for this purpose.

In order to improve the achievement in the building sector, States would also have to

better assess and measure the effects of this sector as well as its achievements, by establishing more complex and complete indicators which are intended to be included in the calculation of the national GDP and other macroeconomic indicators.

The States should decide different measures at the macroeconomic level, in collaboration with specialists from different fields such as economists, engineers, biologists, architects, sociologists.

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