THE BUILDING CERTIFICATION SYSTEM - A TOOL OF SUSTAINABLE DEVELOPMENT OF UNIVERSITY CAMPUSES

Ioana Francesca (Prada) Hanga-Fărcaş [a], C. C. Bungău [a,*], Adriana Aurelia Scurt [b], Monica Cristea[a], Marcela Florina Prada [b]

[a] Doctoral School, Technical University of Cluj-Napoca, 400114 Cluj-Napoca, Romania, E-mails: pradaifrancesca@gmail.com, *constantin.bungau@csud.uoradea.ro, monicacristeaa@gmail.com
[b] Department of Civil Engineering, Faculty of Constructions, Cadastre and Architecture, University of Oradea, 410058 Oradea, Romania, E-mails: adriana.scurt@yahoo.ro, mprada@uoradea.ro

Received: 26.02.2023 / Accepted: 22.03.2023 / Revised: 25.03.2023 / Available online: 31.05.2023

DOI: 10.2478/jaes-2023-0014

KEY WORDS: Sustainable Development, Certification System, University Rankings, Energy Performance Certificate

ABSTRACT:

The study is part of humanity's current concerns of tempering climate change for sustainable development, in the context where the construction sector is responsible for a significant percentage of greenhouse gas emissions. In the present work, through a rigorous documentation, the authors synthesize several existing green and sustainable building certification systems. Extending the study from buildings to green neighbourhoods, to university campuses and even to green cities, models of their sustainable development are highlighted. The authors summarize the results of the various "green" ratings, initiating "Top 10 Greenest Universities in the world", demonstrating the interest of certification and classification. The paper presents the case study of the University of Oradea. From this perspective, participation in a rating of green campuses, as well as certification of buildings, are stimulating elements for approaching a sustainable development strategy. Thus, with the registration in the UI GreenMetric World University Rankings, the University of Oradea is set to rise in the ranking, which actually led to the improvement of the green criteria and implicitly to an orientation towards a sustainable development of the university campus. At the same time, the paper demonstrates that the energy certification of old buildings engaged in the "wave of renovations" is a tool for the sustainable development of university campuses.

1. INTRODUCTION

Concerned about slowing global warming, researchers and designers have turned their attention to standards, codes, assessment methodologies, and certifications for green products and green buildings alike. A new phase of green building design is beginning, which includes health, safety, and environmental comfort. Many design standards and assessment and certification methods address green buildings, sustainable buildings and, more recently, NZEB (Near Zero Energy Building) building programs.

"The ANSI/ASHRAE/USGBC/IES Standard 189.1-2017, Standard for the Design of High Performance Green Buildings except Low-Rise Residential Buildings provides minimum requirements for site, design, construction and operations in mandatory, code-enforceable language" (Vierra, 2022).

One of the first to appear," *The 2018 International Green Construction Code (IgCC) provides the design and construction industry with the single, most effective way to deliver sustainable, resilient, high-performance buildings. The 'IgCC-powered-by-189.1' joint initiative frames the essential sustainable construction building blocks on which future resilient initiatives can develop and expand"* (IgCC, 2018).

The International Green Building Code (IgCC) imposes requirements with the aim of bringing these constructions closer to nature, to the environment, to make them environmentally friendly, it imposes connections and accessibility of the buildings respectively the housings, respectively convenient mobility.

ISO defines: „Certification – the provision by an independent body of written assurance (a certificate) that the product, service or system in question meets specific requirements." *"Accreditation – the formal recognition by an independent body, generally known as an accreditation body that a certification body operates according to international standards"* (ISO, 2022).

Currently, there are many types of green certifications known and certainly many are emerging. It is worth noting that recently the concern of investors in this regard has intensified in order to promote the constructions built by them.

* Corresponding author: Bungău C. Constantin, Ph.D. student, Doctoral School, Technical University of Cluj-Napoca, 400114 Cluj-Napoca, Romania, e-mail: constantin.bungau@csud.uoradea.ro

Green building certification criteria can be different (more or less) and generally refer to: Energy, Emissions, Indoor Environmental Quality, Innovation, Land Use & Ecology, Management, Materials, Transport, Water, Light, Thermal comfort, Sound […].

It is desirable that the authority that makes the certification be independent of the beneficiary, the investor, the manufacturer, the executor or the designer of the building as well as the supplier of materials included in it.

2. MATERIALS AND METHODS

In order to carry out this work, the way of certifying buildings and the way of classifying settlements and university campuses from the perspective of sustainability were analyzed.

1.1 The Most Popular Green Building Certification Systems

Table no. 1 summarizes the most well-known green certification systems for construction:

Year, Country of origin / Building certification system / Managing organization	Building certification criteria / Atribute / Factors / Performance in		
1990, UK / Building Research Establishment Environmen-tal Assessment Method (BREEAM) / BRE Global (Corneliu Bob, 2020; Bungau et.al., 2022, 2022, Eric Rosenkranz, 2022)	**Issues /Areas of focus**	**No. criteria**	**Percent %**
	Management	5	12
	Transport	6	8
	Waste	4	7.5
	Health and Wellbeing	13	15
	Energy	7	19
	Water	4	6
	Materials	7	12.5
	Land use and Ecology	6	10
	Pollution	7	10
	Innovation	-	10
	Level of certification		**Score**
	Outstanding		≥ 85
	Execellent		≥ 70
	Very Good		≥ 55
	Good		≥ 45
	Pass		≥ 30
	Unclassified		≤ 30
1996, United Kingdom / Green Building Tool (GBTool) / International Initiative for a Sustainable Built Environment (IISBE) (Corneliu Bob, 2020, Green Buildings Tool, 2023)	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Site regeneration and development	14 ÷ 122	13.8
	Consumption of resources and energy		19.6
	Actions on the environment		49.7
	The quality of the indoor environment		6.3
	Services quality		6.9
	Social, cultural aspects		3.4
	Cost and economic aspects		1.2
	Level of certification		**Score**
	Acceptable		>1
	Good		1 – 3
	Excellent		3 – 5
1998 USA / Leadership in Energy and Environmen-tal Design (LEED) / U.S. Green Building Council (Corneliu Bob, 2020) (Bungau et.al., 2022, 2022, Eric Rosenkranz, 2021)	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Sustainable sites	15	26
	Materials and Resources	9	14
	Efficiency of water use	4	10
	Indoor Environmental Quality	17	15
	Energy and Atmosphere	9	35
	Innovation and Integrative Processes	2	10
	Location and Transport	1	Aditional
	Level of certification		**Score**
	Certified		> 80
	Silver		60-79
	Gold		50-59
	Platinum		40-49
2001, Japan / Comprehensive Assessment System for Built Environment Efficiency (CASBEE) / JSBC (Japan Sustainable Building Consortium) and its affiliated sub-committees (CASBEE, 2023) Tatsuya Hayashii et all, 2020)	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Q_1 Indoor environment	13	40
	Q_3 Local environment	2	30
	Q_2 Services	9	30
	LR_1 Energy efficiency	2	40
	LR_2 Resource efficiency	10	30
	LR_3 Environment	6	30
	Level of certification		**Score**
	Poor (C)		< 40
	Slightly Poor (B-)		≥ 40
	Good (B+)		≥ 50
	Very Good (A)		≥ 65
	Superior (S)		> 75
2004, USA / Green Globes / Green Building Initiative in the U.S. BOMA Canada (Green Building Initiative, 2023)	**Issues / Areas of focus**	**Percent %**	**Globs**
	- Resource efficiency - Reducing environmental impacts - Improving occupant wellness	85-100	four Green Globes
		70 - 84	three Green Globes
		55 - 69	two Green Globes
		35 - 54	one Green Globes
2006, USA / Core Green Building Certification / International Living Future Institute (Bungau et.al., 2022, 2022) (Criteria for the Passive House, 2022, International Living certification, 2023; International Living Future Institute, Standard, 2023)	**Issues / Areas of focus**	**No. criteria / imperative**	**Score**
	Ecology of place	1	The parameters have various weights or limits or are compared with similar parameters of a reference building
	Human scaled living	4	
	Responsible water use	5	
	Energy + Carbon reduction	7	
	Healthy interior environment	9	
	Responsible Materials	12	
	Universal access	17	
	Inclusion	18	
	Beauty + biophilia	19	
	Education + inspiration	20	
2007, Germany / Deutsche Gesellschaft für Nachhaltiges Bauen (DGNB) (Corneliu Bob, 2020; Bungau et.al., 2019, 2022)	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Size/Quality of the environment	12	22.5
	Economic Size/Quality	2	22.5
	Socio-cultural and functional quality	15	22.5
	Technical quality	5	22.5
	Process quality	9	10
	The quality of the land	6	-
2003, Australia 2008, South Africa / Green Star SA / Green Building Council	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Management	8	12
	Indoor Environmental Quality	10	13.4
	Energy	4	17.4

of South Africa (GBCA) (Corneliu Bob, 2020; Bungau et.al., 2019, 2022)	Transport	5	9.4
	Water	6	8
	Used materials	16	17
	Land Use & Ecology	5	7.4
	Emissions	9	12
	Innovation	3	3.4
2011, Denmark, Olanda / Active House (Becgreen, 2023, Active house, 2023)	**Issues / Areas of focus**		**Percent %**
	Comfort		
	Daylight		30 Scale 1s-4s
	Thermal environment		
	Indoor air quality		
	Energy		
	Energy demand		30 Scale 1s-4s
	Energy supply		
	Primary ebergy performance		
	Environment		
	Environmental load		30 Scale 1s-4s
	Freshwater consumtion		
	Sustainable construction		
2008 / 2020 România / Green Schools Certification / (Green Homes Certification) / Romania Green Building Council (RoGBC) (RoGBC, 2023)	**Issues / Areas of focus**	**No. criteria**	**Percent %**
	Health and quality of the indoor environment	9	13
	Circular economy and resource conservation	6	17
	Exemplary energy performance	7	34
	Optimization of water consumption	3	7
	Biodiversity Sustainable transport	4	13
	Monitoring and education	6	8
	Health and safety	8	8
	Level of certification		**Score**
	Certified / 2 Leaves		40-49
	Execellent / 3 Leaves		50-69
	Higher / 5 Leves		70-100

Table 1. The most well-known green certification systems for constructions

1.2 Sustainable Urban Areas

The goal of sustainable urban areas is to reach equilibrium between social, economic, and environmental sustainability. To attain this balance, it is essential to support innovative and effective solutions that lessen the adverse environmental effects and enhance the quality of life for inhabitants. By easing the transfer of technology, urban areas can implement sustainable practices and solutions suited to their own requirements and resources (Craiut et.al., 2022a).

Moving from the "micro" level to the "macro" level, it is evident that the urban green space is of increasing concern to urban architects. The emergence of green cities of green settlements is highlighted. According to (The Hugsi Report 2021, 2022), following a monitoring of 98 cities, configured since 2016, the expansion share of urban green space increased by 1%, and its vitality by 10%.

In green cities thermal stress is reduced, noise level is reduced, water consumption is reduced. The public green space ensures a healthy life, influencing the climate, air quality and biodiversity, protecting the environment. "Research recently published in Lancet Planetary Health (Barboza and collaborators) concludes that a large number of premature deaths in European cities could be prevented by increasing exposure to green space. Among European capitals: Athens, Brussels, Budapest, Copenhagen and Riga recorded some of the highest death rates linked to a lack of green space. WHO recommends that every person has access to at least 0.5 hectares of green space within 300 meters of their home" (The Hugsi Report 2021, 2022). In addition, studies have demonstrated that the energy efficiency of buildings and access to green spaces are frequently interlinked, as structures that emphasize sustainability tend to include green design elements (Bungau et.al., 2017).

It is predicted that in 2050, 70% of the Earth's population will live in cities (10.5 billion). Swiss Foundation for Technical Cooperation in the article "Green cities" (Swiss Foundation for Technical Cooperation: Green cities, 2023), draws attention to that ”cities and urban areas across the world face major social and ecological challenges: pollution, poverty, unemployment, poor housing, food scarcity and lack of basic services for over 1 billion slum dwellers, constraints on productivity due to lack of basic infrastructure, and a concentration risk due to natural disasters and climate change” (Swiss Foundation for Technical Cooperation: Green cities, 2023).

”Public Authorities are responsible for judicious administrative organization by creating a legal framework for the implementation of energy saving measures and to build sustainable” (Prada et.al. 2015).

The triple helix strategy, which involves collaboration between government, industry, and academia, can promote the development and implementation of sustainable development that addresses the challenges by focusing on the strengths of each sector to foster innovation and address complicated challenges (Craiut et.al., 2022b).

In the current context, it is encouraged ”the idea of the Green City as a process of designing, building and of managing urban development by working with public actors, private sector (from large market players to small and medium enterprises), private foundations and public donor agencies, academic institutions (research, development, innovation and extension) and civil society. This includes helping local authorities to prioritise their actions to address the challenges of local development (Swiss Foundation for Technical Cooperation: Green cities, 2023).For example, accessing the Dortmund City Hall website, we will see in the description "Dortmundt's greens":”The biggest city in the Ruhr Area also convinces with a wide range of possibilities in the cultural and sporting sector, with extensive greens and a high quality of life”. ”Numerous greens, making up almost half of the city’s 280 square kilometers, provide a high quality of life and leisure time”. In figure no. 1, a satellite image of an area of Dortmund, which also includes the Campus of the Technical University of Dortmund, is shown to exemplify the proportion of green areas:

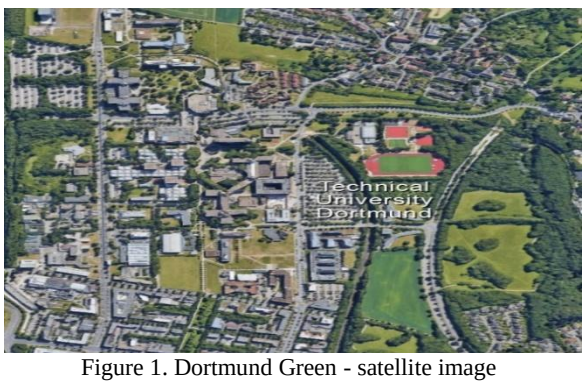


Figure 1. Dortmund Green - satellite image
(Source: https://earth.google.com/web/@51.49477725,7.4254463, 112.45320304a,5508.76133048d,35y,75.67795773h)

”Greens close to home are also, a priority. Dortmund's 90 city districts are surrounded by attractive greens: more than 100 allotment gardens, greenery planted in courtyards and playgrounds, and trees and flowerbeds along the roads are rounding out the city’s outdoor image. The Stadtgarten ("town garden") is the city centre’s green lung. People looking for recreation away from buzzing city life will find what they are looking for in the nearby Münsterland or in the rolling hills of the Sauerland region” (Dortmund's greens, 2023).

The objectives of Directive 2010/31/EU to reduce greenhouse gas emissions are consistent with the concept of green cities, which emphasizes environmental sustainability and low-carbon solutions to alleviate the environmental impact of urbanization (Prada et.al., 2017).

1.3 World University Rankings - Solutions for a sustainable development

In order to have an image of the performing "Green" Campuses / "Green" Universities in the world, the authors of the present study have centralized in table 2, the results of "TOP 10 Green universities" according to five classifications, according to references (UI GreenMetric. Overall Rankings 2022, QS World University Rankings: Sustainability 2022, Staff Writers, The 10 Greenest Universities 2022, Stephen Hall 2022, Kelly Mae Ross and all, 2022):

Top	UI Green Metric Wolld University Rankings 2022	QS World University Rankings 2022	Best Colleges Ranking 2022	Times Higher Education Impact Rankings 2022	Top 10 Global Schools for Environment, Ecology
1.	Wageningen University & Research, Netherlands	University of California, Berkeley (UCB) Berkeley, United States	Stanford University	Western Sydney University, Australia	Harvard University
2.	Nottingham Trent University, United Kingdom	University of Toronto Toronto, Canada	Princeton University	Arizona State University	Stanford University
3.	University of Nottingham, United Kingdom	University of British Columbia Vancouver, Canada	Columbia University New York	Western University Canada	University of Oxford
4.	University of Groningen, Netherlands	The University of Edinburgh Edinburgh, United Kingdom	University of Pennsylvania	King Abdulaziz University, Saudi Arabia	Wageningen University and Research Center
5.	University of California, Davis, USA	The University of New South Wales (UNSW Sydney) Sydney, Australia	Massachusetts Institute of Technology	Universiti Sains Malaysia	Swiss Federal Institute of Technology Zurich
6.	Umwelt-Campus Birkenfeld (Trier University of Applied Sciences), Germany	The University of Sydney Sydney, Australia The University of Tokyo	Cornell University	University Of Auckland, New Zealand	University of California-Berkeley
7.	University College Cork, Ireland	The University of Tokyo Tokyo, Japan	Bowdoin College	Queen’s University, Canada	University of Queensland Australia
8.	University of Connecticut, USA	University of Pennsylvania Philadelphia, United States	Northwestern University	Newcastle University, UK	Tsinghua University, China
9.	Universitat Bremen, Germany	Yale University New Haven, United States	University of California-Berkeley	University of Manchester, UK	Peking University
10.	Universidade de Sao Paulo USP, Brasil	The University of Auckland Auckland, New Zealand	University of Michigan-Ann Arbor	Hokkaido University, Japan	Imperial College London

Table 2. TOP 10 Green universities

In the context of climate change, the need for concern at various levels for sustainable development is obvious: green buildings, green settlements, green cities, and green university campuses. Developing in parallel with green cities, taking over their trends or with their own initiatives, university campuses can carry the "green" attribute or not.

The university campus requires the flexibility to carry out a variety of activities (housing, education, research, recreation, culturalization [...]), and has the mission of educating and ensuring a healthy future for future generations.

It is obvious that the "Green Campus" criteria require the development of a healthy indoor life, a healthy education and of course include the criteria of "green cities"; all of this contributing to climate change mitigation.

The criteria for the certification of buildings as well as those for the classification of campuses are variable in number, with various weights; they are elastic from one type of certification / classification to another.

1.4 Case Study: University of Oradea - UI GreenMetric World University Rankings

The University of Oradea comprises 15 faculties that operate in a university campus that is over 100 years old (being composed of buildings built in various periods of time starting from the 1910s) - figure 2.

The University of Oradea has been included in the UI GreenMetric World University Rankings since 2019. UI Green Metric World University Ranking measure the university’s effort to keep the environment green and sustainable, and ranking purpose and intended groups.



Figure 2. University of Oradea - satellite image highlighting recently renovated buildings (2015-2022)
(Source:https://earth.google.com/web/@47.04347975,21.91918659,128.42246029a,2348.08513614d,35y)

2.4.1 Solutions implemented within the University of Oradea for better classification in the UI GreenMetric World University Rankings: starting from classification criteria, with the desire to improve the score awarded for the following years and corroborating with the university's strategy, the subsequent actions of the University of Oradea from the point of view of sustainability are part of the improvement of the indicators of this reinking. The following aspects/activities were emphasized:

***Setting & Infrastructure:** a technical department was established within the University of Oradea called "Sustainable Campus". Within this department, special attention was paid to the operation and maintenance of buildings, the creation of facilities for people with disabilities and special needs, and a considerable budget was allocated for sustainable investments. Special attention was paid to people with disabilities. The educational spaces were equipped with modern teaching equipment.

***Energy & Climate Change:** in order to mitigate climate change, the University of Oradea emphasized investments in the energy economy. Significant funds have been allocated to the renovation of buildings and their energy efficiency. In this endeavor green building criteria were implemented as far as possible for fifteen existing buildings that were rehabilitated (figure no. 2). They have been equipped with smart building functions by converting them into buildings with intelligent functions. The proposed new buildings on the campus (Technology Transfer Center - Smart Industries) have green building criteria in mind. The projects of new buildings, whose execution is ongoing, have been updated and reoriented towards the design and execution of sustainable buildings. The way of heating the whole campus was redesigned, the thermal points of the buildings were equipped with heat pumps and the installations were modernized in order to use a greater amount of renewable energy.

***Waste:** taking into account that "waste management programs are designed to protect the environment, reduce pollution and encourage recycling throughout community" (Popescu et.al., 2016) was introduced a program to reduce the use of paper and plastic on campus. Also, all construction materials resulting from the renovation activity were recovered, sorted and prepared for recycling or reuse.

***Water:** the renovated buildings were equipped with water-efficient appliances; the watering of green spaces is controlled.

***Transportation:** the pedestrian alleys were modernized; a larger number of bicycle racks were arranged.

***Education & Research:** increased the number of academic publications on sustainability; disciplines in the field of sustainability were introduced into the university curriculum.

1.1.2 Energy Certification of Buildings - Solutions for a Sustainable Development: The paper analyzed the data of the energy certificates developed for the University of Oradea by their author, existing at the "Sustainable Campus" Department of the University of Oradea (Cristea, 2022).

The University of Oradea's investments in the rehabilitation of existing buildings started from their energy certification, respectively from energy consumption. According to the legislation in force in Romania and the financing regulations, of the existing buildings, the certification is done at the beginning of the renovation of the buildings and at the reception of the execution works. In the case of rehabilitated public education buildings, the Romanian norms from 2017 to 2023 imposed the maximum specific annual consumption of primary energy of 123 [kWh/m2an] (Order no. 2641, 2017). Starting from January 2023, the energy consumption regulations of buildings are much stricter, aligning with European norms. For example, this value is restricted to 82.6 [kWh/m2an] (Order no. 16, 2023). These values result from the consumptions calculated and highlighted in the energy performance certificate. It is obvious that in the case of low values of energy consumption as well as those of CO2 emissions, the building will be placed in a higher energy class.

In order to improve the energy efficiency of the buildings that have entered the renovation process, the following solutions have been applied: the building envelope was improved by having thermal insulation at its level. In general, we worked with expanded polystyrene and basalt wool barriers. The base of the buildings was thermally insulated with extruded polystyrene. Thermal bridges have been removed. The exterior walls of the historical monument building were not thermally insulated. Joinery has been replaced with energy efficient aluminum joinery in general. Blinds with automatic control were arranged on the western facades. In the renovated historic monument building, wooden joinery with double-layer double-glazed double-pane glass was installed. The last floor was thermally insulated with basalt wool mattresses. Modern heating-cooling systems were introduced with radiant floors, radiant ceilings, fan coil units, as appropriate. The thermal points of the campus were equipped with high-performance equipment: heat pumps and heat exchangers that use renewable energies. They have also been equipped with monitoring systems, so that various parameters can be followed in various

points of the installation to optimize consumption. Ventilation systems with heat recuperators and fresh air intake were introduced. The lighting fixtures were replaced with LED lighting fixtures. Building spaces have been equipped with motion sensors for turning on and off light bulbs. The existing electrical switchboards were replaced with new high-performance and reliable equipment, equipped with protections for serving consumers safely. The aim was to reduce water consumption in order to use it in accordance with the principle of sustainable development by installing sinks, urinals and flaps with presence sensors or with the possibility of choosing the economic mode, in the case of toilet bowls. By implementing these building energy efficiency solutions, energy consumption and CO2 emissions have decreased considerably.

3. RESULTS

3.1 The classification of the University of Oradea in the UI GreenMetric World University Rankings during 2019-2022

Following the adoption of the measures contained in this work at point 2.4.1. Solutions implemented within the University of Oradea for better classification in the UI GreenMetric World University Rankings, the position of the University of Oradea within the ranking has obviously become better.

Figure 3 shows a screenshot from the UI GreenMetric World University Rankings - 2022 website that highlights the positioning of the University of Oradea in 515th place out of 1050 applying universities (UI GreenMetric. Overall Rankings, 2022):



Figure 3. The UI GreenMetric World University Rankings 2022

-

Corroborating the classification data from the period 2019-2022 within the GreenMetric World University Rankings existing on the dedicated website (UI GreenMetric. Overall Rankings archive) the following centralized results are obtained in table 3:

Relevant aspects - Campus of University of Oradea	**Rankings** / no. entries		
	2020	**2021**	**2022**
Campus settings	**313** / 453	**309** / 491	**269** / 515
Campus population Size (Large)	-	**266** / 356	**253** / 367
Campus Area	-	**296** / 442	**278** / 443
Campus type - Comprehensive	**414** / 587	**407** / 626	**353** / 659

Table 3. UI GreenMetric Ranking Criteria – relevant aspects of the ranking - University of Oradea during 2020 – 2022 (Source: UI GreenMetric. Overall Rankings – archive)

3.2 Energy certification of the buildings of the Oradea University Campus

Figure no. 4 shows the Energy Performance Certificate of building C 53 in the Campus, as a relevant example for all renovated buildings, whose consumptions are comparable. (Cristea, 2022):

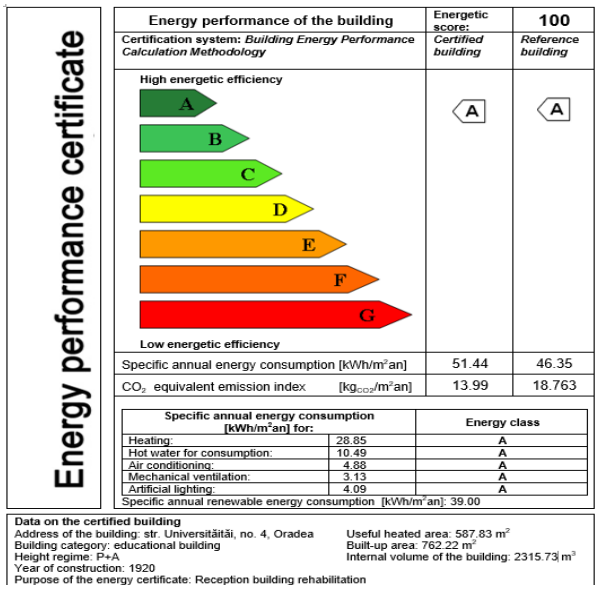


Figure 4. Building C 53 - The energy performance certificate

Figure 6 highlights the position of building C 53 within the campus, being one of eight similar buildings recently rehabilitated during 2019-2022:



Figure 6. Building C 53 - University of Oradea - satellite image (Source:https://www.google.com/maps/@47.0442541,21.9226426,507m/data=!3m1!1e3-)

The energy performance certificate in Romania provides information on the classification in the energy class based on energy consumption and renewable energy consumption. In parallel, the comparison is made with a reference building, with the same geometry but which correspond to the current norms from the point of view of its envelope.

In figure no. 7.a building C53 from the Campus of the University of Oradea is presented, before its rehabilitation, and in figure no. 7.b shows its facade after rehabilitation:



Figure 7. University of Oradea – Building C53 (a - the initial stage, b - after rehabilitation)

There are sustainable energy rehabilitation solutions even for buildings more than 100 years old, buildings with historical value, buildings with a purpose far different from the present one. These involve major renovation, conversion or retrofitting.

4. DISCUSSION

As presented in the paper, in order to join the current trend of humanity to contribute to combating / tempering climate change through clear actions, the University of Oradea referred to the certification criteria of a building and in parallel to the classification criteria of a Green Campus.

As a consequence of them, the university applied to the UI GreenMetric World University Rankings in the years 2019-2022. Depending on the reports made of the requested indicators, the classification highlighted in tables 3 and 4 was made. It is thus observed that corroborating the efforts of the university campus administration as well as of the teaching staff, the University of Oradea occupies a better position in the ranking, reaching the first half of the number of participants. Considering the classification criteria, it can be seen that indicators related to the energy certification of buildings were also introduced within this ranking. On the other hand, it is obvious that the decrease in the energy consumption of a building, concomitant with the increase in the percentage of renewable energy consumed, leads to a decrease in greenhouse gas emissions. All these aspects, in Romania, are mirrored and included in the energy performance certificate of a building. Given that the construction sector contributes a relevant amount to the amount of greenhouse gas emissions, it is obvious that the rehabilitation of as many existing buildings as possible is required. Thus, the effect of these efforts would directly influence the phenomenon of global warming that humanity is witnessing.

4.1 Proposals for a sustainable development of campuses

This paper highlights the fact that the strategy of the University of Oradea is oriented towards sustainable development. This effort must be continued. A successful solution is to refer to the university classification criteria and further allocate financial budget to fulfil as many of the criteria as possible.

In terms of engaging in the "renovation wave" (HG 1034, 2020) of existing buildings, a starting point would be the energy certification of all existing buildings that have not undergone energy efficiency work. Depending on the amount of energy consumed by them, rehabilitation solutions will be given.

There are sustainable energy rehabilitation solutions even for buildings more than 100 years old, buildings with historical value, buildings with a purpose far different from the present one. These involve major renovation, conversion or retrofitting.

5. CONCLUSIONS

Through the studies and analyzes presented in the paper, the authors demonstrate the following relevant aspects:

- in Romania, the energy certification of the building is relevant in demonstrating the reduced energy consumption of the building, the reduced amount of gas emissions with evening effect, the amount of renewable energy used, respectively the inclusion in the higher energy class from the point of view of sustainability. Consequently, it can be seen as a tool for sustainable development;

- the reporting of university campuses to the classification criteria of green / sustainable campuses, their repeated application to a certification system, can be a tool for sustainable development.

6. ACKNOWLEDGEMENTS

This paper was financially supported by the Project “Entrepreneurial competences and excellence research in doctoral and postdoctoral programs - ANTREDOC”, project co-funded by the European Social Fund financing agreement no. 56437/24.07.2019.

References

Stephanie Vierra, Assoc. AIA, LEED AP BD+C, Updated: 06-17-2022, Vierra Design & Education Services, LLC - Green Building Standards and Certification Systems - https://www.wbdg.org/resources/green-building-standards-and-certification-systems (view at 07.01.2023).

IgCC, 2018. International Green Construction Code - https://www.iccsafe.org/products-and-services/i-codes/2018-i-codes/igcc/ (view at 07.01.2023).

ISO, 2022. ISO Certification: https://www.iso.org/certification.html (view at 07.01.2023).

Corneliu Bob, 2020. Durabilitatea și Sustenabilitatea Construcțiilor (RO). (Durability and Sustainability of Constructions). Politehnica Timișoara Publishing House, ISBN.126. pp. 66-69.

Constantin C. Bungau, Tudor Bungau, Ioana Francesca Prada, Marcela Florina Prada, 2022: Green buildings as a necessity for sustainable environment development: dilemmas, challenges and solutions,

Sustainability, EISSN 2071-1050, Published by MDPI, 2022, 14(20), 13121; https://doi.org/10.3390/su142013121.

Eric Rosenkranz, 2022. The 6 BREEAM Certification Levels – How To Be Outstanding. https://smart-cre.com/the-6-breeam-certification-levels-how-to-be-outstanding/ (view at 11.01.2023).

Green Buildings Tool, 2023: https://www.ukgbc.org/solutions/green-buildings-tool/#:~:text=Built%20in%20association%20by%20CFP,%2C%20operations%2C%20maintenance%20and%20management (view at 08.01.2023).

Eric Rosenkranz, 2021. The 4 Levels of LEED Certification and How to Achieve Them https://smart-cre.com/the-4-levels-of-leed-certification-and-how-to-achieve-them/ (view at 11.01.2023).

Comprehensive Assessment System for Built Environment Efficiency (CASBEE), 2023: Space-scale classification and time-process classification. https://www.ibec.or.jp/CASBEE/english/basicconceptE.htm (view at 07.01.2023).

Tatsuya Hayashii, Kyosuke Hiyama, Ryutaro Kubo. 2020. CASBEE-Wellness Office: An objective measure of the building potential for a healthily built environment. Japan Architectural Review. https://doi.org/10.1002/2475-8876.12199.

Green Building Initiative, 2023: How to certify https://thegbi.org/green-globes-certification/how-to-certify/ (view at 07.01.2023).

International Living Future Institute, 2023: Core Green Building Certification. file:///C:/Users/mfpra/Downloads/Core_Standard.pdf . (view at 07.01.2023).

Becgreen, 2023: The Active House Philosophy – A New Building Standard from Europe: https://becgreen.ca/the-active-house-philosophy-a-new-building-standard-from-denmark/ (view at 08.01.2023).

Active house, 2023: Crate a Radar. https://www.activehouse.info/submit-your-project/create-a-radar/ (view at 08.01.2023).

Romania Green Building Council (RoGBC), 2023. Green Schools. http://m.rogbc.org/en/projects/green-schools (view at 11.01.2023).

Lisa Craiut, Constantin Bungau, Tudor Bungau, Cristian Grava, Pavel Otrisal, Andrei-Flavius Radu, 2022, (a): Technology Transfer, Sustainability, and Development, *Worldwide and in Romania, Sustainability, Published by MDPI*, 2022a, 14(23), 15728; https://doi.org/10.3390/su142315728.

Prada M.F., Popescu D.E., Bugău C., 2015. "Building Education, Source of Energy Saving in Romania", *Proceedings of the15th edition National Technical-Scientific Conference Modern Technologies for the 3rd Millennium November 27-28, 2015 - Oradea (Romania)*, ISBN 978-88-7587-724-8; pp. 157-162.

The Hugsi Report 2021, 2022 - cat-de-verzi-sunt-orasele-lumii ? Smart City – https://www.greennews.ro/article/raportul-hugsi-2021-cat-de-verzi-sunt-orasele-lumii (RO) How green are the world's cities? (view at 07.01.2023).

Constantin C. Bungau, Ioana Francesca Prada, Marcela Florina Prada, Constantin Bungau, 2019: Design and Operation of Constructions: A Healthy Living Environment-Parametric Studies and New Solutions, *Sustainability, Published by MDPI*, 2019, 11(23), 6824; https://doi.org/10.3390/su11236824.

Swiss Foundation for Technical Cooperation: Green cities, 2023. https://www.swisscontact.org/en/our-work/our-expertise/green-cities?gclid=Cj0KCQiAzeSdBhC4ARIsACj36uHAjSL_BPvwl1k4Vmy-NTbw2j6fdZXBYdhH6bSwQ-cVMEYB2k2fByQaAhNEEALw_wcB (view at 07.01.2023).

Lisa Craiut, Constantin Bungau, Paul Andrei Negru, Tudor Bungau, Andrei-Flavius Radu, 2022 (b): Technology Transfer in the Context of Sustainable Development - A Bibliometric Analysis of Publications in the Field, *Sustainability, Published by MDPI*, 2022b, 14(19), 11973; https://doi.org/10.3390/su141911973.

Dortmund Leisure, Culture, Tourism: Space to relax – Dortmund's greens, 2023, https://www.dortmund.de/en/leisure_and_culture/greendortmund/index.html (view at 07.01.2023).

Marcela Florina Prada, Daniela Elena Popescu, Constantin Bungau, Rares Pancu, Constantin C. Bungau, 2017: Parametric Studies on European 20-20-20 Energy Policy Targets in University Environment, *Journal of Environmental Protection and Ecology*, Published by Scientific Bulgaria Communications, 2017, 18(3), 1146-1157.

UI GreenMetric. Overall Rankings 2022. https://greenmetric.ui.ac.id/rankings/overall-rankings-2022 (view at 03.03.2023).

QS World University Rankings: Sustainability 2023 – Published on 26.10.2022. https://www.topuniversities.com/university-rankings/sustainability-rankings/2023 (view at 15.01.2023).

Staff Writers, The 10 Greenest Universities, 2022 https://www.bestcolleges.com/blog/greenest-universities (view at 15.01.2023).

Stephen Hall, 2022. Economic progress. These are the world's most sustainable universities, 2022. https://www.weforum.org/agenda/2022/12/world-top-sustainable-universities-sdgs/ (view at 15.01.2023).

Kelly Mae Ross and Ilana Kowarski. U.S.News. Education. 2022. Top 10 Global Schools for Environment, Ecology. https://www.usnews.com/education/best-global-universities/slideshows/see-the-top-10-global-universities-for-environment-and-ecology?slide=10 (view at 15.01.2023)

Popescu D. E., Bungau C., Prada M., Domuta C., Bungau S., Tit D. M. 2016. "Waste Management Strategy at a Public University in Smart City Context"; *Journal of Environmental Protection and Ecology*, Vol. 17, No. 3, ISSN 1311-5065, 2016, pp.1011-1020; Accession Number: WOS: 000417113200032.

Cristea, M. Energy Performance Certificate at Building Reception C 53 - SMART Campus Project - University of Oradea; Oradea, 2022; p. 1.

Ordin no. 2641, 2017. Ordin nr. 2641 – 2017 privind modificarea și completarea reglementării tehnice "Metodologie de calcul al performanței energetice a clădirilor", aprobată prin Ordinul ministrului transporturilor, construcțiilor și turismului (RO) (Order no. 2641 - 2017 regarding the modification and completion of the technical regulation "Methodology for calculating the energy performance of buildings", approved by the Order of the Minister of Transport, Construction and Tourism) pp. 3, Bucharest, Romania.

Ordero no. 16, 2023. Ordin nr. 16 – 2023 privind modificarea și completarea reglementării tehnice "Metodologie de calcul al performanței energetice a clădirilor", aprobată prin Ordinul ministrului transporturilor, construcțiilor și turismului (RO) (Order no. 16 - 2023 regarding the modification and completion of the technical regulation "Methodology for calculating the energy performance of buildings", approved by the Order of the Minister of Transport, Construction and Tourism)" pp. 5, Bucharest, Romania.

UI GreenMetric. Overall Rankings 2022. https://greenmetric.ui.ac.id/rankings/archive (view at 04.03.2023).

*** HG 1034 / 2020, "Strategia națională de renovare pe termen lung pentru sprijinirea renovării parcului național de clădiri rezidențiale și nerezidențiale, atât publice, cât și private, și transformarea sa treptată într-un parc imobiliar cu un nivel ridicat de eficiență energetică și decarbonat până în 2050" (RO). HG 1034 / 2020, "National long-term renovation strategy to support the renovation of the national park of residential and non-residential buildings, both public and private, and its gradual transformation into a real estate park with a high level of energy efficiency and decarbonized by 2050." pp. 74.