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RETROFIT IN BUILDING SYSTEMS FOR RESOURCE OPTIMIZATION

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Abstract: In the current context, the need to promote sustainability in constructions is increasing. Given this issue, it is necessary to study and identify potential technologies that promote sustainability in building systems. This article intends to identify *retrofit* techniques in building facilities that aim to reduce environmental impact and optimize resources. The methodology consists in studying sustainability in building facilities by searching through articles, theses, journals, and other available materials to present possible techniques. The article acknowledges aspects in building systems that cause environmental impact and presents various feasible and sustainable proposals for their minimization, such as implementing green roofs, using residential solar panels, and installing facilities and solutions for rational water usage and water reuse.
Keywords: sustainability, environmental technologies, building systems, retrofit.

INTRODUCTION

According to the World Commission on Environment and Development (1988, p 49), sustainable development is "[...] a process of transformation in which the exploitation of resources, the direction of investments, the orientation of technological development and the institutional change harmonize and reinforce present and future potential in order to meet human needs and aspirations."

Civil construction is one of the sectors responsible for the infrastructure necessary for the development of the economy throughout the country. However, despite its importance in the economy and quality of social life, it can also cause negative impacts on the environment.

In addition to the consumption of energy and natural resources, the construction industry is responsible for the generation of construction and demolition waste - RCD. The amount of CDW collected per year in Brazil has increased significantly since 2010, from 33 million tons to 44.5 million in 2019, according to the Brazilian Association of Public Cleaning and Special Waste Companies (2020).

The environmental impacts generated by the construction industry have been the subject of great discussions. The search for new techniques and technologies that minimize these effects, not only in the design and construction phases, but also during the life cycle of the building and in its maintenance, has been conducted all over the world. (DORIGO and CARI, 2014).

A proposal that has been widely used in Brazil is the retrofit which, according to the Brazilian Council for Sustainable Construction (2013, p.1), in the context of buildings, consists of "[...] intervention carried out in a building with the objective of incorporating improvements and changing its state of utility".

Aligned with the discussions, this article aims to identify retrofit techniques in building installations that aim to reduce the environmental impact and optimize resources.

METHODOLOGY

The elaboration of this article is based on the search, in an exploratory and descriptive way, of articles, dissertations and theses about the concept of retrofit in building systems aiming at sustainability and its possible applications.

This study was carried out by searching academic databases such as Google Scholar, Science Direct and Semantic Scholar, using the key terms retrofit, sustainability in buildings and optimization of resources in building systems. The material found in the bibliographic research was thoroughly evaluated, recognizing relevant approaches to the subject, in order to present possible solutions.

DEVELOPMENT

GREEN RETROFIT

According to Yudelson (2013), the reduction of environmental impacts caused by civil construction is feasible when there is a change in the design concept associated with practices that consider the life cycle of construction materials, water use systems, systems and means for generating and using energy and comfort decisions, such as optimizing natural ventilation and daylighting in order to reduce energy consumption.

A system that has gained prominence is the implementation of green roofs, installed on the roof of the building with the planting of plant species, whose water is retained by the plants or drains through the drainage system, reducing the internal temperature and, consequently, the use of air. conditioned.

According to Lengen (2004), this roof can be made using natural materials such as bamboo, earth and grass. For its implementation, it is necessary to own or build a roof with a minimum slope of 1:10. It is important to nail a board upright at the end of the rafters and place a plastic sheet in order to prevent rainwater infiltration. In the lowest part of the roof, a perforated pipe is placed every 20 cm to drain the water. Finally, the area is covered with slabs of grass. Generally, grass roofs have little slope; in the case of steeper slopes, slats, bamboo or chicken wire must be used to prevent slipping.

Green walls or vertical gardens have a similar function, as they are a simple and natural way to control the heat in an environment. Plants bring moisture into the space, and their presence prevents heat from being trapped in the interior walls, contributing to the maintenance of cooler air and a more pleasant climate.

ENERGY RETROFIT

The current context has driven the search for energy alternatives with less environmental impact and greater economic viability. Conventional energy generation methods require considerable financial investment, which results in economic implications for nations, given the significant cost associated with implementing many of these sources. (ROSA and GASPARIN, 2016).

According to data from the April Monthly Energy Bulletin (2023), the growth of installed capacity of distributed generation - solar DG - in Brazil grew 97.3% compared to April 2022. The installed capacity of centralized generation - non-GD - solar also advanced, with an increase of 71.3% in relation to the same month of the previous year.

Given this situation, the energy retrofit in buildings is interesting, because in the process of modernizing or updating building systems, the search for increased energy efficiency and building performance is enhanced. (RABANI, 2017).

SOLAR POWER GENERATION

In the last decade, it was possible to observe a great growth in the renewable energy sector in Brazil, especially with the installation of photovoltaic systems throughout the country. With ANEEL Normative Resolution No. 482/2012, the consumer now has the right to generate their own energy, through photovoltaic systems, and participate in the electricity compensation system, in which part of the energy consumed from the concessionaire. (RESENDE, 2019)

The photovoltaic system connected to the grid is also known as on grid or grid tie. It dispenses with the use of batteries, as all the power generated by the photovoltaic system is consumed by the loads or is injected directly into the electrical grid. This system sends energy to the grid when generation is greater than consumption, and withdraws from it when consumption is greater than generation. Therefore, the grid works like a large bank of batteries, sometimes storing excess energy, sometimes supplying it at times of greater demand. Thus, according to the normative resolution of ANEEL 482/2012, the user only pays to the concessionaire when he consumes more than he generates, and if he produces more than he consumes, he receives credits (BORTOLOTO, et al, 2017).

The off-grid system for power generation is characterized by not connecting to the electrical grid. Thus, it directly supplies the devices that will use the energy, which are generally built with a local and specific purpose. This system is widely used in rural areas, farms and peripheral regions, where there is less access to the electricity grid. (BORTOLOTO, et al, 2017).

Lima and Moreira (2016) state that because a cell alone cannot fulfill its function, it is necessary to form modules and panels. The module consists of a group of cells that are connected in series or parallel in order to achieve the desired voltage and power, while the panels consist of a group of modules with the same purpose.

Based on geography, the proper installation of a photovoltaic solar module must take into consideration, the daily movement of the Sun. Therefore, the best way to install a fixed solar module, without a solar tracking system, is to orient it with its face. facing the geographic North (BÚSSOLO, 2018).

According to ``Neoenergia`` (2021), the adoption of photovoltaic systems can result in a reduction of up to 95% in the electricity bill. The initial investment in installing solar panels is offset by savings due to reduced energy costs.

According to ABSOLAR (2022), during the year 2022, photovoltaic solar energy grew by more than 40% in Brazil. The development of this technology has enabled the diversification of the energy matrix, in addition to providing the development of industry, job and income generation (LIMA and MOREIRA, 2016).

SOLAR HEATER

The use of solar energy, transformed into thermal energy, also stands out as a water heating technology. Its use is carried out by means of collectors or solar heaters, with various applications, notably the heating of water for bathing. (TOLEDO, 2019).

Most solar heaters manufactured in Brazil have water as thermal fluid, and are composed of two basic items: the solar collector plate and the thermal reservoir or boiler. Added to these items are the pipes and connections, which may or may not have an auxiliary power source. The performance of each of these components is related to each other, with the water supplying the system entering the boiler, going to the collector plates, where it is heated, and returning to the boiler, where it is stored until consumption (SIQUEIRA, 2009).

Siqueira (2009) states that solar thermal technology reduces the environmental damage associated with conventional energy sources: it does not produce toxic gas emissions into the atmosphere; and does not leave residue like radioactive waste. The technology offers social benefits such as reducing the electricity bill, creating jobs per unit of energy transformed, decentralizing its production and selling carbon emissions reduction certificates.

RETROFIT OF FACADES

The reformulation of the façade may include changing frames, treating cracks, placing drip pans and brises to make it more suitable, according to the local insolation, maintaining a more pleasant internal temperature and reducing the use of air conditioning and, therefore, consequently, minimizing the energy impacts of the building (GROSSO, 2015).

VENTILATED FACADE

The ventilated facade can be defined as a system of protection and exterior cladding of buildings, characterized by the spacing between the wall and the cladding, creating an air chamber. The term ventilated derives from this chamber, which allows natural and continuous ventilation of the building wall through the chimney effect, that is, cold air enters at the bottom and hot air exits at the top.

This way, with the ventilation of the wall, humidity and condensation common in traditional facades are avoided (GOMES, 2015).

According to Gomes (2015), the ventilated facade has even better ability to adapt to temperature variations occurring in the building structure, thus causing a decrease in the use of air conditioning.

THERMALLY INSULATED GLAZING

Obtaining greater energy efficiency for the building necessarily involves the use of natural light. In this case, it is recommended to use solar control glasses. The most used are reflective and low-e, which allow natural lighting to enter without compromising the thermal comfort of the environments. (AECWEB PORTAL, 2022)

Reflective glass reduces heat gains due to its ability to reflect and absorb sunlight, which brings thermal comfort to the environment and less intense light transmission. The low-e coating reflects long-wave infrared radiation, which reduces the building's gains or losses of heat and can generate energy savings by creating environments with a balance between the transmission of natural light and the transfer of heat.

RATIONAL USE AND REUSE OF WATER

In view of the degradation of water resources and the consequent scarcity of potable water, its rational use and effective management become important. Despite this, and even with all the discussions on the subject, it is known that the misuse and waste of this resource are common. However, the strategies that help to reverse this situation are currently quite diverse and accessible (DORIGO and CARI, 2014).

With regard to the contribution of the cold-water building system to the promotion of water sustainability, it is worth mentioning the issue of water conservation. Therefore, water conservation measures, by providing savings in the home space, will automatically be saving in the public system and in springs (SANTOS, 2002).

USE OF WATER SAVING DEVICES

With regard to the use of water-saving sanitary appliances and devices, it is important to mention that there are a number of them available on the market, such as sanitary basins with reduced flush volume, showers and washbasins with fixed flush volumes and aerators (DORIGO and CARI, 2014). Another very viable option for the rational use of water is the installation of self-closing faucets with a pressure mechanism.

USE OF ALTERNATIVE WATER SOURCES

According to the Manual for the Conservation and Reuse of Water in Buildings – ANA – (2005), the minimum requirements for the use of non-potable water depending on the different activities to be carried out in buildings are: not to have a bad smell, not be abrasive, do not stain surfaces, do not encourage infections or contamination by viruses or bacteria harmful to human health.

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Specific requirements may vary depending on the intended use of the water. Regardless of the intended purpose, it is essential to know the conditions under which water can meet the needs of a reuse project.

Gray water

Gray water for reuse is the domestic effluent that does not have a contribution from the toilet bowl and kitchen sink, that is, the effluents generated by the use of bathtubs, showers, washbasins, washing machines in homes, commercial offices and schools. (ANA, 2005).

According to May (2009), the gray water reuse system in buildings is formed by collectors, reservoirs for storage and treatment systems. The physical, chemical and bacteriological characteristics of water are influenced by the quality of the supply water and the material that makes up the distribution network.

It can be reused in irrigation, watering the garden, washing floors, flushing toilets, refrigeration and air conditioning systems, washing vehicles, washing clothes and ornamental use, provided that the minimum requirements for the use of non-toxic water are followed. drinking water, according to the Water Conservation and Reuse in Buildings Manual (2005).

Developing a gray water reuse project results in savings in potable water, energy savings and less production of sanitary sewage in buildings. In a broader perspective, it results in the preservation of springs, by reducing the amount of water captured and by reducing the release of sewage by urban areas. In addition, it contributes to the reduction of electricity consumption in the treatment of water and sewage (GONÇALVES, 2006).

Rain water

Currently, the use of rainwater in arid and semi-arid regions is a common practice in many regions of the world, including Brazil. It must be noted, however, that the use of rainwater as an alternative source of water supply requires quality and quantity management. Rainwater can be used as long as there is quality control and verification of the need for specific treatment, so that it does not compromise the health of its users, nor the useful life of the systems involved (ANA, 2005).

This water must be, in an essential way, chlorinated for its reuse in buildings, when it is intended for washing floors, car washing, use in flushing toilets, that is, in all processes in which reuse has human contact. (MORE ENGINEERING, 2022).

In addition, the reuse of rainwater allows the creation of a water reserve for emergency situations or interruption of public supply, helps in a better distribution of the rainwater load in the urban drainage system, which helps to control floods. (MARINOSKI, 2007).

Another benefit is its ability to generate a reduction in potable water consumption, resulting in significant savings in household water supply costs. According to the ``Pensamento Verde portal`` (2013), using rainwater harvesting systems it is possible to reduce water supply costs by up to 60%.

According to Peters (2006), the basic configuration of a rainwater harvesting system consists of the catchment area - roof, slab and floor -, the water conduction systems - gutters, vertical and horizontal conductors -, the water treatment - self-cleaning reservoir, filters, disinfection - and the accumulation reservoir. A discharge piping, upper reservoir and distribution network may also be required.

FINAL CONSIDERATIONS

The civil construction branch causes several environmental damages by using non-renewable raw material from nature, consuming a high amount of energy and generating a large amount of waste.

In the current context, where there is a need for development to be sustainable, building systems are required in their performance in order to promote sustainability. Among the techniques presented, it is shown that the implementation of green roofs helps to maintain thermal comfort, reducing the use of air conditioning. Also noteworthy is the implementation of photovoltaic panels as an alternative for residential energy generation, and the use of ventilated facades or thermally insulated glass are also efficient in reducing environmental impacts. And in view of the degradation of water resources and the consequent scarcity of drinking water, accessible alternatives for the rational use and reuse of water were presented.

It is suggested for future research the detailed study of the potential of retrofit practices and building installations, since this article sought to identify some of the possibilities and introduce them to the reader.

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