# The crystal building: Sustainable performance and technologies

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**ABSTRACT**

Over the past few decades, the concern for sustainability as a crucial component in construction has grown, as has the discussion surrounding its integration into the sector, with the purpose of achieving higher qualitative and beneficial efficiency and user experience. In the architectural field, there is a great interest in improving studies of ecological solutions that reinvent building techniques, materiality and the application of energy sources. In this research, the primary methodology employed is the case study approach, centered around the building known as The Crystal, located in London, United Kingdom. Presently, the building serves as the City Hall. In this context, the research objective is to analyze the connection between the local climate and the primary sustainable and technological strategies applied to the project. This analysis is carried out through digital simulations, physical models, and critical analyses. The building was designed by Siemens as a part of the "London Sustainable Cities" program and has received recognition for its energy efficiency measures and the application of bioclimatic architecture from the beginning of its construction. This building embodies a number of sustainable development principles, including the use of geothermal heat pumps for its bioclimatic systems, renewable energy sources, the effective application of natural ventilation and highly effective materials for thermal and acoustic comfort, which, in short, convert this project into a reference within the theme of sustainability and will be studied and detailed within this research.

**Keywords:** The Crystal, Sustainable Strategies, Bioclimatic Architecture.

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## INTRODUCTION

Over the years, the world has experienced disasters and catastrophes as a result of rising temperatures, fueled by the use of non-renewable energy sources, such as burning fossil fuels for power generation. In addition, greenhouse gases are one of the main factors causing global warming, due to the trapping of heat in the Earth's atmosphere and the production of these gases, resulting from the lack of performance of civil constructions throughout their useful lives. Given this context, it is essential to include the principle of applying sustainability in architecture as a whole, from before the project is built until its demolition. (CLIMATE ACTION TRACKER, 2022)

In the field of architecture, this theme arose from Agenda 21, held in 1992, and the concepts have evolved since then, with the support of the conventions held by the UN and, in addition, with the climate conventions, the "COP" (Convention of the Parties), which take place annually. These define the indispensable instruments for the planning of buildings and provide a great link between environmental efficiency and urban sustainability. On the other hand, a significant portion of the world's energy matrix, focused on the construction sector, uses non-renewable sources and, according to the 2017 Global Status Report, generates 40% of $CO_2$ emissions, in addition to the energy spent on these buildings, which is maximized when there is no concern and/or use of bioclimatic strategies. fundamental to sustainability.

Bioclimatic architecture is based on the use of sustainable criteria and local climatic conditions (incidence of the sun's rays, location, winds and existing vegetation, for example) as essential components to obtain adequate thermal comfort. From these existing environmental sources, together with the integration and application of sustainable strategies, it is possible to obtain results that directly impact the reduction of the effects of greenhouse gases and the reduction of the consequences of global warming. Therefore, it is necessary that in the architectural sector there is adaptation to the climate, in order to create spaces that provide comfort to human beings, and that mitigate the sensations of discomfort imposed by more severe climates (FROTA; SCHIFFER, 2003), in addition to the consideration of the traditional knowledge of the region (COSTA, 2007).

With this scenario, the objective of this research is to evaluate and observe, through a case study (taken as the main methodology), the sustainable strategies and their applications within civil construction around the world, and to analyze how this system connects and integrates with the local climate, based on experiments and digital simulations.The object of the research is *The Crystal* building, former headquarters of the *Siemens* company and current headquarters of the City of London, as this construction is considered a great reference in the area of sustainability, due to the use of bioclimatic strategies built in an intelligent and optimized way, aimed at environmental comfort. In addition, the project achieved two certifications, with the highest levels of international sustainability certification standards, LEED Platinum and BREEAM Outstanding. (WILKINSON EYRE ARCHITECTS, 2022)

## THEORETICAL FRAMEWORK

The concept of sustainable development was created in 1987 in the *Brundtland Report* presented by the UN, with the concern of preserving natural reserves due to the extractive mode of production. Thus, sustainable development should meet "the needs of the present, without compromising the needs of future generations." This definition portrays how sustainability, at its core, is the concern of keeping the environment in which one resides healthy and comfortable, with attention to maintaining the integrity of the place without causing a lack of resources in the future. (BRUNDTLAND, 1991, p.1)

According to Gauzin-Müller (2002), based on his studies, he observes that a good part of the world's energy matrix still uses too many non-renewable sources and that, consequently, there will not be enough sources for future generations. In addition, according to the 2017 Global Status Report, the construction sector was responsible for 40% of $CO_2$ emissions, and the energy spent on these buildings is maximized when there is no integration with bioclimatic strategies, considered a preferable solution in order to minimize energy costs, in addition to promoting comfort and increasing the useful life of buildings. These strategies are defined as those designed based on the local climate and, at the same time, intend to promote thermal comfort (CRES, 2017), in addition to being considered from the beginning of the project, associated with the climate study. (FLEET, 1979) (GIVONI, 1992)

In addition to this thought, Schmid (2005) cites in his book his perception in the course of scientific and technological discoveries over the centuries. In addition, the author also highlights the carelessness and forgetfulness within civil construction regarding the pre-established and determining characteristics of a certain site: "there have been effective contributions to energy performance, since knowledge in thermal insulation and ventilation has also advanced. However, traditional knowledge of adaptation to the local climate has been forgotten." In addition, Schmid also positions himself on the way that buildings are planned "the elegance of the forms did not always correspond to the elegance of the technical solutions.", in addition to emphasizing the lack of planning of sustainable strategies when he points out the following thought "the so-called machines of living and working depended on portentous air conditioning systems".

Thus, environmental comfort in Architecture and Urbanism has as one of its main objectives the viability of human settlements, in association with the basic and necessary conditions of habitability, which are adapted to the conditions of the natural environment, as well as the social, economic and cultural (SCHMID, 2005). In addition, the quality of life in a house is intrinsically linked to the construction techniques applied to it and, consequently, to the architectural project adopted. The contribution of passive and bioclimatic techniques incorporated since the beginning of this planning enables a direct increase in thermal and environmental comfort, in addition to making it possible to minimize the use of active technologies, in order to contribute directly to the environment. (KEELER; BURKE, 2010).

In an interview with the CAU of Rio de Janeiro, Richar de Dear (2020, internet) points out that "bioclimatic strategies must be implemented passively and, as a consequence, reduce energy consumption in buildings". In addition, Gurgel (2012, p. 41 and 42) also recommends in his book the insertion of passive strategies in different types of climate. As an example, in cold climate, he recommends as a passive strategy: "greater sun exposure through the building"; "create an envelope to keep the heat inside the building"; "prevent cold air infiltration"; "protect external access doors from cold winds"; "prevent heat loss by conduction (thermal insulation)"; "Promote the circulation of warm air by convection".

Another example of a solution for cold climates is according to Lee Lanterman (2014), in which he highlights the system of heat pumps, which have the same principles as geothermal energy and, therefore, have the function of transferring the Earth's temperature to the interior of buildings. The pump consists of a closed system that works in an inverse way to the climate and, therefore, in places of intense cold, heat can be collected a few meters from the surface, being taken to the transformer units in order to catch it to provide greater heating. In the same way, in climates of intense heat the process will become reversed and the system captures the coolness of the earth with the intention of cooling the building.

In short, the application of bioclimatic architecture becomes essential in the field of constructions, due to its extreme importance for sustainability and the viability of the way of living, and can be defined as the study that aims to harmonize buildings with the bioclimatic characteristics of each place, to optimize the use of available natural resources.  such as sunlight and wind, generating comfort and, consequently, the promotion of a harmonious relationship between the landscape and the building, taking as an agenda the microclimate and its available natural resources. (NEVES, 2006).

In this research, another theme that will be addressed is that of constructions that apply the "Almost Zero Energy" (*Net-zero energy)* concept. This type of building aims to enable energy savings, with the functional integration of all building systems, namely: energy generation, building automation, thermal insulation and internal air conditioning, all integrated into the bioclimatic project. Preferably, the energy in this concept comes from renewable sources with the possibility of production in the building itself, such as the use of photovoltaic panels. (TORCELLINI et al., 2006)

## METHODOLOGY

### LITERATURE REVIEW

A recap of the literature will be carried out throughout the study, based on research into the concepts of net-zero energy, energy efficiency, characteristics of bioclimatic architecture and sustainability in architecture.

### ON-SITE TECHNICAL VISIT

Visit to the building's premises, carried out in July 2022, with its own funding, for data collection and interview with technicians and site representatives.

### DIGITAL SIMULATION WITH ENVI-MET AND ANDREW MARSH SOFTWARE

Digital simulation produced from the "Envi-Met" software, which allows the understanding of the dynamics in the urban climate and its impacts, based on the urban morphology, the soil configuration and the effects caused by the use of vegetation. The study was carried out at the Environmental Comfort Laboratory of the Mackenzie Presbyterian University, Higienópolis Campus, in order to evaluate the topics of insolation in the surroundings of the building. The simulation carried out by the "Andrew Marsh" software is aimed at the study of the bioclimatic strategy proposed for solar insolation, with a focus on facades, during the summer solstices, winter and equinoxes, in order to better understand and visualize the critical zones and the solutions proposed in the project.

### SIMULATIONS IN PHYSICAL MODELS

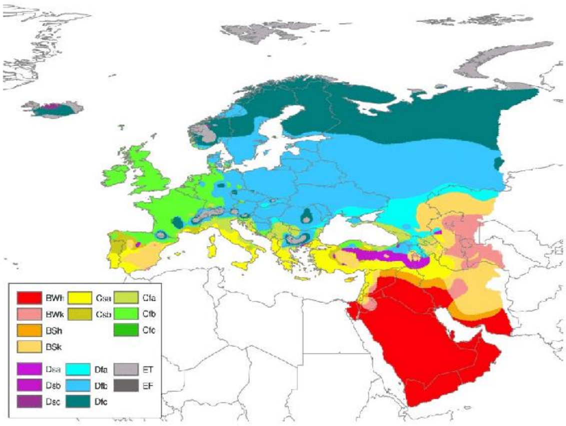
Analysis of ventilation strategies based on the use of two small-scale physical models to understand the relationship of openings, such as ventilation, the chimney effect and the paths of air flows within different spaces, defined by the internal volume of the building. The models were exposed in experiments with directed smoke (in order to simulate a wind tunnel), in search of an understanding of the paths of air flows, through photographs taken in the environmental comfort laboratory of the Mackenzie Presbyterian University.

## RESULTS AND DISCUSSIONS

In the London region, located in the southeast of England, the climate is influenced by the ocean, with a mild and humid marine climate, with no dry season and hot summers. Heavy precipitation, on the other hand, occurs during the winter, being considered mild, and dominated by mid-latitude cyclones. Seasonality is moderate, with the Köppen-Geiger classification as "Cfb - temperate oceanic climate" (KÖPPEN ET AL., 2006). According to WeatherSpark's climate base

(2023), summer is short with "long, very cold winter and strong winds". Throughout the year, temperatures fluctuate between "4 °C to 23 °C", in abnormal situations, and can vary below freezing, "from -1 °C to 29 °C".

Figure 1. Köppen-Geigen Climate Zones




Fonte: Köppen et al. (2006)

Figure 2: Exterior views of The Crystal building

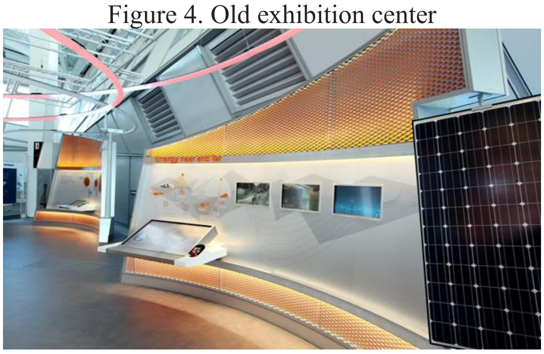
Source: photographs produced by the author (SHINODA,TABATA), taken during the technical visit to the site (July,2022)

The building has an area of 6,300 square meters, and was designed in 2011 by the office of Wilkinson Eyre Architects, primarily a large center for exhibitions, research and conferences of the Siemens company, with the aim of fostering new discoveries and debates on innovation, quality of life and "sustainable urban development". However, in mid-2022, the City of London set up shop on the site.

Figure 3. Current internal view of the site

Source: photo produced by the author (SHINODA,TABATA), made during the technical visit (July, 2022)

Figure 4. Old exhibition center



Fonte: Wilkinson Eyre Architects (2022)

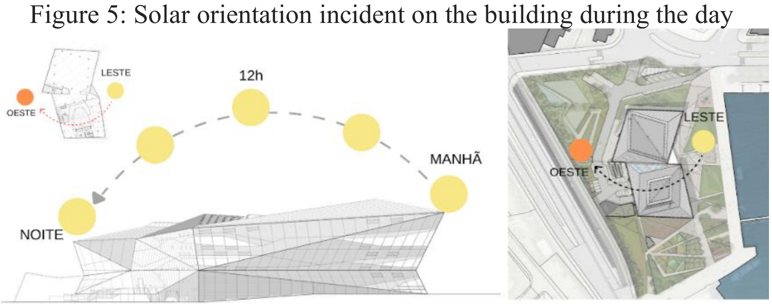
Currently, the building has few places for public visitation, due to the preservation of security for the city hall. In Figure 3, we find the current central courtyard, where some meeting rooms were built for the London government, and in Figure 4, the same place can be seen, but with its old purpose, intended for the old one Siemens' Center for Sustainable Urban Development. The building's former facilities held interactive exhibitions related to art, urbanism and technology, a wide variety of audiovisual shows, which took place on the building's façade, as well as conferences such as the UN Habitat program in 2012 and the conference “Digital Life Design Cities” (SIEMENS AG, 2012), as well as launch events focused on technology and sustainability. (WILKINSON EYRE ARCHITECTS, 2022)

## ANALYSIS OF THE BUILDING'S SUSTAINABLE STRATEGIES

In order to understand this theme, the study of the insolation of the project, located in London, United Kingdom, was carried out from a digital simulation, in the Andrew Marsh software and, for this, it was important to place it in a georeferenced way, taking into account its geometries, entrances, openings and the positions of the facades, which will be analyzed below.

Thus, as shown by the elevation of the building in Figure 5, these facades were designed in such a way as to think about the user's comfort: the main access to the building is to the east, where the sun rises and is milder, at noon, the sun is over the skylights, located on the roof and, at the end of the day,  the afternoon sun illuminates the stairs between the floors and exit of the building, which causes soft lighting in these transitional spaces, as shown in figure 5 (AKBAR, 2021) (QI *et al. 2022).*

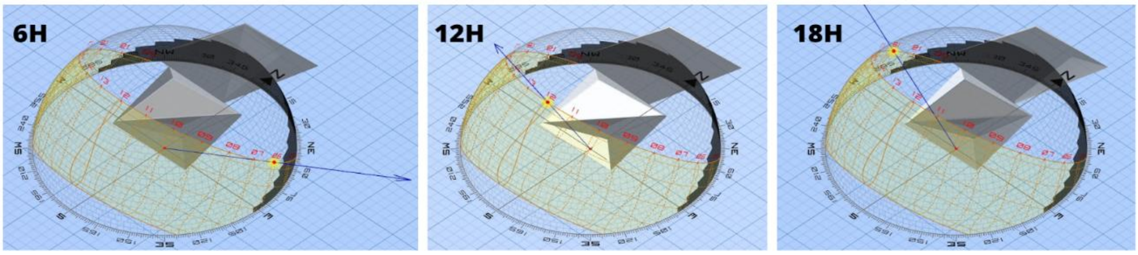
Figure 5: Solar orientation incident on the building during the day




Cast iron: QIU *et al.*,2022

The development of the dynamic mapping of natural light, through the Andrew Marsh software, aims to analyze the periods of insolation and its obstructions, which directly impact the facades of the building, during three times of the year: winter solstice, summer solstice and equinoxes. From the georeferencing of the project in London and the insertion of the 3D model of the roof, in the "Dynamic Overshadowing" application, it was possible to infer the periods of light incidence on the facades (Table 1), since the  degree of shading at the point chosen in the application is quantified based on the percentage of the sky that is occluded in the period and on the date chosen. (ANDREW MARSH, 2016)

Figure 6: periods of insolation on the south façade, which is most critical, at 6 a.m., 12 p.m., and 6 p.m., respectively



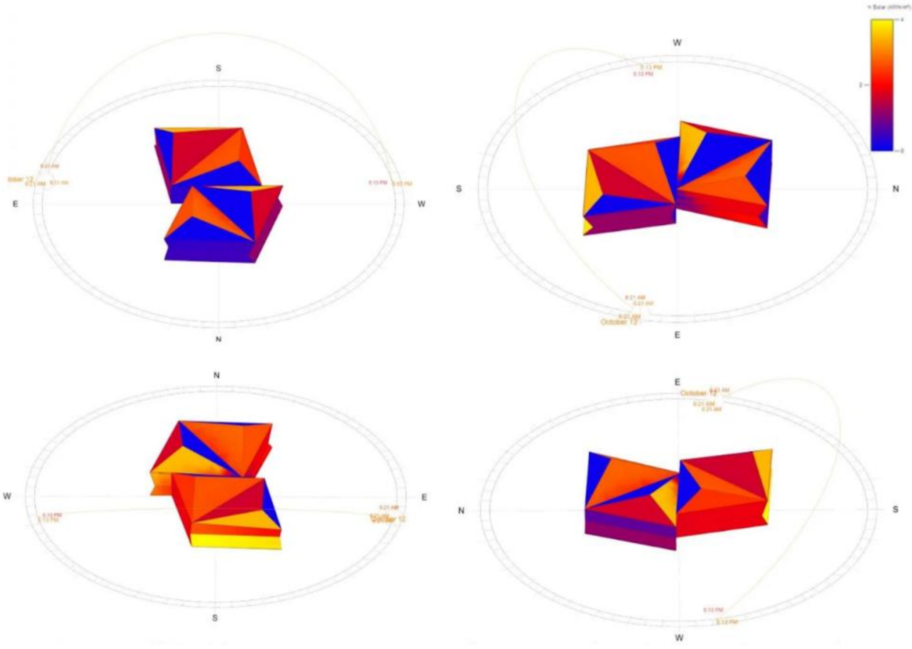

Source: by the author (SHINODA, TABATA), images taken from the digital simulation - Andrew Marsh (2023)

Table 1. Spreadsheet of greater insolation on facades, based on digital simulation

| PERÍODO DE MAIOR INSOLAÇÃO NAS FACHADAS | | | |
|---|---|---|---|
| Fachada | Solstício de Verão | Equinócios | Solstício de Inverno |
| Norte 0° | Entre 4h e 20h | Entre 7h e 18h | Mínima insolação |
| Leste 90 ° | Entre 4h e 17h30 | Entre 6h e 15h | Entre 8h10 e 13h |
| Sul 180° | Entre 5h30 e 19h30 | Entre 6h e 18h | Entre 8h10 e 15h40 |
| Oeste 270° | Entre 8h10 e 20h10 | Entre 10h e 17h50 | Entre 11h50 e 15h40 |

Source: Prepared by the author (SHINODA, TABATA) based on the results obtained in the Andrew Marsh software (2023)

Figure 7: Solar incidence study carried out in Solar GIS



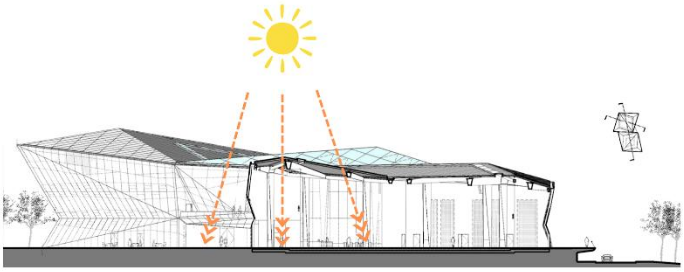
Cast iron: QIU *et al.*,2022

When observing Figure 7, we observe that the building receives a uniform amount of solar incidence and, in addition, in the immediate surroundings, there are no buildings that obstruct this data, since around the construction there is an extensive flat area, with gardens and areas for walks and public walks. The north façade is the coldest. On the other hand, the south façade faces the high solar gain due to the angle of the sun. This information was confirmed by the authors of this work, through the data presented in spreadsheet 1, by the digital simulation in the Andrew Marsh software, as well as confirmed by Qiu *et al. (*2022), shown in the diagrams in Figure 7.

The solution adopted to minimize the effects of the glass facades not becoming critical was the best use of the solar incidence, from its envelope, as a high-performance solar glass was applied. These, "are double glazing with three different types of panels, which allow an average of 70% of the entry of visible light, and the insulating argon gas in the void between the panels minimizes the passage of heat". In the project, therefore, only "30% of the solar energy passes through the glass and the building is not overheated, in addition to obtaining optimal thermal comfort". (WILKINSON EYRE ARCHITECTS, 2022) (SIEMENS, 2013)

Another resource used to promote the entry of natural light was the insertion of skylights, which also provide an increase in internal heating after exposure to the sun during the day. The insertion position of these skylights is strategic and efficient, as they are located at the points where the sun exposure is more incident by the roof. (GLA,2022)

Figure 8: Section of the building with the indication of the solar incidence through the skylights



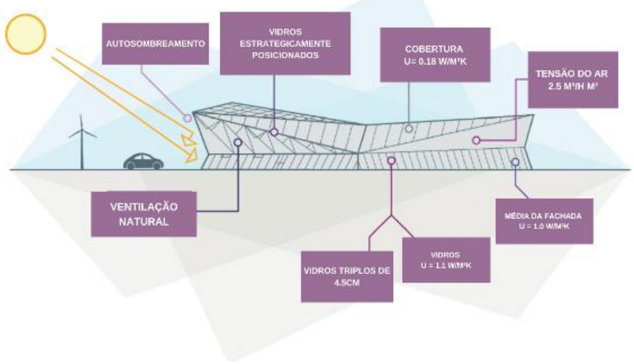
Source: Wilkinson Eyre Architects (2022) adapted by the author - Archdaily

For the design of the building, the inspiring element was nature, perceived in its crystal-shaped geometry, with two parallelogram shapes that have multiple triangular facets. However, "in addition to the aesthetic effect, the angles of the entire building, both on its roof and on its facades, are strategies to minimize the direct incidence of the sun and to reduce the overheating of the building", as highlighted by the authors QIU *et al.*,2022.

The structure of the building uses steel, from the use of a prefabricated minimum weight cut in CNC, the glass panels, which allow maximizing the use of natural light, and reinforced concrete, which is used in the 160 helix-shaped foundation piles that supported the building (the floors are also made of concrete). (ABTEC BUILDING TECHNOLOGIES, 2022)

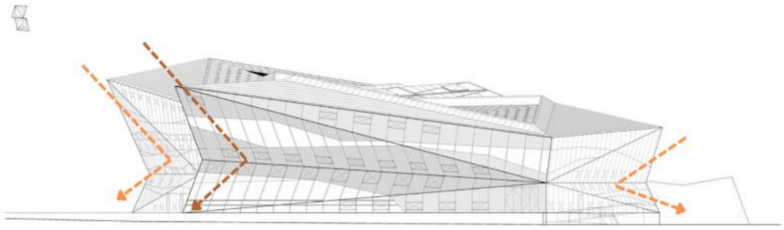
Another strategy applied to reduce the effect of overheating and the high incidence of solar glare was the insertion of skylight glass, made from reflective glass windows, which significantly reduce heat gain due to their properties. In view of this, it is possible to perceive the effect of self-shading on the elevations below, in Figures 9 and 10, because, in order to minimize the "direct penetration of the sun's rays through the glass panels, reflective glass is used on the surfaces, which are facing the sun, while transparent glass is used on the faces away from the sun. towards the ground." (GLA, 2022)

Figure 9: Building envelope strategies




Source: Wilkinson Eyre Architects (2022) adapted by the author (SHINODA, TABATA) - Archdaily

Figure 10: Auto Shading on Building Elevation



Source: Wilkinson Eyre Architects (2022) - adapted by the author (SHINODA, TABATA) - Archdaily

At the angle of the roof, 1,580 m² of photovoltaic solar panels are "arranged", which cover two-thirds of the roof, with 20% of the building's energy generated by the solar panels. All energy use used in the building is constantly monitored, and every kilowatt of electricity used can be measured. (WILKINSON EYRE ARCHITECTS, 2022)

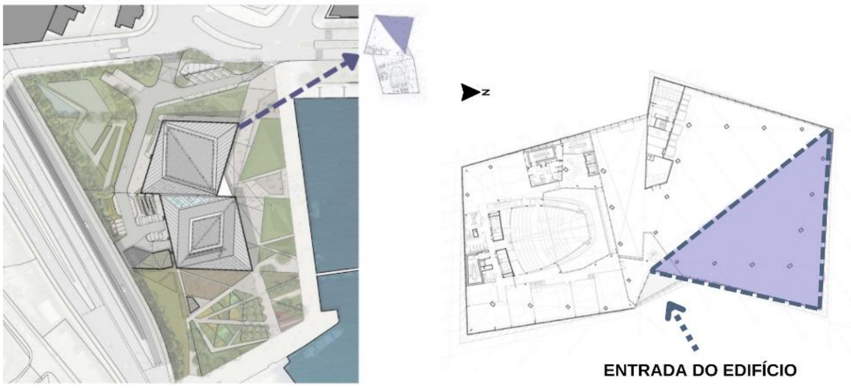
Figures 11 and 12: Rooftop photovoltaic solar panels

Fonte: Wilkinson Eyre Architects (2022)

Therefore, the sustainable strategies adopted throughout the project, such as the solar panels, the skylights on the roof and their geometry, are directly influenced by local climatic conditions (such as the positions of the sun on the building throughout the day) and, at the same time, seek to promote thermal comfort to users.

Then, for the study of the ventilation strategies applied inside the building, two physical models were made on reduced scales, to understand the relationship between the openings and the air flows inside the building, through experimentation in the environmental comfort laboratory of the Mackenzie Presbyterian University. Both models were adapted and reproduced from the ground floor plan, with its openings, shown below (Figure 13).

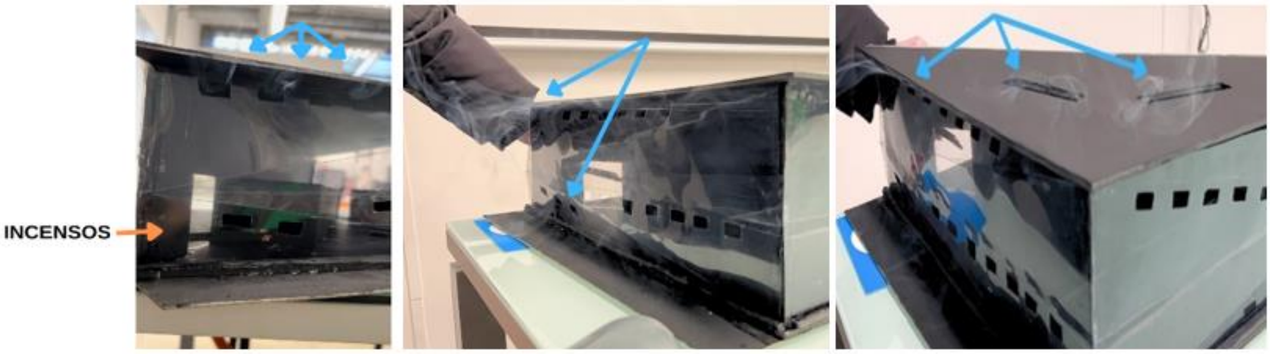
Figure 13. Indication on the deployment plan




Source: Wilkinson Eyre Architects (2022 b), adapted by the author (SHINODA, TABATA) - Archdaily

For the first experiment (Figure 14), a larger-scale model was made, with the main objective of analyzing the ventilation and the perception of the airflow paths in the openings in the facades, considered totally open for this first study. It is possible to observe this flow through the use of incense, positioned at the bottom, and the exit of the smoke directed to the zenith opening of the roof and in the upper windows.

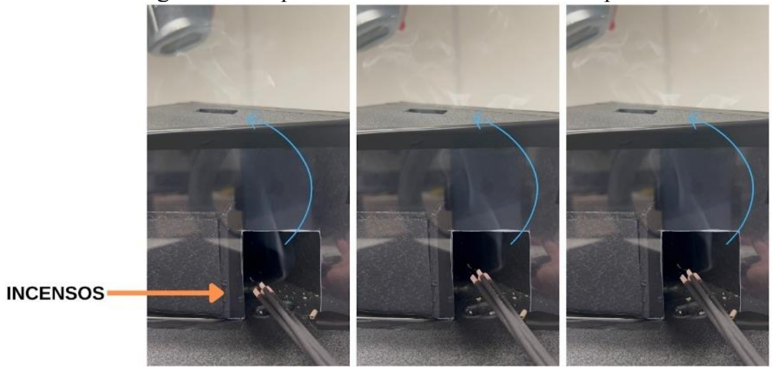
Figure 14. Experimentation with the Model 1




Source: Photos taken by the author, 2023. (SHINODA, TABATA)

For the second experiment (Figure 15), an adaptation was carried out, and a smaller-scale model was considered, with only the zenith opening of the roof (with its reduced angulation), because its purpose was to understand the air vortex and wind tunnels inside the building, in an area that has a large flow of people. On this scale, it is also possible to observe the directed smoke through the use of incense, however, the smoke output above the zenith opening (which represents hot air) is denser and more concentrated. The air vortex forms due to physical barriers (such as building walls and existing constructions, such as new meeting rooms).

Figure 15. Experimentation with the Mockup 2




Source: Photos taken by the author (2023)

These two models prove the efficiency of natural ventilation in architectural projects when they are thought together, this strategy seeks to save on air conditioning and promotes air renewal, improving the quality of the air inside the environments. And therefore, this is one of the items in this project that adds to the rest of the sustainable strategies.

Figure 16. Cross Ventilation Scheme


Source: Wilkinson Eyre Architects (2022 b), adapted by the author (SHINODA, TABATA) - Archdaily

Figure 17. Opening of the windows for ventilation

Cast iron: QIU *et al.*,2022

The solution adopted for the spaces that have a large flow of people, such as the cafeteria and the old exhibition center (now transformed into meeting rooms and a religious space), is to ensure natural ventilation, due to the openings in the facades of the building, as shown in Figure 17, and shown in the experiments with the physical models (Figures 14 and 15). On the other hand, for strictly closed spaces, such as administrative offices, mechanical ventilation is used.

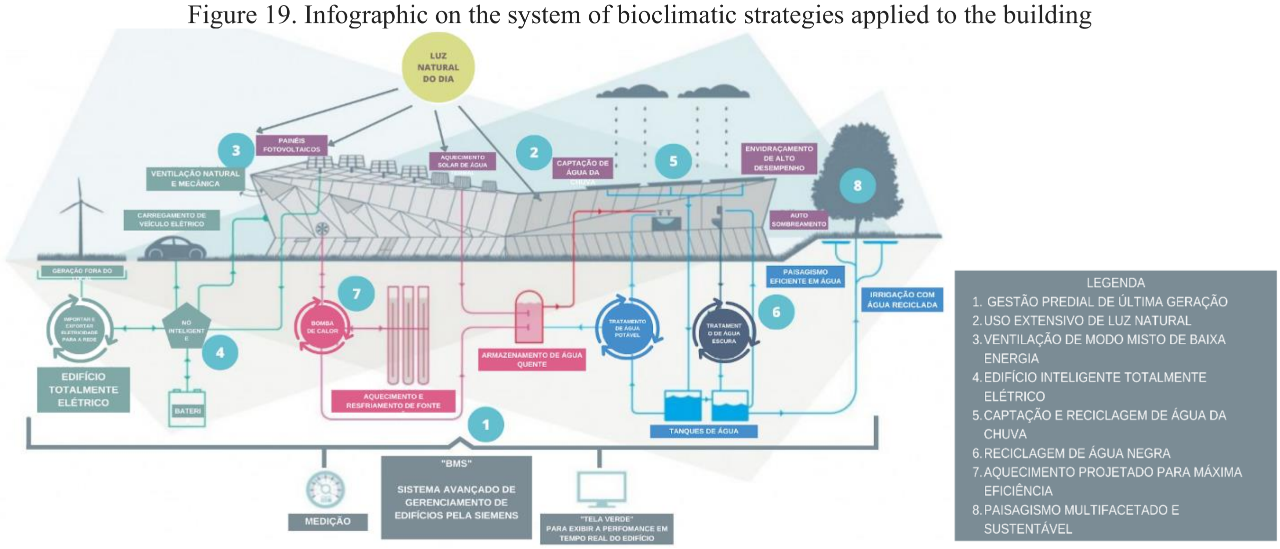
For the building's heating and cooling system (Figure 18), there are geothermal heat pumps, which pump water through pipes that penetrate the ground up to 150 meters deep. The two geothermal heat pumps provide hot and cold water, and pump it into pipes under the floor for heating or cooling. The cold water passes through a beam mounted on the ceiling, so that when the hot air rises it reaches the cooled beam, it cools down and descends, bringing the frigid air to those below. (GLA ,2022)

Figure 18. Building heating and cooling system

Fonts: GLA (2022)

Energy is recovered from thermal wheels. The outgoing air passes through a heat-absorbing disc which then rotates in the incoming airstream, warming the fresh air. About 60% of the heat output or cooling energy is recovered. By using 100% natural heat sources, the building does not need external sources. (GLA, 2022)

Figure 19. Infographic on the system of bioclimatic strategies applied to the building



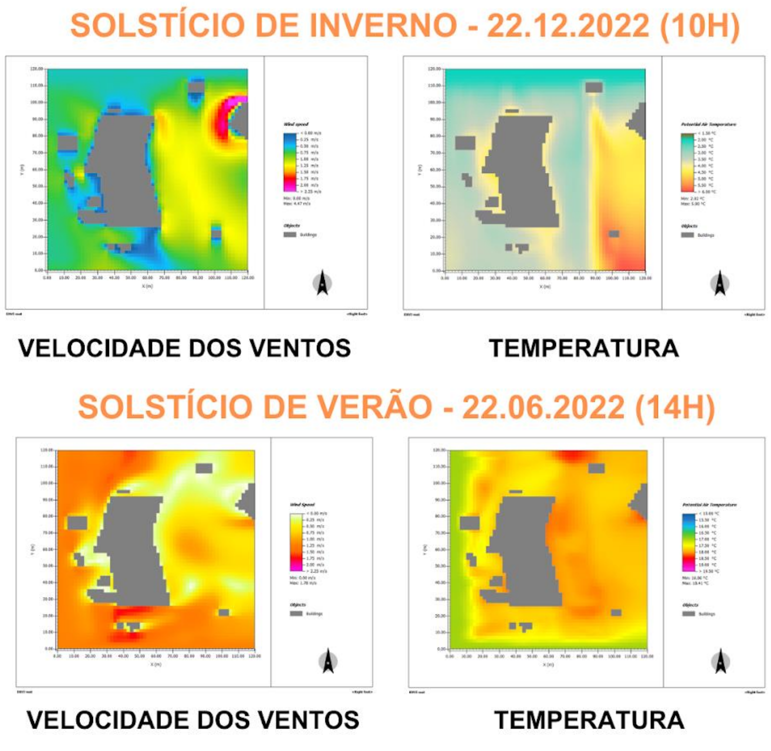

Source: Wilkinson Eyre Architects, rereading and translation by the author, 2022 (SHINODA, TABATA)

In the system above (Figure 19), several types of sustainable and technological systems can be perceived, such as water planning. For rainwater, which is collected by the angles of the building's roof, there is a 30m³ underground storage tank, since, after collection, this water will be treated through ultraviolet filtration and disinfection. As for the black water, which needs more attention, there is a biological tank, as it will be recycled in two treatment areas and two filters. After the treatment of this black water, it is used to irrigate the gardens around the building and flush the toilets. (WILKINSON EYRE ARCHITECTS, 2022)

The system applied to the building in the design of The Crystal (Figure 22), with its bioclimatic and technological strategies throughout its extension, led Wilkinson Eyre Architects to achieve the highest environmental certifications recognized worldwide, LEED Platinum and BREEAM Outstanding. These certifications have several requirements and strategies that need to be achieved, and the primary purpose of these certifications is to achieve highly sustainable, comfortable and efficient constructions. (WILKINSON EYRE ARCHITECTS, 2022)

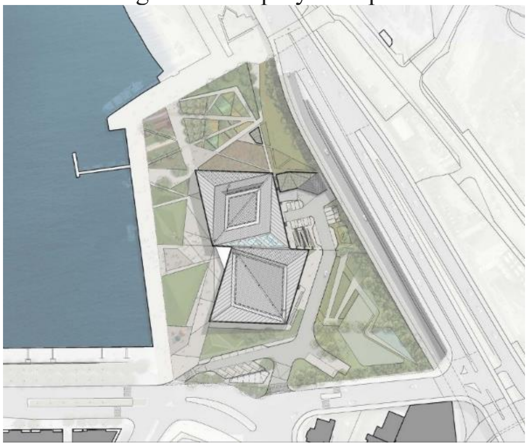
In order to verify the influence of the environment and the existing climatic conditions on the design decisions, a digital simulation was carried out in the ENVI-Met software, which allows the extraction of climatic data from the design of the surroundings, which is conceived from the insertion of the vegetation, the existing buildings, the analyzed surfaces and the materials used in each location.

Figure 20. Digital analysis in the Envi-Met software of wind speed and temperature during the winter and summer solstice)



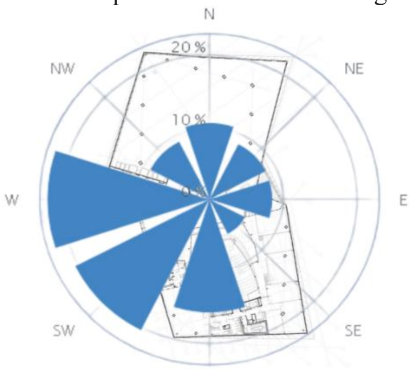

Source: by the author (SHINODA, TABATA), images taken from the digital simulation - ENVI-MET(2023)

Figure 21. Deployment plan



Fonte: Wilkinson Eyre Architects (2022)

Figure 22. London compass rose inserted in the ground floor plan




Source: Archdaily (2023) and World-Weather (2023), adapted by the author (SHINODA, TABATA)

In the simulations analyzed by Envi-met (Figure 20), the average wind speeds around the building, both in winter and summer, occur between 7 km/h (in summer) and 16 km/h (in winter), and the authors QIU et al. (2022), find an average speed of 14 km/h. averaged 2 to 5 °C on the winter solstice and 15.5 °C on the summer solstice. The data taken from the software's simulation, in relation to the average temperature and wind speed, are compatible with the averages of the city of London in the year 2022, as situated in the climate base of WEATHERSPARK (2023)

Therefore, from the compass rose, represented in Figure 22, (WORLD WEATHER, 2023), it can be seen that the winds are more frequent from the west, with 21.9%, and from the southwest, with 20.4%, and the least frequent wind comes from the southeast, with 5.4%, which confirms the data obtained by the Envi-Met simulation.

## FINAL THOUGHTS

Greenhouse gas emissions have had a drastic impact on climate change, especially in large urban centers. Therefore, it is up to the buildings to contribute to the minimization of this effect. However, unfortunately, the solution found by many companies in large-scale works is excessive spending on air conditioning in cold places. Abroad, however, the evolution of this sustainable arm of architecture is remarkable. It is observed that there is great interest in the development of new technologies in search of innovative and creative solutions, such as The Crystal project, which presents high energy efficiency, through its smart and sustainable solutions.

In this sense, the case study of The Crystal building seeks precisely to evaluate and explain how the new smart cities are able to implement new sustainable technological resources in their constructions in a coherent and effective way, which do not harm the environment and provide comfort and well-being for the inhabitants through architecture, without the need for expensive technologies.  obsolete and non-renewable. However, it is important to highlight that the copying of these strategies used for buildings built in the northern hemisphere in a cold climate does not apply to tropical places with a hot climate, even if they are sustainable, such as, for example, the use of glass skins would not be an effective strategy for tropical places, in view of their overheating in the environments during the summer.

Together with the concept of the future of sustainability in buildings sought by Siemens, and with the desire for more comfortable and intelligent constructions, the design of The Crystal building stands out as a great reference, as it establishes an interaction between the internal and external through the adoption of advanced sustainable practices, through the various technologies present in the building to reduce costs and energy consumption.  without relying exclusively on passive systems. The openings in the facades and roofs, their geometry and the surrounding vegetation, enhance the relevance of the connection between the environment and architecture.  Through the case study and the problems presented, it is possible to clarify the reason for the importance of research and analysis of innovative solutions that are around the world, in search of increasingly livable, intelligent cities that care about the environment. By offering an innovative and sustainable urban lifestyle, The Crystal building is a great inspiring reference for a new way of experiencing architecture.

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