Federal Institute for
Research on Building,
Urban Affairs and
Spatial Development

within the Federal Office for
Building and Regional Planning

Zukunft Bauen

Forschung für die Praxis | Volume 10

Sustainable Building by the Federal Government

Principles – Methods – Tools

Imprint

Published by
Federal Institute for Research on Building, Urban Affairs and Spatial Development
within the Federal Office for Building and Regional Planning (BBR), Bonn
Deichmanns Aue 31 – 37
53179 Bonn, Germany

Scientific Support
Federal Institute for Building, Urban Affairs and Spatial Development (BBSR)
Division II 5 Sustainable Building
Julia Müller

Authors
Sabine Dorn-Pfahler, Jessica Stritter, sol·id·ar planungswerkstatt berlin

Translation
Antonia Di Bari

Status
April 2017

Design | Layout | Proofreading
Dr. Günter Löhnert, sol·id·ar planungswerkstatt berlin
A Vitamin Kreativagentur GmbH, Berlin
Probicon GmbH, Berlin

Printed by
Federal Office for Building and Regional Planning
Bonn, Germany

Orders from
zb@bbr.bund.de
Keyword: Sustainable Building by the Federal Government, Volume 10

Picture credits
Page 30

ISBN 978-3-87994-287-9
ISSN 2199-3521

Content

Sustainable Building for the Future

Source: Florian Profitlich

© Milena Schlösser, Bonn

Dear Reader,

Sustainability is aimed at ensuring a long-term and future-oriented development of society, economy, and the environment and in the meantime it has reached a wide social consensus. In addition to generational equality, quality of life, and social cohesion, this also includes the conservation of natural resources and habitats, climate protection, air quality, health, and biodiversity. As contractor, the German Federal Government bears great responsibility, both for its own buildings and as a standard for other public and private building owners. As the buildings realised today will decisively shape our physical environment for decades to come, this is all the more important.

With the Guideline and the Assessment System for Sustainable Building (BNB), the Federal Building Ministry has developed instruments for sustainable building to implement its ambitious goals for federal construction projects. By regularly updating the BNB, the BBSR is supporting the national sustainability strategy of the Federal Government in the building sector and promoting the Guideline's implementation in both the federal construction sector and beyond. Via the Sustainable Building Information Portal, we provide planners and clients with constantly updated information, regulations, and basic data for sustainable construction.

This current brochure presents an overview of the Federal Government's sustainability activities and the practical instruments and tools developed so far which are mandatory for federal buildings, but are available for free via the Information Portal also for the planning of private and municipal building projects.

Harald Herrmann

Director and Professor
of the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR) within the Federal Office for Building and Regional Planning (BBR), Bonn, Germany

Dimensions of Sustainable Building

The objective of sustainable construction - to protect common goods such as the environment, resources, health, culture and funds – is relflected in the three classic dimensions of sustainability, i.e. ecology, economics and social culture. Moreover, technical implementation as well as the planning and construction processes exert a special influence on the building quality actually implemented in architecture. Therefore, in addition to the three conventional dimensions which should be assessed simultaneously and equitably, the national approach to sustainable construction addresses the technical quality and process quality serving as cross-sectional qualities. Furthermore, the selection of the location – and thus the location characteristics – also decisively influences the sustainability quality of the building.

Ecological Quality

Sustainable building is characterised by conserving resources and minimising impacts on the global and local environment. The optimised use of building materials and products, low consumption of land, the preservation and promotion of biodiversity as well as a minimisation of energy and water consumption contribute to the optimisation of energy and material flows over the entire life cycle as far as possible.

Economic Quality

The protection asset of the economic quality is the preservation of the capital employed. The investment expenditure is not of primary consideration here. The aim is rather to optimise the costs over the entire life cycle of a building. This in turn moves structural costs and value stability into the focus of contemplation. Moreover, by assessing space efficiency and adaptability, the issues of profitability and value stability are also being considered.

Sociocultural and Functional Quality

Primarily the assets which influence both social and cultural identity as well as people's perception of value, are protected here. An identification process occurs while the human is realising his ambience and judging it consciously or unconsciously. The resulting positive or negative sensations are reflected in the degree of well-being and motivation.

Technical Quality

The focus lies on the technical realisation of a building and its facilities. The issues under consideration include durability, maintenance, and dismantling potential.

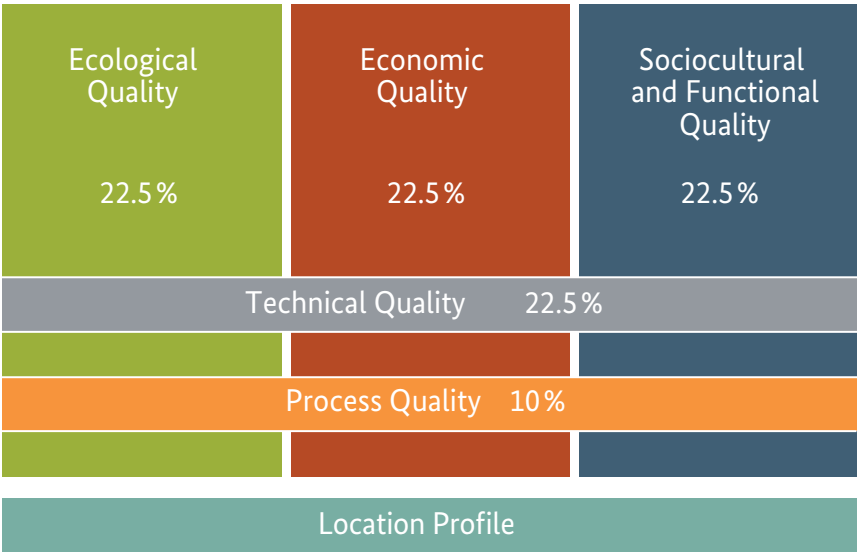
Process Quality

Decisions made during an early design stage have a great impact on the quality of a building. Process quality is therefore of particular importance because, on the one hand, this issue also affects the corresponding sustainability qualities of the building to a great extent and, on the other hand, it will define the degree of actual implementation during the building's realisation. A high process quality in the construction phase of a building is the prerequisite for the optimisation of the entire life cycle.

Location Profile

Furthermore, as a building is always a reaction to specific site conditions, and thus the site's selection, and vice versa, exert a decisive influence on the building itself, features of the location are considered. This means, in addition to political and strategic aspects, the choice of the location must also consider the risks and conditions of the micro location, the characteristics of the neighbourhood and the integration into the local infrastructure. However, since building design can exert only limited influence on location characteristics, these issues are stated separately.

DIMENSIONS OF SUSTAINABLE BUILDING – COLUMNS AND CROSS-SECTIONAL QUALITIES



Source: BBSR

Guideline for Sustainable Building

The Guideline for Sustainable Building has been developed as an essential instrument for the implementation of the national strategy on sustainability into the field of building design and construction. This guideline is mandatory for federal construction measures and provides precise practical help for sustainable planning, building, utility, and operation. It explains general principles and methods, serves as an aid for implementation and defines specific requirements for federal construction measures. The application of this guideline is compulsory for federal construction projects. But it is also suitable for other public clients, such as federal states and municipalities as well as for the private sector.

Part A: Principles of Sustainable Building

Part A covers the general principles and methods of sustainable planning, construction, use, and operation. The principles and dimensions of sustainable building, the qualities as well as the sustainability assessment with the help of the Assessment System for Sustainable Building (BNB) are explained. In addition to basic handling instructions, existing modules and system variants of the BNB system are displayed. Furthermore, tools for implementing sustainable building such as the central Information Portal, the information system WECOBIS or the online building material database ÖKOBAUDAT are presented.

Part B: Sustainable Building Projects

Part B regulates the implementation of the principles defined in Part A throughout the entire design and construction process. Illustrations include task-related principles, life-cycle scenarios to be considered, and the planning bases for new building and refurbishment projects. The structure is based on the chronological sequence of planning addressing sustainability. As the course for the quality of later sustainable construction is already emphasised during project development, the first requirements refer to demand planning.

Part C: Recommendations for the Sustainable Utilisation and Operation of Buildings

Part C describes the methods for optimising utilisation and management processes. The description, the assessment and the targeted influence of the planned characteristics are not in focus during occupancy, but rather the building's actual (real) characteristics and properties. Through continuous controls of performance and consumption, information and clarification on the impact of sustainability as well as periodic analyses of operation and utilisation, costs, environmental impact, and resource consumption can be optimised during occupancy.

Part D: Refurbishment of Buildings

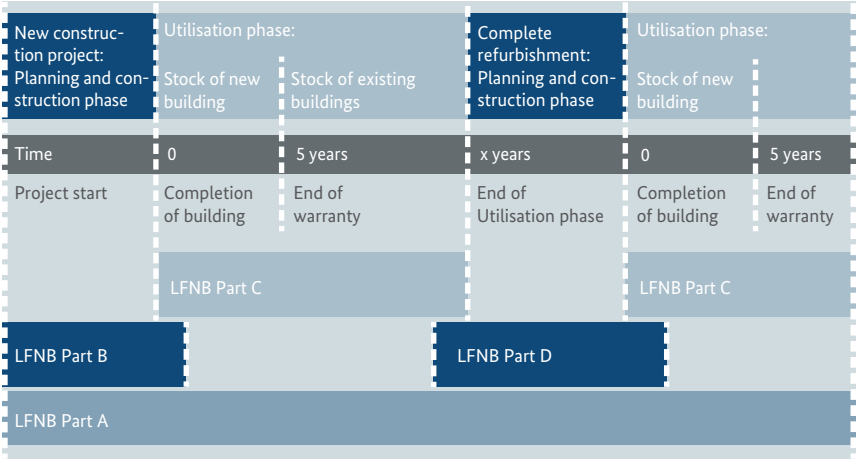
Part D addresses the many special features of existing buildings adding comments, specifications and recommendations and thereby complements Parts A and B. Refurbishment of existing buildings is treated separately for two reasons: On the one hand, the design and construction processes in refurbishment projects differ in many ways from those in new construction projects. On the other hand, certain sustainability issues should be considered from a different perspective when dealing with existing buildings.

Annexes

With these annexes, the Guideline provides comprehensive documents and tools for quality assurance, such as verification requirements for each design phase, templates for target agreements or a sample for the "Energy Target Specifications". The annexes basically serve as recommendations and can be adapted to specific projects.

To ensure the up-to-dateness of the supplementary information, work aids and other documents, the annexes are available for download on the Sustainable Building Information Portal (www.nachhaltigesbauen.de) of BMUB.

APPLICATION OF THE GUIDELINE SUSTAINABLE BUILDING IN BUILDINGS' LIFE CYCLE



Source: BBSR

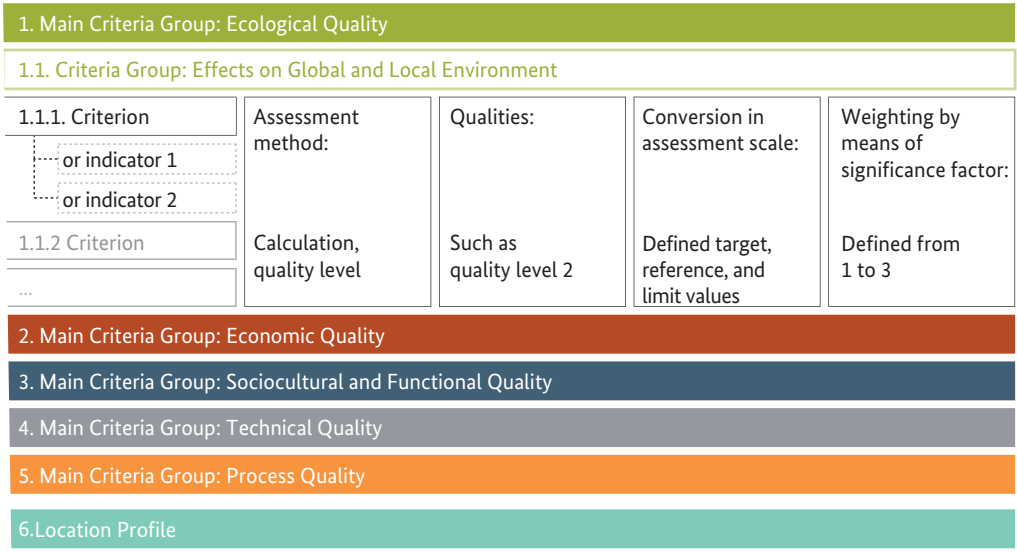
Assessment System BNB

While the Guideline for Sustainable Building is the explanatory framework document for the implementation and operationalisation of sustainable planning, construction, use, and operation, the BNB system defines the applicable verification methodology according to transparent rules and objective methods. With the evaluation criteria and the evaluation benchmarks in the BNB, compliance with the requirements set forth in the guideline are made measurable and representable. The goal is not to optimise individual issues, but instead a holistic optimisation of the building. The BNB is particularly characterised by a comprehensive view of the building's entire life cycle. Beside the final assessment and documentation of the actually achieved quality of the building, the BNB also serves as quality assurance and control.

Based on current research results and taking into account the adjustments in the field of legal norms and regulations, the assessment system is continually under further development. Updates are published via the Sustainable Building Information Portal of the BMUB.

The real assessment of building qualities occurs at the level of individual criteria, which are established in criteria profiles. These mainly comprise descriptions of the single criteria including objective, relevance and assessment methodology, the

ASSESSMENT METHOD OF THE BNB



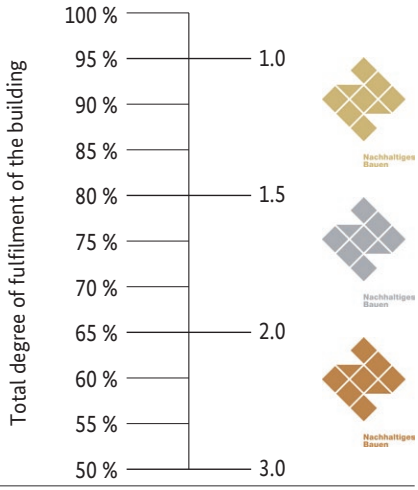
Source: BBSR, Chart: sol·id·ar planungswerkstatt berlin

assessment benchmark and, if applicable, explanatory attachments. The assessment benchmark defines target, reference, and the limit values which must always be verified. The individual criteria profiles are clustered into criteria groups and assigned to the main criteria groups. Depending on the relevance of the individual criteria for the protection goals, a relevance factor of 1 to 3 (low to high importance) is applied within the main criteria group.

The degree of fulfilment in the respective main criteria groups is calculated from the individual results of the criteria. By means of fixed relevance factors, the degree of fulfilment of the five main criteria groups are allocated to the final level of fulfilment which also defines the final score. According to the final score and degree of fulfilment respectively, the quality standards result in Gold, Silver or Bronze. The assessment of the location profile does not affect the overall score and is only stated on the certificate for information purposes.

At the least, federal buildings must comply with the BNB quality standard in silver. Regarding the principle of economic feasibility, new building projects in the BMUB area of operation should generally reach „gold standard“. First federal pilot projects have shown that it is definitely possible to achieve the highest sustainability requirements cost-efficiently.

Degree of Fulfilment	Weighting 22.5 %
Based on the main criteria group as the ratio of the achieved and the maximum possible score	Fixed weighting of the result of the main criteria group for the overall score
Degree of Fulfilment	Weighting 22.5 %
Degree of Fulfilment	Weighting 22.5 %
Degree of Fulfilment	Weighting 22.5 %
Degree of Fulfilment	Weighting 10,0 %
Degree of Fulfilment	Weighting 0,0 %



Degree of fulfilment location profile
(only for information purposes)

System Variants and Modules

Basically, the dimensions, principles, and qualities of sustainable building equally apply to all building types and life cycle phases. However, the different types of buildings have numerous specific peculiarities caused by utilisation, which have to be considered during design and sustainability assessment.

System Variants

To enable systematic consideration of the corresponding requirements in the sustainability assessment, the BNB provides specific systems variants in each case for selected types of buildings and occupancy.

At present, the following system variants are available: Office and administration buildings (BNB_B), educational buildings (BNB_U) and laboratory buildings (BNB_L) as well as intercompany vocational training facilities (BNB_ÜBS) and outdoor facilities (BNB_AA).

Beside a few exceptions, the different system variants consider the same criteria which, if necessary, have been adapted to any specific characteristics of utilisation. For instance, the different benchmarks evaluating life cycle assessment and life cycle costs consider different costs and equipment for administrative and university buildings. During the assessment of laboratory buildings, the higher requirements for the technical equipment are accommodated, both with the specific methodology of the life cycle assessment and with additional criteria of the technical quality. If a building cannot be explicitly assigned to a system variant due to its location, type of building and occupancy, or the extent or depth of its measures, the Guideline offers the possibility of a corresponding application of the modules based on introduced system variants. The individual framework conditions are to be derived from the respective country, climate zone, or building type. The aim is to illustrate the protection goals of sustainability within the project as comprehensively as possible and in accordance with the conformity testing office.

Modules and their Application Potentials

A building and its processes of utilisation and operation can be subject to sustainability assessment procedures several times during its life cycle. In accordance with the structure of the Guideline, the three BNB modules have been developed for this purpose: New Construction module, Use and Operation module as well as Complete Refurbishment module.

At the same time, the modules of new construction and complete refurbishment cover the designed and implemented state of the buildings and are mandatory for federal buildings. The Use and Operation module is used to record and assess the precise property qualities under conditions of occupancy as well as the quality of the use and

operation processes. It can also be used as a supplementary module in combination with the New Construction and Complete Refurbishment modules.

New Construction and Complete Refurbishment

The new construction module is applied during design and realisation phases on new construction projects, serving as a working aid and as a continuous quality control instrument. Thus, the criteria and assessment methods are already considered in the planning and construction phase. At the latest by the time of handover and commissioning, final assessment and certification of the building is carried out with the new construction module.

In terms of sustainable development, the same requirements as in new buildings are to be applied in principle to refurbishment projects. However, it is necessary to cope with the specific features of the refurbishment project, while avoiding disproportionate expenses compared to its later benefit. Therefore, the criteria profile of the Complete Refurbishment BNB module ranges from unchanged and modified new construction criteria to specific criteria for refurbishment projects, too. The structural difference is made by two additional criteria „Stock Taking“ (BNB_BK 5.1.6) and „Demolition Planning“ (BNB_BK 5.1.7).

INTERACTION BETWEEN THE GUIDELINE AND THE ASSESSMENT SYSTEM FOR SUSTAINABLE BUILDING

Source: BBSR

CRITERIA OVERVIEW – NEW CONSTRUCTION AND COMPLETE REFURBISHMENT MODULES

ECOLOGICAL QUALITY	22.5 %	BN	BK	UN	UK*	LN
Effects on Global and Local Environment						
1.1.1 Global Warming Potential		●	◉	○	◎	◙
1.1.2 Ozone Depleting Potential		●	◉	○	◎	◙
1.1.3 Photochemical Ozone Creation Potential		●	◉	○	◎	◙
1.1.4 Acidification Potential		●	◉	○	◎	◙
1.1.5 Eutrophication Potential		●	◉	○	◎	◙
1.1.6 Risks to the Local Environment		●	◉	●	◉	●
1.1.7 Sustainable Material Extraction/Biodiversity		●	◉	●	◉	●
Demand of Resources						
1.2.1 Primary Energy Demand		●	◉	○	◎	◙
1.2.3 Drinking Water Demand and Quantity of Wastewater		●	●	○	○	◙
1.2.4 Land Consumption		●	◉	●	◉	●
ECONOMIC QUALITY	**22.5 %**	**BN**	**BK**	**UN**	**UK**	**LN**
Life Cycle Costs						
2.1.1 Building-Related Life Cycle Costs		●	◉	○	◎	◙
Economic Efficiency and Value Stability						
2.2.1 Space Efficiency		●	●	-	-	◙
2.2.2 Adaptability		●	◉	○	◎	◙
SOCIOCULTURAL AND FUNCTIONAL QUALITY	**22.5 %**	**BN**	**BK**	**UN**	**UK**	**LN**
Health, Comfort and User Satisfaction						
3.1.1 Thermal Comfort		●	●	●	●	◙
3.1.3 Indoor Air Quality		●	●	●	●	◙
3.1.4 Acoustic Comfort		●	●	●	●	◙
3.1.5 Visual Comfort		●	●	○	○	◙
3.1.6 Influence of the User		●	●	○	○	◙
3.1.7 Use Qualities		●	●	○	○	●
3.1.8 Safety		●	●	●	●	◙
3.1.9 Use Flexibility and Appropriation by the User		-	-	○	○	-
Functionality						
3.2.1 Barrier-Free Building		●	●	○	○	◙
3.2.4 Accessibility		●	●	○	○	◙
3.2.5 Mobility Infrastructure		●	●	●	●	●
Ensuring Design Quality						
3.3.1 Design and Urban Quality		●	◉	●	◉	●
3.3.2 Art in Architecture		●	◉	●	◉	●

* From the second quarter of 2017.

TECHNICAL QUALITY	22.5 %	BN	BK	UN	UK	LN
Technical Execution						
4.1.1 Sound Insulation		●	●	○	○	◙
4.1.2 Heat Insulation and Protection against Condensate		●	◉	●	◉	●
4.1.3 Cleaning and Maintenance Friendliness		●	●	○	○	●
4.1.4 Dismantling, Waste Separation, and Utilisation		●	●	●	●	●
4.1.5 Resistance to Natural Disasters		●	●	●	●	●
4.1.6 Maintenance Friendliness of Building Systems		●	●	●	●	-
4.1.7 TGA Flexibility		-	-	-	-	◙
4.1.8 TGA Maintenance and Operation		-	-	-	-	◙
4.1.9 TGA System Quality		-	-	-	-	◙
PROCESS QUALITY	**10 %**	**BN**	**BK**	**UN**	**UK**	**LN**
Management and Design						
5.1.1 Project Preparation		●	●	○	○	●
5.1.2 Integrated Design and Planning		●	●	○	○	◙
5.1.3 Complexity and Optimisation of Planning		●	●	●	●	◙
5.1.4 Invitiation to Tender and Contract Awarding		●	●	●	●	●
5.1.5 Preconditions for Optimum Utilisation and Management		●	●	●	●	◙
5.1.6 Stock Taking		-	◉	-	◉	-
5.1.7 Demolition Planning		-	◉	-	◉	-
Building Construction						
5.2.1 Construction Site/Building Proces		●	●	●	●	●
5.2.2 Quality Assurance of Building Construction		●	●	●	●	◙
5.2.3 Controlled Commissioning		●	●	●	●	●
LOCATION PROFILE	**0 %**	**BN**	**BK**	**UN**	**UK**	**LN**
Location Profile						
6.1.1 Risks at the Micro-Site		●	●	●	●	●
6.1.2 Conditions at the Micro-Site		●	●	●	●	●
6.1.3 Image and Character of Location and Quarter		●	●	●	●	●
6.1.4 Traffic Connections		●	●	○	○	●
6.1.5 Vicinity to Use-Specific Services		●	●	●	●	●
6.1.6 Supply Lines/Site Development		●	●	●	●	●

Source: BBSR, Chart: sol·id·ar planungswerkstatt berlin

● Corresponds to System Variant BNB_BN (Office and Administration Buildings, New Construction)
◉ Corresponds to System Variant BNB_BK (Office and Administration Buildings, Complete Refurbishment)
○ Corresponds to System Variant BNB_UN (Educational Buildings, New Construction)
◎ Corresponds to System Variant BNB_UK (Educational Buildings, Complete Refurbishment)
◙ Corresponds to System Variant BNB_LN (Laboratory Buildings, New Construction)

Outdoor Facilities

In addition to sustainability requirements for building construction measures by the federal government, sustainability issues must also be addressed when it comes to outdoor facilities on federal properties. A distinction must be made here between general sustainability recommendations for complete federal properties (general analysis level) and concrete requirements for outdoor facilities of buildings which have to be considered as part of a specific construction project (specific analysis level). The brochure "Nachhaltig geplante Außenanlagen auf Bundesliegenschaften" (Sustainably Designed Outdoor Facilities on Federal Properties) and the Assessment System for Sustainable Building for Outdoor Facilities have been developed for the two areas of application with their different planning criteria.

The brochure provides recommendations for sustainability in general and overall principles for sustainable construction at real estate level. It provides a checklist „Sustainable Property" for implementation of the requirements, that is intended to facilitate the gathering and retrieval of relevant issues. The recommendations in the brochure shall primarily apply to the construction of outdoor facilities in the building category of office and administration buildings. In principle, however, they can also be used for other building categories, such as education or laboratory buildings and locations of the Federal Armed Forces.

Analogously to the Assessment System for building construction, the Assessment System for Outdoor Facilities is broken down into the six main criteria groups, i.e. ecological quality, economic quality, sociocultural and functional quality, technical quality, process quality and location quality. In contrast to and thus in clear distinction from building construction, the assessment extends to location quality because the assessment of an outdoor facility cannot be separated from its location. The six main criteria groups include a total of 27 individual criteria.

Hence, the Assessment System for Outdoor Facilities also serves as an orientation aid and a communication tool for coordinating individual building qualities and additionally as a steering, control and assessment instrument for implementing the sustainability requirements which have been established for outdoor facilities.

CRITERIA TABLE OUTDOOR FACILITIES

ECOLOGICAL QUALITY	25 %
Effects on Global and Local Environment	
1.1.1 Ecological Impact	
1.1.2 Risks to the Local Environment	
1.1.3 Vegetation	
1.1.4 Biodiversity	
1.1.5 Material Usage	
Demand of Resources	
1.2.1 Energy	
1.2.2 Soil	
1.2.3 Water	
ECONOMIC QUALITY	20 %
Life Cycle Costs	
2.1.1 Outdoor Facilities Life Cycle Costs	
Performance	
2.2.1 Cost-Optimised Planning and Utilisation	
SOCIOLCULTURAL AND FUNCTIONAL QUALITY	20 %
Health, Comfort and User Satisfaction	
3.1.1 Use Qualities	
Functionality	
3.2.1 Barrier-Free Building and Orientation	
3.2.2 Infrastructure for Pedestrians and Cyclists	
Ensuring Design Quality	
3.3.1 Design Competition and Quality	
3.3.2 Infrastructure Facilities Management	
TECHNICAL QUALITY	10 %
Technical Execution	
4.1.1 Maintenance	
4.1.2 Reuse and Recycling	
4.1.3 Sustainable Materials and Construction Methods	
PROCESS QUALITY	15 %
Management and Design	
5.1.1 Project Preparation and Stock Taking	
5.1.2 Integrated Design and Planning	
5.1.3 Integration of Sustainability in Planning and Tender	
Quality of Building Construction	
5.2.1 Construction Site/Construction Process	
5.2.2 Quality Assurance of the Construction	
Quality of Utilisation and Management	
5.3.1 Utilisation and Management Quality of Outdoor Facilities	
LOCATION QUALITY	10 %
Management of Location Profile	
6.1.1 Risks and Conditions at the Micro Site	
6.1.2 Range of Variety of Outdoor Spaces	
6.1.3 Integration and Accessibility	

Source: BBSR, Chart: sol·id·ar planungswerkstatt berlin

Use and Operation

The use and operation of a building usually represents the longest phase in its life cycle and usually also has the biggest economic and ecological effects. The Use and Operation BNB module is used to record and assess the process and object qualities under user conditions and can be applied regularly over the entire utilisation phase of the building. A building that is regularly audited concerning operation and parameters of use, can be optimised with regard to use and management processes, and thus operated more efficiently, more environmentally friendly, and usually more cost-efficiently.

The qualities of use and management processes are primarily assessed. In addition, selected actual qualities (real qualities) are considered that correlate with the planned sustainability qualities. The application of the BNB module for use and operation consequently also provides an essential basis for retrospective assessment of planned qualities and their implementation.

CRITERIA TABLE USE AND OPERATION

REAL QUALITIES	0 %
Effects on Global and Local Environment	
1.1.1 Greenhouse Gas Emissions due to Heating and Electric Energy Consumption	
Demand on Resources	
1.2.1 Heating and Energy Consumption	
1.2.3 Drinking Water Consumption	
Health, Comfort and User Satisfaction	
3.1.1 Actual Thermal Comfort in Winter	
3.1.2 Actual Thermal Comfort in Summer	
3.1.3 Actual Indoor Air Quality	
3.1.9 Actual User Satisfaction	
PROCESS QUALITY OF USE AND OPERATION	100 %
5.3.1 User Satisfaction Management	
5.3.2 Management of Energy and Water Consumption	
5.3.3 Operation Costs Controlling	
5.3.4 Inspection, Servicing and Safety Precaution	
5.3.5 Eco-Friendly and Health-Safe Cleaning	
5.3.6 Technical Operations Management and Qualification of Technical Staff	
5.3.7 Building Documentation throughout the Life Cycle	
5.3.8 Informing and Motivating Users	

Source: BBSR, Chart: sol·id·ar planungswerkstatt berlin

Work Aids and Data Sources

For the application of BNB various work aids and data sources are available.

It is necessary to provide inter alia basic data for the calculation of Life Cycle Analysis (LCA) and Life Cycle Cost (LCC). Calculation and documentation tools simplify the application and prevent multiple entries. Guidelines and system specific brochures provide basics and up-to-date information.

Sustainable Building Information Portal

The Sustainable Building Information Portal published by the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety (BMUB) is the central platform for information from the federal government on sustainable building, hence providing a national and international interface for all parties involved.

In addition to the fundamentals and general explanations on sustainable building, the information on offer includes, in particular, the guidelines and working aids of the Federal Government. Besides the Guideline for Sustainable Building and brochures on BNB, these include information such as “Guideline: Accessibility in Building Design”, the “Leitfaden Kunst am Bau“ (Guildeline Art in Architecture) and the brochure “Systematik für Nachhaltigkeitsanforderungen in Planungswettbewerben“ (Systematics for Sustainability Requirements in Design Competitions). The offer is supplemented by calculation tools, construction material and basic building data, as well as information on research topics, current events, and the presentation of a number of best practices of sustainable building.

Apart from this, the BNB portal (www.bnb-nachhaltigesbauen.de) provides all criteria profiles of all BNB modules or system variants and extensive data sources for download and information on BNB application in practice.

www.nachhaltigesbauen.de

Planning Assistance WECOBIS | Ecological Building Material Information System

WECOBIS helps in the holistic selection of ecological building materials by providing product-neutral environmental and health-relevant data. Aids for the general planning and tendering as well as text blocks for demands on ecological material complement the description of the ecological quality of construction products and basic materials. The content directly relates to the requirements in construction materials from the BNB, simplifying the objective and implementation of qualities with regard to the product selection.

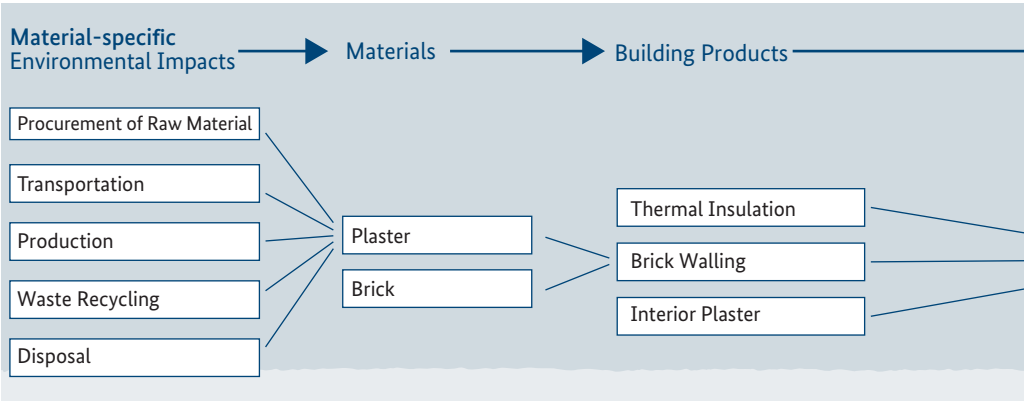
www.wecobis.de

eLCA | Life Cycle Analysis for Buildings

The eLCA was developed by the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR) as a free internet-based software solution for the preparation of eco-balances (LCA) and the calculation of life cycle costs (LCC). The basis for this is the creation of a catalogue on construction elements for the building as well as a direct link to the national online building material database ÖKOBAUDAT. Thanks to the dynamic building block editor supported by a graphical user-friendly interface, individual components can be modelled to entire buildings. The resulting environmental impacts are compared with the BNB benchmarks, taking into account additional data on building use. In addition, there is an export function to submit the calculation data to eBNB.

www.bauteileditor.de

ECO BALANCE OF COMPONENTS AND BUILDINGS



Source: BBSR, Chart: sol·id·ar planungswerkstatt berlin

ÖKOBAUDAT | Material Data for the Life Cycle Assessment

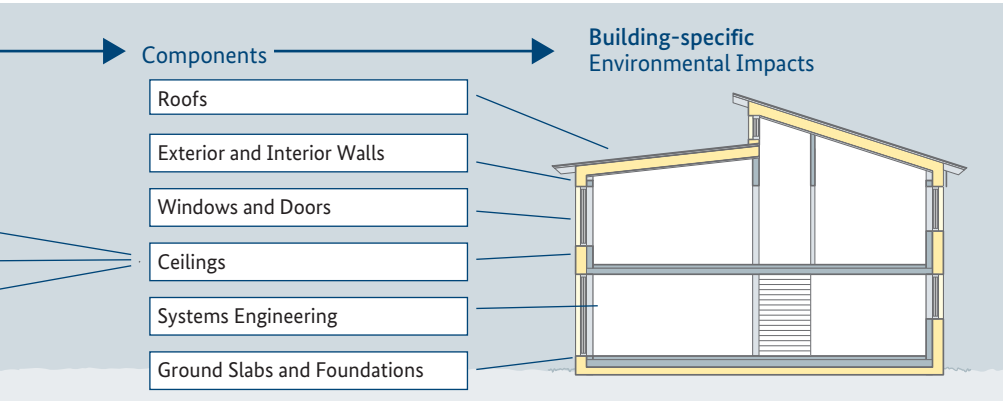
Knowledge of the environmental impacts of products and materials, as well as the respective life cycle and replacement frequency during the assessed period, is the essential basis for the eco-balance.

Via ÖKOBAUDAT, the BMUB provides standardised and quality-tested material and effect balances for the main construction product groups as well as paths for appliction and reutilisation. It thus forms the basis for an eco-balance and building assessment regarding energy consumption, use of resources and global ecological effects that might cause greenhouse effect, acid rain, smog or over-fertilisation. The high quality of the data sources facilitates reliable statements about specific environmental impacts and accordingly about the ecological quality of a building.

Information on the retention times of building components for a determined assessment period of 50 years can be found in the “Service Life Table”. With the help of the life cycle data, forecast scenarios can be developed in the planning phase under conventionally defined boundary conditions which allow an estimation of the Life Cycle Costs (LCC) and an eco-balance (LCA).

Through a standardised interface, the LCA data can be imported from or provided for other software tools.

www.oekobaudat.de



eBNB | Electronic Assessment System for Sustainable Building

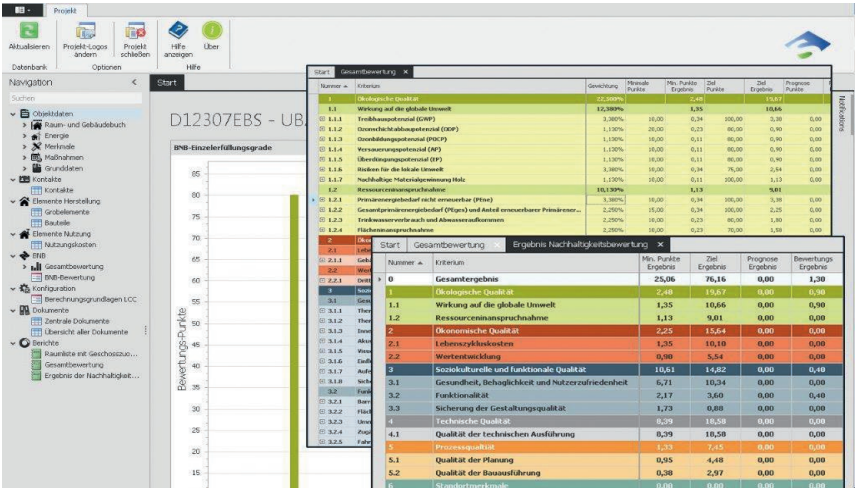
The eBNB was developed as a web-based project management system for the implementation of the BNB for federal buildings. The main objectives are to harmonise the corresponding proof and documentation processes in the BNB, to increase quality assurance in the field of conformity testing, and to improve the flow of information to the federal departments.

With the eBNB as a central database system, it is now possible to systematically record and document all the required information for an entire BNB assessment. The necessary conformity testing can also be carried out digitally. For this purpose, the federal construction departments work in independent, individually adaptable project areas.

It is possible to assess centrally registered complex building information on all federal buildings for scientific questions and to use it for policy advice. In addition, there are import interfaces to BNB arithmetic tools such as the eLCA. Export interfaces to third-party data sources are currently being put to the test.

www.ebnb.bundesbau.de

VIEW OF AN OVERALL ASSESSMENT IN eBNB



Source: BBSR

SNAP | System for Sustainability Requirements in Design Competitions

Significant course-seeting about the building's life cycle, such as the life cycle costs, energy demand and utilisation quality is made already during a building's preliminary design. The performance of design competitions is consequently an important milestone for establishing sustainable buildings.

The Excel-based work aid "Systems for Sustainability Requirements in Design Competitions" (SNAP) already enables the presentation of preliminary design relevant sustainability principles in the preliminary test, so that these can be considered by the jury in addition to the usual urban, architectural, and design qualities. For this purpose, following the BNB system on four thematic areas, such as functionality, comfort and health, cost-effectiveness, and resources and energy, 15 criteria profiles have been developed that make sustainable planning approaches assessable in the competition on the basis of indicators.

The brochure "Systematik für Nachhaltigkeitsanforderungen in Planungswettbewerben" (System for Sustainability Requirements in Design Competitions) compiles detailed recommendations for the application of the work aid, the selection of the relevant sustainability principles, and the scope of the required services.

CRITERIA FOR THE ASSESSMENT OF SUSTAINABILITY IN DESIGN COMPETITION

Subject	no.	Criterion
Functionality	01	Development
	02	Public Accessibility
	03	Barrier-free Building
	04	Communication-supporting Areas and Spaces
Comfort and Health	05	Safety
	06	Noise Protection
	07	Daylight
	08	Indoor Climate
Economic Efficiency	09	Space Efficiency
	10	Use Flexibility
	11	Life Cycle Costs
	12	Soil Sealing
Resources and Energy	13	Construction Materials
	14	Purchased Energy Demand
	15	Coverage of Energy Demand

Source: BBSR

Practical Implementation

Source: Stephan Baumann, bild_raum, Karlsruhe

Federal Environment Agency, “Haus 2019”, Berlin

Office Building (New Construction)	Gold according to BNB_BN 2009_4
Client	Federal Republic of Germany
Architect/Planner	Braun-Kerbl-Löffler architekten+ingenieure, Berlin
Auditor	Dipl.-Ing. Nicolas Kerz, BBSR within BBR
Completion	2013
Gross Floor Area (GFA)	1,254 m²
Gross Construction Costs	€ 4.8 million
Construction Costs (KG 300, 400, 540)	2,218 €/m^2_{GFA} (net)
Operation Costs	996 €/m^2_{GFA} (net)
Life Cycle Costs (LCC)	3,214 €/m^2_{GFA} (net)
Primary Energy Demand (LCA)	total: 214 kWh/(m^2_{NFAa}a) | ne: 159 kWh/(m^2_{NFAa}a)
Global Warming Potential (LCA)	16.6 kg $_{CO_2\ Equiv.}$/(m^2_{NFAa}a)

As a future-oriented building, the first “zero-energy” building already corresponds to the requirements of the European “Energy Saving Ordinance” which demands low-energy building in public new building from 2019 onwards. A compact building with an optimal ratio of the external wall area to the building volume was implemented. The major part of the building shell and façade were made from the renewable raw material wood with high demands on insulation quality and air-tightness while avoiding heat bridges. A photovoltaic system and a groundwater heat pump provide electrical and thermal energy. The ventilation system includes heat recovery and ensures the minimisation of ventilation heat loss. The monitoring shows the successful implementation of the planned concept. In addition to the BNB assessment of the new building, the property was also a pilot project for testing the outdoor facilities system variant.

Source: andreas meichsner photography

Federal Ministry of Education and Research, Berlin

Office Building (New Construction)	Gold according to BNB_BN 2011_1
Client	Institute for Federal Real Estate
Architect/ Planner	Heinle, Wischer und Partner, Christian Pelzeter
Auditor	Thomas Thümmler, WSGreenTechnologies GmbH
Completion	August 2014
Gross Floor Area (GFA)	58,273 m²
Gross Construction Costs (KG 200 - 700)	€ 114.5 million
Construction Costs (KG 300, 400)	1,151 €/m^2_{GFA} (net)
Operation Costs	772 €/m^2_{GFA} (net)
Life Cycle Cost (LCC)	1,922 €/m^2_{GFA} (net)
Primary Energy Demand (LCA)	total: 101 kWh/(m^2_{NFA}a) | ne: 83 kWh/(m^2_{NFA}a)
Global Warming Potential (LCA)	21.86 kg $CO_{2\ Equiv.}$/(m^2_{NFA}a)

The new building of the Federal Ministry for Education and Research in Berlin is the first civil building project of the German Federal Government economically implemented within the scope of a public private partnership (PPP) with high energy quality and likewise high user comfort. The building fulfils the highest demands according to the BNB in the field of pollution avoidance and indoor air hygiene through low-emission construction products and mechanical ventilation. The publicly accessible areas and spaces used as workplaces have also been implemented to the greatest possible extent concerning barrier-free requests. The combination of coordinated measures in building physics and the intelligent networking of the individual system components such as fuel cell, heat and power stations, and photovoltaic systems on roofs and façades will reduce the energy demand according to EnEV 2009 for primary energy requirements by around 70 percent.


Source: BBSR

Federal Constitutional Court Building, Karlsruhe

Nachhaltiges Bauen

Office Building (Complete Refurbishment)	Silver according to BNB_BK_2013_3
Client	Federal Republic of Germany
Architect / Planner	Assem Architekten, Karlsruhe
Auditor	Dipl.-Ing. Jan Zak, ikl GmbH, Karlsruhe
Completion	September 2014
Gross Floor Area (GFA)	16,726 m²
Gross Construction Costs (KG 200 - 600)	ca. € 57 million
Construction Costs (KG 300, 400)	2,297 €/m^2_{GFA} (net
Operation Costs	1,342 €/m^2_{GFA} (net)
Life Cycle Cost (LCC)	3,639 €/m^2_{GFA} (net)
Primary Energy Demand (LCA	total: 166 kWh/(m^2_{NFAa}a) | ne: 147 kWh/(m^2_{NFAa}a)
Global Warming Potential (LCA)	34.1 kg $CO_{2\ Equiv.}$/(m^2_{NFAa}a)

The sustainable complete refurbishment of the monument-protected building presented a considerable challenge. In particular, it consisted of preserving the transparent architectural language as an expression of democratic jurisprudence, while producing a contemporary, energy-efficient, and comfortable building for the next life cycle. Optimal comfort for the user has been achieved, among other things, by the installation of cooling ceilings, the use of pollutant-free and low-odour building materials as well as by external, perforated venetian blinds. High energy quality is achieved by the use of renewable energies for cooling and power generation via photovoltaic panels combined with efficient LED lighting. Overall, after modernisation, the building has undercut the requirements of the EnEV 2009 for primary energy demand for new buildings by 33 percent.

Source: Stephan Baumann, bild_raum, Karlsruhe

Primary School Niederheide, Hohen Neuendorf

Educational Building (New Construction)	Gold according to BNB_UN_2013 Pilot Application
Client	Stadt Hohen Neuendorf
Architect / Planner	IBUS Architekten + Ingenieure GbR
Auditor	Dr.-Ing. Günter Löhnert, sol·id·ar, planungswerkstatt berlin
Completion	June 2011
Gross Floor Area (GFA)	7,414 m²
Gross Construction Costs (KG 200 - 700)	€ 13.75 million
Construction Costs (KG 300, 400)	1,245 €/m^2_{GFA} (net)
Operation Costs	688 €/m^2_{GFA} (net)
Life Cycle Cost (LCC)	1,933 €/m^2_{GFA} (net)
Primary Energy Demand (LCA)	total: 172 kWh/(m^2_{NFA}a) | ne: 52 kWh/(m^2_{NFA}a)
Global Warming Potential (LCA)	14.1 kg $CO_{2\ Equiv.}$/(m^2_{NFA}a)

The first school designed as an energy plus building in Germany stands out due to its highly thermally insulated building shell, heat-storing solid components, and an energy efficient ventilation system. Reinforced concrete is the main statically effective building material. On the one hand, the concept is based on the minimisation of the energy demand for the building and the technical installations, and on the other hand, on the planned use of locally available renewable energy sources. The positive energy balance can be achieved through the use of renewable fuels (wood pallets), innovative technologies, and the installation of a large-area photovoltaic system. Furthermore, a high interior air quality has been achieved through the precautionary selection of low-emission construction products and the effective combination of natural and mechanical ventilation representing a hybrid ventilation concept. High flexibility of use is created by differentiated, divisible, and versatile spaces.

Source: Dr.-Ing. Günter Löhnert

Research and Laboratory Building, Max-Planck-Institute, Cologne

Nachhaltiges Bauen

Laboratory Building (New Construction)	Silver according to BNB_LN_2012_1 Pilot Application
Client	Max-Planck-Gesellschaft, Construction Department
Architect/ Planner	hammeskrause architekten, Stuttgart
Auditors	Andrea Georgi-Tomas, ee concept GmbH, Huiwen Liang, Max-Planck-Gesellschaft
Completion	February 2013
Gross Floor Area (GFA)	21,638 m²
Gross Construction Costs (KG 200 – 700)	€ 71.38 million
Construction Costs (KG 300, 400)	2,237 €/m^2_{GFA} (net)
Operation Costs	1,891 €/m^2_{GFA} (net)
Life Cycle Cost (LCC)	4,128 €/m^2_{GFA} (net)
Primary Energy Demand (LCA)	total: 379 kWh/(m^2_{NFAa}a) | ne: 265 kWh/(m^2_{NFAa}a)
Global Warming Potential (LCA)	62.67 kg $CO_{2\ Equiv.}$/(m^2_{NFAa}a)

The compact building, which is zoned according to functional requirements, offers large, densified laboratory landscapes in direct spatial contact with communication areas. All compulsively mechanically ventilated areas are oriented towards the atrium. The location of the offices at the outer facades allows natural ventilation and partly passive cooling. On the ground floor of the atrium there is an air well with displacement air intake and the office spaces in the upper floors are equipped with natural night cooling through automatic tilt windows. The base load of the institute on thermal and electrical energy is covered by two gas-fueled heat and power stations. The heating of the building results from the waste heat arising from the power generation process, supplemented if necessary by decompression via steam condensation and district heating.

Source: c.Lehmann-photo.de

Abbreviations

BBR	Federal Office for Building and Regional Planning
BBSR	Federal Institute for Research on Building, Urban Affairs, and Spatial Development
BMBF	Federal Ministry of Education and Research
BMUB	Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety
BMVBS	Federal Ministry of Transport, Building, and Urban Development
BNB	Assessment System for Sustainable Building (Bewertungssystem Nachhaltiges Bauen)
CO_2 Equiv	Carbon Dioxide Equivalent (Global Warning Potential)
eBNB	Electronic Assessment System for Sustainable Building
eLCA	Electronic Eco Balance Tool
EnEV	Energy Saving Ordinance
GFA	Gross Floor Area
KG 300	Cost Category 300 (Building – Building Construction)
KG 400	Cost Category 4 00 (Building – Technical Building Equipment)
KG 540	Cost Category 540 (Technical Equipment in Outdoor Facilities)
kWh	Kilowatt hour
LCA	Life Cycle Assessment (Eco Balance)
LCC	Life Cycle Costs
ne	non-renewable
NFA	Net Floor Area
NFAa	all sides constructional enclosed NFA
SNAP	System for Sustainability Requirements in Design Competitions
TGA	Technical Equipping
WDVS	Thermal Insulation System
WECOBIS	Web-Based Ecological Building Material Information System

Picture Credits

Cover:	Federal Environment Agency “Haus 2019” Picture: qatsi.tv GmbH & Co.KG
Page 4:	Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety Picture: Florian Profitlich
Page 24:	Federal Constitutional Court, Karlsruhe Picture: Stephan Baumann, bild_raum, Karlsruhe
Page 25:	Federal Environment Agency “Haus 2019” Picture: andreas meichsner photography
Page 26:	Federal Ministry of Education and Research, Berlin Picture: BBSR
Page 27:	Federal Constitutional Court, Karlsruhe Picture: Stephan Baumann, bild_raum, Karlsruhe
Page 28:	Primary School Niederheide, Hohen Neuendorf Picture: Dr.-Ing. Günter Löhnert, sol·id·ar planungswerkstatt
Page 29:	Max-Planck-Institute, Cologne c.Lehmann-photo.de

Federal Institute for
Research on Building,
Urban Affairs and
Spatial Development

within the Federal Office for
Building and Regional Planning

The Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety (BMUB) is strengthening in cooperation with the Federal Institute for Research on Building, Urban Affairs, and Spatial Development (BBSR) the future-oriented and innovative capacity of the construction industry with its research initiative "Zukunft Bau" (Future Building).

The aim is to improve the competitiveness of German construction in the single European market and, in particular, to support both the increase of knowledge and the findings in the area of technical, structural, and organisational innovations.

FORSCHUNGSINITIATIVE Zukunft BAU

www.forschungsinitiative.de

ISBN 978-3-87994-287-9
ISSN 2199-3521