Estrategia de arquitectura y **construcción sostenible**

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Estrategia de arquitectura y construcción sostenible de la Región de Murcia.

Región de Murcia
Consejería de Fomento e Infraestructuras
Dirección General de Territorio y Arquitectura

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Acronyms and Abbreviations

LCA	Life Cycle Assessment
ACCV	Life Cycle Cost Analysis
AEMA-RM	Association of Environmental Companies of the Region of Murcia
APIRM	Association of Real Estate Developers of the Region of Murcia ARRU Aid for. Regeneration and Urban Renewal
UAI	Innovative Urban Actions
BIM	Building Information Modelling
BRE	Building Research Establishment
BREEAM	Building Research Establishment Environmental Assessment Methodology
CARM	Autonomous Community of the Region of Murcia
EC	European Commission
CES-RM	Economic and Social Council of the Region of Murcia
COAATIEMU	Colegio Oficial de Aparejadores, Arquitectos Técnicos e Ingenieros de la Edificación de la Región de Murcia (Official Association of Quantity Surveyors, Technical Architects and Building Engineers of the Region of Murcia)
COAFMU	Official Association of Property Administrators in the Region of Murcia
COAMU	Official Association of Architects of the Murcia Region
CODID-RM	Official College of Interior Designers and Decorators of the Murcia Region
COIIRM	Official Association of Industrial Engineers of the Region of Murcia
COITIRM	Colegio Oficial de Ingenieros Técnicos Industriales de la Región de Murcia
CONSUMUR	Asociación de Consumidores y Usuarios de la Región de Murcia (Murcia Region Consumers and Users Association)
COP	Conference of the Parties
CROEM	Regional Confederation of Business Organisations of Murcia CTCON Construction Technology Centre
CTE	Technical Building Code
SWOT	Strengths, Weaknesses, Opportunities, Threats and Weaknesses WFD Environmental Product Declarations
EACS	Strategy for Sustainable Architecture and Construction of the Region of Murcia EDUSI Sustainable and Integrated Urban Development Strategy
EESUL	Spanish Strategy for Urban and Local Sustainability
EMAS	Eco-Management and Audit Scheme - Community Regulation on Eco-Management and Audit Scheme
ESECIRM	Circular Economy Strategy of the Region of Murcia
ETSAE	School of Architecture and Building FLC Construction Labour Foundation
WFMRM	Federation of Municipalities of the Region of Murcia
FRECOM	Regional Federation of Construction Employers of Murcia FREMM

Regional Federation of Metal Employers of Murcia

GBC Green Building Council

GBCe	Green Building Council Spain
GBCI	Green Business Certification Inc.
ICIO	Tax on Construction, Installations and Works IDAE
	Institute for Energy Diversification and Saving LEED
	Leadership in Energy & Environmental Design
LER	European Waste List
LOE	Ley de Ordenación de la Edificación
nZEB	Nearly Zero Energy Building, Nearly Zero Energy Demand Buildings
SDGS	Sustainable Development Goals UN
	United Nations
PAREER	Programme of Aid for the Energy Rehabilitation of Existing Buildings
PEMAR	State Framework Plan for Waste
Management PGMO	Plan General Municipal de
Ordenación PHI	Passive House Institute
GDP	Gross Domestic Product
CDW	Construction and Demolition Waste
RIS3MUR	Smart Specialisation Strategy for the Murcia Region
RITE	Regulation on Thermal Installations in Buildings
SUDS	Sustainable Urban Drainage System
UCAM	Catholic University of Murcia
EU	European Union
UPCT	Polytechnic University of Cartagena
USGBC	United States Green Building Council

1. INTRODUCCIÓN: LA CONSTRUCCIÓN SOSTENIBLE

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1. INTRODUCTION: SUSTAINABLE CONSTRUCTION

1.1. The construction process in a circular economy framework

The concept of circular economy emerged in the second half of the 20th century as a desire to resemble the linear industrial production system of design, manufacture, use and end of life to natural cycles, where biological waste serves as raw material for the birth of new species. The oil crises and the rise of environmental movements against the depletion of natural resources such as water and energy inspired a new philosophy based on the transformation of the production chain into a cycle, favouring the reuse and recycling of waste.

In recent years, this concept has gained importance because of its potential for economic, environmental and social development. New product designs, easy to reuse or repair, new products based on secondary raw materials (already used and recycled), new business models based on pay-per-use or rental, new uses of refurbished goods and new recycling and waste recovery techniques have emerged. This leads to the creation of new businesses and new jobs. In addition, the efficient use of products and services increases efforts to maximise the use of natural resources, focusing on the systematic reduction of the subtraction of raw materials and the preservation of the environment. Finally, designs that are easy to use, adaptable to changes in use and integrated into their surroundings increase the well-being of their users and make products and services available to society that achieve greater social benefit at lower economic and environmental cost.

The Ellen MacArthur Foundation defines the Circular Economy under 3 basic principles1:

- Preserving natural resources through the control of finite natural resources and the promotion of renewable flows.
- Optimising the use of resources by ensuring that products, components and materials are kept in the production cycle for the maximum time with maximum utility
- Promote the efficiency of the system, minimising negative external impacts.

The concept of circular economy can and should also be applied to the construction sector, in order to avoid the disappearance of the natural resources it uses that are not renewable and to improve the renewal of those that are. The aim is to encourage the use of these resources as many times as possible within its value chain and to regenerate its production system as efficiently as possible in order to reduce the sector's impact on the environment.

[1] Towards a Circular Economy: Economic Rationale for an Accelerated Transition. Ellen MacArthur Foundation. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Executive_summary_SP.pdf

To this end, the sector must extend its scope of assessment beyond the building, its design, construction and use; and integrate the manufacture and recycling of building materials, the design of new building systems and proper urban planning.

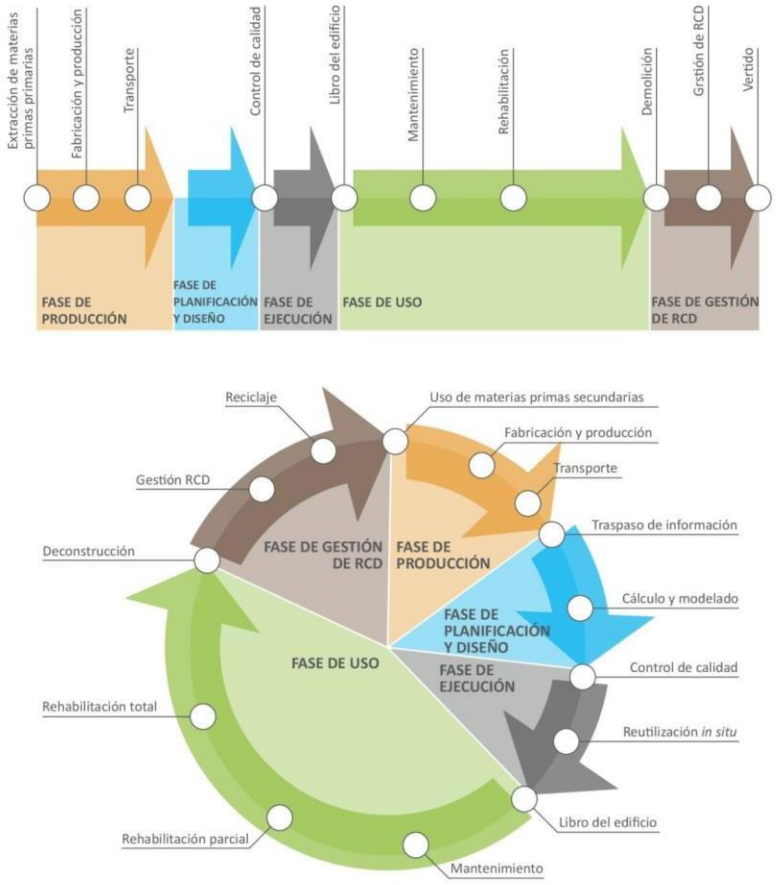

Figure 1. Comparison between linear and circular construction models.
Source: *Green Building Council Europe*

According to the Green Building Council Europe, the construction sector in the European Union represents 2:

- 40% of final energy consumption
- 35% of greenhouse gas emissions
- 50% of all extracted materials
- 30% of water consumption
- 35% of the total amount of waste generated

[2] Circular Economy in the Construction Sector. Working Group WG-6. National Environment Congress 2018. Conama Foundation. http://www.conama.org/conama/download/files/conama2018/GTs%202018/6_final.pdf

- 54% of demolition materials are sent to landfill, although there are significant differences between states (in some countries only 6% are sent to landfill).
- Building produces 71% of the construction and demolition waste produced.
  compared to 29% for civil works

It is therefore necessary to change this trend by promoting circularity in the sector, reducing energy and water needs, carbon emissions and the extraction of raw materials, encouraging efficient waste management leading to the use of recycled materials, promoting designs that use secondary raw materials, both from materials and from other buildings, and generating a culture of efficiency in the use of materials and resources, flexible design for new uses, easily repairable and dismountable.

The increasing use of energy efficiency mechanisms, the trend towards near zero-energy buildings and the systematic reduction of CO_2 emissions are leading to ever greener and more sustainable buildings. The integration of the circular economy concept into the design process is a further step forward, a further advance on previous experience. The general trend towards the design of buildings that minimise waste throughout their life cycle, *non-waste* architecture, draws on these previous concepts and applies a more global vision to them, where sustainability analysis must cover all links in the value chain and convert the phases of the building process into a circular scheme.

Figure 2. Renovation of the Grand Parc building in Bordeaux. Architects Lacaton & Vassal

1.2. Analysis of the building process

It has been considered appropriate to frame the analysis in five thematic stages. The first four correspond to the phases established in the sustainability analysis methodology commonly used in the assessment of the environmental performance of buildings (UNE-EN 15978). A fifth cross-cutting category has been added, called Sustainable City, which includes aspects related to the treatment of urban spaces and urban planning.

Figure 3. Phases of the building life cycle according to UNE-EN 159783. Own elaboration

In this whole process, the architectural project acquires special relevance: the integration of the construction in a given environment, the design of the necessary volumes, the distribution of uses in them, the selection of construction materials including, of course, their specifications and construction techniques, the forecast and calculation of installations, both inside and outside the building, the cost estimate, more or less precise, and the justification of compliance with the obligatory regulations. It is at the moment of the design of the building or urban planning that many aspects are defined that will later lead to greater or lesser sustainability in the different phases mentioned above. In this sense, the analysis of the building's life cycle, carried out in its most conceptual phase, will be a valid tool for estimating a priori the degree of sustainability of a building. The application of new modelling and information management methodologies (such as BIM methodology) to the architectural project facilitates its role as an essential tool for improving the sustainability of the resulting building.

1.2.1. Product Phase

The circular economy model takes particular account of the use of raw materials. and their maintenance over time in value chains. This phase includes the use of

[3] Standard UNE-EN 15978 on sustainability in construction. https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma?c=N0049397

raw materials, their transport to the building materials factory and their processing.
manufacturing. It can be divided into three parts: raw material supply, transport and manufacturing.

1.2.2. Construction Process Phase

This is the phase that covers the processes from the factory gate of the various materials to the completion of the construction site, including the transport of construction-ready materials, services and equipment to the construction site. It can be divided into two parts: transport and construction-installation.

In this phase, different actors involved in the construction of a building come into play: promoters, responsible technicians, construction companies, material suppliers, installers, etc. The role of waste managers starts to become important at this stage, as do the public administrations as the bodies ultimately responsible for the control of the works.

This phase also includes work on the site (earthworks, gardening, etc.), storage and transport of materials within the site, the necessary temporary installations and structures, the construction of building elements, the installation of heating, cooling, ventilation, renewable energy, water and sanitation equipment, etc. and the management of waste produced on site.

The use of water and energy during the construction phase also has an impact on the sustainability of the building.

1.2.3. Use Phase

This is the phase that covers the time period from the practical completion of the construction work to the moment when its useful life ends and its deconstruction or demolition takes place. It involves maintenance, repair and cleaning, energy use and water use in service. The building's installations (heating, cooling, ventilation, water, lighting, safety, security, sanitation, etc.) are relevant here, as their correct functioning will have an impact on the sustainability of the building in its life cycle.

Once the building has been completed, periodic interventions are necessary to ensure its good condition while it is in use. These interventions occur during this phase and may include, among others, the improvement of installations, the repair of façades, the reinforcement of foundations, the technical inspections required by current regulations, the adaptation of spaces to new uses, the complete refurbishment of the building, etc.

It can be divided into seven actions:

1. Building use (excluding energy and water use). Refers to compliance with the expected normal conditions of use.

2. Maintenance of the building and its installations. This includes not only the functional and technical maintenance of the building, but also improvements to the appearance and aesthetic properties of its materials (painting, cleaning, etc.).
3. Repairs. A distinction is made here between operations which repair part of the elements that do not function in the building, without replacing entire elements, but only in part.
4. Replacement of components. These are usually replacements of floors, ceilings, windows, etc. in their entirety.
5. Refurbishment. This sub-phase includes the construction of new elements to improve part of the building. A distinction is usually made between a comprehensive refurbishment (which includes structural and functional adaptations, extension of spaces and change of typology of use) and a partial refurbishment (which does not cover all these interventions). These changes usually extend the useful life of the building significantly.
6. Energy used by the technical systems integrated in the building. A building must have access to energy resources that cover its needs for heating, hot water supply, air-conditioning, ventilation, lighting, energy production systems, etc.
7. Water consumption. A building uses water for consumption, sanitation, irrigation, heating and cooling systems. In addition, it can be extremely necessary for specific installations such as swimming pools, fountains, etc.

1.2.4. End-of-life phase

This phase begins when it is decided that a building cannot house or serve its users, either due to a legal imperative that considers that it presents a structural danger, a loss of habitability in its spaces, lack of minimum services, etc. or for economic reasons, as it is more profitable to eliminate the building than to recover it.

It includes from the demolition project to the management of the waste generated. It would include the organisation of the "dismantling" of the building: defining the steps to be taken, analysing the state of the adjoining constructions, in order to avoid damage, and the construction methods used, making an inventory of the elements that can be recycled, accounting for the necessary resources and their cost. In addition, it would include all the necessary actions for the reuse and recycling as secondary raw material of the waste resulting from the deconstruction process.

It can be divided into four parts:

1. Deconstruction. These include the operations of dismantling, dismantling and demolition of the different parts of the building. They are limited to those carried out on the site of the building.
2. Transport. All transport of building materials has an impact on the sustainability of the

building unless certain materials can be reused on site. In this phase

The type of transport used, the distance travelled and the fuel used also play a role. employee.

3. Treatment for reuse, recycling and energy recovery. All deconstruction, dismantling or demolition debris, materials used for maintenance, repair, replacement or rehabilitation, all rubble, all materials, elements and products used in the construction of the building are considered waste once they leave the building itself. They cease to be considered as such if they meet the following conditions4:

   - the recovered material has a specific use,
   - there is demand for that material in that use, resulting in economic benefits,
   - complies with the regulations and technical requirements for use,
   - does not have a negative impact on the environment and human health.

   In short, the recovery of the deconstruction remains of a building should only be undertaken if it is technically and economically feasible.

4. Final landfill. Processes related to the treatment of landfilled waste reduce the level of sustainability of a building. These processes can be incineration, landfill storage (backfilling spaces prepared for landfill), energy recovery (biogas production), etc.

1.2.5. Sustainable city

Buildings are not isolated, they must be integrated into the place where they are located. It is not possible to speak of a sustainable construction model without taking into account the city model. Adequate urban planning is therefore required to support a more sustainable city model that favours this new building paradigm.

This is why this transversal phase is defined, which would cover everything from the relationship of the building with the surrounding public space to general planning. It would include the efficient distribution of urban uses, the integrated management of the necessary resources, the promotion of green infrastructures, sustainable mobility and other strategies for adapting to climate change, the rehabilitation of historic areas, the regeneration of degraded spaces, the search for new uses for abandoned buildings, etc.

[4] Law 22/2011 of 28 July 2011 on waste and contaminated land. https://www.boe.es/buscar/act.php?id=BOE-A-2011-13046

1.2.6. The architectural project

At the origin of any construction process is the architectural project, a document that should not be limited to the mere design of a building before it is built, but should also be a creative phase in which the design itself responds to the site, the climate, allows the choice of the most appropriate materials, describes the conditions for dismantling at the end of its useful life, selects the most efficient and environmentally friendly installations, etc. To this end, the architect has at his disposal appropriate simulation tools that allow him to assess the degree of sustainability of the building that is the object of the project. In this sense, the certifications described in section 1.4 can be a great help.

1.2.7. Methodologies for modelling and information management of the construction process.

The building process is in full evolution with the use of new methodologies that allow the modelling and management of all the information related to materials and equipment, including their impact on the environment through a life cycle analysis. Numerous simulation tools are already available, although the most commonly used only provide information on the building's energy demand and consumption. However, other types of tools will be necessary to assess the level of sustainability of the building and are already used to obtain some of the certifications described in section 1.4.

But there is no doubt that the real revolution is based on information management. In this sense, the BIM (*Building Information Modelling*) methodology acquires a relevant importance to approach the construction process from the perspective of sustainability. It is a working methodology that allows the integral management of construction projects, in all their phases and during the complete life cycle of the building, by means of virtual models and in a collaborative manner between the different agents involved. In other words, it constitutes a structured work procedure that gathers information on materials, equipment and even construction processes in an orderly manner, constituting a single information model of the building through the use and collaboration of all disciplines, to create a complete database with graphic and technical information on all the elements present. Among the benefits it provides, we can highlight:

- Share all building-related information in a single data model
- It integrates all the disciplines involved in the life cycle of the building, from the conceptual until the end of its useful life
- Enables continuous improvement of work processes
- Facilitates the detection and resolution of interferences between disciplines
- Streamlines budgeting and measuring with greater accuracy
- 3D Modelling and Visualisation

1.3. Standards for assessing the level of sustainability of buildings

In recent years, the use of standards to assess the degree of sustainability of both new buildings and the refurbishment of existing buildings has begun to spread. Most of these standards are based on the UNE-EN 15978 standard, which analyses sustainability in construction and establishes the criteria for assessing its environmental performance, as a reference for the building process. Furthermore, the European Commission, aware of the need to move towards more sustainable building models, proposes, through the Level(s) initiative, a set of reference indicators capable of assessing the degree of sustainability of a building. These indicators are already being incorporated into some of the standards described below.

These standards are valid tools for assessing criteria such as energy use (conventional or renewable), water management and use, use of materials (recycled or virgin), land use, impact on the indoor and outdoor environment, and even social and economic aspects. The evaluation of these criteria is contrasted with reference values, giving rise to a certain score that allows the building to be catalogued.

1.3.1. Standard UNE-EN 15978

The UNE-EN 15978:2012 standard "Sustainability in construction. Assessment of the environmental performance of buildings. Calculation methods "[5] aims to provide a method for assessing the environmental performance of a building. It is part of a wider set of standards that establish a framework for assessing sustainability in building, both in environmental, social and economic aspects (UNE-EN 15643-1, 2, 3 and [46]). Its calculation method is based on the life cycle analysis (LCA) of the building, covering each of its phases. It can be applied to new buildings, existing buildings or renovation projects and aims to support the decision-making process to improve the sustainability of buildings.

The life cycle analysis is based on the information contained in the Environmental Product Declarations (EPD), a standardised document that provides quantified data on the environmental performance of a product, also based on the LCA, in accordance with the UNE-EN 158047 standard.

[5] UNE EN 15978:2012. Sustainability in construction. Assessment of the environmental performance of buildings. https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma?c=N0049397
[6] UNE-EN 15643-1:2012. Sustainability in construction. Assessment of the sustainability of buildings. https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma/?c=N0050349
[7] UNE-EN 15804:2012+A1:2014. Sustainability in construction. Environmental product declarations. Basic product category rules for construction products. https://www.une.org/encuentra-tu-norma/busca-tu-norma/norma/?c=N0052571

Methodology proposed by the UNE-EN 15978 standard.

The standard defines a number of criteria to specify:

- The purpose of the evaluation.
- The different scenarios or phases within the life cycle of the building, delimiting their duration and the elements to which the rule does not need to be applied.
- The procedure for collecting and quantifying the information needed to perform the calculations. necessary.
- The definition of the different indicators and their calculation method.
- The requirements for reporting evaluation results.

In addition, it differentiates 4 categories of indicators: environmental impact, resource use, waste generation and outflows, which, in turn, are to be classified into the four phases of the building process mentioned above.

	IMPACTO AMBIENTAL	USO DE RECURSOS	RESIDUOS GENERADOS	FLUJOS DE SALIDA
FASE DE PRODUCTO	• Calentamiento global • Ocupación del suelo • Afección de hábitats • Sellado del suelo	• Uso de energía (renovable y no renovable) • Materiales basados en materias primas vírgenes y secundarias • Consumo de agua	• residuos peligrosos, no peligrosos y radioactivos • Residuos no peligrosos y radioactivos • Residuos tóxicos y radioactivos	• Materiales para reutilización • Materiales para reciclaje • Materiales para valorización energética • Energía exportada
FASE DE CONSTRUCCIÓN				
FASE DE USO				
FASE DE FIN DE VIDA				

Figure 4. Examples of indicators classified into categories according to the UNE-EN 15978 standard. Own elaboration

1.3.2. Assessment framework Level(s)

Level(s)[8] is a common framework designed in 2017 by the European Commission and several European key stakeholder groups such as GBCe, Saint Gobain, or the Sustainable Building Alliance. It aims to assess the impact of buildings on the sustainability of their environment. It is voluntary and applies to residential and office buildings. It is based on existing environmental and sustainability norms and certification standards. It has recently completed its testing phase by independent professionals, companies and public administrations. The final version of the framework will be ready by summer 2020.

[8] Building sustainability performance - Level(s). https://ec.europa.eu/environment//eussd/buildings.htm

Level(s) defines a set of indicators and tools and a common terminology for assessing the environmental impact of buildings, the well-being of their users, the cost and risks of their future performance. The proposed framework is structured into:

- 6 macro-objectives reflecting such important aspects as energy, efficient use of materials, waste management, water and indoor air quality.
- 9 core indicators, to measure the performance of the building and its contribution to the 6 macro-objectives.
- 4 tools that facilitate the application of life cycle analysis to building performance.
- A system of checklists to qualify future scenarios, risks, costs and value information for property valuation.

It should be noted that this assessment framework aims to apply a more general approach that incorporates the analysis of building performance into the LCA and LCA (Life Cycle Cost Analysis) tools that already study the sustainability of products and processes in other economic sectors. It is applied in all phases of building design, implementation, commissioning and operation, and also provides information for property valuation and investment appraisal.

Methodology proposed by the evaluation framework Level(s)

The six Level(s) macro-objectives structure the entire assessment framework, from indicators to tools for LCA, cost and risk analysis:

1. Greenhouse gas emissions during the life cycle of a building. Minimise the total volume of greenhouse gas emissions during the life cycle of a building, from cradle to cradle, paying particular attention to emissions from energy consumption during the operation of the building.

Indicators: 1.1 Energy efficiency in the use phase (kWh/m2/year).
1.1.1. Primary energy demand
1.1.2. Energy demand supplied
1.2 Global Warming Potential over the life cycle (equivalent of $_{CO2/m}$ /year)

2. Circular and resource-efficient material life cycle. Optimise building design, engineering and form to contribute to a simple, circular flow, extend the long-term usefulness of materials and reduce significant environmental impacts.

Tools: 2.1 Life Cycle Tool: List of Construction Materials (kg)
2.2 Life Cycle Tools: Life Cycle Scenarios, Adaptability and Deconstruction
Indicators: 2.3 Construction and demolition waste and materials (kg/m2).

3. Efficient use of water resources. Use water resources efficiently, especially in areas with long-term or projected water stress.

Indicators: 3.1 Water consumption in the use phase (m3/occupant/year).
General assessment tool:
2.4 Life Cycle Tool: Cradle-to-Cradle Life Cycle Assessment (LCA) (impact/m2/year)

4. Healthy and comfortable spaces. Creating buildings that are comfortable, attractive and productive to live and work in, and that protect people's health.

Indicators: 4.1 Indoor air quality
4.2 Time outside the thermal comfort margin

5. Adaptation and resilience to climate change. Preparing the performance of buildings to cope with projected future climate change, in order to protect the health and well-being of occupants and to curb and minimise risks to the value of the property.

Tools: 5.1 Lifecycle tools

6. Optimising life cycle cost and value. Optimising the life-cycle cost and value of buildings to reflect the potential for improved long-term performance, including acquisition, operation, maintenance, refurbishment, disposal and end-of-life.

Indicators: 6 .1 Life Cycle Cost (EUR/m²/year)
6.2 Value creation and risk factors

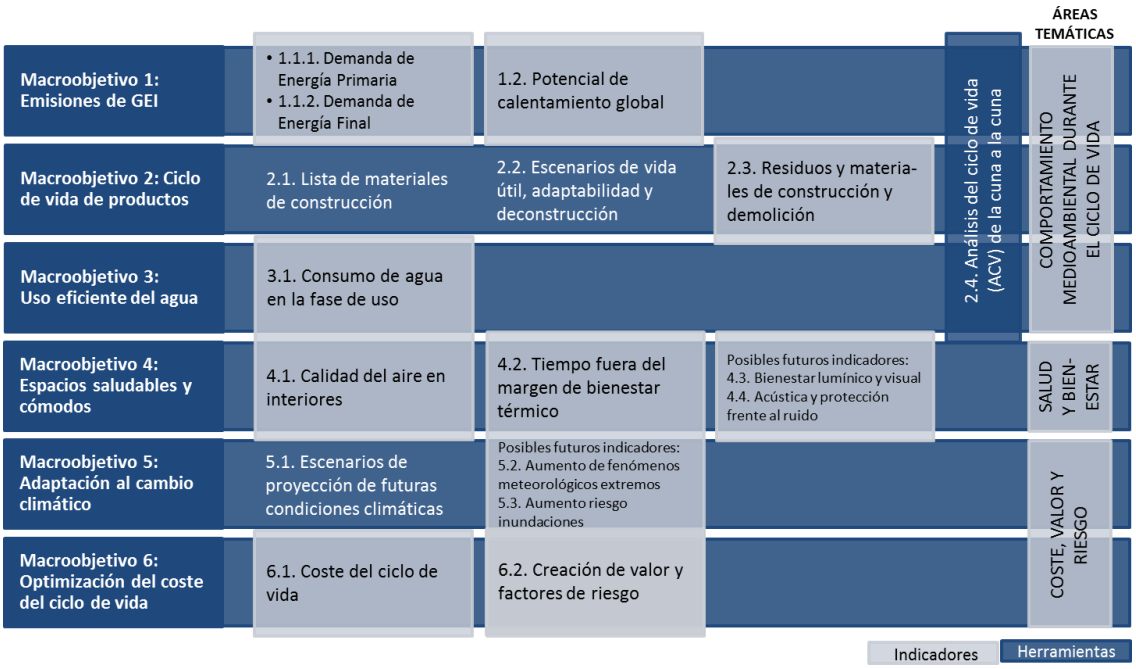

Figure 5. Overview of the Level(s) framework. Own elaboration

1.3.3. GREEN Certification

This is a set of tools9 that seeks to assess the sustainability of a building through a methodology based on the assimilation of the building process to the different phases of life cycle analysis. It has been created by the state association *Green Building Council España* GBCe, which belongs to the international association *World GBC*. It has important research centres, public administrations and companies among its associates.

To define this assessment, it takes as a basis different UNE-EN standards such as UNE-EN 15643 or UNE-EN 15978, but establishing more specific criteria that are adapted to the different types of buildings. These criteria and their corresponding calculation tools are developed for residential buildings, facilities and industrial estates; both new and existing buildings and those undergoing refurbishment. It also makes reference to the energy, accessibility, etc. sections of the Technical Building Code, a mandatory regulation.

Methodology proposed by VERDE certification

The VERDE tool assesses the sustainability of the buildings it certifies with around 38 criteria or indicators, which are grouped into between 5 and 8 categories. Each category is assigned a weighting according to its relation to the impacts defined by the UNE-EN 15643 family of standards, which, as mentioned above, is based on a set of criteria that are defined by the
discussed above, set the framework for assessing sustainability in construction.

In addition, the weighting of each criterion is assessed and the benefit obtained is calculated for those that the rule that
The impact on the other impacts it considers positive, such as accessibility, life-cycle cost savings, etc., as well as the avoided damage on the other impacts it considers negative, such as emissions to air, the depletion of non-renewable energy, generation of waste, etc.

the final score is given graphically, with the building being awarded 1 to 5 leaves according to the percentage of compliance with the criteria (5 being the best design at the lowest cost).

https://gbce.es/certificacion-verde/

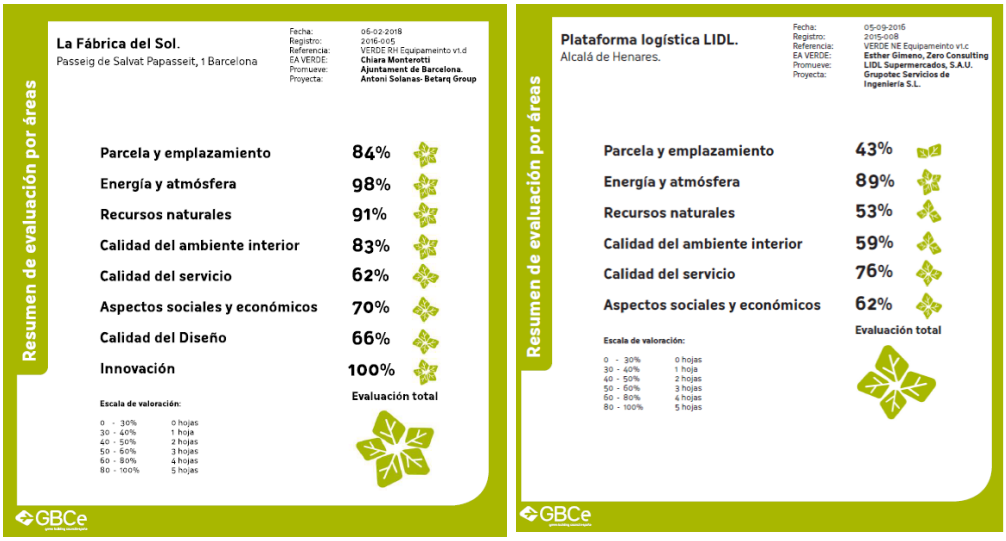

Figure 6. Example of a certificate with the Green Tool

1.3.4. LEED Certification

LEED10 (*Leadership in Energy & Environmental Design*) is a certification system created by the United States *Green Building Council* (USGBC), founded in 1993 by around 60 private and public organisations interested in promoting sustainable practices in the building sector. It was designed in 2000 as a sustainability rating system for buildings. It is a voluntary, independent certification, supported by the international construction industry, which is not dependent on any public administration or based on its rules or regulations.

Green Business Certification Inc. (GBCI) is the USGBC subsidiary that has taken over the administration of LEED certification for all registered office, commercial, residential and institutional buildings worldwide, although the certificates are awarded by the USGBC. In Spain, LEED certification is administered by the *Spain Green Building Council11*.

Figure 7. Seals corresponding to the four levels of LEED certification

https://new.usgbc.org/leed
http://www.spaingbc.org/web/

Methodology proposed by LEED certification

The LEED system introduces an integrative approach to the certification process as it requires the formation of a team that includes from the property and the main architect, to all technicians involved in the design of facilities, land planning, etc., depending on the type of project.
type of project. This is how sustainable construction strategies are effectively achieved.
be considered from the conceptual phase in the building development cycle.

From the outset, developers, architects, engineering firms, landscape architects, consultants, different types of contractors, asset and property managers, and sustainability and sustainability advisors.
LEED certification will work in unison to achieve the level and credits that the building will achieve after successful construction.

Each type of certification establishes mandatory prerequisites for LEED certification, as well as criteria on the basis of which a certain score is obtained, depending on the chosen sustainability strategies. Thus, there is an extensive list of criteria for each type of certification, grouped into categories, from which the project team can choose the ones that best suit their needs.
and what score to obtain for each. The number of points obtained defines the level of certification awarded by USGBC (green, silver, gold or platinum).

1.3.5. BREEAM Certification

BREEAM12 (*Building Research Establishment Environmental Assessment Methodology*) is a method for assessing and certifying the sustainability of urban plans, infrastructures and buildings. It has been developed by the BRE Group (*Building Research Establishment*), an independent, private, non-profit British organisation with almost 100 years of experience. It was the first organisation created in the world for this purpose.

The management of the BREEAM certificate in each country is assigned to a national operator, officially appointed by the BRE Group. In Spain, this assignment falls to the Fundación Instituto Tecnológico de Galicia, which has adapted the BREEAM methodology to the regulations and construction practice in our country.

http://www.breeam.es/

Methodology proposed by BREAM certification

The following certification standards are currently available in Spain, applicable to any building typology and fully adapted to the local language, regulations and construction practice:

- BREEAM Commercial, office buildings, industry and commerce.
- Housing, single-family dwellings and blocks of flats.
- Bespoke, for any building not included in the commercial and residential schemes.
- In Use, applicable to existing buildings.
- BREEAM Urbanism, for urban developments.

The BREEAM ES scheme assesses the sustainability of a building according to a series of categories: management, health and wellbeing, energy, transport, water, materials, waste, land use, and ecology, pollution, innovation, etc. Each category has different requirements and each requirement defines an objective related to the sustainability of the building and evaluation criteria that must be fulfilled in order to obtain points, establishing the maximum achievable score. In addition, each category has a specific weighting in relation to an overall score.

The choice of requirements is flexible, i.e. the promoter and the technical team can choose which requirements in each category they want to achieve. However, there are minimum requirements that must always be met.
depending on the ranking achieved. In addition, there is the option to earn points
extraordinary if the building includes innovative solutions that go beyond best practice.
usual.

Depending on the score assigned, the building is given a classification, which makes it easier to compare with other buildings. buildings:

- Exceptional, if you score more than 85 points
- Excellent, between 70 and 84 points
- Very good, between 55 and 69 points
- Good, between 45 and 54 points
- Correct, between 30 and 44 points.

Buildings that score less than 30 points are not certified. The process is carried out in two phases: Design phase (FD), which provides a provisional certificate and Post Construction phase (FPC), which provides a final certificate. This final certificate has an expiry date. Once expired, it can be renewed under the BREEAM ES In Use standard.

Figure 8. Example of BREAM EN certificate

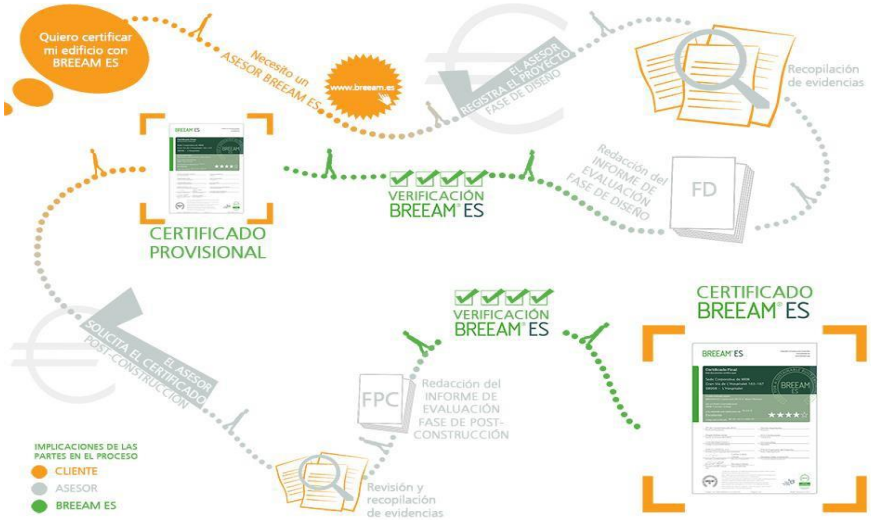

Figure 9. BREAM ES certification process

1.3.6. Passive House

The *Passive House*[13] standard (*Passivhaus* in German and Casa Pasiva in Spanish) allows buildings to reduce their energy needs by 75% compared to traditional constructions. This reduction is mainly achieved through passive solutions such as perfect insulation of spaces, the correct orientation of windows and the design of protection against

[13] https://passivehouse.com/

excessive sunlight. This results in a more energy-efficient, comfortable and comfortable building. for its users and affordable, as it implements solutions with a positive cost-benefit balance.

The *Passive House Institute* (PHI), a private research organisation founded in Germany in 1996, is responsible for promoting the standard, developing the necessary tools and certifying compliance with the standards to developers upon request. In addition, it awards the title of certifier to those professionals who have sufficient experience in this certification, have received specific PHI training and have passed an international examination. PHI offers courses to improve knowledge of the standard from the level of designer, to energy expert, calculation software expert, *Passive House* trainer, etc. Many of these courses lead to the award of a specialist certificate.

Methodology proposed by *Passive House* certification

All *Passive House* certified buildings must meet the following requirements:

- Heating and cooling demand less than 15 kWh/m2 per year
- Primary energy demand (heating, hot water and electricity) less than 120 kWh/m2 per year
- Airtightness less than 0.6 air changes per hour

In addition to the Passive House certificate, there are others that are adapted to those buildings that, although they have a good energy performance, will not be able to reach the proposed minimum for structural reasons, location, etc. For this, PHI has defined the following certifications: EnerPHit, EnerPHit+i and PHI Building.

The program extracts as output a table with the values of key parameters, such as:

- Calculation of the transmittance (U) of building elements
- Surfaces exposed to radiation
- Dimensioning of ventilation systems
- Heating demand
- Solar contribution to DHW production

Sello Casa Pasiva **Sello EnerPHit** **Sello EnerPHit+i (para edificios con aislamiento interior en su mayoría)**

Sello PHI Edificio de baja demanda energética

Figure 10. Different seals offered by the *Passive House* standard

2. MARCO ESTRATÉGICO Y DE REFERENCIA

eacs

Estrategia de arquitectura y construcción sostenible de la Región de Murcia.

/Regionof M urcia
Consejeria de ento e Infraestructuras
Directorate-General for Territory and A itecture

2. STRATEGIC FRAMEWORK AND REFERENCE FRAMEWORK

2.1. The 2030 Agenda and Sustainable Development Goals

In 2000, the United Nations launched an initiative to tackle global poverty through the Millennium Development Goals14 , which spurred progress in key areas such as reducing income poverty, providing access to water and sanitation, reducing child mortality and improving maternal health. The Millennium Development Goals are the precursors to the Sustainable Development Goals15 (SDGs), which aim to create a set of global goals related to the environmental, political and economic challenges we must overcome. This path was initiated at the Rio de Janeiro Sustainable Development Conference in 2012.

Seventeen goals have been defined, which are interrelated, with the success of one affecting the success of the others. Action on climate change has consequences for the management of natural resources; social, health and gender improvements contribute to the fight against poverty; and the reduction of social inequalities will encourage economies to prosper, jointly contributing to the improvement of the quality of life of future generations. This is why they need to be addressed and tackled as a whole and at a global level, with the support of all countries.

The document that brings together the SDGs is the so-called **2030 Agenda**, which since 2016 has been guiding countries' efforts to achieve a sustainable world by 2030.

The SDGs, like many other UN initiatives, are not mandatorily assumed by countries, but are adopted by governments as their own, and they must establish measures at the national level to achieve them. It is therefore the responsibility of the countries themselves to monitor the results of their implementation.

In line with the achievement of the goals set by the 2030 Agenda, other landmark agreements were enacted at the same time as the SDGs. The Paris Agreement, adopted at the Climate Change Conference (COP21), and the Sendai Framework for Disaster Risk Reduction, both in 2015, provide workable standards and targets for reducing greenhouse gas emissions, containing risks associated with natural disasters and climate change.

The SDGs, which embrace issues that affect all of humanity in an ambitious manner, seeking to creating a more sustainable, secure and prosperous planet, are as follows:

1. The end of poverty
2. Zero hunger
3. Health and well-being

https://www.undp.org/content/undp/es/home/sdgoverview/mdg_goals.html
https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/

4. Quality education
5. Gender equality
6. Clean water and sanitation
7. Affordable and clean energy
8. Decent work and economic growth
9. Industry, innovation and infrastructure
10. Reducing inequalities
11. Sustainable cities and communities
12. Responsible production and consumption
13. Climate action
14. Underwater life
15. Life of terrestrial ecosystems
16. Peace, justice and strong institutions
17. Partnerships to achieve the objectives

Figure 11. Sustainable Development Goals (SDGs). Source: UN

The SDGs are related to sustainable construction in a global sense, as they pursue the overall sustainability of human and social systems, available resources and ecosystems. However, they are especially linked to *Goal 6: Clean water and sanitation*, as the availability of quality drinking water is a major problem that is not only a major issue but also a major challenge.

is afflicting all continents, and both drinking water supply and sanitation benefit from sustainable construction.

Similarly, *objective 7: Affordable and clean energy* is at the core of sustainable buildings, as dependence on fossil fuels is global and it is necessary to develop more efficient energy standards that reduce the consumption of this resource in all phases of the building process, from the construction phase to the use and subsequent deconstruction.

Goal 11: Sustainable cities and communities is also critical, as more than half of the world's population now lives in urban areas. And by 2050, that figure will rise to two-thirds of humanity, or 6.5 billion people. Sustainable development cannot be achieved without radically transforming the way we plan, build and manage urban spaces. Cities, which are becoming ever larger due to population growth, are turning into mega-cities with sprawling neighbourhoods and creating deprived neighbourhoods, where action is needed to ensure access to quality, safe and affordable housing, the necessary services, public transport, green spaces, etc.

Goal 12: Responsible production and consumption, is related to the circularity of the consumption model. In order to achieve economic growth and sustainable development, it is urgent to reduce the ecological footprint by changing the methods of production and consumption of goods and resources, including those related to buildings.

Finally, sustainable building models contribute to *Goal 13: Climate Action*, which aims to mitigate climate change and adapt our cities to the impacts of climate events that are already occurring.

Figure 12. Sustainable development goals most relevant to sustainable architecture and construction

2.2. European reference framework

2.2.1. The European Urban Agenda

The European Union (EU) has a well-established position in the field of sustainable development and has committed, together with its member states, to implement the United Nations 2030 Agenda for Sustainable Development.

It was one of the pioneers in its application. Similarly, the EU has made an effort in recent decades to define and promote the urban dimension of European policies, through various initiatives framed within the framework of sustainable urban development. This process, which has gone through various declarations, the summary of which is set out below, has finally resulted in the European Urban Agenda.

Background to the European Urban Agenda

Leipzig Charter on Sustainable European Cities and Towns (2007)[16]

It established the objectives and values to be pursued by European cities, advocating the promotion of integrated urban development policies that include social, efficiency, quality of life, etc. aspects. This document paid special attention to the less favoured neighbourhoods, which are becoming increasingly important in large cities, producing the phenomenon of
associated with the creation of ghettos.

Marseille Declaration (2008)[17]

It highlights and emphasises the importance of climate change, and marks the beginning of the development of a European Reference Framework for Sustainable Cities. This framework is born as an operational tool at the disposal of European cities interested in implementing sustainability objectives. and the integrated approach proposed in the Leipzig Charter, through a web-based tool18.

Toledo Declaration (2010)[19]

It gave impetus to Integrated Urban Regeneration. European urban development must not forget the importance of intervention on the existing city. This declaration stands out for putting the focus of urban development on the integrated regeneration of already consolidated cities, the revitalisation and rehabilitation of neighbourhoods and their residential stock, as a basis for a more inclusive development,
smart and sustainable. The text is accompanied by a Background Paper, which provides a valuable added value by addressing integrated urban regeneration from the environmental, economic, social, architectural, cultural, urban planning and governance perspectives, while providing key elements for the implementation of valid operational tools for the development of the proposed integrated approach.

https://www.fomento.gob.es/portal-del-suelo-y-politicas-urbanas/otros-proyectos-y-actividades/agenda-urbana-europea/la-carta-de-leipzig-2007-sobre-sustainable-european-cities

https://www.fomento.gob.es/portal-del-suelo-y-politicas-urbanas/otros-proyectos-y-actividades/agenda-urbana-europea/la-declaracion-de-marsella-2008-y-the-european-reference-framework-for-the-sustainable-city

http://www.fomentotransporte.es/MFOM/LANG_CASTELLANO/DIRECCIONES_GENERALES/ARQ_VIVIENDA/SUELO_Y_POLITICAS/SOTENIBILIDAD/RFSC/

https://www.fomento.gob.es/portal-del-suelo-y-politicas-urbanas/otros-proyectos-y-actividades/agenda-urbana-europea/la-declaracion-de-toledo-2010-y-el-impulso-a-la-regeneracion-urbana-integrada

Riga Declaration (2015)[20]

This declaration establishes, as one of the common European priorities, the importance of the areas small and medium-sized urban cities. These cities, in terms of spatial development, have a large potential and need to be taken into account in order to achieve European objectives.

Pact of Amsterdam (2016)[21]

It involves defining the elements, principles and operational framework of the Union's Urban Agenda.

The European Union Urban Agenda22 is born in 2019 to drive forward a set of actions designed to develop the full potential of urban areas, boosting their contribution to the achievement of common objectives for EU development. Its main objective is to strengthen the urban dimension, and to translate this strengthening from the EU institutions to national policies, cities and other stakeholders, with a multi-level governance approach for all of them to work together.

The fundamental principles governing the EU Urban Agenda are inherited from previous declarations and documents that have been worked on in recent years, as summarised in Figure 13.

Figure 13. Fundamental principles of the European Urban Agenda

The European Urban Agenda is implemented through partnerships, with each partnership working on one of the twelve priority themes selected. These partnerships work on each theme and are

[20] https://www.fomento.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/actividad-internacional/union-europea/la-declaracion-de-riga-2015

[21] https://www.fomento.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/actividad-internacional/union-europea/el-pacto-de-amsterdam-2016-y-declaracion-de-bucarest-2019

https://ec.europa.eu/info/eu-regional-and-urban-development/topics/cities-and-urban-development/urban-agenda-eu_es

The European Urban Agenda is composed of between 15 and 20 stakeholders through multi-level governance, working as equals to address the agenda's priorities. The twelve priorities set by the European Urban Agenda are depicted in Figure 14. These priorities have been successfully translated into European cohesion and territorial development policies, through initiatives such as the Sustainable and Integrated Urban Development Strategies (SUDS), the Urban Innovative Actions (UAI) or the Urbact Initiative. These programmes involve cities across the EU that develop municipal policies around the aforementioned priorities.

Figure 14. Twelve priority themes of the European Urban Agenda

2.2.2. The EU Circular Economy Strategy

The European Commission produced its circular economy strategy in 2015, under the title "Closing the loop: An EU action plan for the circular economy". This aims to keep the value of products, materials and resources in the economy for as long as possible. In this way, it aims to protect European businesses from resource scarcity and cost volatility, boosting the EU's competitiveness and creating new business opportunities. The European strategy is the starting point for the development of the Spanish Circular Economy Strategy, which is analysed in the national reference framework.

2.3. National frame of reference

2.3.1. The Spanish Urban Agenda

Spain, in a similar way to what is happening in the European Union, embraces the implementation of the United Nations 2030 Agenda and the 17 SDGs. To this end, in 2019, it has drawn up its Spanish Urban Agenda23 , a strategic document that also aims to disseminate sustainability criteria in urban development policies. It is a roadmap that outlines the main axes along which to advance towards 2030, with the aim of turning our towns and cities into friendly, welcoming, healthy and conscientious spaces for coexistence. It is sufficiently open to offer a range of actions so that both public and private agents involved in cities for a more equitable, fair and sustainable development can develop their own Action Plans.

The Agenda advocates 10 strategic objectives (Figure 15) and includes proposals to preserve the best version of the traditional Spanish towns and cities, their architecture, culture and ways of life, but improved and updated for a society facing the new challenges of the 21st century.

Figure 15. Strategic objectives of the Spanish Urban Agenda. Own elaboration

https://www.fomento.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/urbanismo-y-sostenibilidad-urbana/agenda-urbana-espanola

2.3.2. The Spanish Strategy for Urban and Local Sustainability

The Spanish Strategy for Urban and Local Sustainability24 (EESUL) is one of the reference documents on urban and local sustainability, aimed at urban and non-urban municipalities. Developed in 2011, its content is similar to that of the European strategy, but also includes two new topics: rural-urban relations and climate change. It forms a strategic framework (non-binding) that includes the main lines that allow progress to be made towards greater urban sustainability. Its initial diagnosis provides a detailed overview of the urban situation in the recent past and at present, in relation to the territorial and urban point of view; urban planning instruments; accessibility, mobility and transport; urban management and governance; building and rehabilitation; and climate change.

2.3.3. The Green Paper on Local and Urban Sustainability in the Information Age

Both the Urban Environment Strategy and the Spanish Strategy for Urban and Local Sustainability (EESUL) have their fundamental basis in the Green Paper on Urban and Local Sustainability in the Information Age25 (2012), which aims to constitute a reference for the environmental policies needed in the transition of urban systems in our country. The document addresses the main areas related to the urban environment: urban planning, mobility, building, biodiversity and urban management; urban metabolism (including energy flows, water and other resources, waste management, air and urban noise), as well as rural-urban relations; with an emphasis on social sustainability, relating the urban habitat to social inclusion, always in the context of a more sustainable development.

2.3.4. The White Paper on Sustainability in Spanish Urban Planning

The aim of the White Paper on Sustainability in Spanish Urban Planning26 is to provide a set of lines of action that serve as a guide to advance towards more sustainable models in the field of urban planning. It is a reference document at national level. Prepared in 2010, it highlights the close relationship that must exist between urban planning and the principle of sustainability, as set out in the Land Law27 (RDL 7/2015). Urban development plans, which constitute the technical and legal basis on which the criteria for the growth of our cities are established, must favour the existence of urban spaces.

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https://www.fomento.gob.es/areas-de-actividad/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/urbanismo-y-sostenibilidad-urbana/estrategia-espan%CC%83ola-de-sostenibilidad-urbana-y-local-eesul

[25] https://www.fomento.gob.es/areas-de-actividad/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/urbanismo-y-sostenibilidad-urbana/libro-verde-de-urban-local-sustainability-in-the-information-age

[26] https://www.fomento.gob.es/arquitectura-vivienda-y-suelo/urbanismo-y-politica-de-suelo/urbanismo-y-sostenibilidad-urbana/libro-blanco-de-la-sustainability-in-urban-planning-urban-planning-anglais

[27] Royal Legislative Decree 7/2015, of 30 October, which approves the revised text of the Land Law and Urban Rehabilitation. https://www.boe.es/buscar/act.php?id=BOE-A-2015-11723

The EU's growth models must be environmentally friendly, energy-efficient, promote social cohesion, equality, innovation and a better quality of life.

It also incorporates the agreements reached in the Leipzig Charter limiting the uncontrolled growth of cities through "tight control of land supply and speculative development". It is therefore a relevant document for urban planning, proposing valid solutions to manage it effectively.

2.3.5. The Technical Building Code

In the national regulatory framework, Law 38/1999 on Building Regulations28 (LOE) is the fundamental pillar of the building process. It establishes the basic requirements to be met by buildings, setting out their obligations and establishing responsibilities and guarantees for the protection of users. Under the LOE, the Technical Building Code29 (CTE), a framework of requirements that buildings must comply with in relation to their safety and habitability, was created.

It is articulated through basic documents, which establish requirements in terms of structural safety, fire safety, safety in use, as well as accessibility; and habitability: healthiness, noise protection and energy saving. In this way, the CTE aims to improve building quality and user protection, always promoting sustainable development. The CTE applies both to newly constructed buildings and to interventions carried out on existing buildings.

In addition, within the regulatory framework for building construction, there are other mandatory regulations, such as the EHE30 concrete instructions, the seismic-resistant construction standard, the Regulation on Thermal Installations in Buildings31 (RITE), etc., which coexist with the CTE and complement it.

2.3.6. The Spanish Circular Economy Strategy 2030

The Spanish state is immersed in the development of a circular economy strategy with a 2030 horizon, which includes among its aims the promotion of the inclusion of circular economy measures in the development of building regulations.

The strategy highlights the need for technological and organisational innovation in order to move towards new, more efficient value chains. To this end, it identifies economic barriers and constraints

[28] Ley 38/1999, de 5 de noviembre, de Ordenación de la Edificación (Law 38/1999, of 5 November, on Building Regulation). https://www.boe.es/buscar/act.php?id=BOE-A-1999-21567

[29] https://www.codigotecnico.org/

[30] https://www.fomento.gob.es/organos-colegiados/mas-organos-colegiados/comision-permanente-del-hormigon/cph/instrucciones/ehe-08-version-en-Spanish

[31] Royal Decree 1027/2007 of 20 July 2007, approving the Regulation on Thermal Installations in Buildings. Consolidated text. https://www.boe.es/buscar/act.php?id=BOE-A-2007-15820

The EU is also committed to the development of legislative, normative and regulatory measures for the entry of products resulting from the recovery, recycling or transformation of waste. To this end, it establishes the need to develop mechanisms for the exchange of information and coordination between institutions (public and productive sectors), designing new value chains to reduce imports of strategic raw materials and energy dependence on foreign countries.

Its initial diagnosis offers eleven strategic objectives, the vast majority of which are of particular relevance in the building process:

Strategic objectives defined in the Spanish Circular Economy Strategy 2030

1. To protect the environment and ensure human health by reducing the use of non-renewable natural resources and reusing the materials contained in waste as secondary raw materials in the production cycle.
2. Promote the analysis of the life cycle of products and the incorporation of eco-design criteria, reducing the introduction of harmful substances in their manufacture, facilitating the repairability of the goods produced, prolonging their useful life and enabling their recovery at the end of their useful life.
3. To favour the effective application of the waste hierarchy principle, promoting the prevention of waste generation, encouraging reuse, strengthening recycling and favouring traceability.
4. Promote guidelines that increase innovation and the overall efficiency of production processes, through the adoption of measures such as the implementation of environmental management systems.
5. Promoting innovative forms of sustainable consumption, including products and services sustainable, as well as the use of digital infrastructures and services.
6. Promote a model of responsible consumption, based on transparency of information on the characteristics of goods and services, their durability and energy efficiency, through the use of measures such as eco-labelling.
7. Facilitate and promote the creation of the appropriate channels to facilitate the exchange of information and coordination with public administrations, the scientific and technological community and the
economic and social actors, so as to create synergies that favour the transition.
8. Spread the importance of moving from a linear economy towards a circular economy, promoting transparency of processes, awareness and sensitisation of citizens.
9. Promote the use of common, transparent and accessible indicators that provide insight into the degree of of implementing the circular economy.
10. Promoting the incorporation of social and environmental impact indicators derived from the The aim is to assess the performance of companies, in order to be able to evaluate more than just the economic benefits generated by their commitment to the circular economy.
11. Consolidate employment policies that favour the transition to a circular economy, identifying new sources of employment and facilitating capacity-building for the unemployed. themselves.

Similarly to the European strategy on circular economy, the Spanish strategy defines five priority sectors, among which the construction sector stands out, since it generates

The sector has not evolved significantly over the last 25 years, in contrast to other economic sectors. Furthermore, it highlights that the sector is confronted with the under-utilisation of residential and office buildings, their high energy consumption and the huge amounts of waste generated by construction and demolition activity (25% to 30% of total waste at European level).

2.3.7. The Public Sector Contracts Act

Law 9/201732 on Public Sector Contracts establishes that environmental criteria can be considered among the objective evaluation criteria, for which a life cycle analysis of the product or service will be required. This opens the door to a considerable improvement in the sustainability of public buildings, allowing the administration itself to act in an exemplary manner in this change in the building model.

2.4. Regional frame of reference

2.4.1. The Circular Economy Strategy of the Region of Murcia.

In 2018, the regional administration developed the Circular Economy Strategy of the Region of Murcia 203033 (ESECIRM), from which the EACS stems. Its objective is to stimulate the transition from a linear to a circular economy, improving competitiveness, fostering sustainable economic growth and creating new jobs in related sectors. ESECIRM sets out an action plan for the coming years (until 2025) in the sectors of sustainable production, sustainable consumption, resource management, secondary raw materials, water efficiency, research, development and innovation, knowledge, awareness and participation, and employment and skills.

Within its action plan, the ESECIRM establishes lines of action that are materialised in a series of specific actions to be developed during its period of validity, until 2025, framed in the aforementioned sectors. Thus, some of the general lines of action are linked to the waste generated in the building process, such as LA8 entitled "Promotion of separation at source of construction and demolition waste for reuse as secondary raw materials".

This action line is related to the following actions:

[32] Law 9/2017 of 8 November on Public Sector Contracts. https://www.boe.es/buscar/act.php?id=BOE-A-2017-12902 https://www.carm.es/web/pagina?IDCONTENIDO=60946&IDTIPO=100&RASTRO=c2749$m

GR7 Waste reuse plan prior to demolition, which aims to develop a plan to encourage the drafting of studies prior to demolition actions, indicating which waste and how it will be reused.

MPS1 Plan for the recovery of construction waste as secondary raw materials, treating it to make it easier to reuse.

PS10 Sustainable architecture and construction strategy, as a strategic framework to be developed in the region to articulate a paradigm shift in the process of design, construction, use and management of buildings, minimising waste generation throughout the life cycle under the premise of "reduce, reuse and recycle".

2.4.2. Waste Plan for the Region of Murcia

In line with the State Framework Plan for Waste Management34 (PEMAR) 2016-2022, the Region of Murcia has developed its Waste Plan for the Region of Murcia35 for the period 2016-2020. This plan analyses the waste situation grouped into three categories: household and similar waste, industrial and commercial waste, and construction and demolition waste.

The analysis shows an upward trend in the generation of household waste and waste from construction and demolition activities until 2020, despite the fact that in previous years it had decreased. For this reason, it is the aim of the plan to prevent a reversal of the trend in the generation of this type of waste. It develops waste prevention and management programmes for the three categories analysed, defining specific measures and actions.

The measures designed in the construction and demolition waste programme, most directly related to sustainable construction, are the following:

Prevention programme

MPC.01 Dissemination campaign to promote sustainable construction techniques and selective demolition.

MPC.03 Guide to Sustainable Consumption in the Construction Sector

Management programme

MGC.02 Dissemination campaign to promote the use of recycled aggregates and design alternatives in public development projects.

MGC.04 Integrated Management Programme for Construction and Demolition Wastes

[34] Plan Estatal Marco de Gestión de Residuos (PEMAR) 2016-2022. https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/planes-y-estrategias/pemaraprobado6noviembrecondae_tcm30-170428.pdf

[35] Waste Plan of the Region of Murcia 2016-2020. https://www.carm.es/web/pagina?IDCONTENIDO=53799&IDTIPO=100&RASTRO=c507$m1463

The application of these measures is a first step towards a more circular building model.
in the region.

2.4.3. Energy Plan for the Region of Murcia

The Energy Plan for the Region of Murcia36 2016-2020 is in line with the objectives established in the European Union's energy policies. Its objectives are to guarantee the functioning of the energy market and the security of energy supply; to promote energy efficiency and savings and renewable energies; and to promote the interconnection of energy networks. In its diagnosis, a reduction in the overall efficiency of energy use between 2007 and 2013 in the region is evident, with an increase in final energy consumption, despite a reduction in primary energy consumption, together with an increase in regional energy intensity (the amount of energy needed to produce one economic unit of GDP).

The plan presents more than a hundred measures to reverse this situation, emphasising the value of energy as a fundamental resource in production processes and its impact on the competitiveness of the regional economy. Among the measures proposed, the following are related to sustainable construction:

Measures of the Energy Plan for the Region of Murcia related to the EACS

13. Assessment of construction processes from an energy point of view. Catalogue of construction solutions according to their energy efficiency.

20. Promotion of solar photocatalysis for air purification and the decontamination of pavements, façades and roofs. Dissemination of knowledge of photocatalysis in construction and urban planning.

22. Promotion of energy service companies for renewable electricity applications

31. Study on tax exemptions for "A" and "B" energy rated dwellings.

2.4.4. The White Paper on Construction in the Murcia Region

The White Paper on Construction in the Region of Murcia37 sets out the roadmap for the sector. construction sector during the period 2015-2025. The document is articulated around five of the

http://portaleslr.carm.es/documents/4106806/8264765/documento+completo_Rev2.pdf/ef6c8e7d-450e-42cf-a415-8bc9111bf5a1
https://www.carm.es/web/pagina?IDCONTENIDO=15018&IDTIPO=246&RASTRO=c2195$m36284,36305

areas in which the construction sector is directly involved: spatial planning, land use planning, and The book establishes that, through sustainable building, the aim is to: - promote

sustainable building, urban planning, housing, public works, construction quality

and accessibility. The book states that, through sustainable building, the aim is

to:

- Create awareness and demand for more efficient buildings among private consumers, developers and public purchasers.
- Improve the knowledge and information of stakeholders regarding the resources and environmental impacts of buildings.
- Remove barriers created by different requirements for the environmental performance of buildings.
- Improve efficiency in the use of materials, including the prevention and management of construction and demolition waste.
- Promote the use of empty buildings instead of building new ones.

It also establishes the premises to be taken into account for the development of sustainable construction:

- Conservation of natural areas and biodiversity.
- Preferential use of materials from renewable resources.
- Efficient use of non-renewable materials.
- Promoting the reuse and recycling of waste.
- Prohibition on the use of potentially hazardous materials.
- Use of materials with low or zero toxic emissions.
- Use of materials with greater durability and flexibility of use.
- Quality in the manufacture of materials to extend service life.
- Optimisation of the use of materials.
- Choice of materials and application that facilitate disassembly, selective separation and reuse or recycling of waste at the end of its useful life.
- Promoting the Use of EMAS.
- Promote awareness, training and application of building sustainability criteria covering the whole life cycle from design, construction, use and consumption of resources, maintenance, adaptation, refurbishment, rehabilitation and recycling, such as those contained in the international LEED and BREEAM methodologies.

The White Paper also reflects sustainability criteria in tendering procedures for works promoted by the public administration, so that the use of sustainable materials, maintenance and conservation criteria during their useful life, and the preservation of the environment are taken into account in contracting processes as quality criteria.

Finally, it considers the correlation between quality architecture and environmentally responsible architecture, incorporating sustainable and energy-efficient building materials and designs through the use of passive solutions.

3. DIAGNÓSTICO DE SITUACIÓN ACTUAL

eacs

Estrategia de arquitectura y construcción sostenible de la Región de Murcia.

Región de Murcia
Consejería de Fomento e Infraestructuras
Dirección General de Territorio y Arquitectura

3. DIAGNOSIS OF THE CURRENT SITUATION

3.1. SWOT analysis

The SWOT analysis is based on the assessment of the following criteria with regard to the issue treated:

- Weaknesses. Elements, resources, practices and attitudes present in the Region of Murcia that prevent or hinder the implementation of a sustainable architecture and construction model and that need to be identified and mitigated.
- Strengths. Attributes in which the Region of Murcia stands out and which represent a competitive advantage in relation to its environment for the implementation of an EACS.
- Threats. External factors that can negatively affect the implementation of an EACS in the Region of Murcia and that need to be foreseen and combated.
- Opportunities. Favourable external factors that the Region of Murcia can take advantage of for the implementation of an EACS.

It has been considered appropriate to frame the analysis in five thematic stages. The first four correspond to the phases established in the sustainability analysis methodology commonly used in the assessment of the environmental performance of buildings (UNE EN 15978). A fifth cross-cutting category has been added, called Sustainable City, which includes aspects related to the treatment of urban spaces and urban planning.

These five phases are as follows:

1. Product phase. This includes the supply of raw materials, transport to the factory and the manufacture of the materials and products used in construction. It can be divided into three parts: supply of raw materials, transport and manufacture.
2. Construction process phase. This is the phase that covers the processes from the factory gate of the different materials to the completion of the construction work, including the transport of the materials to the construction site. It can be divided into two parts: transport and construction-installation.
3. Use phase. This is the phase that covers the time period from the practical completion of the construction work to the moment when deconstruction or demolition takes place. It can be divided into seven parts: use of the building (excluding energy and water use), maintenance of the building and installations, repairs, replacement of components, renovations, energy used by the technical systems integrated in the building and water consumption.
4. End-of-life phase. It can be divided into four parts: deconstruction, transport, treatment for reuse, recycling and energy recovery and final disposal.

5. Sustainable city. This section includes aspects referring to the relationship of the building with the surrounding public space up to the general planning: efficient distribution of urban uses, resource management, green infrastructures, sustainable mobility, adaptation to climate change, etc.

These phases have been included in a figure that accompanies each of the points detected in the SWOT analysis, highlighting the phases in which this characteristic is applied. This figure represents in a more schematic and visual way the phases of the building process affected by each of the aspects dealt with.

Figure 16. Graphics representing the phases of the building process used in the EACS. Own elaboration

3.1.1. Weaknesses

D1 **Lack of public knowledge and awareness of the environmental and cost-saving benefits of living in and using sustainable buildings.**

Despite the fact that we are at a time in history when citizens have more information about the impact of human activity on the environment, this knowledge has not yet led to a significant change in their consumption habits. The information channels do not influence citizens to the point of bringing about this change. In this respect, there is a lack of linkage between the awareness-raising measures under the various existing regional plans, in order to optimise their impact.

It is necessary to stress the temporary unfeasibility of the current model based on linear economics. In addition, experiences in the construction of sustainable buildings, mainly in terms of energy quality, have resulted in significant reductions in energy demand, leading to economic savings of up to 80%.

This fact also leads to a certain scepticism among developers about the economic viability of investing in sustainable building models. Indeed, the construction sector has suffered, in recent decades, moments of ups and downs that no other sector in Spain has experienced. The last crisis in 2008 hit this sector hard, dragging a significant number of companies out of business. At the current moment, when the light is coming back, investors are mainly looking for stability and a representative majority of them are not willing to take the risk of developing sustainable developments that could compromise their profitability.

D2 Lack of training of technicians on sustainability criteria applied to building and urban planning.

Advancing towards sustainability in the building process not only entails a change in the mentality of all the agents involved, but also new skills still to be acquired by technicians and designers. Knowledge about the impact of the use of materials, the behaviour of buildings and their relationship with the environment, their capacity to adapt to new uses over time, the tools for assessing sustainability and new technologies is a necessity for the development of a sustainable building.
of more sustainable cities.

D3 Lack of modernisation of construction systems, especially in small and medium-sized construction companies.

More sustainable building models involve the application of new environmentally friendly solutions. Sometimes, there is a lack of capacity on the part of small and medium-sized construction companies to implement construction techniques based on new, less conventional sustainable technologies, which leads to defective execution and generates negative consequences for the environment.
final performance of the building.

D4 Slowness of the administrations in the management of construction-related dossiers

There is a significant delay on the part of local administrations in granting building permits, which has a deterrent effect on developers to introduce innovative sustainability aspects that could further lengthen the process. This delay is also typical of the

The processing of urban development plans, making it equally difficult to incorporate the criteria of sustainability that could be reflected in new developments.

It is also the case that the processing of aid offered by the Autonomous Community for the renovation of residential buildings follows a complicated procedure. This fact, together with certain delays in the resolution of these subsidies, has a dissuasive effect on citizens.

Finally, the same applies to the authorisation of LER codes (European Waste List) for waste management companies. The procedures with the regional administration take up to 2 and 3 years, while in neighbouring regions they usually do not exceed 3 months. This situation may be aggravated by the lack of a regional public body specialised in environmental management, as it exists in other regions such as the Basque Country (Ihobe) and Catalonia (Agencia de Residuos de Cataluña). This fact discourages the presence of waste managers in our region, with a preference for other neighbouring regions, which hinders local management itself.

D5 Lack of a regional green procurement plan

Although Law 9/2017, on Public Sector Contracts, encourages the assessment of environmental and sustainable criteria in the procurement processes of public administrations, in tenders for buildings, the economic offer is still valued over sustainability in the construction process and during the useful life of the building. The drafting of a regional green procurement plan would provide incentives and guidelines for public administrators to ensure that in new building contracts
The use of efficient solutions should be prioritised.

D6 Lack of ordinances on the management of CDW in municipalities

Inadequate management of CDW leads to uncontrolled dumping that has a significant environmental impact. It is necessary for local councils to issue specific by-laws regulating the management of this waste, even in minor works, in order to avoid this malpractice. Only a few municipalities have
of specific ordinances for this purpose.

D7 Lack of competitiveness of recycled material vs. virgin raw materials for the manufacture of building materials and lack of information on their availability

There is a cultural barrier to the idea that a material from waste can be reused, recycled and converted into a material with similar characteristics to those based on virgin raw materials. This generates mistrust about the performance and quality of secondary raw materials from waste.

The low demand for recycled materials (mainly precast) means that their cost is still higher than their quarry-based counterparts. This is a major barrier, as until economies of scale are developed, precast manufacturers will prefer quarried materials to aggregates from demolition or deconstruction of buildings. This in turn leads to a shortage of local suppliers of recycled building materials. In addition, it is important that all actors involved in the building process have clear and accurate information on the availability and characteristics of recycled building materials. This type of information is lacking and is also necessary to encourage the use of local materials, reducing the impact on the environment.

D8 Lack of experience on the performance of construction solutions adapted to the climatology of the Region of Murcia.

Sometimes, architectural or design solutions are used to improve the energy performance of buildings whose effectiveness has been demonstrated elsewhere. However, in most cases, these locations do not represent the same climatic conditions as those existing in the Region of Murcia, especially in terms of climatic severity and rainfall. Experiences need to be developed to make empirically based decisions.

D9 Poor maintenance of buildings, which reduces the durability and performance of building elements and the performance of installations.

The use of sustainable materials sometimes requires specific maintenance. This is also the case with more efficient energy installations or those that make use of renewable energies. However, the first cost that is usually reduced in a building is maintenance. The lack of such maintenance accelerates the deterioration of materials and reduces the efficiency of energy systems, failing to meet design expectations. This happens because there is no minimum maintenance requirement for the building. Only the Building Assessment Report reflects the shortcomings of maintenance when such a survey is compulsory (buildings over 50 years old)

D10 Preferential culture for the construction of new buildings instead of recovering the existing building stock

The preference for new construction over the recovery of existing buildings is part of the cultural substratum of our Region of Murcia. This hinders the rehabilitation and regeneration of the existing building stock, which would be a much more sustainable practice.

D11 **Lack of teamwork culture in sustainable building projects requiring multidisciplinary teams**

The drafting of projects that take into account sustainability criteria involves the collaboration of professionals specialised in different fields, such as the efficient design of facilities, environmental waste management, the use of recycled materials, etc. This complicates the organisation of works, which used to involve a smaller team, the execution of more advanced installations, and the durability of these while maintaining the performance expected in their design.

D12 **Lack of clear and unified criteria for assessing the sustainability of urban planning concepts and for drafting environmental assessments.**

All urban development plans require validation by the Region's environmental department. Law 21/2013 of 9 December 2013 on environmental assessment requires the preparation of a strategic environmental assessment. However, there are no specific sustainability assessment tools and sometimes the technicians who assess them do not have clear, solid and simple criteria. This leads to significant delays in processing, as well as a lack of homogeneity in the response.

Something similar occurs due to the lack of clear criteria that allow the creation of more sustainable urban planning figures, which complicates the task of both the drafter of the figure and the technicians of the administration who will finally evaluate its environmental suitability.

3.1.2. Strengths

F1 **Presence of universities and research centres in the Region with the capacity to carry out research work on sustainable architecture and construction.**

Research groups have been identified in the schools of architecture, both at the UPCT and the UCAM, which develop lines of work related to sustainability within the building process. In addition, the CTCON has specific lines of work on waste recovery methods as an alternative to virgin raw materials. The existence of this research network, provided that it is strengthened, means that feasible to develop projects to move towards more sustainable materials and techniques.

F2 Capacity of training entities to provide courses on sustainable construction for building agents.

The Fundación Laboral de la Construcción is a national entity, based in Murcia, with more than 25 years of experience in training the different professionals involved in the construction process. From the region they promote training in environmental management of works, energy efficiency and BIM. This institution would be able to set up specific courses on sustainability in construction. Similarly, the Regional Federation of Metal Entrepreneurs of Murcia has extensive experience in the training of technicians specialised in renewable energies and all types of installations related to buildings. The professional associations also have the means and experience for training.
specific to its members. This capacity is a strength as long as its development is enhanced.

F3 Local experience of energy installation companies renewables

The existence of a business fabric capable of providing renewable energy generation facilities guarantees that the Region's buildings have viable options to significantly reduce greenhouse gas emissions and, therefore, to be more sustainable during their useful life. In addition, there is a business fabric interested in the sustainability of the building process, which
can make a decisive contribution to moving towards this new model.

F4 Existence of strategic plans that contribute to the implementation of a sustainable construction model.

In line with European and national policies for the transition to a circular economy, the Region of Murcia has developed strategic documents in line with the Sustainable Architecture and Construction Strategy. These include the Circular Economy Strategy of the Region of Murcia 2030, the Waste Plan of the Region of Murcia 2016-2020 and the Energy Plan of the Region of Murcia 2016-2020, which are being updated for a more distant horizon and the Smart Specialisation Strategy RIS3MUR, in which the habitat sector is included as a priority and which will require an update in view of the new programming period of European Structural and Investment Funds (2021-2017). These documents frame and contribute transversally to the strategy, although they leave aside
The development of the EU is a strength if no specific funds are available for its development.

F5 Existence of the Air Quality Improvement Plan for the Region of Murcia 2016-2018 for the prevention and mitigation of atmospheric pollution.

The design of sustainable buildings and cities will have a favourable effect on the reduction of pollutant gas emissions into the atmosphere and therefore contribute to the improvement of air quality. The promotion of the Air Quality Improvement Plan, in the process of being updated to the 2020-2025 period, is in line with the awareness and sustainability measures foreseen in the EACS, promoting a substratum of sustainable buildings and cities.
favourable to its implementation.

F6 Experiences in governance and participation projects citizen

The processes of governance around the city and its design, the participation of citizens in decision-making about their immediate environment, which have been developed by some city councils in the Region of Murcia, have yielded positive results, both in their design and in their joint execution. These governance models should be transferred to other municipalities for the design of more sustainable cities.
sustainable and inclusive.

F7 Existence of aid lines for investments in building renovation, energy efficiency and energy renewables

Public administrations, both at regional and national level, call for investment aid for the improvement of energy efficiency and the promotion of renewable energies aimed at homes, businesses and local authorities for the improvement of public buildings, in line with EU policies that establish energy transition in cities as one of the priorities of the European Urban Agenda and the European Commission's European Urban Agenda.
Spanish.

3.1.3. Threats

A1 **The cost overruns of sustainable construction can leave it out-of-market**

The use of recycled materials, more efficient installations, designs based on a detailed study of the environment, industrialised systems, etc., tend to increase the initial cost of a building. Although it is not a determining factor, this increase in investment can dissuade more conservative buyers. As a result, developers and technicians are less likely to opt for
more sustainable solutions.

A2 **Lack of building materials databases that include information on their Life Cycle Assessment.**

Although there are several databases in Spain with detailed information on materials and construction units (such as those of the company Cype, the BEDEC of the Institute of Construction Sciences of Catalonia, etc.), they do not include information on the life cycle analysis (LCA) of materials, which makes it difficult to carry out a life cycle assessment.
Global LCA to the building. BIM methodology can contribute to information management.

Foreseeable difficulty in implementing the sustainability-related criteria of the future Structural Code

The current Spanish structural regulations (EHE-08) include calculation methods to establish the level of sustainability of a building structure, defining different indicators that depend on the efficiency in the use of resources: the use of recycled raw materials and low carbon footprint, the achievement of environmental and quality certifications, the minimisation of the impact on the environment, the extension of the useful life etc. In addition, it limits the use of recycled aggregates, from the crushing of concrete waste, to 20% of the coarse aggregates used to make new concrete, which must be identified as recycled. A higher percentage implies specific tests for water penetration, frost resistance, corrosion protection, etc. In addition, the origin of the waste must be strictly controlled in order to avoid special concrete mixtures or those with pathologies. The declaration of this index is completely voluntary, which makes it difficult to extend its use. The draft of the new code, which does not improve much in this respect compared to the current one, indicates that it could
This is a missed opportunity.

A4 Climatic conditions not suitable for the use of the most widespread passive systems in cold climates.

Many of the design solutions that contribute to obtaining environmental certificates work more efficiently in areas with a cooler climate. The environmental threats we face (increased air pollution, loss of biodiversity in cities, heat island effect, water loss through run-off, etc.) do not favour the use of foreign solutions that face completely different threats. It is necessary to further develop and implement passive solutions designed for hot climates.

A5 Complexity of installation and maintenance of the most efficient thermal systems (geothermal, aerothermal, solar, etc.).

Although in recent decades, heating and cooling installations in buildings have considerably simplified their operation, it is still a specialised task that must be controlled by competent technicians. Their preparation must be adequate to guarantee the performances estimated in the design phase. In addition, in some high-efficiency systems, such as those based on geothermal energy, it is necessary to perform large-scale interventions such as excavations, special structures, etc.

A6 Technical difficulty in carrying out the rehabilitation of buildings on consolidated urban land and implementing sustainable improvements.

A significant proportion of the buildings to be rehabilitated are located in areas of the city with a dense grid, without sufficient access to natural light. In addition, the excessive rigidity of urban planning regulations to adapt urban planning to new sustainability requirements limits freedom in sustainable design, demolition and construction. On the other hand, the very characteristics of the buildings to be rehabilitated, often of great antiquity and far from compliance with current regulations, complicate the choice of more environmentally efficient solutions.

A7 Difficulty in achieving end of waste status of certain wastes that could be used in the manufacture of construction materials

There are difficulties in removing the category of waste from a material in the current regulations. The European Union is working on establishing a directive that establishes a common regulatory framework for obtaining end-of-waste status for revalued waste. The complexity of the processes

The definition of these normative parameters is made difficult by the technological requirements for efficient processing of some wastes.

A8 **Difficulty in transporting waste to the most appropriate waste managers.**
close to the site if they are located in another community autonomous community because different authorisations are required in each autonomous community

The fact that each Spanish autonomous community has an authorisation procedure for transporters who deposit waste in authorised waste managers in its territory, reduces the chances that a construction site located in areas close to the border with another community will transport its waste to an authorised waste manager in its territory.
nearest landfill, if it is located in another region.

A9 **Technical difficulty in recovering certain wastes, such as insulation, foams, plastics and plasters.**

The recovery of CDW requires a complete separation of its different fractions, preferably at source (during the demolition process of buildings), if not at the waste manager's own facilities. There are currently technical difficulties in separating gypsum, fibrous insulation materials, foams and certain plastics, which greatly complicates their recovery.

However, in recent years, emerging technologies are emerging, e.g. a new method to remove gypsum from waste (based on NIR, near infrared technique). This recovered gypsum can
can be recycled and reused in gypsum plasterboard without reducing its performance.

3.1.4. Opportunities

O1 **Law 9/2017 on Public Sector Contracts regulates the inclusion of clauses relating to sustainability.**

The law provides for the inclusion of environmental criteria both as solvency criteria for companies and as award criteria. To achieve the latter objective, for the first time, contracting authorities are obliged to ensure that the design of award criteria allows for high-quality works, supplies and services, specifically by including qualitative, environmental, social and innovative aspects linked to the subject matter of the contract. It also provides, in the case of
the special conditions of execution, the obligation on the contracting authority to lay down in the specifications

At least one of the special environmental, social or employment-related performance conditions listed in Article 202. There is the possibility of implementing sustainability requirements in new public subsidised housing developments. However, both the Green Public Procurement Plan of the General State Administration and the development of this law should help to move towards procurement models that favour sustainable criteria.

O2 Availability of building sustainability assessment and certification tools (VERDE Tool, BREAM, LEED, Passivhaus, etc).

At European level, a variety of tools are available to planners to assess and certify the sustainability of buildings. These tools evaluate aspects such as the situation of the building, the environmental quality of its interior, the management of energy, water and the materials used, aspects of social integration or the technical quality of the building and its monitoring during the use phase. Although the implementation of these standards is still scarce in the Region of Murcia, there are already some certified buildings that could serve as a showcase to evaluate the performance of the solutions provided and constitute an example to be followed in other buildings.

In addition, the Ministry of Public Works has developed the "Municipal System of Urban and Local Sustainability Indicators", a tool that overcomes the barrier caused by the lack of information to assess sustainability at the urban or rural core level.

O3 Development of the BIM methodology, which allows the management of the entire building process with sustainability criteria.

The BIM (Building Information Modelling) methodology facilitates the collaborative modelling of buildings. The use of BIM goes beyond the design phases, encompassing the execution of the project and extending throughout the life cycle of the building, allowing it to be managed with sustainability criteria. This methodology, however, is difficult to implement in buildings of small size.

O4 EU development of a common framework of core sustainability indicators for residential and office buildings (LEVEL(s))

Level(s) is a framework developed by the EC for the assessment of environmental performance in the built environment to improve the sustainability of buildings. Building on existing standards, Level(s) contributes to the circular economy by providing a step-by-step procedure for the assessment of the environmental

life cycle through a series of indicators, without forgetting other key aspects such as comfort and health, water management or resilience to climate change.

O5 Advancement of industrialised construction methods

The transformation that the construction industry is undergoing is shifting towards construction methods that use automated processes for the design and production of structural and non-structural materials that are transported to the final location for dry assembly. These shop-floor manufacturing processes are more sustainable in that they generate less waste, as they are more controlled, and follow a standardised design, which ensures the efficient use of the various component materials. In spite of the lack of implementation of industrialised methods in the Region of Murcia, the
The possibility of a boost from public procurement is an opportunity.

O6 Improving the performance of building elements and installations

Improving the energy performance of windows, external thermal insulation systems (EIFS), heat recovery systems, home automation and advanced control and, in general, of the available installations generates greater energy efficiency in buildings, reducing the building's energy consumption during its period of use and maintaining or increasing indoor comfort levels.

Similarly, the extension of the design of accessible thermal, electrical and plumbing installations facilitates their maintenance and the preservation of their performance throughout their useful life.

However, these improvements needed to be contextualised in the life cycle of the building in order to have a objective weighting.

O7 New regulatory framework that removes obstacles to the self-consumption with renewable sources

The European Commission has recently approved the new Directive 2018/2001/EC on Renewable Energies, promoting renewable self-consumption in Europe. This, together with the recent disappearance of specific tolls for self-generated energy in Spain and the high level of solar radiation received in the Region of Murcia, is contributing to the increase in self-consumption photovoltaic installations, which have increased by 90% in 2018 compared to the previous year.

O8 Existence of a documentation of the completed building which facilitates maintenance work

Among the documents that form part of the Building Book are the Instructions for Use, Maintenance and Emergencies, which contain specific instructions on these aspects, including the express definition of the cleaning schedule, inspections and replacements, the repairs carried out, and the records of the actions related to all these operations. This documentation can facilitate the correct maintenance of buildings with sustainability criteria.

O9 Requirement to achieve a 70% reuse rate for CDW in 2020

One of the objectives of the Waste Framework Directive 2008/98/EC is to improve the management, legislation and recycling targets for CDW in order to make the transition to a circular economy. To this end, the European Commission, aware of the difficulty of achieving the objectives set, urges Member States to take the following measures
measures to promote CDW separation systems (at least wood, aggregates, metal, glass and gypsum).

O10 Existence of European funds that promote the sustainable construction

Sustainable urban development is one of the priorities of the European and Spanish Urban Agenda. In the current programming period 2014-2020, funds have been articulated for its achievement, mainly through the ERDF (European Regional Development Fund), with initiatives such as the Sustainable and Integrated Urban Development Strategies (EDUSI), the Innovative Urban Actions and the URBACT initiative. This priority will be maintained in the next programming period, 2021-2027.

Other research and innovation programmes, such as LIFE, Horizon 2020, Innovative Urban Actions, etc. also promote solutions for the renaturation of cities and adaptation to climate change.

O11 The Technical Building Code and other building regulations promote sustainable construction.

Compliance with the CTE means that all new buildings must have a near-zero energy demand. Furthermore, water, like energy, is a resource to be preserved in order to ensure sustainable development. The separation of rainwater and greywater networks, in separate hydraulic circuits, makes it possible to recycle treated water for uses in which the use of drinking water is not essential, which means that the following is possible savings and more efficient management of this resource.

O12 Enabling environment for the implementation of urban policies sustainable

Models of sustainable, smart and inclusive cities that are climate-friendly and take into account the different needs of each gender and the most vulnerable groups are at the heart of the 2030 urban agendas developed by the UN, the European Union and the Spanish state. The improvement of green areas and public spaces, the reduction of polluting traffic or the social integration of disadvantaged groups are priorities in these documents, as 70% of the population in Europe lives in urban areas.

In addition, it is worth highlighting the existence of state-level documents such as the White Paper on Sustainability in Spanish Urban Planning, the Guide to Energy Efficient Urban Planning and the Green Paper on the Urban Environment, which represent a national commitment to the development of general plans that are drawn up with a less deterministic and more strategic approach, with the aim of moving towards more compact and sustainable city models.

OBJETIVOS ESTRATÉGICOS Y LÍNEAS DE ACTUACIÓN

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Strategy for sustainable architecture and construction of

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Region of Murcia
Consejeria de Fomento e Infraestructuras
Direcci6n General de Tenitorio *y* Arquitectura

4. STRATEGIC OBJECTIVES AND LINES OF ACTION

In any strategic development process, the logical framework of intervention ensures a link between the information perceived in the diagnostic phase and the final design of an action plan that specifies what is to be done, how, when and why. In this case, this logic follows the process reflected in Figure 17.

The starting point was the knowledge gathered in the diagnosis phase, thanks to the contributions received from the experts who make up the Technical Committee. Subsequently, and working together with these experts, a complete SWOT analysis has been developed, which clearly reflects the weaknesses that need to be strengthened and the threats that require actions to mitigate their risk. The SWOT also detects the strengths of the Region of Murcia that should be consolidated and used as a stimulus to move towards more sustainable building models, as well as the opportunities that loom in the environment, whose favourable effect should be exploited for the same purpose.

Figure 17. Intervention logic for the development of the EACS. Own elaboration

4.1. Definition of Strategic Objectives

One of the main conclusions of the diagnosis phase is the limited culture that exists among the different actors involved regarding sustainability criteria in buildings. This means that citizens, clients and end users of buildings show a low demand for this type of building, both new and refurbished. Hence, the dissemination of this culture and the benefits it produces (environmental and economic), constitute one of the main objectives of the future action plan.

But in order to move towards more sustainable models, there is also a significant lack of knowledge about the benefits of applying certain practices that have been shown to be sustainable in other climate zones. The set of actors involved in the design and execution of buildings therefore demand increased investment in research and development for local applications. As a result of the consolidation of this knowledge among technicians, the application of more sustainable solutions that contribute to a more circular building model should be encouraged.

Improper management of existing buildings has also been identified as a cause of major deviations from their original operating conditions, resulting in a continuous decline in their level of sustainability. Cutting maintenance costs, a poor approach to refurbishment processes of old buildings, or poor implementation of energy installations, are serious barriers to progress towards sustainability in the sector.

The lack of methodologies and objective indicators that allow a comparison between two or more buildings, with sustainability criteria, has also been identified. The trend in this regard is to apply methodologies based on life cycle analysis (LCA), as it allows for a more exhaustive assessment, with circular economy criteria. In this sense, Law 9/2017 on public sector contracts also proposes this type of analysis to assess sustainability criteria by public administrations.

Finally, aspects related to urban planning and the sustainable design of cities are decisive in moving towards a circular economy in the sector. Appropriate urban design is the basis for achieving high levels of sustainability in the buildings that are subsequently constructed. It is therefore necessary to move towards more flexible urban planning models that allow for the adaptation of the most sustainable building models.

In this way, the strategic objectives proposed for the Region of Murcia to progress towards higher levels of sustainability in the building sector are as follows:

- SO1: Move towards a culture of sustainability in the building process.
- SO2: Encourage initiatives towards more sustainable building and urban patterns.
- SO3: Implement Life Cycle Assessment of Buildings.
- SO4: Increasing the durability of buildings and their adaptability to new uses under sustainability criteria.
- SO5: Fostering more flexible urban planning models and promoting urban policies based on multi-level governance for greater sustainability.

These objectives are in line with the priorities of the European Urban Agenda and with the strategic objectives of the Spanish Urban Agenda. Similarly, the clear trend towards the circularity of the building process can be framed within the different strategic packages on circular economy: European, national and regional. The strategic objectives also favour the different reference areas described in the diagnosis. Finally, it should be noted that they are also in line with the Sustainable Development Goals, especially with goals 6 - Clean Water and Sanitation, 7 - Affordable and Clean Energy, 11 - Sustainable Cities and Communities, 12 - Responsible Production and Consumption and 13 - Climate Action.

Strategic Objective 1 (SO1): Move towards a culture of sustainability in the process. building.

It is necessary to spread a new culture of sustainable building among all the agents involved in the process. Citizens need to be aware of the benefits of this type of building, both for themselves and for the environment. This benefit goes beyond an improvement in construction quality or an increase in interior comfort. In most cases, it means considerable economic savings in the use of air conditioning and heating systems, as the buildings are better protected against adverse weather conditions and have less need to activate these systems.

It will therefore be the objective of this strategy to disseminate this new culture, through concrete actions of dissemination, information and awareness campaigns, and specific training for the technical actors involved in the design of buildings and cities, and in their implementation.

Relationship with the SWOT analysis:

SO1 - Move towards a culture of sustainability in the building process			
Weaknesses	**Threats**	**Strengths**	**Opportunities**
D1 D2 D10 D11	A5	F2 F6 F7	O7 O8

Strategic Objective 2 (SO2): Encourage initiatives towards more sustainable building and urban patterns. sustainable.

It is necessary to move towards more sustainable building and urban models. To this end, research and development are determining factors when we want to establish a new economic model based on circularity. It is necessary to develop working methods and techniques that ensure the correct behaviour of buildings, in an environmentally sustainable and long-lasting manner. The Region of Murcia has organisations capable of promoting innovation in the field of building. However, its limited resources constitute an important barrier to the development of innovative solutions adapted to the peculiar climatic characteristics of the region, so different from those present in other areas of Spain and, even more so, in central and northern Europe.

It is also necessary to promote passive solutions, material technologies and construction systems that contribute to the circularity of the building process and to water saving. In most cases, there is a certain resistance to change, to using new materials or technologies, or secondary raw materials based on the recovery of CDW, which have not yet been sufficiently tested, even among technical agents.

Relationship with the SWOT analysis:

SO2 - Encourage initiatives towards more sustainable building and urban patterns			
Weaknesses	**Threats**	**Strengths**	**Opportunities**
D1 D2 D3 D7 D8 D12	A2 A3 A4 A5 A6 A9	F1 F2 F3 F4 F7	O5 06 O7 O9 O10 O11 O12

Strategic Objective 3 (SO3): Implement LCA assessment tools for buildings.

The life cycle analysis of buildings is the fundamental tool for assessing the degree of sustainability of a building and for comparing different buildings with each other. However, this analysis is complex and requires training for technicians, which is why its promotion is an essential objective in this transition towards a circular economy in the sector. Moreover, the criteria for assessing sustainability in public procurement processes must also be based on this methodology.

Relationship with the SWOT analysis:

SO3 - Implement the LCA approach in the building process			
Weaknesses	**Threats**	**Strengths**	**Opportunities**
D4 D5 D12	A2	F1 F2	O1 O2 O3 O4

Strategic Objective 4 (SO4): To increase the durability of buildings and their ability to adaptation to new uses under sustainability criteria.

The most widespread culture encourages new building construction as opposed to the more sustainable recovery of the existing building stock. This is a major barrier to the development of a new building model based on the circular economy. It is therefore a strategic objective to favour the energy rehabilitation of buildings, acting not only on their envelope, but also on their installations and incorporating systems that take advantage of renewable resources, as well as promoting the correct maintenance of buildings to prolong their useful life and their re-adaptation for new uses.

Relationship with the SWOT analysis:

SO4 - Increase the durability of buildings and their capacity to adapt to new uses under sustainability criteria			
Weaknesses	**Threats**	**Strengths**	**Opportunities**
D1 D9 D10	A5 A6	F3 F4 F7	O5 O6 O7 O7 O10 O11

Strategic Objective 5 (SO5): Encourage more flexible urban planning models and promote urban policies based on multi-level governance that favour greater sustainability.

Inefficient urban planning will inevitably lead to difficulties in achieving sustainability criteria in the buildings that are constructed there. Therefore, more sustainable building solutions have their starting point in urban planning that is less prescriptive and more flexible, allowing the incorporation of innovative designs, guaranteeing or favouring access to solar radiation and the much-needed urban renaturation. Multilevel governance schemes and stakeholder participation are a practice that has proven to be very successful in the past.

The EACS therefore aims to move towards urban planning models that, with greater flexibility, allow the construction of buildings with a degree of sustainability that would be difficult to achieve with current planning.

Relationship with the SWOT analysis:

SO5 - Encourage more flexible urban planning models and promote urban policies based on the following in multilevel governance that favour greater sustainability			
Weaknesses	**Threats**	**Strengths**	**Opportunities**
D4 D6 D12	A2 A7 A8	F4 F5 F6	O9 O11 O12

4.2. Definition of main lines of action

In order to achieve the objectives of the strategy, some general lines of action are defined, on the basis of which a complete Action Plan will subsequently be designed. These lines, in short, seek to advance towards more sustainable building models, responding to the previously defined strategic objectives. The lines of action are:

LA1. Dissemination of knowledge in society about the benefits of sustainable building and urban space.

As has been detected in the diagnosis of the current situation, it is necessary to disseminate a new culture of sustainability in our buildings in society. To this end, the public must be provided with information on the economic, social and environmental benefits of this type of construction, creating a global trend that will help in this transition towards the circularity of the building process and the involvement of all citizens in more sustainable models.

LA2. Training of the agents involved in the building and town planning process.

The implementation of the necessary changes in the construction sector for the transition towards a circular economy in the field of construction requires specialised and continuous training for technical designers, as well as for the rest of the agents involved in the building process. This training should be addressed both in the field of official education and through specific courses and conferences.

LA3. Promote the use of LCA-based assessment tools.

Life Cycle Assessment is the best methodology for assessing the sustainability of any product, including the entire building process. EACS will promote its use, relying on existing standards, which require LCA-compatible analysis and offer certifications with valid information for citizens and all the agents involved in the process.

LA4. Implement sustainability and eco-design in the project drafting phase.

In the design phase, the designer must foresee and plan all aspects that will contribute to achieving the highest standards of sustainability, guaranteeing the maximum durability of the building and the circularity of the process: passive solutions aimed at reducing energy demand and consumption in the use phase, decisions on materials and construction elements that minimise the water and carbon footprint, modular construction systems and the use of industrialised construction elements that facilitate the deconstruction and dismantling of the building so that the products can be reused or recycled after use, design of flexible spaces that can be adapted to future uses.

LA5. Availability of more sustainable building materials.

Any improvement in building sustainability, from a life cycle perspective, requires the use of materials with a low environmental footprint during manufacture and transport, greater durability and the possibility of being reused or recycled, as well as minimising the use of exhaustible resources. This requires promoting the use of Eco-labels and Environmental Product Declarations, and it is essential to have up-to-date and reliable databases that incorporate all the environmental characteristics and impacts of products.

LA6: Use of renewable energies in buildings.

A basic aspect to achieve increasingly sustainable buildings is to increase the presence of renewable energies and improve their architectural integration. The new regulations on self-consumption, the climatic conditions of the Region of Murcia and a progressive reduction in the cost of renewable energies have led to an increase in the use of renewable energies in buildings.

of the installations will favour their implementation, especially in the energy sector. photovoltaics. The use of energy installations with maximum efficiency should also be encouraged.

LA7: Improving the management of demolition and construction waste.

An improvement in the management of waste originating in the building process is required, through an adaptation of its procedures, with special emphasis on those referring to small works. Progress should be made towards the end of the waste status for CDW, which will stimulate the creation of a bank of secondary raw materials and favour an industrial symbiosis with other productive sectors.

LA8. Updating and improvement of construction processes.

One of the conclusions of the diagnosis carried out in the EACS is that the construction process has evolved very little in recent decades, or at least not as much as in other productive sectors. Therefore, the design of actions that help to improve the construction process, resulting in greater sustainability, should be the object of this strategy. Aspects such as industrialisation, the reduction and management of waste generated during the construction process and the opportunities offered by new technologies such as BIM methodology and 3D printing will represent progress towards more sustainable construction models.

LA9. Promotion of collaborative methodologies for the creation and management of projects.

New technologies have provided tools that facilitate the collaboration of the agents involved in building and that will be a great help in moving towards more circular models in all sectors. The BIM methodology is in itself a collaborative methodology for creating and managing projects, which offers greater information on the process, encouraging the participation of all the necessary agents and joint decision-making, which results in more sustainable architecture and construction.

LA10. Actions led by public administrations as an example and driver of innovation

Public administrations must play a leading role in this transition towards the circularity of the building process. Their actions must be innovative and exemplary, and serve as a reference and model for the private sector. It is urgent to promote green procurement schemes in which price is not the main decision criterion for a project or construction of public buildings. Progress should be made in the implementation of e-government so that it is more accessible to citizens and administrative procedures are streamlined. Similarly, multilevel governance schemes in which the citizen is given a special role, as a relevant user of urban environments, favour a friendlier and more sustainable city model.

LA11. Promote a culture of building maintenance and rehabilitation.

Efficiency in the use of resources necessarily involves keeping them in their value chains for as long as possible. In the case of buildings, it is essential to extend their useful life by maintaining or improving their energy performance. This is achieved by promoting the maintenance of buildings and their installations throughout their useful life, the change of use and their refurbishment at the end of their useful life, and by offering a new opportunity to existing buildings, improving their consumption of resources such as water and energy.

LA2. Development of sustainable urban planning models

Urban planning figures are a determining factor in moving towards a more sustainable city. However, they are sometimes a barrier to this development model, hindering the implementation of more sustainable buildings. Existing legislation needs to be improved to establish criteria for the adaptation of existing planning towards more sustainable urban models that favour the renaturalisation of cities and the application of a more circular model in the building process.

LA13. Boosting nature-based solutions

Any sustainable urban model is based on the efficient use of natural resources. The current trend to renaturalise cities includes the replacement of grey infrastructures with others based on nature. This line of action will promote interventions with this type of solutions in the existing city, contributing to a less aggressive city that is friendlier and more pleasant for the citizen.

Relation of the general lines of action to the strategic objectives:

LA1	Dissemination of knowledge in society about the benefits of building and the sustainable urban space	SO1 SO5
LA2	Training of actors involved in the building process and urban planning	SO1 SO3
LA3	Promoting the use of LCA-based assessment tools	SO1 SO3
LA4	Implementing sustainability and eco-design in the project drafting phase	SO2 SO3
LA5	Availability of more sustainable building materials	SO2 SO3
LA6	Use of renewable energy in buildings	SO1 SO2
LA7	Improving the management of demolition and construction waste	SO2 SO5
LA8	Updating and improving construction processes	SO2 SO3
LA9	Promotion of collaborative methodologies for the creation and management of projects.	SO2 SO5

LA10	Actions led by public administrations as an example and a driving force of innovation	SO2 SO5
LA11	Promoting a culture of building maintenance and rehabilitation	SO2 SO4
LA12	Development of sustainable urban planning models	SO2 SO5
LA13	Boosting nature-based solutions	SO2 SO5

ANEXO

eacs

ategia de arquitectura y

egión de Murcia.

Región
Consejería
Dirección

Region of Murcia
Consejeria de Fomento e Infraestructuras
Direcci6nGeneral de Territorio y Arquitectura

ANNEX. METHODOLOGY FOR THE ELABORATION OF THE DIAGNOSIS

In order to be able to bring together the existing knowledge on the subject, not only in the Region of Murcia, but also outside it, the diagnosis of the current situation of sustainable architecture and construction has been carried out through an eminently participative process. To this end, in this first phase of the development of the strategy, a Technical Committee, a consultative body that brings together the main regional agents involved in the sector of design, construction, use and dismantling of buildings, has collaborated. Agents responsible for urban planning, which can have such an impact on the sustainability of the construction process, have also been included in this roundtable.

A.1. Participatory methodology

In order to draw up a diagnosis of the situation that is as realistic as possible and in agreement with the agents concerned, an active participation process has been implemented in which all the entities that form part of the Technical Committee have had the opportunity to intervene through one or more representatives.

The key element in achieving a transition towards more sustainable models that favour a more circular economy lies with the agents involved in the building process. They are the ones who know it best and who have the greatest interest in its evolution, in order to guarantee an activity that is so necessary for citizens and generates so much wealth.

In this sense, 3 general meetings of the components of the Technical Committee and a timeframe for the correct development of the participation actions have been established:

- First meeting. After a brief presentation of the members of the round table, the regional, national and European reference framework was presented during the meeting. Finally, a free turn by the attendees provided an initial overview of the process by the agents involved. The meeting concluded with the announcement of the subsequent bilateral meetings with all the entities, in order to gather key information first hand.
- Second meeting. The meeting begins with a presentation of the main conclusions obtained after the bilateral meetings held with each of the participating entities. A SWOT analysis proposal was also brought to the meeting, as a result of the information obtained in the interviews with each of the agents. Following the presentation of this analysis, a participatory methodology was implemented to finalise its definition and validation.
- Third meeting. The Strategic Objectives and Lines of Action that are incorporated into the EACS document are presented. The methodology for the elaboration of the EACS Action Plan is presented, inviting all the members of the Bureau to participate in the generation and proposal of specific actions.

Figure 18. Image of the first meeting of the Technical Bureau

Figure 19. Images of bilateral meetings

Figure 20. Images from the second meeting of the Technical Bureau

Figure 21. Image of the third meeting of the Technical Bureau

A.2. Composition of the Technical Bureau

The Technical Committee that has been set up includes representatives of the regional and local administrations, the teaching and research community, the business sector and associations and representatives of citizens and users:

Composition of the EACS Technical Bureau

1. Directorate-General for the Environment and the Mar Menor of the Autonomous Community of the Region of Murcia. Murcia
2. Directorate-General for Energy and Industrial and Mining Activity of the Autonomous Community of the Region of Murcia. of Murcia
3. Directorate General for Assets, IT and Telecommunications of the Autonomous Community of the Region of Murcia
4. Urban Planning Service of the Directorate General of Territorial Planning, Architecture and Housing of the Autonomous Community of the Region of Murcia.
5. Construction Technology Centre (CTCON)
6. Polytechnic University of Cartagena (UPCT)
7. San Antonio Catholic University of Murcia (UCAM)
8. Regional Confederation of Business Organisations (CROEM)
9. Regional Federation of Metal Entrepreneurs of Murcia (FREMM)
10. Association of Environmental Companies of the Region of Murcia (AEMA-RM)
11. Regional Federation of Construction Companies in Murcia (FRECOM)
12. Construction Labour Foundation (FLC)
13. Association of Property Developers of the Region of Murcia (APIRM)
14. BIMMATE
15. ECOPROYECTA Study
16. Studio ALMA VERDE
17. VERBO Studio
18. Official College of Architects of the Region of Murcia (COAMU)
19. Official College of Industrial Engineers of the Region of Murcia (COIIRM)
20. Official College of Civil Engineering (COICCP-RM)
21. Official Association of Industrial Technical Engineers of the Region of Murcia (COITIRM)
22. Official Association of Interior Designers and Decorators of the Region of Murcia (CODID-RM)
23. Official Association of Property Administrators of the Region of Murcia (COAFMU)
24. Official Association of Quantity Surveyors, Technical Architects and Building Engineers of the Region of Murcia. Murcia (COAATIEMU)
25. Federation of Municipalities of the Region of Murcia (FMRM)

In this way, all the areas of knowledge necessary to produce a change in the construction process.

A.3. Interviews for the collection of information

In order to obtain valuable first-hand information for the development of the diagnosis from the agents involved, bilateral meetings were held with each of them. In order to speed up these meetings, the main points on which specific information was sought and their opinion as experts in the building process were sent to them sufficiently in advance. These points are as follows:

- Your organisation's experience in process sustainability and the circular economy
- Good practices detected within and outside the Region of Murcia
- Main barriers in the region of Murcia for a transition to the circular economy
- Proposed actions
- Existence of data, previous studies, etc.
- What do you expect from EACS?
- What can it contribute?

Valuable information was obtained from these interviews, which can be summarised as follows:

A.3.1. Experiences in process sustainability and circular economy

The Construction Technology Centre (CTCON) is analysing the reuse of recycled aggregates (80% of CDW) with companies that manufacture prefabricated paving stones, vaults, terrazzo and kerbstones. In addition to a multitude of projects that allow progress to be made towards a more sustainable construction model, CTCON is developing two notable projects in the field of urban adaptation to climate change. These are the LIFE Heatland38 project on the use of light asphalts with high reflectance and low absorbance in the urban environment in order to reduce the heat island effect, and the design of Sustainable Urban Drainage Systems (SUDS) located under the streets and using recycled material from CDW.

In general, an important advance is detected in the thermal, electrical and plumbing installations of buildings, tending towards registrable systems that favour not only their maintenance and repair, but also a future dismantling of the buildings and their installations at the end of their useful life. The implementation of BIM methodology will help to consolidate this trend.

Similarly, it is necessary to highlight the extensive experience existing in the Region of Murcia in photovoltaic solar installations. Their use, in the form of self-consumption, can make a decisive contribution to the development of near-zero energy demand buildings (nZEB).

https://heatlandlife.eu/el-proyecto-life-heatland-prueba-en-murcia-un-asfalto-frio-que-reduce-la-contaminacion-en-las-ciudades/

One of the most important aspects dealt with in this section was the management of CDW. Demolition and construction projects where CDW is generated include a descriptive report on its management (RD 105/200839 , which regulates the production and management of construction and demolition waste). The annual reports that all CDW managers must submit to the environmental department of the autonomous community are also available. A thorough analysis of this information would be useful to achieve greater knowledge and better management of this waste.

However, the reuse of aggregates from CDW is complex. Even the concrete used in structural elements is difficult to recover. The need for local ordinances dictating the procedure to be followed to ensure that the CDW generated ends up in the facilities of the managers and not in uncontrolled landfills is highlighted.

The training capacity of the region is remarkable. Both the Fundación Laboral de la Construcción (FLC) and the Federación Regional del Empresarios del Metal de Murcia (FREMM) and the professional associations have extensive experience in training on the environmental management of works (and its monitoring by the FLC), energy efficiency and the use of renewable energies in buildings. In this regard, it is worth highlighting the BIMstone project, in which the Marble, Stone and Materials Technological Centre is participating, for the creation of training materials in BIM methodology.

There is also aid for investment in energy rehabilitation of the envelope, energy efficiency and the use of renewables in the residential, tertiary and industrial sectors. This aid is managed by different departments of the autonomous community. In addition, other state programmes also offer aid for the renovation of buildings, such as PAREER40, managed by the IDAE.

The need to be able to include environmental clauses in the tendering of building-related projects has been discussed, so that price is not the most important criterion in these contracts. In this regard, the Economic and Social Council of the Region of Murcia (CES-RM) is analysing the inclusion of eco-social (social and environmental) clauses in public procurement procedures, in accordance with Law 9/2017 on Public Sector Contracts41.

The Region of Murcia has professionals trained to design and construct buildings with high standards of sustainability and very low energy and water consumption. The number of buildings constructed with an A energy rating is still incipient, but those certified with the Green Tool or complying with *PassivHaus* requirements are beginning to spread. Also, the number of buildings certified with the Green Tool or complying with *PassivHaus requirements is* increasing.

https://www.fomento.gob.es/areas-de-actividad/ferrocarriles/normativa/03-impacto-ambiental/0311-real-decreto-1052008-de-1-de-febrero-por-el-que-se-regulating-the-production-and-management-of-construction-and-demolition-waste

https://idae.es/ayudas-y-financiacion/programa-de-ayudas-para-la-rehabilitacion-energetica-de-edificios-existentes

[41] Law 9/2017, of 8 November, on Public Sector Contracts, transposing into Spanish law the Directives of the European Parliament and of the Council 2014/23/EU and 2014/24/EU, of 26 February 2014. https://www.boe.es/buscar/act.php?id=BOE-A-2017-12902

experiences in sustainable urban design should be highlighted, with parks adapted to climate change that incorporate indigenous species and include SUDS. One example is the pilot projects developed within the framework of the LIFE Adaptate42 project. Other building projects that include the collection and use of rainwater, as well as the integration of renewable electricity generation and sun control, such as the Regional Printing House, are examples of the good work of designers and installers.

The meetings have highlighted the importance that the use of BIM (Building Information Modelling) methodology is already having, but above all, will have in the near future, throughout the building process. The Murcian Health Service (SMS), through the Directorate General of Information Technology, Assets and Telecommunications (DGIPT), is carrying out a pilot project that will use the building project in BIM format for tendering its construction and will also be useful in the different phases of the building's life cycle.

It is necessary to mention the training and research capacity of the universities in the region that offer studies related to the subject. While the UCAM has a course on "Sustainable Architecture" in which training is given on sustainable materials (earth, rammed earth, adobe, etc.), the UPCT has a research group working on polymer concretes which, as they do not require *clinker*, have a considerably lower carbon footprint. Researchers from both universities are working on the development of prefabricated products made from construction waste and, in general, on aspects related to sustainable construction.

A.3.2. Main barriers to the transition towards a circular economy in the Region of Murcia

These barriers that could hinder progress towards more sustainable building models have been classified as economic, regulatory or legislative, cultural, training and knowledge generation, and technological.

Economic barriers

- Building materials from recycled materials are more expensive than those coming directly from quarries and pose a higher risk.
- Waste managers have no outlet for the recycled product, so it is eventually landfilled.
- There are regional subsidies for housing rehabilitation, but so far the procedure is complicated due to the documentation required and the short opening period of the calls for proposals, and they take a long time to be resolved.

[42] http://lifeadaptate.eu/

- There is a shortage of suppliers of recycled building materials in the Region of Murcia, e.g. concrete with a certain amount of recycled material.
- Price increase in sustainable construction could put it out of business at present.
- Lack of maintenance in neighbourhood communities to reduce costs, which leads to a reduction in the performance of energy-consuming systems.

Regulatory and legislative barriers

- The main legislative barrier is related to the end of the waste status of many CDW fractions, which limits the possibility of a secondary raw material pool.
- There are considerable differences between Autonomous Communities in the administrative procedures of the agents involved in the management of CDW. In the Region of Murcia, the authorisation for such management can take a long time (up to 2 or 3 years), while in other neighbouring regions it takes no more than 3 months to obtain it. This leads to a lack of final hazardous waste treatment facilities in the region. On the other hand, waste transporters need a regional authorisation, which causes problems in border areas.
- A certain lack of communication between the different departments and levels of public administrations has been detected. This, in addition to coordination problems, generates a certain resistance to change at all levels.
- There is a dispersion of regulations concerning urban planning, between municipalities and between different departments of the Autonomous Community. In addition, the land law has led to an excessively restricted urban planning.
- Urban plans do not include sustainability criteria (waste management, energy and mobility) and, if they need to be modified, the process is excessively complex and time-consuming (it could take more than 10 years). There is also slowness in the granting of building permits and special planning documents.
- The establishment of a green tax policy is a valid tool in the hands of local authorities. However, tax benefits are regulated by the state law on local administration, which does not include aspects related to sustainability, which hinders its development.
- Public tenders give too much weight to price over other criteria such as sustainability, with the culture of low bidding prevailing despite the fact that the law on public sector contracts allows for its evaluation. However, local administrations may find it difficult to have professionals specialised in the evaluation of these concepts.
- Finally, it is necessary to mention the existing barriers to the use of renewable energies in buildings, due to the legal uncertainty that has been created during the last decade, with different changes in the regulatory framework.

Cultural barriers

- There is sometimes a belief that recycled material is of a lower quality.
- There is also a certain scepticism on the part of builders about the more sustainable models, since, after a period of severe crisis in the sector, they need a minimum of stability and shy away from any risk.
- Lack of awareness among professionals that architecture should be integrated into the site, take into account climate, terrain, etc.
- Sustainability in architecture must be present from the beginning of the project, not only through corrective measures.
- The use of standards based on life cycle analysis to certify that a building is sustainable is not yet widespread, although some examples already exist in the region.

Barriers to training and knowledge generation

- A lack of information and training has been detected on aspects related to sustainable architecture and construction in general, from the technicians of the public administrations to those corresponding to studios and companies in the sector. This lack of knowledge is also evident in the design of more advanced and efficient thermal and energy installations, which generates a certain lack of confidence when it comes to applying more efficient and innovative solutions. Something similar occurs with the use of BIM methodology or 3D printing, which will be fundamental in building processes in the medium term.
- Much progress has been made in passive systems, but the most studied examples at international level belong to colder climates, and local studies and experiences on the behaviour of buildings in our climate are needed.
- The shortage of organisations providing training on the different construction certifications The sustainable development of the region is also a barrier to its development.
- In order to be able to include sustainability-related assessment criteria in public contracts, it is necessary for materials to have certificates showing the environmental footprint they have generated in their production, information that is difficult to find in most cases. The lack of capacity of the administration's technicians to assess the LCA of building projects is also a major barrier to its application.

Technological barriers

- At present, there are technical difficulties in recovering insulation and foams, plastics and plasters from CDW.
- Inherent complexity of the most efficient thermal and energy installations.
- Construction companies are not keeping pace with planners to implement new building solutions.
- Excessive use of metals (mainly iron) in construction.
- The information on each material available in the BIM methodology may not be available in the BIM methodology.
  complete or inaccurate.

Architecture strategy y construction sustainable

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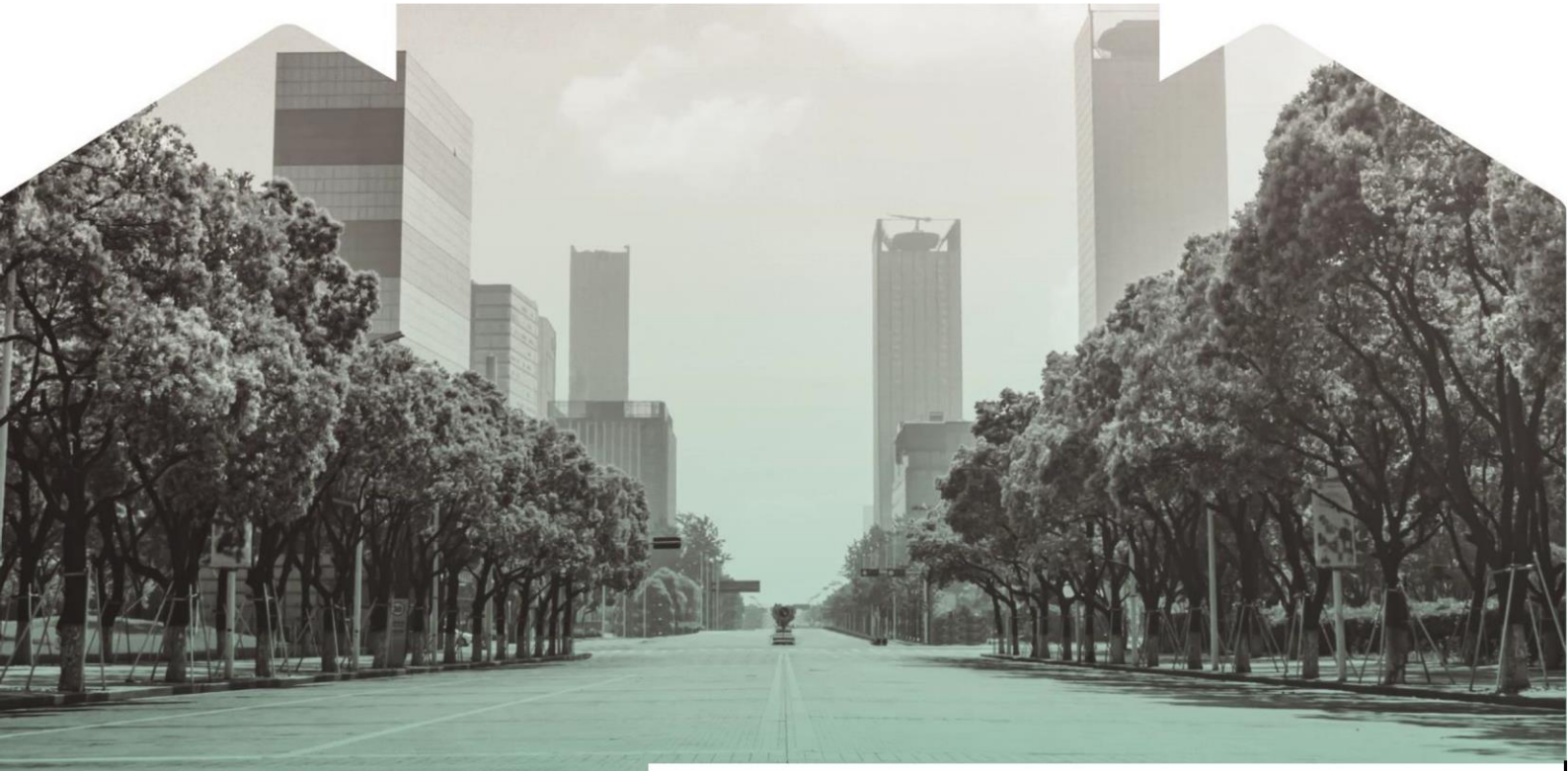
Strategy for sustainable architecture and construction in the Region of Murcia.



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Dirección General de Territorio y Arquitectura