The Assessment System for Sustainable Building BNB by Taking the Example of the Complete Refurbishment BNB Module for Educational Buildings

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ABSTRACT

Sustainable building is a key issue for the public procurement in Germany since the mid-1990s. The Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) formulated essential and mandatory requirements for the Federal Buildings, which are regularly further developed with the Guideline for Sustainable Building and the Assessment System for Sustainable Building BNB. Besides sustainable new buildings the sustainable development of existing buildings needs to be considered equally. Around two thirds of the building stock were erected before the first Ordinance on Heat Conservation in 1977 and most of them have not yet undergone complete energy efficiency improvement. Furthermore, existing buildings represent a high ecological value. Extending the period of use of existing buildings is one way to save resources and protect the environment. Currently especially the refurbishment of educational buildings becomes an important construction field. Therefore, also an assessment system for refurbished educational buildings is necessary. Within the framework of a research project, the BNB was adapted for existing educational buildings. Basis are the BNB-modules "New Construction" and "Complete Refurbishment" for office buildings. To meet the special requirements of these buildings some assessment criteria had to be substantively revised.

Keywords: *policy and regulation, sustainability assessment, existing buildings*

1. SUSTAINABLE PLANNING, CONSTRUCTION, USE AND OPERATION OF BUILDINGS

The starting point for developing principles and assessment criteria for sustainable building is the overarching concept of a policy of sustainable and future-enabled development, which is based on the three dimensions of sustainability ecology, economy and socio-culture. This concept simultaneously addresses ecological, economic and socio-cultural requirements as equally important aspects. In the national approach the technical quality is included as a cross-sectional quality because the technical properties of a building have a strong impact on sustainability quality. The same applies to the process-related aspects of planning. While the quality of the planning process already strongly influences the other sustainability qualities in the early planning phase, it also determines the degree to which the planned quality is actually implemented during execution. In addition, qualities regarding the location profile are also examined because a building and its location always interact with each other.

As a tool for the sustainability assessment of buildings the Federal Building Ministry published the Guideline for Sustainable Building for the first time in 2001. This Guideline explains the generally valid principles and methods for sustainable planning, construction, use and operation and can be used as a tool for taking aspects of sustainability throughout the entire life cycle of buildings. Since it was updated in 2013, the Guideline now covers not only new buildings, but also refurbishment and building conversion projects. While the Guideline for Sustainable Building provides an explanatory framework document for implementing and operationalising sustainable planning, building, utilisation and operation, the Assessment System for Sustainable Building (Bewertungssystem Nachhaltiges Bauen: BNB) delivers verification methodology to be applied. For all federal buildings, the silver standard of the BNB is the minimum standard that must be adhered to. The gold standard should be the target for selected buildings. First model projects by the federal government have shown that the highest sustainability requirements of the gold standard are economically feasible while providing a high level of user comfort.

2. ASSESSMENT SYSTEM SUSTAINABLE BUILDING (BNB)

The Assessment System transposes the requirements set forth in the Guideline into a structure of evaluation criteria and assessment benchmarks. The aim here is to describe and assess the sustainability quality in its entire complexity. The system takes a comprehensive view of the entire life cycle of buildings, giving equal consideration to ecological, economic and socio-cultural qualities as well as technical and process qualities. The BNB is also a quality management system for planning, building, using and operating buildings. It can be used by owners and planners as a checklist, a decision-making and planning tool as well as a basis for discussion and agreement.

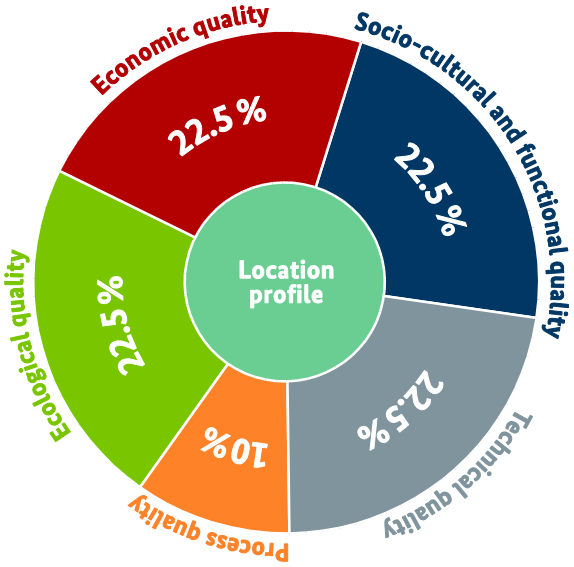

Figure 8: Weighting of the main criteria groups (BBSR)

Sustainability assessment according to the BNB

The Assessment System BNB is structured on the levels of the main criteria groups which are derived from the five sustainability qualities and the location profile, and the individual criteria. Assessing with the BNB the quality of each main criteria group is quantitatively mapped on the basis of the individual criteria. The assess-ment is carried out for each individual criterion by assigning an assessment score according to defined rules and assessment standards. The individual results are compiled within the respective main criteria group while the individual criteria are weighted with a fixed factor of relevance 1 to 3 depending on their relevance for the protection goals. The degree of fulfilment within the main criteria group is calculated using the ratio between the maximum possible score and the score actually achieved. The results of the main criteria groups are calculated with a defined weighting factor to identify the total degree of fulfilment. The quality standard reached - gold, silver or bronze - depends on the degree of fulfilment. The conformity test, a binding examination of the result documents, ensures the quality assurance within the scope of certification.

System variants

For selected types of buildings and uses the BNB system provides specific system variants so that the particular requirements can be systematically taken into consideration in the sustainability assessment. Basically, the dimensions, principles and qualities of sustainable building equally apply to all types of buildings. Nevertheless, different types of buildings have many type-specific characteristics. This may make necessary different priorities, other individual aspects or a different weighting factor in the sustainability assessment. The system variants are:

- Office and administration buildings
- Educational buildings
- Laboratory buildings
- Inter-company vocational training facilities
- Outdoor facilities

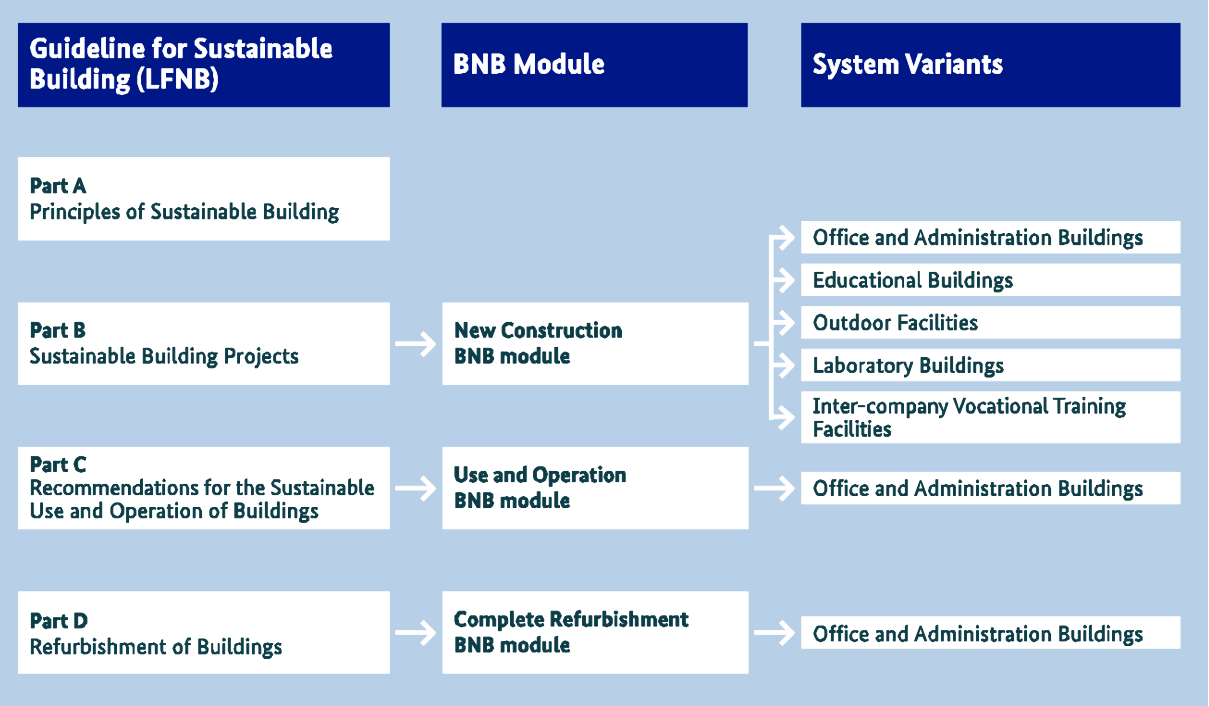

Figure 2: The BNB and its modules and system variants (BBSR)

If it is not possible to clearly assign a building to one system variant due to its location, type of building or use or scope of the project, analogous application of the BNB is generally possible. In this case, the general conditions for the respective country, climate zone or building type must be identified. The aim is to consider the protection goals of sustainability in the project as broad as possible.

Modular layout

A building as well as its use and operation processes can undergo multiple sustainability assessments during the life cycle of the building. For this purpose the BNB has a modular structure with following three modules:

- New construction module
- Use and operation module
- Complete refurbishment module

The BNB modules reflect the cases planning and erecting new buildings, using and operating buildings, as well as planning and performing refurbishment and conversion projects.

Principles of sustainable refurbishment

The principles of sustainable development must be implemented for existing buildings in much the same way as in the case of new buildings. When it comes to qualifying and converting existing buildings, the same ecological, economic and socio-cultural aspects must be equally taken into account. However, the special requirements of the existing building must be considered without generating excessive costs in relation to the benefits. The Complete Refurbishment BNB module is made up of unchanged criteria for new buildings, modified criteria for new buildings as well as specific criteria for existing buildings. The set of criteria reflects the special features of refurbishment projects. The only structural difference exists in the two additional criteria “Stock-Taking” (5.1.6) and “Demolition Planning” (5.1.7), as part of the process quality.

Focus of examination is the entire building and not individual structural intervention measures alone. This means that the building which results from refurbishment or conversion will be considered. Accordingly, the products and building parts already installed into and remaining in the existing building are considered in conjunction with the selected assessment criteria and calculations. The scope of application of the Complete Refurbishment BNB module depends on the complexity of refurbishment, which is a function of the scope of the measure, its depth of

intervention in the building and the type of measure. A distinction is made between “complete refurbishment” and “partial refurbishment”. Complete refurbishment is characterised as follows:

- Scope of the measure: complete refurbishment means construction work on an independent, existing structure in its entirety.
- Depth of intervention in the building: the purpose of complete refurbishment is to provide an existing building in its entirety with characteristics and features that correspond largely to those of a new building. Existing buildings are largely stripped down to the structurally relevant elements of the building.
- Type of measure: complete refurbishment encompasses comprehensive work on existing buildings and generally several types of measures. It is characterised by interaction between repair work, refurbishment work, conversion work and interior work.

All building measures of existing buildings that do not go along with this definition are so called partial refurbishments. One of the main differences is that partial refurbishment projects mostly lead to an analogous application of the Complete Refurbishment BNB module since the individual aspects cannot be fully assessed. For partial refurbishment measures the determination of the total degree of fulfilment with the Complete Refurbishment BNB-module usually means an unreasonable level of effort and is hence dispensable. Furthermore, a quantitative assessment of partial refurbishment measures using benchmarks is generally impossible for certain criteria because a general benchmark cannot be developed in view of the wide range of different construction measures. However, the individual measures performed within a partial refurbishment project must be in line with the requirements of sustainable building. A binding target agreement table must be formulated without determining the total degree of fulfilment nor any partial degrees of fulfilment.

3. SUSTAINABLE REFURBISHMENT OF EDUCATIONAL BUILDINGS

Currently around 70% of the educational construction projects are refurbishment projects. Therefore, besides the BNB assessment system for refurbished office buildings, which was introduced 2013, also the assessment of refurbished educational buildings will become an important field for the federal government, the federal states and the municipalities in Germany.

Education and educational facilities are an important part of our society. Educational buildings are part of the public life and can act as a link between different social groups with different cultural and social backgrounds. At the same time, educational buildings must adapt continuously to changes in society. The concept for educational buildings must hence offer sufficient flexibility because of the different functional requirements with a view to room types and functions, use times and the different users.

Within the framework of a research project, the BNB criteria were adapted for existing educational buildings. Basis were the BNB-modules “New construction” and “Complete refurbishment” for office buildings. Besides the criteria of these two BNB-modules who were adopted as they stand, some criteria had to be substantively revised to meet the special requirements of refurbished educational buildings.

Education specific aspects

The sustainability assessment for educational buildings pays particular attention to user needs. The aim is to enable the highest possible degree of user satisfaction in the building, flexible, diverse and synergistic use of rooms and areas, spatial qualities inside and outside and, through public accessibility, to have the building anchored and accepted in the neighbourhood. Especially with the criteria profiles 3.1.5 “Visual Comfort”, 3.1.7 “Outdoor Use Qualities”, 3.1.9 “Indoor Space Quality”, 3.2.1 “Barrier-free Building”, 3.2.4 “Accessibility” and 4.1.3” Cleaning and Maintenance-friendliness” (vandalism prevention), these aspects are brought more into focus. Outdoor areas of educational buildings are regarded as an integral part of the building structure because they should not be separated from the teaching function. For educational buildings the barrier-free accessibility has to be realised for the entire building so that all rooms are reachable and usable. Being able to obtain space, high-quality materials and equipment boosts identification with and appreciation of the building and also helps to prevent vandalism and preserve long-term value.

In order to take the enormous diversity of building types into account, there are also some criteria as 2.1.1 “Building-related Lifecycle Costs” or 6.1.4 “Traffic Connections”, which define differentiated requirements for different use types as schools and universities.

The Educational Buildings system variant does not foresee any quantitative assessment of space efficiency - this is the only structural difference - because the circulation areas are used as recreational areas and increasingly for informal learning so that their dimensions are usually more generous.

Refurbishment specific aspects

Besides the specific educational demands there are also specific requirements concerning existing buildings which the BNB module variant for refurbished educational buildings is taking into account in particular with the criteria of the Life cycle analysis (1.1.1-1.1.5, 1.2.1), the 2.1.1 “Building-related Lifecycle Costs” and 2.2.2 “Adaptability”.

Assessing complete refurbishment measures, the eco-balance assessment is influenced in a positive way when the construction is saved. The assessment standard is considering the fact, that an existing building generally won´t reach the energy efficiency of a new building. The old building substance, which remains in the building, is only recognized in the “end of life” life cycle phase.

Measures with buildings worth listing must be performed in a manner that complies with the needs of such buildings and thus constitute an important aspect of sustainable construction. This must also be considered in sustainability assessments. So for listed buildings the opportunities to improve the energy efficiency is even more limited. Therefore, these buildings can get additional points in the cases of a low thermal transmittance coefficient of the opaque outer walls or a high ceiling height. Moreover, within the assessment of the 2.1.1 “Building-related Lifecycle Costs” of listed buildings, special conditions can be claimed by deducting the project-specific costs of the costs of manufacture. Also the adaptability of listed buildings is limited and therefore the criterion offers special rules for some indicaors, if fulfilling was not possible - or only with a disproportionate effort - because of conditions of preservation.

CRITERIA TABLE – EDUCATIONAL BUILDINGS SYSTEM VARIANT

COMPLETE REFURBISHMENT BNB MODULE | BNB_UK (UK: UNTERRICHTSGEBÄUDE KOMPLETTMODERNISIERUNG)				
Sustainability criteria			**Factor of relevance**	**Percentage share of overall result**
ECOLOGICAL QUALITY				**22.5%**
Effects on Global and Local Environment				
UK	1.1.1	Global Warming Potential (GWP)	3	3.750%
UK	1.1.2	Ozone Depletion Potential (ODP)	1	1.250%
UK	1.1.3	Photochemical Ozone Creation Potential (POCP)	1	1.250%
UK	1.1.4	Acidification Potential (AP)	1	1.250%
UK	1.1.5	Eutrophication Potential (EP)	1	1.250%
BK	1.1.6	Risks to the Local Environment	3	3.750%
BK	1.1.7	Sustainable Material Extraction/Biodiversity	1	1.250%
Demand of Resources				
UK	1.2.1	Primary Energy Demand	3	3.750%
UN	1.2.3	Drinking Water Demand and Quantity of Wastewater	2	2.500%
BK	1.2.4	Land Consumption	2	2.500%
ECONOMIC QUALITY				**22.5%**
Life Cycle Costs				
UK	2.1.1	Building-related Life Cycle Costs	3	13.250%
Economic Efficiency and Value Stability				
UK	2.2.2	Adaptability	2	9.000%
SOCIO-CULTURAL AND FUNCTIONAL QUALITY				**22.5%**
Health, Comfort and User Satisfaction				
BN	3.1.1	Thermal Comfort	3	2.500%
BN	3.1.3	Indoor Air Quality	3	2.500%
BN	3.1.4	Acoustic Comfort	2	1.667%
UN	3.1.5	Visual Comfort	2	1.667%
UN	3.1.6	Influence of the User	2	1.667%
UN	3.1.7	Outdoor Use Qualities	2	1.667%
BN	3.1.8	Safety	1	0.833%
UN	3.1.9	Indoor Space Quality	3	2.500%
Functionality				
UN	3.2.1	Barrier-free Building	2	1.667%
UN	3.2.4	Accessibility	2	1.667%
BN	3.2.5	Mobility Infrastructure	1	0.833%
Ensuring Design Quality				
BK	3.3.1	Design and Urban Quality	3	2.500%
BK	3.3.2	Art in Architecture	1	0.833%
TECHNICAL QUALITY				**22.5%**
Technical Execution				
UN	4.1.1	Sound Insulation	2	4.500%
BK	4.1.2	Heat Insulation and Protection against Condensate	2	4.500%
UN	4.1.3	Cleaning and Maintenance-friendliness	2	4.500%
BN	4.1.4	Dismantling, Waste Separation and Utilisation	2	4.500%
BN	4.1.5	Resistance to Natural Disasters	1	2.250%
BN	4.1.6	Maintenance Friendliness of Building Systems	1	2.250%
PROCESS QUALITY				**10.0%**
Management and Design				
UN	5.1.1	Project Preparation	3	1.200%
UN	5.1.2	Integrated Design and Planning	3	1.200%
BN	5.1.3	Complexity and Optimisation of Planning	3	1.200%
BN	5.1.4	Invitation to Tender and Contract Awarding	2	0.800%
BN	5.1.5	Preconditions for Optimum Utilisation and Management	2	0.800%
BK	5.1.6	Stock Taking	3	1.200%
BK	5.1.7	Demolition Planning	1	0.400%
Building Construction				
BN	5.2.1	Building Site/Building Processes	2	0.800%
BN	5.2.2	Quality Assurance of Building Construction	3	1.200%
BN	5.2.3	Controlled Commissioning	3	1.200%
LOCATION PROFILE				
Location Profile				
BN	6.1.1	Risks at the Micro-Site	2	–
BN	6.1.2	Conditions at the Micro-Site	2	–
BN	6.1.3	Image and Character of Location and Quarter	2	–
BN	6.1.4	Traffic Connections	3	–
UN	6.1.5	Vicinity to Use-specific Services	2	–
BN	6.1.6	Supply Lines/Site Development	2	–

Source: BBSR

4. INSTRUMENTS OF SUSTAINABLE BUILDING

All criteria profiles of the Educational Buildings system variant of the BNB system – as well as all other system variants – and more detailed information can be downloaded from the Sustainable Building Information Portal www.bnb-nachhaltigesbauen.de as a general platform.

Furthermore, various fundamentals, information and tools are available for the integrated design, planning and assessment of sustainability aspects in the construction sector. In addition, application tools are available to make it easier to calculate, record and comprehensively document sustainability aspects. The most important are:

- eBNB (Internet-based assessment and documentation tool)
- Data and databases such as ÖKOBAUDAT (www.oekobaudat.de) or WECOBIS (www.wecobis.de)
- eLCA (eco-balance instrument)
- Brochures on different system variants
- System for sustainability requirements in design competitions (SNAP)
- Procurement tools (sustainability compass)

The BMUB's Sustainable Building Information Portal www.nachhaltigesbauen.de provides general information and basics on sustainable building and all necessary guides and tools, construction material and building databases along with information about research projects and events.

5. FUTURE-PROOF PLANNING OF EDUCATIONAL BUILDINGS

Well planned educational buildings support the teaching process and promote the sense for building culture. Being defining components in the neighbourhoods and spaces for learning and living for a variety of people, school- and university buildings have a high social relevance. Therefore, especially for educational buildings, a high quality is very important. A holistic planning process is basis for reaching this high standard. To minimise the impact on the global and the local environment, the energy consumption and the life cycle costs while meeting all user requirements, more than a highly insulated building envelope and optimised MEP-systems are required especially for existing buildings. Because of the interactions of the different relevant topics sustainable building is a complex task. In order to find the best strategies and solutions all stakeholders need to work together. The Assessment System for Sustainable Building for refurbished educational buildings is providing a holistic criteria catalogue.

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