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GREEN BUILDINGS AND ENVIRONMENTAL CERTIFICATION: BREEAM, AQUA AND LEED SYSTEMS

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Abstract: The practice of sustainability is an extremely important subject nowadays. Its application in civil construction and urban planning is essential to minimize the negative environmental impacts generated by the sector, considering the entire life cycle of the building and the externalities of the urban environment. Thus, the objective of this research was to discuss the main environmental certifications as well as the practice of sustainability in constructions. The study will address the issue from a deductive perspective, through an exploratory and bibliographical research and a quantitative approach. Through case studies, it was verified that the savings generated by adopting an environmental certification system can reduce the consumption of natural resources, replacing old systems with innovative and sustainable solutions. It is concluded that the environmental certification systems have a positive impact when implemented, reducing the use of natural resources, providing greater environmental comfort to users and generating economic benefits to owners.
KEYWORDS: Environmental certification, Green building, Sustainability, Sustainable development.

INTRODUCTION

With the oil crisis in the early 1970s, people began to think more about energy reduction and alternative energy sources (GONÇALVES; BODE, 2015). As the construction sector, until then, did not plan for efficient energy consumption in buildings, it was pressured to adopt more efficient means of using energy.

In addition to the high consumption of primary energy consumed by buildings, the building sector was also identified as a world leader in CO2 emissions, in the fourth report produced by the International Panel on Climate Change (IPCC, 2007). However, the report indicates the sector as having the greatest capacity to reduce its emissions, through its projects and use of advanced technology.

The unfolding of the 1974 crisis culminated in the creation of the *International Energy Agency* (IEA), based in Paris and started with the implementation of energy regulations for the building sector (GONÇALVES; BODE, 2015). After the creation of the IEA with regard to the buildings sector, many countries began to develop policies aimed at reducing their participation in the international energy matrix. For this, countries such as the US have adopted existing technical guidelines as a means of preventing a new energy crisis.

In the United States, the American Society *of Heating, Refrigerating and Air-Conditioning Engineers* (ASHRAE) was adopted. And so it happened in other countries that, similarly to the USA, decided to accept the technical guidelines already used by professionals in their countries, adapting them to then be transformed into laws. ASHRAE is a global professional association founded in 1894 in New York City, formed by engineers, architects and other professionals who seek advances in relation to heating, ventilation, air conditioning and refrigeration systems (BARSANO, 2012).

Concomitantly with the implementation of these public policies, a second environmental movement emerged. The UN, during the 1970s until the beginning of the 1980s, held several conferences warning of the need to optimize the protection of natural resources, emphasizing that they could not be exploited in such a way (DIAS, 2011).

However, it was with the conferences held in Copenhagen and Rio de Janeiro that a new global environmental policy was proposed. At this time, it was clear how much buildings could contribute to reducing the exploitation of natural resources. One can cite, for example, savings in water, energy and material resources

of primary extraction.

With this need to reduce the impacts of buildings on the global environmental scene, in developed countries tools and initiatives were created in order to fill a lack of public policies.

One of these tools became known as environmental certification systems. The certifications, in addition to adding value to the projects, ensured new buildings where environmental inefficiency would no longer be part of. As the concept of *green building* has a strict connection with environmental certifications, it must be noted that the International Energy Agency defines a green building as one with greater energy efficiency and lower consumption of water and materials, in addition to considering the quality of indoor air (IEA, 2008).

Considering that buildings, when certified, have good environmental and energy performance, can become more resilient to climate change, and can contribute significantly to the structuring of sustainable cities, given the low externality and reduction of environmental impacts.

OBJECTIVES

GENERAL

Discuss the main environmental certifications as well as the practice of sustainability in buildings.

SPECIFIC

Establish a broad understanding regarding the importance of the role of sustainability in conserving a healthy life for future generations and the livable environment;

Find out about methods for the development of a green building in the form of technical and material possibilities;

Analyze the main environmental certifications existing in Brazil

Make a comparison between the seals, verifying the singularities and main focuses of each one;

METHODOLOGY

In order to obtain satisfactory results from the outlined objectives, the exploratory research method was adopted, with the purpose of analyzing the advantages of opting for a sustainable system in buildings. Considering the purpose of the research, the adopted approach was of a qualitative nature, conducting the development in a theoretical way so that the information transmitted through this article can be visualized in a daily situation and applied in society.

The nature of the study was applied research, adopted with the aim of presenting the knowledge acquired through the works of the authors referenced through bibliographical research, together with the data collection process classified as indirect research, where previously developed content is analyzed . (Figure 01).

The building selection process was carried out using the database provided by the USGBC, filtering the manually registered buildings and choosing buildings with particularities.

RESULTS

TECHNIQUES AND MATERIALS FOR A SUSTAINABLE CONSTRUCTION

The need for a sustainable development model led to an academic race in search of different techniques and improvements of simple and accessible materials, making them capable of performing fundamental functions in civil construction. Adherence to constructive solutions aiming to make the building more efficient and integrated with the environment is the key to sustainable evolution.

Through simple technical solutions, it is possible to transform an ordinary building into a great ally of nature, extracting the

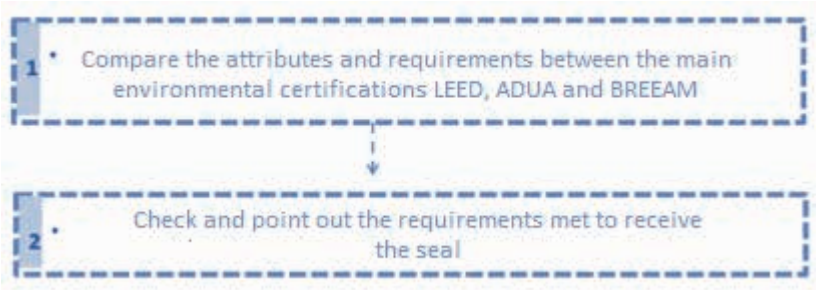


Figure 01. Delimitation of the search.

Source: From the author, 2022.

Energy	Emission of CO2;
	Low or zero carbon technologies;
	energy submeasurement;
	Efficient building systems;
Health and wellness	Daylight;
	Occupant thermal comfort;
	Acoustic;
	Indoor air and water quality;
	Lighting;
Innovation	Exemplary performance levels;
	The use of BREEAM accredited professionals;
	New technologies and construction processes;
Land use	Location selection;
	Protection of ecological features;
	Mitigation/improvement of the ecological factor;
Materials	Impact of the material's embedded lifecycle;
	Material reuse;
	Responsible sourcing;
	Robustness;
Management	Commissioning;
	Impacts on the construction site;
	Security;
Pollution	Use of refrigeration and leakage;
	Risk of flooding;
	Emission of NOx;
	Water course pollution;
	External light and noise pollution;
Transport	Public transport network connectivity;
	Facilities for pedestrians and cyclists;
	access to amenities;
	Travel plans and information;
Waste	Construction waste;
	Recycled aggregates;
	Recycling installations;
Water	Water consumption;
	leak detection;
	Water reuse and recycling;

Table 01. BREEAM environmental certification review categories.

Source: Adapted from Jagger, 2021.

maximum of its functionality, in addition to reducing the negative impact that its design causes to the environment.

A technique that is increasingly widespread today is the use of the retrofit concept. This method consists of updating an existing building, applying procedures to improve it through contemporary resources (KANTOR, 2014), such as the installation of green walls or vertical gardens with an automated irrigation system that reuses rainwater, in blind gables of buildings, resulting in the aesthetic appreciation of the property and in the reduction of the internal temperature and verification of the air quality. Another technique applied in order to make the most of what construction can offer is the adoption of modular constructions, or prefabricated buildings, which bring benefits in terms of speed of execution and low demand for labor, also lacking a initial care with thermoacoustic treatment (PAIVA, 2021). In addition to the common model, the adhesion of container houses is an increasingly present trend in Brazil, reducing the consumption of materials recently extracted from nature and reusing cargo compartments, no longer useful for their initial purpose, in addition, their construction method allows the mobility of the structure, being rebuilt in the intended location (QUEIROZ, 2020).

Due to studies carried out in order to find alternative sources to optimize and reduce energy consumption, it was possible to develop sustainable energy systems. Energy harvesting models, such as photovoltaics, are extremely efficient and exploit abundant renewable resources to generate electricity. Photovoltaic energy, in the long term, generates significant financial savings and reduces the demand for resources withdrawn from distribution companies through the installation of solar panels, responsible for intercepting solar rays and, through the collision of particles with silicon atoms, creating a direct electric current, which, when transformed into alternating current by the solar inverter, supplies the house through an on-grid, off-grid or mixed system (CASTRO, 2002).

It must be noted that the expansion of the urban area causes several negative impacts on the environment, impairing the quality of life of the inhabitant population. The growing production of CO2 in urban centers, without a satisfactory volume of vegetation to neutralize its effects, raises the need to find appropriate methods to sequester the excess carbon generated by the mass of vehicles. To this end, the implementation of vertical gardens and green roofs is an intelligent dynamic, given that the spaces intended for vegetation are reduced, prioritizing the construction of new buildings. The techniques of vertical gardens and green roofs beautify the building and reduce the need for rain collection systems, which can perform this function themselves, in addition to serving as a thermoacoustic element and improving air quality through the consumption of CO2 and release of O2 (COELHO, 2010).

Prioritizing natural ventilation and lighting systems is essential for sustainable development, as their application generates long-term cost savings by taking advantage of factors such as the position of the building in relation to the sun (LIMA, 2018), volumetry and its influence in the natural ventilation of the environment, the application of techniques that reduce the need for artificial ventilation and the adoption of economical and sustainable materials.

The incorporation of contemporary techniques is a huge step towards the sustainable purpose, fundamental for the dissemination of the cause, offering numerous methods that can be used according to the need and intention of the designer. The introduction of these procedures is able to

significantly reduce the demand for natural resources, extracting the maximum from what is already in use, in addition to taking advantage of inexhaustible natural elements, such as sunlight and wind, resulting in the minimization of impacts.

In addition to techniques developed through sets of good sustainable practices, other fundamental allies were found to achieve the desired and increasingly efficient sustainable construction. The discovery of ecological materials through in-depth studies on simple elements, made adherence to the concept of sustainability easier to envision, taking into account the easy access to resources, in addition to economic viability.

Within this context, the adoption of ecological bricks is an interesting idea and has been increasingly specified in projects. The main one used is the soil-cement brick, created from soil, cement and water, it does not need baking in the oven, it is only pressed, ensuring the reduction of polluting gases. In addition, its precast element feature results in faster execution, avoids waste and waste generation, saving up to 30% compared to conventional masonry (MOTTA et al, 2014).

With increasingly diverse and advanced research sources, it is worth mentioning other sustainable bricks created in an intelligent way. Among them, we have the RePlast brick, developed using plastic taken from the ocean, it does not need glue or mortar and is assembled only by fitting, the Eco BLAC brick, composed of 70% of ash and not requiring burning, the ecological brick of tire, created to reduce the number of tires in landfills, providing thermoacoustic comfort in addition to being non-flammable, sustainable bricks made from PET bottles, replacing sand with polyethylene terephthalate, in order to reduce the amount of waste generated by plastic bottles (RANGEL, 2017), however, with the exception of PET bottle bricks, certified by the Subsecretaría de Hábitat de la Nación, despite these products representing enormous contributions to the sustainable community, they are still not certified and are easily found in the Brazilian market.

An ingenious alternative, capable of reusing waste and maintaining, or even raising, the quality of the product, is the manufacture of concrete with waste, using the most diverse complements. A concrete developed by ‘’Universidade de **São Paulo** in **São** Carlos ‘’ (USP), for example, replaces 70% of the natural sand with foundry sand and 100% of the stone with steel slag, waste from steel production, reducing the need to use new resources (RODRIGUES, 2021).

The efficiency of alternative elements can offer desirable characteristics such as the replacement of wood through the application of bamboo, a material that grows fast and has high tensile strength, in addition, the use of wood itself can be appropriate, if of sustainable origin. The use of certified wood, guaranteeing the origin of the product, and demolition wood, reusing residual wood from the end of the life cycle of other buildings, offers security regarding the ecology of the material.

Furthermore, the adoption of sustainable coating techniques supports the environment and reduces the need for resources extracted from nature to design a building in its entirety. The use of clay mortar replaces cement with clay, providing greater thermoacoustic efficiency and preventing excessive humidity in coated environments. The finalization of the finish with the use of ecological paints, made from completely natural raw materials, reducing, or even completely removing, the presence of oil in the design of the paint (ALVES, 2017). An ecological paint worth mentioning is earth paint, its use provides high durability at low cost, without harming the health of those who come into contact with

the product, and its manufacture is handmade (FURUKAWA; CARVALHO, 2011).

Regardless of the technique or material used, it is essential that there is good supervision, ensuring that the processes and products used are, in fact, of high quality and allies of sustainable development. For this, the creation of certifications for buildings built with sustainable principles is a fundamental milestone in the search for ecologically correct evolution.

THE ENVIRONMENTAL PERFORMANCE CERTIFICATION OF BUILDINGS

The recent perception of the lack of a sustainable model of life and its impacts on current and future generations required the establishment of means to ensure the adoption of an ecologically correct concept in various sectors. Its implementation can be observed through the creation of environmental certifications, developed with the aim of inspecting and certifying the ecological origin of materials and construction processes used in products, buildings and food.

Civil construction is a branch in constant evolution, requiring frequent updates. The idea of adopting environmental certification systems in buildings has encouraged many companies to join the green side, improving the quality of life of building users and valuing future generations.

BUILDING RESEARCH ESTABLISHMENT ENVIRONMENTAL ASSESSMENT METHOD (BREEAM)

In 1992, England reached a new level of awareness by creating the first model of environmental certification in buildings, the BREEAM seal, with almost 600,000 certifications (INOVATECH, 2022). The seal has 10 main categories: energy, health and well-being, innovation, land use, materials, management, pollution, transport, waste and water. Obtaining it occurs through credits, evaluated by a professional and acquired through subcategories, with objectives and requirements, within the main ones (BREEAM, 2022). At the end of the development or renovation of the building, the calculation of each category is carried out and duly scored according to the credits acquired and the weight of the category. From 30 points you can receive your seal, 45 for good rating, 55, very good, 70, excellent and 85 outstanding (INOVATECH, 2022). Table 01 shows the analysis categories.

The concern of the BREEAM certification system with strengthening the sustainability tripod is visible. By observing Table 01, it is possible to find criteria that are attentive to the adaptation of users in the building, in addition to valuing planning and management, avoiding the waste of natural resources and reducing construction costs. Graph 01 indicates the growth in the search for BREEAM certification.

Adherence to the BREEAM certification system is growing in other countries, as it can be seen, the search for the seal increases exponentially, contributing to the dissemination of environmental certification systems and the acquisition of trust from users and owners.

HIGH ENVIRONMENTAL QUALITY - HQE (AQUA)

AQUA, High Environmental Quality, developed in 2008, is the first Brazilian certification seal, conceived using as inspiration the French certification seal, HQE, Haute Qualité Environnementale. Its analysis considers the specificities of Brazil, evaluating the building in 14 criteria, divided into 4 categories (Figure 03).

The eco-construction category analyzes

the surroundings of the site, ensuring that the work has a low environmental impact on the surroundings, eco-management values the efficiency of the resources used, certifying their conscious use, the comfort division ensures the adoption of techniques in order to provide thermoacoustic, olfactory and/or visual insulation, finally, the health item requires confirmation of the adoption of good quality systems in terms of water and sanitation (CARRÉRA, 2015). Table 01 points out the analysis categories of the AQUA environmental certification system.

Upon reaching the desired characteristic in each criterion, the building can receive confirmation of performance at the levels good, superior and excellent, being necessary, in order to obtain the seal, a minimum performance of Good in 7 categories, Superior in 4 and Excellent in 3 (VOITILLE, 2020). The first buildings certified by the AQUA seal were Espaço Immensità and the Leroy Merlin store in Niterói, acquiring their seals on the same day, March 23, 2009, honorably mentioning the first residential building to be certified, Park One Ibirapuera, São Paulo (AQUA -HQE, 2022), and the first building already in operation, the Eólis Building, Porto Alegre (INOVATECH, 2022). According to the Vanzolini Foundation (2021), there are currently 707 buildings in the certification process, of which 416 are residential, 231 are non-residential under construction and 59 are non-residential in operation, and 356 are certified buildings.

The technical reference of the AQUA certification system is structured in an Enterprise Management System (SGE) and in the Environmental Quality of the Building (QAE). The SGE comprises the definition of the project that is intended to be achieved, requiring good management and organization for decision making. The QAE evaluates the construction performance, according to the parameters defined in the SGE (FERNANDES, 2014).

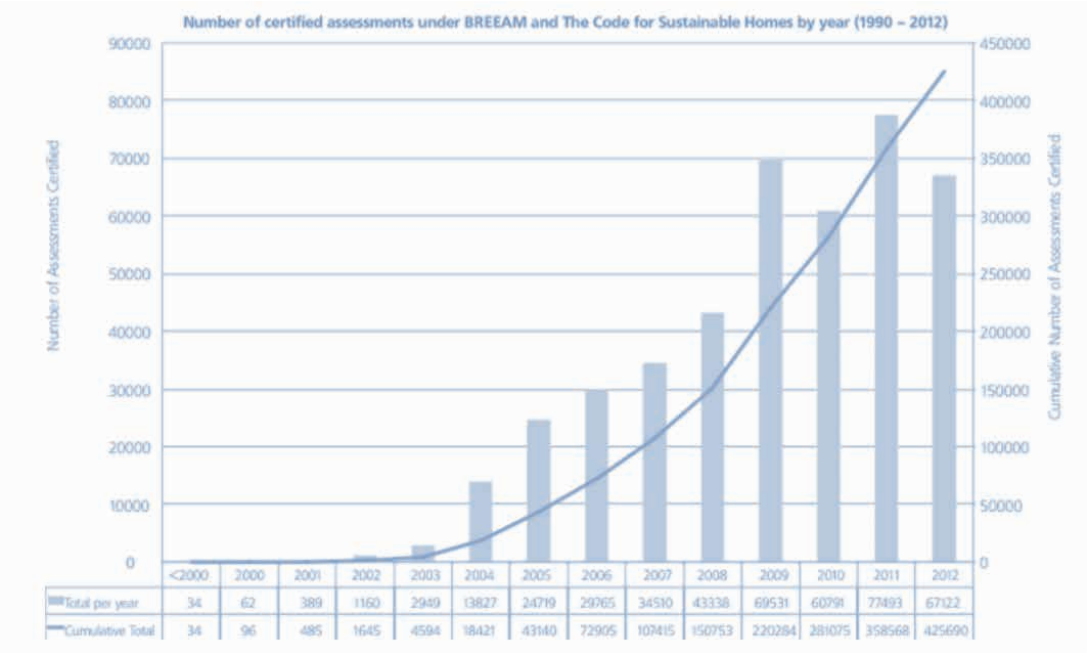
The AQUA seal is still a new environmental certification system and is undergoing maturing processes, however, its structural adaptation based on the specific conditions in Brazil is an important differential and can be well explored.

LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN (LEED)

Developed in 1993 by the United States Green Building Council (USGBC), the LEED seal comprises an international certification system, created in order to encourage the adoption of sustainable practices in the design and maintenance of buildings (KLABUNDE, 2018). The seal can be classified into 4 main types, being analyzed into 9 categories, with prerequisites and suggestions, generating credits when met. Figure 03 presents four main typologies of the LEED seal.

The BD+C typology seal, provides parameters for new constructions or major renovations of buildings, the ID+C category includes projects for the interior of buildings, without changing the main structure of the building, O+M encompasses the maintenance of buildings already existing areas and the ND comprises renovation projects in neighborhoods, making them more sustainable (GBC BRASIL, 2022). There are also other less common types of seal, such as residential LEED, LEED zero, LEED for schools and LEED for healthcare (SUSTENTARQUI, 2020). Table 02 displays some specific typologies of the LEED certification system.

The LEED system follows a policy based on the tripod of sustainable development, verifying benefits in each pillar (GBC BRASIL, 2022). Chart 03 points out the benefits of the LEED seal directed to the tripod of



Graph 01. Number of buildings certified by BREEAM between 1990 and 2012.

Source: BREEAM, 2014.

Eco-Construction	Eco-Management	Comfort	Health
• Relationship of the building with its surroundig; • Integrated choice of products, systems and construction processes; • Construction site with low environmental impact;	• Water management; • Power management; • Waste management from use and operation of the building; • Maintenance: permanence of environmental performance;	• Hygrothermal comfort; • Acoustic comfort; • Visual comfort; • Olfactory comfort;	• Sanitary quality of environments; • Sanitary air quality; • Sanitary quality of water;

Table 01. AQUA environmental certification analysis categories.

Source: Adapted from Voitille, 2020.

Figure 03. Types of LEED environmental certification.

Source: GBC Brazil, 2022.

LEED NC	• New constructions;
LEED CS	• Envelopment and common spaces;
LEED EB-OM	• Operation and Maintenance of Existing Buildings;
LEED CI	• Commercial Interior - Offices;
LEED Retail	• Retail stores;
LEED for Schools	• Schools;
LEED for Healthcare	• Hospitals;
LEED ND	• Neighborhoods;

Table 02. Types of the LEED seal.

Source: Adapted from GBC Brasil, 2022.

Economical

- Reduces operating costs;
- Decreases regulatory risks;
- Values the property for resale;
- Increases building occupancy speed.

Social

- Improves the health of building occupants;
- Promotes awareness of users;
- Increases employee and student productivity (in schools), speeds patient recovery (in hospitals);
- Attracts investors with greater socio-environmental responsibilities;
- It increases the satisfaction and well being of users.

Environmental

- Promotes rational use and reduced extraction of natural resources;
- Reduces water and energy consumption;
- Decreases the effects of climate change;
- Reduces, treats and reuses the waste generated by the building.

Table 03. LEED certification on the tripod of sustainable development.

Source: Adapted from GBC Brasil, 2022.

sustainability.

Valuing the basis of sustainable development is essential for implementing a healthier model of life, extinguishing the culture of consumerism and allowing innovations to move society into the future. The LEED v4 certification categories, seal update carried out in 2014, can be divided into integrative process, sustainable space, efficiency in the use of water, energy and atmosphere, materials and resources, internal environmental quality, innovation and processes, regional priority and, in 2014 a new category was added, making the selection more rigorous, location and transport (GBC BRASIL, 2022). Table 04 presents the main categories of the LEED certification system;

In order to obtain certification, the building must meet some basic criteria. The MPR, Minimum Program Requirements, consists of demanding basic categories, presented above, considering the current laws, the SS, Sustainable Space, scores resolutions for major urban problems, the WE, Water Use Efficiency, verifies the reuse and recycling of water , EA, Energy and Atmosphere, addresses the conscious use of energy, focusing as much as possible on energy efficiency, RM, Materials and Resources, promotes the reuse of materials in order to avoid waste, finally, EQ, Internal Environmental Quality , verifies the well-being of the internal environment (GBC Brasil, 2022). Figure 04 shows the LEED certificate levels.

Through its criteria and credits, the LEED seal scores the buildings through levels, reaching a maximum of 110 points. Between 40 and 49 points, the building receives the seal, obtaining the Certified level, between 50 and 59 points, it reaches the Silver category, in the range of 60 and 79 points, it reaches the Gold level, if its score exceeds 80, the maximum level of the seal is conquered, the Platinum level (GBC BRASIL, 2022).

CONCLUSIONS

With this research, it was aimed to encourage the dissemination of the use of sustainable techniques and materials, intending the proliferation of information about the importance of adherence to the green culture, analyzed more deeply through civil construction.

Studies carried out on environmental seals indicate economic advantages established by the adoption of environmental solutions in buildings, drawing the attention of owners, in addition to generating benefits for users. The advantages observed when adhering to environmental certification systems help in the process of disseminating the importance of sustainability in civil construction, making them indispensable in the sustainable cause.

When analyzing the environmental certification systems, it was possible to notice a significant saving of natural resources and a brief economic return. This difference is observed more deeply when studying the buildings that obtained the seal of operation and maintenance, tracing a parameter of comparison in relation to the consumption of natural resources, the generation of waste and the comfort of users before and after obtaining the seal, where the adoption of the seal generated small savings over the course of a year that can be leveraged when analyzing a broader panorama, with a longer time interval.

As a suggestion for future research, I point out an interesting analysis on the efficiency of the applicability of the seals in other cities and regions, in order to evaluate the dissemination of the systems on a larger scale, also being able to carry out this evaluation on a global scale, exploring the advantages of adopting environmental seals, as well as the adoption of innovative techniques in other countries, according to local needs.

Integrative Process	• It encourages multidisciplinarity in the preparation of projects;
Sustainable space	• Promotes the reduction of the environmental impact caused by the implantation of a building and by urban centers;
Efficiency of water use	• Encourages the reuse of water, avoiding waste;
Energy And Atmosphere	• Encourages the adoption of energy efficient techniques;
Materials and resources	• Encourages the reuse of materials in order to reduce the impacts caused by the extraction of natural resources;
Indoor environmental quality	• Stimulates the adoption of techniques and materials aimed at the comfort of building users;
Innovation and processes	• Encourages the search for new sustainable methods, combining green techniques with technology;
Regional priority	• Motivates the acquisition of credits defined as a priority for each region, respecting their climatic, environmental, social and economic differences;
location and transportation	• Feeds the choice of land in urban spaces where alternative means of transport already exist;

Table 04. Main categories of obtaining LEED certification.

Source: Adapted from GBC Brasil, 2022.

Figure 04. LEED certification system levels.

Source: GBC Brazil, 2022.

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