18

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First experiences in the development of slovenian sustainable building indicators

FIRST EXPERIENCES IN THE DEVELOPMENT OF SLOVENIAN SUSTAINABLE BUILDING INDICATORS

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SUMMARY: The construction sector is recognised as having a key impact on the life on Earth. Consequently, the EU has set clear environmental goals for 2030 and 2050, and is developing policies and tools to achieve them. One of the tools for achieving these goals is to establish a system for the evaluation of the environmental performance of buildings, with the priorities of reducing GHG emissions, saving with natural resources and preserving the environment, while maintaining sustainable development and ensuring a healthy living environment. Slovenia has joined in achieving this goal with a study on the state-of-play, commissioned a few years ago by the Ministry of the Environment and Spatial Planning, as the starting point for the development of sustainable building indicators (SBIs). The research, which included an analysis of the Slovenian legislation, commercial certification systems for sustainable buildings and development in the field of green public procurement, exposed complementary but rather different goals and views. It further showed that the Level(s), which provides a common EU approach in assessing the environmental performance of buildings, seems to be the most appropriate framework and the basis for the development of the Slovenian system of SBIs. The development of the Slovenian SBIs is currently underway within the project LIFE IP CARE4CLIMATE with the preparation of guidelines, data sources and procedures for determining the value of individual indicators for the assessment of buildings. Initial research with key construction stakeholders has shown that the solution must be linked to the national building legislation, computational methods and software tools, and also to the established planning procedures. The analyses have also shown that, parallel to developing such a system, it is essential to provide a functional supporting environment and a specific, purposely designed information platform to connect the stakeholders with the developers of the sustainable building indicators system.

KEY WORDS: sustainable building indicators, evaluation, assessment, Level(s), CARE4CLIMATE.

1 INTRODUCTION

One of the key factors for the sustainable development of society is the establishment of a sustainable approach in construction. The sustainable approach addresses a holistic view of the built environment and the building itself, which must be user friendly and environmentally friendly. Therefore, the holistic view must include the assessment and the evaluation of buildings according to sustainability criteria, i.e. environmental, economic and social aspects, as well as technical and functional aspects. In order to achieve this high quality in the process of construction of new buildings and/or their renovation, an evaluation system needs to be developed and adopted. The assessment should include a comprehensive system for the evaluation of sustainable buildings and should be based on the criteria for the assessment of individual indicators and their integration into a balanced scheme.

In the field of the evaluation of sustainable construction and certification of buildings, commercial systems already exist. Among them, the most widespread and recognisable are LEED, BREEAM and DGNB. However, they are very complex to use and are not uniform or mutually comparable to each other. The European Commission (EC) is therefore trying to establish a common framework for the evaluation of sustainable buildings, Level(s), covering the whole life cycle of a building and thus able to address their great potential for reducing greenhouse gas emissions, resource efficiency and material flow, and the health and well-being of building users [1]. The key challenge of the EC is to ensure that the uniform metric of sustainable construction is widely used throughout the value chain of the construction sector in the Europe [2].

Level(s) is a framework system of sustainable building indicators, based on the standards of the CEN/TC 350 group, and is not designed as a certification scheme with a final evaluation score for classification. Level(s) mainly provides guidelines for the planning and construction of buildings according to sustainable principles. The system is still evolving at a European level, both in structural and functional terms, but nevertheless already provides the basis for future adaptation to national conditions. Level(s) implementation will have a significant impact on the introduction of a circular economy system, which is in line with the European Green Deal's plan to make Europe the first climate-neutral continent by 2050 [3, 4]. In fact, Level(s) is strongly related to the statement of a new Action Plan for the circular economy, which for 2021 announces a new “comprehensive strategy for a sustainable built environment”. The document also mentions the involvement of Level(s) in life cycle assessments in public procurement and European sustainable financing schemes [5].

Slovenia is aware of its commitments to the EU's goals regarding climate change and the exploitation of raw materials and natural resources. In addition, we are conscious of the importance of Slovenia's transition to a sustainable society, so we recognise the need for developing and implementing criteria for sustainable buildings. At various segments and levels, quite a few attempts have already been made to switch from energy efficiency to environmental efficiency in buildings as well, and to introduce the principle of life cycle consideration into planning. Attempts at market initiatives, incentive programmes for the implementation of state policies, as well as attempts at legal requirements in the field of construction and change in the framework of green public procurement are known. However, all these did not lead to significant progress yet. It is therefore quite obvious that Slovenia also needs a convincing professional base in this area for raising the level of the necessary professional knowledge, collection and editing of required data and for selecting the tools. In particular, Slovenia needs a methodology that will adequately cover the sustainability aspects of buildings.

The development of the Slovenian system for the evaluation of sustainable buildings was therefore proposed as an important research task in Action C4.4 within the research project LIFE17IPC/SI/00007 – LIFE IP CARE4CLIMATE (2019–2026). The activity is carried out by two institutes, GI ZRMK and ZAG, together with the Ministry of the Environment and Spatial Planning. The main aim of the Action C4.4 in the project is to create Slovenian sustainable building indicators (SBI), the comprehensive system for sustainable assessment and evaluation of buildings. The aim is also the establishment of a supportive e-environment in the form of knowledge, accessible databases and tools useful for general use. This national SBI system will be conceptually harmonised with the European system Level(s) and the content will be adjusted to the national specifics of the construction sector.

The aim of this paper is to highlight the basis for the development of Slovenian sustainable building indicators, SBI, and to provide the currently identified main obstacles and shortcomings to their implementation, which were perceived in the first phase of system development.

2 THE BASIS FOR SBI

The starting point for the development of the Slovenian SBI was the study of the current situation in Slovenia, “Review of the system of sustainability criteria with a transfer proposal” [6], which was prepared in 2017 by GI ZRMK and ZAG on behalf of the Ministry of the Environment and Spatial Planning. Based on the results of comparing existing international schemes for assessing sustainable buildings, and evaluating the possibility of transferring individual systems to the Slovenian legislative environment, the researchers prepared an initial suggestion for a set of criteria. They also proposed an action plan for the introduction of a system of sustainable building indicators (SBI). The concept was in line with current trends in sustainable construction in the EU, with the emerging Level(s). The Slovenian concept also supported the implementation of priority policies in the field of reducing greenhouse gas emissions in the life cycle of the building. Furthermore, it promoted efficient use of water, raw materials, healthy and comfortable living conditions, and addressed the adaptation to climate change.

The basis for the development of the Slovenian system is the aforementioned European framework Level(s), prepared by the Joint Research Centre – JRC in 2015-2017 [7]. Level(s) is a common EU framework of core sustainability indicators for the evaluation of office and residential buildings. The system is structured into six macro objectives and provides a set of individual indicators, scenarios and tools for assessing the environmental performance in a building's life cycle. In addition to environmental characteristics, it also includes an assessment of other important properties of buildings that affect healthy and comfortable living, as well as an assessment of life-cycle costs and the management of potential future risks for the operation of the buildings.

The common EU Framework of core sustainability indicators, presented in the JRC publication [7], provides:

- Macro objectives, defined in the areas of energy, materials and waste use, water and indoor air quality, which contribute to the set European and national policy orientations in the field of sustainable construction.

- A set of nine core indicators (and sub-indicators) and common metrics for measuring the properties of buildings that contribute to each macro objective. The system is designed to promote the use of the Life Cycle Assessment (LCA) and Life Cycle Costing (LCC) methods.

- Lifecycle-based scenario tools: a set of four scenario tools and one data collection tool, together with a simplified LCA analysis that supports a comprehensive analysis of building properties taking into account the entire life cycle.

- Property valuation influence and reliability rating, which can assess the potential positive effect on the valuation of the property and demonstrate the reliability of the performance appraisal in the valuation using the Level(s) framework.

Depending on the complexity, the method provides for three levels of assessment (hence the name of the method: Level(s)):

- Level 1: Common performance assessment – determination of indicators based on a common methodology, the simplest and most accessible type of use for each indicator.

- Level 2: Comparative performance assessment – comparison between functionally equivalent buildings, at the national level or within the portfolio of buildings of one investor (need for laying down the rules to support the comparability of results).

- Level 3: Performance optimisation assessment – advanced use of indicators, for professionals to perform complex analyses (which may include accurate simulations, modelling, anticipating future costs, risks and life cycle opportunities) and determine the optimal design of the building.

The Level(s) framework is not yet finalised at this time; its Beta version was available for testing from autumn 2017 to September 2019, which, according to the analysis [2], included 136 construction projects from 21 countries, including 2 from Slovenia. Detailed analysis [8] of the response of experts revealed the general expectations of the profession regarding Level(s). It showed that due to the complexity of the system, only indicators at Level 1 were mostly tested. It also highlighted methodological gaps, especially in the life cycle aspect and in the use of results in the decision-making process, as Level(s) does not provide reference values.

The European Commission continues with the development of the Level(s) framework, with great emphasis in the future on integration into digitised planning through BIM tools and on the realisation of the idea of a building passport.

3 DEVELOPMENT AND CONCEPT OF SBI

3.1 Action plan of SBI

In the next phase of the development of Slovenian sustainable buildings indicators (SBI) the research work became part of the project LIFE IP CARE4CLIMATE (2019-2026), Action 4.4. The first two years were dedicated to stakeholder consultations and the preparation of the initial Alpha version of SBIs. Stakeholders were consulted through several workshops: workshop with the public sector, construction industry, architects and engineers, researchers, professional organisations, the Eco Fund, ministries, etc. Designing of the Alpha version of SBI took place in an inclusive process with key decision makers, users and developers.

Like Level(s), the Alpha version of the SBI will undergo a testing process, which will involve interested users. The purpose of this first testing is to verify the applicability of individual, nationally adapted indicators and to define the content of everything that is needed at the national level when adapting Level(s) (e.g. knowledge, tools, databases, criteria). Testing of the Alpha version will take 12 months and will go on interactively through a "supporting environment and e-platform", including online training. Both the SBI supporting environment and the e-platform are essential for the development of the indicator system (Figure 1). The process of formation, improvement and upgrading of the SBI supporting environment and the e-platform will take place gradually. It will be created in close cooperation with external experts in various fields in order to provide information and data to assess the selected indicator, and to share the necessary knowledge about methods, tools, standardisation and about the progress in a particular field [9].

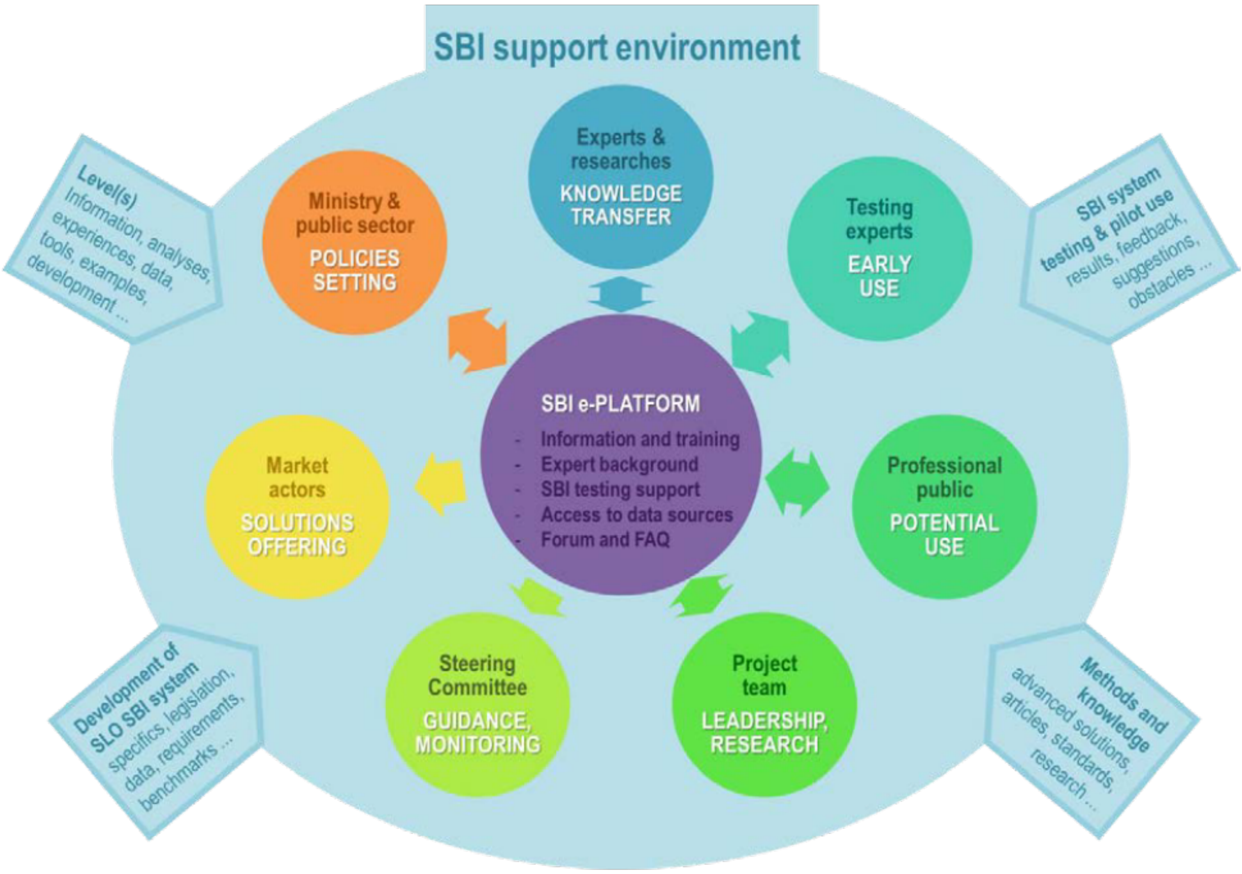

Figure 1: Structure of supporting the environment and the e-platform for Slovenian sustainable building indicators.

The second part of the project is planned for the development of the SBIs upgrade. The SBI will be integrated into a comprehensive evaluation system called the Beta version. This will be followed by the phase of balancing the indicators and testing them on the selected projects. Thus, by 2026, the plan is to prepare a functioning system for the evaluation of sustainable buildings, nationally adapted and in line with the updated Level(s) framework.

3.2 Concept of SBI

The Alpha version of the SBI contains the same structure of the six macro objectives of the Level(s) framework, and the corresponding set of indicators and tools. Already in this first version, some preliminary values of indicators are envisaged, which are harmonised with Slovenian legislation, building regulations and rules of good practice. Identified gaps in the criteria, software tools and databases have been added; as well as gaps in the knowledge required to carry out the assessment and in established construction procedures and legal bases. In this way, the general harmonisation of the Slovenian SBI and circular economy in the construction sector with European guidelines will be ensured. The proposed structure of the Alpha version of the SBI is presented by the individual macro-objectives below along with key findings and comments.

Macro-objective 1: Greenhouse gas emissions during a buildings life cycle

For indicator 1.1, *Use stage energy performance*, the procedures for determining energy use in a building are methodologically supported with the building regulation, the Rules on the efficient use of energy in buildings [10], the corresponding technical guideline and with the EN EPB family of standards. Through all the analyses, ambiguities were found, such as the determination of renewable and non-renewable parts of primary energy. But they are expected to be eliminated with the adoption of a new regulation that will consistently build the calculation methodology on the standards of the EN EPB. The various software used in Slovenia to calculate energy consumption are mainly suitable for determining the indicator. In particular, when using simpler programmes with a monthly calculation method, it is taken into account that the reporting of energy flows is allowed in a slightly aggregated way.

Indicator 1.2, *Life cycle Global Warming Potential*, is more complex and its gradual introduction into practice can be expected. In order to define the indicator, it is necessary to make a LCA of building from cradle to cradle in accordance with SIST EN 15978. LCA analysis at this level is still very demanding for real implementation in the Slovenian environment, and a number of input data is missing. However, it is possible to apply simplifications based on the treatment of an incomplete life cycle, such as life cycle stages, described in modules in EN 15978 "A1-3, B4, B5, B6" or "A1-3, B6, C3-4, D". These are primarily phases that demonstrate the environmental impact of the materials used and the impact of the use of the building, but may also include the impact of the end of the life cycle of the building and the burdens and benefits across system boundaries. Among the key input data for the implementation of LCA analyses are EPDs, so it will be necessary to provide a EPD database for products on the Slovenian market. Another option is to lay down rules for the use of generic data for building products and materials.

Macro-objective 2: Resource efficient and circular material life cycles

The first tool, 2.1, *Bill of Materials (BoM)*, is based on an inventory of individual materials. Inventory must include all materials that are installed in an existing building (or in case of planning, materials that will be installed) and also the materials that are expected to be available upon demolition of the building in question. For this indicator, an overview of the building components is first made, which is approximately similar to the so-called "inventory of construction works" that is a required part of Slovenian construction documentation. An overview of the materials contained in the components is then prepared and finally classified into four groups according to Eurostat: metal materials, non-metallic mineral materials, biomass-based materials and fossil energy materials. As the "inventory of construction works" in Slovenia has not yet been standardised, the preparation of the BoM will require quite a bit of effort. It can be expected that the practical use of BIM tools, which will enable the systematic provision of the necessary data from the early project phases in the design of buildings, will simplify the preparation of the BoM.

The BoM is an important starting point for the determination of some other SBIs and for the use of the group of 2.2 *Scenarios for building lifespan, adaptability and deconstruction*. These address three aspects: the planning aspect of the building and elements lifespan, the planning aspect for the adaptability and renovation of the building, and the planning aspect for decommissioning, reuse and recycling. The result is information about the building in terms of scenarios for building lifespan, its adaptability and deconstruction.

The indicator 2.3, *Construction and demolition waste and materials*, is the only indicator from Macro-objective 2 in Slovenia, which is already regulated by the construction waste management plan during construction and must be harmonised with the Decree on the management of waste generated during construction works.

The tool 2.4, *Cradle to grave Life Cycle Assessment analysis*, performed in accordance with SIST EN ISO 14040/44 and SIST EN 15978 requires in practice the use of specialised software and, above all, access to a wide range of databases. Generic data in various databases are available, but for fine optimisation at level 3, specific data on individual products and materials related to the Slovenian construction sector – production and market – is needed. Supporting software packages that meet the requirements for the implementation of the LCA are available and are already used in Slovenia. However, due to the relatively high complexity and required knowledge of the software operators, the use of these tools requires a suitably qualified user and additional resources on the part of the project team, as well as a well-informed client.

Macro-objective 3: Efficient use of water resources

This macro-objective contains only one indicator: 3.1, *Total water consumption*, which refers to the efficient use of water in the use phase of the building. The indicator assesses the use of water per occupant per year, with the exception of the use of water for the manufacture of products for the building and for the construction of the building. The Slovenian SBI has adopted the Level(s) tool for this indicator, which offers Excel tables with default values that can be used for estimations when data are not available.

The indicator is suitable for use in the Slovenian construction sector and is methodologically sufficiently supported. However, real data for the water use factor per user and for microclimatic factors (in the case of assessing the need for water for irrigation) are missing for Slovenia. But in the first step, these values can be defaulted from the Level(s) system.

Macro-objective 4: Healthy and comfortable spaces

The first of the two indicators in macro-objective 4, 4.1, deals with *Indoor air quality*. One of the building ventilation simulation tools should be used for the assessment at the planning stage, and the entire building should be included in the calculation. All parameters predicted by the method, ventilation rate, CO_2 concentration, relative humidity, benzene concentration and particulate matter ($PM_{2.5/10.0}$), must be classified according to the prescribed standards. In accordance with the standards, it is also possible to assess the presence of mould.

From the point of view of controlling emissions of harmful substances into the indoor environment, the method is also based on a systematic inventory of all key materials that will be installed in the building and on the indication of their emissions. Emissions of harmful pollutants for each material must be determined on the basis of standard test methods. However, the challenge in Slovenia is the availability of these data. An assessment based on measurements is performed after the completion of construction, with mandatory testing of the operation of the ventilation system, and optional measurement of radon concentrations.

The second indicator, 4.2, *Time outside of thermal comfort range*, is assessed with two sub-indicators, the operating temperature or PMV and PPD index, and the criteria for local thermal comfort. The assessment is carried out during the design of the building by means of simulations of the thermal response of the building by switching heating and cooling on and off. Any computational tool (e.g. PHPP, EnergyPlus, IDA ICE, TRNSYS) can be used for simulations. The method does not prescribe the use of dynamic simulations, but gives them an advantage. It is also possible to perform a simplified determination of the indicator with an estimate of overheating.

Macro-objective 5: Adaptation and resilience to climate change

Macro-objective 5 with one indicator, 5.1*, Scenarios for projected future climate conditions*, which refers to the climatic conditions in 2030 and 2050, has the same methodological procedure. Here, with the help of the scenario tool "Protection of occupier health and thermal comfort", the possible medium- and long-term effects of climate change on the user's health and thermal comfort in the building are examined. The analysis can be carried out with one of the proposed climate change scenarios and relevant climate data for the future. In addition to the original design of the building, simulations on the model can predict more efficient designs using advanced materials with a number of passive and active measures to reduce the effects of extreme summer temperatures caused by climate change.

Macro-objective 6: Optimised life cycle cost and value

The indicator 6.1, *Life Cycle Costs (LCC)*, is used to estimate the costs and values in the life cycle of a building. The standardised procedure covers the initial costs of building construction and the costs of operating the building, including energy, water, the maintenance, repair and/or replacement of building parts and components, and end-of-life costs. Land costs and costs for activities taking place in the building are not included in the assessment.

The LCC analysis determines the net present value (NPV) of the total discounted costs over the estimated useful life-span of the building. The use of special computer programs for this purpose is neither necessary nor common in practice. At the beginning of the introduction of the method, a simplified LCC analysis can also be used, covering only selected life cycle phases. This reduces the complexity of the analysis and brings the LCC closer to the user of the sustainable building evaluation. Selected phases can be, for example, the product phase (A1-3) and the application phase – energy and water (B6-7) or the product phase (A1-3) and the application phase – maintenance, replacement, repair, energy (B2-4, B6).

DISCUSSION

The analysis has shown that experts in Slovenia are very likely to master the Macro-objective 1 well, but they will have significantly more problems with the Macro-objective 2, as they have practically no experience with its particular indicators and tools. From its group of criteria, Building bill of materials (BoM), unified scenarios for building lifespan, adaptability and deconstruction and Cradle to grave Life Cycle Assessment, only the treatment of the indicator Construction and demolition waste and materials is already established. In addition, indicator 3.1, Total water consumption, is suitable for use in the Slovenian construction sector. It is methodologically sufficiently supported, assuming that it will be supplemented with missing data on real water use. The study further revealed that evaluating a building according to indicators 4.1, Indoor air quality, and 4.2, Time outside of thermal comfort range, means that it is necessary to master more demanding software tools. On the other hand, the implementation of BIM and the development of plug-ins for BIM software, which will enable simpler modelling of energy flows and thermal comfort parameters in the building, are expected to facilitate and automate the process and enable its control. As this is a methodologically identical principle, a similar finding applies to indicator 5.1, Scenarios for projected future climate conditions. Additionally, it can be established that for preparing the analyses for this indicator, it will be necessary to select one of the proposed climate change scenarios at the national level and then use data from one of the climate atlases (e.g. Meteonorm) or prepare the necessary national data. And finally, the study showed that indicator 6.1, Life Cycle Costs (LCC), is manageable; nevertheless, the biggest challenge in LCC analysis will be to provide input data and boundary conditions for analysis.

Investors are currently not yet acknowledging the slightly higher planning input due to the digitisation of the process and the evaluation of sustainability aspects in buildings [10]. In the public sector, incentives and pilot projects are typically needed to highlight public procurement processes in the field of sustainable buildings. It is clear that the faster the digitisation of the construction process, especially the implementation of BIM, also means great opportunities for implementing the sustainability evaluation. But it also brings with it the need to establish system support – to provide, for example, harmonised unified databases for products and systems. Last but not least, it also brings the need to set legislative requirements for environmental product declarations (EPDs), which are gradually gaining importance on the Slovenian market [11].

With the Level(s) upgrade, the EC grasps great potential for expanding the method, including integration with national building policies and in public procurement of buildings. On the other hand, the results of testing the Level(s) framework showed a relatively low level of maturity of the system. Therefore, radical changes can be expected in the new version, which will also affect the development of the SBI in Slovenia.

CONCLUSION

The importance of sustainable buildings in Slovenia is gradually being recognised on several levels of the construction sector, including in the design profession. However, there are still many obstacles for their actual use in practice. In most cases, organisational, technical and procedural constraints, a lack of knowledge for planning and skills, gaps in the digitisation of sustainable building design and a deficiency of databases emerged. But most importantly, there is no metric for sustainable buildings in Slovenia. This shortcoming is intended to be remedied by developing the national sustainable building indicators SBI, the task currently being performed in the LIFE IP CARE4CLIMATE project in accordance with the EU Level(s) framework.

Based on initial research with key construction stakeholders, it can be concluded that the SBI solution must be strongly linked to the national building legislation, computational methods and available software tools, as well as to established planning procedures. In parallel with the development of the SBI system, it is also essential to provide a functional supporting SBI environment and e-platform.

Above all, it can be concluded that the development of Slovenian indicators of sustainable construction in Slovenia is taking place at just the right time to catch the European development wave in the introduction of common metrics for sustainable buildings.

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