LIFE my building is green

LIFE17 ENV/EN/000088

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

Action: Mainstreaming and transferability at local, national and European level

Deliverable: Protocols (2) for expert workshops on NBS and quality certificates

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Index

1. SUMMARY IN ENGLISH

This deliverable is part of action C5. "Integration and transferability at local, national and European level". It includes two short protocols on possible considerations to be taken into account by experts working with Nature-Based Solutions (NBS) and trying to certify the quality of these solutions through the certification of the sustainability of the buildings where these solutions are implemented.

In the first protocol, the importance of the prior considerations necessary to propose NBS as strategies for the improvement of building sustainability, the criteria that support the proposal of these technologies, was made clear. This document discusses the necessary aspects to deepen and substantiate the proposal, especially quantitatively. This section shows methods and tools for estimating and monitoring the performance of NBS.

In a second protocol, more detail is given on the design of the energy and sustainability certificates, as well as on the construction and use of the building in which the proposed solutions are implemented.

2. RESUMEN ESPAÑOL

Este entregable forma parte de la acción C5. "Integración y transferibilidad a nivel local, nacional y europeo". Se incluyen dos breves protocolos sobre posibles consideraciones que deben tener en cuenta los expertos que trabajen con Soluciones basadas en la Naturaleza (SbN) y que tratan de certificar la calidad de estas soluciones a través de la certificación de la sostenibilidad de los edificios donde estas soluciones son implementadas.

En el primer protocolo de esta serie se ha dejado clara la importancia de las consideraciones previas necesarias para proponer las SbN como estrategias para la mejora de la sostenibilidad del edificio, los criterios que avalan la propuesta de estas tecnologías. En este documento se habla sobre los aspectos necesarios para profundizar y fundamentar la propuesta, sobre todo cuantitativamente. En esta sección se muestran métodos y herramientas para estimar y monitorizar el comportamiento de las SbN.

En un segundo protocolo, se expone mayor detalle del diseño de los certificados energético y de sostenibilidad, así como sobre la construcción y el uso del edificio en el que se implementan las soluciones propuestas.

3. RESUMO EM PORTUGUÊS

Este resultado faz parte da ação C5. "Integração e transferibilidade a nível local, nacional e europeu". Inclui dois pequenos protocolos sobre possíveis considerações a ter em conta por peritos que trabalham com Soluções Baseadas na Natureza (SBN) e que tentam certificar a qualidade destas soluções através da certificação da sustentabilidade dos edifícios onde estas soluções são implementadas.

No primeiro protocolo desta série deixámos clara a importância das considerações prévias necessárias para propor as SBN como estratégias para a melhoria da sustentabilidade do edifício, os critérios que suportam a proposta destas tecnologias. Este documento discute os aspectos necessários para aprofundar e fundamentar a proposta, especialmente a nível quantitativo. Nesta secção, são apresentados métodos e ferramentas para estimar e monitorizar o desempenho dos SBN.

Num segundo protocolo, é dado mais detalhe sobre a conceção dos certificados energéticos e de sustentabilidade, bem como sobre a construção e utilização do edifício em que as soluções propostas são implementadas.

4. PROTOCOL ON SBN AND ITS RELATION TO ENERGY CERTIFICATION. PART 1.- CONCEPTUAL DESIGN

Recognition of the negative impact of the building sector on climate change has led to the establishment of adaptation and mitigation actions. In this context, certification systems such as LEED, BREAM and Level(s), among others, have helped to assess the commitment of stakeholders to more sustainable buildings. Most of these certification systems take into account the aspects of the project that have the potential to generate comfortable, healthy and safe conditions in the building. In the case of existing buildings that do not meet the required performance, there are construction techniques that can improve their capacity to respond to climate change.

In this sense, the potential of nature as support systems for the energy rehabilitation of buildings has now been revalued. These systems have adopted the name nature-based solutions (NBS). Many technologies have been integrated under this concept, such as green roofs and façades, or draining floors. However, a large part of the professionals involved in the creation and maintenance of buildings do not have a clear idea of the potential of these systems to improve the sustainability of buildings. This fact contributes to overlooking SBNs as viable techniques for the realisation of more sustainable projects.

As part of the LIFE-myBUILDINGisGREEN project, this pair of documents compiles relevant and useful information on the general benefits of SBNs in sustainability certification processes. The Level(s) certification system has been taken as a reference to order and expose the points that were considered necessary to facilitate stakeholders' understanding of the positive influence of these techniques to the sustainability rating of buildings.

This document, written as a protocol, has been divided into two parts. The first part shows the guidelines are focused on the design phase, while the second part focuses on the detailed design process, construction and use of the building.

The guidelines to be considered are divided into the following sections:

1. Greenhouse gas emissions and pollutant emissions
    a. Energy efficiency
    b. Global Warming Potential
    c. Design for deconstruction
2. Efficient use of water resources.
3. Healthy and comfortable spaces.
    a. Indoor air quality
    b. Lighting and visual well-being
    c. Acoustics and noise protection
4. Resistance to extreme weather events
5. Value creation and risk exposure

Each of these points is developed further below.

4.1. <u>Greenhouse gas and air pollutant emissions during the life-cycle of a building</u>

From the design phase, the proposed inclusion of techniques such as SBNs should consider their potential benefits to justify their incorporation into the project. The energy contributions of these systems are generated from the reduction of the energy consumption of other active systems: cooling, heating, ventilation, lighting, etc.

a. Energy efficiency

According to the criteria established in certification systems such as Level(s), priority is given to the strategies to be implemented to achieve energy efficiency in buildings. In this sense, passive technologies applied to the building envelope have the highest preference, systems integrated to the enclosures that achieve a better mediation of the climatic conditions to improve the energy performance of the building. If these measures are not sufficient, energy efficient equipment can be used. Lastly, it is possible to opt for the use of equipment whose energy requirement comes from renewable energies.

A key factor is the interaction of the building with its environment. It is often the lack of compatibility between these elements that leads to excessive energy use.

A design proposal must take into account the pre-existing conditions on the site. Climate is a key factor. By knowing the climatic behaviour of the site, it is possible to generate a design proposal that takes advantage of meteorological variables before trying to contain them.

In order to propose the incorporation of a SBN, it is essential to be aware of local conditions: temperature, solar radiation, rainfall, wind speed and direction. Knowledge of these factors will help to optimise the selectivity of rehabilitation strategies.

In the case of renovations, in addition to climatic knowledge, it is important to know the state of the building to be renovated. The implementation of SBNs requires compliance with certain conditions on the part of the building. In relation to plant structures, the plants to be incorporated as part of the SBN must be selected in accordance with the natural environment and the building's capacity to accommodate these systems.

The introduction of SBN can aid energy reduction by optimising the thermal properties of building components. The use of green roofs can improve the thermal insulation of an envelope to delay the passage of heat through the envelope, while natural ventilation strategies can reduce indoor temperatures. These actions result in more comfortable thermal environments.

In the energy refurbishment of buildings, it is necessary to know the background of the building: year of construction, construction characteristics, infrastructure, equipment, location and information on previous occupants. The collection of this information will allow for a better incorporation of the renovations. In relation to SBNs such as green roofs, the structural capacity of a roof to accommodate one of these green systems without the need to reinforce the pre-existing structure must be known. It is important to remember that the loads that increase with the incorporation of a green roof depend on its type: extensive, intensive or intermediate, as each involves the placement of plants of greater or lesser size and different thicknesses of substrate.

In a certification system such as Level(s), all considerations regarding the implementation of SBNs as energy improvement systems can be included in the corresponding formats and sections. Such documents can specify the elements and criteria taken into account for the inclusion of these strategies in the design and the way they are planned to be implemented.

b. Life Cycle Global Warming Potential

Construction is one of the sectors with the greatest influence on global warming, as many of the materials used in this field involve high greenhouse gas emissions. Logically, these emissions can be significantly reduced by reducing, reusing or recycling the materials involved in the process, as well as opting for those that generate fewer emissions.

From the design phase, the efficient use of the materials that will make up the works can be foreseen. This assessment can also be applied to SBNs. Although these strategies are useful in addressing climate change, they are not exempt from the rationalisation of their materials.

There are substrates for green roofs that come from recycled materials, such as clay bricks, which in addition to having suitable properties represent a higher ecological value.

Global warming can also be reduced by prolonging the life of building elements. In this sense, the proposal for green roofs and façades can be based on the extension of the useful life of the host structures. These green roofs have the capacity to reduce deterioration due to solar incidence and exposure to temperature changes that normally occur in an envelope exposed to the exterior.

c. Design for deconstruction

One of the items that is rated in a certification system is the ability to recycle or reuse the built elements. In this respect, green roofs and facades have many advantages, as their components are not combined, but remain independent elements that can easily be separated. These elements do not contain any concrete or other similar elements that involve a mixture of materials. From the design phase, it is envisaged that green roofs will be implemented on existing enclosures and elements of the project or on non-permanent structures. In this aspect and taking Level(s) as a reference, some of their capacities are exposed:

- Disassembly: In ground cover, most of the component layers of the system are separable. In vegetated canopies, steel or similar structures can usually be disassembled and reassembled elsewhere relatively easily and without significant damage.

- Reuse: Some of the layers of the green roof system contain elements with standardised dimensions that can be removed and become part of a similar system. As for the vegetation, often the plant included in the system can be replanted on another substrate.

- Recycling: Some of the component layers of green roofs are made of materials suitable for recycling processes.

The benefits considered for the proposal should be presented in the appropriate formats, showing the specific element, the capacity for deconstruction considered and the description of the disassembly, reuse or recycling process.

4.2. Efficient use of water resources

Water efficiency is addressed in certification schemes such as Level(s). The design phase should take into account the water capacities and demands of the SBNs. A water management plan can be established to identify the elements necessary to optimise water use and reuse.

In this sense, techniques such as drainage floors and green roofs, which have the capacity to capture rainwater for later reuse, are relevant. The use of reused water allows savings in the use of drinking water by the building.

As with the design of conventional green areas in a project, for green roofs and facades it should be proposed to use vegetation with low water consumption, to avoid unnecessary irrigation through a moisture monitoring system in the substrate and to generate a suitable environment that delays the evaporation of moisture.

Decisions regarding the selection of strategies based on their water performance should be presented in appropriate formats, showing the concept as it relates to water treatment and describing the performance involved.

4.3. Healthy and comfortable spaces

Design proposals involving the inclusion of SBN in the project should be assessed against criteria relating to hygiene and comfort within the spaces. Such comfort should be considered beyond thermal aspects. The capabilities of SBNs are recognised in the current scientific literature, which recognises their positive influence on aspects such as:

- Air quality
- Thermal well-being
- Lighting comfort
- Acoustic comfort

It is necessary to clearly establish the criteria taken into account for the implementation of these systems, considering the advantages in each of the above-mentioned areas.

a. Indoor air quality

For the selection of SBNs dedicated to improving indoor environmental quality, the principles of how each strategy works must be understood. There is a vast amount of literature that addresses the effectiveness of SBNs in reducing indoor pollutants. Among these strategies are natural ventilation techniques and the use of vegetation as purification elements. These techniques should be strategically located and configured to address the areas with the most critical levels.

The natural ventilation strategy, as well as the other SBNs to be incorporated, should correspond to the requirements of each space, considering the needs and expectations of the users. They should also consider outdoor conditions, pollution levels and local climate.

Pollutants come from a variety of sources, from inhabitants and building materials to air conditioning equipment. Natural ventilation involves a number of configurations to renew indoor air and minimise the use of active systems. Although it is not always possible to dispense with the use of such equipment altogether, the aim is to minimise their use as much as possible.

With regard to vegetation as a purification element, prior knowledge of the reduction potential of the plant species considered for the project, including the type of pollutant it reduces, must be obtained.

b. Time outside the thermal comfort interval

The designer should identify the parts of the building where thermal comfort conditions can be generated and suggest the use of SBN to counteract them. In this regard, knowledge of the thermal needs of the user and the context of the project should be taken into account. In the case of refurbishment works, the characteristics of the building to be refurbished should also be identified.

Knowledge of the pre-existing conditions will enable the correct location and use of thermal improvement strategies. In this area, SBNs have great potential, and there are many examples of the effectiveness of such strategies in improving thermal conditions. The addition of vegetated sunshades on façades whose orientation generates solar overexposure in summer will allow for better management of solar energy. An additional benefit of this vegetation technique is the dynamic behaviour of the vegetation. Unlike a static element, the use of deciduous plants will reduce the sun's rays in summer, while in winter the falling leaves will allow more sunlight to fall.

On the other hand, the layers that make up the green roofs are elements that add thermal insulation to the roofs, generating warmer interior spaces with less temperature fluctuations. In addition, in hot climates, the effects of photosynthesis and evapotranspiration will contribute to the cooling of the envelope, reducing dependence on cooling systems.

The Level(s) system itself recognises the capabilities of vegetation as a micro-climatic improvement element, i.e. the thermal benefits that plants bring not only to the interior but also to the exterior of the building are recognised.

With regard to vegetation as a purification element, prior knowledge of the reduction potential of the plant species considered for the project, including the type of pollutant it reduces, must be obtained.

c. Lighting and visual well-being

Natural light is healthy for people, increases the feeling of comfort and improves work processes. However, there may be levels of lighting that are harmful, generating glare or visual discomfort that affect the performance of activities by users.

It is the task of architectural design to regulate lighting levels through the design of the building itself. For this, in addition to knowledge of the appropriate lighting levels, special emphasis should be placed on the radiation levels and the solar path of the region, which in addition to being useful criteria for the sizing and arrangement of the building's windows, are also useful for the design of sunshades.

There are mobile and fixed shading systems. Although fixed systems, such as sunshades, are most often made of conventional materials, there are plant-based alternatives that can offer greater benefits in terms of daylighting. These SBNs have the ability to regulate light conditions and avoid glare. Although their main task is to reduce solar incidence where necessary, by filtering natural light through the leaves, adequate levels of illumination can be maintained.

d. Acoustics and noise protection

Within the concept of comfortable and healthy spaces, acoustics must be considered. Sound disturbance can create an uncomfortable environment for the user, interfere with communication between people in a space and, at certain levels, can even cause health problems.

From the project concept, design criteria should be channelled to obtain acoustically efficient spaces. External noise barriers can be provided, it is always suggested that the enclosures are constructed of materials with good acoustic properties. However, the capacity of these barriers can be increased through SBNs.

Green elements such as green roofs and green walls not only have thermal, energy, psychological and lighting benefits, but also acoustic advantages. These techniques have proven to be elements that can reduce decibels between two spaces. In order to make a correct arrangement of SBNs in the project, it is important to identify the usual sources of these sounds.

The proposal for the implementation of SBN for acoustic treatment may be elaborated under the advice of specialists, interior designers and other related professionals.

All considerations regarding the implementation of SBNs as acoustic improvement techniques may be included in the relevant formats and sections. This type of document should identify the type of insulation to which the SBN relates (acoustic, airborne noise, impact noise, equipment noise, indoor absorption) and the rationale for the selection of the technique, describing its capabilities and its relevance to the project.

4.4. Resistance to extreme weather events

This indicator refers to the capacity of the building to cope with these natural phenomena. As explained in Level(s), it is not possible to reduce such events, but action can be taken to reduce their effects on a building.

The region's historical information on such events should be available and likely adaptation measures should be identified. This is where SBNs can be proposed. In a green roof, the substrate is a water absorbing element. With respect to rainwater, this property delays the release of this water into the streets or the public drainage network, reducing the risk of flooding.

These measures would be classified under the type "Green Adaptation Measures" which, under the same definition as Level(s), are "*Measures to improve the resilience or adaptive capacity of a building based on nature-based approaches*".

The cost and benefits of adaptation measures should be included. As stated in Level(s), in the case of SBNs, the benefits of increased biodiversity and improved user welfare may be included.

4.5. Value creation

This section tries to establish the increase in value due to the effect of sustainability. The section will take into account all the above benefits, which can be summarised as energy savings, healthy and comfortable spaces and a building that is more resistant to extreme weather events. Compliance with some of these conditions will undoubtedly increase the market value of the building.

4.6. Conclusions

The indicators of the Level(s) system are divided according to the phases of the project: conceptual design, detailed design, construction and use of the building. This document places special emphasis on the design aspects, i.e. it considers the aspects of the SBNs that should be foreseen at the time of project design. The established protocol contains important points to consider in order to implement and justify the proposed SBNs in the design phase of a project that intends to certify its sustainability.

The conceptual design stage is the moment when improvement strategies are proposed. Despite being the first stage of the project, the proposals must be based on functionality criteria, beyond aesthetic aspects. SBNs are not a fashionable concept, they are alternatives to increase the sustainability of buildings. Most of these strategies have been fully studied, their benefits have been demonstrated and quantified.

In the paper, it has been shown how SBNs have the potential to positively influence sustainability ratings issued by certification schemes such as LEVELS. The benefits of these systems fit into most of the categories of this system.

Thermal, lighting and acoustic comfort, and energy and water efficiency are fields included in the objectives of the SBN and valued in certification systems. However, it is the task of those involved in the generation of the project to propose and argue for the inclusion of these technologies that work with natural resources.

5. PROTOCOL ON SBN AND ITS RELATION TO ENERGY CERTIFICATION. PART 2.- DETAILED DESIGN, CONSTRUCTION AND USE OF THE BUILDING

In the first document of this series, the importance of the prior considerations necessary to propose SBNs as strategies for the improvement of building sustainability, the criteria that support the proposal of these technologies, was made clear. This document discusses the necessary aspects to deepen and substantiate the proposal, especially quantitatively. This section shows methods and tools to estimate and monitor the performance of SBNs.

In this document, the last two categories considered by part 1 of the document have been omitted, as they are not developed in the reference certification scheme (Level(s)) and cannot be suggested by the authors of this document. Therefore, the sections present in this part 2 are:

1. Greenhouse gas emissions and pollutant emissions
    a. Energy efficiency
    b. Global Warming Potential
    c. Design for deconstruction
2. Efficient use of water resources.
3. Healthy and comfortable spaces.
    a. Indoor air quality
    b. Lighting and visual well-being
    c. Acoustics and noise protection

Each of these points is further developed below.

5.1. Emissions of greenhouse gases and air pollutants during the life cycle of a building

a. Energy efficiency

At the detailed design stage, it is necessary to estimate the potential benefits of the technologies to be incorporated. It is possible to calculate the contributions that the incorporation of SBNs represents in terms of energy. To do this, it is necessary to have the reference information that allows these calculations and the appropriate tools for this task.

By means of an energy simulation programme, it would be possible to estimate the thermal contributions to the interior that a green roof of a given type will represent, mainly based on the thermal coefficients of the enclosures, the construction plans and the climatic archives of the region. The results will be a quantified basis for the potential benefits of these systems.

Once the SBNs have been installed and before the handover of the building site, the correct functioning of the implemented strategies must be ensured. It is recommended to carry out relevant tests according to the type of technique, such as thermal behaviour or air tightness tests. According to the test results, it will be possible to identify if there are any defects and, depending on the case, an appropriate solution can be found.

After the user has lived in the building for a considerable period of time, the spaces can be monitored in order to keep a quantified record of energy consumption. In this way it is possible to identify where the highest energy consumption occurs: heating, cooling, lighting, and where appropriate, corrective actions can be taken to the installed SBNs. For example, it will be possible to identify that the placement of a vegetal parasol is inadequate and is generating a greater use of natural lighting, so the arrangement of the element could be improved. It is important to take into account the ways in which the incorporated techniques are used, as this could considerably modify their performance.

b. Life Cycle Global Warming Potential

In the detailed design phase it is important to consider estimating the benefits of including SBN. As for the overall life-cycle warming potential, the estimate can be calculated through a computerised LCA programme. With reference to SBNs, software tools already exist that can perform LCA of green roofs.

Before using a computer programme for simulation, its suitability should be assessed through the following questions: is the programme specific to construction, how many LCA phases does it cover, does it take into account environmental product declarations and relevant standards, how is it operational, how much does it cost, does it have any certification to back up its results, how much does it cost, does it have any certification to back up its results?

Estimates under this heading should take into account the design of new buildings or refurbishment of existing buildings. It is also desirable to take into account the useful life of each SBN and future conditions that may alter its performance.

These estimates should indicate the origin of the process, raw material and product data used for the life cycle analyses. Currently, some companies include "Environmental Product Declarations" (EPD) for green roof systems. These reports, in addition to providing reliability on the environmental information of the system elements, allow the comparison of similar products and contribute to improve the selectivity of the SBN.

In the project detailing phase, the SBN materials must be quantified, the necessary technical requirements, the details of their implementation in the design, the costs of the materials involved and their useful life must be available. For example, at this stage, the type of vegetation cover to be installed (extensive, intensive or intermediate), the irrigation periods and sources, and the spatial conditions necessary for its maintenance, among other aspects, must be defined.

Once the SBNs have been built, the actual heating potential of the incorporated technique can be estimated using the same methodology used in the detailed design phase, but now taking into account what was actually used for their construction.

c. Design for deconstruction

In the detailed design phase the construction potential of the elements incorporated in the project, in this case the SBNs, will be estimated. As part of this objective a scoring method can be established that considers the components to be deconstructed, the type of deconstruction, quantities and other valuations.

It is necessary to make a plan for the treatment of the elements to be deconstructed, carrying out an analysis to establish their final destination.

As with any construction material, quantification of the waste or reused materials must be carried out during the execution of the work. In addition to the quantification, the cost of each waste and its destination may be included.

At the detailing stage the quantification of the materials will be provisional, while once the building is constructed this quantification will correspond to what has actually been purchased.

5.2. Efficient use of water resources

In the project detailing phase, the water consumption needs of the proposed SBNs and the amounts of water reuse that can be provided by systems with this capacity should be quantified. Different scenarios can be established to determine the optimal design that best manages water use.

A table can specify, for example, the characteristics of the areas of vegetation cover to be installed, including vegetation type, irrigation demand, density and micro-climatic impact. For reclaimed SBNs, the origins and destinations of the reclaimed water must be determined, even if they are linked to systems outside the implemented SBN (toilets, sinks, irrigation systems, etc.).

Once the building is constructed, quantification of water use can be derived from actual bills. Estimates calculated in the detailed design can be compared with actual consumption data.

5.3. Healthy and comfortable spaces

a. Indoor air quality

The detailed design and construction should consider the thermal and energy effects that the strategies will have on the building. Different ventilation strategies can be simulated using computer systems to determine their effectiveness in renewing indoor air.

When the building is in operation, the instrumentation needed to monitor pollutants, ventilation and humidity within the space and the strategy to be followed to collect and analyse this data should be established.

As a follow-up measure, surveys can be carried out with the inhabitants to find out their perception of the space and, in case of any disagreements, bring them to the attention of the person in charge of managing the building's affairs.

b. Time outside the thermal comfort interval

In terms of detailed design, in order to know the thermal levels at which the user feels comfortable, the current regulations should be consulted. Computer modelling can be used to simulate the thermal conditions that could be generated in the building and to determine the number of hours in and out of the thermal comfort range throughout the year. The computational models can include a building with SBN and one without. In this way the thermal benefit of adding these techniques can be quantified.

Once the building is operational, the actual thermal records can be obtained and compared with what was predicted in the previous simulation. For monitoring, a plan needs to be established involving the inhabitants for the installation of the instruments. The thermal performance of the spaces with the built-in SBNs will have to correspond with the perception of the inhabitants, so surveys will be developed to record the opinion of the users.

c. Lighting and visual well-being

As discussed in the previous sections, simulation and calculation methods are used in the detailed design phase and during the construction and use of the building to estimate the potential benefit and then check it once the project is built. In systems such as Level(s), lighting comfort is only considered at the conceptual design stage as it is based on qualitative elements. However, the reference documentation makes clear the intention to include lighting and visual comfort in subsequent phases of the conceptual design and clarifies that there are quantitative parameters that can be adopted.

In this regard, lighting simulation systems could be adopted to generate a model that provides an approximate quantification of the potential benefits of SBNs. If the proposal includes a deciduous vegetal sunshade, the development of an approximate computational model of this technique would allow determining the amount of lux present inside the building during the summer and winter seasons.

This quantification would be useful to establish different scenarios that, in cases like this one, contemplate both the lighting and thermal models, since, in the case of vegetal parasols, the results of each can be linked.

A lighting monitoring system can also be specified to detect insufficient light in the space. In a vegetal sunshade, the leaves can grow to such an extent that they affect the visual comfort of the inhabitant.

Once the building is constructed, the data resulting from the computational model can be compared with the monitoring measurements to determine the correspondence of the data.

d. Acoustics and noise protection

In the Level(s) system, the processes for assessing acoustics at the detailed design and construction stage and the use of the building have not been developed. However, it is recommended to investigate acoustic simulation software in order to establish a suitable parameter for estimating the acoustic benefits of SBNs.

Initially, decibels and noise maps generated from models simulating project-specific spaces and sources of sound disturbances could be considered as the unit of estimation.

Following the logic of the certification system procedures, noise monitoring would need to be implemented so that simulated data can be compared with real data when the building is constructed.

However, these recommendations need to be reviewed and validated by experts in the field.

5.4. Conclusions

In this part 2 of the protocol, which covers the detailed design, construction and use of the building, the processes for quantifying the improvement potential of SBNs within a project are shown in a general way. This action brings reliability to the selection of the technique in the conceptual part. Subsequently, it is a matter of checking that the results of the estimation correspond to reality once the building has been constructed, for which, in many cases, a suitable monitoring system must be set up to provide the required data.

In order to properly estimate the benefits of SBNs, the right tools must be available. Many of the simulation programs referred to above have the potential to simulate the behaviour of SBNs and, in line with current technological developments, there will be many more that will optimise these calculation processes, if and when society demands them.

For this reason it is important to disseminate the advantages of SBNs as optimisation measures. Through popular interest, calculation tools, studies and regulations will be forced to integrate these technologies into their objectives.

6. BIBLIOGRAPHY

This document is based on the Levels(s) course of the eu academy, an official website of the European Union. It can be accessed via the following link: https://academy.europa.eu/