FUTURE CITIES AND ENVIRONMENT

# Traceability of Technologies for Positive Climate Assessment: A Prospective Patent Study from the Year 1970 to 2022

TECHNICAL ARTICLE

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## ABSTRACT

In this article, we present a study carried out through a qualitative-quantitative methodology of the exploratory-descriptive objective to investigate technologies that have obtained patents and contribute to the areas of architecture and urbanism, as well as information systems enhance the verification of the situation environmental and urban climate.

In the investigation of these patents, we used a methodology divided into three stages: 1st – "Comprehensiveness", 2nd – "Specification", and 3rd – "Immersion" to identify the technologies described above and for the evaluation of the "positive climate" in urban areas, which are related to the reduction of environmental impacts as well as the reduction of $CO_2$ levels.

The analyses resulted in a universe of 38,413 patents that were divided by year. From the results of the patent mapping, we observed the advantages in the areas of technology, sustainability and energy obtained by countries such as China, USA, Europe and India. We obtained two units of patents granted, directly related to the theme of "climate positive", however, none focused on zero carbon emission measures, positive energy balance, environmental performance or clean energy strategies. Thus, there was a need to encourage vigorously the development of more and better tools to achieve the goal of a "positive climate".

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## INTRODUCTION

Growing concern about the climate crisis has required urgent global-scale actions to minimize environmental impacts and reduce emissions corresponding to greenhouse gases (Comissão Mundial sobre Meio Ambiente e Desenvolvimento 1992; Ipcc 2018). In this sense, the negotiations held at the Climate Convention (COP26) in the year 2021 boosted the constitution of the Glasgow Pact with the intention of defining a global carbon market to accelerate the energy transition to clean sources, in addition to establishing the reduction of emissions by about 45% by the year 2030 to achieve carbon neutrality by 2050 (Global Carbon Atlas 2021).

Indeed, urban areas are responsible for approximately 74% of $CO_2$ emissions (Bertule et al. 2014), so it is essential that cities are planned and managed to ensure an ecological balance between emissions and absorption.

In this way, the field of architecture and urbanism has expanded in the quest to achieve the goals of the Paris Agreement, which require a limit to the increase in global temperature of 1.5°C by 2030 (Ipcc 2018). To achieve this goal, projects should consider the concept of sustainability in their planning through strategies (Mourão and Pedro 2012) that are aligned with the criteria of sustainability, which requires a holistic view of the territory (Castelbranco 2009), the urban system, its morphology, technologies and the resources used. Everything is designed, built and used by man in the city.

> "Cities themselves should be seen as ecological systems, and this attitude translates our thinking into the planning of cities and the administration of the use of their resources." (Rogers 2001)

As stated earlier, the progress of research on climate change and the scope of neutrality has become increasingly greater regarding the urban scale and the building. Therefore, achieving emissions targets and making a project positive for the climate or "positive climate"[1] is the goal of many cities worldwide.

To this end, some programs have emerged to support large-scale urban projects, including the Positive Climate Development Program (C40 Cities[1] 2016; C40 Cities[2] 2016). With support from the C40 Cities Group and the Clinton Foundation, the project implemented approximately 18 neighborhoods spread across six continents. The purpose is to plan urban areas considered positive for the climate, thus achieving zero $CO_2$ emissions.

This means that transforming the neighbourhoods into a "positive climate" ensures an ecologically balanced urban space and is socially just and economically viable for the community. Hence, verifying these same studies and patents related to this theme became the focus of this investigation to avoid what is designated as "Greenwashing".[2]

According to the National Institute of Industrial Property of Brazil (Barros et al. 2020), the patent is a temporary property title over an invention or utility model the State grants to inventors or authors or to other natural or legal persons holding rights over that same creation/invention. The inventor or the patent holder has rights over the object of his patent and/or process or product obtained directly by a process he patented. On the other hand, the inventor undertakes to disclose in detail all the technical content of the material protected by the patent (INPI 2020). Thus, patents are important sources of information about technological advances in various areas.

In general, the procedure for the acquisition of a patent in any country can last about 30 months from the submission of the application (which is studied according to the national laws of each country) and can obtain the concession or refusal in its final order, which means that the same invention can be refused or granted in different countries (Eportugal 2022). In this sense, prospecting studies are necessary for decision-making and defining strategies in the public and private sectors (Quintella et all. 2011). These studies constitute a systematic means to map scientific and technological developments globally and encourage such researches (Alencar 2008; Mayerhoff 2008; Reis, Castelar e Santos 2017; Saccaro 2011; Santos et al 2021).

Given the importance of documents for patents and a prospective study, the general objective of this article is the prospective analysis and identification of the main trends, solutions or technologies related to the evaluation of the "positive climate" in urban environments, using as a source of information a patentometric study.

## METHODOLOGY

The study of applied nature generates knowledge regarding the valuation of technologies for application in the short term since the authors provide results for technology development. It has a qualitative-quantitative approach with an exploratory-descriptive objective.

- Exploratory research is used when one wishes to obtain data on the nature of a problem. The interest is to obtain a volume of information that explores in depth how the research occurs.
- Descriptive research, on the other hand, aims to identify factors and their relations with the occurrence of phenomena to explain the reason for things (Gil 1946).

Patent prospecting was developed using the methodology of Zhang, Li and Li (2015), which seeks to systematize patent mining, illustrated in Figure 1. And in the case of this article, the methodology follows the diagram below.

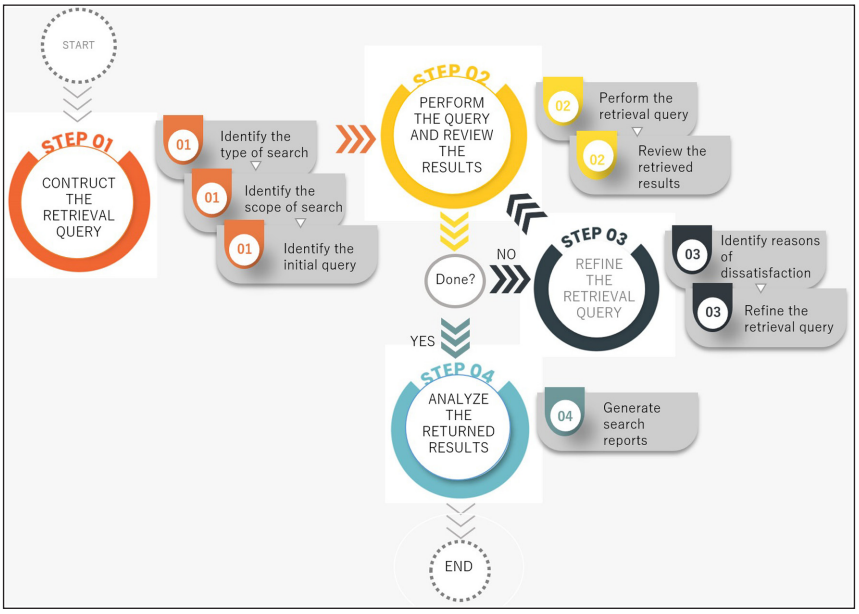


**Figure 1** Description of the methodological step-by-step. Photo: (Zhang, Li and Li, 2015) adapted by the authors.

The structuring of stage research 1 (STEP 1 – Construct the retrieval query) was carried out through the Scopus and Web of Science platforms and sought articles on the term "positive climate" and its relationship with the terms "environmental assessment systems" and "urbanism", allowing a systematic survey of the product to be patented.

Next, we use Orbit Intelligence (Suzuki 2016), which is a tool also used by the French company Questel Expansion SAS. The choice of this tool was given by the wide range of sources, which includes the patent filings of more than 90 international offices, as well as the constant updating (not having delays of more than a week) of the platform that, in relation to most sources (Questel 2020). The geographical coverage of this database comprises registrations of almost a hundred countries and patent authorities, including applications for the same invention filed in different countries, thus avoiding the duplication of data and generating more specific results for the prospective study (Barros et al. 2020; Barbosa et al. 2014; Castelbranco 2009; Santos et al. 2021).

The search for Orbit took place in 2022 and we consider a period of 52 years, starting in 1970 – an emblematic date that precedes the Stockholm International Declaration (United Nations Conference on Human Development and Environment – 1972, with the creation of 26 principles and the United Nations Environment Program – until 2022 current historical moment.

Next, we carried out STEP 2, which was responsible for carrying out the consultation and reviewing the results, or means of Technological Prospecting, so that it was possible to identify the stage of maturity of the technology that is sought and how it is inserted in society (Ciais et al. 2021). With this, search strategies were defined that are divided into:

- Patent search strategy I: comprehensiveness analysis, which analyzes general terms and large areas of scientific knowledge.
- Patent search strategy II: analysis of interrelationships between terms of interest and applications of synonyms and related terms; therefore, analysis of more specific knowledges.

The International Patent Classification (IPC) was adopted for the searches of documents, with the search for evident terms in the titles, summary and invention of the object. The formation of search strings was used among the combinations of the joint terms of the boolean operators – AND, OR, parentheses () – following the exemplification of the search strategies in Figure 2 below.

STEP 3 (Refine the retrieval query), after the previous analysis of the results, evaluates the volume and specification of the patents found. It is a qualitative analysis that verifies the level of inference of the search terms. Then, there is the adjustment as to the restrictions and scope of the searches or depending on the results, it might include new search strategies for better results.

Thus, it was observed the need to include a new search strategy, which is the Patent Search Strategy III, which obtained a restriction per patent section, to cite the sections "Y02 A" "Y02E" "Y02P" "Y04S" as described in Figure 3 below.

As for the fourth and final step (STEP 4 – Analyze the returned results), the results presented in Figure 4 below are considered.

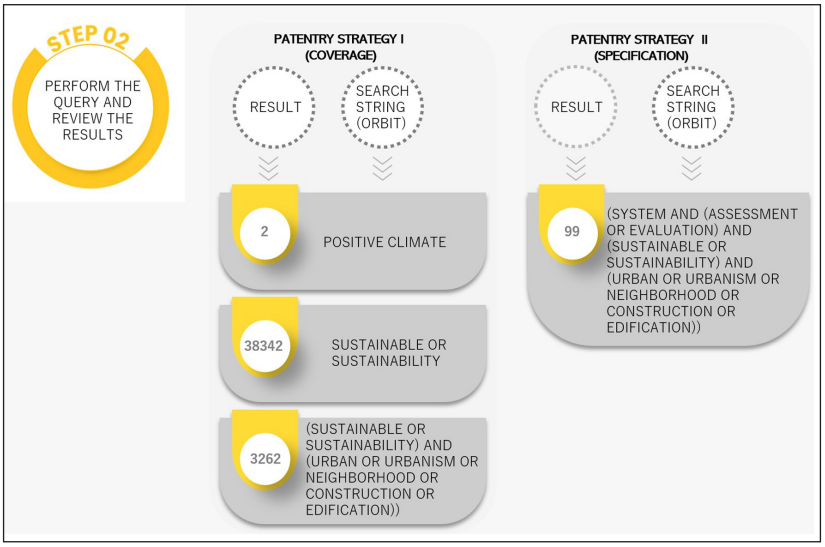


**Figure 2** Search strategies I and II. Photo: Authors.

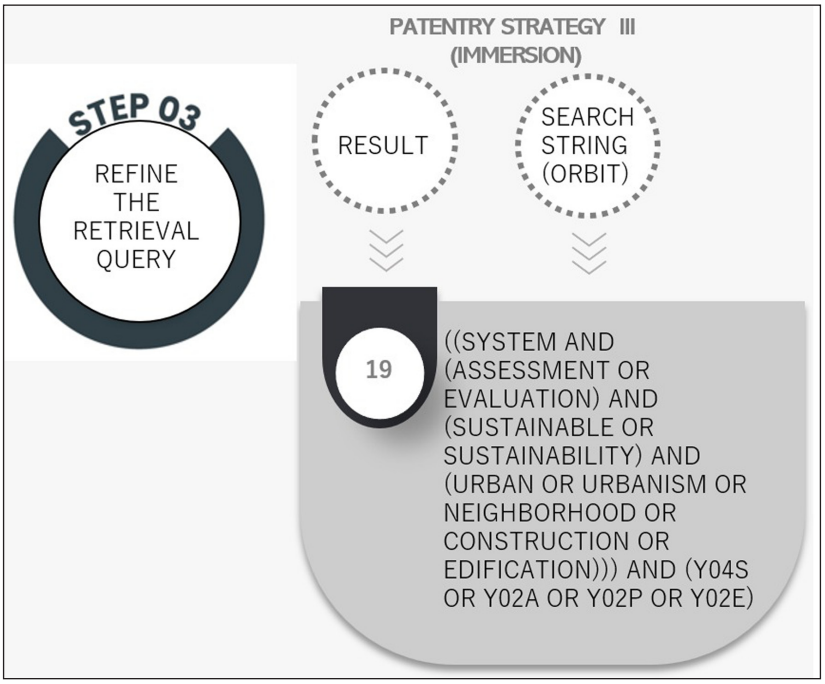


**Figure 3** Search strategy III. Photo: Authors.

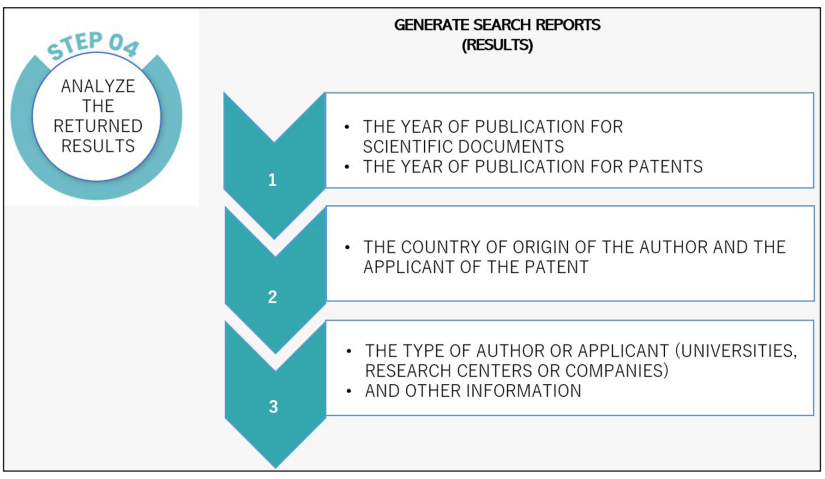


**Figure 4** Search results. Photo: Authors.

## RESULTS AND DISCUSSION

With the intention of obtaining the results of the searches in the chosen databases, we considered the amount obtained and the discussion of the relevant points for this study. And according to the methodological flow described above, the patent search strategies were subdivided into 3 points (1st – "**Scope**"; 2nd – "**Specification**"; and 3rd – "**Immersion**"):

### PATENT SEARCH STRATEGY I – SCOPE

The search allowed the quantitative mapping of the available technologies on the terms "*positive climate*" and "*sustainable*" or "*sustainability*".

On the subjective of "*positive climate*", there were two patents available with "Granted" status. However, the results of the research had nothing to do with the search for measures of zero carbon emissions; nor with positive energy balance, or environmental performance, or clean energy strategies, or with waste water treatment.

As for the terms "*sustainable*" or "*sustainability*" that are part of the scope of discussion of this work and are classified as terms of extreme relevance for the search for patents by scope, resulted in 38,413 patents and are distributed by quantity per year (Figure 5).

The patent chart above shows substantial growth over the years, apart from 2021 due to possible reflections of COVID-19, in which many studies were directed to the pandemic impacts and the year 2022, in the first quarter the current year were also included.

Relating the graph to the historical events that occurred, the discussions of sustainability began after the first environmentalist studies emerged in 1962. Next, the United Nations Brundtland Report "Our Common Future" (Ipcc 2018) in 1987, which proposes the concept of sustainable development as a guide for a global economic policy to meet current needs without compromising the needs of future generations (Rogers 2001), followed by an increase in the number of patents, hence a greater commitment to environmental balance.

It identifies a progression in the number of discussions between communities about global warming and the impacts it causes on the global scenario between 2005 and 2014, a period declared as the United Nations Decade of Education for Sustainable Development (UNESCO) (ONU[1] 2020).

There was also a sharp increase in the number of patents from 2014 to 2015, with the number of submissions exceeding 600 compared to previous years, which came in an average progression between 100 and 200 applications per year in the area of sustainability.

The years 2014 and 2016 were marked by the United Nations Environmental Assembly (UNEA), a period that dissented from the UN platform. The first concerns placed the environment as a world problem in the same fields as peace, security, economy, and health (Nações Unidas Brasil 2020).

Still about the Figure 5, it is observed that the increase in the number of patents shown in the graph is directly related to the historical moment, clearly demonstrated by the parallelism between the awareness of environmental issues and the growth in the search for solutions for the mitigation of CO2 emissions. However, these solutions were still insufficient.

Among the patents analyzed in the time interval from 1970 to 2022, 33.7% of patents have «Granted» status are active and on legal effects, 20.6% of patents are with «Pending» status in the process of evaluation with pending and the remaining 45.7% disposed of as «Lapsed», «Expired» or «Revoked».

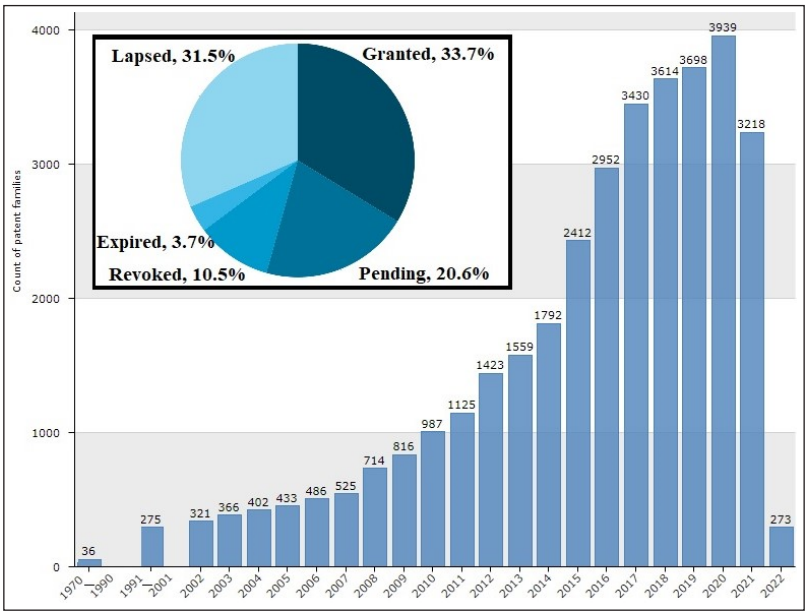


**Figure 5** Sustainability – Set of science knowledge patent by the year. Photo: Orbit.

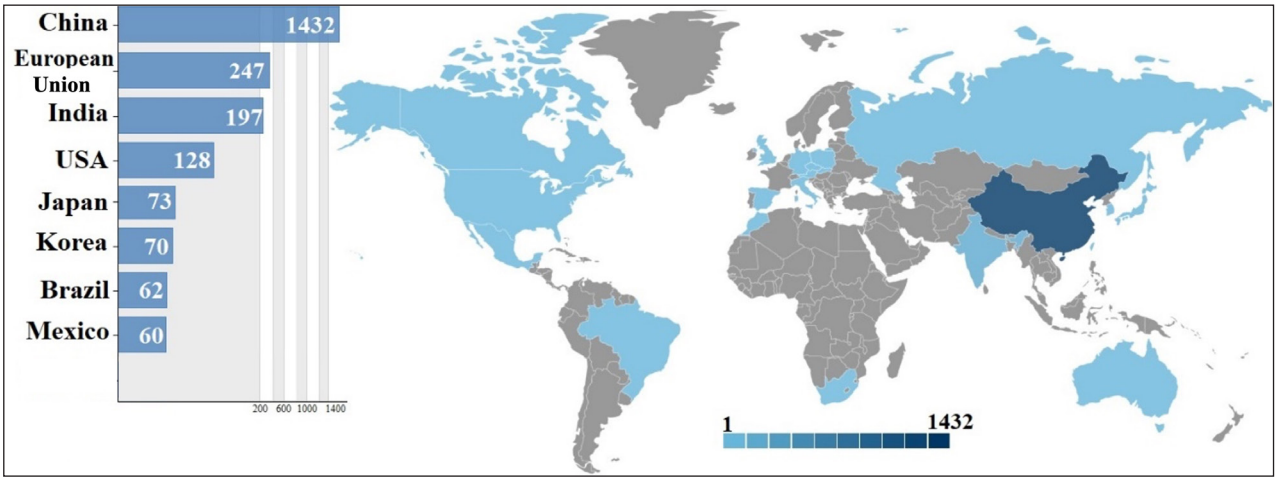


**Figure 6** Set of science knowledge patent by Protection country. Photo: Orbit.

Due to the high number of patents in the field of sustainability, the terms "*sustainability*" and "*urbanism*" were analyzed together, including synonymous terms, resulting in 3,268 patents, of which 33.5% are under protective legal effect. Figure 6 shows the distribution of countries with the highest patent index.

There is a large number of patents in China which differentiates it on a large scale to other countries. In a qualitative analysis, it is noted that patents in "Granted" status have an index of 57.3% of patents indicating that active patents are higher than the global analyses of all countries with an index of 33.5%. However, the relevance, applicability or profitability and merit of these patents is not discussed here, such questions are necessary for a deeper analysis and present extreme complexity for its understanding since it is a dynamic flow of the economy where there has been a large volume of active patents in recent years.

In addition, the first places in this chart are occupied by China, India and the United States and refer to countries with large economies and very populous and that are in the ranking of high emissions of carbon dioxide ($CO_2$) in the atmosphere in 2020. Therefore, according to the survey of the Global Carbon Project (GCP), these countries contribute the most to advances and studies for solutions for climate change in the world (Global Carbon Project 2022), in terms of number of patents.

## PATENT SEARCH STRATEGY II – SPECIFICATION

In the Specification stage of this research, it is possible to address the core of the problem of this article, in the identification of technologies related to the environmental assessment systems for the urban "positive climate", which enables measuring what the market, the industry and the large research centers are producing in order to promote climate-positive culture.

The patents related to the terms "evaluation systems", "urbanism", and "sustainability" and their respective synonyms present a result of 99 patents, the largest amount with a number of 51 patents catalogued by China.

On relating to the year 2022 (Figure 7 and Table 1), of the "Global Carbon Project" (GCP)[3] (WIPO 2021) in 2021, the situation of the emissions of the countries that most pollute the atmosphere. It is interesting to note that the highest emissions per country come from China, although the average emissions per inhabitant are roughly the same as Japan (8.04 t $tCO_2$/per capita), which compared to the US is almost half (14.85 $tCO_2$/per capita).

When analyzing the graphs in Figure 8, we note a large share of China in global carbon emissions compared to total global emissions in 2022, reaching a value of approximately 31%. When considering the sum of the five most polluting countries, the percentage reaches approximately 59% of the global emissions.

According to the Global Energy Monitor data presented in Table 2, the coal-fired power plants in operation in China as of January 2023 are a total of 3,092 units, of which 211 are under construction. Second in the ranking of the number of plants in operation is India with 840 units and 19 units under construction.

It is worth mentioning that China, India and the US have been the countries with the largest investments in renewable energy sources in recent years, seeking to reduce dependence on coal and to reduce greenhouse gas emissions.

Analysing the time scale in the patent databases presented in Figure 9 below, the first patent catalogue appeared in 2001 and in 2014, there was a significant increase in the number of patents. It is observed through the structure presented in the graph that this is a growing theme over the years, and which allows the study of new solutions to evaluate neighbourhoods with a "positive climate".

The list of patent applicants for the terms studied in this article is represented in Figure 10 below. This demonstrates that among the 20 most influential applicants, most patents are related to the area of "Information Technology Methods for Management". In addition, it is observed

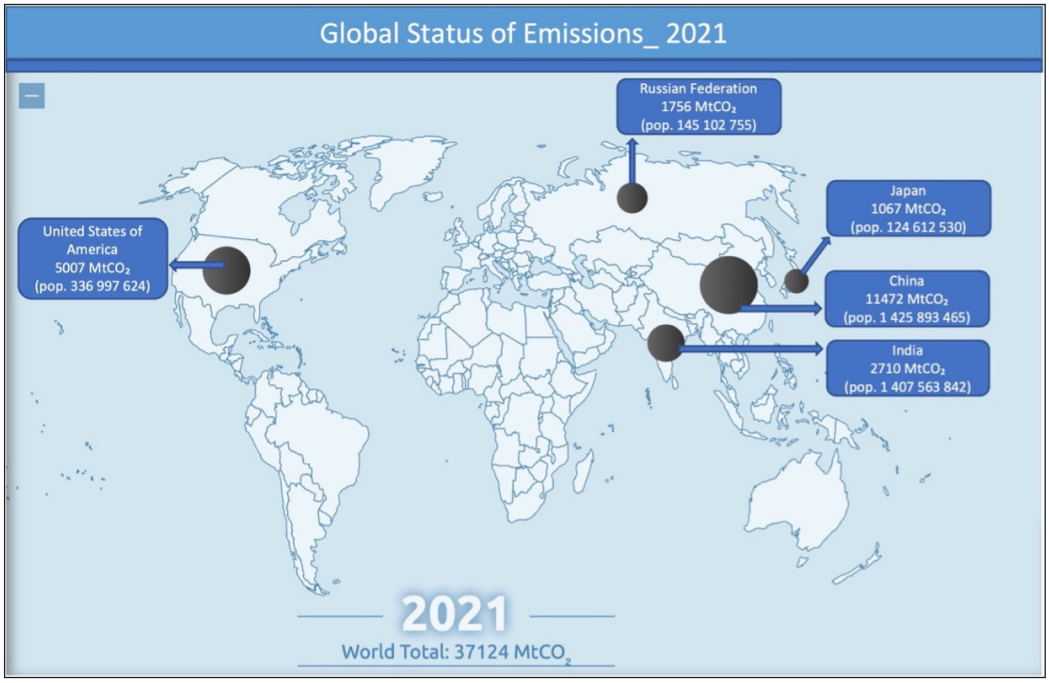


**Figure 7** Situation of emissions in countries with the largest economy and population in 2021. Photo: Global Carbon Project (2022) adapted by the authors.

| COUNTRIES | EMISSIONS ($TCO_2$) | POPULATION | $CO_2$ EMISSIONS PER CAPITA (TONS) |
|---|---|---|---|
| **China** | 11,472,000,000 | 1,425,893 465 | 8.04 |
| **Eua** | 5,007,000,000 | 336,997,624 | 14.85 |
| **India** | 2,710,000,000 | 1,407,563,842 | 1.92 |
| **Russian federation** | 1,756,000,000 | 145,102,755 | 12.10 |
| **Japan** | 1,067,000,000 | 124,612,530 | 8.56 |
| **World average** | 37,124,000,000 | 7,880,000,000 | 4.71 |

**Table 1** Emissions per capita, data from the "Global Carbon Project" (GCP) from the last report carried out in the year 2021.
Fonte: Adaptation authors.

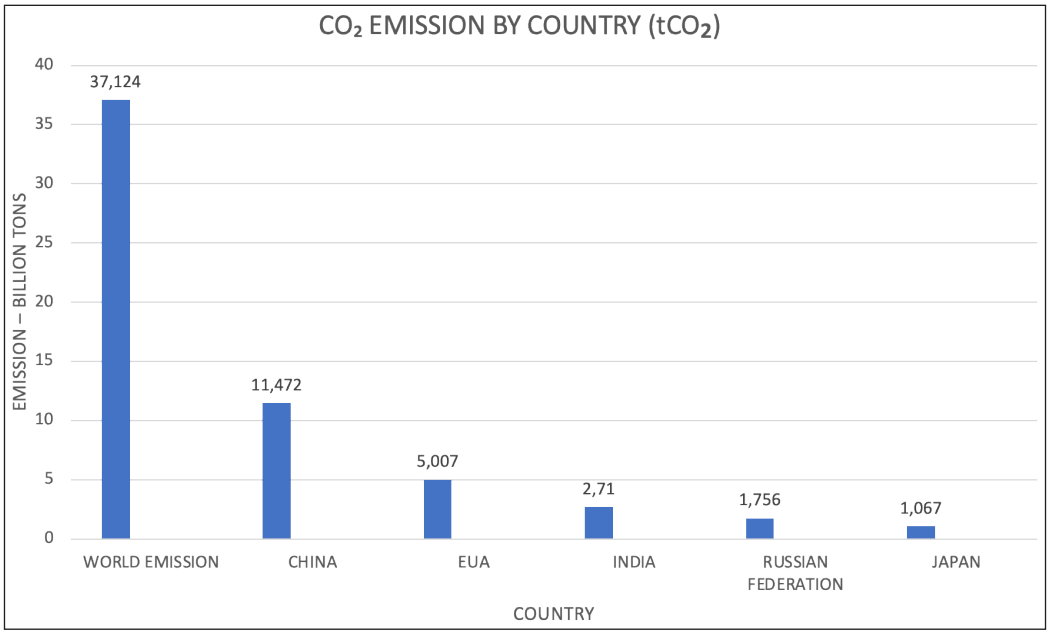


**Figure 8** $CO_2$ emissions by country (billion $tCO_2$). Photo: Global Carbon Project (2022) adapted by the authors.

| COAL-FIRED POWER UNITS BY COUNTRY GLOBAL COAL PLANT TRACKR, JANUARY 2023 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **COUNTRIES** | **ANNOUN-CED** | **PRE-PERMIT** | **PERMIT-TED** | **ANNOUNCED+ PRE-PERMITED + PERMITTED** | **CONSTRU-CTION** | **SHED-VED** | **OPERA-TING** | **MOTH-BALLED** | **CANCEL-LED 2010–2022** | **RETIRED 2000–2022** |
| CHINA | 112 | 138 | 150 | 400 | 211 | 67 | 3,092 | 9 | 1,005 | 1,087 |
| INDIA | 12 | 14 | 18 | 44 | 49 | 21 | 840 | 10 | 767 | 158 |
| RUSSIAN FEDERATION | 0 | 1 | 0 | 1 | 4 | 0 | 152 | 3 | 23 | 19 |
| JAPAN | 9 | 3 | 0 | 12 | 2 | 2 | 312 | 2 | 31 | 62 |
| EUA | 0 | 0 | 0 | 0 | 0 | 1 | 441 | 0 | 45 | 738 |

**Table 2** Coal- fired Power Units by Country.

*Source:* Global Energy Monitor (2023) adapted by the authors.

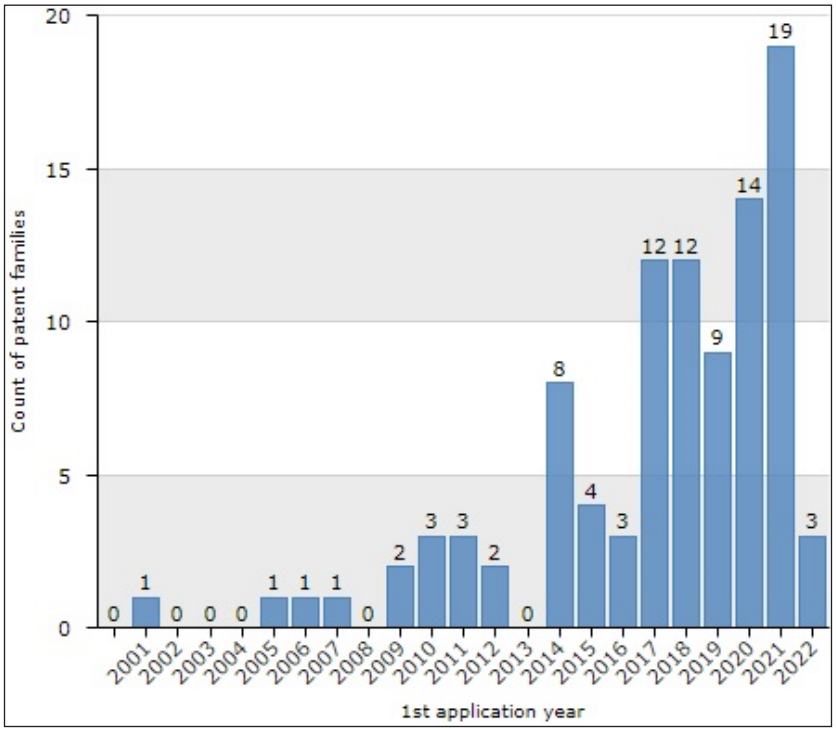


**Figure 9** Evaluation/Urbanism/Sustainability – Set of science knowledge patent per the year. Photo: Orbit.

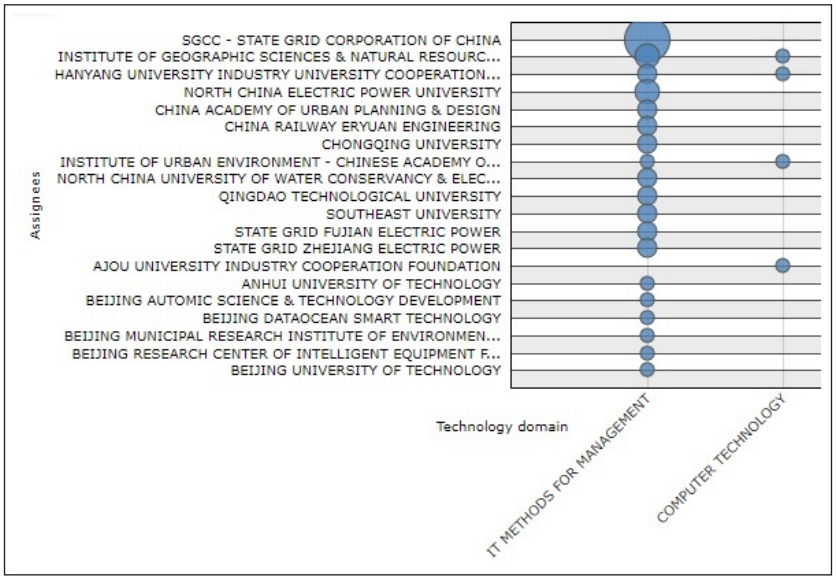


**Figure 10** Assignees for the Technology domain. Photo: Orbit.

that there is no concentration of a single applicant. The distribution occurs by several research centres, institutes and companies, primarily Chinese.

In a closer examination this patent classification, it is possible to identify the framing sections of patent records, which makes delimit the point of action of technologies related to research of this study "evaluation systems", "urbanism", "sustainability".

Among the groupings of catalogued patents presented in Figure 11, the vast majority of applicants are Chinese. The emphasis of these patents is on the "G06" classification, which corresponds to the area of "Computing; Calculating; Accounting".

According to Espacenet, a database of the European Patent Office (EPO), which allows free access to more than 130 million patent documents from government intellectual property offices of more than 100 countries through its web platform (INPI, 2022), this classification covers the sections described in Table 3 below, and the application in specific technologies can be seen in the description.

According to the classification systematization of the Cooperative Patent Classification (CPC), other levels of more specific classification layers are presented in Figure 12. Thus, the sub-items with the highest number of citations among the patents catalogued are presented.

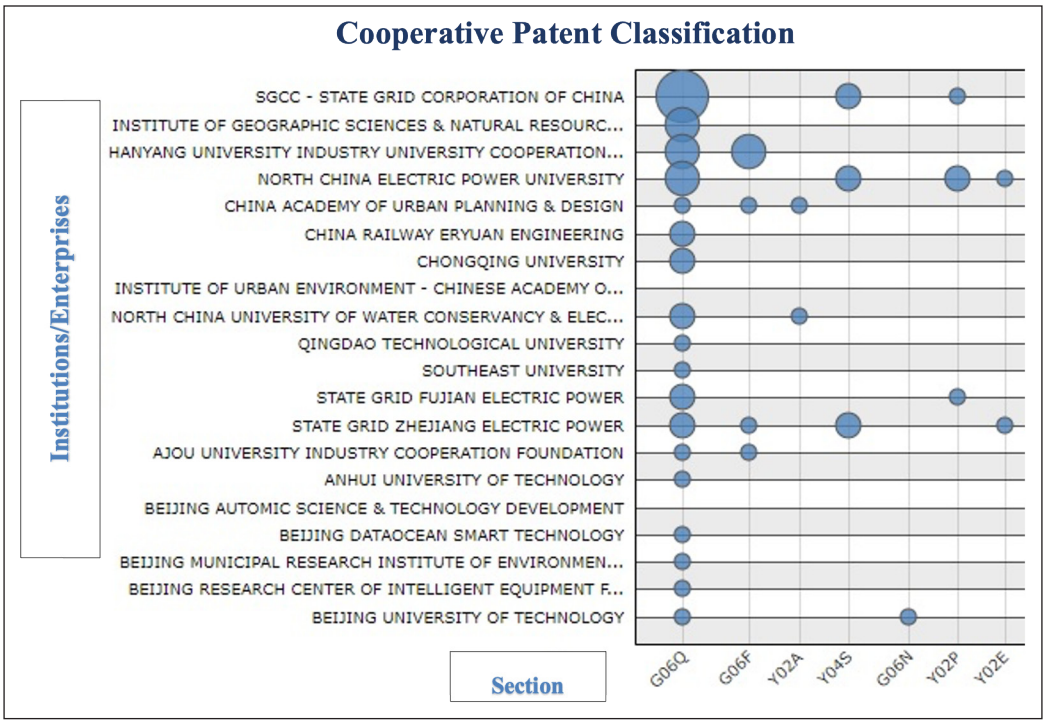


**Figure 11** Assignees form CPC subclass. Photo: Orbit.

| SECTION | DESCRIPTION |
|---|---|
| G06Q | data processing systems or methods, specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes; systems or methods specially adapted for administrative, commercial, financial, managerial, supervisory or forecasting purposes, not otherwise provided for |
| G06F | electric digital data processing (computer systems based on specific computational models) |
| Y02 A | technologies for adaptation to climate change |
| Y04S | systems integrating technologies related to power network operation, communication or information technologies for improving the electrical power generation, transmission, distribution, management or usage, i.e. smart grids |
| G06 N | computing arrangements based on specific computational models |
| Y02P | climate change mitigation technologies in the production or processing of goods |
| Y02E | reduction of greenhouse gas [ghg] emissions, related to energy generation, transmission or distribution |
| A01K | animal husbandry; care of birds, fishes, insects; fishing; rearing or breeding animals, not otherwise provided for; new breeds of animals |

**Table 3** Description of Patent Sections (CPC).

*Source:* CPC.

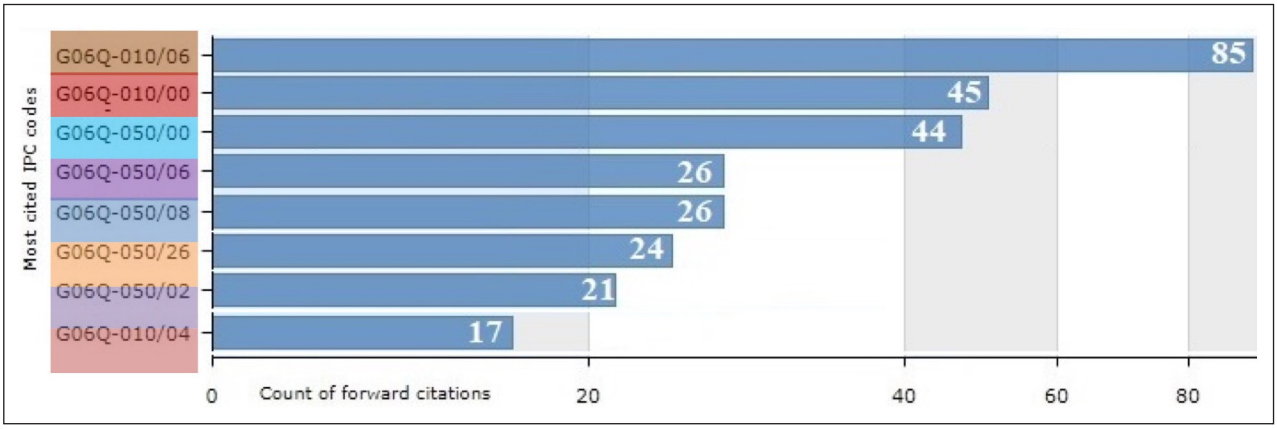


**Figure 12** CPC classification sub-section. Photo: CPC.

| | DESCRIPTION OF THE CPC SUB-SECTIONS |
|---|---|
| G06Q-10/06: | Resources, workflows, human or project management, e.g. organizing, planning, scheduling or allocating time, human or machine resources; Enterprise planning; Organizational models – financial asset management; |
| G06Q-50/26 | Government or public services |
| G06Q-50/06 | Electricity, gas or water supply |
| G06Q-50/08 | Construction |
| G06Q-10/04 | Forecasting or optimization, e.g. linear programming, "travelling salesman problem" or "cutting stock problem"(data collection specially adapted for marketing, price determination or demand forecasting) |
| G06Q-50/02 | Agriculture; Fishing; Mining |
| G06Q-10/00 | Administration; Management |
| G06Q-50/00 | Systems or methods specially adapted for specific business sectors, e.g. utilities or tourism – healthcare informatics. |

**Table 4** Description of Patent Sections (CPC).

*Source:* Orbit.

For a better understanding, when a new technology is patented, the patent application's inventor(s) or examiner(s) should make citations of other patents or other documents. These citations serve to demonstrate the state of the art of a given technology, and to analyze the origins and inspirations as well as related technologies which compete, or that serve as a foundation for the construction of a new technologies.

The descriptions according to the framework of the sub-sections of the CPC are in Table 4 and Figure 12:

The results of the "G06Q" section are related to patents pertaining to the problems of the urban quotidian, such as: the organization, planning and management of human resources; urban mobility; government services such as water, gas and electricity; and construction. Note in Figure 12 that the citations of the patents analyzed, are concentrated in a more specific field of application to cite the sub-sections: G06Q-(010/06; 010/00; 050/00; 050/06; 050/08; 050/26; 050/02; 010–04).

However, the topics related to the section "G06" do not fully contemplate the interest of this research, because it is noted that there are other sections such as "Y02" and "Y04" that also consider topics related to the interest of this research, the first acting in the area of Technologies or applications for mitigation or adaptation against climate change and the second, in the area of Information or Communication Technologies with an impact on other technologies (see Table 4).

In the course of the analyses, it was noted that among the 20 applicants the highest incidence of patents of interest in the subjects of this research are in:

- 2 records from section "Y02 A", on **technologies for adaptation to climate change**;
- 6 records of section "Y04S", addressing **technologies applied to energy efficiency in the transmission, generation, distribution, management and use of energy**;
- 4 records from section "Y02P", on **climate change mitigation technologies in the production or processing of goods**;
- 2 records of section "Y02E", dealing with the **reduction of greenhouse gas emissions, related to the generation, transmission or distribution of energy**.

## PATENT SEARCH STRATEGY II – IMMERSION

In Stage 3 (Immersion phase), the objective was to reduce the results related to the search terms by specification, which were based on the classification sections of the CPC and IPC "Y02 A", "Y02E", " Y02P" and "Y04S".

This adjustment makes it possible to direct the study to the technologies related to the evaluation of sustainability in the context of the "positive climate", making it essential to check what the market, the industry and the large research centers are producing to promote the concept of the "positive climate".

For example, the search for patents for the terms "evaluation systems", "urbanism" and "sustainability" together with their respective synonyms, includes the classification sections "Y02 A", "Y02E", "Y02P", "Y04S". As such, this search resulted in 19 patents catalogued in three countries, including: 15 patents in China; three in Australia; and one in South Korea. Among these, only 13 patents have patent protection and six are inactive.

It was observed that these registrations occurred between the years 2007 and 2019, having a peak in the year 2020, when six patents were registered, four of which are related to the energy sector.

The results of Stage 3 presented the main concepts obtained, highlighting "sustainable development", "sustainability", "evaluation" and the equivalent terms used in the patent search.

It was noted the little use of concepts that correspond to the field of evaluation of positive climate, such as: "Power grid" – in the area of energy; "economy", "decision making" and "analyzing" – related to management; "infrastructure", "construction project" and "society" – related to urbanism; and finally, the terms that encompass the technologies of information and the environment.

Figure 13 below presents the result of the patent research of Stage 3, verifying the presence of concepts that contemplated solutions related to technology, sustainability and urbanism, more specifically tangential to the field of climate change and energy technologies. However, there is a lack of important concepts regarding the assessment of the positive climate, namely: the "positive carbon balance", "renewable energy" and "mobility".

From the results obtained, ten patents with a high degree of relevance according to the Orbit tool were listed (see Table 5). When analyzing the description of the content of the patents, it was found that some patents are related to an evaluative method of sustainability applied to the urban context, emphasized by the energy sector with environmental or social attention.

With the results from this research, it was found that the production of related patents to this field of study have been concentrated in the last three years. However, it also presents a scarcity of the strategic solutions and specific technologies aimed at the environmental assessment of the "positive climate" in urban areas.

Another worrying factor is the concentration on patent production in a smaller number of countries, although they have large populations and have a high purchasing power. These are countries with large investments in intellectual property, R&D, innovation and new technologies that can collaborate with the business and marketing process in order to meet the challenges of the "positive climate" concept.

Therefore, more and more countries should be encouraged to collaborate with the changes towards decarbonization agreed in the Paris Agreement and the last Climate Conferences (COP 26 and the current COP 27) (United Nations Climate Change 2021). These must commit to providing funding for solutions and strategic tools to expand concrete and effective actions for the

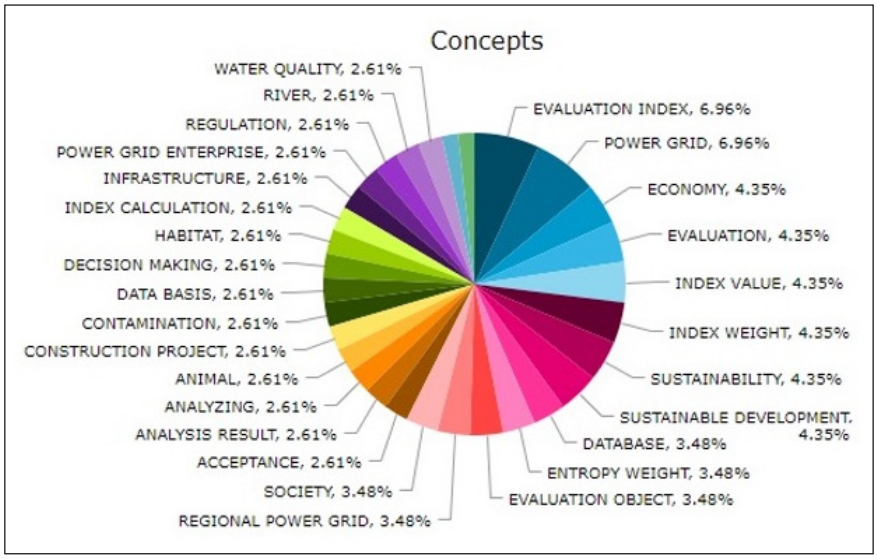


**Figure 13** Concepts. Photo: Orbit.

| PUBLICATION ID | PATENT TITLE | YEAR |
|---|---|---|
| CN109034625 | Method for sustainability evaluation of power grid construction project | 2018 |
| CN111523772 | Construction method of evaluation index system based on electric power spot market transaction | 2020 |
| CN103903094 | System and method for bearing capacity evaluation of power grid enterprise | 2014 |
| CN111932090 | Method and device for evaluating sustainability of energy composite system based on advantage-disadvantage solution distance | 2020 |
| CN109118101 | River health assessment method suitable for rivers in southern cities | 2018 |
| CN113361900 | A fire-containing wind-solar storage power supply regional power grid planning evaluation system and method | 2021 |
| CN110969532 | Investment effect evaluation method for power grid production and technical improvement project | 2019 |
| CN103093297 | Urban service and energy efficiency system of control and management integration | 2011 |
| CN111798082 | Rural electrification comprehensive evaluation index system construction method | 2020 |
| CN111241624 | Green and environment-friendly urban landscape design method | 2020 |

**Table 5** 10 Most relevant patents according to Orbit.

*Source:* Orbit.

climate emergency focused on the "positive climate" in urban areas (Eportugal 2022; European Environment Agency 2022).

## CONCLUSIONS

As we verified, the basis for this study was carried out in three stages: Scope, Specification and Immersion, and divided into four parts. We obtained information related to the mapping of patents with the help of the Orbit software to evaluate the "positive climate" in urban areas. This analysis proved to be adequate and efficient for verifying patent registrations in the fields related to technology, sustainability and energy.

The results show some gaps in specific solutions to the problem of assessing the "positive climate". However, some patents were found that correlated with the "positive climate" framework and contributed to climate assessment.

The evaluation demonstrated a low volume in the production of patents and a field to be explored and used for new inventions related to the emerging themes most discussed today at the Climate Conference (COP 27) (United Nations Climate Change 2021).

There was also an increased curve in the production of patents and a concentration of the terms searched in recent years. Thus, it was concluded that in the coming years, the production of patents, especially those related to the technologies and solutions of the theme of this study, should increase.

The global engagement for climate change has been intensified by the constant debates about the mitigation of climate change due to the significant increase in global average temperatures in the last decade (2011–2020) (a period noted by an increase of patents observed in United Nations Climate Change (2021), reaching 0.90°C to 1.20°C compared to pre-industrial average levels (Duch Guillot 2022).

As has been demonstrated, patents related to the terms «evaluation systems», «urbanism», «sustainability», and their respective synonyms have been catalogued mostly in China, the USA, India and Europe and according to data from the «Global Energy Monitor» and the «Global Carbon Project» (GCP) which are the largest holders of coal-fired power plants in operation and the major polluters of the atmosphere. Thus, there has been no increase in the interest of these countries in researching technologies and solutions to environmental issues and emission reduction in the global context.

All these factors reinforce not only the need to maintain the signed agreements, but also encourage other countries that have not yet done so or that are not members of the Conference of the Parties (COP) to the UNFCCC (United Nations Framework Convention on Climate Change) to commit themselves to the Paris Agreement (2015) (European Environment Agency 2022), and further encouraging government interest in expanding debates, studies, products, solutions and new technologies that corroborate with the minimization of environmental impacts.

According to the research on the themes Scope and Specification, the studies reported here presented limitations in the patents related to the «Y» classification sections. However, although the occurrence is not observed, it is possible to note that the use of technologies related to other themes that make up the other classification sections, such as $CO_2$ emissions, the greenhouse effect, renewable energies, the positive carbon balance, among other terms equivalents are of the utmost importance for further studies to encourage the development of more tools and technologies aimed at solving climate problems related to urban areas, these effectively accounting for 74% of the problem of carbon emissions.

## NOTES

1 "Positive climate" this is when an activity goes beyond zero $CO_2$ emissions and becomes using sustainable, environmentally positive strategies. The positive result for the climate must be achieved by reducing local emissions in a compensated manner and reducing the level of $CO_2$ in the neighboring community (C40 Cities[1] 2016; Bernoville 2022).

2 "Greenwashing" or "green bath" it is when there is a misappropriation of environmental benefits by an entity or organizations or people using marketing and public relations actions and techniques to acquire financial profits.

3 The Global Carbon Project is a platform that dynamically exploits the most up-to-date data on carbon flows resulting from human activities and natural processes (Global Carbon Atlas 2021).

## ETHICS AND CONSENT

If the research being described in the paper involves human or animal subjects then a statement must be present to declare that the research was conducted and published according to recognised international standards, e.g. the Declaration of Helsinki. Declaration that the research was approved by an appropriate ethics committee is required, when appropriate, including the name of the ethics committee and reference number of the approval. The identity of the research subject(s) should be anonymised whenever possible. For research involving human subjects, informed consent to participate in the study must be obtained from participants (or their legal guardian).

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## COMPETING INTERESTS

The authors have no competing interests to declare.

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