CEDES

(*Comprehensive Environmental Design and Evaluation System*)

1. Description

CEDES (*Comprehensive Environmental Design and Evaluation System*) is a GBRS (*Green Building Rating System*) adopted by the *National Association for Sustainable Architecture*, in Spain.

CEDES was designed in 2024, after 25 years of continuous research and, above all, after having analysed in detail the GBRS most commonly used throughout the world.

CEDES can be used both as an evaluation tool and as a design method to design buildings with the highest level of sustainability is prioritized from the outset.

The CEDES evaluation tool uses a simple scoring system. Each indicator is assigned a whole number score ranging from 0 to 5. This score is then multiplied by the indicator's specific weight. The final evaluation is obtained by adding all the resulting values together.

This process provides a total value between 0 and 5, indicating the overall ecological and sustainable level of a building. A partial value can be determined for each category, showing how well the building performs in that specific area. Values for each indicator can also be identified, highlighting potential environmental deficiencies in different aspects.

These results can identify the most cost-effective actions and effective actions that can be taken to enhance a building's ecological sustainability.

2. CEDES categories and indicators

1. Optimization of resources (18%)

1.1. Use of natural resources

- *1.1.1.1. Rain water*
- *1.1.1.2. Groundwater*

1.1.2. Vegetation

- *1.1.2.1. Wild vegetation*
- *1.1.2.2. Unprocessed wood*
- *1.1.2.3. Vegetable waste*

1.1.3. Soil

- *1.1.3.1. No elaborated stones*
- *1.1.3.2. Soil*

1.1.4. Choice of site

- *1.1.4.1. Use of non-arable land*

1.1.4.2. Accessibility
1.1.4.3. Positive impact on the site
1.2. Resource optimization
1.2.1. Amount of resources needed
1.2.1.1. Resources needed in construction
1.2.1.2. Resources needed when using the building
1.2.1.3. Resources needed for building maintenance
1.2.1.4. Abundance of resources used for components
1.2.2. Durability level of components and materials
1.2.3. Waste utilization level
1.2.4. Reusability of components
1.2.4.1. Use of previously used components
1.2.4.2. Component reparability level
1.2.4.3. Component reusability level
1.2.4.4. Disassembly level. Reconfigurability
1.2.5. Component recycling
1.2.5.1. Use of recycled componentes
1.2.5.2. Use of recycled water
1.2.5.3. Level of future recyclability of components
1.2.6. Level of resource exploitation
1.2.6.1. Refined design
1.2.6.2. Industrialization level
1.2.7. Building component durability
1.2.8. Functional adaptation of components in building

2. Reduction in energy consumption (34%)
2.1. Energy consumption in obtaining materials
2.2. Energy consumption in the transportation of materials
2.3. Energy consumption in the transportation of labor
2.4. Energy consumption in building construction process
2.5. Energy consumption by building throughout its lifecycle
2.5.1. Energy consumption in building accessibility
2.5.1.1. Accessibility to the area
2.5.1.2. Accessibility to the rooms of the building
2.5.2. Energy consumption by technological equipment of building
2.5.2.1. Heating
2.5.2.2. Air-conditioning
2.5.2.3. Level of technological adequacy
2.5.2.4. Ventilation systems
2.5.2.5. Lighting
2.5.2.6. Home appliances
2.5.2.7. Telecommunication systems
2.5.3. Energy consumption in building maintenance
2.5.3.1. Cleaning
2.5.3.2. Repairs
2.5.3.3. Improvements
2.6. Bioclimatic architectural design
2.6.1. Location
2.6.1. Correct N-S orientation
2.6.2. Appropriate architectural typology

2.6.3. Efficacy of sun protections
2.6.4. Architectural heating systems
2.6.5. Architectural cooling systems
2.6.6. Proper thermal inertia of building
2.6.7. Proper building insulation
2.6.8. Natural ventilation
2.6.9. Thermal bridges
2.7. Energy consumption in the process of demolishing/disassembling

3. Use of natural energy sources (13%)
3.1. Solar energy
3.1.1. Thermal solar energy
3.1.2. Photovoltaic solar energy
3.2. Geothermal energy
3.2.1. Geothermal energy without heat pump
3.2.2. Geothermal energy with heat pump
3.3. Renewable energies for the natural ecosystem
3.3.1. Wind power
3.3.2. River and sea energy
3.3.3. Energy from underground sources

4. Reduction of waste and emissions (12%)
4.1. Waste and emissions generated in obtaining construction materials
4.1.1. Waste
4.1.2. Emissions
4.2. Waste generated in the manufacturing of components
4.2.1. Waste
4.2.2. Emissions
4.3. Waste generated in the transportation of components and materials
4.3.1. Waste
4.3.2. Emissions
4.4. Waste and emissions generated in construction process
4.4.1. Waste
4.4.2. Emissions
4.5. Waste and emissions generated in building maintenance
4.5.1. Waste
4.5.2. Emissions
4.6. Waste and emissions generated in demolition of buildings
4.6.1. Waste
4.6.2. Emissions

5. Increased health and quality of life of building occupants (8%)
5.1. Harmful emissions to natural ecosystem
5.2. Harmful emissions to human health
5.3. Number of illnesses of building occupants
5.4. Degree of well-being of building occupants

6. Economic cost (10%)
6.1. Direct economic cost in building construction
6.2. Indirect economic cost

6.3. Economic cost in maintenance
- *6.3.1. Materials*
- *6.3.2. Labor*
- *6.3.3. Technological equipment*
- *6.3.4. Cleaning*

6.4. Cost of emissions and waste management
6.5. Cost of treating diseases and illnesses
6.6. Economic revaluation of the building
6.7. Economic revaluation of the environment
6.8. Construction speed

7. Social adequacy (3%)
7.1. Local level of economic development
7.2. Local technological level
7.3. Local quality preferences
7.4. Local design preferences
7.5. Local preferences for construction systems
7.6. Local type of family unit

8. Complementary sustainable aspects (2%)
8.1. Adaptability to change and flexibility of the building
8.2. Social aesthetic appeal of building
8.3. Ecological regeneration of environment

3. Description of CEDES indicators by category

1. Optimisation of resources

Resource optimization in construction can only be achieved in two ways. Firstly, natural resources can be used. Logically, in order to be considered natural resources, they must be used as they are found in nature, or with minimal processing. Secondly, processed resources can be used. If natural resources are not suitable for construction, they must be processed in an appropriate manner to ensure their functionality and, above all, their durability. In other words, resources should be used with minimal processing, or processed only to the extent that ensures their maximum durability.

1.1. Natural resources

Natural resources are those that we can find in nature, simply by collecting them, and with minimal processing. In other words, efficient use of resources to minimize energy consumption. As a matter of fact, there are few natural resources that can be used directly in construction today.

1.1.1 Water

This indicator measures the amount of water needed in construction. The less water used, the higher the score. Water is a resource that we can use directly in construction, used in various construction processes, and even consumed directly by the occupants of buildings once built. There are two main sources of natural water in buildings.

1.1.1.1. Rainwater

This indicator measures the amount of rainwater used, instead of using water from municipal network. The score is higher when less water is used from the mains and when more rainwater is used. Rainwater can be used simply by collecting it and storing it for later use. It can be used both in the construction of buildings and for consumption by their occupants. Rainwater must be stored in tanks with a volume that can be calculated depending on the intensity of local rainfall. Rainwater needs a simple treatment to make it suitable for human consumption.

1.1.1.2. Groundwater

This indicator measures the amount of groundwater used, rather than using water from municipal networks. The less water from the networks and the more groundwater used, the higher the score. Water stored in the subsoil can be used where a construction site is located. There are two types of groundwater: phreatic water and water from underground streams. Phreatic water is easier to use as it usually requires shallow wells, whereas groundwater usually requires deeper drilling. This water should not be used on a massive scale as it can damage the local water cycle, so its use should be supplemented with rainwater. This water usually requires more complex treatments to be suitable for human consumption.

1.1.2. Vegetation

Natural vegetation can be used in a variety of ways in the construction of buildings.

1.1.2.1. Wild vegetation

This indicator measures the amount of wild vegetation used in a construction. Wild vegetation can be used in gardens and on green roofs of buildings. Native vegetation should be used so that it requires as little water and care as possible. Very creative use can be made of vegetation in buildings such as sun protection, shading and cooling systems, wall cladding, creation of steps and pergolas, etc.

1.1.2.2. Low-processed wood

This indicator measures the amount of low-processed wood that has been used in a construction. Low-processed wood consists of trunks and tree branches that have hardly been processed. Leaves and twigs are usually removed, and elements are obtained that can be used directly in construction. Some possible uses are supporting pillars, beams, green roofs, parasols, wall cladding, interior partitions, furniture, creation of composite walls, decorative elements, etc.

1.1.2.3. Plant waste

This indicator measures the amount of plant waste utilized for building.

The plant waste that can be used in construction can be wild or cultivated. Plant waste can be used, suitably crushed, as a plant substrate for gardens or farmland. It can also be used for green roofs mixed with soil. However, larger plant waste (reeds, branches, etc.) can be braided to make roofs, sun protection, or decorative elements of all kinds. Of course, and especially in rural areas, plant waste can be used as an energy source for different heating systems.

1.1.3. Soil

Soil everywhere can be used as a construction element.

1.1.3.1. Unprocessed stones

This indicator measures the amount of natural stones used in a construction.

Stones are widely used in construction, and are used to build load-bearing walls, retaining walls, pavements, etc. With the help of various types of binding elements, such as mortar, plaster, etc., natural stones can be used to make floors, load-bearing walls, paths, etc. Natural stones can also be used with the help of gabions or other materials (trusses), and can be used as architectural envelopes, load-bearing walls, drainage walls, etc.

1.1.3.2. Soil

Soil is the most widely used natural element in construction, and can be used to make load-bearing walls, floors, paths, green roofs, etc. To improve the mechanical capacity of the soil, plastic exoskeletons, fabrics, wooden moulds, metal moulds, etc. can be used. The use of elongated plastic bags filled with soil (superadobe) is one of the most robust, ecological and cheapest construction elements that can be used in construction.

1.1.4. Site selection

The choice of the location to build on is a fundamental aspect of the ecological and sustainable level of construction. The goal is to avoid using arable land for construction, even with the increasing population. Instead, we should prioritize utilizing land that has already been developed or nearby land that is not suitable for farming.

1.1.4.1. Use of non-cultivable land

Building on cultivable land and natural land should be avoided, and instead, historically consolidated urban land should be used.

1.1.4.2. Accessibility

To promote denser population centers, new construction should be concentrated on readily accessible land within existing urban boundaries.

1.1.4.3. Positive impact

When building on a certain piece of land, the biome that previously existed on the site should be restored, even if only partially. Therefore, when building, the animal and plant species that were previously present in the area should be preserved, even if only partially.

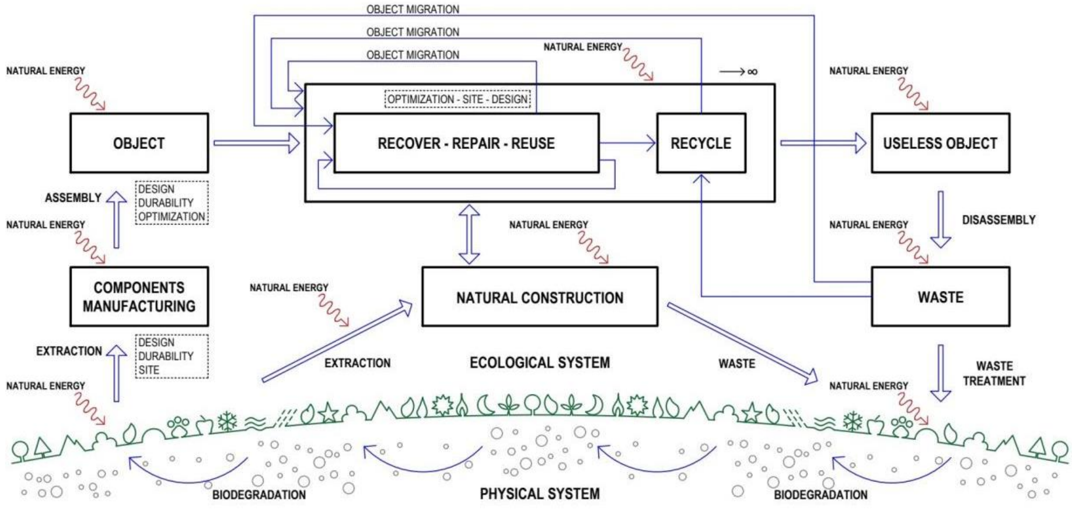
1.2. Optimisation of artificial resources

The primary consideration when manufacturing artificial resources is to ensure their longevity and minimal maintenance requirements. This is the most important factor, above other traditionally overvalued indicators (reduction of resources and energy in the manufacture of resources), since the longer the lifespan of a certain material, the lower its environmental impact per unit of time. In this sense, planned obsolescence is the most severe ecological attack.

In order to extend the lifespan of manufactured resources to the maximum, each and every stage of the life cycle of any component of the build must be optimised. This

approach maximizes the lifespan of buildings, minimizes maintenance requirements, and ensures the lowest environmental impact over time.
To maximize the durability of a building, several different and structured strategies must be followed throughout the stages of its lifecycle.

1. The first stage to achieve optimized constructions is based on components manufacturing, which allows the production of an enormous variety of components and the use of a greater amount of materials, but this requires a large amount of energy, produces a greater amount of emissions and waste, increases the economic cost, and can impact the well-being animals. To minimize the environmental impact of this stage, three strategies must be used. The first, and most important, is the design. Components must be designed in such a way that they can be easily assembled and disassembled, so that they can be easily repaired and reused. The number of components should not be very large, and they should be able to be used in several different types of constructions. Secondly, the place where components are manufactured must be chosen with the upmost care in order to minimize its environmental impact. Thirdly, very durable materials must be used, and can be easily treated to facilitate biodegradation at the end of their life cycle.



Detailed *Life Cycle Assessment* (LCA) of the construction process

2. In a second stage, using the previously manufactured components, a wide variety of buildings (or objects) can be manufactured with the lowest possible environmental impact, and three different strategies are employed to achieve this goal. First of all, the

quantity and variety of components necessary in a building must be reduced to a maximum (optimization). Secondly, the design of buildings must guarantee that they consume the least possible amount of energy, have the least possible maintenance, and generate the least possible amount of emissions and waste. Thirdly, buildings must be designed with a flexible architectural structure so that they have the greatest possible durability, and can be easily reconfigured, adapting to the conditions of each stage of their lifecycle.

3. In the third stage, and once the construction of a building (or object) has been completed, its useful life can be extended to the maximum using several consecutive strategies. Firstly, all its components can be repaired and reused when they have degraded. To do this, in the previous stage, building components had to have been designed so that they can be extracted, repaired and reused with the greatest possible ease, and therefore using the least possible amount of energy and resources. Secondly, severely deteriorated components of buildings can be used, repeatedly, in increasingly less demanding buildings (migration), thereby maximizing the durability of both the components and the buildings (or objects). There will come a time when the components will be so deteriorated that they can no longer be used in any type of building, so they must be recycled. It must be taken into account that the recycling process involves the use of a large amount of energy and resources and generates waste and emissions, so components should only be recycled when their reuse possibilities have been exhausted. New recycled components must be designed so that they can be used in the widest possible variety of buildings, and that they can easily migrate to others.

4. In the fourth stage, there will come a time when some components can no longer be recycled again, since some of their properties (mechanical, physical or chemical) will have decreased considerably, and must be biodegraded so that its basic components can properly return to nature. To do this, they must be disassembled and treated appropriately to facilitate their biodegradation, using the least possible amount of energy and generating the least possible amount of emissions and waste. These basic components will continue to biodegrade in nature, and after a certain time they can be extracted again, repeating a new cycle as described.

Therefore, to ensure the highest level of sustainability in buildings, indicators must be established that can score all the stages described.

1.2.1. Amount of resources needed

After deciding to produce an item, the initial step is to produce only the necessary quantity with the fewest essential components. In this way, the least amount of resources and the lowest possible energy consumption will be used. A prime example are cheap cars with few parts and a combustion engine. They are made to order, have few components, and there is always more demand than supply. A poor example is expensive electric cars. Many more are manufactured than ordered, and they have many non-essential parts, and there is always more supply than demand.

1.2.1.1. Resources used in construction

This indicator evaluates the amount of resources used in construction. The fewer resources used, the higher the score. The number of buildings constructed should be minimized, and they should have the fewest possible components and materials. A small house with few components and few materials would be a good example. An unnecessary large museum with many pieces would be a negative example, since a smaller museum can be designed with fewer components and be more attractive and functional. Similarly, it is more ecological to build the same building with fewer auxiliary means than to build it with many auxiliary means. Similarly, a prefabricated building consumes fewer resources than the same building built conventionally.

1.2.1.2. Resources needed in the use of the building

This indicator evaluates the amount of resources used during the use of the building. The fewer resources used, the higher the score. Some common resources are: packaging, paper, water, chairs, tables, food, ink, machines, air conditioning units, heating units, purification units, ventilation units, utensils, etc.

1.2.1.3. Resources needed in maintenance

This indicator evaluates the amount of resources used in the maintenance of the building. The fewer resources used, the higher the score. Some common resources are: cleaning materials, water, repair materials, paint, cleaning equipment, human resources, etc.

1.2.1.4. Abundance of resources used to manufacture components

This indicator evaluates the abundance of resources used in the construction of the building. The more abundant they are, the higher the score. Some buildings use very abundant materials: lime, sand, clay, stones, plaster, etc. On the other hand, others use very rare or highly processed resources: rare marbles, rare stones, tropical woods, rare metals, etc.

1.2.2. Durability of materials and components used

This indicator evaluates the durability of materials and components used in the construction of the building. The more durable they are, the higher the score. A very common mistake is to use materials that required little energy to obtain, but these materials are usually short-lived and must be replaced frequently. Instead, the use of durable materials should be encouraged, which contribute to the building's durability being as long as possible. Therefore, once a decision is made to manufacture a material, its durability must be given priority above all else.

1.2.3. Amount of waste used

This indicator assesses the amount of waste used in the construction of the building. The greater the amount of waste, the higher the score. Waste is understood to be those resources that have been used and are deemed to be no longer usable. However, with ingenuity they can be reused occasionally in some parts of the building. For example, certain residual metal materials (such as bed frames, spoons, umbrellas, metal pipes, etc.) could be used as reinforcement for the concrete of certain construction elements, such as load-bearing walls, flooring, paths, etc. The waste generated in a given construction can be used as filling material for certain parts of the building structure.

1.2.4. Reusability of components

The most important strategy to extend the durability of a building is to be able to easily recover all its components, and repair them, so that they can be used again. Some of these components, after several cycles of reuse, might not be reused again, but could be recycled, and replaced by other components.

1.2.4.1. Use of previously used components

This indicator evaluates the use of components previously used in the construction of the building. The greater the number of reused components, the higher the score.

1.2.4.2. Repairability of components

This indicator evaluates the ease of repair of components that have been previously used in the construction of the building. The easier they are to repair, the higher the score. Some components are easily repairable, for example a load-bearing beam made of wood or metal can be easily repaired, whereas a reinforced concrete beam is more difficult to repair. A prefabricated component can be easily repaired, whereas a non-prefabricated component is more difficult to repair.

1.2.4.3. Future reusability of components

This indicator assesses the reusability of the materials and components used in the construction of the building. The more easily they can be reused in the future, the higher the score. Reusability depends on several factors, but above all it depends on the way it is integrated with other components of the building. For example, an iron plate in a false ceiling is easier to repair than an aluminium plate, since it bends permanently. A wooden or metal beam is easier to repair than a reinforced concrete beam.

The components of a building can be reused in that same building, or in any other, depending on its specific design. When a component is designed so that it can be used in several buildings, both its own durability and the durability of the buildings in which it can be incorporated are being extended. And thus the environmental impact per unit of time is reduced to a minimum.

1.2.4.4. Disassembly and reconfigurability capacity

This indicator assesses the disassembly capacity of the building components used in the construction of the building. The easier it is to assemble and disassemble the components without being damaged, the higher the score. This characteristic is directly associated with the ability to reconfigure the different components of a building and thus be able to reconfigure or expand. Furthermore, if the components can be easily disassembled, they can be used both in that building and in any other building. By amplifying the migration of components from one building to another, the durability of said component is increased, and therefore the durability of the buildings in which it can be placed.

1.2.5. Recyclability of components

When a component of a building has been repaired and reused several times, both in that building and in other buildings, there will come a time when its repair is very difficult or very expensive. Then it is time to recycle it. It should be noted that recycling a given component into a similar or completely different component requires the use of a large amount of energy and new resources, so recycling should be the last stage in the life cycle of a given resource, after having completely exhausted the previous stages (durability, recovery, repair, reuse in the same building, reuse in other buildings). It should also be noted that recycling a given resource modifies its physical, chemical or mechanical characteristics to a greater or lesser extent.

1.2.5.1. Use of recycled components

This indicator assesses the amount of previously recycled components used in the construction of the building. The more recycled components used, the higher the score. Recyclability has been wrongly promoted in our society over durability, flexibility and reuse, which is why it is quite common to use previously recycled resources in construction, such as: glass, chipboard, plastic, cardboard, iron, steel, textiles, insulation, etc.

1.2.5.2. Use of recycled water

This indicator assesses the amount of recycled water used in the construction and use of the building. The more water used, the higher the score. Recycled water is usually obtained from wastewater normally generated in the use of the building (washing, irrigation, cleaning, etc.), but it can also come from stagnant water, contaminated water, rainwater, etc.

1.2.5.3. Recyclability of components

This indicator assesses the ease of recycling of the components used in the construction of the building, with the aim of creating new components that can be used in the same building, or in anything else. The more easily the components can be recycled, the better. It should be noted that not all materials are equally recyclable. Some resources are easily recyclable, such as paper, cardboard, bricks, etc.; others have medium recyclability, such as glass, iron, zinc, steel, wood, etc.; and others, however, are very difficult to recycle, such as batteries, aluminium, titanium, concrete, etc. Any existing material can be recycled, but it is very expensive and not very ecological to recycle some of them, so they should be originally designed to never be recycled, and instead facilitate their continued reuse.

1.2.6. Level of exploitation of resources

After deciding to manufacture a specific component, readily available resources are used, producing only the absolutely essential items, with high capacity for repair and reuse, and that can be recycled; in order for it to have the highest possible ecological and sustainable level, the only remaining step is to ensure that the resources used in its production have been optimized to the greatest extent possible. To do this, both the design and the manufacturing process of said components must be optimised.

1.2.6.1. Refined design

This indicator evaluates the quality of the design of the components used in a building so that the least possible amount of resources are used, and the least possible amount of waste is generated. The better the design, the higher the score.

A good design must take into account a multitude of features, and in order to provide a high ecological and sustainable level, the different components must be designed to make the most of the available resources, wasting the least amount of them possible. There are many examples. One of them would be the modularity of porcelain tiles. What dimensions should ceramic tiles have in order to make the most of them and generate the least amount of waste? The smallest possible formats are undoubtedly desirable, and the mosaic of tiles measuring 1 or 2 cm on each side is the best option. Extrapolating the reasoning, the "trencadis" technique would be the optimal option, since in addition to making the most of the resources, waste is being used.

1.2.6.2. Level of industrialization

This indicator evaluates the level of industrialization used in the production of the components used in the construction of the building. The more industrialized the process, the higher the score.

Component industrialization can have several technological levels, but what is being evaluated with this indicator is the ability to make the most of the resources used in component manufacturing. Therefore, it should not be confused with other possible advantages of certain industrialized systems.

1.2.7. Functional durability of components

This indicator assesses the functional durability of components used in the construction of the building. The higher its functional durability, the higher the score. A given component has a certain durability, but this can be radically reduced depending on its position within a building. So this indicator actually measures the successes of the functional design of the building. Let's look at an example. A ceramic tile could easily last a million years. But ceramic tiles are commonly used for wall coverings in bathrooms and kitchens. The average worldwide user change of bathroom and kitchen coverings is one generation (about 25 years), and these ceramic tiles are so damaged that they cannot even be reused once. So the actual lifespan of ceramic tiles is 25 years, not a million years. If the ceramic tiles had been placed on a façade, they might have lasted about 200 years. In any case, it is worth asking why ceramic tiles are installed in bathrooms and kitchens, and why other cheaper materials are not used, even if they are less durable (since they only last 30 years would be enough). It is also worth asking why people continue to spend huge amounts of money changing ceramic tile coverings in basements and kitchens every generation. The reasons why ceramic tile manufacturers do not manufacture construction systems that allow the reuse of ceramic tiles are easy to understand.

1.2.8. Functional adaptation of components

This indicator evaluates the functional adaptation of the components used in the construction of the building. The greater their functional adaptation, the higher the score. A very ecological and sustainable component may be poorly located in a certain building and thus cause economic and sustainable collateral damage. Let’s look at an example. A glass step may be perfectly functional, durable and easy to clean. However, if a professional installs a glass step on a busy bridge in a marine environment, the glass will always be very dirty and slippery. As a result, a lot of cleaning and maintenance resources will be needed, and even direct damage to people's health and safety may be caused.

2. Reduction of energy consumption

To reduce energy consumption as much as possible in the construction and use of a building, all stages of its life cycle must be taken into account, from its design to its dismantling, and its components biodegrade and return to nature. The objective, again, is to ensure the maximum durability of the components and buildings with the least possible maintenance required. In this way, energy consumption per unit of time will be as low as possible.

2.1. Energy consumption in obtaining materials

This indicator evaluates the energy consumption used in obtaining materials and components used in the construction of the building. The lower the energy consumption, the higher the score. It should be noted that the consumption of materials and components commonly used in construction varies widely. Very little energy has been consumed in the production of some materials such as wood, concrete, bricks, concrete blocks, etc., whereas a great deal of energy has been consumed in the production of others such as aluminium, plastics, surface treatments, etc. There are numerous tables indicating in an orderly manner the energy consumption used in the production of the most common materials in construction. However, there is a huge disparity in the data, depending on who publishes them. Therefore, it is not so important to know the real data, since it is subject to constant manipulation, but rather the order in the table. Only those materials whose production required the least amount of energy should be used (the first places in any table), and the others should be avoided.

2.2. Energy consumption in the transport of materials

This indicator evaluates the energy consumption used in the transport of materials and components used in the construction of the building. The lower the energy consumption, the higher the score. This indicator is related to several factors that can be taken into account directly. One of them is remoteness. Obviously, materials close to the construction site should be used, especially the heavier ones. Another factor is the scarcity of resources. If a resource cannot be obtained close to the site, brining it from afar should also be avoided, and it is preferable to replace it with a closer one. Another important factor is the means of transport. If transport is by large sea vessels, the energy impact per material is very small, whereas if transport is by land, in small vehicles, the impact is very high. Another factor is urgency. Materials must be ordered well in advance so that urgency does not force a last-minute waste of money and energy.

2.3. Energy consumption in the transport of labour

This indicator evaluates the energy consumption used in the transport of human resources and machinery used in the construction of the building. The lower the energy consumption, the higher the score. It is clear that the workforce must be local, and it is preferable to train it, rather than having to find more qualified labour from further away. The same applies to the transport of the necessary machinery.

2.4. Energy consumption in the construction process of the building

This indicator evaluates the energy consumption used in the construction process of the building. The lower the energy consumption, the higher the score. The same building can be built using different techniques, some of which consume more energy than others and must be chosen appropriately. However, the most important thing is that when designing a building, certain limits are voluntarily adopted, with the aim of consuming the least amount of energy possible when constructing it. As an example: the same single-family home can be designed by designing a structure based on reinforced concrete pillars and a reticular slab. The same home can be designed using load-bearing walls made of prefabricated blocks and semi-joists simply supported. The construction of the first version requires many more auxiliary means, more time and more labor than the second.

2.5. Energy consumption of the building throughout its useful life

Upon occupation of the building, it begins to consume energy, depending on its design and the activities that take place inside it. The most important factor is the design. A good design can make the building consume almost no energy, whereas a bad design can make the building consume a lot of energy. The education and training of the occupants is also important.

2.5.1. Energy consumption in accessibility to the building

To access the place where the building is located, a certain amount of energy is consumed, depending on the type of building. Energy is also needed to access the building, and also to move around the different rooms of a building. Therefore, the location where the building is to be built must be carefully chosen, as well as the architectural typology of the building.

2.5.1.1. Energy consumption in accessibility to the location

This indicator evaluates the energy consumption required to access the area in which it is built in the building. The lower the energy consumption, the higher the score. The location where a certain building is to be built must be chosen correctly in order to be located as close as possible to those who will occupy it. In this way, the energy consumption to reach the building will be as low as possible.

2.5.1.2. Energy consumption in accessibility to the rooms of the building

This indicator evaluates the energy consumption required to access the different rooms of a building. The lower the energy consumption, the higher the score. The design of buildings must ensure that the least possible energy is consumed when accessing all its rooms. For example, some shopping centres incorporate a huge number of stairs, lifts and ramps to access from one room to another, and a better design would probably avoid them. Another example is airports, since depending on the type of airport chosen, some airports need a huge number of moving walkways, and even buses and trains, to access the different rooms. In contrast, other, better designed airports hardly need any accessibility machines.

2.5.2. Energy consumption of building appliances

The design of many buildings has deteriorated so much over time that they need more and more machines (energy consumers) to be able to live in them. At the same time, occupants demand more and more things, even if they are not necessary. Some machines may be absolutely essential, such as telecommunications equipment and office equipment. However, many appliances are completely banal, such as the huge number of automatic devices that are becoming more common. Other appliances would not be necessary if the building had been properly designed. A good architectural design can maintain an adequate interior temperature in a building without the need for heating and air conditioning appliances.

2.5.2.1. Heating appliances

This indicator evaluates the energy consumption of heating in a building. The lower the energy consumption, the higher the score. Some buildings are better designed than others, and make better use of the free energy from the sun in winter, and hardly need heating appliances to maintain a comfortable temperature inside. Proper education of occupants and proper building design can significantly reduce heating energy consumption.

2.5.2.2. Air conditioning equipment

This indicator assesses the energy consumption of air conditioning in a building. The lower the energy consumption, the higher the score. Some buildings are better designed than others and are better protected from solar radiation, and are able to generate cooling through certain architectural strategies, so they do not need air conditioning equipment in summer to maintain a comfortable interior temperature.

2.5.2.3. Technological suitability to human parameters

This indicator assesses the suitability of the technology incorporated in a building to intrinsic human parameters. The greater the suitability, the higher the score. Technological suitability is mainly related to equipment that is intended to provide comfort to humans. For example, humans are more thermodynamically sensitive to radiation and less to convection (approximately 20%). Therefore, with equal energy consumption, convection heating would be approximately 20% less effective than radiant heating. Therefore, with equal energy consumption, convection is 20% less energy efficient than radiant heating. The same can be said for cooling. And something similar occurs with respect to luminaires that provide light spectra that are not suitable for human perception.

2.5.2.4. Ventilation devices

This indicator evaluates the energy consumption of a building's ventilation systems. The lower the energy consumption, the higher the score. A huge mistake in the design of many current buildings is to make them airtight in order to reduce energy consumption for heating or air conditioning. This leads to enormous health problems, and forces the installation of complex and expensive ventilation systems that consume energy. What is saved on one hand is spent on the other. Instead, it is advisable to design porous architectural envelopes with high thermal inertia and great thickness, which allow continuous ventilation without energy losses.

2.5.2.5. Lighting fixtures

This indicator evaluates the energy consumption of a building's lighting fixtures. The lower the energy consumption, the higher the score. The design of many current buildings is very poor, since many spaces have insufficient lighting during the day, and this requires the incorporation of luminaires that consume energy. Perhaps a more studied and refined design could have guaranteed that all spaces in the building have sufficient natural lighting to carry out the activities for which it was designed.

2.5.2.6. Household appliances

This indicator evaluates the energy consumption of household appliances in a building. The lower the energy consumption, the higher the score. One of the most surprising things about our time is that people have decided to surround themselves with multiple household appliances to perform all kinds of tasks that could perfectly be done manually and without energy consumption. Cooking, cleaning, observation, etc., and even dental cleaning are done with appliances, although they could perfectly be done manually.

2.5.2.7. Telecommunications equipment

This indicator evaluates the energy consumption of a building's telecommunications systems. The lower the energy consumption, the higher the score. Telecommunications systems hardly consume energy, but given their abundance, it would be convenient to limit their number with sustainability criteria. It is probably not necessary to install video surveillance equipment in a home to be able to observe from work if the dog is sleeping.

2.5.3. Energy consumed in building maintenance

The maintenance of the components of any building requires resources and also energy. In addition, a common strategy today is to reduce the quality of buildings to the legal maximum, and this requires expensive maintenance. The explanation is that the seller of the building is not usually the user of the same. Therefore, more and more energy is needed to maintain buildings whose design complies with an enormous amount of regulations, but which are increasingly precarious.

2.5.3.1. Cleaning

This indicator evaluates the energy consumption in the cleaning of a building. The lower the energy consumption, the higher the score. The use of more and more capricious materials requires more and more cleaning work in buildings. As it is also desired to carry out these tasks as quickly as possible, more and more aggressive materials are used, which pose a serious problem for the health of the occupants and cause high environmental damage. Manufacturers of cleaning products value the speed of cleaning more than the health of people and the environmental impact of their products.

Therefore, a radical change must be made to this trend and two complementary strategies must be implemented. On the one hand, using materials that are easy to clean and do not show dirt, and on the other hand, using less aggressive cleaning systems and doing it manually.

2.5.3.2. Repairs

This indicator evaluates the energy consumption in the repairs of a building. The lower the energy consumption, the higher the score. As has been said, many current buildings are designed from the beginning with a high level of planned obsolescence with the dual purpose of reducing the purchase price and of rebuilding a new building as soon as possible. This necessarily generates a great need for continued repairs in order to keep the building functional in its increasingly short useful life. Of course, improving the initial design of the building would substantially improve the situation and reduce the need for repairs to a minimum.

2.5.3.3. Improvements

This indicator evaluates the energy consumption in the improvements of a building. The lower the energy consumption, the higher the score. Improvements are usually required as a result of changes that are necessary to the building to adapt to a new function, and which were not initially planned. These changes require energy and resources. However, if the building had initially been designed with a high degree of flexibility, to cope with possible future changes, there would have been no need for substantial changes. Therefore, it is essential to think carefully about the initial design of the future, so that it can adapt to future changes, and provide it with the necessary flexible elements.

2.6. Bioclimatic architectural design

Bioclimatic design is understood as that which allows buildings to regulate themselves thermally and maintain a comfortable internal temperature at all times, and without the need for air conditioning or heating equipment. This is possible in most places on the planet. However, in some places with extreme temperatures, the help of heating or air conditioning equipment may be needed, but in this case the number of equipment and their power is minimal, and therefore their energy consumption is very low. In any case, it must be clear that the investment necessary to achieve a bioclimatic building must always be lower than the cost of the equipment that would have to be incorporated in the building if it were designed in a conventional way. In any case, the worse the design of a building, the more heating, air conditioning, ventilation and lighting equipment it will need.

2.6.1. Location

This indicator evaluates the correct location of a building. The better its location, the higher the score. When choosing the location of a building, there are a wide variety of aspects that must be taken into account to achieve a correct bioclimatic design, such as: shade that the building projects, shade that the building receives, prevailing winds, height, relationship with other buildings, relationship with vegetation, etc. The correct choice of location is essential, since if an inappropriate location is chosen, the design of the building will be less effective.

2.6.2. Adequate N-S orientation

This indicator evaluates the correct orientation of the building. The better its orientation, the higher the score. A perfect south orientation is essential, since any error committed at this point will make the rest of the actions very ineffective, or even counterproductive. The south orientation means that the building must be developed along an east-west axis, with the main rooms facing south, and the secondary ones facing north. The south facades must have a perfect east-west orientation, and must have effective solar protection. There should be no gaps in the east and west facades, or they should be as small as possible, and with effective solar protection.

2.6.3. Adequate architectural typology

This indicator evaluates the suitability of the architectural typology of the building. The better the typology, the higher the score. The architectural typology is a topological structure of the different rooms, delimited by a certain fuzzy shape, both of the building and its rooms. Both the rooms and the entire building are defined in a fuzzy way and ordered according to a certain structure. There is an enormous variety of architectural typologies, some of which facilitate bioclimatic design and others hinder or prevent it. Therefore, the correct typological definition of a building is a fundamental stage for the correct bioclimatic design of the building.

2.6.4. Effective solar protections

This indicator evaluates the effectiveness of the solar protection of the building. The more effective the solar protection, the higher the score. Solar protection is usually called this way, but in reality they should be called solar control structures, since what they really have to do is facilitate at all times the correct amount of solar radiation that can penetrate the windows of the building. These structures are static since in reality their operation is dynamic, because the sun is in constant movement during the day, and throughout the year. In winter, these solar control structures must facilitate the maximum amount of solar radiation entering the building, so that it heats itself. In contrast, in summer, the least amount of solar radiation must pass through to prevent the building from heating up (and the cooling architectural structures from being effective). In the design of any building, complex calculations must be made to design these solar control structures, and to ensure their effectiveness is adequate.

2.6.5. Architectural heating systems

This indicator assesses the effectiveness of architectural heat generating systems that have been incorporated into the building design (and that do not consume energy). The more effective they are, the higher the score. Architectural heat generating systems are specific integrated designs of the windows together with various parts of the building that are intended to allow the building to heat itself. There are various sources of heat generation, such as solar radiation, underground hot water pockets, building underground, etc. These sources can be used by the usual architectural structures in any building, but which have been optimized to generate heat free of charge. Direct solar radiation and the greenhouse effect produced by the windows of buildings are certainly the most important source of heat, and can be maximized by correct bioclimatic design. The objective is to heat the building as much as possible during the day and keep it warm at night due to high internal thermal inertia and high external thermal insulation. There are a huge number of architectural structures capable of heating the building, and they must be applied consecutively from the cheapest to the most expensive, until the available budget is exhausted. In any case, they are cheaper than the technological systems they replace.

2.6.6. Architectural cooling systems

This indicator evaluates the effectiveness of architectural cooling systems that have been incorporated into the design of the building (and that do not consume energy). The more effective they are, the higher the score. Architectural cooling systems are certain architectural structures common in any building that have been optimized to generate the maximum amount of cold. The largest source of cold is the drop in temperature during the night, and the second largest source of cold is the low temperature existing in the subsoil. Therefore, the objective of architectural structures that generate cold is to take the cool night air, cool it even further underground, and introduce it into the interior of the buildings during the night to cool them as much as possible, and to keep them cool throughout the following day due to the high internal thermal inertia and adequate external thermal insulation.

2.6.7. Adequate thermal inertia

This indicator evaluates the thermal inertia of the building. The greater the thermal inertia, the higher the score. Thermal inertia is achieved by maximizing the internal mass of the building so that in summer it stores the cold generated during the night (and maintains it throughout the following day), and in winter it stores the heat generated during the day (and maintains it throughout the following night). The increase in the thermal inertia of a building does not necessarily mean a substantial increase in its cost, since very inexpensive materials can be used, such as stones, sand, water, etc., and even the waste generated during the building construction process.

2.6.8. Adequate insulation

This indicator evaluates the exterior insulation of the architectural envelopes of the building. The greater the insulation and the better it is placed, the higher the score. The score is twofold. Firstly, the insulation must always be placed on the outside of the architectural envelopes to ensure that the thermal inertia remains inside the building and can thus store the heat or cold generated by the architectural structures that generate heat and cold. In addition, the insulation must be as high as possible to reduce the building's energy losses in winter (or climates that are always cold) and the energy gains in summer (or climates that are always hot) to a minimum.

2.6.9. Adequate ventilation

This indicator evaluates the natural ventilation without energy losses of the building. The greater the ventilation without energy losses, the higher the score. There are several ways to ensure natural ventilation with the least possible amount of energy losses. One of them, the most used throughout history, is ventilation through architectural envelopes. In this case, the architectural envelopes must be as thick as possible and have the greatest possible thermal inertia, together with adequate porosity. Another way is to use architectural heat recovery units. The alternative of using forced ventilation devices with heat recovery units is not a good option, since their existence denotes a specific energy consumption and the absence of adequate transpiration through the architectural envelopes, which translates to a significant loss of comfort and health.

2.6.10. Thermal bridges

This indicator evaluates the number of thermal bridges in the building. The greater the number of thermal bridges, the higher the score. Thermal bridges are common in various parts of buildings (floors, windows, doors, ventilated façade fixings, roofs, etc.) and should be reduced to a minimum by meticulous design of the construction details designed for the building. Sometimes it is convenient to force thermal bridges in some parts of the building to force certain energy losses in order to heat or cool the ventilation air entering the building. In this case, the thermal bridges cease to be thermal bridges and become heat exchangers.

2.7. Energy consumption in the demolition or disassembly process

This indicator evaluates the energy consumption required to demolish or disassemble a building. The lower the energy consumption, the higher the score. Of course, the best way to reduce energy consumption as much as possible in the demolition of a building is to never demolish it. In this case, it is a matter of disassembling the different components of a building, with the aim of reusing them in the construction of another building. It is therefore advisable to industrialise and prefabricate the different components of a building, and to equip them with certain joining systems, which allow them to be assembled and disassembled as many times as desired. In any case, a building must be designed with the idea that one day it will have to be demolished, and it will be advisable to make the most of the reuse of its components and reduce the energy of the demolition process as much as possible.

3. Use of natural energy sources

In order for human activity to be as integrated as possible in the ecosystem, from an energy point of view, energy consumption must be reduced to a minimum, and renewable and natural energy sources must be used above all. There are two natural energy sources that can be used in every place on the planet: solar energy, and underground energy. Solar energy is the energy that reaches the planet Earth from the Sun, and rounding off we can say that it is about 1,000 kW/m2. Underground energy (usually called geothermal) consists of using the stable temperature of the subsoil to heat or cool a building. Finally, there is another natural renewable energy source that occurs as a result of thermal imbalances on the Earth's surface, such as wind energy, wave energy, tidal energy, geyser energy, river current energy, underground aquifer energy, etc.

3.1. Solar energy

Solar energy is the energy that we can use from solar radiation that reaches the Earth's surface. There are many methods to use this energy, and energy efficiency is the ratio between the energy obtained with each method and the energy that comes from the sun.

3.1.1. Solar thermal energy

This indicator evaluates the use of solar thermal energy. The more it is used and the more energy efficient it is, the higher the score. Solar thermal energy is usually obtained through hot water generating devices, but it can also be obtained through architectural structures closely integrated into the architecture. The heat energy of hot water, in relation to the energy of solar radiation, determines the energy efficiency of the different devices that can be manufactured, and in any case it is around 95%.

3.1.2. Photovoltaic solar energy

This indicator evaluates the use of photovoltaic solar energy. The more it is used and the more energy efficient it is, the higher the score. Photovoltaic solar energy is the electrical energy obtained through certain devices that integrate a set of silicon sheets conveniently interconnected. The energy efficiency of these devices is very low, less than 15%, so their use must be studied carefully. The use of photovoltaic solar energy must be complemented with other energy sources, and above all with the correct education of building users, so that their energy consumption is reduced to a minimum.

3.2. Geothermal energy

As one descends underground, the temperature becomes more stable and is situated at an intermediate level between the temperature variations that exist above ground. Let us imagine an environment, for example Madrid, where in winter the temperatures can drop to 10º below zero and in summer rise to 40º above zero, since five metres below ground the temperatures can fluctuate between 15º and 18º. This temperature below ground could be used to heat the building, and in turn to cool it in summer. The difficulty is how to use this difference in temperature between the subsoil and the crust to heat a building. There are three options. The simplest option is to bury a building as much as possible, and thanks to a special design, the building can be heated or cooled as needed. The second option would be to transport underground fluids (gas or water) to the building and condition it thermally through a set of pipes distributed in the floors, walls and ceilings of its rooms. The third option is to bury a conduit (about 100 m deep) through which a coolant is injected so that it acquires the temperature of the subsoil. Once the liquid returns to the subsoil temperature, it is heated or cooled a little more by means of a heat pump. In this way, a geothermal heat pump usually consumes a quarter of the energy consumed by a heat pump powered by electricity.

3.2.1. Geothermal energy without heat pumps

This indicator evaluates the use of geothermal energy without heat pumps. The more it is used and the more energy efficient it is, the higher the score. There are two forms of geothermal energy without heat pumps. The simplest is to bury the building as much as possible. In this way, the underground part of the building acquires a fairly stable temperature, intermediate between the maximum and minimum that occurs annually on the crust. In this way, upper rooms can be cooled by radiation or by convection. Fresh air can be pushed up to the upper rooms of the buildings using impulse fans (very low energy consumption) and systems for extracting hot air from above by chimney effect. In this way, ascending air currents are created that cool the building continuously, especially at night. Another way is to drill holes to access air pockets and fluids in the subsoil. Cold fluids are extracted in summer to cool the building, and hot fluids are extracted in winter to heat it.

3.2.2. Geothermal energy with heat pumps

This indicator evaluates the use of geothermal energy with heat pumps. The more it is used and the more energy efficient it is, the higher the score. A heat pump generates heat or cold based on the expansion and compression of a gas, and it consumes energy to do so. Well, if part of the heat or cold is extracted from the subsoil, the heat pump consumes much less energy. Most commonly a hole of about 100 m is made and a conduit introduced through which a heat-carrying liquid is injected. This liquid obtains the temperature of the ground, which is cold in summer and hot in winter. Therefore the heat pump is functioning much less and its energy consumption is substantially lower. In many cases it is not drilled so deep and the conduit runs through the lower part of the foundation of the ground.

3.3. Natural renewable energy

Natural renewable energy is understood to be that which exists in nature, as a consequence of imbalances in the physical system. For example, wind is generated by a thermal imbalance, and cold air is sucked in by the rising air generated by overheating of the nearby ground. The most common natural renewable energy comes from river currents, tides, ocean waves, wind, rain, geysers, waterfalls, etc. Of course, the economic investments to obtain energy from these sources are different, and the most appropriate ones must be chosen in each specific environment.

3.3.1. Wind energy

This indicator evaluates the use of wind energy. The more it is used, the higher the score. Wind energy is generally obtained by wind turbines, which are large dynamos that rotate with large blades moved by the wind to generate electricity. This electricity is distributed through existing power grids. The problem with wind energy is that it is only generated where people do not want to live, as it is only effective where there is strong and continuous wind; and these environments are not suitable for living.

3.3.2. River and marine energy

This indicator evaluates the use of river and marine energy. The more it is used, the higher the score. It is obtained by taking advantage of the speed of water in rivers, and also of sea waves and sea tides. There is a wide variety of different technologies to take advantage of this type of energy, and in any case it can only be obtained in places where it is possible and effective. The energy obtained is electrical and is distributed through the electricity grid.

3.3.3. Underground energy

This indicator evaluates the use of energy from underground currents. The more it is used, the higher the score. Energy from underground sources can have two origins, since they can be static water pockets, or they can be underground water currents. It is usually used in large buildings built on large plots of land, since these underground energy sources cannot be found everywhere.

4. Reduction of waste and emissions

Manufacturing building components generates waste and emissions. Therefore, it is necessary to go through all the stages of the building construction process to create all kinds of strategies that allow for the reduction of waste or emissions to a minimum, or even repurposing the waste, without causing damage to human health or the environment.

4.1. Waste and emissions generated in the production of materials

In the production process of materials, both waste and emissions are usually generated. Therefore, these processes must be improved in order to reduce them as much as possible. Waste is generally the name given to solids and liquids, and emissions are the name given to gases.

4.1.1. Waste

This indicator evaluates the quantity of waste generated in the production of materials, and also its toxicity. The lower the quantity and the less harmful they are, the higher the score. Industrialization is a way of reducing the quantity of waste, but good management of the manufacturing process can be equally effective.

4.1.2. Emissions

This indicator evaluates the quantity of emissions generated in the production of materials, and also their toxicity. The lower the quantity and the less harmful they are, the higher the score.

4.2. Waste and emissions generated in the production of components

The manufacturing process of components is not completely efficient and both waste and emissions are usually generated. Therefore, manufacturing processes must be improved in order to reduce them as much as possible. Waste is generally defined as solids and liquids, and emissions are defined as gases.

4.2.1. Waste

This indicator evaluates the quantity of waste generated in the manufacture of components. The smaller the quantity and the less harmful they are, the higher the score.

4.2.2. Emissions

This indicator evaluates the quantity of emissions generated in the manufacture of components. The smaller the quantity and the less harmful they are, the higher the score.

4.3. Waste and emissions generated in the transport of materials

Means of transport generate emissions and also waste, since the materials transported can be damaged. Obviously, long journeys should be avoided, but above all, large means of transport should be used, so that the impact of the emissions and waste generated by the means of transport has the least possible impact on the materials and components transported.

4.3.1. Waste

This indicator assesses the amount of waste generated in the transport of materials and components. The smaller the amount and the less harmful the waste, the higher the score.

4.3.2. Emissions

This indicator assesses the amount of emissions generated in the transport of materials and components. The smaller the amount and the less harmful the waste, the higher the score.

4.4. Waste and emissions generated in the building construction process

In the construction process of a building, waste and emissions are produced for various reasons. Of course, these waste and emissions can be treated in order to reuse part of them and cause the least possible environmental impact. However, the most important, economical and convenient thing is to reduce as much as possible the amount of waste and emissions that can be generated. There are several possible strategies to reduce the amount of waste and emissions, but without a doubt the most important is to industrialize and control the construction process as much as possible.

4.4.1. Waste

This indicator assesses the amount of waste generated in the building construction process. The lower the amount and the less harmful the waste, the higher the score.

4.4.2. Emissions

This indicator assesses the amount of emissions generated in the building construction process. The lower the amount and the less harmful the waste, the higher the score.

4.5. Waste and emissions generated in building maintenance

Maintenance of the building throughout its useful life consumes a quantity of resources and generates a considerable amount of waste and emissions that must be reduced as much as possible.

4.5.1. Waste

This indicator assesses the amount of waste generated in the building construction process. The smaller the amount and the less harmful the waste, the higher the score.

4.5.2. Emissions

This indicator assesses the amount of emissions generated in the transportation of materials and components. The smaller the amount and the less harmful the waste, the higher the score.

4.6. Waste and emissions generated in the demolition of the building

When a building is demolished, both waste and emissions are generated. The amount of waste can be reduced by properly designing the different components of a building so that they can be reused. The more components can be reused, the less waste and the fewer emissions are generated.

4.6.1. Waste

This indicator assesses the amount of waste generated in the demolition of the building. The smaller the amount and the less harmful the waste, the higher the score.

4.6.2. Emissions

This indicator evaluates the quantity of emissions generated by the demolition of buildings. The lower the quantity and the less harmful they are, the higher the score.

5. Health and quality of life of building occupants

This category evaluates the impact of construction on the health and well-being of building occupants. The impact can be direct or indirect, altering the balance in the ecosystem in certain aspects.

5.1. Emissions harmful to the ecosystem

This indicator evaluates the quantity of emissions that can alter the current balance in the ecosystem. The lower the quantity and the less harmful they are, the higher the score. Altering certain aspects of the ecosystem can cause discomfort or illness in people. For example, the heat emitted in summer by a huge number of aerothermal devices massively installed in the buildings of a city can considerably increase the average temperature in its public spaces, and the level of noise pollution. Carbon dioxide emissions can increase the greenhouse effect and therefore increase the temperature.

5.2. Emissions harmful to human health

This indicator assesses the amount of emissions harmful to human health. The lower the amount and the less harmful they are, the higher the score. For example, formaldehyde emissions from wood derivated panels, finishes and furniture can have a direct impact on people's health.

5.3. Number of illnesses among building occupants

This indicator assesses the number of illnesses associated with a given building, or with different types of buildings within a given area (for example: hospitals, administrative buildings, office buildings, apartment blocks, etc.). The lower the amount and the less harmful they are, the higher the score.

5.4. Well-being of building occupants

This indicator assesses the inconveniences associated with a particular building, or the different types of buildings within a particular area. The smaller the number and the less harmful they are, the higher the score.

6. Economic cost

This category assesses the economic cost of the building throughout its life cycle and of all its components.

6.1. Direct economic cost of building construction

This indicator assesses the direct economic cost of building construction. The lower the cost, the higher the score.

6.2. Indirect economic cost of building construction

This indicator assesses the indirect economic cost of building construction. The lower the cost, the higher the score. An example of indirect economic cost of a building could be its poor design. If a building is poorly designed and its orientation, window location, sun protection, etc. are not taken into account, may force its occupants to install heating or air conditioning systems that, if the building were well designed, they might not need.

6.3. Economic cost of maintaining a building

This indicator evaluates the economic cost of maintaining a building. The lower the cost, the higher the score.

6.3.1. Materials

This indicator evaluates the economic cost of the materials needed to maintain a building. The lower the cost, the higher the score.

6.3.2. Labor

This indicator evaluates the economic cost of the labor needed to maintain a building. The lower the cost, the higher the score.

6.3.3. Technological equipment

This indicator evaluates the economic cost of the technological equipment needed to maintain a building. The lower the cost, the higher the score.

6.3.4. Cleaning

This indicator evaluates the economic cost of the need for regular cleaning of a building. The lower the cost, the higher the score.

6.4. Economic cost of waste and emissions management

This indicator assesses the economic cost of managing waste and emissions generated by a given building. The lower the cost, the higher the score.

6.5. Economic cost of treating illnesses and diseases

This indicator assesses the economic cost of treating illnesses and diseases contracted in a building. The lower the cost, the higher the score.

6.6. Economic cost of a building's depreciation

This indicator assesses the economic cost resulting from a building's temporary depreciation. The lower the depreciation, the higher the score. A building can be economically depreciated over time, for example, due to lack of maintenance, due to the type of users living there, due to the appearance of certain pathologies, etc.

6.7. Economic cost of a building's environment depreciation

This indicator assesses the economic cost resulting from a building's temporary depreciation of its environment. The lower the depreciation, the higher the score. The surroundings of a building may be devalued over time, for example because a nightclub has been built nearby, because noise has increased due to the proliferation of cafes, terraces, etc.

6.8. Speed of construction

This indicator evaluates the economic cost derived from the speed of construction of a building. The faster the execution, the higher the score. The faster a building is built, the cheaper it is, since the interest on capital loans is lower and less nuisance is created in the area.

7. Social suitability

This category evaluates the suitability of a building to the social environment in which it is located.

7.1. Local level of economic development

This indicator evaluates the relationship of the building's construction system and architectural characteristics with the economic development of the environment in which the building is located. The better the relationship, the higher the score. A building made of poor materials (for example, built primarily with adobe) would have little environmental impact if built in a small town in Mexico, since the materials are very common and the labor is very cheap and local. On the other hand, the same building would have a great environmental impact if it were built in New York, since, among other things, the labor required for its continuous maintenance would be very expensive and, in turn, would require the consumption of a large amount of resources and energy.

7.2. Local technological level

This indicator evaluates the relationship between the building's construction system and architectural characteristics in relation to the technological development of the environment in which the building is located. The better the relationship, the higher the score. A high-green building will create a substantially greater environmental impact in a low-green environment than a low-green building and vice versa.

7.3. Local quality preferences

This indicator assesses the relationship between the building's construction system and architectural characteristics and the architectural quality preferences of the environment in which the building is located. The greater the relationship, the higher the score. In each cultural environment there are preferences for a certain type of quality of the components of a building, which will create a certain rejection of other qualities, and this will result in a certain environmental impact.

7.4. Local design preferences

This indicator assesses the relationship between the building's construction system and architectural features and the cultural preferences in the general design of the environment in which the building is located. The greater the relationship, the higher the score. Trying to introduce a design that is very different from the cultural preferences that may exist in a given environment may cause rejection, and this will result in economic increases and certain environmental impacts.

7.5. Local preferences for construction systems

This indicator assesses the relationship between the building's construction system and architectural features and the construction preferences of the environment in which the building is located. The greater the relationship, the higher the score. The local preferences of a certain construction system are the result of an economic balance when exploiting the available resources. If buildings are built that are far from local preferences, a certain social rejection may be achieved, which will result in the waste of certain resources.

7.6. Local type of family unit

This indicator assesses the relationship between the architectural characteristics of the building and the type of family unit in the environment in which the building is located. The greater the relationship, the higher the score. If housing types are built that are not in line with the types of family units in a given environment, this may lead to a certain waste of resources and, as a consequence, an increase in the cost of construction.

8. Complementary sustainable aspects

This category evaluates complementary aspects of sustainability that cannot be classified in any previous category.

8.1. Adaptability to change and flexibility of the building

This indicator evaluates the flexibility of a building to adapt to new uses throughout its useful life, at the lowest possible economic cost and with the least environmental impact. The greater its flexibility, the higher the score. Some buildings, due to their architectural design, adapt more easily to possible changes in use that they may have in the future. In some buildings, certain important changes and transformations must be made to adapt to new uses that were not initially foreseen. These changes inevitably imply a certain energy consumption, resource consumption and waste generation, as well as a substantial economic cost. In contrast, other buildings, due to a special initial design, can adapt very easily to continued unforeseen changes with hardly any environmental or economic impact.

8.2. Social aesthetic appeal of building

This indicator evaluates the visual appeal and architectural quality of a building. The more attractive a building is, the higher the score. A beautiful building will be much more carefully maintained than a less attractive one, and will therefore require less maintenance, and therefore fewer resources, and will have a greater overall durability.

8.3. Ecological regeneration of environment

This indicator assesses the capacity of a building to regenerate its ecological environment. The greater this capacity, the higher the score. A building may have the capacity to regenerate a degraded ecosystem since, depending on its architectural characteristics (occupancy, shape coefficient, landscaping, plant species it includes, etc.), it can help its natural environment to recover ecological factors that deteriorated at some point.

4. Specific weights of CEDES indicators

The CEDES hierarchical structure makes it easier to determine the relative importance of each indicator in relation to the total set, making it easier to assign an appropriate weight. As seen, categories are divided into subcategories. When subcategories cannot be divided, they become indicators, and when they can be divided, they are divided into sub-subcategories. In turn, when sub-subcategories cannot be divided, they become indicators, and when they can be divided, they are divided into indicators.

The result is a set of categories and indicators structured in 4 levels of abstraction and with a perfectly balanced weight. The last column on the right shows the weight of each indicator in relation to the total set of indicators.

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
1. Optimization of resources 18%		0.18			
1.1. Use of natural resources	0.1		0.018		
1.1.1. Water	0.4 * 0.1			0.0072	
1.1.1.1. Rain water	0.6 * 0.4 * 0.1				0.00432
1.1.1.2. Groundwater	0.4 * 0.4 * 0.1				0.00288
1.1.2. Vegetation	0.25 * 0.1			0.0045	
1.1.2.1. Wild vegetation	0.3 * 0.25 * 0.1				0.00135
1.1.2.2. Unprocessed wood	0.4 * 0.25 * 0.1				0.0018
1.1.2.3. Vegetable waste	0.3 * 0.25 * 0.1				0.00135
1.1.3. Soil	0.25 * 0.1			0.0045	
1.1.3.1. Not elaborated stones	0.5 * 0.25 * 0.1				0.00225
1.1.3.2. Soil	0.5 * 0.25 * 0.1				0.00225
1.1.4. Choice of site	0.1 * 0.1			0.0018	
1.1.4.1. Use of not arable land	0.3 * 0.1 * 0.1				0.00054
1.1.4.2. Accessibility	0.3 * 0.1 * 0.1				0.00054
1.1.4.3. Positive impact on the place	0.4 * 0.1 * 0.1				0.00072
1.2. Resource optimization	0.9		0.162		
1.2.1. Amount of resources needed	0.08 * 0.9			0.01296	
1.2.1.1. Resources needed in construction	0.3 * 0.08 * 0.9				0.00388
1.2.1.2. Resources needed throughout the lifecycle of building	0.2 * 0.08 * 0.9				0.00259
1.2.1.3. Resources needed for building maintenance	0.1 * 0.08 * 0.9				0.00129
1.2.1.4. Abundance of resources for component manufacturing	0.4 * 0.08 * 0.9				0.00518
1.2.2. Durability level of components and materials	0.18 * 0.9			0.02916	0.02916
1.2.3. Waste utilization level	0.01 * 0.9			0.01620	0.01620
1.2.4. Reusability of components	0.34 * 0.9			0.05508	
1.2.4.1. Use of previously used components	0.1 * 0.34 * 0.9				0.00550
1.2.4.2. Component reparability level	0.2 * 0.34 * 0.9				0.01101
1.2.4.3. Component reusability level	0.2 * 0.34 * 0.9				0.01101
1.2.4.4. Disassembly level. Reconfigurability and expandability	0.5 * 0.34 * 0.9				0.02754
1.2.5. Component recycling	0.04 * 0.9			0.00648	
1.2.5.1. Use of recycled components	0.25 * 0.04 * 0.9				0.00162
1.2.5.2. Use of recycled grey water	0.25 * 0.04 * 0.9				0.00162
1.2.5.3. Component recycling level	0.5 * 0.04 * 0.9				0.00324
1.2.6. Level of exploitation of resources	0.25			0.045	
1.2.6.1. Refined design	0.6 * 0.25				0.02700
1.2.6.2. Industrialization level	0.4 * 0.25				0.01800
1.2.7. Functional durability of components	0.06			0.01080	0.01080
1.2.8. Functional adaptation of components	0.04			0.00720	0.00720

Weight of *sub-categories* and *indicators*, within the *"optimization of resources" category*

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
2. Reduction in energy consumption 34%		0.34			
2.1. Energy consumption in obtaining materials	0.043		0.01462		0.01462
2.2. Energy consumption in transportation of materials/components	0.022		0.00748		0.00748
2.3. Energy consumption in transportation of labor	0.013		0.00442		0.00442
2.4. Energy consumption in building construction process	0.115		0.03910		0.03910
2.5. Energy consumption by building throughout its lifecycle	0.325		0.1105		
2.5.1. Energy consumption in building accessibility	0.05 * 0.325			0.00552	
2.5.1.1. Accessibility to the area	0.5 * 0.05 * 0.325				0.00276
2.5.1.2. Accessibility to the rooms of the building	0.5 * 0.05 * 0.325				0.00276
2.5.2. Energy consumption by building devices	0.9 * 0.325			0.09945	
2.5.2.1. Heating	0.35 * 0.9 * 0.325				0.03480
2.5.2.2. Air-conditioning	0.35 * 0.9 * 0.325				0.03480
2.5.2.3. Human technological adequacy	0.05 * 0.9 * 0.325				0.00497
2.5.2.4. Ventilation systems	0.05 * 0.9 * 0.325				0.00497
2.5.2.5. Lighting	0.05 * 0.9 * 0.325				0.00497
2.5.2.6. Home appliances	0.1 * 0.9 * 0.325				0.00994
2.5.2.7. Telecommunication systems	0.05 * 0.9 * 0.325				0.00497
2.5.3. Energy consumption in building maintenance	0.05 * 0.325			0.00552	
2.5.3.1. Cleaning	0.3 * 0.05 * 0.325				0.00165
2.5.3.2. Repairs	0.4 * 0.05 * 0.325				0.00221
2.5.3.3. Improvements	0.3 * 0.05 * 0.325				0.00165
2.6. Bioclimatic architectural design	0.458		0.15572		
2.6.1. Location	0.025 * 0.458				0.00389
2.6.2. Correct N-S orientation	0.1 * 0.458				0.01557
2.6.3. Appropriate architectural typology	0.3 * 0.458				0.04671
2.6.4. Efficacy of sun protections	0.1 * 0.458				0.01557
2.6.5. Architectural heating systems	0.1 * 0.458				0.01557
2.6.6. Architectural cooling systems	0.1 * 0.458				0.01557
2.6.7. Proper thermal inertia of building	0.1 * 0.458				0.01557
2.6.8. Proper building insulation	0.1 * 0.458				0.01557
2.6.9. Natural ventilation	0.025 * 0.458				0.00389
2.6.10. Thermal bridges	0.05 * 0.458				0.00778
2.7. Energy consumption in demolishing/disassembling	0.024		0.00816		0.00816

Weight of *sub-categories* and *indicators*, within the *"reduction in energy consumption"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
3. Use of natural energy sources 13%		0.13			
3.1. Solar energy	0.6		0.078		
3.1.1. Thermal solar energy	0.7 * 0.6				0.0546
3.1.2. Photovoltaic solar energy	0.3 * 0.6				0.0234
3.2. Geothermal energy	0.3		0.039		
3.2.1. Geothermal energy without heat pump	0.8 * 0.3				0.0312
3.2.2. Geothermal energy with heat pump	0.2 * 0.3				0.0078
3.3. Renewable energies for the natural ecosystem	0.1		0.013		
3.3.1. Wind power	0.3 * 0.1				0.0039
3.3.1. River and sea energy	0.4 * 0.1				0.0052
3.3.1. Energy from underground sources	0.3 * 0.1				0.0039

Weight of *sub-categories* and *indicators*, within the *"use of natural energy sources"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
4. Reduction of waste and emissions 12%		0.12			
4.1. Waste and emissions generated in obtaining materials	0.2		0.024		
4.1.1. Waste	0.3 * 0.2				0.0072
4.1.2. Emissions	0.7 * 0.2				0.0168
4.2. Waste and emissions generated in manufacturing	0.15		0.018		
4.2.1. Waste	0.2 * 0.15				0.0036
4.2.2. Emissions	0.8 * 0.15				0.0144
4.3. Waste and emissions generated in transport	0.05		0.006		
4.3.1. Waste	0.1 * 0.05				0.0006
4.3.1. Emissions	0.9 * 0.05				0.0054
4.4. Waste and emissions generated in construction process	0.2		0.024		
4.4.1. Waste	0.5 * 0.2				0.0120
4.3.1. Emissions	0.5 * 0.2				0.0120
4.5. Waste and emissions generated in building maintenance	0.2		0.024		
4.4.1. Waste	0.3 * 0.2				0.0072
4.3.1. Emissions	0.7 * 0.2				0.0168
4.6. Waste and emissions generated in demolition of building	0.2		0.024		
4.4.1. Waste	0.9 * 0.2				0.0216
4.3.1. Emissions	0.1 * 0.2				0.0024

Weight of *sub-categories* and *indicators*, within the *"reduction of waste and emissions"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
5. Health and quality of life of building occupants 8%		0.08			
5.1. Harmful emissions to natural ecosystem	0.2		0.0160		0.0160
5.2. Harmful emissions to human health	0.3		0.0240		0.0240
5.3. Number of illnesses of building occupants	0.3		0.0240		0.0240
5.4. Degree of well-being of building occupants	0.2		0.0160		0.0160

Weight of *sub-categories* and *indicators*, within the *"health and quality of life of building occupants"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	*Percentage*	*Category weight*	*Subcat1 weight*	*Subcat2 weight*	*Indicator weight*
6. Economic cost 10%		0.10			
6.1. Direct economic cost in building construction	0.4		0.040		0.040
6.2. Indirect economic cost in building construction	0.05		0.005		0.005
6.3. Economic cost in maintenance	0.2		0.020		
6.3.1. Materials	0.1 * 0.2				0.002
6.3.2. Labor	0.3 * 0.2				0.006
6.3.3. Technological devices	0.3 * 0.2				0.006
6.3.4. Cleaning	0.3 * 0.2				0.006
6.4. Cost of emissions and waste management	0.1		0.010		0.010
6.5. Cost of treating diseases and illnesses	0.05		0.005		0.005
6.6. Economic revaluation of the building	0.05		0.005		0.005
6.7. Economic revaluation of the environment	0.05		0.005		0.005
6.8. Construction speed	0.05		0.005		0.005
6.9. Cost of demolishing/disassembling	0.05		0.005		0.005

Weight of *sub-categories* and *indicators*, within the *"economic cost"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	Percentage	Category weight	Subcat1 weight	Subcat2 weight	Indicator weight
7. Social adequacy ***3%***		0.03			
7.1. Local level of economic development	0.2		0.006		0.006
7.2. Local technological level	0.2		0.006		0.006
7.3. Local quality preferences	0.1		0.003		0.003
7.4. Local design preferences	0.2		0.006		0.006
7.5. Local preferences in construction systems	0.2		0.006		0.006
7.6. Local type of family unit	0.1		0.003		0.003

Weight of *sub-categories* and *indicators*, within the *"social adequacy"* category

Name of the Category, Subcategory 1, Subcategory 2 and Indicator	Percentage	Category weight	Subcat1 weight	Subcat2 weight	Indicator weight
8. Complementary sustainable aspects ***2%***		0.02			
8.1. Adaptability to change and flexibility of the building	0.3		0.006		0.006
8.2. Social aesthetic appeal of building	0.3		0.006		0.006
8.3. Ecological regeneration of environment	0.4		0.008		0.008

Weight of *sub-categories* and *indicators*, within the *"complementary sustainable aspects"* category

5. Final CEDES score

The building evaluator must give a score between 0 and 5 to each of the indicators. This score is then multiplied by the specific weight of each indicator. Then the results of all the indicators are added up for each category. Finally, the results of the different categories are added up and a final score between 0 and 5 is obtained. Multiplying this score by two gives a score on a decimal scale, from 0 to 10.

Category	*score*
1. Optimization of resources	
2. Reduction of energy consumption	
3. Use of natural energy sources	
4. Reduction of waste and emissions	
5. Increase in the quality of life of the occupants	
6. Reduction in economic cost	
7. Social adequacy	
8. Others	
Total (0 - 5)	
(* 2) Total (0 - 10)	

Overall score using CEDES