my building is green
A LIFE PROJECT

LIFE my building is green

LIFE17 CCA/EN/00088

Application of Nature-Based Solutions for local adaptation of educational and social buildings to Climate Change

Action: A.1
Deliverable: Reference report to design and selection of technical criteria
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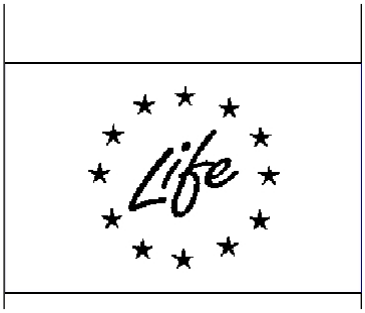
Date: Dec/2018



LIFE my building is green - LIFE17 CCA/EN/00088

Deliverable: Technical Criteria Design and Selection Reference Report

Date: Dec/2018

Data Project

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1.

1. SUMMARY EN ESPAÑOL

This deliverable contains an initial analysis of the general characteristics of the buildings that may be the object of the action.

The criteria have been grouped into two main categories to assist in the selection of buildings for demonstration: exclusive and inclusive criteria. The first ones must be used to carry out an initial filtering and remove from the initial inventory those buildings that are not susceptible of housing the proposed NBS. Subsequently, the inclusive criteria are used so that their evaluation in each building prioritizes the most suitable buildings for the demonstration, among which the appropriate one will be chosen in each location.

In each section the particularities of each place are taken into account (municipality of Porto, Comunidade de Alentejo Central and province of Badajoz).

2. SUMMARY

The objective of action A1, in which this deliverable is framed, is to define the criteria to be used for the selection of the buildings to be used as demonstrators. These criteria include both characteristics that seek the replicability of the solutions (such as the type or age of the building) and an adequate evaluation of the impact of the solutions based on appropriate indicators according to constructive, social, economic and environmental criteria.

This deliverable includes an initial analysis of the general characteristics of the buildings susceptible to be the object of the action. The selection of these criteria was made by all project partners seeking to maximize the impact of the project actions to demonstrate the goodness of the nature-based solutions (hereafter NBS[1]) proposed in *LIFE mybuildingisgreen*. The consortium developed a user-friendly internal document that outlined the design and selection of the technical criteria for the selection of the demonstrators.

The criteria have been grouped into two main categories to assist in the selection of buildings for the demonstration: exclusionary and inclusionary criteria. The former are to be used to perform an initial filtering and remove from the initial inventory those buildings that are not likely to house the proposed NBS. Subsequently, the inclusive criteria are used to evaluate each building and prioritize the most suitable buildings for the demonstration, from which the most suitable building will be selected in each location.

In the planned monitoring scheme, reference zones (areas similar to the NBS implementation areas but where no interventions will be made) are established for comparison. These reference zones can be within the same prototype building or in another one. Therefore, a section is also included to collect the conditions required for buildings that can be used as a reference or mirror to assess the impact of the implemented solutions.

Each section takes into account the particularities of each site (municipality of Porto, Comunidade de Alentejo Central and province of Badajoz).

Finally, there is a final section on other aspects to be taken into account that includes a legal aspect that may affect the selection of the building and an additional study proposed in mBiG regarding the concentration of radon gas in this type of building.

[1] Nature-Based Solutions.

3. CRITERIA EXCLUDING FOR THE SELECTION OF THE BUILDING

These criteria have been included because they are necessary for the realization of the demonstration and therefore allow a first filtering of the building inventory. This process speeds up the selection of buildings by applying the inclusive criteria listed in the previous section.

3.1. Technical criteria.

3.1.1 Flat and horizontal cover.

A flat and horizontal roof is necessary for the implementation of the typology of green roofs foreseen, so it is established as an EXCLUDING CRITERION that there is a flat and horizontal roof. If there is no space, **0 points in total**.

It is possible to install green roofs on sloping surfaces, but in addition to the technical complexity involved, this type of construction usually involves the existence of air chambers that already protect the interior from high temperatures and where the potential of this type of solution cannot be observed.

3.1.2 Availability of outdoor space.

Building with a courtyard or plot around it and with the possibility of planting trees, installing shading structures at some access points and draining soils. The minimum size of the patio is set at 800 m^2 and the distance from the trees to the buildings, in order to have induced natural ventilation, must respect the minimum distance established by regulations. Radiation will be taken into account.

As one of the expected results, the proposal established the objective of increasing the green areas (between the 3 buildings) by 0.5 ha (5,000 m²), including roofs, facades, floors and canopies or shading. Taking into account the estimated costs, and/or the maximum addressable areas, the required area could be broken down roughly as follows:

- Roof: 500 m².
- Frontage: 200 m².
- Canopy (car or pedestrian): 200 m².
- Soils (draining, green areas, with vegetation for ventilation): 800 m².

In any case, it is an inherent aspect of each building typology, so it is established independently by each partner.

An EXCLUDING CRITERION is that there must be an outdoor area of more than 800 m² in the case of DIPBA and CIMAC, and 500 m² in the case of Porto. If there is no space, **0 points in total**.

3.1.3 Anchoring to facade.

Facade without the possibility of anchoring. It will be necessary to have permitted anchorage areas, being the necessary loads very low, so any façade in good condition will be susceptible to be used.

3.1.4 No water intake available

It is established as an EXCLUDING CRITERION that there is a water connection. If the possibility does not exist, **0 points in total**.

3.1.5 There is no 220 single-phase electrical outlet available.

It is established as an EXCLUSIVE CRITERION that there is a 220 single-phase electrical outlet. If this possibility does not exist, **0 points in total**.

3.1.6 Availability of space for installations.

Availability of a small space for the installation of the auxiliary elements necessary for the green façade system, with a minimum area of 5-10 m2. These auxiliary elements include the systems for irrigation and fertilization of the garden and storage of other elements necessary for maintenance. Therefore, it is established as an EXCLUDING CRITERION that there is the possibility of having or implementing such space. If there is no possibility, **0 points in total**.

3.1.7 Ease of implementation of the NBS.

The availability to carry out work in July-August -during the closing of the school year- is established as an EXCLUDING CRITERION. If there is no possibility, **0 points in total**.

3.2. Socio-economic criteria.

3.2.1 Buildings with heritage protection

These buildings are not eligible for the demonstration because of the difficulty involved in promoting interventions in them.

3.2.2 No information is available.

If information on energy consumption (electricity and/or fuel) is not available, an adequate assessment of the impact of the implemented solutions will not be possible.

3.2.3 There is no possibility of interaction with building users.

If it is not possible to interact with users, social and some economic indicators will remain unassessed and are also very important for the demonstration.

4. CRITERIA INCLUDING FOR THE SELECTION OF THE BUILDING

The following is a non-exhaustive list of the requirements that will be requested/assessed to the buildings to house the installation of the NBS prototypes to be implemented in the project. These requirements are requested to facilitate the execution of the necessary works and the monitoring of the impacts of the designed actions. It should be noted that the criteria are not listed in order of importance, but only as a list without prioritization. The constructive and environmental criteria to be evaluated will be:

4.1. Technical criteria.

4.1.1 Roof in good state of conservation.

Roof in a good state of conservation without the need for work prior to installation. Absence of leaks or other problems in the roof that need repair. If this were the case, they would have to be repaired in a timely manner so as not to affect the installation of the green roof.

- If repair work is NOT required to eliminate leaks or other damage, **2 points**.
- If repair work is necessary to eliminate leaks or other damage, **1 point**.

4.1.2 *Flat and horizontal roof with gravel finish.*

Other finishes without gravel can be studied. Roofs with a slight slope (5-10%) will be allowed, but this will generate areas with water accumulation, so it will be necessary to design a drainage system or change the plant species to be incorporated to make them resistant for a longer period of time.

- If the flat roof is finished in GRAVA, **2 points**.
- If the flat roof has a finish other than GRAVA, **1 point**.

4.1.3 *Availability of space for installations.*

Availability of a small space for the installation of the auxiliary elements necessary for the green façade system, with a minimum area of 5-10 m^2 . These auxiliary elements include the systems for irrigation and fertilization of the garden and storage of other elements necessary for maintenance.

- If physical space exists but construction is required, **1 point**.
- If there is already space available for installations, **2 points**.

4.1.4 *Availability of outdoor space*

This criterion is assessed on a partner-specific basis.

In the case of DIPBA, according to the corresponding exclusionary criterion, the minimum yard size is set at 800 m^2 , but the greater or lesser value of this area may be valued as follows:

- Outdoor space >800 m2, <1,000 m2, **1 point**.
- Outdoor space >1,000 m2, **2 points**.

-In the case of CIMAC, a preferential outdoor area greater than 800 meters was established, weighted with a rating of 2 points. Areas less than 800m2 were assigned 0 points. The area of the flat roof was also considered. Thus, for a reference coverage of 500m2, the following classification was assumed: Coverage area between 200 and 500m2, 2 points. Coverage less than 200m2, 0 points and greater than 500m2, 1 point.

-In the case of PORTO, the score change was set at 2,000 m^2 .

4.1.5 *Availability of communications for monitoring.*

To enable monitoring of indoor air quality in buildings, it is necessary to have *wifi* in the building (for communications of carbon dioxide, humidity and temperature sensors). Accessibility to sensor control.

- If *wifi* is available, **2 points**.
- If there is no *wifi*, **0 points**.

4.1.6 *Building in need of improvement in air conditioning.*

To ensure that these are buildings with climate adaptation needs to improve their indoor environmental conditions, it will be necessary to assess whether there are records of excessive indoor temperatures, or requests by users to take effective measures for episodes of inadequate temperatures, either in the form of complaints, news or simply actions by different government bodies, such as the temporary closure of schools.

- There are press reports of episodes of complaints, **2 points**.
- There is no news in the press about episodes of complaints but users request action: **1 point**.

4.1.7 *Ease of implementation of the NBS.*

The ease of installation, mainly on the roof (transport and lifting of materials to the roof), and access, both during and after the work, are valued:

- Easy access to the roof. 1-story building: **2 points**.
- Difficult access to roof. 2-storey building or other conditions: **1 point**.

4.1.8 *Construction characteristics: Insulation.*

The suitability of the building, based on its thermal insulation, will be assessed based on the year of construction. The buildings with the worst construction characteristics, and therefore in which the impact of the action will be greater, are those built between 1939-1979, therefore the choice of buildings from this period will be prioritized. The evaluation of this criterion is included in the following section, because the same periods are used to justify the type of insulation.

In Portugal, the Regulation of Thermal Performance Characteristics of Buildings (the Building Standards), approved by Decree-Law no. 40/90, of February 6, was the first legal instrument imposing requirements for the design of new buildings and major renovations in order to safeguard the satisfaction of thermal comfort conditions in

those buildings without excessive energy needs both in winter and summer. Subsequently, Decree-Law no. 198/98, of May 7, 1998, deepened the legal rules on air conditioning in buildings, so it is also considered to be a relevant legal framework. In 2006, Decree-Law no. 80/2006 introduced the Regulation on the thermal performance characteristics of buildings, taking into account the thermal comfort requirements "(...) regardless of whether or not (...) they are subject to licensing or authorization in the national territory (...)". Thus, taking into account this brief history, the following assessments are proposed:

- Buildings prior to 1990 were rated at 5 points, considering that they have the least favorable thermal conditions;
- School buildings erected between 1990 and 1998 were given a score of 3 points;
- For buildings constructed between 1998 and 2006, an appreciation of 1 point was granted;
- For buildings constructed after 2006, the weighting will be 0 points.

4.1.9 Building with potential for replicability.

In order to promote replicability, the fact that in the period between 1960-1980 a large number of houses were built, due to the population growth that occurred at that time and that consequently led to the construction of a large number of schools, has been assessed (IETcc). By acting on schools from this period (mainly from the 1970s), the impact of the action will be more likely to be replicated (because they are similar buildings) and the result of the impact calculation will be more feasible.

In the case of Spain, NBE-CT-79 came into force on 22/1/1980 for buildings that did not have a building permit at that date. Buildings whose construction projects were subsequently licensed -and which therefore already complied with NBE-CT-79- would be completed as of 1981. Prior to this, Decree 1490/1975 came into force on 11/10/1975, which already required certain thermal transmission values by geographical zones. These buildings would be completed in 1976.

After a first analysis and in the absence of buildings with flat roofs prior to 1981, the criteria should be established around the dates 1981 and 2006 (entry into force of the CTE), as follows:

- Building constructed or undergoing renovation affecting the thermal transmission of the envelope PRIOR to 1981: **3 points**.

- Building constructed or with alterations affecting the thermal transmission of the envelope, POST 1981 and PREVIOUS to 2006: **2 points**.
- Building constructed or undergoing renovation that affects the thermal transmission of the envelope AFTER 2006: **1 point**.

In the case of CIMAC and PORTO, see previous section.

4.2. Socio-economic criteria.

The inclusion of these criteria also seeks to evaluate socio-economic variables in order to favor with this demonstration those areas with less possibilities or less social demand and therefore, in principle, with less budgetary availability to make interventions.

4.2.1 Population of the municipality.

-In the case of rural areas, in the case of Spain, priority will be given to a municipality with a population of less than 5,000 inhabitants for the selection of the building.

- Municipality with a population between 1 and 2,000 inhabitants: **3 points**.
- Municipality with a population between 2,000 and 5,000 inhabitants: **2 points**.
- Municipalities with a population of more than 5,000 inhabitants: **1 point**. It could be included as an excluding criterion, in order to limit the scope of the previous study.

-In CIMAC, however, given that the size of the municipalities is different in Spain and Portugal, other criteria were established. Even in areas of low density (as is the case of Central Alentejo), only 2 of the 14 municipalities have less than 5,000 inhabitants, the average being 12,000 inhabitants:

- Municipalities with a population of less than 12,000 inhabitants - 2 points;
- Municipalities with resident population between and 50,000 inhabitants - 1 point;
- Municipalities (only 1) with population over 50,000 inhabitants - 0 points

-This criterion was not applied in Porto, as it is a municipality.

4.2.2 Ratio of students per class.

Priority will be given to buildings with a lower ratio because they will be the schools with the lowest demand due to their characteristics.

- Ratio of less than 25 students/class: **2 points**.

- Ratio equal to or higher than 25 students/class: **1 point**.

4.2.3 Location in a disadvantaged neighborhood.

-In the case of urban areas in DIPBA, it will prevail that the location of the social or educational facility is in a disadvantaged neighborhood.

- Building located in disadvantaged neighborhood: **2 points**.
- Building NOT located in a disadvantaged neighborhood: **1 point**.

-This aspect has not been considered necessary in the CENTRAL ALENTEJO area.

-In PORTO, the percentage of the population living in social housing (% Moradores em Habitação Social (Freguesia de implantação do edifício)) was taken into account, establishing a scale of between 1 and 7 points.

A criterion of 0 or 1 point was also established in Porto as to whether or not the project is located in a disadvantaged neighborhood.

4.2.4 Unemployment rate.

It will be assessed that the registered unemployment rate is higher than the national and/or regional average (in the municipality or in the neighborhood, in the case of cities).

-For the case of the province of BADAJOZ for example, SEPES data[2] in August 2018 establish gross rates (over general population) of between 3.4% and 19%. The following valuation will be established, taking into account the proportion:

- Unemployment rate higher than 10%: **2 points**.
- Unemployment rate below 10%: **1 point**.

This aspect has not been considered necessary in the Central Alentejo area.

-In the case of PORTO, the percentage of unemployment was taken into account, establishing a range between 1 and 7 points between neighborhoods.

[2] SEPE - Servicio Público de empleo Estatal (State Public Employment Service). https://www.sepe.es/

4.2.5 *Family income level.*

It will be prioritized that the household disposable income index per inhabitant in the locality or neighborhood where the building is located, is below the national and/or regional average. The GDP per capita (€/inhabitant) should be below the national and/or regional average.

-For the case of the province of BADAJOZ for example:

- GDP BELOW the average (14,600 €): **2 points**.
- GDP ABOVE the average (14,600 €): **1 point**.

-Not taken into account in Central Alentejo and Porto.

4.2.6 *Evolution of the population in the locality or neighborhood.*

Areas with a negative population trend will be sought.

-For the case of the province of BADAJOZ, for example:

- Decrease of MORE than 10%: **2 points**.
- Decrease LESS than 10% or growth: **1 point**.

-As for the demographic variation rate in Central Alentejo, the following assessment was assumed:

- - Municipalities with population losses greater than 10% between 2001 and 2011 (Census). - 2 points;
- - Municipalities with population losses of less than 10% between 2001 and 2011 (Census) - 1 point;
- - Municipalities with population increase between 2001 and 2011 (Census) - 0 points.

-In the case of PORTO, scales were established for each neighborhood, awarding between 1 and 7 points.

4.2.7 *Others.*

In case of needing to further refine the selection of buildings, other indexes can also be used, such as:

- Child dependency ratio,
- dependency ratio for the elderly,

- dependency ratio of children and adolescents
- and municipal social welfare index below the national and/or regional average.

On the other hand, in the case of cities with a population of more than 50,000 inhabitants, some indicators present in the *Urban Audit* methodology could also be chosen[3] .

[3] http://ec.europa.eu/regional_policy/en/policy/themes/urban-development/audit/

5. CRITERIA FOR REFERENCE BUILDINGS OR AREAS

The definition of a mirror or reference building is considered to be a building close to the one chosen as the project demonstrator and with similar characteristics (necessarily in the same town to ensure the same climatic conditions for comparison). In this reference building a monitoring of the impact indicators would be carried out similar to that of the prototype buildings in order to have a baseline with which to compare.

Example: two schools in the same village, a health center and a social services center in the same town, etc...

5.1. Criteria

The following is a non-exhaustive list of the requirements that would be requested of the buildings used as a mirror image of the buildings where the NBS prototypes are implemented:

- Have *wifi* in the building (for carbon dioxide, humidity and temperature sensor communications).
- Construction characteristics (materials, date of construction) and orientation similar to those of the prototype building.
- Proximity to the chosen project demonstrator is highly desirable.
- Preferably with episodes of need for action on temperature-related issues, in the form of decisions, complaints or news.
- Availability of information on energy consumption (electricity and/or fuel).
- Possibility of interaction with building users.

6. OTHER ASPECTS TO TAKE INTO ACCOUNT

When applying the proposed solutions to the building, the necessary compliance with current building regulations must be taken into account.

In the case of Spain, the **Technical Building Code (Código Técnico de la Edificación),** and in particular the energy saving provisions of the **CTE-HE**, according to which, in interventions in existing buildings (section 2.2.2.2.1).

2 En las obras de reforma en las que se renueve más del 25% de la superficie total de la *envolvente térmica* final del edificio y en las destinadas a un cambio de *uso característico* del edificio se limitará la *demanda energética conjunta* del edificio de manera que sea inferior a la del *edificio de referencia*.

La exigencia de limitación de la demanda energética que resulta aplicable en el caso de las obras de reforma tiene en cuenta el alcance de la intervención, de modo que se distinguen dos casos: cuando en la intervención se renueva más del 25% de la superficie total de la envolvente térmica del edificio (que es el que está especificado en el párrafo 2 anterior), y el resto de obras de reforma en las que no se supera el porcentaje citado (que es el caso recogido en el párrafo 3 siguiente).

A efectos del cálculo del porcentaje de la superficie total de la envolvente térmica del edificio afectada por la reforma, se ha de tener en cuenta lo indicado en el apartado 5.2.1 de esta sección, según el cual está compuesta por todos los cerramientos que delimitan los espacios habitables con el aire exterior, el terreno u otro edificio, y por todas las particiones interiores que delimitan los espacios habitables con espacios no habitables en contacto con el ambiente exterior.

Lo que establece esta exigencia es que la demanda energética conjunta del edificio reformado no supere la demanda energética conjunta del edificio de referencia (edificio que se define en el apéndice D de esta sección y cuya construcción es similar al edificio de la opción simplificada que se recogía en el CTE 2006). Es decir, no hay una exigencia explícita para los elementos considerados individualmente (por ejemplo, no hay fijadas unas transmitancias térmicas máximas para cada elemento), pero sí una exigencia implícita para ellos al estar limitada la demanda energética del edificio en su conjunto. Ello puede permitir una mayor libertad al proyectista en cuanto a las soluciones a disponer, pero a la vez puede obligar a adoptar soluciones con transmitancias menores a las del edificio de referencia si no se opera sobre todos los elementos. Asimismo, en algunos casos el cumplimiento de esta exigencia puede implicar intervenir en elementos inicialmente no previstos, en la línea de que se lleven a cabo intervenciones globales y profundas en los edificios.

Cabe mencionar que en la Introducción del DB HE, apartado IV "Criterios de aplicación en edificios existentes" se incluye el denominado "criterio de flexibilidad", En caso de aplicar dicho criterio, en el proyecto debe justificarse el motivo de su aplicación y en la documentación final de la obra debe quedar constancia del nivel de prestación alcanzado y los condicionantes de uso y mantenimiento, si existen. Conviene indicar, asimismo que, según se establece en la parte I del CTE (modificación introducida mediante la disposición final undécima de la Ley 8/2013, de 26 de junio, de rehabilitación, regeneración y renovación urbanas), queda bajo el criterio y responsabilidad del proyectista o, en su caso, del técnico que suscriba la memoria, la aplicación de aquellas soluciones que permitan el mayor grado posible de adecuación efectiva al Código Técnico de la Edificación.

3 En las obras de reforma no consideradas en el caso anterior, los elementos de la *envolvente térmica* que se sustituyan, incorporen, o modifiquen sustancialmente, cumplirán las limitaciones establecidas en la tabla 2.3. Cuando se intervenga simultáneamente en varios elementos de la *envolvente térmica*, se podrán superar los valores de *transmitancia térmica* de dicha tabla si la *demanda energética conjunta* resultante fuera igual o inferior a la obtenida aplicando los valores de la tabla a los elementos afectados.

Esta redacción de la exigencia hace posible, por ejemplo, superar el límite de transmitancia establecido en la tabla 2.3 para un elemento aislado a cambio de compensar su impacto en términos de demanda energética conjunta mediante una actuación más profunda en otro u otros elementos aislados que sean objeto de reforma. Una aplicación de este caso podría ser la incorporación de huecos con altas prestaciones para limitar la necesidad de mejorar las prestaciones energéticas en la zona opaca de una fachada que es objeto de reforma, lo que podría ser conveniente, por ejemplo, en el caso de edificios con fachadas de muros de carga de gran espesor, con interés arquitectónico, etc.

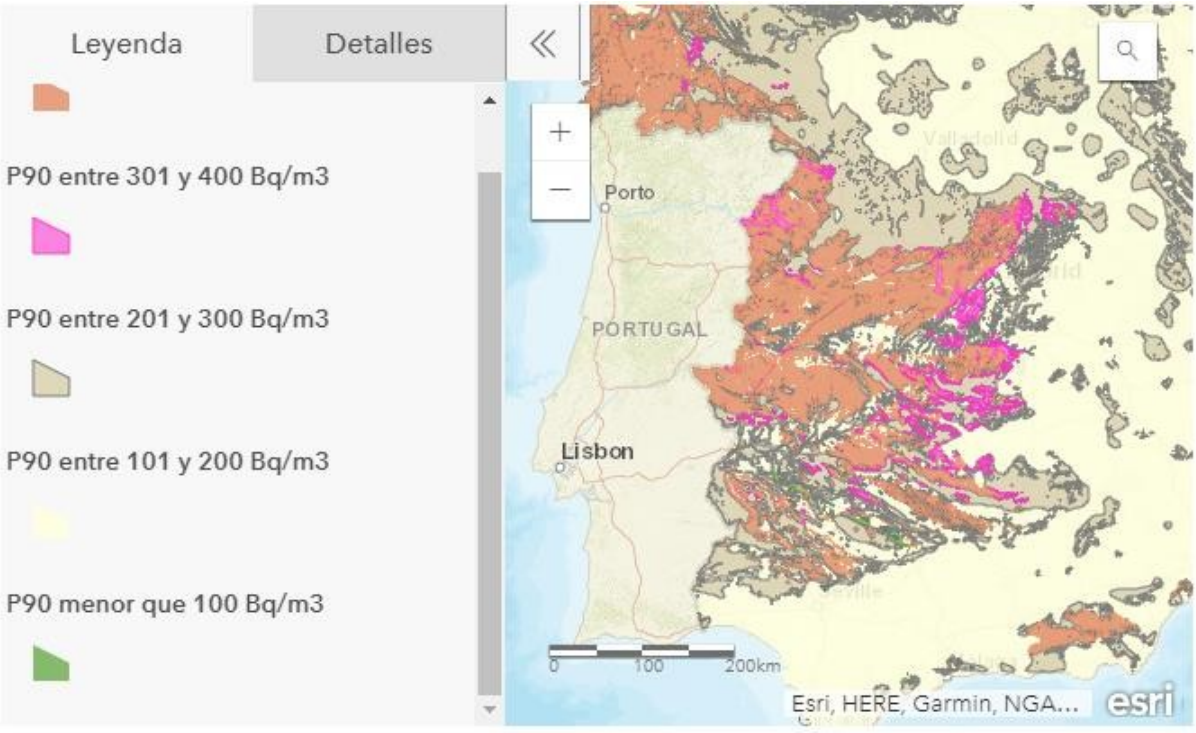
La comprobación de que dicha compensación es válida a efectos de cumplimiento de la exigencia está ligada a que el edificio reformado sea equivalente a efectos energéticos al correspondiente a haber aplicado la tabla 2.3 a los elementos afectados, lo que se verifica mediante la comprobación de que la demanda energética conjunta del edificio así reformado resulta igual o inferior a la demanda energética conjunta obtenida aplicando los valores de la tabla 2.3 a los elementos afectados.

Figure 1. Excerpt from the Technical Building Code.

This document shows that in the event that the surface area of the building (roof and façade) exceeds 25% of the building envelope, the "combined energy demand" of the building should not exceed that of the "reference building" (according to concepts defined in the CTE), which would inevitably lead to having to renovate other elements where no action is initially planned. This element will have to be evaluated before the final selection of the building because it would significantly modify the scope of the action.

On the other hand, in order to evaluate an additional impact of the implementation of this type of solutions, the **radon gas** concentration measured during the on-site screening visit is considered for the selection of the building within the short list. This parameter is outside the intended scope of the project but it turns out to be a possible benefit associated with the implementation of this type of solutions in general, and in particular by the incorporation of natural ventilation criteria inside the building. The problem of radon gas accumulation in certain buildings is also relatively prevalent in many areas of southern Europe, which would share the problem of climatic adaptation of public buildings.

In the case of Spain, the province of Badajoz has a high potential for the presence of radon gas, and there are higher concentrations in the north and northeast, although with a wide dispersion, which does not allow us to operationally establish a selection criterion for this aspect:



FDE-02.17 Mapping the radon potential of Spain