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Guideline for Sustainable Building

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Guideline for Sustainable Building

Preface

Around 300 years ago, a guiding principle for forestry was developed in Germany that still holds today: to preserve the long-term usability of forests, do not cut down more trees than grow again. This simple and sustainable basis for action can be applied to almost all areas of policy and spheres of life. In light of the current challenges caused by climate change, scarce resources and demographic trends, this approach is more relevant than ever. As far back as 2002, the German government adopted a National Sustainability Strategy increased with specific, measurable targets. Since that time, the course taken has been reviewed and advanced. The construction and real-estate sectors play an important role in this, especially given that a third of the energy consumption in Germany can be dedicated to constructing and operation of buildings.

Our strategy in the construction sector covers the entire life cycle of a building, i.e. from the first planning steps and the construction phase until the time after occupancy phase. The Guideline for Sustainable Building has been developed as a practical guide for action. This current Guideline is being implemented with success in federal construction projects and enables to assess the quality of planning and realisation with coordinated methods and clear rules for evaluation. Moreover, it offers recommendations for environment-friendly and resource-efficient real estate management.

Sustainable building is one of today's so called megatrends and needs intelligent, energy-efficient building designs as well as the courage to combine modern materials with high-quality architectural implementation.

I hope that the information and suggestions in this Guideline will encourage to meet this challenge, and that it draws attention not only to construction projects on the level of the federal states and municipalities, but also of private investors.

Dr. Barbara Hendricks
Federal Minister for the Environment, Nature Conservation, Building and Nuclear Safety

Contents

Introduction to this Guideline

Introduction to this Guideline

1. Sustainable planning, construction, use and operation of buildings

Buildings and structural works as part of the built environment are complex systems designed to fulfil defined tasks and functions. Buildings and structures provide both living space and a work environment, and they affect their users' well-being, health and satisfaction as well as the quality of social life. They represent commercial and economic values, help to create and protect jobs and values, and they trigger energy and substance flows which affect the global and local environment. They thus have a significant impact on sustainable development.

The structural and technical solution initially adopted in each case must represent the latest state of the art (i.e. mandatory features and properties) and under defined conditions must be capable of fulfilling both the legal and statutory requirements as well as the specific use specifications (optionally agreed features and properties) which are typically determined by the customer. All further descisions will be entirely based on the initial solution. Furthermore, requirements in terms of ecological, social and economic qualities must be defined in order to ensure that buildings fulfil their function in relation to the environment and society and to warrant economic efficiency. The quality of urban planning and design, the cultural value of existing buildings and settlement structures as well as the contribution towards the culture of building are vital elements of the social quality. Furthermore, technical, functional and process-related aspects have been discussed in the past, and the additional inclusion of such features and properties has now been laid down for functional and technical specifications in DIN EN 15643-2 to 4.

The contribution of buildings towards sustainable development must be actively shaped and managed. This means that all stakeholders who influence a property directly or indirectly during its life cycle must be aware of this role and responsibility. Within their sphere of work, responsibility and influence, stakeholders must hence be able to understand and drive the form and extent of their influence in a positive way.

The underlying ideas of this Guideline for Sustainable Building are:

- The principles of sustainable development including the identification of goals and the verification and evaluation of progress and success become an integral part of all planning, design and decision-making processes during a property's life cycle.
- In order to support relevant stakeholders, the applicable work, responsibility and influence spheres and the respective life cycle phase must be known, and specific requirements, concepts and tools must be developed and made available on this basis.
- Requirements, approaches and tools must adequately address the complexity of planning, building and operation as well as the complexity of the sustainability assessment exercise which forms part of typical decision-making processes and at the same time leads to realistic solutions which can be implemented at a reasonable cost and within a realistic time frame.

This Guideline for Sustainable Building addresses the building in its context with the property over its entire life cycle. Both essential characteristics and properties of the building and of measures on the property as well as the building's impact on the environment, society and the economy during its life cycle are identified and evaluated. In line with ISO 21929 and, in particular, with DIN EN 15643, the assessment of the contribution towards sustainable development (sustainability assessment) is only considered to be complete if the above-mentioned impacts on the environment, society and economy take place at the same time and with equitable shares as well as over the entire range of the issues addressed herein (see Fig. 1). DIN EN 15643 additionally calls for consideration and evaluation of functional and technical quality.

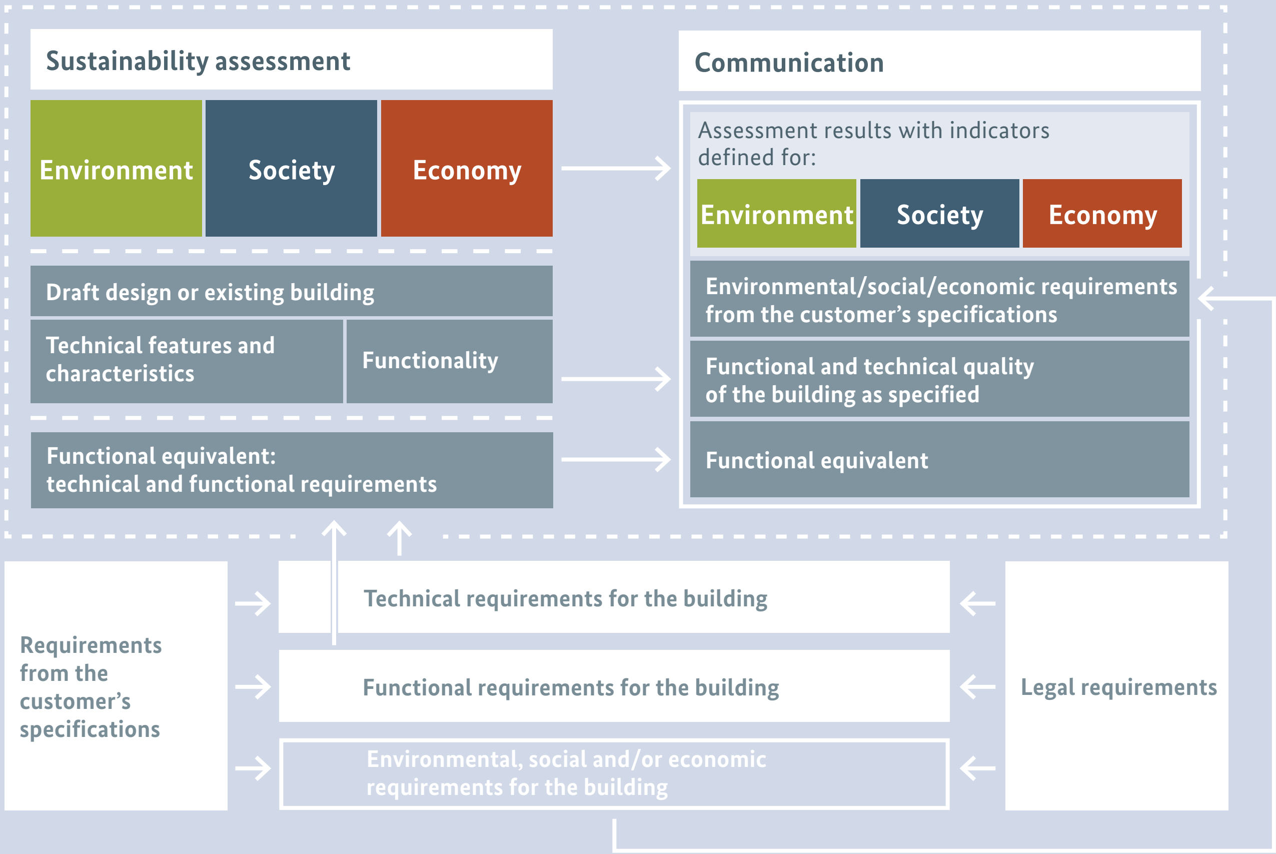

Fig. 1: Concept for assessing the sustainability of buildings (with reference to DIN EN 15643-2:2011)

The life cycle analysis is a suitable means to this end if the following conditions are fulfilled:

- The building and its life cycle must be suitably modelled and it must be both adequately and completely described according to the given assessment task.
- The time of the decision and/or action to be supported must be defined and identified in the life cycle.
- The relevant stakeholders for the decision and/or action to be supported must be identified.
- An observation horizon must be defined which is adequate for the stakeholder and his or her sphere of action, responsibility and influence, including clarification of the perspective (focus on the current situation, prognosis, retrospective analysis).

Against this background, this Guideline for Sustainable Building addresses principal/client[1] and their contractors, as well as other stakeholders, during the design, planning and construction phases of new buildings and during refurbishment projects with existing buildings. However, this Guideline for Sustainable Building also provides guidance for facility management, building diagnostics, due diligence (DD), success monitoring and/or post occupancy evaluation (POE) with a focus on the given user behaviour. Each of the stakeholders should be enabled to identify, evaluate and drive their contribution towards the sustainability of a building. This is the context for the concept of planning, construction, use and operation orientated towards and conducive to sustainable development.

[1] As defined within the scope of the processes in the Guideline for Sustainable Building: project sponsor (owner) (legal entity, which assess the means of a project in its houshold)

2. Scope of this Guideline for Sustainable Building

2.1 Reasons

Based on the resolutions of the Rio de Janeiro Conference in 1992, the German federal government adopted the National Sustainable Development Strategy [2] in 2002. This strategy titled "Perspectives for Germany" presents the results of consultations involving various groups of society and outlines not just measures and projects, but also political guidelines for sustainable development. 21 indicators and goals are used to identify and assess progress.

Regular reports cover the status of developments and address new focal issues. The contents of the 2012 progress report, which is based on the recommendations of its predecessor from 2008, include sustainable economy, climate and energy as well as sustainable water policies. "With its 2012 progress report, the German federal government [...] is upgrading its National Sustainability Strategy [...]. The basis is a concept of sustainability which links economic performance to ecological responsibility and social fairness [...]. It is about a policy and concept of the economy [...] which replaces short-term thinking with a long-term, integrated policy of responsibility." [3] These goals cannot be achieved on a political level alone. Instead, the business community, society and every citizen should contribute towards the process. "The guiding principle of sustainable development is especially applicable to administrative measures. The public sector must live up to its role model function and, through its procurement budget, exerts a relevant influence on demand for and development of sustainable products." [4] The related measures adopted by the Federal Committee of State Secretaries for "Sustainable Development" at its meeting on 6 December 2010 titled "Concrete implementation of sustainability in administrative action" identify twelve points for implementing the National Sustainability Strategy in administrative measures, including the aspect of orientating federal buildings towards the requirements of the Assessment System for Sustainable Building as the first of these points.

The Federal Committee of State Secretaries will be strengthened further in the interest of better sustainability management. Its tasks include the implementation of the National Sustainability Strategy, the further development of its contents and regular monitoring of the state of implementation. This "Green Cabinet" is also the point of contact for the Parliamentary Advisory Council on Sustainable Development, for the federal-state administrations and local authorities' national associations with whom it co-operates on current sustainability issues. In line with the conclusions from the meetings of the Federal Committee of State Secretaries for Sustainable Development from December 2008 to June 2009, modules for a future sustainable government programme were drafted. They suggest that the "sustainability of buildings [...] is to be increasingly made transparent, measurable and verifiable during the entire life cycle by including ecological, economic and social aspects whilst at the same time addressing the quality of urban planning and design along with technical and functional requirements. The assessment must be based on recognised scientific methods of eco-balancing and life cycle costing." [5] In light of the federal government's intentions, the aim of the meeting of the Federal Committee of State Secretaries in October 2012 was to double raw materials productivity by 2020 compared to 1994 and to create further momentum for more efficient use of raw materials. "One key module here is the German Resource Efficiency Programme [...]. The committee's discussions placed special emphasis on the question as to how activities related to consultancy for operational resource efficiency, sustainable building and public procurement can be further strengthened. [6]

On a European level, measures to support these goals included action plans as part of the European Commission's lead market initiative for Europe [7]. Six market areas were identified as highly innovative, including "sustainable building" and "renewable energies".

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[2] See "Nationale Nachhaltigkeitsstrategie" (2002)
[3,4] See "Fortschrittsbericht 2012"
[5] See "Staatssekretärsausschuss Nachhaltige Entwicklung"
[6] http://www.bundesregierung.de/Content/DE/Pressemitteilungen/BPA/2012/10/2012-10-09-nachhaltigkeit.html?nn=493022
[7] See EU (2007 a)

The national governments were called upon to uphold their commitment especially in the construction sector with regard to construction culture and sustainability.[8]

As a logical consequence of national and European political and social goals, this Guideline for Sustainable Building will be further updated and amended on national level in order to address the above-mentioned general requirements for the construction sector and to meet the federal government's role model obligations. The 2013 update now covers both new building issues as well as refurbishment and building conversion projects. Recommendations for use and operating processes, which are orientated towards sustainable development, are discussed in Part C of this Guideline under the heading "Recommendations for the sustainable use and operation of buildings".

2.2 Application and scope

This Guideline for Sustainable Building from the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) explains the generally valid principles and methods for sustainable planning, building, operation and use of buildings and properties. It thus addresses both the planning, design and construction phase of new building and refurbishment projects as well as the use and operating phase of existing buildings. However, this Guideline also serves as a tool when it comes to considering aspects of sustainability during the entire life cycle of buildings and properties.

Within the sphere of responsibility of the BMUB and of the Federal Ministry of Defence (BMVg)[9], the application of this Guideline by the administrations in charge of federal government construction projects is hence subject to the Guidelines for Federal Construction Measures (RBBau Guidelines)[10] and the "Additional Engineering Criteria" (ZBau) as well as the latest decrees. What's more, this Guideline also lends itself to use for other building projects. With regard to public building projects on federal-state and municipal level, this Guideline serves as a set of recommendations. Private building owners are free to use this Guideline as an optional reference document.

This Guideline adresses particularly with the Part C, "Recommendations for the sustainable use and operation of buildings", the tasks of real property managers in charge of operation. Part C describes the advantages of applying this Guideline to federal buildings and, more specifically, to buildings and properties of direct or indirect federal authorities.

The Guideline describes methods and goals (including, for instance, limit and target values) as well as recommendations with regard to sustainability aspects for

- the design, planning and implementation of new construction and expansion projects including landscaping measures,
- the design, planning and implementation of refurbishment, conversion and reuse projects including landscaping measures,
- the use and operation as well as maintenance of buildings and properties.

The revision of the Guideline for Sustainable Building and its 2013 update mark the coming into effect of new rules for the application of the Assessment System for Sustainable Building for federal buildings. This Guideline generally refers to properties as an entity consisting of a building structure and real property. This is due to the client and/or owner's primary sphere of influence and responsibility. When it comes to quantifying sustainability (especially in conjunction with eco-balancing and life cycle costing), the system and hence assessment boundaries are determined by the object in question (typically the building or outdoor facility).

8 See Bundesregierung (2009)

9 In view of the special characteristics of military buildings, the BMVg has issued its own specific guidelines regarding the form and extent to which this Guideline is to be applied in the Ministry's sphere of responsibility.

10 BMVBS (2013 b)

With regard to the standards mentioned in this Guideline as well as the applicable documents and technical requirements for products and test methods, the following should be noted: On condition that the specified protection level is permanently achieved with a view to safety and fitness for use, products and test methods may also be used which comply with standards or other regulations and/or technical rules of other EU member states, EFTA states or Turkey. The Federal Construction Principles and Guidelines for Federal Construction Measures Abroad (GRB-A) must be observed for federal construction projects outside Germany.

2.3 Layout of this Guideline for Sustainable Building

This Guideline for Sustainable Building is broken down into the following parts:

- Part A – Principles of Sustainable Building
- Part B – Sustainable Building Projects
- Part C – Recommendations for the Sustainable Use and Operation of Buildings
- Part D – Refurbishment of Buildings

Part A "Principles of Sustainable Building" presents the general principles and methods of sustainable planning, building, use and operation. These can be equally applied to public-sector and private construction projects. For this purpose, this document describes the principles of sustainable development as applied to the construction and real property sector, the dimensions and qualities of sustainable building, use and operation as well as the general procedures for sustainability assessments.

Part B "Sustainable Building Projects" explains the task-related principles, the life cycle scenarios to be considered and the planning principles for new construction projects and construction projects in connection with existing buildings (such as full-scale refurbishment projects). They are based on the chronological order of the planning phases as stipulated in the RBBau Guidelines and on the work phases as stipulated in the Official Scale of Fees for Services by Architects and Engineers (HOAI). All stakeholders involved in the planning process can make use of these resources in order to implement measures that are based on the principles and aims of sustainable development.

Part B "Sustainable Building Projects" is supplemented for refurbishment projects by separate rules and explanations in Part D, "Refurbishment of Buildings".

Part C "Recommendations for the Sustainable Use and Operation of Buildings" describes methods for optimising use and management processes while taking into account criteria of the Assessment System for Sustainable Building. In this way, it can be ensured that the requirements for sustainable building are fulfilled throughout the entire life cycle of a construction project. During the use period of a building, the focus is on its actual properties and characteristics; the description, assessment and targeted influencing of planned features are of secondary importance in this phase. Costs, environmental impacts and resource consumption during the use period can be lowered by continuous monitoring of performance and consumption. Further steps include informing and educating owners/operators as well as users about the effect of certain measures on sustainability as well as periodic operation and usage analyses. Deviations from limit values which are found can trigger necessary improvement and modernisation measures.

Part D "Refurbishment of Buildings" addresses the specific aspects of sustainable refurbishment. This part of the Guideline supplements the requirements in Parts A and B with specific aspects of building refurbishment. Parts A and B are hence also generally applicable to construction measures in existing buildings. The explanations, requirements and recommendations of Part D address the many special features of existing buildings and therefore supplement Parts A and B. The refurbishment of existing buildings is treated separately for two reasons. On the one hand, the planning and construction processes in refurbishment projects differ in many ways from those in new construction projects. On the other hand, certain sustainability aspects must be looked at from a different perspective when dealing with existing buildings.

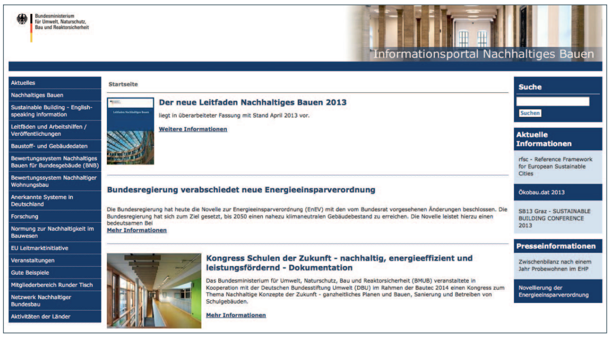


Fig. 2: Information Portal Sustainable Building

The documents needed to implement this Guideline are included in its Annexes and can be downloaded via the "Information Portal Sustainable Building" (www.nachhaltigesbauen.de). These documents include, for instance, the criteria profiles, input data or minimum fulfilment levels for the Assessment System for Sustainable Building. This concept enables the ongoing updating of the information, tools and other documents which supplement this Guideline and thereby ensures that these documents are as up to date as possible. The version of the Guideline published on the information portal is the relevant version in each case.

2.4 Interaction between this Guideline for Sustainable Building and the Assessment System BNB

With a view to supporting the implementation and practical performance of sustainable planning, building, use and operation, a systematic relationship exists between this Guideline for Sustainable Building as an explanatory framework document and the Assessment System for Sustainable Building (BNB) as the applicable verification methodology. The Guideline sets forth principles, describes requirements and assessment criteria, identifies benchmarks and aims and provides support for planning, operating, use, decision-making and assessment processes. What's more, it also offers tools and supporting documents. This Guideline thus forms the basis, for instance, for the Assessment System for Sustainable Building which includes specific system variants for selected types of buildings and uses. The Assessment System transposes the requirements set forth in this Guideline into a structure of evaluation criteria and assessment standards, so that the degree of fulfilment of the Guideline's requirements can be measured and presented. The result of the application of the Assessment System is the degree of fulfilment of the Guideline's requirements.

The cases dealt with in this Guideline, planning and construction of new buildings, planning and performance of refurbishment and conversion measures, as well as use and operation of buildings, are reflected by the corresponding modules of the system variants of the Assessment System. The "New Construction" and "Refurbishment" BNB-modules address the planned and as-built states. Part A, "Principles of Sustainable Building" and Part B, "Sustainable Building Projects", of this Guideline are particularly important for new buildings. Part D, "Refurbishment of Buildings", applies to construction measures for existing buildings and supplements Parts A and B in this respect. The "Use and Operation" BNB-module serves to identify and assess the concrete quality of a building in use as well as the quality of its use and operating processes. This module is hence directly related to Part C, "Recommendations for the Sustainable Use and Operation of Buildings" of this Guideline. Together with Part C, the "Use and Operation" BNB-module also enables the analysis of the as-built condition of an existing building which has not yet been analysed under sustainability aspects, so that suitable modernisation measures can be identified as a result of such an analysis. The as-built analysis of individual buildings also provides information that can be used for the portfolio analysis of existing buildings.

Fig. 3: Interaction between the Guideline for Sustainable Building and the Assessment System for Sustainable Building

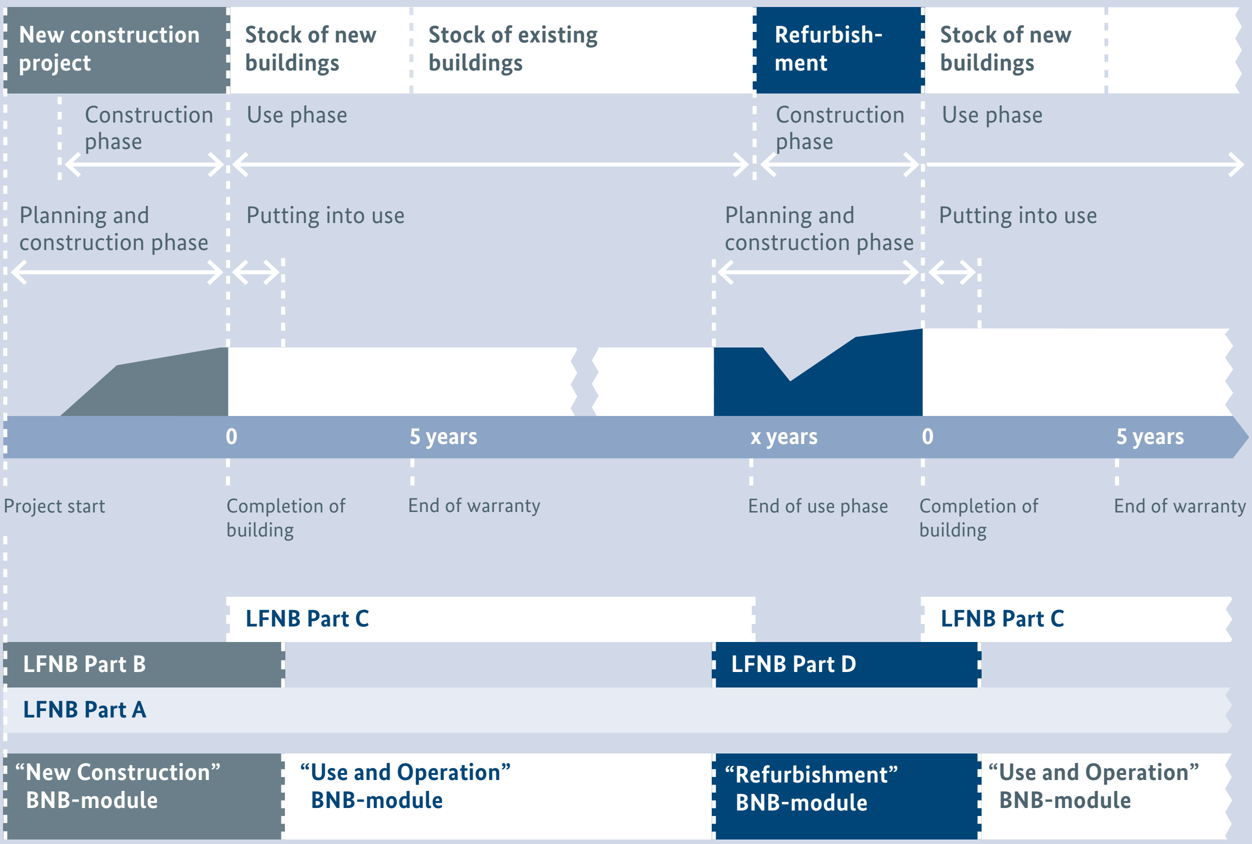


Fig. 4: Timeline of interaction between the Guideline for Sustainable Building (LFNB) and the Assessment System for Sustainable Building

3. Sustainability assessment using the BNB

3

In 2011, Germany introduced the Guideline for Sustainable Building as a set of binding rules for the use of the Assessment System for Sustainable Building (BNB).

3.1 Assessment System for Sustainable Building (BNB)

The BNB is a "second-generation", i.e. an hollisitc, assessment system. Unlike other certification systems of the "first generation", it provides a more far-reaching assessment of the building that covers its entire life cycle including all sustainability dimensions. During two years of co-operation between the Federal Building Ministry and the German Sustainable Building Council (DGNB), a first national catalogue of criteria was developed for an integrated analysis and assessment of sustainability aspects for buildings. The results were discussed with stakeholders from the construction sector by the "Round Table Sustainable Building" at the Federal Building Ministry and have been published since 2009 as the BNB.

The BNB considers not just ecological, economic, socio-cultural and functional qualities, but also technical and process quality. The previous three pillars of sustainability were extended to five quantifiable sustainability qualities which now represent the five main criteria groups of the BNB. This ensures that the assessment methodology is as standard-compliant as possible. The BNB is also a quality management system for planning, building, using and operating buildings.

Clients and planners can use its modules as a common language during the planning, design and construction phases. Furthermore, it can also be used as a checklist and as a decision-making and planning tool and as a structure for a description of major building components and features. The module for the use phase supports owners/operators and users, allowing them to use and manage buildings according to sustainable development goals. The module also enables the provision of data, for instance, for the use of environmental management systems or sustainability reports which are required in an ever-increasing number of cases. The assessment scheme of the system can be used to identify outstanding planning achievements in the field of sustainable building and to recognise such achievements in a downstream conformity testing process. Thanks to this standardised assessment approach, the BNB generates the required system transparency for all stakeholders on the market (owners, planners and designers, users, investors, etc.) and is hence equally understandable for everybody.

This Guideline and the supporting decree on the introduction of the BNB are the binding basis for the mandatory application of this system. The Assessment System, including the description of criteria and procedures, is published on the Information Portal Sustainable Building [11] in addition to the Guideline for Sustainable Building. This portal provides access to contact details as well as rules for the assessment process, for conformity testing and regarding certification documentation requirements and coordinator training procedures. When it comes to assessing the contribution of individual buildings towards sustainable development, the BNB uses a range of methods, tools and fundamentals, such as eco-balance data, which can be found via the portal. It also refers to or directly provides certain calculation tools (such as a life cycle cost calculator) and describes relevant documentation requirements.

[11] http://www.nachhaltigesbauen.de/bewertungssystem-nachhaltiges-bauen-fuer-bundesgebaeude-bnb.html

3.2 Layout and methodology

The Assessment System for Sustainable Building is based on a modular approach. Three modules are basically available for the different system variants and the underlying types of use:

- "New Construction" module (such as BNB_BN)
- "Use and Operation" module (such as BNB_BB)
- "Refurbishment" module (such as BNB_BK)

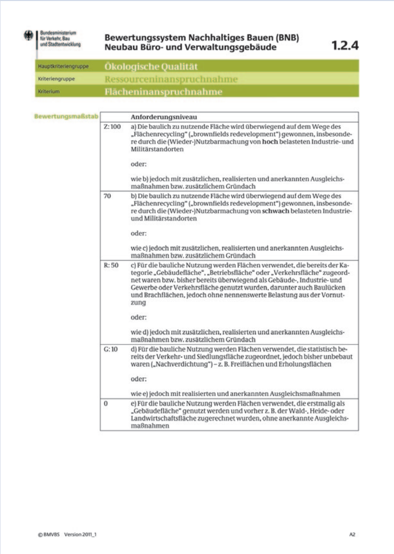
  The first letter represents the system variant, the second one the module. In the system descriptions, the letter "B" represents the "Office and administration building" system variants, whilst the letter "N" refers to the "New Construction" module.

Depending on the degree of maturity of the different system variants, all three or only certain sub-modules are available for application.

This Guideline explains the principles of the BNB. Assessments according to this system provide quantitative mapping of the five main criteria groups of sustainable building on the basis of different individual criteria. The five main groups of criteria are precisely defined by dedicated criteria profiles which are essentially structured in terms of (A) descriptions of the individual criterion, (B) assessment standard and (C) annexes. Although the sustainability qualities are closely interrelated, they are separately assessed and, following weighting at defined rates, combined to an overall rating. In this way, outstanding qualities can also be identified separately in one or more sub-areas. This concept ensures that buildings as well as their use and operating processes can be assessed and compared.


Bewertungssystem Nachhaltiges Bauen (BNB)
Neubau Büro- und Verwaltungsgebäude 1.2.4
Ökologische Qualität
Ressourceninanspruchnahme
Flächeninanspruchnahme

Part A: Description and methodology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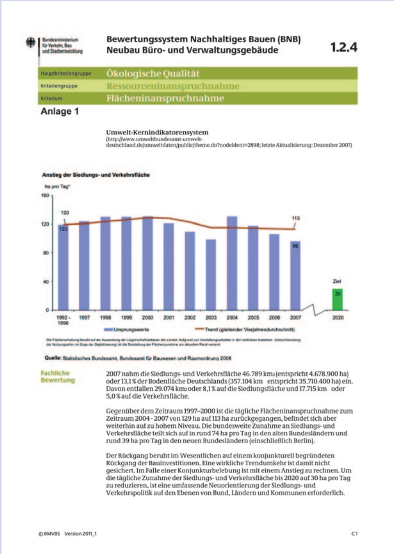
Neubau Büro- und Verwaltungsgebäude 1.2.4
Ökologische Qualität
Ressourceninanspruchnahme
Flächeninanspruchnahme

Part B: Assessment standard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Neubau Büro- und Verwaltungsgebäude 1.2.4
Ökologische Qualität
Ressourceninanspruchnahme
Flächeninanspruchnahme
Anlage 1

Part C: Annexes

Fig. 5: Criteria profile example

Part A Principles of Sustainable Building

Part A – Principles of Sustainable Building

1. Sustainable building principles

The overarching concept of a policy of sustainable and future-enabled development – based on the three equally important dimensions of sustainability (see Fig. A1) – is the starting point for the development of principles, solution approaches and assessment criteria for sustainable building. This concept simultaneously addresses ecological, economic and socio-cultural requirements as equally important requirements and includes future generations as an inseparable part of the analysis. Furthermore, the concept also underlines the responsibility of the individual and, in particular, the function of the public sector as a role model.

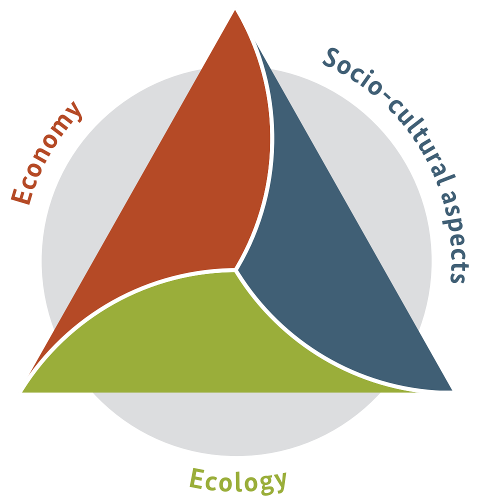

Fig. A1: Dimensions of sustainability

In a first step, general protective goods and targets can be derived from the three dimensions of sustainability. These goods and targets have to be adapted to the respective action level and the specific item of interest (building, outdoor facility or property) and integrated into the relevant workflows and decision-making processes, evaluation methods and instruments. Fig. A2 shows the protective goods and targets which have to be considered when it comes to planning, designing and building as well as using and operating buildings.

Besides features and characteristics of the building which affect the environment, economic aspects as well as socio-cultural and functional protective targets, technical features as well as aspects of the building planning, design and construction process have a decisive influence on quality. Furthermore, since a building always responds to the characteristics of its location, these characteristics must hence be known especially with a view to selecting the right site.

The sustainability potential describes the optimum implementation of all protective targets and sustainability aspects on a building level. The evaluation of the above-mentioned sub-aspects and their quantification determine qualities of parts of the building and in total the sustainability quality of the building as a whole. The sustainability of a building can thus be described and assessed on the basis of the five identifying qualities shown in Fig. A3 together with the relevant location characteristics. These parameters typically interact, so that an holistic assessment is now obtained.

Sustainable planning, building, use and operation are a function of an integrated view of these five sustainability qualities. The aim is to optimise the building during its entire life cycle in order to minimise energy and resource consumption, reduce environmental burdens and improve overall economic efficiency whilst at the same time addressing the need to improve social and cultural aspects. This is accomplished, for instance, by optimising measures to provide health and comfort which enhance the quality of life and performance of building users. Technical quality should be seen as a cross-sectional quality here. This also holds true for process quality which significantly determines the sub-aspects of sustainability during the early planning and design phase and also ensures that the planned quality will be achieved during the execution phase.

		Ecology	Economy	Socio-cultural aspects
Protective goods	Sustainability in general	■ Natural resources ■ Natural environment	■ Capital/assets ■ Economic performance	■ Human health ■ Social and cultural values
Protective goods	Sustainable building	■ Natural resources ■ Global and local environment	■ Capital/assets	■ Health ■ User satisfaction ■ Functionality ■ Cultural value
Protective targets	Sustainability in general	■ Protection of natural resources/ sustainable use and management of natural resources ■ Efficiency improvement ■ Reduction of pollution exposure/ environmental influences ■ Protection of atmosphere, soil, groundwater and waters ■ Promotion of environmentally compatible production	■ Reduction of life cycle costs ■ Reduction of subsidy volume ■ Reduction of debt ■ Promotion of responsible entrepreneurship ■ Creation of sustainable consumption patterns ■ Creation of dynamic and co-operative international economic conditions	■ Protection and promotion of human health ■ Reinforcing inclusion and solidarity ■ Protection of cultural assets and values ■ Equal opportunities ■ Protection of capacity to work and jobs ■ Fight against poverty ■ Education/training ■ Equal rights ■ Integration ■ Safety/liveable environment
Protective targets	Sustainable building	■ Protection of natural resources ■ Protection of the ecosystem	■ Minimising life cycle costs ■ Improvement of economic efficiency ■ Protection of capital/assets	■ Protection of health, safety and comfort ■ Maintenance of functionality ■ Protection of aesthetic and urban development quality

Fig. A2: Protective goods and targets in general and for the construction area in particular

Conventional building planning is still limited to a host of individual aspects in individual life cycle phases without addressing any mutual dependencies or interactions which may exist. One example is the focus on the construction phase with usually “capped” investment costs or the energy efficiency calculations pursuant to the Energy Saving Ordinance (EnEV) which are restricted to the use phase.

Buildings and their operation will thus in future call for holistic and integrated planning that focuses on the entire life cycle of the building “from the cradle to the grave”. It should, however, be noted that conventional planning already includes many aspects of integrated planning. Integrated planning sensibly links and supplements these aspects from an interaction perspective and uses the results to develop complete solutions on this basis. The aim is to create the preconditions for an objectifying and quantifying method for assessing different building designs.

According to Fig. A4, the main phases of the life cycle of a building are: planning/design, construction, use including maintenance, modernisation as well as demolishing, recycling and disposal.

The possible phases of a building's life must be analysed with a view to the different sustainability aspects and optimised with regard to their interaction in order to achieve and maintain as long as possible a high building quality at minimum costs and with minimum repercussions on the environment, as well as a high quality of use. This means that the evaluation and assessment standards for the protective targets, which are a function of the dimensions and qualities of sustainability, must always be orientated towards the entire life cycle. The entire life cycle of the building hence determines the maximum life span within the meaning of DIN EN 15643-2 [1]. The relevant life span to be applied to buildings additionally depends on the type of building and its type of use. The dimensional system limit to be considered is a function of the asset of interest (building, outdoor facility or property) as well as the relevant protective target of the respective criterion.

Ensuring the long-term usability of construction materials and construction elements (typically defined by their service life) ideally extends the life of buildings and reduces maintenance and replacement of the components concerned. In the case of any materials and components with a service life that is shorter than the life cycle of the building, the costs and effects of replacement investments must be considered in addition to general maintenance requirements. This chiefly concerns technical equipment and surface coatings, such as paint or linings and facings (plaster, flooring, etc.).

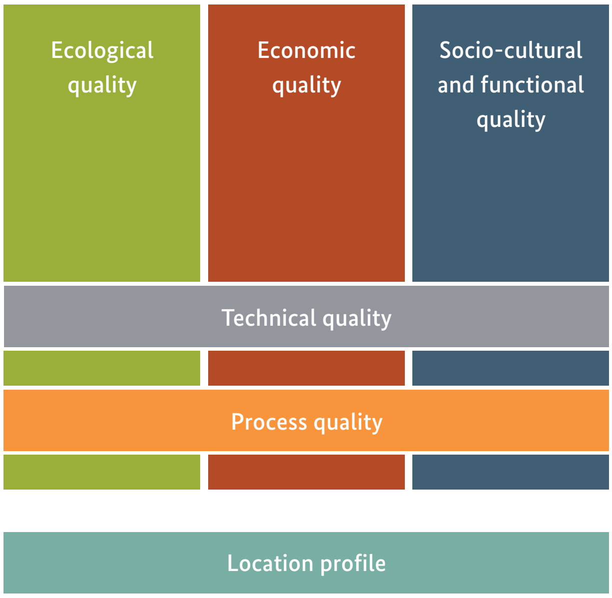

Fig. A3: Qualities of sustainable building

Life cycle assessments within the scope of the BNB cover a defined period of typically 50 years. The inputs needed for these assessments include, for instance, data regarding the duration of use of components in buildings which the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR) makes available specifically for the defined building-related assessment period of 50 years in the form of a table titled "Service life of building elements". This information is available from the Information Portal Sustainable Building under the heading "Baustoff- und Gebäudedaten" (Construction material and building data) [2], whilst VDI 2067 [3] provides the relevant data for technical building systems.

1 See DIN EN 15643-2 (2011)
2 http://www.nachhaltigesbauen.de/baustoff-und-gebaeudedaten/nutzungsdauern-von-bauteilen.html
3 See VDI 2067 (2012)

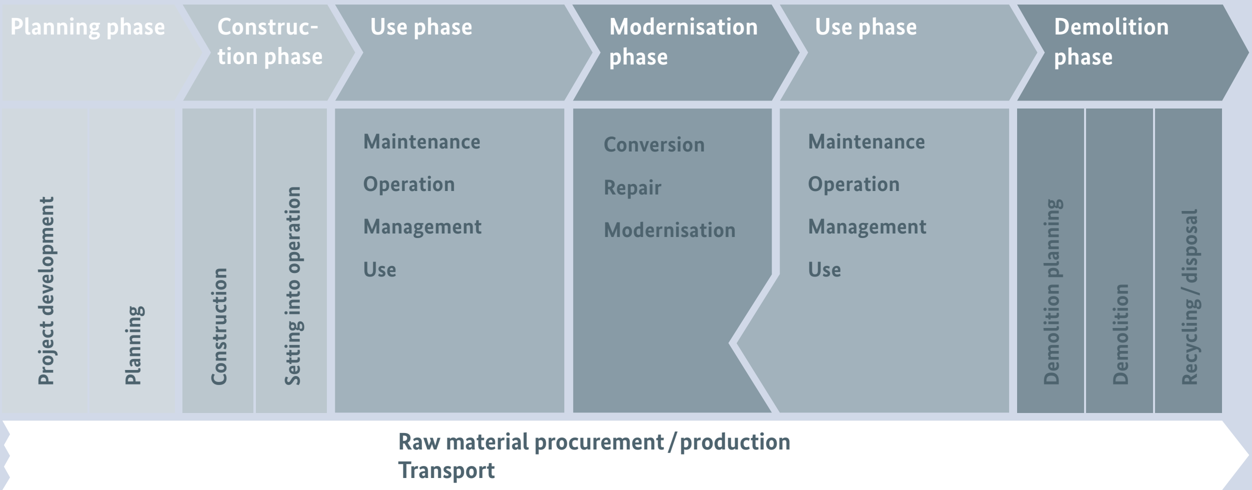

Fig. A4: Simplified presentation of the life cycle [4]

It should be noted that the assessment period is not necessarily identical to the planned service life or the maximum service life of a building.

An integrated planning approach must be adopted for new construction and rehabilitation projects in order to achieve a reasonably long (residual) use period for a building in terms of maintenance and modernisation costs. The advantage of continued use or new forms of using an existing building is that significantly lower energy and material flows are required for the necessary construction measures. The continued use of existing buildings and their adaptation to new requirements reduce the consumption of natural resources and protect the environment. There may, however, be cases when the different variants, i.e. conversion, expansion, partial or complete demolition and new construction, have to undergo an holisitc comparison because a full stock-taking and balancing exercise covering a defined use period is then the only way to determine whether a particular variant will pay off. In the case of maintenance and modernisation measures involving replacement of suitable elements and equipment, the resultant material flows and environmental impact of demolition, disposal or recycling work must be taken into consideration. The same applies to the demolition of buildings or parts of buildings.

One can conclude that there is no one single fixed concept for sustainable building. Instead, every single project requires a specific concept or sub-concept with different approaches, alternatives and measures.

[4] Refer to Lützkendorf, T. (2007)

2. Dimensions and qualities of sustainable building

2.1 Ecological quality

Ecological quality addresses the “natural environment” asset with the following protective goals:

- Protection of natural resources (see section 2.1.1)
- Protection of the ecosystem (see section 2.1.2)

Construction activities are characterised by enormous energy and material flows. Sustainable building aims at optimising the selection of components and energy sources in order to minimise the consumption of energy and other resources as well as repercussions on the environment and is thereby particularly well in line with the National Sustainability Strategy [5]. Quantifiable indicators have been determined in order to describe the different ecological protective targets and measure their level of achievement. These indicators [6] are based on the eco-balance methodology with the calculation of net effect data (see section 2.1.3) as an instrument for the ecological assessment of buildings. This form of assessment is more objective than the negative/positive lists which are traditionally used in the construction industry as an equivalent means for assessing construction products as placeholders for “environment-friendly building” and hence enables a significantly higher quality of decision-making.

2.1.1 Protection of natural resources

Targeted measures to protect natural resources in the construction industry include:

- Reduced land use
- Reduced resource demand in conjunction with the construction and operation of buildings
- Longer use of products, structures and buildings
- Fewer transports of construction materials and parts
- Minimised energy demand during the use phase
- Use of regenerative energy
- Use of rainwater or, if possible, grey water and reduced fresh water consumption
- Use of construction products/materials which can be reused or recycled
- Safe recycling of materials and substances

The effects of a building on resource consumption can be described by the energy and material flows which occur during its life. The reduction of land use and thus effective protection of soils and natural spaces can, for instance, be achieved by space-saving building concepts or soil re-exposure measures.

The following criteria of the Assessment System for Sustainable Building can be used to describe and hence assess the degree of achievement of the goal of protecting natural resources:

Criteria		Description and assessment with a view to
Primary Energy Demand, Non-Renewable	**BNB 1.2.1** [7]	Protection of limited fossil fuels
Primary Energy Demand, Renewable	**BNB 1.2.2**	Increasing coverage rate through renewables
Fresh Water Demand and Quantity of Wastewater	**BNB 1.2.3**	Reducing fresh water pollution resulting from fresh water and sewage treatment
Demand of Space	**BNB 1.2.4**	Minimising additional soil sealing and measures to re-expose sealed surfaces
Sustainable Logging/Wood	**BNB 1.1.7**	Threats to tropical, sub-tropical and boreal forest regions
Abiotic Resource Depletion	**Set aside in BNB**	Protection of limited raw material resources

Table A1: Criteria serving to protect natural resources

The resultant requirements correspond to national goals, for instance, regarding primary energy consumption, as well as to the goals of Germany’s “Integrated energy and climate programme”.

5 See “Nationale Nachhaltigkeitsstrategie” (2002), “Maßnahmenprogramm Nachhaltigkeit” (2010), BMU (2012)
6 See DIN EN 15643-2 (2011)
7 See the relevant criteria profiles, at: http://www.nachhaltigesbauen.de/bewertungssystem-nachhaltiges-bauen-fuer-bundesgebaeude-bnb.html

2.1.2 Protection of the ecosystem

With regard to the protection of the ecosystem, a distinction must be made between impacts on the global and the local environment. In order to enable a description of the different impacts on the environment, indicators [8] are determined which can be quantified on the basis of the latest discussion results, so that assessment criteria are also available.

Global repercussions on the environment can be described by the following equivalent action potentials:

Action potentials		Impact with a view to
Global Warming Potential (GWP)	**BNB 1.1.1**	Global warming
Ozone Depletion Potential (ODP)	**BNB 1.1.2**	Ozone layer depletion
Photochemical Ozone Creation Potential (POCP)	**BNB 1.1.3**	Creation of ground-level ozone as summer smog
Acidification Potential (AP)	**BNB 1.1.4**	Acidification of soils, waters and rain
Eutrophication Potential (EP)	**BNB 1.1.5**	Waters, ground water and soils

Table A2: Global impact on the environment

The following criteria for local influences on the environment are identified:

Criteria		Description and assessment with a view to
Risks to the Local Environment	**BNB 1.1.6**	Potential risks to water, soil, air resulting from the processing of materials at the construction site or due to weather exposure during the use phase
Microclimate	**Set aside in BNB**	Building-specific heat island effects of urban structures compared to the surrounding areas, and reduction or avoidance of such effects

Table A3: Local impact on the environment

Especially the goal of global environmental protection is supported by:

- The update of the national climate protection programme with a commitment of a 40% reduction in emissions of the greenhouse gases covered by the Kyoto Protocol [9] by the year 2020 compared to 1990
- The Directive on the energy performance of buildings [10]
- The “Integrated energy and climate programme”

2.1.3 Eco-balance

The following three instruments are available for assessing the environmental quality of buildings and functionally equivalent building parts:

- Ecological risk analysis
- Material flow analysis
- Eco-balance

The aim of the ecological risk analysis is to assess ecological use compatibility in cases of unreliable data.[11] The ecological risk analysis is a qualitative rather than a quantitative method.

The material flow analysis provides a balance of the input and output flows of a model space (i.e. a building or component). [12] Although the result does not enable any conclusions regarding environmental influences, it can nevertheless be used as a data basis for further analyses, such as an eco-balance.

The eco-balance (LCA - life cycle assessment) [13] is an instrument that enables quantitative calculations of the environmental influence of a system which can be a single product, a structural element or an entire building. Life cycle assessments are used to determine the environmental impact of construction products during the life cycle phases from raw material production to ex works delivery. These results are compiled for the individual construction products in

[8] See DIN EN 15643-2 (2011)
[9] See UNO (1997)
[10] See EU (2008 a) as well as DIN V 18599 (2011)
[11] See Öko-Institut (2004)
[12] See ITAS-ZTS (2002)
[13] See DIN EN ISO 14040 (2009) and 14044 (2006)

the form of environmental product declarations (EPDs) and published, for instance, in Germany by the Institute Construction and Environment (IBU – Institut Bauen und Umwelt e.V.) or other parties with comparable expertise. Furthermore, a database (Ökobau.dat) in the Information Portal Sustainable Building contains industry-specific average data for construction products.[14] On the basis of this product-related data and the related life cycle phases, a quantitative assessment of building products or parts of buildings is then possible (see Part B, section 3.4.1).

2.2 Economic quality

The economic quality of a building is reflected by the degree to which the following protective targets are implemented:

- Optimising life cycle costs (see section 2.2.1)
- Increasing resource productivity by applying principles of economic efficiency (see section 2.2.2)
- Protecting capital and (building) value (see section 2.2.3)

Costs, return and value stability are bundled under the "Capital" protective good and assessed on the basis of various indicators depending on the given project and life cycle phase. The importance and relevance of the individual indicators vary depending on the life cycle phase and the specific general conditions. The economic assessment always aims at holisitc optimisation of economic parameters. This means that measures designed to optimise life cycle costs must be reasonably in line with the value of the building and its maintenance. The related long-term timeline, especially for federal buildings, focuses on the economic efficiency of the property throughout its entire life and also considers economic factors. The key centre of interest is the building and its use which generate costs and at the same time create and preserve asset values.

2.2.1 Life cycle cost analysis

A life cycle cost analysis of public-sector assets must consider the costs generated during the construction, use and demolition of a building. In the interest of maximum economic efficiency, this method can ensure that costs are optimised throughout the entire life cycle of a building. One of the results of the life cycle cost analysis is a time-adjusted sum (cash value) per unit of usable or gross floor area (€ per sqm). For this purpose, all foreseeable costs are aggregated, including existing risks and price increase rates. The present value is determined using the net present value method. The selected building-related life cycle costs (LCC) to be considered within the scope of the application of the Guideline for Sustainable Building exclusively include costs in terms of payments:

Life cycle costs in the sustainability assessment	
Costs of manufacture according to DIN 276-1 [15]	Construction costs
Costs of building use according to DIN 18960 [16]	Operating costs
	Costs of cleaning, service and maintenance
	Replacement investment
Demolition costs according to DIN 276-1	Costs of demolition and disposal

Table A4: Life cycle costs

The major challenge when it comes to estimating supply demand and operating costs is that these factors are subject to different influences whose forecast development may at times vary considerably. Such influences include, in addition to the type of building use and service level agreements (SLAs) [17], user behaviour, climatic conditions as well as functional and technical characteristics of the building. Furthermore, each of these parameters can vary during the observation period. Orientation guidance is available from studies of use-dependent incidental costs or selected

[14] http://www.nachhaltigesbauen.de/baustoff-und-gebaeudedaten/oekobaudat.html
[15] See DIN 276-1 (2008)
[16] See DIN 18960 (2008)
[17] Service level agreements are quality standards for services which are defined as service-specific, contractually agreed service parameters, such as response and repair times

cost data in the PLAKODA planning and cost database [18]. ISO 15686-5 [19], for instance, provides a systematic assessment basis.

Furthermore, all public-sector measures having financial implications must adhere to the principles of economic efficiency and good housekeeping. With a view to the financial consequences of a measure, special attention should also be paid to future revenue and payment streams. In order to do justice to the minimum approach, the costs of a construction measure must, as a minimum, be considered according to the BNB-life cycle cost (LCC) methodology. The typical observation period to be used for the calculation is the expected period of the present and/or future use [20].

However, a tenancy term as laid down in the infrastructure agreement may also be relevant in other cases. Price developments depend on the trend in international commodity prices, the development of the exchange rate of the euro to the dollar, as well as cost trends for domestic production factors. This means that annual price increase rates must be determined and subsequently applied in a uniform manner. A cost assessment must additionally consider the effects of the use period if this differs from the technical service life of the building, at least if the building is strongly dependent on specific uses. Fig. A5 shows that the consequential costs exceed the costs of construction of a building during its lifetime. A high quality of the finished building should lead to significantly lower costs during the use phase. Depending on the complexity of the planning and design task, this may mean higher construction as well as planning and design costs. A variant comparison based on a life cycle cost analysis can already be used during the planning phase to determine the optimisation potential.

The life cycle spanning analysis of a construction measure can hence be helpful when it comes to identifying significant potential for savings regarding relevant component groups and can enable the economic efficiency of the measure in its entirety to be assessed. Within the scope of an assessment, this approach can also be used to analyse the different structural options in order to address the space needed and ultimately implement the most efficient variant.

2.2.2 Economic efficiency

The economic efficiency analysis describes the economic advantages of an (investment) project from the federal government's perspective as the ratio between costs and benefits. The aim is to ensure the efficient use of funds in the interest of permanently high resource productivity. In view of different goals and aims of a project, different methodological approaches can be used to analyse economic efficiency. The type of project and the stakeholders' respective opinions and expectations have a central role to play in this respect. Energy-efficient refurbishment of a building, for instance, means capital investment on the one hand and ongoing savings on the other. These can be compared as part of an evaluation of economic efficiency. Whilst amortisation of costs due to reduced operating costs is the key factor in the case of owner-used property, the focus in the case of property that is rented out would be on increasing base rent and hence return on investment.

Fig. A6 shows that microeconomic analyses generally distinguish between static and dynamic methods. Unlike static methods, dynamic approaches consider the development of cash flows over the course of time. The net present value method is the most commonly adopted practical approach when it comes to assessing the economic efficiency of a property. Static methods are generally not suitable for assessing the economic efficiency of property investment. This applies specifically to life cycle-orientated analyses.

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[18] PLAKODA Planungs- und Kostendatenmodule der Länder und des Bundes (Planning and cost-data module of the federal states and federal government

[19] BS ISO 15686-5 (2008)

[20] For a description of the specifications for uniform analysis time frames, see Part B, section 2.2: "Identification of costs and profitability analysis".

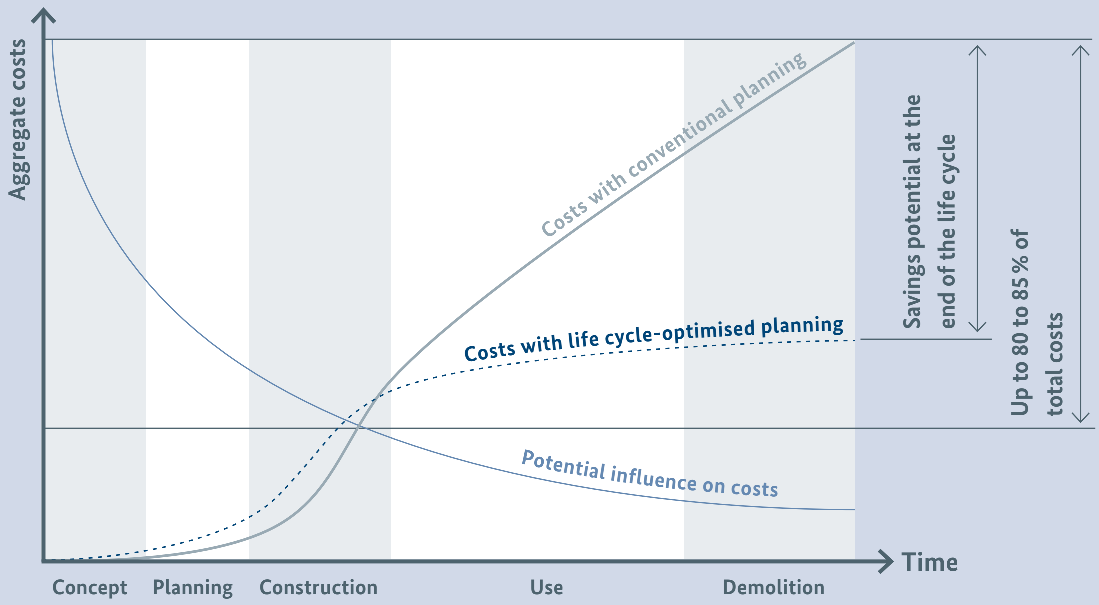

Fig. A5: Life cycle costs [21]

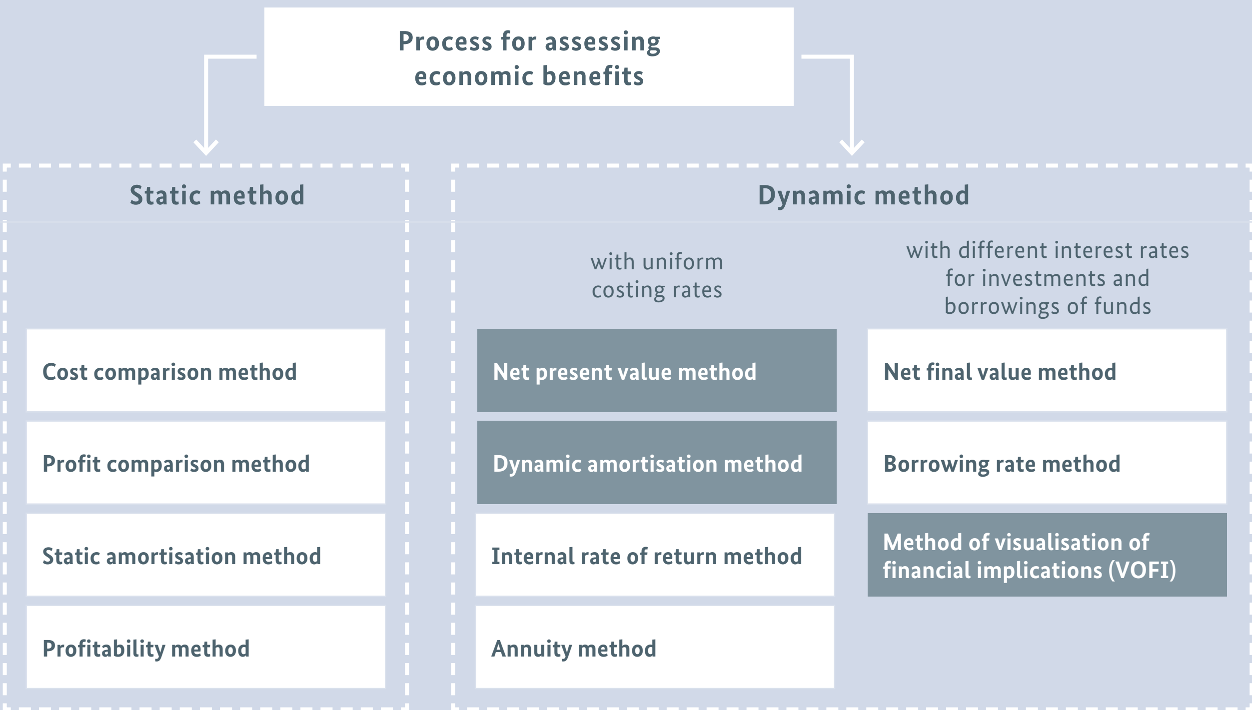

Fig. A6: Investment analysis [22]

[21] See Jones Lang LaSalle (2008 b)
[22] Source: Pfarr (1984)

The Federal Budget Code (BHO)

Pursuant to § 7 of the BHO, the evaluation of economic efficiency is to be based on the net present value method. The relationship between costs and usable area space and the comparability of different buildings are expressed by the € to sqm of main usable area. Pursuant to the BHO, economic efficiency analyses must be performed both during the planning and design phase and as part of audits during procurement and investment projects. In this respect, there is no difference between new construction and refurbishment projects because budget law commits all stakeholders in the public sector to the principles of economic efficiency and good housekeeping.

The members of the interdisciplinary planning team already have to co-operate closely under the responsibility of an overall co-ordination leader during the planning and design phase. The project sponsor (owner/operator) and the user [23] must be involved during the early planning and design phases. If the operator function is not yet known, the owner should represent the operator's interests during the planning process. The following aspects deserve special attention:

- Optimisation of purchase requisitions
- Optimisation of life cycle costs (LCC)
- Reduction of maintenance/follow-up measures

The question as to whether a is necessary or whether an existing building can be reused is another aspect to be addressed during the economic efficiency assessment. Furthermore, different procurement variants, i.e. public private partnership (PPP), leasing or renting, should also be considered.

Relevant provisions for the performance of economic efficiency assessments on a federal level include, in addition to § 7 of the BHO, the related administrative regulation (VV), the "Introduction to economic efficiency assessments" [24] guideline, the applicable provisions of the RBBau Guidelines and – specifically with a view to life cycle-orientated economic efficiency analyses – the guideline "Economic efficiency assessments in PPP projects" [25].

2.2.3 Value stability

Protecting economic capital and assets is one of the protective targets of the economic dimension of sustainable development. With regard to the property issue, this means the preservation and protection of the (economic) value of a property over the course of time or a property's life. The most common definition of the economic value of a property is its fair or market value. § 194 of the Building Code defines the fair/market value of a property as follows: "The fair value (market value) is determined by the price which could be realised in arm's-length transactions at the time to which the determination relates according to the legal and factual conditions, the other characteristics and the location of the property or the other subject matter of the value determination regardless of exceptional or personal situations." The stability of the value of a property can thus be measured or assessed via the development of the fair value of the property over the course of time. The value of a property can hence be called stable if the fair value of the property remains constant or even increases rather than decreases.

The purpose of property value determination is to establish the fair value. Since property prices – unlike the prices of other, homogenous assets and commodities – cannot be easily monitored and compared on the market, the aim of property value determination is to develop a well-founded price forecast for a hypothetical property transaction or to identify a property value without knowing whether the free market would in fact honour such value.

[23] Users here means the organisation (company, enterprise, office etc.) using the property.

[24] "Arbeitsanleitung Einführung in Wirtschaftlichkeitsuntersuchungen" (2011), circular by the Federal Ministry of Finance on 12 January 2011

[25] Guideline "Wirtschaftlichkeitsuntersuchungen bei PPP-Projekten" communicated in letter Ref. IIA3-H1000/06/0003 by the Federal Ministry of Finance dated 20 August 2007

This is because the price actually paid for a property and its estimated value are not necessarily identical. The value is an objectivised and (ideally) verifiable term which results from the supply and demand situation on the market. The (ideally) "objective value" is a function of the many subjective benefit assessments by market participants. It is the result of analyses, assessments and valuations, whereas in each and every concrete case the price of an asset lies between the subjective value assessments by the buyer and seller and the final price can be influenced by different bargaining positions and other subjective factors. The price is the sum of money effectively paid for a particular asset or service. The price is a reality and can be proven. The aim of property value determination is to minimise the difference between estimated values and prices actually paid or payable.

In Germany, §§ 192 to 199 of the Federal Building Code (BauGB) contain the provisions applicable to the determination of property value. However, the provisions of the Building Code and, more specifically, the provisions regarding the fair or market value, do not suffice when it comes to practical determination of the value of a property. The "Ordinance Regarding the Principles for the Determination of the Fair Value of Properties (ImmoWertV)"[26] is hence designed to ensure that generally uniform principles are used to determine property values. Furthermore, the "Guidelines for the Determination of Fair Values (Market Values) of Properties" (WertR) offer practical guidance for value determinations.

Pursuant to the ImmoWertV, there are basically three methods for determining the fair or market value of properties. These methods are shown in the overview on this page. The particular valuation method to be used depends on the purpose of the valuation, the type of property to be valuated and the specifics of the property market concerned. The key aspect, however, is that the value and its development and hence the stability of the value of a built-up property are influenced – relatively independent of the specific method used to determine the value – by a host of factors which can be classified as location, market and building related. Location and market-related factors (external factors) include, for instance, aspects of building law, local amenities, immissions, transport infrastructure, the economic structure and situation and many more. These factors are not constant. Instead, they are subject to changes over the course of time and hence to a market and location change risk as well as a resultant risk of a change in value. In order to minimise market and location risks as a whole, detailed market and location analyses are usually

Methods relevant for determining fair and market values of properties pursuant to the Ordinance Regarding the Principles for the Determination of the Fair Value of Properties:

- **Comparative value method: "presence-orientated":** Market values are compared directly or indirectly. This means that the comparative value method reflects an arrangement already made between market participants. The comparative value is determined on the basis of prices reached in recent market transactions involving comparable assets.

- **Asset value method: "history-orientated":** This method is based on the cost of reproduction and/or manufacture or construction of the asset to be assessed. The underlying principle of the asset value method is that the purchase price and hence the fair value of a built-up property will reflect the costs necessary to obtain a comparable, undeveloped piece of land and to erect comparable structures on such a property.

- **Discounted cash flow method: "future-orientated":** This method is orientated towards the future cash flow that can be generated on an ongoing basis with a built-up property. The discounted cash flow is the sum of the cash values of all net revenues which can be generated from the property on an ongoing basis, including the cash value of the land, on condition that the property is correctly managed.

[26] ImmoWertV 2010

conducted before starting any project development measures. However, the degree to which external factors can be influenced during the use phase of a property tends to zero. This means that options to minimise risks and to create the preconditions to maintain a high value of a property must already be ensured during the planning phase through appropriate building-related features and characteristics. Building-related factors include, for instance:

- Space efficiency
- Possibility of conversion and reuse
- Flexibility and adaptability
- Resilience
- Durability
- Energy characteristics

These and other factors directly influence the value and its development and hence the stability of the property's value. The guidance document titled "Sustainability and Determination of the Value of Properties"[27] provides a detailed explanation of the relationships between different, sustainability-related building factors and property values. This Guideline for Sustainable Building focuses on the building-related factors (in as far as they influence value). It should, however, be noted that building-related factors cannot be considered and assessed separate from location and market-related parameters. A property ideally has features and characteristics which enable it to respond to specific market and location conditions and to adapt or to be adapted to changes in external factors over the course of time with minimal resource consumption as a key prerequisite for maximum value stability.

2.3 Socio-cultural and functional quality

Socio-cultural aspects mean all factors that influence the socio-cultural identity of humans. During this identification process, the individual perceives and assesses their environment. The individual's social needs and expectations are just as important here as the cultural values of a social system. These include, first and foremost, non-material values, such as inclusion, participation and health as well as education, demographic factors, mobility and quality of life. This means that social needs and cultural values and assets must first be identified in as far as these are relevant for sustainable building.

Properties represent a micro-level of the factors which influence an individual's socio-cultural identity. The analysis here focuses on the quality of the built environment where functional, design and sometimes monument protection aspects as well as comfort expectations have to be considered in addition to integration into the urban and landscape environment. Since this Guideline uses the object of interest itself (i.e. a building, an exterior facility or a property) as the physical system boundary, the focus moves to the individual and their related socio-cultural needs and expectations. Individuals assess their immediate vicinity, whether on a conscious or sub-conscious level. The resultant positive or negative feelings and emotions are expressed by the degree of comfort and motivation .[28] The aim should be to provide the highest possible quality of conditions for use and to maintain these throughout the life cycle. The following socio-cultural protective targets should, as a minimum, form part of the sustainability analysis:

- Ensuring functionality (section 2.3.1)
- Ensuring design quality (section 2.3.2)
- Ensuring health, comfort and user satisfaction, safety (section 2.3.3)

[27] The guideline "Nachhaltigkeit und Wertermittlung von Immobilien" can be downloaded at: www.nuwel.de

[28] See: Widuckel, Werner (2003)

Socio-cultural and functional qualities are very important for the assessment of a building by its users and society. These qualities are hence essential for the design of a building because user satisfaction has a positive and sustainable effect on the building and leads to special appreciation and long-term value of the building. This means that all socio-cultural aspects must be geared towards the individual and aim at creating high use value.

The quality of use of a building is determined by the socio-cultural and functional criteria, in as far as these can be objectivised according to the BNB, as well as factors that cannot be quantified. According to the "philosophy" of the BNB, only those socio-cultural aspects are considered which can be currently quantified. As a consequence of this approach, the descriptions of the individual phases of the planning and design as well as the construction processes in this Guideline consider only quantifiable sub-aspects of the socio-cultural and functional criteria. This means that the evaluation and identification of use requirements enable definitions of measurable and/or quantifiable qualities.

In contrast to the methodology of the BNB, those qualities which are strongly based on subjective effects and perceptions (such as an up-to-date and consistent design idea or material aesthetics and quality) can only be assessed in the form of an evaluating comparison by experts and, during the use phase, by interviews and surveys of the respective users. These qualitative criteria for design and location should be separately assessed by experts specifically for every single project.

The determination of the degree of fulfilment of the socio-cultural and functional criteria of the BNB is hence only a sub-measure of user satisfaction which, for its part, can serve as a general indication of the higher-level use quality of the building. It is hence all the more important that project sponsor (owners) and users focus on identifying suitable, non-quantifiable design and functional qualities and criteria with regard to health, comfort and user-friendliness. During the use phase, user satisfaction should be evaluated in interviews and surveys.

2.3.1 Functionality

Functionality is the ability of a property to fulfil certain functions that depend on given use requirements. A building is, for instance, functional if the overall design concept, the assigned functions and spaces, detail and interior design, infrastructural accessibility as well as supply and disposal functions are optimally co-ordinated in relation to each other and the use requirements. This optimisation must be achieved first and foremost through sustainable building planning and design.

Besides a general reduction in the use of new land, increasing the efficient use of soil already sealed is thus one of the goals of the federal government's National Sustainability Strategy. Increasing space efficiency (BNB 3.2.2) in buildings is one important measure to this end.

Considering the long service life which is today expected from new buildings, the challenge is that not only present, but also future use requirements will have to be met. Capability of conversion (BNB 3.2.3) is hence of paramount importance for sustainable building. In this context, it is important to assess which level of flexibility the structures in question permit and/or how complex the required adaptation and conversion work will be if general conditions change. Crucial parameters in this area include, for instance:

- Cross-sections of technical utility shafts
- Design and number of access cores
- Space breakdown (floor area, usable floor area, circulation area)
- Type and capacity of media and utilities (such as heating, connected capacity)
- Headroom
- Spatial structure and load transfer of partition walls

The conversion capability of a property influences not just the total service life of the property, but also building-specific costs during its life cycle and related material flows.

Socio-cultural aspects of sustainability also include user-group orientated conversion and adaptation measures, most notably with regard to barrier-free building (BNB 3.2.1). Accessibility directly impacts the usability of buildings for individuals with impaired visual, hearing or motor capabilities. Accessibility indirectly enhances user comfort and reduces health and hazards related to the risk of injury. Especially with regard to demographic change in Germany and the resultant growing share of older people, accessibility is becoming more and more important. Everybody must be equally enabled to participate in social life.[29] Buildings and facilities are defined as being accessible "if they are accessible and usable by all people, with or without handicaps, in the customary manner without any special impediment and generally without any assistance"[30]. The provisions of the Equal Opportunities for Disabled People Act (BGG) are binding for federal-government construction projects.

Acceptance and integration of buildings within urban quarters, cities and regions can be enhanced by increasing public accessibility (BNB 3.2.4) of the building. Public accessibility supports communication and communities. A diverse offering of uses vitalises the public space, increases the users' safety perception and contributes towards the economic sustainability of the building. Acceptance and integration of a building into its neighbourhood as part of its urban quarter can be promoted by public accessibility and uses which are conducive to the quarter.

Offerings for staff which facilitate the use of bicycles support the political goal of encouraging greater use of environment-friendly forms of travel to work. The qualitative aspects of bicycle comfort (BNB 3.2.5) – regarding the building and its property – include sufficient space, the location and distance of bicycle racks from main entrances, the features of the bicycle racks (rain protection, lighting and theft protection) as well as showers and lockers and the possibility to dry cycling clothes.

2.3.2 Ensuring the design quality

The public sector and its buildings are particularly visible to the general public. The public sector thus has to consider its role model function. Federal buildings should reflect the level of building culture in Germany and how it is perceived whilst additionally protecting existing cultural assets. Ensuring a high design quality in government building projects hence has an important role to play. This applies not just to the demanding architectural design of the building and its outdoor facilities, which must reflect the respective location and its use, but also to the quality of its integration into the urban space. Sustainable planning not only means that current values have to be considered. Instead, future values must also be taken into consideration in view of the long-term timeline. Planners are thus faced with special challenges in terms of design aspects because sustainability means that the design quality has to be ensured for the entire life of the building. It is neither possible to identify standards for architectural and urban planning qualities for a single building nor to give a permanently valid, standard answer to questions of identity and acceptance. Due to the complex nature of these aspects, the focus differs from case to case. A uniform assessment is possible on a very abstract level only.

The implementation of competitions on the basis of the "Design Competition Guideline" (RPW 2013 – Richtlinie für Planungswettbewerbe 2013) can provide an initial framework. Design competitions offer a tremendous opportunity to not only ensure aspects of design quality but also to integrate sustainability protective targets through the design and urban quality criterion (BNB 3.3.1). The process of contracting design services through competitions in order to obtain the best architectural and structural solution is a tried-and-tested concept which helps to maintain diversity in building culture. It is a way of adequately addressing the enormous complexity of a single project in conjunction with multidimensional sustainability requirements. Other discursive methods involving independent expert bodies can also help to enhance architectural quality during the planning and design process.

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[29] See BGG (2007), § 1

[30] See DIN 18040-1 (2010)

Fig. A7: "Guideline Accessibility in Building Design" (BMUB (2014))

Art in architecture (BNB 3.3.2) is an element of building culture which adds to the quality and expressive force of a building. It is hence an integral part of the building project. In this sense, art in architecture[31] is an element that should be integrated into the building as a natural feature and help to enhance building quality. Artists should therefore be commissioned when it comes to the construction of federal buildings on condition that the purpose and importance of the building justify this under the RBBau Guidelines.

2.3.3 Health, comfort and user satisfaction

Health, comfort and user satisfaction as well as safety are of particular importance for the acceptance of both new construction and refurbishment projects. Whilst these issues are addressed on the basis of the applicable technical construction rules for new buildings, user satisfaction surveys are an additional means when it comes to assessing refurbishment measures. The following aspects refer to the resultant minimum requirements.

Health

Health risks resulting from hazardous substances and exposure to environmental or building influences must be reliably ruled out (BNB 3.1.3). Whilst immissions into ambient air are addressed and limited by a large number of laws and ordinances, most notably by the "Federal Immission Control Act"[32] including the related ordinances and the "Technical Instructions on Air Quality Control"[33], there are only very few legal provisions for indoor air. An exception are working spaces where production processes can cause air pollution which has to be limited pursuant to labour law. By selecting suitable construction materials (such as low-odour and low-emission products), potential health risks – especially for persons suffering from allergies – can be avoided and interior spaces created with low concentrations of volatile and odour-active substances. Sufficient air change rates – with both natural and mechanically assisted ventilation – can ensure good indoor air quality also with a view to CO_2 levels. The "Guidelines for Indoor Air Hygiene in School Buildings"[34] published by the German Federal Environment Agency contain further information and details regarding particulate matter exposure, CO_2 content as well as ventilation rules and avoidance of mould.

The federal state building regulations include requirements regarding health compatibility of construction products. Random measurements of VOCs, formaldehyde and other emissions which are carried out after a reasonable decay time following completion of the construction work serve as quality assurance measures (BNB 3.1.3). It must be generally ensured that problematic substances (see Annex A1) which pose a toxicological risk for humans are avoided or reduced to acceptable levels (BNB 1.1.6). The REACH Regulation[35] (Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals) which is valid EU-wide

[31] See BMVBS (2012) "Leitfaden Kunst am Bau", also available for downloading: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html
[32] See BImSchG (2012)
[33] See TA Luft (2002)
[34] See UBA (2008)
[35] See REACH Regulation (2012)

must always be observed with regard to substances with an environmental hazard potential. The REACH Regulation is supplemented by the CLP Regulation [36] (Regulation on classification, labelling and packaging of substances and mixtures).

Comfort

In order to create a comfortable atmosphere, a pleasant indoor climate must be ensured in terms of temperature, acoustics, visual and olfactory parameters. Scientific studies [37] have shown that productivity and user satisfaction directly correlate with the conditions of use. Comfort is additionally determined by other factors which cannot be directly measured, such as the haptic quality of the materials and surfaces used.

Thermal comfort at workplaces (BNB 3.1.1 and 3.1.2) is a precondition for efficient and effective working. Moreover, the way in which thermal comfort is created also influences energy consumption. Thermal comfort strongly correlates with satisfaction at the workplace and must hence be ensured all year round. Relevant parameters include room temperature, humidity, air velocity and the related draught risk, radiation temperature asymmetry as well as floor temperature, the vertical temperature gradient as well as times of excessively high temperatures in summer. DIN EN ISO 7730 [38] offers orientation for designers in this respect.

With regard to acoustic comfort (BNB 3.1.4), verbal communication is the most important aspect to be considered for most types of space use in office and administration buildings. In office buildings, for instance, spoken communications must be clearly audible, whilst a sufficiently low noise level in meeting and seminar rooms, single offices etc. is another vital precondition for using such spaces. With other types of use, a certain minimum sound insulation factor (BNB 4.1.1) for partition walls and optimised orientation of spaces in relation to each other are decisive. One requirement which applies to all forms of use is acoustic insulation of spaces with a use-dependent minimum sound absorption level to be achieved by surrounding walls.

Visual comfort (BNB 3.1.5) is achieved by adequate lighting without major sources of annoyance, such as direct light exposure or glare, and a sufficient lighting level as well the possibility to adapt lighting to the users' individual needs. Lighting is also a relevant environmental factor which strongly influences human vision and use comfort. Instead of artificial lighting, natural lighting should be selected because it requires less additional energy and is more pleasant for the human eye. In order to ensure the appropriate availability of daylight, openings (windows and skylights) should create a pleasant level of brightness and enable sufficient visual contact between interior and exterior spaces. Early and integrated planning of natural and artificial lighting can help to achieve high-quality lighting with low energy demand. The "Technical Rules for Workplaces" (ASR) set forth orientation values for minimum lighting levels in relation to specific forms of use.

Another way of meeting the users' individual comfort demands is to enable maximum influence of the user (BNB 3.1.6) on ventilation, sunlight protection, glare protection and temperature during and outside the heating period as well as on natural and artificial light control. This increases acceptance, performance and satisfaction on the part of users and also correlates directly with energy consumption at the workplace.

Public spaces in the immediate building-related outdoor area (BNB 3.1.7) promote the general well-being of users. Attractive, weather-protected exterior spaces of office and administration buildings promote communications between staff and additionally enhance the overall appearance of the building. Attractive exterior spaces generally contribute towards the quality of use and hence towards the users' sense of comfort. Further sustainability requirements for exterior spaces are described in section 6 and in the brochure titled "Sustainably designed outdoor facilities on federal properties" and in the "Assessment system for sustainable building for outdoor facilities".

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[36] See CLP Regulation (2009)
[37] See BOSTI study (1985), EU Health and Safety Policy 2007–2012
[38] See DIN EN ISO 7730: Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria (2006)

Safety

Another goal is to enhance the users' sense of safety by protecting users and assets and by avoiding hazards and accidents (BNB 3.1.8). The individual's sense of safety also contributes essentially towards the feeling of comfort. Measures which enhance the individual's sense of safety are usually also suitable when it comes to warding off the risk of unlawful acts by others. Objective safety is ensured by avoiding real danger situations to the maximum extent possible and/or by minimising the extent of damage. Furthermore, the feeling of safety in the broader sense is also determined by the occurrence of accidents, fires and disasters. Feelings of uncertainty and fear can restrict the freedom of movement.

In order to exploit the full potential for a positive, subjective sense of safety, suitable prevention measures must be considered in the design of a building whilst additionally resorting to security services during the use phase. This is a function of security requirements resulting from the particular use and location of a property.

2.4 Technical quality

Technical quality focuses on the quality of the technical features of the building and its equipment. The following minimum aspects should be considered:

- Structural stability and resistance to environmental influences
- Fire protection
- Sound protection
- Heat and humidity protection
- Cleaning and maintenance issues
- Possibility to demolish the building

In addition to these aspects, there are further technical parameters which should also be considered. Load-bearing capacity reserves, if commercially justifiable, mean more adaptation and conversion options for the building. In addition to fundamental structural stability issues, the building must be considered and assessed in relation to its location when it comes to issues of climate-compatible construction. Future, holisitc design concepts must hence increasingly consider sufficient resistance of the building envelope structures to hail, strong wind or floods.

The requirements for structural fire prevention and protection measures are laid down in the applicable federal state building regulations and in the technical construction rules. The revised "Fire Safety Guide"[39] from the Federal Building Ministry is another binding tool for federal buildings and must be considered in planning and design.

The requirements for structural sound insulation (BNB 4.1.1) are subject to the generally accepted rules of technology. The minimum requirements are laid down in DIN 4109[40]. This warrants that the minimum sound insulation required by the building regulations is guaranteed. Recommendations for enhanced sound protection against third-party working spaces and recommendations for standard and enhanced protection against sound transmission from internal working spaces in office buildings must be identified

[39] See BMVBS (2006), also available at: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html

[40] See DIN 4109 (1989), including corrections

as part of the project sponsor (owner) and user's specifications and/or as part of the building functions. Supplement 2 to DIN 4109 describes the technical context.

In the case of both fire protection and sound protection, retrofitting of features during the construction or use phase means technically complex and usually very costly measures. Special attention should hence be paid to the development of the respective concepts during the early design and planning phases.

The goal of heat insulation and protection against condensate (BNB 4.1.2) is to minimise heat and cold demand for air conditioning in buildings pursuant to the Energy Saving Ordinance (EnEV – Energieeinsparverordnung) whilst at the same time ensuring a high level of thermal comfort (see section 2.3.3) and avoiding damage to the structure due, for instance, to condensation or mould.

The cleaning and maintenance-friendliness (BNB 4.1.3) of the structure strongly influences costs and the environmental footprint of a building during its use phase. Structural elements which are maintained in a perfect condition achieve a maximum service life. Surfaces which are easy to clean require small amounts of detergents, reduce water consumption and usually cost less to clean. The design should aim at selecting suitable materials in order to avoid elements that require intensive cleaning and maintenance. It should also aim to achieve the maximum possible service life of materials by selecting suitable cleaning and maintenance strategies during the lifetime of the building. At the same time, cleaning and maintenance costs should be kept as low as possible during the use of the building. An important aspect is to involve the project sponsor (owner)/ operator in the planning and design decision.

In view of the fact that around 76.5% of mineral waste in Germany originates from the construction sector[41] and that the construction industry accounts for around 52% of the total waste volume, the suitability of a building for dismantling, waste separation and utilisation (BNB 4.1.4) should already be considered during the planning phase in the interest of future-orientated building. The following priorities should be considered here: Waste avoidance should have preference over waste reduction, and reuse of materials should have preference over recycling. If this is not possible, thermal utilisation would follow and, finally, disposal on dumps. Unnecessary parts and structural elements should be avoided whenever possible. Furthermore, waste types should be separated as precisely as possible and, most importantly, hazardous substances should be avoided. Demolition and the necessary separation of different potential harmful substances, including certain composite materials, must be taken into consideration here.

When it comes to selecting technical systems, maintenance and operation-friendliness must be considered with a view to ensuring trouble-free operation. Furthermore, accessibility and extendability must also be considered in order to enable long-term flexible adaptation to changing use requirements or technical progress. A high quality of technical features is equally important in order to achieve longevity and a low level of susceptibility to defects in the interest of minimising life cycle costs and the environmental footprint.

In terms of their durability, structures must reflect the use period of the building which is highly dependent upon the type of use. Industry halls or retail spaces, for instance, are designed for a significantly shorter use period than office and administration buildings or museums, for example.

[41] Waste volumes by industries according to the EU Regulation on waste statistics 2008, Federal Statistics Office, Wiesbaden 2011

2.5 Process quality

The following aspects must be considered in conjunction with process quality:

- Quality of the planning process (see section 2.5.1)
- Quality of the building construction (see section 2.5.2)
- Quality of preparation for operations (see section 2.5.3)

2.5.1 Planning quality

Since the decisions made during the early planning and design phase – for instance, within the scope of the Decision-making Documents (ES – Bau) – have a major impact on the future quality of the building, the quality of planning itself is also very important. As Figs. A5 and A8 show, the greatest possibilities to influence the costs of a measure exist at the beginning of the measure. Decisions with major cost implications are already made at the time the programme is defined (requirements planning) and during the first concept phase. This also applies to related environmental impacts. Aspects, such as development and issues of planning law as well as functional, urban, architectural and legal aspects (most notably structural stability and fire protection), must be identified in their totality and optimised in the interest of sustainability at an early stage during preliminary planning and as part of architectural and engineering competitions.

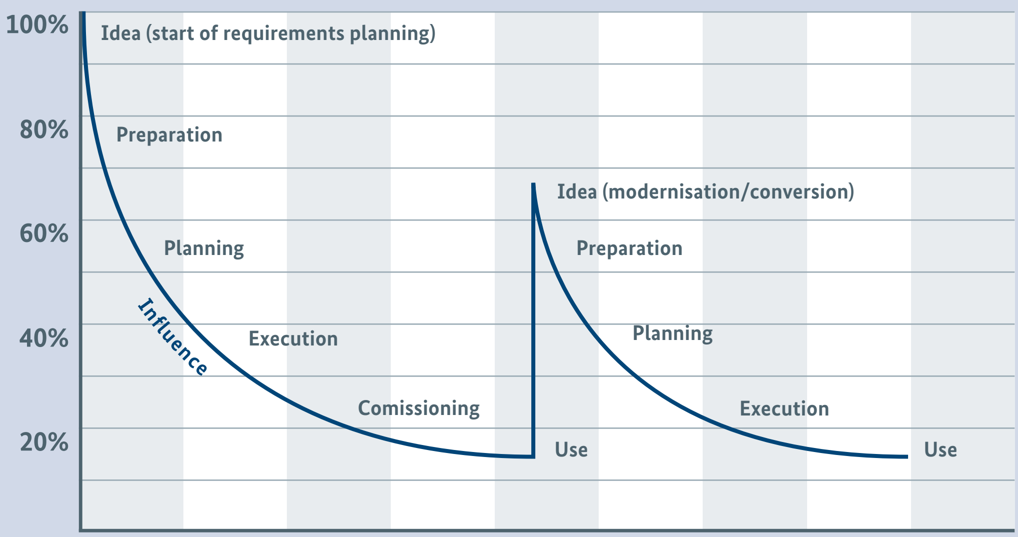

Fig. A8: Options to control the properties of a building during the planning and design phase

The quality of the planning and design process is described on the basis of the following criteria:

Criteria for the quality of planning processes	
BNB 5.1.1	**Project Preparation**
	Requirements planning
	Target agreement
	Preparation of a planning competition
BNB 5.1.2	**Integrated Design**
	Integral design and planning team
	Integral design process
	User participation
	Public partizipation
BNB 5.1.3	**Optimisation and Complexity of Planning**
	Safety and health protection plan
	Different media and utility concepts for supply and disposal
	Water concept
	Concept to optimise daylight and artificial light
	Concept to ensure cleaning and maintenance friendliness
	Concept to support conversion, dismantling and recycling friendliness
	Examination of planning and design documents by independent third parties and performance of variant comparisons
BNB 5.1.4	**Sustainability Issues in Tender and Placing**
BNB 5.1.5	**Requirements for Optimal Utilisation and Management**
	Preparation of building documentation/building passport during the planning and design process
	Preparation of maintenance, inspection, operation and service manuals
	Adaptation of plans, drawings and calculations to the as-built condition
	Preparation of a user manual

Table A5: Quality of planning and design processes

The quality of a building's sustainability depends on the quality assurance of the planning and design process, from the identification of demand to the development of optimisation concepts, sustainable tendering and contract awarding right through to the documentation of the building.

2.5.2 Construction quality

The construction process must also be managed with a view to the aim of protecting the environment and resources. At the same time, the health of all stakeholders must be protected. In addition to the quality of production site planning, it must hence be ensured that the planned sustainability criteria are also implemented in the building processes in order to warrant sustainable planning. This requires comprehensive quality control so that defects and damage to the building can be avoided. The implementation of the draft design must be monitored and the materials and construction products used must be fully documented. Practical experience confirms that incorrect construction workflow plans, typical, but foreseeable delays, unclear definitions, etc. quickly affect the construction quality of the building and thus lead to considerable deviations from designs and drawings.

The following factors determine the quality of the building[42]:

- Quality of construction supervision by architects and planners
- Degree of construction site attendance on the part planners
- Co-ordination of the construction process
- Cost control
- Contractor's quality management system
- Quality of project management services
- Quality assurance and integration of project management into quality assurance processes
- Training and further professional qualification of contractors

[42] See BBR (2002)

The quality of the construction work is described on the basis of the following criteria:

Criteria for the quality of the building construction	
BNB 5.2.1	**Building Site/Building Processes**
	Low-waste building site
	Low-noise building site
	Low-dust building site
	Soil/groundwater protection at the building site
BNB 5.2.2	**Quality Assurance of the Building Construction**
	Documentation of the materials, auxiliary materials and safety data sheets used and applied
	Quality control measurements (including, for instance, air tightness check of the envelope)

Table A6: Quality of building construction

2.5.3 Quality of preparation for operations management

Controlled commissioning (BNB 5.2.3) co-ordinates and adjusts the individual components of the building equipment to operate together after acceptance. Following this, operation of the equipment and technical systems must be re-adjusted and optimised once again no later than after around one year of operation. Regarding the optimisation of operation during the use phase, please refer to Part C of this Guideline.

The measuring equipment necessary to enable effective and comprehensive monitoring (BNB 5.1.3) by measuring the most important energy and utility parameters must already be considered during the design and planning phase. In this way, the results of the construction and use phases can be measured, documented and assessed as part of the quality assurance programme. Furthermore, monitoring is also an important element of the "management of energy and water consumption" during the use phase (see Part C of this Guideline, section 3.2.3.1, and BNB_BB 5.3.2). Besides the possibility of success control (which means that the results of the construction and operation phases are measured, documented and assessed in comparison with the planning and design requirements), energy and water consumption management is a quality management tool to be applied during the use phase so that energy and water consumption can be permanently monitored and minimised.

To these ends, federal buildings must be geared towards efficient energy and water consumption management during the use phase (see Part C, section 3.2.3). Energy efficiency must be continuously improved by systematically optimising the necessary planning, design and execution quality as well as the setting into operation of the building. This improvement requires the involvement of the project sponsor (owner/operator) and the user as well as information for the user along with adequate operations management and control (see BNB_BB 5.3.2). DIN EN ISO 50001[43] – Energy management systems, for instance, contains requirements for the introduction, implementation, maintenance and improvement of such an effective energy management system. Efficient operative and commercial energy management must include regular evaluations of media consumption during operation in order to identify and assess any nonconformities on the basis of suitable benchmarks and to trigger remedial measures, when necessary. The Energy Target Specifications (see Part B, section 2.4.3) deal with the requirements for the technical concepts which are necessary to these ends.

[43] See DIN EN ISO 50001 (2011): Energy management systems – Requirements with guidance for use

2.6 Location profile

The political and strategic aspects which are relevant for selecting the location include, for instance:

- Lack of regional supply
- Infrastructure decisions (centralised/decentralised)
- Restructuring of contaminated fallow land
- Regional strengthening of the labour market
- Capital city aspects
- All kinds of properties of the federal armed forces and the related administration

Furthermore, the decision considers concrete features of the respective location which reflect interdependencies between the quarter, property and land on the one hand and the planned building on the other. This means that the location and the building always influence each other. Climatic and geological conditions of the location as well as orientation options of the building on the property have a crucial impact on the implementation of sustainability goals, such as the use of regenerative energy in the building, necessary energy-related features of the envelope or structural measures as protection against the elements. The aspects of the location which influence sustainability must hence be identified and described when the location for a building is being sought. These aspects must be considered as part of the qualitative location assessment.

Since Parts B, C and D of this Guideline for Sustainable Building focus on the building itself as the object of interest and physical system boundary, the final sustainability assessment of the building additionally identifies the location profile which were determined for the pre-assessment of the location.

Taking the above-mentioned restrictions into consideration, the location of a building must be judged at least according to the following criteria:

Criteria		Description and assessment with a view to
Risks at the Micro-Site	**BNB 6.1.1**	Natural risks and anthropogenic disasters
Conditions at the Micro-Site	**BNB 6.1.2**	Existing pollution with health-damaging potential
Image and Character of Location and Quarter	**BNB 6.1.3**	Social quality
Public Transport Connections	**BNB 6.1.4**	Networking of rail, bus, rapid transit railways and private transport (integrated urban and local transport)
Vicinity to Use-Specific Services	**BNB 6.1.5**	Quantity and distance
Supply Lines/ Site Development	**BNB 6.1.6**	Demand for alternatives with regard to supply and disposal services for developed sites according to the federal government's integrated energy and climate programme from December 2007 [44]

Table A7: Location assessment criteria

[44] See Bundesregierung (2007)

3. General sustainability assessment procedures

A 3

3.1 Tools to support the sustainability strategy

Various fundamental tools are today available for the holisitc design, planning and assessment of sustainability aspects in the construction sector. These tools are designed to support the life cycle analysis (eco-balancing, life cycle cost analysis) and to enable and ensure the integration of sustainability aspects into planning, design and execution and their comprehensive documentation. These include, for instance:

- Information Portal Sustainable Building
- Various databases
- Assessment System for Sustainable Building
- Additional calculation tools supplementing the BNB
- Consideration of sustainability criteria in planning and design competitions
- Documentation rules

The information portal

The Information Portal Sustainable Building[45] of the BMUB provides various fundamental tools for life cycle analyses for buildings and their holisitc assessment (see Introduction, section 3.1).

Data and databases

The information portal also features several construction material and building databases with the data stock necessary for life cycle analyses:

- Ökobau.dat: eco-balance data base for construction products without a specific manufacturer reference; methodological principles for the examination of analogous EPDs
- The WECOBIS Information System on Ecological Building Materials with manufacturer-independent information regarding health and ecological aspects of construction product groups; linked to the WINGIS Information System for Hazardous Substances (information regarding environmental compatibility and safety of substances and products) (www.wingis-online.de)
- The table for use periods and replacement cycles for building construction parts to be used for the assessment of federal buildings
- EPDs (type III environmental product declarations).

Type III environmental product declarations (e.g. EPDs) offer manufacturer-related eco-balance data (energy and resource consumption, environmental conditions, technical characteristics) for ecological life cycle assessments. Type III environmental product declarations are audited by independent third parties and are hence a reliable and secure data source for construction product information of environmental and health relevance. Furthermore, other ISO-compliant type-III EPDs from industrial sources can be used. In Germany, they are published, for instance, by the Institute Construction and Environment (IBU) or other organisations with comparable qualifications. The layout and contents of EPDs are laid down in the standardisation documents developed within the scope of the European Commission's mandate M/350 "Sustainability of Construction Works".[46]

The Assessment System for Sustainable Building

The 2011 update of the Guideline for Sustainable Building has laid down binding rules for the application of this assessment system as a standardised verification method for public and, in particular, federal buildings (see Foreword, section 3.1). In the course of the scientific further development of the system, the performance of trial phases and day-to-day practical application in the federal construction administrations, the assessment system is gradually being implemented in the federal sector.

Consideration of sustainability criteria in design competitions according to RPW 2013[47]

The design competition should not only consider urban development, architectural and design qualities, but should additionally address further selected sustainability criteria, such as ecological, economic, socio-cultural and functional aspects as well as technical quality. The selection of the relevant sustainability criteria, the scope of services to be performed and the relevance of the sustainability concept for the decision by the jury must always reflect the respective competition and the specified quality level according to the BNB. The Information Portal Sustainable Building

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45 www.nachhaltigesbauen.de

46 See DIN EN 15804: 2012 – Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products

47 2013 Design Competition Guideline, see BMVBS (2013 a)

provides assistance when it comes to considering sustainability requirements in competitions in the form of a recommendation for action (such as the "SNAP" system for sustainability requirements in design competitions) as well as a pre-examination instrument (see also Part B, section 1).

Documentation rules

Complete documentation of a construction project is the foundation for the successful management and operation of buildings. The object-specific documentation varies depending on the particular phase and purpose for which the individual documents are required. Besides the documentation of the appropriate construction quality in project files, documentation of a number of individual aspects, including, for instance, the following is mandatory:

- Plans, drawings and detail descriptions
- Material grades and qualities
- Servicing and Maintenance manuals
- Energy certificate
- Photographs, etc.

Within the scope of the standard documentation for construction projects for federal buildings, the following must be applied: the "Building-related guidelines for documentation of existing buildings" (BFR GBestand) and the "Building-related guidelines for surveying" (BFR Verm) of the Federal Building Ministry and of the BMVg, as well as federal and federal-state requirements in the form of documentation directives, such as the documentation guideline (DLR) of the BBR, as well as specifications, etc. In addition to the existing documentation requirements, the sustainability aspects as implemented in the building must be adapted in the project management and controlling instruments which have been developed specifically for this purpose in order to apply the Assessment System for Sustainable Building.

Databases (evaluation)

The data which is captured and evaluated within the scope of sustainability assessments (including, for instance, economic and ecological life cycle analyses, assessments according to the BNB, as well as measuring and monitoring data for existing buildings) must be prepared according to the applicable interface conventions in such a manner that the data captured can be imported into the central databases (such as PLAKODA/LAGUNO or the BNB-database of the BBSR). The aim is to compile material that can serve as a basis for planning and design decisions and to enable recommendations as well as scientific simulations and evaluations.

3.2 Sustainability assessment of the planning, design and construction process according to the BNB

In order to enable the implementation and quantification of the above-mentioned general requirements for sustainable building, the "New Construction" BNB-module and the "Refurbishment" BNB-module have been developed for the holisitc assessment of federal buildings. The systematic assessment of individual aspects which are orientated towards the protective targets of sustainable building now means that buildings can for the first time be fully assessed and compared with a view to sustainability quality.

The basis of the two modules of the BNB for the design, planning and construction phase is the national catalogue of criteria which the Federal Building Ministry has developed during two years of co-operation with the German Sustainable Building Council (DGNB) that focused on the holisitc identification and assessment of sustainability aspects for buildings. The results were discussed at the "Round Table Sustainable Building" of the Federal Building Ministry together with stakeholders from the construction sector. The system aims at recognising outstanding planning and design achievements in the field of sustainable building and, with its standardised assessment approach, creates the system transparency which all stakeholders (owners, designers and planners, users, investors, etc.) need. The system takes a comprehensive view of the entire life cycle of buildings that includes ecological, economic, socio-cultural qualities as well as technical and process aspects. The system is transparent and objectively verifiable. It thus also reflects international standardisation developments as well as other sustainable building initiatives and is closely orientated towards DIN EN 15643-2[48].

[48] DIN EN 15643-2 (2011)

In addition to the two above-described modules of the BNB for the planning, design and construction phase, the "Use and Operation" BNB-module enables the use and operation processes to be assessed during the use phase of buildings (see Part C of this Guideline). The "Use and Operation" BNB-module includes a dedicated catalogue of criteria which reflects the many interactions with the "New Construction" and "Refurbishment" BNB-modules.

Information concerning contacts for questions and rules regarding the performance of assessments, conformity testing, assessment documentation as well as the provision of training material can be requested from the Administrative Office for Sustainable Building .

As part of the assessment on the basis of the "New Construcion" and "Refurbishment" BNB-modules, scores are assigned for the different criteria on the basis of fixed rules. The total score results from the respective scores of the individual criteria and from the weighting of the respective main criteria groups (Fig. A9). The result is the total degree of fulfilment which reflects the ratio between the score actually reached and the maximum score possible. Depending on the degree of fulfilment, a certain quality level is reached (such as gold, silver or bronze). The final examination of the result documentation (conformity testing) serves as a quality assurance measure.

Note that the building – or, in the case a few individual criteria also the pertinent property – was chosen as the physical system boundary of the subject matter of the sustainability assessment of the planning, design and construction phase because the building is in the owner's immediate sphere of influence. The underlying time frame is the life cycle including the dismantling of the building. The life cycle is examined on the basis of the actual data of the structure which has to be combined with the forecast data for the use and demolition phase. In the case of a new office and administration building, for instance, the first 50 years have to be considered.

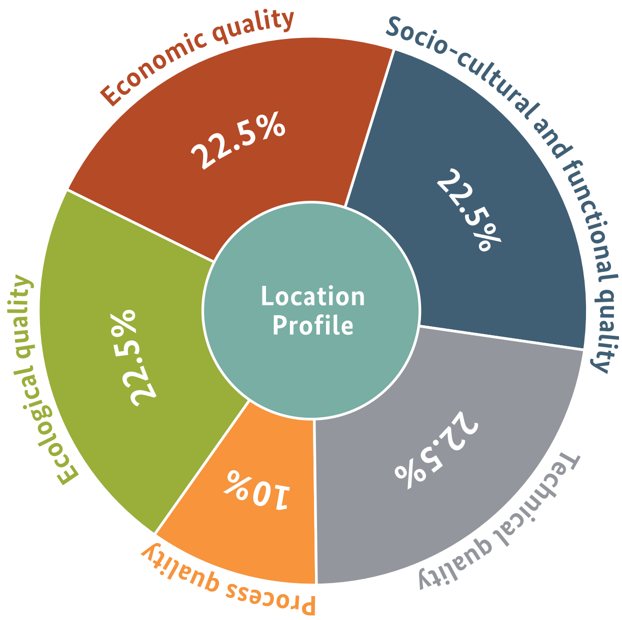


Fig. A9: Weighting of the main criteria groups of the "New Construction" and "Refurbishment" BNB-modules based on the example of the "office and administration building" system variant

3.3 Modular structure

A building as well as its use and operation processes can be subjected to multiple sustainability assessments during the life cycle of the building. The modular structure of the Assessment System for Sustainable Building reflects this fact. The following three modules should be applied in the system variants which are specific for building and use types:

- "New Construction" module (such as BNB_BN)
- "Use and Operation" module (such as BNB_BB)
- "Refurbishment" module (such as BNB_BK)

This modular approach is now for the first time available for the "office and administration building" system variant (BNB_B).

The application of the different modules depends on the concrete decision situation and the assignment to the corresponding life cycle phase. The evaluation always refers to a relevant date or point in time. The "Use and Operation" module of the Assessment System for Sustainable Building has a special role to play in this context because this module can also be used as a supplementary module in conjunction with the two "New Construction" and "Refurbishment" BNB-modules. Fig. A10 illustrates the applications which will be explained below in more detail.

I Development phase
I.1 New construction project

The "New Construction" BNB-module is applied to new construction projects during the planning, design and construction phases. The criteria and assessment methods are considered during the planning, design and construction phase. Immediately after completion of the building, the "New Construction" BNB-module is used to describe and assess the new construction projects and test the conformity.

I.2 New building stock after new construction measure

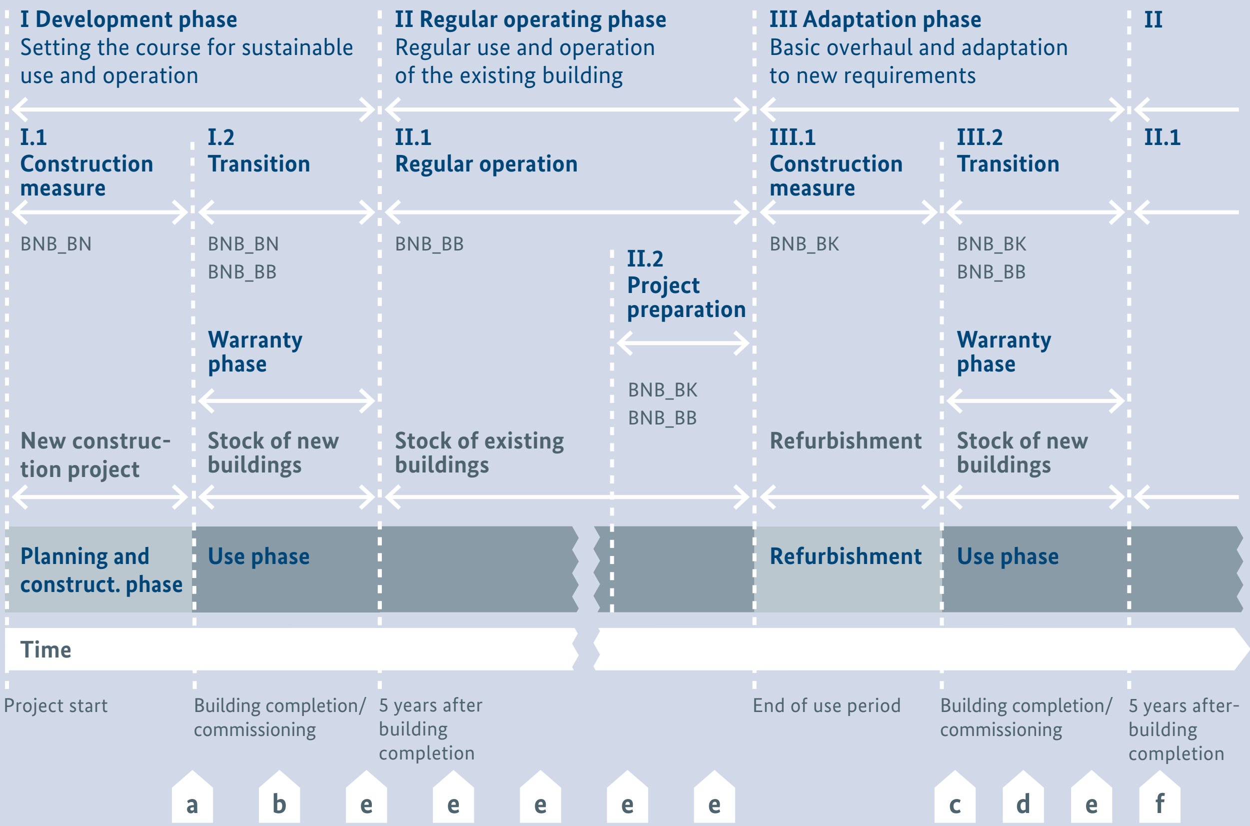
The "New Construction" BNB-module can be combined with the "Use and Operation" BNB-module and applied to existing buildings which can be classified as new building stock. Either the existing assessment can be updated, or the existing building can be described, assessed and its conformity tested for the first time. Pursuant to Section H of the RBBau Guidelines, the assessment work must commence no later than five years following handing over of the building. For a definition of the term "new building stock" and other explanations, recommendations and procedures, please refer to Part C of this Guideline.

II Regular operating phase
II.1 Old building stock/success control and optimisation of operation

The "Use and Operation" BNB-module can be applied during the use of the building as a quality management instrument in order to ensure sustainable process and asset qualities. This module enables the assessment of use and operating processes. A description, assessment and conformity testing can be carried out after the building quality has been assessed using the "New Construction", "New Building Stock" or "Refurbishment" BNB-modules (success control). However, prior assessment of the building quality is not mandatory. The "Use and Operation" BNB-module can also be applied independent of other parts (optimisation of operation). It can also be applied repeatedly at regular intervals throughout the entire use phase.

Special case in II.1 Old building stock/building diagnosis independent of a specific measure

This case is relevant for existing buildings which have not yet been assessed under the BNB and for which no complex construction measure is currently foreseen. In this case, the structure of the BNB serves as a basis for describing and assessing an existing building. The purpose of such a diagnosis is to determine how far a building is from a positive assessment result. This also enables an assessment of total quality compared to a new building. In analogy to the "new building stock" application (I.2), the assessment is based on the "New Construction" BNB-module which integrates the criteria of the "Use and Operation" BNB-module. In contrast to the "New Building Stock" application, the analogous application of all criteria of ecological, economic, socio-cultural and technical quality is necessary. These must be transposed into real qualities on a case-to-case basis. The application is not tied to a particular time or phase with the only exception being that it takes place during the use phase. It is hence not shown in the illustration above.



Possible assessment times:
- **a** Assessment of new construction project
- **b** Classification of new building stock as new construction (special solution for the transition phase)
- **c** Assessment of refurbishment
- **b** Classification of new building stock as refurbishment (special solution for the transition phase)
- **e** Assessment of the “Use and Operation” module (examples)
- **f** Special case of building diagnosis not linked to a measure (example)

Fig. A10: Possible applications of modules and assessment times

II.2 Old building stock/project preparation

The “Use and Operation” BNB-module can be used as part of comprehensive building diagnosis in order to identify the asset qualities which actually exist. This is especially important during the preparation of a measure in order to satisfy a need which has been identified (meeting requirements). Parts C and D of this Guideline contain further explanations, recommendations and procedures.

III Adaptation phase

III.1 Refurbishment

The “Refurbishment” BNB-module is applied to complex construction measures in existing buildings during the planning, design and construction phase. The criteria and assessment methods are considered during the planning, design and construction phase. Immediately after completion of the building measure, the “Refurbishment” BNB-module is used to describe, assess and test the conformity of the construction measure in the existing building.

III.2 New building stock after refurbishment

The “Refurbishment” BNB-module can be combined with the “Use and Operation” BNB-module and applied to existing buildings which, following refurbishment, can be classified as new building stock. Either the existing assessment can be updated, or a first-time description, assessment and conformity testing can be carried out. Pursuant to Section H of the RBBau Guidelines, the assessment work must commence no later than five years following handing over of the building. For a definition of the term “new building stock after refurbishment” and other explanations, recommendations and procedures, please refer to Part C of this Guideline.

4. Outdoor facilities of federal properties

A 4

4.1 Sustainability requirements for outdoor facilities on federal properties

In addition to the above-mentioned sustainability requirements for building construction measures by the federal government, sustainability aspects 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).

Two separate instruments have been developed for the two different applications with their different planning and design levels:

- Brochure: “Sustainably designed outdoor facilities on federal properties”
- “Assessment system for sustainable building for outdoor facilities”

Brochure: “Sustainably designed outdoor facilities on federal properties”

The “Sustainably designed outdoor facilities on federal properties” (BMVBS (1212 a)) brochure contains detailed explanations and information regarding the general principles of sustainable buildings on a property level as well as recommendations for the inclusion of sustainability aspects in property concepts. The following topics are presented:

- Sustainable building as a federal government task
- Subject matter
- Sustainability of outdoor facilities
- Integration of sustainability aspects into the planning and design process for outdoor facilities for the public sector
- Annex – “Sustainable properties” check-list

The “Sustainable properties” check-list in the annex to the brochure addresses the characteristics and aspects of sustainable federal properties. This check-list is designed to support the process of identifying the contents and addressing the different sub-aspects which are necessary for an holisitc overall concept. The 20 measure concepts listed here together form the basis for sustainable property development:

Ecological quality
- Water and sewage concept with decentralised rainwater management
- Concept for measures regarding soil protection and sealing level
- Concept for measures regarding climate change
- Biodiversity concept

Economic quality
- Concept for cost efficiency measures
- Multi-use concept
- Concept for preparation, reserve and service space measures
- Concept for energy measures

Socio-cultural and functional quality
- Free-space zoning concept
- Concept for development and mobility measures
- Concept for “Design for all” measures
- Concept for “Physical exercise and game” measures
- Concept for heritage conservation measures

Technical quality
- Concept for adapted technology use measures
- Material catalogue
- Clearing and recycling concept

Process quality
- Concept for integral planning and design measures
- Information and participation concept

Location quality
- Local development concept
- Regional flood protection concept

The recommendations of the brochure apply primarily to outdoor facilities of the “office and administration building” category. Furthermore, they can also be applied, albeit with certain restrictions, to other building categories and types of use, such as schools and training buildings, laboratory buildings or properties of the armed forces.

Assessment System for Sustainable Building for Outdoor Facilities

The Assessment System for Sustainable Building for Outdoor Facilities (BNB Outdoor Facilities) defines concrete requirements for the planning, design, construction and operation of outdoor facilities of buildings which must be considered within the scope of construction measures.

In analogy to the Assessment System for Building Construction, the BNB Outdoor Facilities is broken down into six main criteria groups, i.e. ecological quality, economic quality, socio-cultural and functional quality, technical quality, process quality and location quality. In contrast to and thus strictly different from building construction, the assessment extends to the location quality because an assessment of the outdoor facility cannot be separated from its location. The six main criteria groups (Fig. A11) include a total of 27 individual criteria. The BNB Outdoor Facilities hence also serves as an orientation aid and communication tool for co-ordinating individual building qualities and additionally as a steering, control and assessment instrument for implementing the sustainability requirements which have been laid down for outdoor facilities.

4.2 Interaction between property, outdoor facilities and building

Federal properties typically contain several individual buildings, often with different uses and of different age. Planning and construction of larger federal properties seldom take place as one single project. Instead, the process usually proceeds in several demand-driven phases which are often related to existing buildings. The aim is hence to already address sustainability aspects for properties at an early stage of concrete construction planning. Concepts which cover the area of the entire property (property concept, master plan) are ideally suited for this purpose.

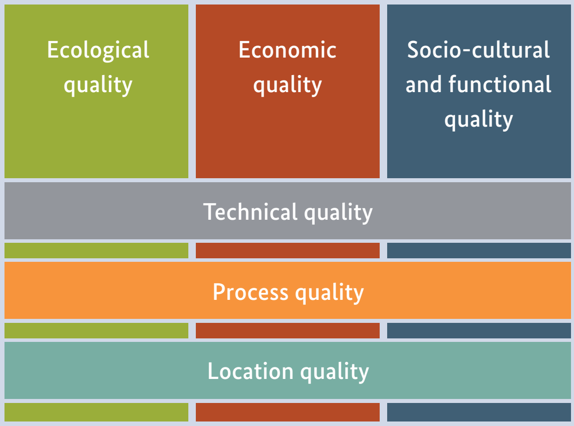


Fig. A11: Main criteria groups of the Assessment System for Sustainable Building for Outdoor Facilities

Construction measures on partial areas of a larger federal property are often difficult to clearly distinguish from each other. In the interest of sustainable overall development, it is hence mandatory to consider physical structures, even beyond the boundaries of the actual construction site and even beyond the property itself, and to integrate these into the concept. At the same time, however, only the area of the actual construction site (area marked red in Fig. A12) can be considered for the purposes of the assessment according to the BNB Outdoor Facilities because this is the only area which the designer can in fact influence.

Effective implementation of sustainability requirements calls for both a well-balanced and sensible combination of all the necessary individual measures, as well as the careful analysis and consideration of optimisation options within the scope of life cycle analyses. Higher-level concepts for larger federal properties often have to consider other aspects than in the case of concrete construction projects for outdoor facilities of a particular building.

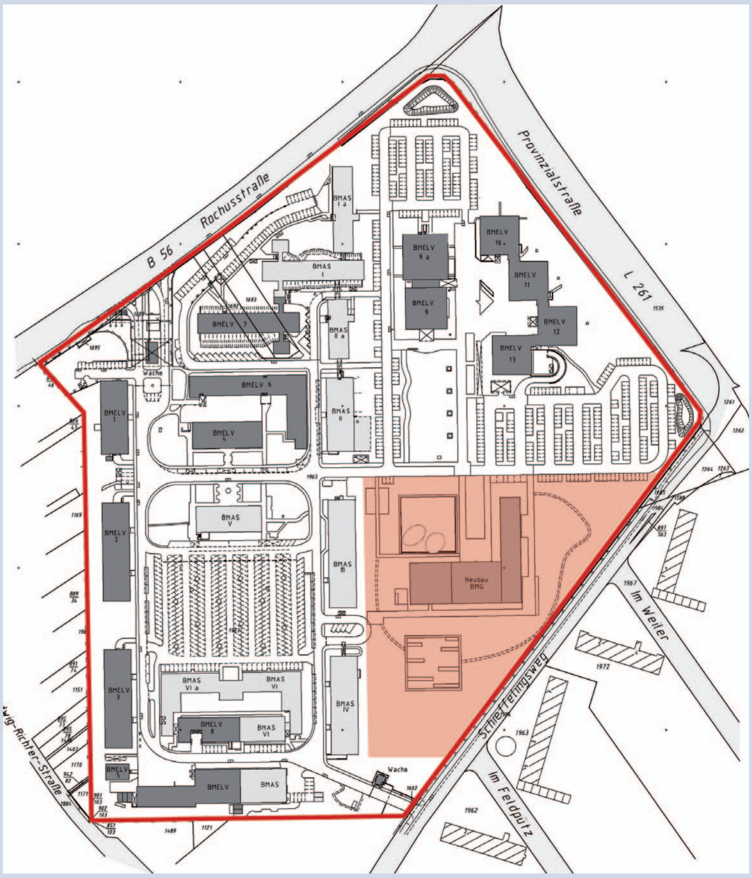


Fig. A12: Site plan – Construction site of the Federal Ministry of Health on the Rochusstraße property in Bonn

Since construction measures of the federal government usually include both buildings and outdoor facilities, sustainability requirements have to be considered equally for both. When such construction projects are carried out, interaction between building-related decisions and requirements which are relevant for the outdoor facilities has to be taken into consideration. Close co-operation between the planners and designers of the building on the one hand and of the outdoor facilities on the other is hence a precondition for a building solution that fulfils integrated requirements.

Since the Assessment System for Sustainable Building contains independent modules for buildings and outdoor facilities, the assessment of such construction projects must hence be carried out separately using these two instruments. However, the necessary individual co-ordination work between building and outdoor facility planners and designers must already take place during the first planning and design phases in order to enable optimised overall solutions.

The separate assessment of the building and its outdoor facilities must then be followed by an overall assessment of the entire building measure. The Office for Sustainable Building has laid down relevant rules and procedures to this effect.

Part B Sustainable Building Projects

Part B – Sustainable Building Projects

1. Integration of sustainability aspects into the planning process

As described in Part A of this Guideline, the way is already paved in the early planning phase for the future sustainable quality of buildings. That's why it is vital that the planning process be optimized with a view to various aspects of sustainability. These aspects must be taken into account in all planning, construction and management processes in order to achieve (new constructions), maintain (building use and operation) and improve (refurbishment of buildings) the quality of the building.

Construction projects by the federal government are subject to the Guidelines for Federal Construction Measures (RBBau)[1]. These Guidelines require for large and small new buildings and extensions (RBBau Parts E and D) that the Guideline for Sustainable Building be observed while taking the related introductory decree into account. The layout of Part B of this Guideline is based on the planning workflow as contained in Section E of the RBBau Guidelines (large new buildings, conversions and extensions) as shown in Fig. B1. These also show the corresponding work phases according to the Official Scale of Fees for Services by Architects and Engineers (HOAI)[2]. This allows the information contained in the Guideline to be transferred to construction projects which do not fall under Section E of the RBBau Guidelines. Such projects include, for instance, municipal or federal-state projects, as well as small new buildings, conversions or extensions (Section D of the RBBau Guidelines).

The holistic assessment of the quality of a building must be presented using the Assessment System for Sustainable Building. With this Assessment System (see Part A, section 3.2), the following main qualities of sustainable building undergo qualified assessment on the basis of various individual criteria:

- Ecological quality
- Economic quality
- Socio-cultural and functional quality
- Technical quality
- Process quality
- Location profile

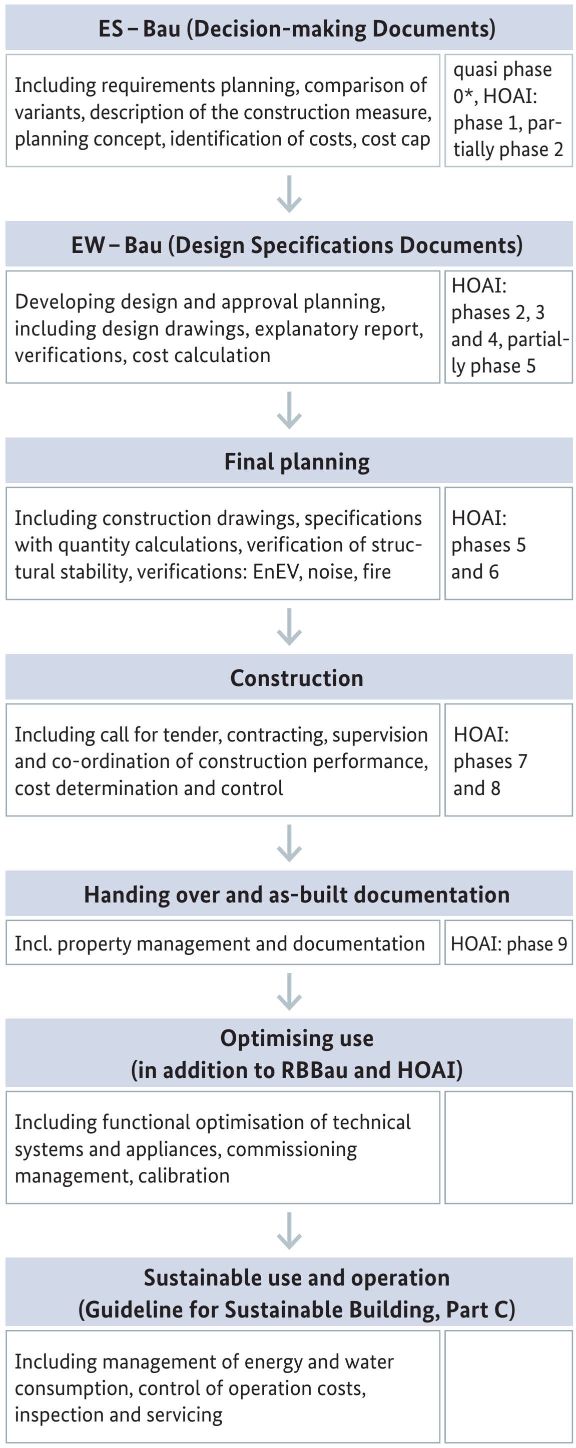


Fig. B1: Planning workflow according to RBBau[3] and corresponding work phases according to HOAI[4] as an indication for building planning and erection outside the scope of RBBau
* within the meaning of the "Utilization concept" before LP 1

[1,3] See BMVBS (2013 b)
[2,4] See HOAI (2009)

When the assessment is concluded, an overall degree of fulfilment or an overall rating is calculated. With this rating, the sustainability of buildings can be objectified, quantified and hence compared.

With the application of this Guideline, the minimum verification of the criteria explicitly stated in the BNB is mandatory according to the following sections for the individual planning phases corresponding to the RBBau Guidelines and the following sections. The criteria are processed according to Annexes B2.1 – B2.3 (see also Figs. B2, B3 and B4). These provide an overview of the criteria to be observed or processed during each of the planning phases. The text also refers to the relevant criteria which in this part of the Guideline generally apply to the "New Construction" and "Refurbishment" BNB-modules. The criteria for the "Use and Operation" BNB-module will be described in Part C of this Guideline.

Harmonised minimum requirements must be met for each individual criterion of the Assessment System. Annex B1 shows the respective minimum requirements or the minimum degree of fulfilment for the individual criteria along with the resultant minimum degree of fulfilment for the main criteria groups and for the overall degree of fulfilment, all of which must be adhered to when processing the individual criteria. Overall assessment of the building is carried out after the planning and erection phase.

Due to the fact that up to now neither the model contracts of the RBBau Guidelines nor the HOAI directly require verification of the assessment criteria, it must be examined which work is required in addition to the basic services as a prerequisite for a comprehensive sustainability assessment. The work or services to be performed by architects and specialist planners must be contractually specified during the contract awarding process. In this case, project management should specifically allocate basic or special services. The purpose of this allocation is to highlight relationships and to specifically identify potential synergies which could

PHASE ALLOCATION								
		Phases acc. to RBBau						
Criteria group	Description	ES – Bau	Competition	EW – Bau	Final planning	Construction	Comissioning and building documentation	Use optimisation
ECOLOGICAL QUALITY								
Effects on the global and local environment	1.1.1 Global Warming Potential (GWP)		* See separate recommendation	*			o	
	1.1.2 Ozone Depletion Potential (ODP)			*			o	
	1.1.3 Photochemical Ozone Creation Potential (POCP)			*			o	
	1.1.4 Acidification Potential (AP)			*			o	
	1.1.5 Eutrophication Potential (EP)			*			o	
	1.1.6 Risks to the Local Environment			×		×	o	
	1.1.7 Sustainable Logging/Wood				×	×	o	
Demand of resources	1.2.1 Primary Energy Demand, Non-Renewable (PE_{ne})	× *		*			o	
	1.2.2 Total Primary Energy Demand and Share of Renewable Primary Energy (PE_e)	× *		*			o	
	1.2.3 Fresh Water Demand and Wastewater Volume	× *		× *			o	
	1.2.4 Demand of Space	× *		×			o	
ECONOMIC QUALITY								
Life cycle costs	2.1.1 Building-Related Life Cycle Costs	× *		× *			o	
Performance	2.2.1 Value Stability	× *		×			o	

Fig. B2: Excerpt from Annex B2.1 "Overview of criteria to be observed in the individual phases of the RBBau Guidelines (new construction)" result in cost-optimised planning workflows and therefore enable project management to commission third parties with a view to integrated sustainability aspects.

For federal construction projects, Annex B2.1 provides an overview of the criteria of the Assessment System in terms of the respective phases according to the RBBau Guidelines. The table excerpt below (Fig. B2) shows the criteria that must be taken into account during the different phases of planning and construction. A distinction must be made here between standard construction measures and construction measures with special requirements as foreseen in this Guideline. Either quantitative or qualitative verification ensures that the criteria are observed. Furthermore, Annex B3 "Pre-check" provides a matrix for applying the BNB in the early planning phases. Annex B4 "Sustainability Requirements for Planning Competitions" also refers to the separate brochure: "SNAP – system for sustainability requirements in design competitions" and criteria are listed which can be checked during competitions using SNAP.

Key to symbols used in Fig. B2:

- × Qualitative verification for standard buildings
- **×** Quantitative verification for standard buildings
- ⭑ Qualitative verification for special buildings
- **⭑** Quantitative verification for special buildings
- o Final verification of the individual criterion for all types of buildings

* Depending on the competition procedure and the sustainability goal, specific recommendations are made available in the Information Portal Sustainable Building.

2. Decision-making Documents (ES – Bau)

The cost cap for large new buildings, conversions or extensions according to Section E of the RBBau Guidelines is laid down in the Decision-making Documents (ES – Bau). This documentation comprises the documents contained in § 24 of the BHO. Pursuant to the administrative regulations for § 24 of the BHO, these documents are governed by the RBBau Guidelines. Section F1 of these Guidelines lay down the contents of the ES – Bau.

In requirements planning for the ES – Bau, the project sponsor (owner) and the user identify their qualitative and quantitative requirements for the building. These requirements have a direct impact on the investment and operation costs of the building. Requirements planning forms the basis for execution. The special sustainability requirements of a building must be explicitly laid down in requirements planning. Requirements planning is approved by the user's supreme authority.

The project sponsor (owner) analyses variants to meet requirements in order to determine which variant is to be used. In the case of new construction projects, a cubic capacity survey can be used to prove technical feasibility. The costs are calculated here using cost indicators. The purpose of this analysis is to capture all structural, planning and construction-law aspects in terms of quantity, quality and costs in such a manner that alternative options for meeting with requirements and the overall economic efficiency of the measure can be assessed.

If, based on the examination of variants, the user's supreme authority itself opts to erect the building, the project sponsor (owner) commissions the building authority to supplement documentation in order to include the costs in the federal budget pursuant to § 24 of the BHO.

According to Section F1 of the RBBau Guidelines, these documents are:

- Correspondence
- Documents on requirements planning (quantitative and qualitative requirements planning)
- Documents on variant analysis, including a cost-to-benefit analysis, if applicable
- Supplementary documents of the "self built" variant, including:
  - Description of the construction measure according to Sample 7of the RBBau Guidelines
  - Identification of costs according to Sample 6 of the RBBau Guidelines
  - Rough estimate of the expected operation costs according to Annex 1 to Sample 7
  - Extract from the land survey register
  - Drawings showing the planning concept
  - Space calculation according to DIN 277
  - Target/as-is comparison of space, based on the space requirement according to Sample 13

These documents can also be used either directly or indirectly in order to assess the sustainability of a building design in an early planning phase.

Depending on the complexity of the project and the special characteristics of the individual building, additional feasibility studies and cost comparisons may also be necessary which, for their part, provide important information for an early assessment of sustainability qualities. If, in exceptional cases, in-depth planning is necessary in order to examine the sustainability of a building design, this planning must be agreed to with the supreme technical authority.

The additional documents needed for the time schedule, budget and correspondence are not usually used to assess sustainability.

In addition to the verifications and documents required in the ES – Bau, the construction document is supplemented by the "Report on the evaluation of sustainability" (Annex B6).

2.1 Requirements planning

The ES – Bau are prepared on the basis of the identification and description of the requirements of a construction project by both the user and the project sponsor (owner). The purpose of describing requirements is to methodologically identify the needs of the user and the project sponsor (owner) in order to translate these needs into qualitative and quantitative requirements and to implement these in building structures. The building authority advises the user and the project sponsor (owner) during the preparation of the requirements description. This is where the user and the project sponsor (owner) can define their qualitative requirements. The criteria described in the BNB, such as location profile, can be very useful here. The user can consult the project sponsor (owner) in order to define minimum requirements for the individual sustainability qualities which are also reflected in Sample 13 (User demands). The aim here is to specifically address and examine the space requirement requested by the user in terms of need and reasonability, especially with a view to over-supply, and to avoid a new building by making better use of existing buildings. Requirements planning should also include the intended equipping standards. The related rules, such as the "Ordinance on safety and health in the use of video display workstations" (BildscharbV)[5], must be observed.

2.2 Analysis of variants to meet requirements

Assisted by the building authority, the project sponsor (owner) analyses variants to meet requirements in order to identify the variant with which requirements planning can be implemented with the greatest economic efficiency. The following variants should be examined, initially as part of a general suitability test of procurement variants based on qualitative criteria:

- Lease of property, including conversion or extension measures that may be necessary
- Purchase of existing building structures, including conversion or extension measures that may be necessary
- Lease or lease-purchase
- New construction, conversion or extension measures as own building measure
- Public-private partnership

When examining the variants, consideration must be given to the principles of life cycle-orientated cost optimisation, especially of future operating, other use and risk costs. In addition to the pure cost-based comparison of variants, a benefit analysis is recommended, so that aspects of sustainable building which cannot be quantified, for instance, are sufficiently taken into consideration. Furthermore, long-term property developments must also be included.

The BNB does not foresee any direct assessment of location and property with a view to aspects of urban development policy. As part of the analysis of variants to meet requirements, urban development and location-specific issues must thus be specifically examined with a view to the sustainability approach being pursued. When planning new buildings, municipal urban development concepts must be taken into consideration.

The goals of sustainable urban development policy include the following aspects:

- With a view to ecology, thrifty and careful use of space for buildings and minimisation of surface use for development.
- Preference must be given to compact structures that minimize the site occupancy index.
- One important aspect when planning the project is that urban development must integrate new projects into the existing environment.
- The following aspects must also be considered: possible exemplary issues regarding size and direction of the building structure, future traffic flows, shading situations, building-specific noise immission, as well as wind flows typical for the area which ensure natural ventilation of the surrounding settlement areas.

[5] See BildscharbV (2008)

The use of industrial wasteland, areas formerly used for military or other purposes, as well as the possibility to close gaps between buildings should also be examined. Contaminated areas are not generally ruled out for further use and should hence be included in planning. Please refer to the "Guidelines for Soil and Groundwater Conservation"[6]. Generally speaking, soil waste must be kept to a minimum. Unavoidable soil waste can often be reduced by refill measures on the property or through other forms of utilisation. The requirements of environmental and nature conservation must be observed. Existing groups of trees and hedges must be maintained if possible.

Before a decision is made in favour of a new building, the analysis of variants must clearly show that the need for space cannot be economically covered by existing buildings – including options for optimising occupancy. In this case, options for a change in use, conversion or replacement of existing buildings must be considered. In order to protect natural areas, the goal is to minimise demand of space (BNB 1.2.4), to avoid settlement of open country and to minimise additional sealing of the soil surface. The possibility of space recycling must be considered. Preference should be given to the utilisation of areas that are already sealed (BNB 3.2.2).

The risks and conditions (BNB 6.1.1 and BNB 6.1.2) at the micro site must also be included in choice of location and planning considerations as must proximity to use-specific services and access to utilities (BNB 6.1.5 and BNB 6.1.6). It is often better to use an existing infrastructure rather than build a new one. Preference should be generally given to locations with good public transport connections (BNB 6.1.4) in order to minimise traffic flows. Since many journeys by car are shorter than 5km, using a bicycle instead can contribute to eco-friendly, energy-efficient mobility. In addition to the largely quantitative aspects, it is also the qualitative aspects of bicycle comfort (BNB 3.2.5) which are decisive for user acceptance.

Building-related outdoor qualities (BNB 3.1.7) must be included in planning because they boost user satisfaction and promote communication. Furthermore, public accessibility (BNB 3.2.4) as well as the inclusion of open air enclosures into the appearance of the building can increase acceptance, integrate the building more into the city quarter and hence help to improve the urban image of the neighbourhood.

At the best, the quarter itself becomes more attractive as a whole (BNB 6.1.3 – Image and Character of Location and Quarter). Outdoor facilities must be planned in line with the requirements laid down, so that they demonstrate a long life cycle and multi-functionality. Development areas within properties must be reduced and when it comes to the choice of surfaces, adherence to the specifications regarding water seepage[7] must be verified.

Identification of costs and profitability analysis

An important part of the ES – Bau involves examining economic efficiency within the scope of analysing variants to meet with requirements. There are many guides and tools available that address the methodology for the life cycle-orientated profitability analysis. The "Working paper – an introduction to profitability analyses" from the Federal Ministry of Finance and the "Guide on Profitability Analyses during Preparation of the Civil Engineering Measures by the Federal Government" from the Federal Building Ministry are of particular relevance in this context.

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6 See BMVBS (2010 b), also available at: www.arbeitshilfen-bogws.de

7 See LABO (2009): "Bodenschutz in der Umweltprüfung nach BauGB – Leitfaden für die Praxis der Bodenschutzbehörden in der Bauleitplanung", 2009 (Soil protection in environmental assessments according to the Federal Building Code – Practical guide for soil protection authorities in construction land-use planning)

The methodology described in the Guideline for Sustainable Building for identifying and calculating building-related life cycle costs (BNB 2.1.1) is applied during or after a construction measure. The methods described in the two documents referred to above are primarily used as part of the analysis of variants to meet requirements and serve as tools for identifying the most economical procurement variants. Not only the aim, but also the time of application and the data bases are thus different from an evaluation that uses the "building-related life cycle costs" criterion of the BNB. The aim of this criterion is to make construction projects comparable on the basis of specified boundary conditions using the final costs. This enables an evaluation on the basis of a uniform evaluation standard.

In order to achieve a positive evaluation with the BNB-criterion 2.1.1 "Building-related life cycle costs", the criterion should already be applied at an early stage of planning and construction and during the planing and design process. In this case, the result must be estimated at an early point in time according to the criterion. During the ES – Bau phase, the estimation according to this criterion converges with the profitability analysis according to the above-mentioned documents. Using altered boundary conditions, the profitability analysis can be based on the input values and results of the estimate according to the BNB-criterion 2.1.1 because the costs must usually be recorded in more detail according to the BNB-criterion 2.1.1.

Based on the calculation of costs as shown in Sample 7 of the RBBau Guidelines, the building-related life cycle costs can be estimated. Based on the cost categories calculated, the building authority and the project sponsor (owner)/operator must identify and evaluate the cash value in [€/m² gross floor area] over the first 50 years of use according to the calculation rules of the criterion in 2.1.1 of the BNB.

The following costs must be taken into account here:

Construction costs according to DIN 276-1 Building costs: Part 1 – Building construction		
KG* 300 Building – structure	KG 310	Construction pit
	KG 320	Foundation
	KG 330	Exterior walls
	KG 340	Interior walls
	KG 350	Ceilings
	KG 360	Roofs
	KG 370	Structural fitments
	KG 390	Other construction-related work
KG 400 Structure – services	KG 410	Sewage, water and gas systems
	KG 420	Heating systems
	KG 430	Air handling systems
	KG 440	High-voltage systems
	KG 450	Telecommunications and IT systems
	KG 460	Elevators
	KG 470	Function-related systems
	KG 480	Building automation
	KG 490	Other service-related systems
KG 500 External works	KG 540	Technical systems in outdoor installations
Operation costs according to DIN 18960 Operation costs in building construction		
KG 300 Operating costs	KG 310	Utility costs (power/electricity, water)
	KG 320	Waste disposal
	KG 330	Cleaning and care of buildings
	KG 350	Operation, inspection and servicing
KG 400 Repair costs	KG 410	Structural repair work
	KG 420	Repair of building services

Table B1: Construction and operation costs to be included in the calculation of costs
*KG: Cost Categories

The building costs must be calculated on the basis of either the results of the cost estimate according to DIN 276-1 or cost indicators from comparable construction projects that have been completed. If no data is available, databases, such as PLAKODA, are recommended in order to identify costs.

The period of reference is as follows:

- The reference period covers a period of 50 years. In addition to this, other reference periods may be agreed to depending on the type of building use.
- In the case of PPP projects[8], it is recommended that comparison calculations be carried out for a 30-year reference period[9].
- A reference period of 80 years should be used for building structures with a longer technical life cycle. The expected utility costs are calculated according to Sample 7 of the RBBau Guidelines.

An assumed annual price increase rate is the only way in which price developments can be taken into account. The general annual price increase and, in deviation from that, the annual increase in heating and electric energy costs, as well as the discount rate in the case of the cash value method can be found in the latest publications by the Federal Ministry of Finance. For the purpose of final evaluation according to the BNB, verification must be based on the billed as-is costs of the construction measure and the comparison factors for the system variants or the comparison factors stored.

The aim of the cost calculation is to minimise total costs, i.e. building costs plus use/operation costs. Possible alternatives should be outlined and evaluated, especially with a view to the following priorities:

- Investment costs versus operating costs
- Investment and operating costs versus external costs and environmental impacts
- Conventional versus innovative construction

Furthermore, as part of the profitability analysis, alternative procurement variants, such as rent, purchase or contracting models (e.g. PPP projects) must be analysed in as far as these have been found to be suitable (see the previous section on “Analysis of variants”) and do not rule out a flexible choice of location (BNB 5.1.1).

Apart from calculating costs, no quantifying evaluations or verifications are carried out during this phase for standard buildings. Instead, the planning concept is described in terms of quality. This applies in particular also to sustainability. In the case of special buildings, however, additional verifications may already be necessary in the ES – Bau phase.

Special buildings as contemplated in this Guideline are buildings:

- where construction costs according to the cost calculation exceed (a gross sum of) € 10m
- which are erected in an prominent urban development situation
- which are subject to stricter quality requirements during the assessment of overall sustainability (> 80% fulfilment in two of the five main criteria groups of the BNB) or in major individual aspects (100% fulfilment in the individual criterion).

The supreme technical authority together with the project sponsor (owner) and the user decide which buildings are to be planned as special buildings, or whether exceptional approvals are to be issued.

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[8] PPP project: project with a public-private partnership

[9] See NRW (2007)

ES – BAU (DECISION-MAKING DOCUMENTS)							
Criteria group	**Description**	**Mandatory verification for standard buildings**	Qualitative	Quantitative	**Additional verification in the case of special buildings** (selected on the basis of the special features of the building)	Qualitative	Quantitative
ECOLOGICAL QUALITY							
Demand of resources	1.2.1 Primary Energy Demand, Non-Renewable (PE_{ne})	Estimation of primary energy demand (non-renewable) without construction		×	Estimation of primary energy demand (non-renewable) in the life cycle – construction and operation		×
	1.2.2 Total Primary Energy Demand and Share of Renewable Primary Energy (PE_e)	Estimation of primary energy demand (non-renewable) without construction		×	Estimation of primary energy demand (renewable and non-renewable) in the life cycle – construction and operation		×
	1.2.3 Fresh Water Demand and Wastewater Volume	Estimation of fresh water demand and wastewater volume according to Annex 1 to Sample 7		×	Estimation of the water consumption indicator on the basis fresh water demand and wastewater quantity		×
	1.2.4 Demand of Space	Evaluation of the type, scope and direction of the actual use of the area beyond the requirement level	×			×	
ECONOMIC QUALITY							
Life cycle costs	2.1.1 Building-Related Life Cycle Costs	Estimation of costs according to Sample 6, Annex 1 to Sample 7 and Sample 11		×	Estimation of building-related costs in the life cycle for cost categories 300 and 400		×
Performance	2.2.1 Value Stability	Combination of criterion 3.2.2 and criterion 3.2.3	×		Combination of criterion 3.2.2 and criterion 3.2.3	×	

Fig. B3 Excerpt from Annex B2.2 "Verification requirements in the ES-Bau phase" (new construction)

Depending on how the buildings are classified, the sustainability criteria listed in Annex B2.2 (refer also to the table extract in Fig. B3) and their verifications must be taken into account in the ES – Bau with a view to quality and, in individual cases, in terms of quantity. This means that as part of the ES – Bau phase, the foundation can be laid for a future evaluation of sustainability (refer to Part A, section 3).

Furthermore, the topic of value stability (BNB 2.2.1) of building structures, which is of paramount importance for sustainable building, must also be viewed in addition to the ES – Bau. Within the meaning of the Assessment System for Sustainable Building, space efficiency (BNB 3.2.2 – verification according to Sample 6) and capability of conversion (BNB 3.2.3) must be verified for the building. In order to evaluate a building's capability of conversion, the following aspects must be analysed:

- Building geometry (room height, building depth, vertical and exterior accessibility)
- Ground plans
- Structure
- Technical equipping

2.3 Qualification of ES – Bau – completing documents according to § 24 of the BHO

If, based on the analysis of variants, the user's supreme authority itself opts to build the building, the project sponsor (owner) commissions the building authority to complete documentation pursuant to Part F of the RBBau Guidelines. The reports by building experts, the extract from the land survey register, drawings, target/as-is comparisons as well as the calculation of spaces must be included in the explanations and verifications that form the basis for the reasons.

2.4 Design and planning quality assurance

Design and planning quality forms the basis for the sustainable quality of the building. This means ensuring the quality of project preparation (BNB 5.1.1) through comprehensive requirements planning. The target agreement especially is an essential component of high-quality project preparation. A sustainability-orientated target agreement is used to define concrete site and project-specific design and planning goals. This establishes the prerequisites for targeted design and planning and ensures that all of the criteria serving sustainability are taken into account. The target values agreed to by the building authority and the project sponsor (owner) and user before design and planning begin (however, at least the minimum degree of fulfilment specified in Annex B1), the necessary services and measures, as well as deadlines and responsibilities should be laid down on a project-specific basis in the target agreement table (refer to Annex B5) for each individual criterion. This makes it possible for the building authority and the project sponsor (owner) and the user to check that these values are being adhered to in the individual design and planning phases.

Design competitions held according to RPW 2013 (Design Competition Guidelines) with independent consultancy by an expert jury is the ideal way to assess the architectural quality of a design and its integration into urban planning (BNB 3.3.1). When hosting design competitions [10], aspects of sustainability must already be addressed in the preparation of the competition. The task description must name the main requirements concerning sustainable building – based on this Guideline and/or the evaluation criteria of the Assessment System. Demonstrated compliance with these requirements must be demanded in the competition. It is recommended that at least one expert adjudicator be involved in the competition procedure who is able to judge sustainability with a focus on operation, energy and ecology. This, however, will not affect the requirement that the majority of adjudicators have the same qualifications as participants.

Furthermore, early involvement of different specialist planners and designers (interdisciplinary planning team, refer to BNB 5.1.2), along with the user and the public, supports target-orientated development of a co-ordinated sustainability concept. Demonstrated experience in ecology and economics, as well as architecture and design are important characteristics for appropriate project management. The building authority itself can perform project management or place this in the hands of external service providers.

Integrated planning (BNB 5.1.2) supports optimisation of the design and planning process with a view to a building-specific, balanced sustainability concept. Integrated planning extends across the entire life cycle of a building. It begins with project development and ends with the dismantling of the building. There is very complex interaction between architecture, structure, technical building equipment, etc. Integrated planning makes this interaction transparent and optimises it simultaneously and iteratively. The integrated planning team together with the other stakeholders (project sponsor (owner), user, building authority, etc.) develops a holistic concept in the form of a sustainability-orientated overall strategy through which high quality planning enables the thrifty utilisation of resources while improving comfort and economic efficiency.

Each planning decision has various impacts on the individual aspects of sustainability. In order to identify and calculate the complexity of planning (BNB 5.1.3), design and planning documents must be checked according to the “four-eyes” principle while optimisation concepts must also be already drawn up when planning begins. This includes the following as a minimum:

- Comparison of design and planning variants
- Drafting of an energy concept (including the examination of the use of renewable energy) as well as a metering/measuring concept
- Creation and implementation of an occupational health and safety plan
- Fire protection concept
- Observance of other sub-criteria for the thrifty use of resources
- Concept to optimise daylight and artificial light
- Water concept
- Management concept (cleaning and maintenance)
- Concept for waste, dismantling and recycling capability
- Health, comfort and user satisfaction
- Barrier-free building
- Art in architecture

2.4.1 Sustainability concept and evaluation

Due to the fact that buildings and properties are subject to very different boundary conditions, this Guideline cannot deliver a complete checklist for taking all aspects of sustainability into account. The statements made in the previous sections provide a very comprehensive overview of the issues that normally need to be considered in order to develop an integrated sustainability concept. It is vital that the relationships and measures described in the sub-sections be discussed in addition to the design report, while decisions must be recorded in writing, attached to the building document and marked as “Report for evaluating sustainability” (see Annex B6).

[10] See. BMVBS (2013 a)

2.4.2 Building structures and their properties

During the early design and planning phase of the ES – Bau, the definitions needed to ensure technical quality, especially with a view to structural stability, fire protection, heat insulation and protection against condensate (BNB 4.1.2), must be agreed to by checking technical feasibility. Depending on the type of building, the minimum requirements for fire protection are set forth in the latest version of the state building regulations, the "Guideline for the use of flammable building materials in construction" [11], as well as the applicable standards. The "Fire Safety Guide" [12] from the Federal Building Ministry is another useful tool. This Guideline specifies uniform fire protection principles for the planning, execution, operation and maintenance of federal government construction projects and offers useful information for developing a fire protection concept.

2.4.3 Energy and metering/measuring concept

Energy consumption is minimised by drafting and implementing an energy and metering/measuring concept which takes into account the planning of energy supply and the use of regenerative energy (refer to Annex B7 Energy Target Specifications). From a life cycle perspective, primary energy demand as well as final energy demand of the building must be minimised (BNB 1.2.1). Special attention must be paid here to passive and renewable energy (BNB 1.2.2). The plans for the ES – Bau must already define the type of building, the building shape and its location as preconditions for low primary energy demand during the use phase.

The level of a building's future energy consumption is heavily influenced by the architectural design, the location and geographical direction. This applies, for instance, to the option of passive solar energy and hence annual heating, cold and electricity demand for lighting depending on the share of window surfaces and, if applicable, mechanically assisted ventilation.

In order to reduce energy consumption further, hot water taps are to be restricted to the following areas of use:

- Kitchens
- Cleaning rooms
- Accommodation
- Showers (e.g. for cyclists)
- Work areas with higher dirt accumulation

As part of the ES – Bau, the first decisions must be made regarding the energy quality of the building, building envelope and technical equipment (refer to Annex B7 Energy Target Specifications). These decisions will then have to be implemented as binding requirements in future final planning. The energy quality demanded in this Guideline for the building envelope and the technical equipment (lighting, heating, if applicable, hot water, air handling systems) must be selected in such a manner that energy consumption is 20% lower than the requirements of the EnEV 55/72/73 2009 [13] regarding primary energy demand or 30% in the case of heat supply from combined heat and power plants (see Annex B7 Energy Target Specifications). As part of the ES – Bau, final energy and primary energy demand must be calculated for the use phase. In the case of special buildings, primary energy demand must be additionally estimated for the structure. Internal or external energy consultants can be involved in energy planning. In addition to energy-related aspects, the choice of heating systems must also consider limiting the local burden on the environment caused by emissions of particulate matter.

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[11] See RbBH (1992)

[12] See BMVBS (2006), also available at: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html

[13] See EnEV 2009

The economical use of renewable energy should go beyond the requirements of the Renewable Energies Heat Act (EEWärmeG)[14]. With regard to the geographical direction or angle of the exterior surface of the building, consideration must be given to intended solar energy use and, moreover, a yield estimate must be drawn up.

The decisions made must be sufficiently considered in the calculation of costs. If it is not possible when calculating life cycle costs to demonstrate the economic efficiency of a measure in the analysis of variants, the related profitability analysis must be repeated with external costs included (Part A, section 2.2.2) in relation to expenditure on use in order to support the decision. In this case, external costs must initially only be identified for the environmental impact of the "greenhouse gas potential" in relation to the primary energy demand of the building during the use phase and its monetisation for possible execution variants. In order to calculate external costs, final energy demand, including upstream energy sources, the corresponding CO_2 equivalents (e.g. according to GEMIS with the latest version) as well as the external cost factor for greenhouse gases must be identified on the basis of the latest publications by the Federal Environment Agency. Based on these values, the external costs must be calculated in absolute terms according to the calculation steps shown below (Table B2) and in relation to the reference areas used to identify costs (see also online publication 17/2010 by the Federal Building Ministry[15]).

	Calculation steps
CO_2 equivalent = [t]	$\sum (EndE_{Use} * CO_2 \text{ equivalent factor})_i$
External costs = [euro]	CO_2 equivalent* EX-CO_2

EndE	Final energy demand according to energy sources
i	1 to n
n	Number of energy sources
EX-CO_2	External cost factor in [euro/t]

Table B2: Calculation steps to identify external costs

As part of comparing the costs of the different variants, the calculated external costs can also be generally included in the evaluation. The requirements for the energy quality of the building can be found in the Energy Target Specifications (see Annex B7). The aforementioned requirements must be calculated in more detail as the depth of planning progresses in the EW–Bau (final planning).

The measuring/metering concept (BNB 5.1.3) must include monitoring of resource consumption and operating costs during the use phase. The prerequisites for efficient building management must already be established in the design and planning phase. This means that stakeholders, i.e. user/project sponsor (owner/operator)/building authority/planners must work together during requirements planning. The necessary measuring and metering equipment must be planned and the costs calculated must be taken into account. Monitoring during the use phase must be regarded as part of the necessary comparison process. Details of the requirements for measuring/metering concepts, in particular, details regarding the technical measuring facilities needed to record resource consumption and the measured variables to be evaluated, can be found in the Energy Target Specifications (see Annex B7).

Suitably organised measures should ensure the continuity of expert support throughout the life cycle. Using the latest updates of software-based stock-taking and consumption data (EMIS/PLAKODA), buildings and properties compete with each other. The aim is to improve their characteristics, i.e. typically to reduce costs, protect resources and the environment and boost user comfort.

[14] See EEWärmeG (2011)
[15] BMVBS (2010 c)

2.4.4 Water and wastewater concept

Since each new building means intervening in natural water supply due to surface sealing, the preparation of a concept for water supply and disposal is a key element of the ES – Bau. The aim is to employ suitable measures to reduce fresh water consumption, to reduce expenditure on the provision of drinking water and wastewater treatment and hence to largely avoid disrupting the natural circulation of water. During planning, the prerequisites are established that influence water consumption independent of use behaviour. These prerequisites can be checked and analysed on the basis of defined assumptions regarding use behaviour and the planned handling of greywater and rainwater. In contrast to this, water is also an energy medium (use of heat) so that the possibility to use drinking water, wastewater, rainwater and greywater for energy purposes should also form part of concept planning.

Water

As part of property-based water-supply concepts, existing water supply facilities must be identified and evaluated with a view to structure, hydraulics and hygiene. At this stage, the subject of fire water supply according to the fire protection concept must also be taken into account because fire water is supplied either in a pipe system that is also used to supply drinking water or via its own dedicated network. In order to protect water as a natural resource and its natural circulation, water consumption in administration buildings must be reduced as far as possible using water-saving sanitary installations (e.g. flush tanks with <6 litres per flush, sinks with a max. flow rate of 6 litres per minute, if possible, with sensor control, water-free urinals). Wet rooms should be arranged as close to each other as possible in the building in order to optimise pipe routing.

Wastewater

Irrespective of the pending construction projects, a property-based wastewater disposal concept (LAK) must be drawn up. This concept will serve as a basis for deciding upon the necessary construction projects. In this case, an overall drainage system concept will be developed for the entire property – also taking into account future structural changes. In this context, reference is made to the "Wastewater Guide"[16] which contains the fundamental, technical and procedural regulations for planning, executing, operating and documenting wastewater systems of the federal government. The remedial concept of the LAK Part B forms the basis for the budget documents (ES/EW – Bau) which may need to be drawn up according to the RBBau Guidelines. With sound planning, the use of wastewater pump stations should be avoided due to the additional energy and high servicing needed.

[16] See BMVBS (2010 a), also available at: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html

Rainwater

As an alternative to conventional forms of discharge via the sewage system, natural rainwater management is becoming increasingly popular because this combines many water management and economic advantages. The major processes of drainage, retention, purification and also the possible use of rainwater are increasingly shifting the focus towards managing water as a resource rather than disposing of it.

The following positive effects must be noted:

- Draining and retention measures lessen the hydraulic burden on sewers and natural outlet channels because high-water peaks are reduced.
- Draining through the vitalised soil zone ensures effective removal of dirt particles from surface water.
- The work needed to maintain wastewater systems is reduced because sewers are not needed.
- Groundwater volumes are permanently increased.

Furthermore, the use of rainwater can form part of a wastewater concept. In this case, rainwater is temporarily stored in cisterns and can be used, for instance, for irrigation or in a separate pipe system for toilet flushing. Special hygiene requirements apply to the two latter forms of use. Since the technical measures needed to use rainwater must usually be considered to be complicated and hence expensive, their economic efficiency should be examined for each specific measure.

Greywater

The water collected from showers, baths or sinks is only or very slightly contaminated. If treated properly, it can be reused, for instance, for watering in outdoor areas. This method calls for a separate wastewater system along with technical components to store and treat the water collected. The economic efficiency of this method must be examined for each specific property.

2.4.5 Cleaning and maintenance-friendliness

The building design should generally be such that the building and equipment parts require a low level of cleaning and maintenance for management processes (BNB 4.1.3). With a view to low cleaning requirements, preference must be given to smooth surfaces and mostly uniform materials (flooring). Glass components require considerable cleaning work, depending on the installation situation. Moreover, attention must be given to the possibility of cleaning surfaces on both sides or accessibility of larger intermediate spaces.

Depending on the size of the building and its large cleaning areas, the possibility of using machines for cleaning must be examined and enabled. Inaccessible corners, recesses, dead angles, intermediate spaces, columns in hallways and rooms, as well as structures that require the use of complicated lifting equipment should be avoided. Stairways, for instance, can be designed with lateral water protection or lateral grooves and attached handrail supports can be avoided. Sanitary furnishings, cleaning rooms, water taps and power sockets should be arranged to make cleaning easier. Furthermore, maintenance work and maintenance friendliness must be considered when selecting individual building components and technical systems. Technical systems should be as simple as possible. They should be safe, easy to maintain and should operate without the risk of incorrect operation.

2.4.6 Health, comfort and user satisfaction

In terms of socio-cultural functionality, the focus must be placed on issues of comfort, i.e. thermal comfort in winter (BNB 3.1.1), which is achieved through a high level of structural thermal insulation, and in summer (BNB 3.1.2), for instance, by limiting the window surface area, arranging sun-protection devices or using components with storage capability. In normal office rooms, pleasant, healthy temperatures should be maintained in summer generally without the need for technical cooling systems. If technical cooling systems are needed to maintain thermal comfort, these systems should be designed and implemented so that they can run with as little fossil fuel as possible. Reference is made here to the application of the "Guideline on construction and planning requirements for building measures by the federal government to warrant thermal comfort in summer"[17].

In order to ensure indoor air quality (BNB 3.1.3), low-emission and low-odour building materials must be selected. In order to enable users to verify indoor air quality and to ensure comfort and user friendliness, various ancillary measures must be included in the design. These measures could include, for instance, the installation of CO_2 "traffic lights" which measure carbon dioxide in the air and, when levels are too high, trigger visual or audible signals for ventilation. The installation of hygrometers and thermometers is another option. These devices measure and display air humidity and room temperature. In order to determine the necessary external air flow rates, see the Energy Target Specifications in Annex B7.

Furthermore, planning should foresee the maximum user influence (BNB 3.1.6) on the following parameters: ventilation, protection against sunlight, glare protection, room temperature and control of daylight and artificial light at the workplace in order to ensure comfort at the workplace, in as far as this is compatible with central control of the technical systems. Another important aspect is enhancement of the users' subjective feeling of security which can be influenced through a number of different measures (BNB 3.1.8). These include, for instance, additional security systems and services, the presence of contact persons outside regular working hours or the illumination of the building and the property.

2.4.7 Barrier-free building

The aspects of barrier-free building (BNB 3.2.1) according to DIN 18040-1[18] must be addressed in close co-operation with the user. As early as during the ES – Bau phase, the necessary barrier-free workplaces must be included in requirements planning and must be addressed with a view to the principle of multiple senses. Ramps in the entrance area, for instance, can be integrated as design elements into the overall concept. Lifts, doors or the layout of switches and electronic push-buttons can often be arranged at no extra cost to meet the needs of people with disabilities. Visual, tactile or acoustic aids must be included. Sustainable buildings should also offer added value in this area by surpassing the requirements of the standards that apply here. The requirements for barrier-free access apply equally to new and existing buildings. However, it may well be that existing buildings cannot be refurbished to such an extent that they meet the criteria for barrier-free buildings. Despite this, the requirements for barrier-free access must also be implemented for existing buildings and/or these requirements must be identified in a transparent manner for the existing building.

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17 See BMVBS (2008 a)

18 DIN 18040-1 (2010)

2.4.8 Art in architecture

Art in architecture should help users and the public to accept and identify with the building. Art in architecture should draw attention to the building and create additional profile for locations (BNB 3.3.2). Useful information can be found in the “Guideline for Art in Architecture” [19]. The cost of art in architecture should already be laid down in the ES – Bau. Statements should also show how generally suitable the project is for art in architecture and these statements must be specified in more detail in the further course of planning (EW – Bau).

2.4.9 Waste and recycling

Over the course of its entire life cycle, a building must meet with the following requirements of the Closed Substance Cycle and Waste Management Act (KrW-/AbfG) [20]:

- Save natural resources
- Avoid waste
- Correctly and safely recycle unavoidable waste
- Eliminate waste that cannot be recycled commensurate with the public good

The “Guidelines for Recycling” [21] from the Federal Building Ministry describe the planning and execution of the measures necessary for the handling of recycling building materials as well as construction and demolition waste. In addition, the recycling of waste is described in more detail here. By reducing landfill space, raw materials and production energy, they can help to achieve the principles of sustainable planning over the entire life cycle of a building.

Planning and erection

According to the “Guidelines for Recycling”, the following building-related resource-saving aspects must be taken into account in the interest of sustainable planning:

- Reuse of building parts or fittings
- Examination of the possible use of recycled building materials
- Examination of the possible use of building materials/ parts that can be recycled
- Preference for low-waste structures thanks to the possibility of dismantling materials separately
- Waste avoidance during execution of construction work

In order to meet a specified need for space, it is hence necessary to first check whether existing buildings can be maintained. With a view to waste generated from use, future modernisation and end of use, suitable concepts must be drawn up in the case of a new building. The demolition concept as part of the ES – Bau includes the description of the planned procedure for demolition and the waste generated along with the requirements regarding working conditions.

Planning and the invitation to tender call for exemplary disposal of construction waste. This can take place through a binding query sent to companies regarding disposal routes. With a view to the demolition and dismantling of a building, the building parts, products and materials must be recycled in as far as possible and to the best extent possible and waste must be avoided. The “Guidelines for Recycling” must be observed here. Building materials must be selected on the basis of durability, reusability and recyclability. Disposal of waste generated must be planned, tendered, monitored and finally assessed. As part of public construction projects, this is ensured by the federal and federal-state building authorities.

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19 See BMVBS (2012), also available at: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html

20 See Krw-/AbfG (2009)

21 See BMVBS (2008 b), also available at: www.arbeitshilfen-recycling.de

Depending on the size of the building measure, expenditure on clearing the construction area or preparing the construction pit are included in a dismantling and disposal concept which should be attached to the ES – Bau. Construction site waste must be minimised during construction operations. Unavoidable waste must be stored so that recycling is possible. Waste destined for disposal must be minimised and stored separately from recyclable waste.

Use phase

Buildings must be planned in such a manner that use-related waste is kept to a minimum and eco-friendly recycling of unavoidable waste during the use phase is possible. This means that structural preconditions must be provided so that waste can be separated and recyclable materials collected.

During the use phase, fittings and technical equipment must also be procured in line with the following criteria: environmental compatibility, health protection, long life, reuse and repair-friendliness. Unavoidable waste must also be collected separately here too and passed on for correct and safe recycling or elimination commensurate with the public good. The quantity of waste should be documented and regularly, at least once a year, analysed and the result should be made known to the user. Sufficiently spacious areas for suitable waste containers should ensure simple pre-separation of the waste generated. The concept of expansion areas for more collection containers in the future must also be examined along with the necessary access routes and, when necessary, included in planning and provided during erection of the building, unless this results in additional costs. It must be examined whether space for storing biodegradable waste on the property offers ecological and economic benefits compared to the collection and disposal of such waste. Biodegradable waste should be used for composting on the property in as far as this is possible in a correct and safe manner and if the structural and operating preconditions can be fulfilled on the property. This calls for regular management, qualified staff as well as sufficiently large areas for spreading the compost produced.

End of building's use

With a view to economic efficiency and technical feasibility, preference should be given to the conversion of the building at the end of its use. The building may only be demolished if it cannot be reused. Such demolition must take place in compliance with existing recycling concepts, the Closed Substance Cycle and Waste Management Act and the "Guidelines for Recycling".

3. Design Specification Documents (EW – Bau)

B 3

As required by the applicable guidelines for federal government construction projects and following approval of the ES – Bau by the supreme technical authority and recognition under budget law by the Federal Ministry of Finance, the Design Specification Documents (EW – Bau) are then drawn up by the building authority according to Section E of the Federal Construction Guidelines (RBBau). The EW – Bau largely address work phases 2 (pre-planning), 3 (design planning) and 4 (approval planning) according to the HOAI and end with complete design and approval planning. In as far as necessary, parts of final planning can be included in the EW – Bau. When preparing the EW – Bau, the contents of the ES – Bau are binding. The ES – Bau continue to provide the cost framework. Any modification of or amendment to requirements planning requested during preparation of the EW – Bau and which increase costs must be approved in the procedure required for the ES – Bau and recognised under budget law. This also applies if it becomes apparent during preparation of the EW – Bau that the cost framework laid down in the ES – Bau cannot be maintained due to the detailed planning depth and while taking all possible options for cutting costs into account. If the building authority finds that the EW – Bau comply with the cost framework laid down in the ES – Bau it can then proceed with final planning.

The quantitative and qualitative requirements from requirements planning are then implemented in the EW – Bau in a specific building design – normally at a scale of 1:100. This phase of planning offers the greatest room for influence on the future development of costs for the construction project. Any subsequent modification of the design will lead to additional planning costs. At this stage of planning, concepts must be designed which incorporate aspects of sustainable building into design planning, and the special sustainability requirements of the construction project as laid down in the requirements planning can be implemented here. If the aspects of sustainable building are not (sufficiently) taken into account in design planning during this phase, their inclusion in planning at a later point in time will mean a considerable amount of additional work and hence lead to a significant increase in costs.

Pursuant to the RBBau Guidelines, Section F2 [22], the EW – Bau must include, among other things, the design documents described below:

- Drawings (including an overview drawing, land register map, site plan, design and approval drawings)
- Explanatory report (RBBau Guidelines, Sample 7, Annexes 1 and 2)
- Verifications (structural design, fire protection, EnEV, sound insulation)
- Cost calculation (RBBau Guidelines, Sample 6)

During the EW – Bau phase, sustainability must be evaluated with a view to quantity and at times also with a view to quality for the relevant criteria listed in Annex B2.3 (refer also to the table excerpt in Fig. B4). In the case of special buildings as contemplated in this Guideline (refer to section 2.2, p. 60), the criteria already highlighted in the ES – Bau phase must undergo more in-depth evaluation in order to ensure compliance with the stricter requirements for such buildings. Therefore, more detailed calculations or qualitative evaluations that go beyond the evaluation depth demanded in the table must be carried out for the criteria in question.

3.1. Explanatory report (building and services)

According to the RBBau Guidelines, Sample 7, the explanatory report contains the description of the design along with details regarding production and utilisation costs as well as energy-related data for the building. The explanatory report pursuant to the RBBau Guidelines must be supplemented by the “Report on the evaluation of sustainability” as shown in the sample report in Annex B6. The design description includes the following information:

- Design idea, design requirement and exterior design
- Technical building systems and installation layout
- Energy concept
- Conversion capacity and expansion options

[22] See BMVBS (2013 b)

EW – BAU (DESIGN SPECIFICATION DOCUMENTS)							
Criteria group	**Description**	**Mandatory verification for standard buildings**	Qualitative	Quantitative	**Additional verification in the case of special buildings** (selected on the basis of the special features of the building)	Qualitative	Quantitative
ECOLOGICAL QUALITY							
Effects on the global and local environment	1.1.1 Global Warming Potential (GWP)				Calculation of the criterion acc. to BNB 1.1.1		×
	1.1.2 Ozone Depletion Potential (ODP)				Calculation of the criterion acc. to BNB 1.1.2		×
	1.1.3 Photochemical Ozone Creation Potential (POCP)				Calculation of the criterion acc. to BNB 1.1.3		×
	1.1.4 Acidification Potential (AP)				Calculation of the criterion acc. to BNB 1.1.4		×
	1.1.5 Eutrophication Potential (EP)				Calculation of the criterion acc. to BNB 1.1.5		×
	1.1.6 Risks to the Local Environment	Verification of the criterion acc. to BNB 1.1.6	×				
Demand of resources	1.2.1 Primary Energy Demand, Non-Renewable (PE_{ne})				Calculation of the criterion acc. to BNB 1.2.1		×
	1.2.2 Total Primary Energy Demand and Amount of Renewable Primary Energy (PE_e)				Calculation of the criterion acc. to BNB 1.2.2		×
	1.2.3 Fresh Water Demand and Wastewater Volume	Estimation of the water consumption indicator on the basis fresh water demand and wastewater quantity		×	Calculation of the criterion acc. to BNB 1.2.3		×
	1.2.4 Demand of Space	Verification of the criterion acc. to BNB 1.2.4	×				
ECONOMIC QUALITY							
Life cycle costs	2.1.1 Building-Related Life Cycle Costs	Estimation of building-related costs in the life cycle for cost categories 300 and 400		×	Calculation of building-related costs in the life cycle according to 2.1.1		×
Performance	2.2.1 Value Stability	Combination of criterion 3.2.2 and criterion 3.2.3	×				

Fig. B4: Excerpt from Annex B2.3 “Verification requirements in the EW – Bau phase (new construction)”

Moreover, the description also includes information regarding special exterior conditions which have a special impact on the design and hence on the production and utilisation costs. With a view to the cost categories which must be listed in the explanatory report, information regarding the structure, including material and properties, must also be provided. Due to the detailed planning stage, the breakdown of costs in the EW – Bau (refer to DIN 276-1[23]) must be adapted accordingly. The building utilisation costs must be broken down according to DIN 18960[24].

3.2 Verifications

3.2.1 Heating, hot water, ventilation, cooling, lighting, power supply

At the same time as the EW – Bau are being prepared, other specifications must be drawn up for the energy-related quality of the building which result from the requirements already mentioned in section 2.4.3 (see Annex B7 Energy Target Specifications). The way for this was already paved in the ES – Bau so that the requirements and verifications can be addressed in more detail in the EW – Bau. In order to implement an exemplary and advanced environmental policy concept, the reduction of primary energy demand of the planned building, and, more importantly, of final energy demand, must be a top priority.

The EW – Bau must contain the verifications required under the applicable EnEV. According to the ES – Bau and subject to the Energy Target Specifications (see Annex B7), the requirements laid down in this Ordinance must be outperformed. Energy demand for hot water supply, demand for electric energy and cold demand are also subject to the requirements laid down in the Energy Target Specifications.

While heating energy consumption is continuously declining in federal government buildings, consumption of electric energy is rising significantly. In order to also achieve a reduction in carbon emissions in conjunction with electricity supply and hence help achieve the goals for climate protection, demand for electric energy must be reduced dramatically, e.g. by using more efficient systems, such as:

- daylight and presence-controlled lighting systems and adapted intensity levels for lighting
- more efficient drives
- highly efficient IT systems (new and replacement systems).

[23] DIN 276-1 (2008)
[24] DIN 18960 (2008)

In the case of equivalent systems, preference should be given to electric devices which use very little electricity when in operation or in standby. If permitted, devices should feature an OFF switch which can be used to fully disconnect the device from the mains. More information on today's standards for reducing energy consumption can be found, for instance, in the test criteria of the German Blue Angel eco-label and the GED energy saving label (German Energy Label Group). The use of electricity from renewable energy is another measure. The focus must be especially directed towards informing the user at the time requirements planning is drawn up of the schedule for operating hours and workplace design and towards user training with a view to energy-saving behaviour.

3.2.2 Heat insulation and protection against condensation

With a view to structural heat insulation in winter, the applicable requirements of the EnEV for heat transfer coefficients must exceed those of the reference building. The aim is to reduce heat demand for air conditioning in buildings while at the same time ensuring a high degree of thermal comfort and avoiding damage to the building. Furthermore, the quality of heat insulation and protection against condensation for the building envelope (BNB 4.1.2) must be reflected by requirements for the following properties:

- Component-based average heat transfer coefficient U [W/(m²· K)]
- Thermal heat bridge correction ΔUWB [W/(m²· K)]
- Air permeance class (joint permeability)
- Condensate volume within the structure [kg/m²]
- Air changes n_{50} [h-1] and, if applicable, q_{50} [m/h]
- Solar radiation index S [-]

Pursuant to the minimum fulfilment rating in Annex B1, quality level 2 is the minimum requirement during planning for both thermal heat bridge correction and air changes. Air permeance must comply with quality level 3 while the sub-criteria of condensation water and the solar radiation index must meet with quality level 1. When it comes to determining the average heat transfer coefficient U, reference is made to the requirements in the Energy Target Specifications regarding the energy quality of the building envelope (see Annex B7).

Effective sun protection primarily means the prevention of summer heat entering the building. Temperature balancing is preferably ensured by ventilation at night without neglecting security issues. Furthermore, the "Guideline on construction and planning requirements for building measures by the federal government to warrant thermal comfort in summer" must be considered in the building classification process.

3.2.3 Structural design, fire protection and sound insulation

The EW – Bau must verify structural stability. Whenever possible, the load-bearing structure chosen should ensure maximum resource savings and durability and should include economically reasonable load-bearing reserves in order to enable future conversion (BNB 3.2.3). At the same time, it should also reflect structural conditions, such as required storage capacity, acoustic insulation and fire behaviour, etc. It must be possible to add, relocate or dismantle non-load bearing partition elements so that conversion measures carried out while the building is in use will have little or no effect on the operation of the building.

Depending on the type of building, the minimum requirements for the fire protection concept to be presented are laid down in the applicable state building regulations. The "Fire Safety Guide"[25] from the Federal Building Ministry is another useful tool. It may be necessary to plan a fire protection level that goes beyond that of the statutory requirements, for instance, due to individual use requirements for certain rooms, components or building sections, because the minimum requirements for fire protection normally focus on safe evacuation of a building. More extensive fire protection concepts may be needed not only to protect human life, but also for stored documents, EDP, fixtures, etc. These concept variants must be examined and compared from both an economic and ecological perspective.

[25] See BMVBS (2006)

Examples of measures that go beyond the minimum requirements stipulated by the building authorities include:

- Avoiding the installation of substances/products that in a fire could lead to the development of toxic gases and heavy smoke or could cause the fire to spread quickly (e.g. due to burning drops of melted material)
- Installation of automatic fire/smoke detectors or other alarm systems
- Installation of automatic fire extinguishing systems (e.g. sprinkler systems)
- Creation of smaller fire and smoke zones
- Creation of enlarged cross-sections for smoke discharge
- Implementation of higher fire ratings

The requirements for structural sound insulation are subject to the generally accepted rules of technology. The minimum requirements are laid down in DIN 4109 [26]. This warrants that the minimum sound insulation required by the building regulations is guaranteed. Avoiding annoyance caused by sound transmission, ensuring privacy and considering the needs of people with hearing disabilities are other, stricter requirements for sound insulation (BNB 4.1.1) in office buildings. Sound insulation must be verified on the basis of the following criteria:

- Insulation against outdoor airborne noise
- Insulation against airborne noise from other workrooms and within work areas (partition walls, partition ceilings, stairwell walls)
- Insulation against impact noise from other workrooms and within work areas (partition walls, partition ceilings, stairwell walls)
- Sound insulation of technical systems (water installation, other building equipment)

3.3 Cost calculation

The aim of the cost calculation is to minimise building-related costs in the life cycle (BNB 2.1.1). The building costs according to DIN 276-1 [27] for cost categories 300 (Building – structure) and 400 (Building – services) can already be presented in detail in the EW – Bau, for instance, using cost catalogues, such as PLAKODA. Furthermore, all other cost categories according to DIN 276-1 must be listed and documented. When designing technical equipment for the building (heating, ventilation and air-cooling systems, sanitary installations, electrical systems, lighting, etc.), the recommendations by the Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities (AMEV – Arbeitskreis Maschinen- und Elektrotechnik staatlicher und kommunaler Verwaltungen) in particular must be adhered to. If the advantages or disadvantages of different, competing technical services cannot be identified without detailed investigation, the technical solutions are compared as follows:

- Economic variant comparison: investment, annual costs according to the annuity method, full-cost method, complete financial plan, net present value method (only if savings are to be expected)
- Energy and annual balance

Based on the comparison, the building authority recommends a preferred solution.

The calculation of energy demand allows the expected operating costs to be presented in greater detail. According to DIN 18960 [28] (BNB 2.1.1), calculations must be made for the following types of operation costs:

Operation costs according to DIN 18960 Operation costs in building construction		
KG* 300 Operating costs	KG 310	Utility costs (power/electricity, water)
	KG 320	Waste disposal
	KG 330	Cleaning and care of buildings
	KG 350	Operation, inspection and servicing
KG 400 Repair costs	KG 410	Structural repair work
	KG 420	Repair of technical building services

Table B3: Costs to be calculated according to DIN 18960
*KG: Cost categories

The costs for dismantling and disposal must be identified, when necessary, using the current state of the art in demolition and recycling.

[26] DIN 4109 (1989), including corrections
[27] DIN 276-1 (2008)
[28] DIN 18960 (2008)

3.4 Other important aspects of the design

3.4.1 Ecological aspects

As soon as costs have been calculated, an ecological evaluation (LCA) is also possible in the EW – Bau stage of planning because the IT-based evaluation programs are based on the corresponding principle of element catalogues.

The following global environmental impacts must be currently quantified:

- Global Warming Potential (BNB 1.1.1)
- Ozone Depletion Potential (BNB 1.1.2)
- Photochemical Ozone Creation Potential (BNB 1.1.3)
- Acidification Potential (BNB 1.1.4)
- Eutrophication Potential (BNB 1.1.5)

The following criteria must be demonstrated to show the level of energy resources used:

- Primary Energy Demand, Non-Renewable (BNB 1.2.1)
- Primary Energy Demand, Renewable (BNB 1.2.2)

In future, the criteria listed above must be supplemented by the consumption of abiotic resources.

The building design must meet with the minimum fulfilment rates shown in Annex B1 for the respective main criteria groups. In the comparison of variants, structural and technical system components must be sensibly selected in order to achieve optimisation based on the method referred to in Part A, section 2.1. Furthermore, pursuant to the requirements and ancillary conditions of section 1.1.6 of the BNB, the use of substances and products should be reduced or avoided if such substances or products, due to their composition or individual components, could pose a risk to environmental resources, i.e. groundwater, surface water, soil and air, either while work is being carried out with such substances or products on the construction site or due to weathering (e.g. washout, leaching, etc.).

3.4.2 Socio-cultural and functional aspects

Comfort is evaluated on the basis of thermal comfort, air quality, noise and lighting. The influence of the user (BNB 3.1. 6) is directly linked to performance and satisfaction as well as energy consumption.

Thermal comfort at the workplace must be warranted both in winter (BNB 3.1.1) and in summer (BNB 3.1.2). The requirements already addressed in the ES – Bau must also be complied with in the EW – Bau phase.

Buildings must be generally built in such a manner that any impairment of indoor air quality caused by air pollution (BNB 3.1.3) can be ruled out. Low-emission products and materials must be used since emissions from building products and from fittings and fixtures have a significant impact on the quality of indoor air. Indoor air quality is measured using room air measurements (measuring volatile organic compounds and separate measurement of formaldehyde). These measurements are carried out after the building has been completed (see section 6).

Creating good acoustic conditions (BNB 3.1.4) has a positive impact on acoustic comfort and performance. Acoustic comfort is evaluated either by way of calculations made in the planning process or by measurements taken after completion of the building (see section 6).

Early and integrated planning of natural and artificial lighting (BNB 3.1.5) can help to achieve high-quality lighting for lighting and cooling with low energy demand. It has been demonstrated that a high level of natural lighting boosts performance and health at the workplace while reducing operating costs. Natural and artificial light planning must take the following requirements into account:

- Availability of natural light at the workplace and throughout the building
- Visual contact with outdoors
- No-glare natural and artificial light
- Distribution of light
- Colour rendering

Different areas of acticity are subject to different rules regarding required light intensity (AMEV "Lighting 2011" guideline [29], Technical Rules for Workplaces ASR). In the case of federal buildings, indoor lighting is also designed on the basis of the requirements laid down in the Energy Target Specifications (Annex B7).

Accessibility, freedom of movement and appropriate usability are decisive factors for the barrier-free building criterion (BNB 3.2.1). If the building function or use permits, it should be possible to make the building accessible to as many people as possible.

Another aspect that influences the usability, integration and acceptance of the planned building is public accessibility (BNB 3.2.4) which is expressed through the following aspects:

- General public accessibility (in as far is the building use permits such access)
- Opening the outdoor and internal building facilities (e.g. libraries or cafeterias) to the public
- Possibility for third parties to rent rooms within the building

Integration and acceptance of a building is heavily influenced by an appropriate design and urban quality (BNB 3.3.1) which includes the architectural design of the building, its outdoor facilities as well as the quality of integration into the urban environment. Design competitions and other discourse-based procedures involving independent expert commissions can promote, secure and/or boost the quality of the building design.

[29] See AMEV (2011)

4. Final planning

B 4

As part of final planning, construction drawings and specifications with quantity calculations are drawn up in preparation of the invitation to tender and contract awarding. These are the parts of work phases 5 and 6 or comparable work phases of the specialist areas of the HOAI which are required for the complete presentation of final planning. During this phase, audited structural stability calculations with structural analyses must be presented, along with the verifications required by the EnEV, sound insulation and fire protection verifications. The most important definitions regarding the sustainability criteria were already laid down in the ES – Bau and in the EW – Bau, i.e. the specifications made there must now be implemented in detail planning. This means that as part of final planning the sustainability goals defined in the ES – Bau and in the EW – Bau must be once again examined in the interest of ongoing quality assurance. In the event of changes in planning compared to the EW – Bau, the economic and ecological life cycle analyses must be updated. The cost framework laid down in the approved and under budget law recognised ES – Bau and EW – Bau is binding for final planning of federal building construction. If this cost framework is exceeded during the preparation of final planning, such increase must be approved and recognised under budget law in the procedure prescribed for the ES – Bau.

During final planning, the definition of quantities and qualities describes in detail the work required. In this case, the requirements of the criteria already referred to in the ES – Bau and EW – Bau (see Annexes B2.1 – B2.3 and sections 2 and 3) must be observed. This means that there is only very limited room to exert influence.

Sustainable planning means that tender documents must be drawn up with a view to an environmentally responsible procurement policy and must include specific requirements regarding social standards (BNB 5.1.4), so that a decision in favour of a product or service is not only determined by economic and ecological aspects, but also by social aspects. In order to rule out any discrimination against products, no products with a specific eco-label may be specified. That being said, however, the criteria underlying an eco-label can be used in the specifications in order to describe the desired environmental specifications.[30] The bidder must also be permitted to prove, using other means of proof, e.g. test reports, that its product meets with the environmental criteria laid down in detail in the tender documents. When drawing up the specifications, the construction products must hence be specified with a view to their use – based on the requirements from the standardised or approved ratings and classes – and in detail with a view to their environmental and health-related properties.

The test criteria, of the following eco-labels amongst others can provide assistance when describing and selecting products:

- Blauer Engel (German eco-label for eco-friendly products and services)
- EU Ecolabel (European eco-label for eco-friendly products and services)
- IBO test mark (Austrian building biology and building ecology test mark for building materials and interior furnishings)

Additional information is also available from the WECOBIS Information System on Ecological Building Materials (www.wecobis.de).

In order to ensure good room air quality, suitable verification of the emission behaviour of the building products to be used must be submitted together with the bid. In this case, building products are evaluated according to the concept valid at the time of execution and laid down in the BNB (BNB 3.1.3). Final planning must also pay particular attention to the description of the interior work materials and the impact of ancillary building materials on health and safety. Annex A1 lists indoor air pollutants and their sources which may be caused by building products and building systems. The scope of confirmation testing, e.g. room air measurements, must also be listed.

30 See EU (2001)

B 4

In the event of equivalent technical systems, preference is given to recycled materials. The reuse of building materials, building products and building parts (e.g. demolished concrete, stairs, windows, beams from a conversion or other dismantling project, or from a recycling materials exchange) as well as the use of recycled building materials must be clearly described in the respective item in the specifications.

The construction drawings must be drawn up in suitable detail (if necessary, up to a scale of 1:1) on the basis of the EW – Bau. In the case of projects involving a design competition, attention should be given to the actual implementation and further-development of the competition concepts in final planning in order to achieve a high degree of design and urban quality for the building.

5. Construction

The construction phase begins as soon as the first construction contract is signed. In addition to the invitation to tender and contract awarding, this phase also involves cost steering and cost control by the building realization level.

B 5

5.1 Invitations to tender and contracting

The integration of aspects of sustainability must be warranted in the invitation to tender and contracting of construction work (BNB 5.1.4). The sustainability criteria considered in design and planning are used as a basis for high-quality performance of the works. Furthermore, it must be ensured during the invitation to tender and contracting phase that final planning is implemented with determination. This is especially important in the case of demanding design and urban development requirements for a building for which a design competition was held.

5.1.1 Invitation to tender

The requirements for the principles of sustainability, such as:

- durability
- easy cleaning
- requirements for health and eco-friendliness
- environmental and social standards

must be described in the tender documents/programmes, specifications or in the technical specifications without reference to a specific product. Special attention should be given here to ensuring that the installation of materials or products with a potential toxic risk for the environment or humans can be avoided in as far as possible by including appropriate requirements in the specifications. The following aspects must be taken into account here:

- Dangerous substances (CLP Regulation [31]) and in particular substances of concern (REACH Regulation [32])
- Release of hazardous substances due to leaching
- Heavy metals
- Organic solvents
- Halocarbon cooling and blowing agents
- Biocides (Biocide Directive, or beginning 1 Sept. 2013 Biocide Regulation [33]) and heavy metals with a biocidal effect

If recommendation criteria, such as eco-labels or other standards, have to be listed in exceptional cases, this requires the addition of "or equivalent". The ecological requirements in the case of possible exclusion criteria, such as emission ratings or tropical wood from accredited forestation, must be similarly listed in the specifications. The submission of ancillary offers and special proposals should encourage alternatives that may better fulfil the requirements.

5.1.2 Contracting

The purpose of including aspects of sustainability is to improve the expected quality of the building. Product-related environmental properties can generally be taken into consideration, such as the offer of a permanent surface finish that makes the use of cleaning agents largely unnecessary during the use phase. On the other hand, environmental properties that are related to the supplier must be ignored during selection, e.g. if the supplier states that his vehicle fleet runs on rapeseed oil.

One prerequisite for correct and hence high-quality construction is the awarding of contracts exclusively to companies that have demonstrated their suitability in terms of reliability, expertise and performance pursuant to the General Provisions Relating to the Award of Construction Contracts, Part A (VOB/A). Contract awarding offices must examine the suitability of construction companies. The contract awarding office does not need to perform this check for prequalified construction companies because suitability is already checked during prequalification (PQ VOB) by one of the prequalification offices on the basis of the requirements defined in § 6 of VOB/A . Prequalification covers the entire performance chain right down to the use of subcontractors. The extensive examination of companies in terms of their suitability by the prequalification offices

[31] See CLP Regulation (2008)

[32] See REACH Regulation (2012)

[33] See Biocide Regulation (2013); the Biocide Directive remains in force until 31 Aug. 2013 (1998) and will be superseded by the Biocide Regulation.

lessens the burden on the customer significantly. The customer can trust in the complete and qualified examination of credentials. In the case of contractors that are not prequalified, the contract awarding office is responsible for this examination. All prequalified contractors must be listed and updated on a daily basis in the prequalification list (PQ list). Following once-off registration with the Association for the Prequalification of Construction Companies (PQ Association), the contract awarding office can access the examined credentials which are stored in a protected area. In the case of restricted invitations to tender or no-bid contract awarding for federal construction projects, the contract awarding offices must primarily request bids from prequalified construction companies. Due to the suitability issues examined during the prequalification of companies, prequalification in itself is not a criterion for assessing the building and is hence not addressed separately in the BNB.

5.2 Construction process

The construction or building processes (BNB 5.2.1) must also be defined in order to protect resources and the environment. At the same time, the health of all stakeholders must be protected.

According to the Federal Immission Control Act[34], each construction site should be planned, set up and operated in such a manner so as to avoid noise that can be avoided according to the latest state of the art. Precautions must be taken in order to minimise unavoidable noise from the construction site. The avoidance of dust on the construction site can significantly help to protect people working on the site and other persons. Furthermore, the environment must be protected against damage caused by substances. Soil, vegetation and groundwater must be protected against harmful contamination and mechanical damage.

Construction planning and execution must meet the requirements of the Closed Substance Cycle and Waste Management Act. The aim is to protect natural resources, avoid waste, and achieve the high-quality, correct and safe reuse of unavoidable waste in as far as possible, as well as to dispose of non-reusable waste in a manner that serves the public good. In addition to the quality of production site planning, it must be ensured in the interest of sustainable planning that the planned sustainability criteria are also observed in the building processes. In order to avoid defects or damage to the building, comprehensive quality checks must be carried out during the building process and following completion of the building (BNB 5.2.2). The implementation of the competition design (BNB 3.3.1) must be particularly monitored. The materials and building products used must be precisely documented using safety data sheets and product descriptions.

[34] See BImSchG (2012)

6. Comissioning and building documentation

At the time of handing over, responsibility for the building passes to the project sponsor (owner). After this, the building is handed over to the user/tenant. Comprehensive documentation of the measures carried out is one of the key tasks of the planning process. Extensive documentation of the property (BNB 5.1.5) helps to simplify the future processes in the life cycle of a building. Handing over of the building and as-built documentation are described in detail in the RBBau Guidelines, Part H. The "Building-related guidelines for documentation of existing buildings" (BFR GBestand)[35] and the "Building-related guidelines for surveying" (BFR Verm)[36] contain supplementary rules.

B 6

Once a building measure has been completed, digital documentation of existing buildings according to the RBBau Guidelines, Part H, describes the condition actually built and forms the basis for the digital updating of the building stock. It contains the CAD documentation with the digital structural and technical as-built drawings along with alphanumerical structural and technical description data of the schedule of rooms and buildings which must be commissioned at least according to the standard scope of data laid down in the BFR GBestand. A schedule for existing rooms and buildings provides the user/project sponsor (owner)/operator of the building with various information regarding the building which is relevant for his area. This is designed to ensure that both users and operators correctly use the building and its features made available to them.

With a view to sustainability, the project sponsor (owner), operator, user and building authority can also agree to other documents in terms of scope and form. The cost of preparing and updating these documents must also be listed in the ES – Bau. This includes overviews of the materials and building products to be used as well as submission of safety data sheets and product descriptions (BNB 5.2.2). The documentation of the materials used/installed during construction, which at times is already part of the documents and verifications to be furnished by contractors according to the General Technical Terms and Conditions for Construction Work (ATV – Allgemeine Technische Vertragsbedingungen für Bauleitungen), is of paramount importance for the future phases of the life cycle. Especially in the case of conversion or demolishing measures, detailed information is vital regarding the materials and ancillary materials used in construction. The safety data sheets contain important information regarding the identity of a product, risks, safe handling and prevention measures, as well as for incidents. The definition of safety data sheets is as laid down in the EU Directive. These data sheets must be collected by a previously named institution (firm, service provider, etc.).

Complete documentation of the building-related repair, service and operating manuals is important for efficient operation of the building and hence has a positive impact on building-related costs in the life cycle. Furthermore, updated calculations regarding the execution process can be used to confirm a target status aimed for in design and planning. These documents form an important basis for any future modernisation, revitalisation or renovation work in a later phase of the life cycle.

Quality assurance of the building construction (BNB 5.2.2) can be demonstrated using various measurement methods. The aim of these measurement and analysis methods is to check and document whether target values have been reached. The following measures are recommended as part of quality assurance:

- Methods for controlling the energy quality of a building (e.g. air-tightness test, thermography)
- Acoustic measurements (e.g. airborne sound, footfall sound test, reverberation time)
- Other measurement methods (e.g. indoor air measurements, light measurements)

In order to ensure and document the quality of indoor air, indoor air measurements must in any case be carried out within the first four weeks following completion of the construction project. The results of these measurements must at least comply with the indoor air quality criterion (BNB 3.1.3). The Federal Environment Agency has set up the Indoor Air Hygiene Commission (IRK – Innenraumlufthygiene Kommission) to address issues of air hygiene. Since 1993, an IRK workgroup has already been drawing up guidelines and recommendations for pollutant levels in

[35] See BFR GBestand (2012)

[36] See BFR Verm (2007)

indoor air. The currently valid recommendations and values can be found on the website of the Federal Environment Agency (Health and Environmental Hygiene/Indoor Air Hygiene). If the results of measurements question the permanent use of the building for reasons of hygiene, measures must be taken to improve the quality of indoor air.

In addition to ruling out high levels of pollutants in indoor air, a minimum value must also be ensured for the ventilation rate per person. Average values can be found in the criterion for indoor air hygiene (BNB 3.1.3).

In order to assess acoustic comfort (BNB 3.1.4), reverberation time measurements must be carried out after completion of the building or calculated in advance according to DIN 18041[37].

As part of this Guideline, the guidelines referred to above for documentation of existing buildings are supplemented by the "BNB Examination Document". In addition to providing documentation of purely structural and technical properties according to the RBBau Guidelines, it also compiles the verifications and calculations (e.g. LCC and LCA calculations, user manual, results from indoor acoustic and air measurements, etc.) which result from the individual criteria of the BNB.

[37] DIN 18041 (2004)

7. Optimising operations

Part C ("Recommendations for Sustainable Use and Operation of Buildings") contains detailed information regarding optimisation of building operations.

The "Use and Operation" BNB-module is a useful tool for optimising use and operation processes. With this BNB-module, sustainability assessments can be performed during the use phase and then used to specifically record, influence and steer the quality of processes and the building.

Controlled commissioning is essential in order to achieve the best-possible operation of the building as soon as use begins and can help to ensure long-term and efficient functioning of building services. Another precondition for environment-friendly and economical building operations is the possibility to record and analyse measurements of energy and media flows, so that weaknesses can be identified and eliminated. For this purpose, a measuring/metering and monitoring concept is required in order to enable comprehensive and appropriate energy management during the use phase.

B 7

7.1 Controlled commissioning

Controlled commissioning is essential for optimising the functionality of building equipment. During controlled commissioning (BNB 5.2.3), the individual components of the technical building equipment are co-ordinated and adjusted to operate together following acceptance. After this, the system can be re-adjusted once again after around one year as part of optimising operations. A concept for adjustment and re-adjustment is required for controlled commissioning. Since this work is not a standard service, it must be contractually specified. It must be performed and documented by specially qualified staff or contractors. In addition to verification of adjustment, this documentation must also include the main settings for the system, so that any incorrect changes, e.g. by the user, can be reversed.

7.2 Management of energy and water consumption

The basic goal of energy and water consumption management (see Part C, section 3.2.3.1 or BNB_BB 5.3.2) is to monitor and minimise energy and water consumption during the use phase. This requires systematic recording of all consumption values and their analysis in order to identify higher consumption and other irregularities. The purpose of this is to uncover the potential for savings and to develop possible solutions in order to lower energy and water consumption. As part of monitoring, energy and water consumption is hence periodically recorded and analysed. The analysis particularly focuses on comparing the results with consumption from previous periods.

The quality of energy and water consumption management is determined by the following sub-aspects:

- Recording (monitoring) and analysis of energy and water consumption
- Initiating measures in response to demand and circumstances

Through ongoing monitoring of performance and consumption accompanied by repeated analyses of use and operation data by the owner/operator and user, consumption and therefore both costs and environmental impacts can be reduced during the use phase. Informing users of the effect of certain measures on sustainability is also very important here. For this purpose, the preconditions for measurements and metering must already be foreseen in the design (see section 2.4.3).

The required technical concepts for technical building systems are laid down in the Energy Target Specifications, section 2, "Requirements for Technical Concepts" (see Annex B7) and must be observed in the design.

The consumption values and operating costs must be reported to Landesbetrieb Vermögen und Bau Baden-Württemberg pursuant to the provisions of Section K 6 of the RBBau Guidelines. Sample 3 of the RBBau Guidelines must be used for reporting. This ensures that the data can be reused in PLAKODA .

Part C Recommendations for the Sustainable Use and Operation of Buildings

Part C – Recommendations for the Sustainable Use and Operation of Buildings

1. Sustainable use and operation

The principles, protected goods and targets which were laid down during the design and planning phase for new buildings or complete refurbishment and conversion measures (see Part A, section 2 “Dimensions and qualities of sustainable building”) also apply in principle and in particular to the use phase. During the use phase, however, the focus is on the building’s actual properties and characteristics; the description, assessment and targeted influencing of planned features are of secondary importance in this phase.

The parameters that influence the actual features and properties are diverse in nature. These include the actual structural and technical condition achieved as well as the type and scope of its preservation and its ongoing improvement. Contrary to the planning and construction phase, which is characterised by target values, assumptions and goals, the actual climate and other real external factors are what influence the building during the use phase. Building operations are also now characterised by the actual type of operation and use and hence by real operator and user behaviour. These are the most influential factors during the use phase. User behaviour not only includes the direct behaviour of users and visitors, but also the use processes of the institution using the building. Operator behaviour refers to the behaviour of all those involved either directly or indirectly in the operation of the building. However, the quality of the management and decision processes of the owner or of third parties appointed by the owner (e.g. operator) is particularly important.

Extensive data can be collected during the use phase. This data provides an insight into the actual features and properties of the building. For this purpose, data must be collected regarding the actual use of resources, the specific impacts on the global and local environment, operation costs, actual user satisfaction and the resultant conditions in the building (e.g. air quality). By collecting and analysing this data, it is possible to identify, describe and assess to a large extent how much a building and its use actually contribute to sustainable development (sustainability assessment).

However, the sustainability assessment is much more than just an assessment of building quality during the use phase. Another important part of this assessment involves analysing and assessing the type, scope and quality of the management processes that accompany use and operation. Sustainability assessments performed during the use phase make it possible to specifically record, influence and steer the quality of processes and the building.

A sustainability assessment can be carried out at any particular point in time. This can be used either for permanent controlling or for first-time or follow-up assessment of a building, or in preparation of refurbishment or conversion planning. The assessment can also be used as a quality control tool following completion of new construction, refurbishment or conversion measures (also in order to enforce warranty claims) and following changes to the type of operation. In the case of PPP projects, as with all other projects, the sustainability assessment can be used to actively report on building behaviour and the quality of processes and hence to check compliance with the agreed features, properties and parameters.

The specific evaluation of both the building qualities as well as the use and management processes can help to provide conclusions, recommendations, characteristics and benchmarks for future planning and use phases. There is a direct correlation between the sustainability assessment of the use and operation of a single building and the portfolio analysis and preparation of various reports, such as sustainability reports, energy, greenhouse gas or environmental reports as well as reports on corporate social responsibility.

2. Stakeholders during the use phase

The extent to which buildings can contribute to sustainable development during the use phase is determined both by the features and properties that result from planning and implementation as well as the given climatic and other boundary conditions. The behaviour, especially of those stakeholders involved in use and operation, influences the building's contribution. The type and scope of this influence results, among other things, from the respective area of responsibility and the options available to the relevant stakeholders to act and exert influence explained in greater detail below.

Operator

The operator is the public authority or body which is responsible for the operation and maintenance of the building (building management). Pursuant to the provisions of Section C (building maintenance) and K15 (operations management) of the RBBau Guidelines, this is the task of the office managing the building. The operator can also be the owner of the building. The operator is responsible for all building management processes and hence also for compliance with the recommendations of Part C of the Guideline for Sustainable Building. The operator is supported by the building authority and the operational monitoring service according to the RBBau Guidelines.

Commissioned third parties

The operator can fully or partially assign the tasks of building management to third parties. However, this does not release the operator from its obligation to implement the requirements of the Guideline for Sustainable Building. The operator is required at all times to employ suitable means to ensure that these requirements are met. Third parties who have been commissioned with building management must also implement the requirements of the Guideline for Sustainable Building while advising and supporting the operator with regard to compliance with requirements.

Using authority (body or public authority using the building)

The using authority is the body or public authority using the building. Both the building and its management processes must meet the user's needs and must be aligned to its activities and services. Environmental management is increasingly shifting into the line of focus at public and private institutions according to their responsibility and the growing public interest in environmental protection issues. With environmental management, the respective institution can ensure the environmental compatibility of its services, products and operation processes as a contribution to sustainable development. Moreover, environmental management also enables the transparent demonstration of efforts in the field of sustainable environmental protection. In addition to sustainable building, the sustainable use and operation of buildings is a key component of successful environmental management.

The using authority can hence demand sustainable building management from the operator because this is the only way in which this authority can meet with its own requirements in terms of environmental management. Operators or third parties commissioned by them are required to report to the institution or agency using the building or its central representation.

Users (staff and visitors)

Within the scope of this Guideline, the direct users of the building are the authority staff working in the building. In the case of buildings that are open to the public and which are heavily frequented, visitors are also considered to be users who avail of the services provided by the authority using the building. Both groups are jointly referred to as users in this Guideline.

Building authority

The building authority is responsible for proper repair if an order has been placed to implement consumptive measures pursuant to Section C of the RBBau Guidelines. This includes measures to maintain buildings, including technical building equipment and outdoor facilities. Scheduled servicing and inspection do not form part of building maintenance nor does preparation work which becomes necessary due to a new function (see Section C of the RBBau Guidelines). With the scope of its tasks as laid down in the RBBau Guidelines, the building authority supports the operator in all processes of building management.

Operational monitoring service

The operational monitoring service examines operations management by the operator with a view to its application and compliance with the principles of operations management. Furthermore, the service assists the operator with expert advice. The purpose here is to ensure efficient building operations.

BNB sustainability coordinator

It is the task of the operator to check the building management processes for compliance with the Guideline for Sustainable Building, to coordinate sustainability in the use phase and to perform sustainability assessments. The operator assigns these tasks to a BNB sustainability coordinator who is supported by the authority using the building, the building realization level and the operational monitoring service within the scope of their tasks pursuant to the RBBau Guidelines.

Responsibilities, tasks and areas of responsibility on the part of stakeholders in the use and operation of the building (operator, facility management company, users, administration, etc.) are laid down in numerous regulations and specifications and are also partially defined by the RBBau Guidelines. Part C of the Guideline for Sustainable Building contains recommendations that supplement the existing regulations and specifications with a view to securing sustainable use and management processes (including the RBBau Guidelines, Parts C, H, K6 and K15). When applying this Guideline to the use and operation of federal government buildings, compliance with the rules of the RBBau Guidelines is automatically a precondition for compliance with the requirements of the Guideline for Sustainable Building. One example is reporting of consumption rates pursuant to Part K6 of the RBBau Guidelines. Their relevance for sustainability is explained in section 3.2.10 “Reporting obligations”. The provisions of the RBBau Guidelines must be adhered to in order to ensure the necessary process quality for sustainable building management. Irrespective of the recommendations laid down in this Guideline, the provisions of the RBBau Guidelines and other binding regulations and specifications that apply to the use phase remain in effect, especially with a view to responsibilities and workflows. The following guidelines, guides and tools must be mentioned here:

- Building-related Guidelines for Documentation of Existing Buildings (BFR GBestand – Baufachliche Richtlinien Gebäudebestandsdokumentation)
- Guideline for Monitoring the Safety Precaution of Federal Government Buildings and Structures (RÜV – Richtlinien für die Überwachung der Verkehrssicherheit von baulichen Anlagen des Bundes)
- Fire Safety Guide for Federal Government Buildings
- Guidelines for Recycling

3. Criteria for sustainable use and operation

C 3

The use and operation of a building are normally the longest phase in the life cycle of a building. The use and operation phase (collectively referred to here as the use phase) is typically also the phase with the strongest economic and ecological impacts. This is the phase during which socio-cultural and functional aspects come to bear. That's why the assessment of sustainability is so important during the use phase. When the operating and use parameters of a building are regularly checked, the use and management processes can then be optimised in order to operate the building in a more efficient and environmentally friendly manner and perhaps even at less cost. At the same time, it is possible to improve functional quality and maintain or continuously improve user satisfaction.

Furthermore, use and management parameters that have been identified and documented can, when needed, be used for a comprehensive diagnosis of the building. This diagnosis can then be used as a basis for refurbishment, conversion or remodelling decisions and planning. Process and property qualities must be examined, assessed and recorded during the use phase.

3.1 Overview of process and property qualities during the use phase

The most important tasks of the operator include defining the goals to be achieved in the management process as well as the regular examination of the potential for optimisation possible within the scope of the services to be provided. These services are generally covered by the term "building management" and, pursuant to DIN 32736:2000-08 "Building management – terms and services", include technical, infrastructural and commercial building management. The information needed to exploit the possibilities for improvement along with reporting to the owner can be primarily generated using a Computer Aided Facility Management system (CAFM system).[1]

The use phase contains a host of complex processes that involve numerous stakeholders. In order to ensure that the economic, ecological and socio-cultural factors are sufficiently addressed, a comprehensive quality management system is required to manage the building. This is the reason why the "Use and Operation" BNB-module of the federal government's Assessment System for Sustainable Building must be used during the use phase. Using this BNB-module, the following process qualities are examined, assessed and documented during the use phase in order to achieve sustainable use and operation in as far as possible.

Criteria group: "Process quality of use and operation"

- User Satisfaction Management (BNB_BB 5.3.1)
- Availability, type, scope and up-to-Dateness of the Operating Concept (BNB_BB 5.3.2 and 5.3.3)
- Management of Energy and Water Consumption (BNB_BB 5.3.2)
- Operation Costs Controlling (BNB_BB 5.3.3)
- Inspection, Servicing and Safety Precaution (BNB_BB 5.3.4)
- Eco-Friendly and Health-Safe Cleaning (BNB_BB 5.3.5)
- Technical Operations Management and Qualification of Technical Staff (BNB_BB 5.3.6)
- Property Documentation during the Life Cycle (BNB_BB 5.3.7)
- User Information and Motivation (BNB_BB 5.3.8)

The actual property qualities must also undergo regular examination and assessment. In this case, it is necessary to analyse and assess how the building actually behaves in day-to-day operations under real use conditions. Requirements for checking property qualities have been integrated into the "Use and Operation" BNB-module in order to enable a uniform and comparable assessment. In this case, the actual property quality of the building is examined which results from sustainability-orientated design and planning, erection, use and operation. However, the examination of property quality can also be carried out as part of a comprehensive diagnosis of an existing building.

[1] See Eser (2009), p. 36

The “Use and Operation” BNB-module must be regularly used in order to examine and document an exemplary selection of actual property qualities. This is carried out as part of the “real qualities” criteria group.

Criteria group: “Real qualities”

- Greenhouse Gas Emissions due to Heating/ Electric Energy Consumption (BNB_BB 1.1.1)
- Energy Consumption (Final Energy) due to Heating/ Electric Energy Consumption (BNB_BB 1.2.1)
- Drinking Water Consumption (BNB_BB 1.2.3)
- Actual Thermal Comfort in Winter (BNB_BB 3.1.1)
- Actual Thermal Comfort in Summer(BNB_BB 3.1.2)
- Actual Indoor Air Quality (BNB_BB 3.1.3)
- Actual User Satisfaction (BNB_BB 3.1.9)

In the case of a new construction, or a complete refurbishment, conversion or conversion measure, an assessment must be carried out for the first time three years after commissioning.

Actual expenditure on heating energy and electricity (final energy) is closely linked to the energy consumption certificate. The greenhouse gas emissions identified on this basis correspond to a carbon footprint in the use phase as part of the carbon footprint for the building.

Annex C1 provides an overview of the minimum requirements for achieving sustainable building operations. Furthermore, recommendations for sensible improvements in quality are also provided.

3.2 Description and assessment of the property and process qualities during the use phase

3.2.1 Operating concept

At the beginning of the planning and construction process, i.e. during the requirements planning phase, a comprehensive operating concept must already be drawn up for all of the individual activities to be carried out in a building (see the Guideline for Sustainable Building, Parts A and B). The operating concept must be continuously updated and adapted during the use phase. If no operating concept is available, this must be drawn up for the first time. The operating concept must define both the measures to be performed in order to achieve the required service levels as well as the requirements for reporting. In order to ensure good process and property quality, it is vital that an operating concept be drawn up. An operating concept shows the actual condition of the building and its management in relation to the user or owner requirements.

The operating concept must be geared to the type and scope of building use although this can develop or change during the use phase of a building. In some cases, the forecast or planned building use, which served as a basis for design and planning during requirements planning or in the planning phase of a building, can differ from the actual resultant building use at the beginning of the use phase. As part of sustainable building management, the actual building use must hence be regularly examined and the operating concept adapted accordingly. The following factors of building use are relevant:

- Actual type of use
- Current space programme
- Actual room occupancy
- Actual working and operating hours
- Current user demand for functionality, security/safety, comfort
- Current structural and technical equipping standard
- Current user behaviour
- Current user and use-specific equipping

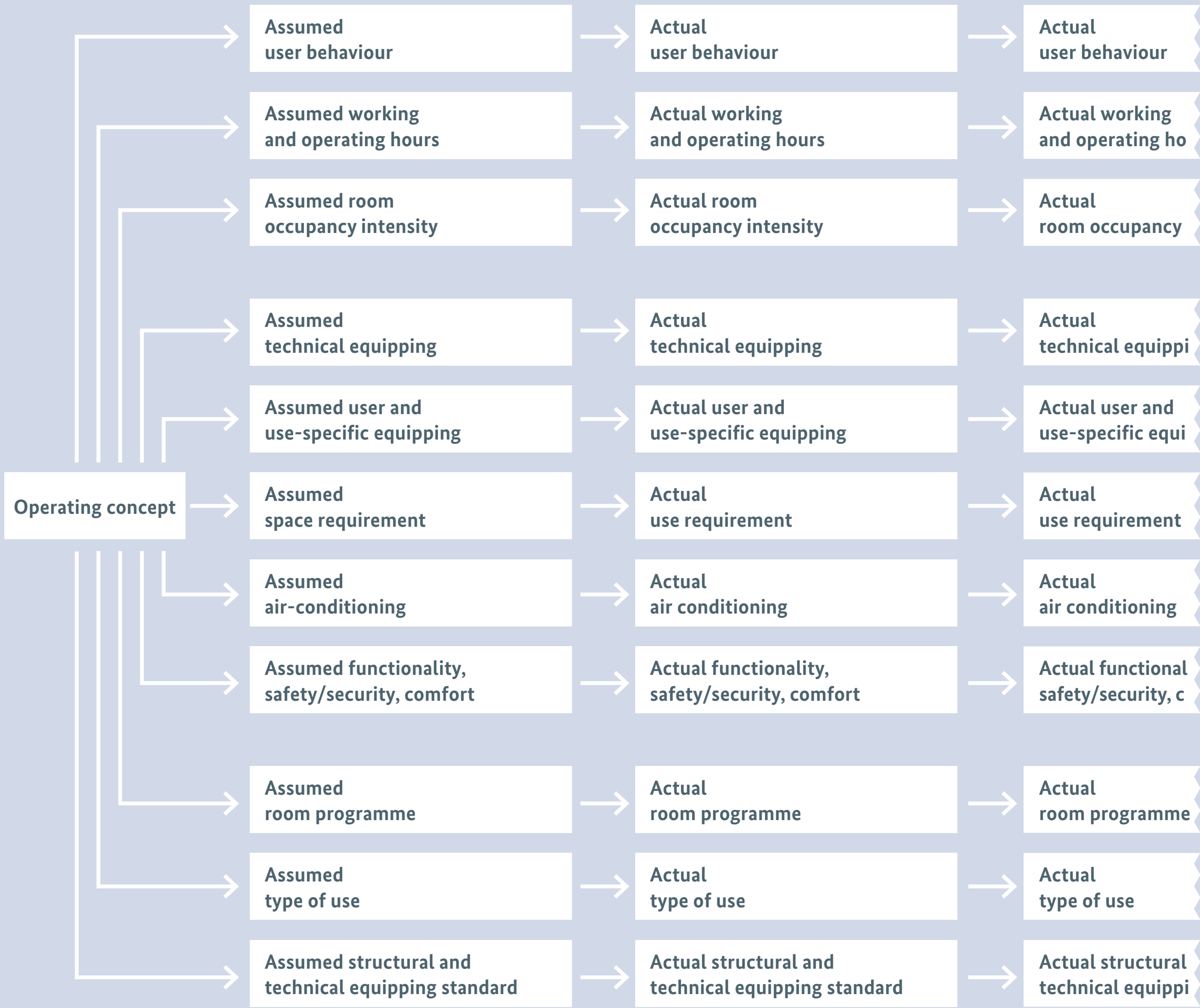

Fig. C1: Aspects of the use and management analysis

Use and management analysis

Actual building use must be regularly examined as part of a comprehensive analysis (use and management analysis , see Fig. C1) and the operating concept must be adapted accordingly. The use and management analysis is an important task for the authority using the building because it can be used to exploit possible optimisation potential. The use and management analysis is a precondition for both successful operation costs controlling (see section 3.2.2) and energy management (see section 3.2.3.1). Minimum requirements and recommendations can be found in Annex C1.

The operator is required to support the authority using the building during its use and management analysis. The results of the use and management analysis along with all relevant information regarding actual building use must be made available to the operator. This information includes immediate notification of changed factors and boundary conditions related to building use as shown in the list contained in Annex C1.

3.2.2 Operation costs controlling

Operation costs as used in this Guideline refers to operating and repair costs. Operating and repair costs (cost categories 300 and 400 according to DIN 18960) and their share in operation costs have a key role to play in life cycle costs and hence on the economic quality of buildings. Planning, recording and analysing operating and repair costs on the basis of a uniform method makes it possible to identify potential cost savings and provides an indication of improvement possibilities. As part of operating and repair cost controlling (operation costs controlling , BNB_BB 5.3.3), the costs actually incurred must be compared to the cost targets set by the operator for the specific building. If the cost targets are exceeded, the reasons for this development must be identified and analysed so that either potential for optimisation can be found or the cost targets can be adjusted as required. Following this, suitable measures to control costs must be introduced. The aim of operation costs controlling is to reduce the operation costs, i.e. to identify and exploit potential savings. In addition to a suitable organisation and workflow to record and analyse actual costs according to type of costs and cost centres, functional cost control calls for the creation and analysis of time series and the comparison of benchmarks.

The quality of cost controlling is determined by the following sub-aspects:

- **Planning operation costs:**
  Frequency and degree of detail
- **Recording and analysing operating and repair costs:**
  Frequency, scope and degree of detail
- **Operation costs analysis and measures programme:**
  Availability, quality and implementation

Operating and repair must be recorded and broken down according to DIN 18960. The controlling of operating and repair costs must at least include cost categories 310 to 350 and 410 to 440 according to DIN 18960. As a minimum, the breakdown must comply with the breakdown depth shown in Annex C2. Costs in conjunction with replacement investments (complete exchange and replacement of building parts/components) must be separately recorded in cost controlling. Target values or budget planning for building realization level and repair costs can be drawn up with a reference to information from maintenance and full service contracts. It is recommended that bids already be requested for these contracts during the design and planning phase.

The operator is responsible for cost controlling. According to the RBBau Guidelines, other stakeholders are also involved in sub-tasks of cost controlling. With a view to this, the advisory services of the building authority (building realization level) can be named when identifying the costs for building repair. The tasks of the building authority are laid down in Part C of the RBBau Guidelines. The tasks of the operational monitoring service are laid down in Part K 15 of the RBBau Guidelines.

Planning operation costs

Operation costs planning includes planning operating and repair costs as well as reporting. As part of operation costs planning, cost targets must be set for the budget year ahead. These are then used later to assess the operating and repair costs actually incurred. Operation costs planning must be carried out periodically (every 12 months) and must be broken down to the minimum degree of detail shown in Annex C2. Ideally, the costs should be broken down throughout to the 3rd level in accordance with DIN 18960.

When deciding on the target values for the property-specific and location-specific operating costs, the current and the foreseeable boundary conditions must be taken into account, such as:

- Type and scope of use
- Definitions and standards regarding user comfort (e.g. operative temperature in summer)
- Results from the analysis of previous cost records
- Calculations based on the operation concept that forms the basis for building management (e.g. identification of energy costs after optimisation measures have been implemented)
- Orientation and best values which were achieved with the management of exemplary, comparable buildings (best practice)
- Local rates for energy and services

In order to determine repair costs according to cost categoriy 400 of DIN 18960, all the necessary work must be carefully identified. With a view to this, the provisions of Part C of the RBBau Guidelines apply to the implementation of federal government construction tasks. Repair costs are planned on the basis of the construction requirement determined as a result of the current condition of the building. In order to identify the condition of the building and the necessary repair work, the building must be periodically inspected. This building inspection must be carried out according to the applicable provisions of the RBBau Guidelines (see Part C).

Operating costs planning must include target values for utility costs. The procedure to be used here is described in section 3.2.3.1 "Management of energy and water consumption". Target values for other operating cost categories (cost category 300 according to DIN 18960) can be identified, for instance, on the basis of the contract awarding results or existing contracts with service providers (e.g. building cleaning or servicing and inspection work).

The operator is responsible for compiling the complete operation costs planning according to the above rules. The operator is required to document operation costs planning in a report. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

Recording and analysing actual operating and repair costs

Actual operating and repair costs must be periodically recorded, analysed and documented as part of reporting. Cost recording requires a cost recording concept that contains the costs to be recorded, as well as responsibilities, information flow and the infrastructure required to identify and document operating and repair costs. This also includes the suitable rules for compiling at a central point the cost information that is often supplied by various stakeholders. The operator is responsible for drawing up the cost recording concept.

As part of cost controlling, operating and repair costs according to cost categories 310 to 350 and 410 to 440 according to DIN 18960 must be recorded and analysed periodically. Recording and analysis must be carried out regularly, at least once a year, and should have the minimum degree of detail as shown in Annex C2. Regular recording and analysis every three months is recommended. The core element of the cost analysis is the comparison of actual and planned costs. Irregularities and deviations from benchmarks must be identified on the basis of examinations of absolute amounts and cost structure (shares of fixed and variable costs, identification of main cost drivers, etc.). When necessary, costs must be adjusted with a view to impacts which were not foreseeable when operation costs were planned (e.g. price developments, weather, special conditions resulting from use/operation).

The operator is responsible for recording and analysing actual operating and repair costs. The operator is required to document the results in a report. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

Operation costs analysis and the measures programme

The operating and repair costs identified must undergo an operation costs analysis which involves a root-cause analysis and a general analysis of the operation costs.

Root-cause analysis in the case of benchmark violations

If target values in operation costs planning are violated or in the case of other irregularities identified during recording, the operator is required to find the underlying cause. The causes identified must be considered in a measures programme which should eliminate the reasons for the higher operation costs.

Operation costs analysis

A operation costs analysis must be carried out periodically for the operating and repair costs and the parameters that must be reported must be identified. This must be carried out even if there are no signs of deviations from the planned figures or of potential savings. The analysis must be basically carried out every three years and following major structural or organisational changes.

The operation costs analysis generally examines the aspects below.

- Whether structural or technical potential exists to reduce operating costs (with a distinction between investment measures and low-investment improvement measures)
- Whether the operating concept is being implemented correctly
- Whether differences exist between the operating concept and actual building use (see section 3.2.1)

Measures programme

The measures programme involves the planning, assessment and monitoring of the success of measures which aim to reduce operating and repair costs. Measures must be generally implemented if a measure offers apparent economic benefits or if the economic benefits can be demonstrated in a profitability analysis that takes qualitative assessment methods into consideration (e.g. benefit analysis).

The operator is responsible for identifying the reasons behind why target values have not been reached or other irregularities found, as well as for the operation costs analysis and the measures programme. The operator receives the support of the building authority and the operational monitoring service within the scope of their tasks according to the RBBau Guidelines. When it comes to identifying actual building use as part of the use and management analysis, the operator is supported by the authority using the building.

Each year, the operator drafts a report documenting the results of the operation costs analysis and, if applicable, the root-cause analysis and the measures programme. Section 3.2.10 “Reporting obligations” contains information concerning the distribution and minimum contents of the report.

3.2.3 Energy and water consumption

Energy and water consumption is extremely important because it has a considerable impact on the economic and ecological quality of the use phase. The operator must hence focus on monitoring and optimising energy and water consumption. The quality of this monitoring is determined by much more than just the consumption rates. The only way to ensure that the best possible consumption rates can be or have been reached is by gearing the use and management processes to a sufficient degree to monitoring and optimising energy and water consumption. This means that during the use phase the actual building qualities must be examined on the basis of consumption rates while management of energy and water consumption must be established in the management process.

3.2.3.1 Management of energy and water consumption

The basic goal of energy and water consumption management (BNB_BB 5.3.2) is to monitor and minimise energy and water consumption during the use phase. This requires systematic recording of all consumption rates and their analysis with a view to higher consumption and other irregularities. The purpose of this is to identify potential for savings and to develop possible solutions in order to lower energy and water consumption. As part of monitoring, energy and water consumption is hence periodically recorded and analysed. The analysis is carried out primarily by comparing consumption in previous periods after consumption rates have been adjusted – in as far as possible. It must be examined whether the use conditions can be compared. It only makes sense to compare calculated target values if the system boundaries are identical. Monitoring energy and water consumption allows malfunctions and defects in operations management to be identified and the management processes for the building to be continuously improved.

The quality of energy and water consumption management is determined by the following sub-aspects:

- Recording (monitoring) and analysis of energy and water consumption
- Initiating measures in response to demand and circumstances

The operator is responsible for energy and water consumption management.

Recording and analysing energy and water consumption

Energy and water consumption must be periodically recorded, analysed and documented as part of reporting. In order to ensure that the relevant consumption rates are directly recorded, a measuring/metering concept is needed which not only determines the consumption rates to be recorded, but also the responsibilities, information flow and the infrastructure required to identify and document energy and water consumption. The measuring/metering concept must already be drawn up during the design and planning phase of a building (see Part B, section 2.4.3 "Energy and metering/measuring concept" and BNB 5.1.3), achieved in the construction phase and implemented in the use phase. With a view to the degree of detail with which consumption is to be recorded, the sample in the Energy Target Specifications (Annex B7) must be observed. At the very least, the minimum requirements of the Energy Target Specifications must be met. It is recommended that all of the recommendations outlined in the Energy Target Specifications be implemented.

During the commissioning phase, consumption rates must be identified and documented on a monthly basis. Once steady – albeit perhaps not optimum – operation has been reached, this monthly basis should still be maintained. Only when steady and optimum operation has been reached can the identification and documentation of consumption rates be carried out less frequently depending on effort and expense. In order to ensure sustainable operation of the building, seasonal differences must be recorded and it must be possible to detect disruptions on time. This means that identification and documentation of consumption rates should not be carried out at intervals of more than three months. Depending on the technical equipping of the building, there may be justification for longer intervals if a short response time to disruptions or defects is ensured.

As part of the analysis, the consumption rates recorded must be compared to the building-specific benchmarks (total consumption and partial consumption rates or partial energy parameters). Benchmarks must be identified using the consumption rates identified in previous periods and calculations made on the basis of the operating concept. If planning figures from the planning and construction phase of the building are available, these must also be used as benchmarks in as far as they have the same system boundaries and are otherwise suitable. The aim of the analysis is to identify benchmark violations and other irregularities, such as a sudden increase in consumption for a technical system compared to the previous period. Recording and analysing energy and water consumption must enable timely countermeasures (elimination of defects or disruptions). Before the analysis is carried out, consumption rates must be adjusted in as far as possible with a view to weather and any other special circumstances in conjunction with the use and operation of the building.

The operator is responsible for the recording, adjustment, documentation and analysis of energy and water consumption as well as the elimination of any defects or disruptions. The operator is required to document in a report the results of consumption recording and analysis. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

Initiating measures

Measures must be taken in the cases listed below:

Initiating measures when benchmarks are violated

If benchmarks are violated or in the case of other irregularities identified during consumption recording and analysis, a search must be carried out to find the reason for the violation. Once the reason has been found, the defect or disruption must be immediately eliminated (short response time).

Initiating optimisation measures

An examination must be carried out periodically (basic interval: every 12 months and depending on structural and organisational conversion) in order to determine whether there is a structural or technical potential to reduce energy and water consumption (energy and water consumption analysis). In addition to referring to the concept for and assessment of organisational and/or investment measures which are to lead to a reduction in energy and water consumption, the energy and water consumption analysis should also examine whether possibilities exist for short-term, low-investment optimisation measures to reduce energy and water consumption. These measures could be carried out during inspection and servicing work on heating, ventilation, cooling and lighting systems. Organisational measures should always be implemented immediately. The results of the use and management analysis (see section 3.2.1, paragraph on "Use and management analysis") must be taken into consideration in the analysis of energy and water consumption.

Measures programme

The deviations, weak points and potential for optimisation identified in the energy and water consumption analysis and in the root-cause analysis, if any, must be included in the measures programme. The measures programme includes the planning, assessment and implementation of structural, technical and organisational measures which aim to reduce energy and water consumption. Measures should only be implemented if they have been assessed and found to be both economically and ecologically beneficial. The assessment of a measure must document the reasons why measures were abandoned which would lead to reduced energy and water consumption rates (e.g. when the costs for implementing a measure are disproportionate to the savings in water and energy). Success must still be monitored as part of implementing the measure. After the measure has been implemented, actual energy and water consumption must then be compared with the consumption rates forecast.

Initiating measures when neither a measuring/metering concept nor recording are available

If no measuring/metering concept is available for existing buildings or if the concept available and its technical implementation are not up to date, such shortcomings must be eliminated. Detailed information regarding the preparation of measuring/metering concepts can be found in the sample in the Energy Target Specifications (Annex B7).

Energy and water consumption management supports cost controlling. As part of cost controlling, the costs in conjunction with the management of the building are planned, recorded and analysed. The potential for costs savings is also examined. The potential to save costs in conjunction with the management of energy and water consumption is also part of cost controlling. The viewpoint, however, is different because the management of energy and water consumption focuses exclusively on making use of physical potential for savings but ignores tariff optimisation. However, this potential for savings cannot always be achieved with economic measures. The "management of energy and water consumption" criterion (BNB_BB 5.3.2) hence permits the rejection of measures to reduce energy and water consumption, if justified. One possible reason for this is the lacking economic efficiency of a measure.

The operator is responsible for the root-cause analysis, the energy and water consumption examination and the measures programmes.

3.2.3.2 Energy consumption

Actual (measured) heat and electric energy consumption (BNB_BB 1.2.1) is an important indicator both for the real use of resources and environmental pollution, i.e. ecological quality, as well as for the operation costs and hence the economic quality of a building. Identifying and assessing energy consumption in the use phase provides important information regarding the energy-related quality of a building and its management processes. The energy quality of a building impacts both the identification and development of a building's value and is hence another economic quality that affects the stability of a building's value.

Energy consumption is recorded and analysed in analogy to the provisions for issuing energy consumption certificates according to the EnEV 2009. Wherever possible, information from the energy consumption certificate can be used. The focus is on the building's real (measured) heating and electric energy consumption. In the case of office buildings, this includes consumption for heating, central hot water, cooling, ventilation and fitted lighting, including ancillary energy. The energy consumption measured is adjusted to standard boundary conditions and referred to a suitable variable. It can then be assessed by comparing it with benchmarks for heating and electric energy consumption. If no consumption orientated energy certificate is available for the building, consumption rates must be identified and compiled according to the rules for consumption-orientated energy certificates in line with the EnEV 2009.

The assessment must be made on the basis of the parameters shown or calculated in the energy consumption certificate for heating and electric energy consumption (final energy). If and to what extent reference values have been exceeded or not reached has to be examined. In the event that the parameters shown or calculated in the energy certificate contain special loads, the parameters must be adjusted accordingly. Special loads include computer centres, commercial kitchens, canteens (not tea kitchens) and other forms of use where energy consumption differs significantly from office use. The reference values can be determined on the basis of the reference values in the "Bulletin – rules for energy consumption parameters and comparative values in non-residential buildings" (30 July 09) from the Federal Building Ministry (see Table C1) which are referred to in the EnEV 2009. The comparative values are statistical values and are hence average values that do not reflect specific building parameters.

Use	Comparative values in [kWh/(m²NGF a)]	
	Heating/ hot water	Electricity
Office building, heated only	105	35
Office building, heated and ventilated	110	85
Office building with full air-conditioning, conditioning independent of outdoor temperatures	135	105

Table C1: Comparative values according to the "Bulletin – rules for energy consumption parameters and comparative values in non-residential buildings" from the BMVBS dated 30 July 2009

The operator is required to document in a report the recorded and adjusted actual energy consumption which forms the basis for an assessment. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

3.2.3.3. Drinking water consumption

Although per-capita water consumption in Germany is relatively low on an international scale and even though there is generally no shortage of water in Germany, minimising water consumption is still a management goal, for instance, for cost reasons and in conjunction with the energy consumption and environmental pollution that result from water treatment and supply.

Actual consumption of resources and the resultant environmental pollution are always the result of actual consumption. It is hence necessary to identify actual drinking water consumption (BNB_BB 1.2.3), to adjust it with a view to special loads, if any, and to arrive at conclusive consumption parameters. By comparing values for similar types of buildings and using best values achieved through the management of exemplary, comparable buildings (best practice), weak points can be identified in installation systems and in building operations, or user behaviour can be identified that deviates from the assumed behaviour. Mean water consumption must be determined based on the rule shown below. Annual building consumption for the past three years must be identified on the basis of consumption bills from the water company or meter readings. If no data is available for precisely one year, but for 50 or 54 weeks, for instance, this data must be extrapolated or interpolated to 365 days. The consumption parts of special loads, if any, must be deducted (adjustment) for the assessment of annual consumption rates.

The following special loads must be deducted:

- Watering of outdoor facilities
- Types of use where water consumption differs considerably from office use, such as kitchens/canteens (not tea kitchens), building supervisor apartments, gyms, etc.

Mean annual consumption (arithmetical mean) is derived from the adjusted annual consumption rates for the past three years. The water consumption parameter is calculated on the basis of the usable floor area of offices (total floor area with use according to DIN 277-2:2005-02, Table 1, No. 2). In order to calculate an annual consumption parameter, mean annual consumption must be referred to the usable floor area of offices. It is not possible to include the space share of special loads, if any. Water consumption can also be referred to the number of users (normally staff) and compared to benchmarks on this basis.

The operator is required to document in a report the recorded and adjusted actual water consumption which forms the basis for an assessment. Section 3.2.10 “Reporting obligations” contains information concerning the distribution and minimum contents of the report.

3.2.3.4 Greenhouse gas emissions due to heating and electric energy consumption

It is a central goal of the Federal Republic of Germany to persistently reduce energy consumption in existing buildings until they have almost reached a climate-neutral level. Climate-neutral means a very low level of energy consumption in buildings where the remaining energy demand is largely covered by renewable energy. That’s why actual greenhouse gas emissions (GHG-emissions, BNB_BB 1.1.1) caused during the use phase are of paramount importance. These emissions are largely the result of energy consumption and should be recorded and analysed in addition to energy consumption. The choice of fuel and energy supply systems has a more differentiated impact in the identification and assessment of greenhouse gas emissions (environmental impacts) than in a primary energy assessment (demand of resources).

Identification of greenhouse gas emissions

Actual greenhouse gas emissions can be used to assess the energy quality of a building, operation and user behaviour, as well as the energy supply concept and its quality. Greenhouse gas emissions are not normally directly measured. They must be derived from the energy consumption rates and using emission factors. Greenhouse gas emissions must be identified in two different ways:

- Greenhouse gas emissions based on adjusted energy consumption
- Greenhouse gas emissions based on non-adjusted energy consumption in the year under review

Both calculations are based on actual energy consumption rates for heating and electric energy (see section 3.2.3.2 "Energy consumption").

GHG-emissions emissions based on adjusted consumption

The aim of this calculation is to assess greenhouse gas emissions on the basis of comparable data. For this purpose, the energy consumption rates measured must be adjusted to reflect weather and location. This adjustment must be carried out using the method for energy consumption certificates contemplated in the EnEV 2009.

GHG-emissions based on non-adjusted consumption

This calculation of greenhouse gas emissions is to be carried out on the basis of the actual energy consumption rates measured without any adjustment. The purpose of this method is to record actual GHG-emissions in a report.

The emission factors to be used can be found in the current "Energy and CO_2 Report on Federal Properties" by the BBSR. The greenhouse gas emissions used in the report include the greenhouse gas emissions that are generated on site during energy conversion along with the necessary upstream process chain (extraction, transport, conversion). Greenhouse gas emissions are recorded and expressed in kg CO_2-equivalents. In addition to CO_2-emissions, other climate gas emissions are recorded, converted to CO_2-equivalents and included in the emission factor.

Energy sources	Total GHG-equivalent emissions (incl. upstream chain) in kg/MWh				
	1990	1995	2000	2005	2010
Thermal energy source					
Lignite briquette	408	408	408	408	408
Natural gas	254	254	254	254	254
District heating (Germany mix)	263	263	263	249	249
Liquefied gas	278	278	278	278	278
Heating oil	317	317	317	317	317
Wood chips	22	22	22	22	22
Wood pellets	29	29	29	29	29
Coke	405	405	405	405	405
Crude lignite	394	394	394	394	394
Hard coal	446	446	446	446	446
Mains gas	158	158	158	158	158
Electric energy					
Electric energy Electricity mix Germany	768	697	633	626	620
Electricity from solid biomass (CHP 50%)			24	24	24

Table C2: Emission factors for energy sources over time
Source: "Energy and CO_2 Report on Federal Properties 2012", BBSR 2012

If emission factors which cannot be found in the current report are needed to determine actual GHG-emissions, factors can be used that are available via the Federal Environment Agency's ProBas web portal (www.probas.umweltbundesamt.de). If the building is heated using district heating, the GHG-emission factors of the respective utility can be used. If the utility company is unable to supply greenhouse gas emission factors, the table above can be used instead. If power is supplied via a private electricity grid/property grid with its own share of supply (e.g. from a combined heat and power plant), the GHG-emission factors of the respective plant operator can be used. A private electricity grid/property grid is a system which is connected to the public grid but which is largely operated independent of the rest of the grid.

Since the procurement of green electricity does not automatically lead to the more widespread generation of renewable energy, the GHG-emission factor for the German electricity grid (electricity mix Germany) must be generally used. It is not generally possible to include so-called green rates/green electricity. If the awarding of contracts for the supply of green electricity ensures a lasting reduction in electricity from non-renewable energy sources and an increase in the number of plants producing electricity from renewable energy sources, the GHG-emission factor of the green electricity procured can be used in justified cases in order to calculate actual greenhouse gas emissions. This is considered to be the case when the "Procurement of Green Electricity – Tool for Pan-European Public Tendering" by the Federal Environment Agency has been applied.[2]

The GHG-emissions calculated must be compared to reference values. The reference values are calculated using the emission factors from the comparative values for the EnEV in the latest version of the "Regulatory Guidelines for Energy Consumption Rates and Comparative Values in Existing Non-residential Buildings" . The greenhouse gas emissions calculated correspond to the carbon footprint during the use phase as a result of heating and electric energy consumption and are hence part of the building's carbon footprint. If these emissions are to be published as the carbon footprint, they must be published together with details of system boundaries, information regarding the type and scope of adjustment and details explaining the reference parameters. Please refer to the latest carbon footprint standards.

The operator is required to document in a report the actual greenhouse gas emissions identified as a result of heating and electric energy consumption. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

The following details must be noted here:

GHG-emissions resulting from heating energy consumption
Buildings which use only one type of energy source to heat rooms and for hot water are assessed on the basis of the heating energy consumption shown in the energy consumption certificate or calculated according to the rules of the energy consumption certificate. Using the GHG-emission factor specified for the final energy source (see Table C2), the energy consumption rate is converted to the GHG rate as a result of heating energy consumption.

If more than one source of energy is used for heating energy, separate rates in kWh/(m² usable floor area x a) must first be calculated for each of the energy sources. These must be adjusted to reflect weather and location using the method used for the energy consumption certificate. The greenhouse gas rates of the respective energy source are calculated using the GHG-emission factors that correspond to the respective energy sources. These are added to form the GHG-rate that results from heating energy consumption.

GHG-emissions resulting from electric energy consumption
This is assessed on the basis of the electric energy consumption rate stated in the energy consumption certificate or calculated according to the rules of the energy consumption certificate. Taking the GHG-emission factor for the reference year for the electric energy electricity mix in Germany, the GHG-rate is formed as a result of electricity consumption.

Total GHG-rate
The rates for greenhouse gas emissions resulting from heating energy and electricity consumption are added together in order to obtain a rate for total greenhouse gas emissions in kg GHG/(m² usable floor area x a).

[2] http://www.umweltbundesamt.de/publikationen/beschaffung-von-oekostrom-arbeitshilfe-fuer-eine

Evaluation

The evaluation is performed only for the total GHG-rate which was calculated on the basis of weather-adjusted and location-adjusted energy consumption. The total GHG-rate must be evaluated on the basis of a scale. The comparative values must be identified using the comparative values of Regulatory Guidelines for Energy Consumption Rates and Comparative Values in Existing Non-residential Buildings (30 July 2009) of the Federal Building Ministry which refer to the EnEV 2009. An average energy mix of 50% natural gas and 50% extra light heating oil is taken to calculate the emission factor of heating energy supply. The greenhouse gas emission factor to be used for heating energy supply hence totals 286kg of CO_2-equivalents per MWh (refer to the criterion of BNB_BB 1.1.1). The greenhouse gas emission factor used for electric energy is that of Germany's electric energy electricity mix.

The target value is at least 30% lower than the comparative value, while the reference value adheres to the comparative value and the limit value is no more than 40% higher than the comparative value. If comparative values are exceeded or if other irregularities are found, a root-cause analysis is necessary (see section 3.2.3.1 "Management of energy and water consumption").

3.2.4 Building documentation throughout the life cycle

Building documentation throughout the life cycle (BNB_BB 5.3.7) is a basic requirement for sustainable management. During the use phase, this documentation helps to avoid any loss of information and serves as a basis for maintenance measures for the building and its technical equipment. Building documentation throughout the life cycle, as the starting point for planning future refurbishment and conversion measures, is also important for identifying value, for portfolio analyses, and for verifying maintenance and repair.

A vast range of data is recorded in building documentation. It describes, for instance, use qualities and documents technical features, planning characteristics, execution details, equipment, materials, operating costs and consumption rates. The quality of building documentation throughout the life cycle is largely measured by the scope and systematic recording of the relevant information.

The main elements of building documentation throughout the life cycle are as follows:

1. Construction documentation: Documentation of the building measures which resulted in the existing building
2. Documentation of the existing building from geometric inventory data and alphanumeric description data (condition actually built at the end of a building measure)
3. Primary verification: as original, permanently updated documentation of existing buildings
4. Collection of servicing, inspection and user manuals
5. Continuously updated documentation of building management from:
   - Documentation of energy and water consumption
   - Documentation of operating and repair costs
   - Documentation of existing supply and disposal contracts as well as servicing and maintenance agreements
   - Documentation of inspections, servicing and testing (inspection reports, inspection records, etc.)
6. Continuously updated building parts catalogue: Documentation of materials and ancillary materials installed

Building documentation throughout the life cycle is hence equal to a building passport or building file and forms the basis for a Building Information System (BIS)[3].

[3] See OBJEKTinfo research project (KIT/ÖÖW), 2011

The operator is responsible for building documentation throughout the life cycle. In order to ensure sustainable building management, the operator must maintain building documentation throughout the life cycle that meets with the requirements of at least items Nos. 1 to 5.

Up-to-date building documentation is vital for sustainable building management. The definition of responsibility for keeping primary verification ensures that building documentation is up to date. Furthermore, the definition of responsibilities ensures access to building documentation throughout the life cycle. Those involved in building management are ensured access to the building documentation data through copies of and excerpts (secondary verification) from the original building documentation throughout the life cycle (primary verification). Depending on the size of the building, this responsibility can be assigned to a single person or to an organisational unit.

The content, scope and responsibilities of Section H of the RBBau Guidelines and the Building-related guidelines for documentation of existing buildings (BRF GBestand)[4] must be observed for federal government buildings and structures. The latter guidelines have been partially laid down in greater detail and supplemented by more far-reaching documentation guidelines, such as the documentation guideline (DLR) of the BBR[5]. When it comes to the collection of servicing, inspection and user manuals and the continuously updated documentation of building management, Section K 15 of the RBBau Guidelines must be additionally observed.

3.2.5 Inspection, servicing and safety precaution

Inspection and servicing of building parts and technical equipment are part of maintaining the building (BNB_BB 5.3.4). Their purpose is to reduce the risk of failure and susceptibility to disruptions. The requirements for safety precaution are based on the obligation to secure sources of danger. This means that those who create or maintain a source of danger must ensure that third parties are protected against damage. Buildings must be secured as a possible source of danger and users and any third parties whatsoever must be protected against harm.

3.2.5.1 Inspection and servicing

Systematic inspection and servicing based on an inspection and servicing schedule that has been tailored to the building and its technical equipment reduces repair costs and protects against follow-up costs on a long-term basis. Many technical systems have (manufacturer-) recommended or statutory servicing intervals. Empirical values and manufacturer instructions can be used for building parts. According to DIN 31051, inspection means “all measures for determining and assessing the actual condition of the object being examined, including the determination of the cause of wear and tear and the identification of the necessary consequences for future use“ and servicing refers to “measures to delay the reduction of the existing wear reserve” which must be distinguished from repair and improvement measures.

Thanks to early recognition of weak points, regular inspections can help to preserve value and prevent damage. Systematic servicing additionally reduces the work and costs involved in maintaining the building. This means that early replacement of used or defective components can improve value and reduce operating costs. Systematic inspection also reduces the duration and probability of failure and is hence an important precondition for operating safety and user satisfaction. In order to warrant safe operation of the building, requirements under public law regarding technical safety tests, visual inspections and function testing of safety systems and components also apply. With a view to climate protection, the requirements of the EnEV must be observed. According to this Ordinance, systems and technical equipment for heating, cooling and ventilation purposes must be maintained and air-conditioning/ventilation systems with a nominal power for cold demand of more than 12kW must undergo regular energy efficiency tests.

[4] See BFR GBestand (06/2012)

[5] See BBR (2008)

The basis for systematic inspection and servicing is a corresponding schedule that has been tailored to the building and its technical equipment which can be mapped in the inventory lists.

The inspection and servicing schedule must contain at least the following information for each system or component:

- Dedicated ID number (also on-site)
- Description
- Type of system or part
- Location
- Year built and designed service life
- Warranty dates
- Servicing and testing cycles
- Date of last service or test as well as dates or deadlines
- Safety and environmentally relevant requirements
- Technical specifications, including performance and supply range
- If applicable, length, width, diameter
- Servicing, inspection and user manuals
- Necessary servicing and inspection work according to manufacturer recommendations
- Necessary servicing and inspection work according to generally accepted rules of technology (e.g. hygiene inspection of ventilation systems, damage identification and removal of mould)
- Necessary servicing and inspection work according to public law regulations (e.g. energy inspection according to § 12 of the EnEV)
- Necessary safety tests as well as visual inspections and function testing (e.g. for technical fire protection)
- Information regarding the necessary qualifications or expertise of the companies/employees commissioned to perform the individual inspection and servicing work, e.g. for the hygiene inspection of ventilation systems
- Preparation of the necessary documentation of the results/performance of inspections, servicing and testing (inspection reports, inspection records, etc.)

Energy-related inspections must be carried out pursuant to § 12, "Energy-related inspections of air-conditioning systems", of the EnEV. Hygiene inspections must be carried out on ventilation systems pursuant to VDI 6022. If water damage occurs, or if humid spots are found or the user reports suspected mould in the form of a musty or mouldy odour or dark spots on walls, ceilings or furniture, the damage must be recorded as laid down in the Guideline for the prevention, examination, analysis and rehabilitation of mould growth inside buildings ("Mould Guide") from the Federal Environment Agency's Indoor Air Hygiene Commission [6].

In order to ensure sustainable building management, inventory lists must be kept during the use phase of all of the technical systems and components which must be inspected, serviced and/or tested according the manufacturer's recommendations or public-law requirements. It is possible to deviate from these recommendations and requirements in justified cases. The inventory lists must be kept and continuously updated. The operator is responsible for drawing up and updating the inventory lists. The operator receives the support of the building authority and the operational monitoring service within the scope of their tasks according to the RBBau Guidelines.

The operator must perform the energy inspections according to the details and requirements of DIN SPEC 15240. A host of documents, such as sample contracts, inventory lists or service catalogues, are available from the Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities. Using these documents ensures correct inspection and servicing. The operator is required to document inspection and servicing in a report. Section 3.2.10 "Reporting obligations" contains information concerning the distribution and minimum contents of the report.

[6] UBA (2002)

3.2.5.2 Safety precaution

Anyone who creates or maintains a source of danger must ensure that third parties are protected against damage. Buildings, as a possible source of danger, must be secured and users and any third parties must be protected against harm. This responsibility of the owner is referred to as safety precaution obligation (BNB_BB 5.3.4). The safety precaution obligation results from different requirements. Under public law, this obligation is rooted in the accident prevention regulations or the “Occupational health and safety rules of the occupational accident insurance fund” and in the building regulations of the federal states (refer, for instance, to § 16 of the Berlin Construction Rules (BauO Berlin)). This obligation, however, is also required under civil law. It was under civil law, in particular, that the safety precaution obligation was developed, primarily through court decisions, so that it is difficult for the party obligated to ensure safety precaution to identify the precise scope of this obligation. What is decisive is that this party is not obligated to protect against every source of danger. However, precautionary measures must be taken on all accounts in order to protect against recognisable hazards in the case of correct and even slightly incorrect use.

Under construction law, protection must be provided against hazards posed by buildings or structures. With a view to this, the “Guideline for monitoring the safety precaution of federal government buildings and structures” (RÜV – Richtlinien für die Überwachung der Verkehrssicherheit von baulichen Anlagen des Bundes) is applicable to federal government buildings. This guideline describes responsibilities for monitoring stability and safety precaution in terms of the safe preservation of buildings and structures and determines interaction between the building authority and the operator.

In addition to the provisions of the RÜV-guideline, other protection measures are often also needed in order to meet with the safety precaution obligation. The applicable rules of the occupational accident insurance fund must be mentioned here. If these rules are not observed, a violation of the safety precaution obligation can be assumed. Furthermore, other protection measures are usually required due to safety precaution obligations under civil law.

The measures listed below, for instance, may be required:

- Clearing access routes and paths of snow and ice
- Protecting paths and common areas against roof avalanches and falling icicles
- Lighting access routes and ensuring level floor surfaces
- Keeping access routes free of dangerous objects (nails, broken glass, etc.)
- Putting up signs to warn of possible dangers which cannot be ruled out in the building (e.g. ponds and other water areas, slippery surfaces on wet floors, etc.)
- Visual assessment of trees on the property to check stability, falling trees and broken branches, twice a year, leafed and leafless

Therefore, in addition to the safety precaution obligation measures required under public law (e.g. procedures according to RÜV), the entire hazard potential of the respective property must be recorded, analysed and assessed in the interest of sustainable building management. If measures are considered to be necessary, they must be implemented and responsibilities must be defined along with the type and scope of measures monitoring.

The safety precaution obligation regarding the hazards posed by the respective property (premises, including the main components and accessories) falls to the owner (who may also be the operator). He will be supported by the operator and the building authority as part of their tasks according to the RBBau Guidelines and by the authority using the building. In some cases, special rules have been made between the parties involved in building management for individual federal government buildings and structures. The authority using the building must inform of hazards recognised by it and is also responsible for all other safety precaution obligations. It is supported by the building authority as part of its tasks according to the RBBau Guidelines and by the operator in as far as protection measures are to be implemented using structural means.

The operator is required to document adherence to the safety precaution obligations in a report. Section 3.2.10 “Reporting obligations” contains information concerning the distribution and minimum contents of the report.

3.2.5.3 Building maintenance according to Section C of the RBBau Guidelines

As already explained in section 2 "Stakeholders during the use phase", the consumptive measures of building maintenance according to Section C of the RBBau Guidelines are maintenance measures. Small, non-essential structural modifications or extensions can be carried out (see Section C RBBau) as part of building maintenance. Within the meaning of this Guideline, these non-essential investment measures are considered to be equivalent to consumptive measures.

It is neither reasonable nor often possible in the case of consumptive measures to quantify sustainability aspects and determine an overall degree of fulfilment according to a BNB-module for the planning and construction phase (new construction or refurbishment). The requirements for the sustainable procurement of services are applicable here. The "Sustainability Compass" [7] by Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) is available as a useful tool here.

In the interest of sustainable building management, it must be ensured with a view to consumptive measures that the qualities found in existing buildings are maintained. Therefore, consumptive measures should in no way lower (deterioration ban), but instead should at best raise the qualities of existing buildings. In addition to the qualities found during an inspection, the qualities documented (see section 3.2.4 "Building documentation throughout the life cycle") should also provide the starting point for a sustainably consumptive measure. If the planning and construction phase of an existing building was already assessed using a BNB-module, extensive documented qualities will usually then be available. These qualities must be basically preserved.

First of all, the criteria of the BNB-module ("New Construction" or "Refurbishment") must be identified which can be influenced by the respective measure (influenced criteria). After this, the achieved qualities of the influenced criteria must be identified (existing qualities). The existing qualities can be found in the documentation of the BNB assessment of the planning and construction phase or in the building documentation throughout the life cycle. The qualities of the consumptive measure (planned qualities) must be defined on the basis of the existing qualities. The planned qualities must at least match the existing qualities.

When determining the planned qualities, the assessment standards of the influenced criteria of the BNB must be used as a basis for orientation. If these cannot be directly applied to the case in question, analogous application should be carried out. In the case of analogous application, the goals of the criterion must be identified and applied to the specific case.

Depending on the respective consumptive measure, one or more criteria may be influenced. Appendix C3 contains a useful tool: "The Criteria table for building maintenance measures". This tables makes it easier to identify influenced criteria and helps to secure quality. The existing qualities and quantities must be compared in the criteria table with the planned qualities and quantities. The table must be drawn up by the building authority and handed over to the authority and the operator for their approval. The criteria table is part of the building requirements record according to the RBBau Guidelines.

[7] See http://oeffentlichebeschaffung.kompass-nachhaltigkeit.de

3.2.6 Eco-friendly and health-safe cleaning

The purpose of cleaning a building (BNB_BB 5.3.5) is not only to take care of the building parts and inventory, but also to ensure the comfort and health of its users. The goals of cleaning a building include maintaining hygiene, maintaining visible surface qualities, maintaining functionalities and protecting against harmful influences. In order to avoid burdens on the environment and health, compatibility with the environment and health must be observed, especially during the production, use and disposal of the products used and when the corresponding technologies are used. Furthermore, it must be assessed whether cleaning meets with the selected and required service level.

In order to ensure eco-friendly and health-safe cleaning, the Federal Environment Agency has drawn up the guide „Leitfaden zur nachhaltigen öffentlichen Beschaffung von Reinigungsdienstleistungen und Reinigungsmitteln“ [8]. This guide must be applied to cleaning services in federal government buildings. The operator is responsible for ensuring eco-friendly and health-safe cleaning.

3.2.7 Technical operations management and qualification of technical staff

Technical operations management (BNB_BB 5.3.6) is part of technical building management.

As part of technical operations management, the following activities are performed with a view to the building and its systems:

- Operation
- Monitoring
- Troubleshooting
- Optimisation
- Maintenance
- Repair

These activities are primarily geared towards maintaining building operations and correct use. Efficient building management depends heavily on the skills of the staff employed here. When it comes to large office and administration buildings or special properties, extensive and complex technical systems and equipment are in place which not only have to be correctly set at the time of commissioning, but which must also be permanently monitored, correctly operated and, when necessary, adjusted. Depending on the type of system and technical equipment, this calls for special skills and the staff working here must be sufficiently trained and educated.

Operating staff include staff who are familiar with technical operations management. This staff includes individuals who operate and monitor technical systems and are responsible for safety/security equipment. Operating staff can be either permanently posted on site for the most part or can permanently monitor the building services systems per remote control. The greater the complexity and the bigger the building, the more qualified staff should be. That’s why in addition to qualifications, further training of operating staff is so important.

Generally speaking, it is irrelevant from the perspective of sustainable management whether operations management tasks are performed by internal staff (staff employed by the operator, the building authority or the authority using the building) or by external staff (e.g. firms specialising in building management). In both cases, it must be ensured that operating staff are sufficiently qualified. This can be seen to be the case if the operating staff employed are skilled personnel who have been sufficiently trained for the tasks to be performed. Furthermore, operating staff should attend regular training in the respective tasks in which the focus is preferably on one of the following topics: sustainability, energy management, energy savings or optimising operations.

[8] UBA (2012): “Guideline for sustainable public procurement of cleaning services and cleaning agents”

In both cases, the aim is to achieve equally high performance for technical operations management. When commissioning a specialist firm with a service level agreement, for instance, the response time, scope, reporting and troubleshooting speed must be guaranteed to such an extent that response times to malfunctions are short and high system availability is guaranteed. If technical operations management is carried out by internal operating staff, this must also be guaranteed with the same level of quality. The operator must draw up a structural and functional organisation for troubleshooting. The aim here must also be short response times to malfunctions and high system availability.

3.2.8 Building users – information, motivation and satisfaction

User behaviour influences resource consumption, effects on the environment, operating and repair costs as well the quality of use. The potential to cut costs can only be exploited if the building and its systems are also used in a suitable manner. Behaviour-related measures at the workplace alone can lead to significant energy savings or losses compared to the planned and target figures. Incorrect use of components and technical systems can reduce service life. For this reason, comprehensive information and motivation of users (employees working in the building) are needed as part of sustainable building management.

Furthermore, user satisfaction can be regarded as an indicator for the building quality actually achieved. With this in mind, information regarding potential for optimisation and weak points must be collected. The primary goal is to achieve a high degree of user satisfaction with workplace and building conditions. Conditions that help to create user satisfaction promote creativity and productivity among employees. Regular user satisfaction analyses provide an insight into the potential for optimisation. Users know the property from everyday situations and can provide valuable information. The possibility to express opinions contributes towards user participation. For this reason, information from users concerning the potential for optimisation and weak points must be collected and analysed (communication management).

3.2.8.1 Influencing user behaviour

When it comes to sustainable operation of a building, both users and operators can bear equal responsibility. Through co-operation and mutual exchange, both stakeholder groups can warrant the sub-goals of saving and protecting resources, minimising operation costs and maintaining health, comfort and safety. In addition to qualified operating staff, this also calls for the provision of information and adequate passing on of knowledge to users who do not normally have detailed expertise (BNB_BB 5.3.8). It is vital here that information be prepared specifically for the respective target groups and attractively designed and that users be informed of their responsibility and options to act in their own areas of work. Measures to create awareness among users and suitable recommendations for action can directly promote sustainable behaviour at the workplace.

The means to be used here include:

- Information for users concerning current consumption rates
- Motivation of users through suitable incentive schemes
- Training offers for users
- Target agreements between the operator and users (e.g. for energy saving goals)
- A permanently updated user manual

The process of influencing users is made up of three phases: creating awareness, informing and motivating as well as monitoring success and reporting (see Fig. C2).

Phase 1: Creating awareness

Sufficient information regarding the situation, goals and measures forms the basis for motivating users. Transparency and knowledge create acceptance, awareness and the willingness to act in a sustainable manner.

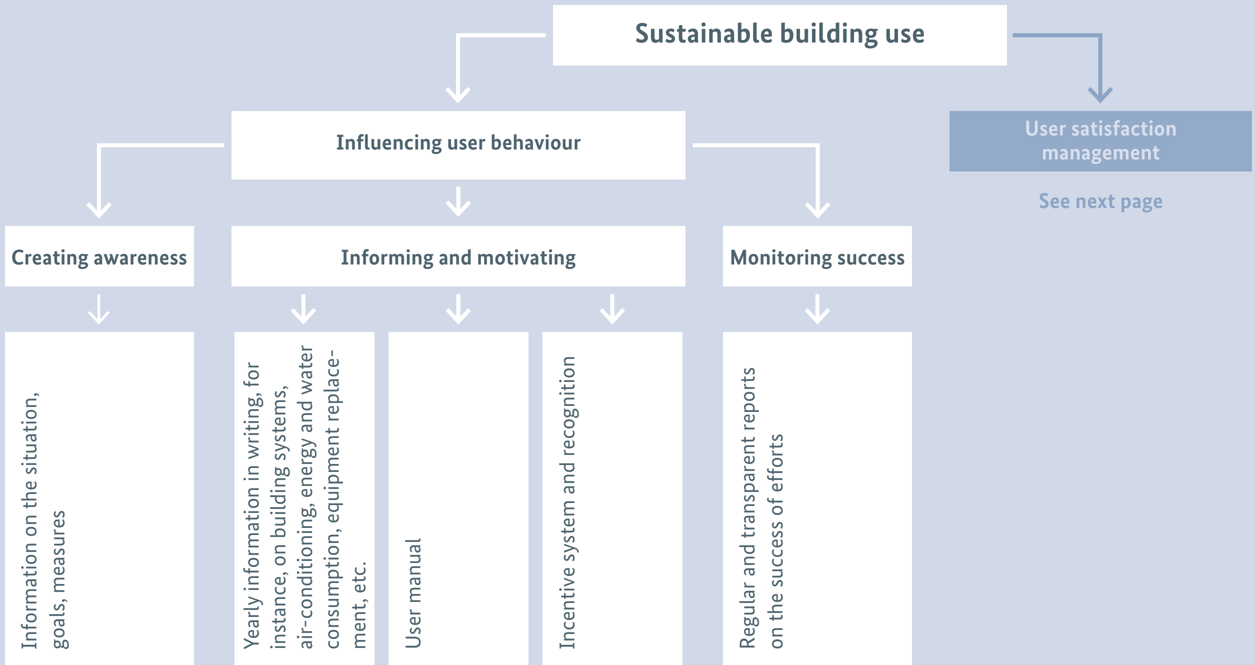

Fig. C2: Influencing user behaviour

Phase 2: Informing and motivating

The information and motivation process must be designed as a continuous exercise. In no way should it demand too much of the user. What's important here is to provide building users with recommendations for action that have been adapted to their respective possibilities for exerting influence and to motivate them to act. In order to ensure sustainable building management, the operator must provide users at least once a year with up-to-date, target-group specific information in writing (digital or analogue). This information contains at least details of the following areas:

- Operation of building services in the user's range of influence
- Healthy room climate
- Low energy and water consumption
- Avoidance, separation and disposal of waste
- Modification or revision of the building energy concept
- Modification or revision of user-relevant equipment
- Recommendations for actions related to the seasons (including suitable ventilation in summer or winter, etc.)
- Mapping of energy and water consumption rates over the past three years

Part of preparing target-group specific information must take place in a continuously updated user manual which contains as a minimum generally understandable explanations of the technical situations and the special features of individual parts and components. In order to ensure that the user manual receives the necessary attention, it should be attractively designed.

People can be motivated by offering incentives for individual behaviour. An incentive system must be developed that motivates users to address aspects of sustainability and encourages them to make personal efforts to contribute towards the sustainable management of buildings. Recognition is one vital element of a successful incentive system. This can be expressed through very different measures. Possibilities here include competitions (energy-saving and ideas competitions) with award ceremonies or a theme office party with suitable contributions and awards for committed users. Measures like these can have a decisive impact on joint motivation and this can boost the quality of sustainable operation of the building.

Phase 3: Monitoring success and reporting

Other essential components of the information and motivation process are monitoring success and reporting which should be both regular and transparent for users so that they can be informed of the success of their efforts in due time.

Participants in the information and motivation process

The operator is responsible for the process of informing and motivating users. He must take the necessary measures in order to prepare the information for the specific target groups and to explain about responsibilities and options to act in the respective work area. The authority using the building must support the operator here. This is particularly true with regard to motivation. The authority using the building should also propose to the operator an incentive system, including recognition, that can motivate users to address topics of sustainability. The operator is responsible for monitoring success and reporting.

3.2.8.2 User satisfaction management and user satisfaction

User satisfaction is not only decisive for the acceptance of the building, it also serves as an indicator for the quality actually achieved with the building and its management processes. A high level of user satisfaction has a positive impact on productivity among employees and is an important part of a sustainably managed building.

In order to boost user satisfaction and improve the quality of a building and its management processes, user satisfaction management (BN_BB 5.3.1) must be set up. User satisfaction management is made up of two elements:

- Recording information (user satisfaction analysis and communication management)
- Measures programme

The “Recording information” element can be used to identify the strengths and weaknesses of a building. The operator is required to document the results of user satisfaction management in a report. Section 3.2.10 “Reporting obligations” contains information concerning the distribution and minimum contents of the report.

The operator is responsible for both recording information and for the measures programmes. The authority using the building must support the operator when user satisfaction analyses are being carried out and when suitable structures are being set up for communication management. As part of its tasks according to the RBBau Guidelines, the building authority helps the operator to set up the measures programme and during the evaluation, planning, implementation and monitoring of the success of measures.

Information can be recorded either through a user satisfaction analysis or communication management.

User satisfaction analysis

The user satisfaction analysis is the component of recording information in which the operator actively approaches users (proactive component). The user satisfaction analysis indicates the extent to which conditions at the immediate workplace or in the building as a whole meet the requirements and ideas of the individual users. Regular user surveys are an important quality feature of good management.

The quality of the user satisfaction analysis is determined by the following aspects:

- Scope of user satisfaction analyses (qualitative)
- Frequency of user surveys (quantitative)
- Handling of results (qualitative)

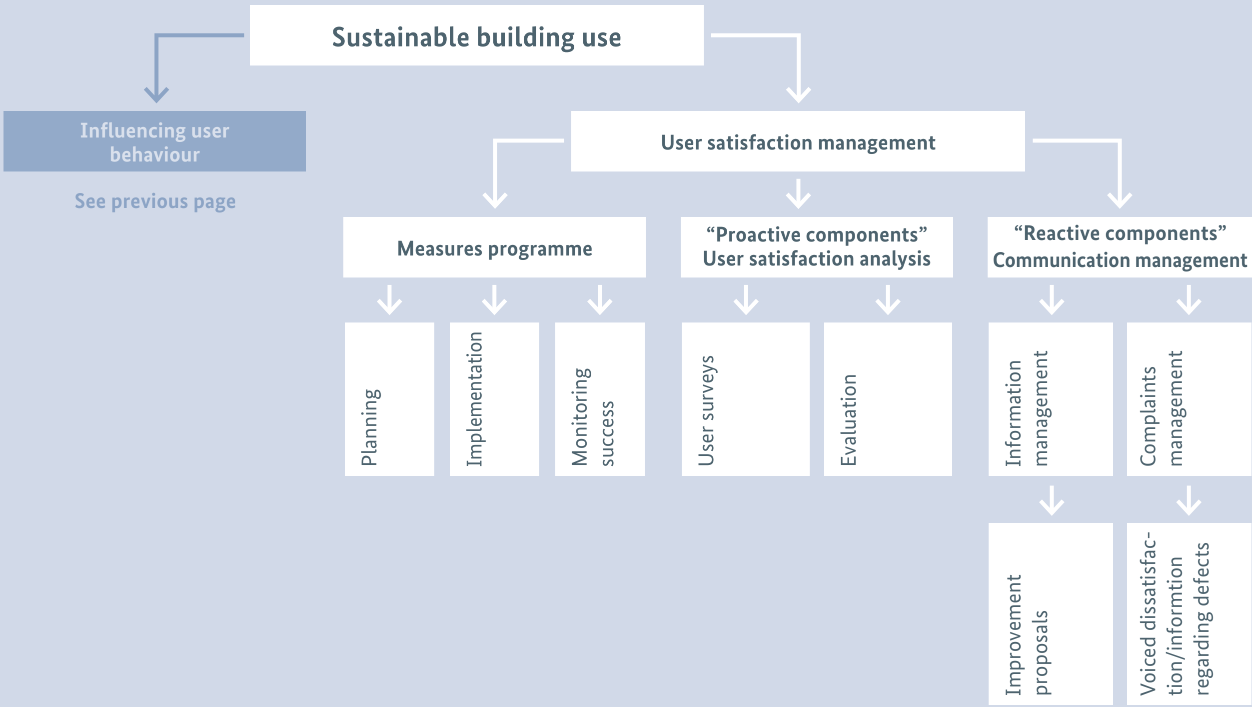

Fig. C3: User satisfaction management

The user satisfaction analysis must be conducted in a standardised form. The "Tool for user surveys on comfort at the workplace (INKA)" is available for this purpose. This tool comprises standardised questionnaires and supplementary documents that are available via the information portal: www.nachhaltigesbauen.de. The questionnaires cover individual user satisfaction with air room quality, acoustic, visual and thermal comfort, as well as the type and scope of options for the individual design of conditions at the workplace. User satisfaction with the building and surrounding areas is additionally included in the survey.

The user satisfaction analysis must be conducted at regular intervals of no more than four years and two separate surveys must be carried out in summer and winter in order to record seasonal differences. There are two different versions of the INKA questionnaire (the long and short version). The long version of the questionnaire (total index) must be generally used for first-time surveys or following extensive organisational or structural changes. Any approach that deviates from this must be explained.

Based on the results of the user surveys, building quality can be evaluated with a view to the social sustainability dimension and the potential for improvement can be drawn up. One result of the user satisfaction analysis is the user satisfaction index which can be used as a scale for presenting actual user satisfaction (BNB_BB 3.1.9). The result of the identification of actual user satisfaction is important as an absolute value, especially when surveys are repeated regularly. This allows the development of user satisfaction to be recorded and the effects of measures can be identified and documented in order to monitor success. It is also possible to conduct comparisons with the user satisfaction index of similar buildings with similar use.

Communication management

Communication management refers to the systematic recording and processing of information (e.g. improvement proposals) and notification of dissatisfaction (e.g. complaints or information regarding defects) which were initiated by the user. The operator acts in response to such information and notifications. Communication management is the reactive component of recording information. It is used to record defects and complaints as well as improvement proposals. The implementation of communication management is a basic requirement for sustainable building management. Communication management must ensure that:

- Easy-to-reach contacts are available to motivate users to make contact
- The information brought forward is systematically accepted and documented, and is treated as confidential
- The information accepted is promptly processed and the sender receives feedback regarding his information
- The information received is analysed, for instance, with a view to the number of complaints, the extent to which the information creates a representative picture of user opinion, frequency of similar cases, etc.

Measures programme

In addition to recording information, user satisfaction management has a second element: the measures programme. This is where the findings of the information recorded are gathered which aim to optimise building and operating quality, to eliminate weak points found or to boost user satisfaction. In addition to planning, the measures programme must also include the implementation of the measures and monitoring success (e.g. through follow-up surveys). In justified cases, individual measures do not have to be implemented. It must be explained, for instance, why the measure violates the principles of economic efficiency and good housekeeping, why the measure is not necessary and why it cannot be implemented.

3.2.9 Actual air climate quality

The goal of actual air climate quality is to maintain and promote the health of room users. A good air climate is also an important precondition for user satisfaction and performance. Actual air climate quality is part of the socio-cultural and functional quality of a building.

The main quality parameters for a good room climate, which are strongly influenced by the type of use and building operation, are as follows:

- Thermal and hygienic room conditions (temperature, absences of drafts, air humidity)
- Odour quality of room air (room air quality)
- Absence or sufficient removal of harmful substances from room air

Other criteria for a good room climate are good room acoustics, a sufficiently low sound pressure level, sufficient daylight in the room as well as glare-free, adequate lighting for workplaces. These criteria, however, are largely a function of the building structure. They are already defined in the building design, however, at the latest when the building is erected, and are essential for assessing the sustainability of new buildings. These parameters can be influenced to little or no extent during building operations, so that they are of no use as quality characteristics of sustainability-orientated building use and are not included at this point in the evaluation.

The room climate quality parameters above can be directly influenced by building operations and building use through the following aspects:

- Operation of heating and air-conditioning systems with a focus on achieving optimum thermal comfort, however, at least within the scope of the agreed limits
- Operation of air handling systems with external air flow rates orientated towards good indoor air quality
- Regular servicing of all technical building systems, including control systems, if necessary, prompt adjustment also to changes in room occupation or room use

- Regular, high-quality servicing, repair and checking of air handling systems with a special emphasis on hygiene
- Prompt removal of microbial infestation (mould), including the defects causing infestation, e.g. in the building structure
- Hygiene-orientated cleaning, especially with a view to the cleaning agents used
- Low-emission room fixtures and use (furniture, selection and arrangement of laser printers)

The decisive processes for a good room climate are considered in the profile of the criterion: BNB_BB 5.3.4 "Inspection, servicing and safety precaution" which focuses on process quality. The success of these processes is documented on the basis of the quality level of the following criteria profile actually achieved: "Actual thermal comfort in winter" (BNB_BB 3.1.1) "Actual thermal comfort in summer " (BNB_BB 3.1.2) and "Actual indoor air quality" (BNB_BB 3.1.3).

A very limited number of measured variables is sufficient for a comprehensive evaluation of thermal comfort. Depending on the heating and ventilation concept selected, it is often sufficient to record the room temperature. At best, measured values will be recorded anyway by the central building control systems or as part of energy monitoring (BNB_BB 1.2.1) so that reliable evaluation of thermal comfort is often easily possible. If the situation, for instance, the occurrence of drafts, calls for additional measurements, these can be carried out with reasonable effort.

A comprehensive evaluation of indoor air quality is much more complicated because a vast number of substances can be verified in the room air depending on the sources of substances inside and outside the building. As part of assessing sustainability, indoor air quality is evaluated on the basis of concentrations of selected substances.

The substances or substance groups to be measured have been selected so that:

- They have a good correlation with the odour quality of the indoor air ("indicator effect")
- They typically reflect pollution in offices with modern equipment, although it is also assumed that the building structure only releases substances into the room air which do not rule out the use of the building material or building structure
- They can be compared with the criterion for new office buildings (BNB_BN 3.1.3 "Indoor air quality")
- The measuring equipment is suitable for the purpose

With a view to this, the following substances/substance groups were selected for measuring:

- Carbon dioxide content of room air as an indicator for odours caused by human activities or the outside-air change per user
- Volatile Organic Compounds (VOCs) and formaldehyde as indicators for levels of odorous and/or health-relevant substances released by the building structure and fittings
- Radon, particulate matter and fibres to rule out any special danger to user health

Microbial examination of room air is not foreseen as part of criterion 3.1.3. It is assumed that the buildings meet the requirements described in the criteria for new buildings so that grave structural defects that promote mould are unlikely. If these defects do in fact occur, they must be identified and eliminated as part of the required inspection and servicing (BNB_BB 5.3.4 "Inspection, servicing and safety precaution") . Furthermore, targeted microbial testing with a high-quality process must be carried out as required (e.g. hygiene inspection of the air handling system).

3.2.10 Reporting obligations

As part of sustainable building management, the operator must make cost and consumption data from ongoing management processes available on a regular basis. This data is then available as comparative values for management processes for the operator's own property and for other properties, and serves as a basis for designing future construction projects. For this purpose, the energy and water consumption data as well as the operating and repair costs must be sent at least once a year to a central data recording unit. During the use phase of federal government buildings, the provisions of Section K6 of the RBBau Guidelines must be observed in this context. Sample 3 must be used for reporting annual consumption rates and operating costs according to the RBBau Guidelines.

3.2.10.1 Operator's sustainability report

There are many people involved in the use and operation of a building. To ensure sustainable building management, the various participants must contribute to the necessary extent. The transparency of management processes and actual building quality are hence also an indication of sustainable building management. For this purpose, the main services and results of building management must be communicated in a sustainability report to the participants of building management. This report should also sufficiently honour the efforts of all participants in the field of sustainable building management. The sustainability report should be drawn up by the operator and handed over in digital and analogue form to the authority using the building, the building realization level and the operational monitoring service. During preparation of the report, the operator receives the support of the building authority and the operational monitoring service within the scope of their tasks according to the RBBau Guidelines.

The sustainability report must be drawn up each year and must be distributed by the fourth quarter of each year at the latest. The report essentially contains a review of the past budget year. In some areas, it presents an outlook for the coming budget year. The report must be drawn up on the basis of the checklist in Annex C4. A sample to be filled in is available from the information portal: www.nachhaltigesbauen.de.

3.2.10.2 Reporting in preparation of a BNB assessment

If an assessment is foreseen with the "Use and Operation" BNB-module, the "Operator's sustainability report" must be additionally sent in digital form to the Conformity Testing Office and the Office for Sustainable Building at the BBSR. Proof of compliance with the reporting obligation according to Section K 6 of the RBBau Guidelines is a basic precondition for the performance of a conformity test and hence a condition for recognition of the assessment with the "Use and Operation" BNB-module.

4. Consideration of sustainability criteria during the use phase

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The criteria of sustainable use were explained in the previous section. Tools are now available so that these criteria can be considered in use and management processes. These include, for instance:

- Databases and electronic data processing applications (DP tools)
- The "Use and Operation" module of the Assessment System for Sustainable Building for federal government buildings (BNB)
- The Information Portal Sustainable Building
- The "Tool for user surveys on comfort at the workplace (INKA)"
- The "Sustainability Compass" from Deutsche Gesellschaft für internationale Zusammenarbeit [9]

4.1 Databases and DP tools

The comparative values needed for cost controlling and energy management are available from building databases. The databases of numerous private suppliers can be used for this purpose. Generally speaking, operators should build up their own databases on the basis of past consumption and cost data. This is particularly important for operators of extensive building stocks.

When it comes to planning and managing public sector buildings, the "Planning and cost-data module of the federal states and federal government" tool (PLAKODA – Planungs- und Kostendatenmodule der Länder und des Bundes) has become established. This tool was developed and is updated by Staatliche Vermögens- und Hochbauverwaltung Baden-Württemberg (VBV). Based on a comparison of properties, the PLAKODA modules provide comparative values for operation costs and energy consumption. In order to ensure that the PLAKODA modules have a sufficient and up-to-date data basis, actual costs and consumption rates must be reported regularly. With a view to the management of federal government buildings, the provisions of Section K 6 of the RBBau Guidelines must be observed in this context. In order to ensure that PLAKODA can provide the required values for sustainable planning and management, compliance with the reporting obligations pursuant to Section K 6 of the RBBau Guidelines creates an important basis for sustainable building operations.

Systematic and standardised recording and analysis of costs and consumption rates are important preconditions for setting up a database and for reporting. The DP tools of numerous private suppliers can be used for this purpose. The "Energy and media information system of the federal government and federal states" (EMIS), which is being developed further via the EMIS working group, was drawn up for the recording and analysis of cost and consumption data of public sector buildings. The operator and the operational monitoring service must use this tool or an DP tool with similar functionalities in conjunction with the management of federal government buildings.

4.2 Sustainability assessments in the use phase

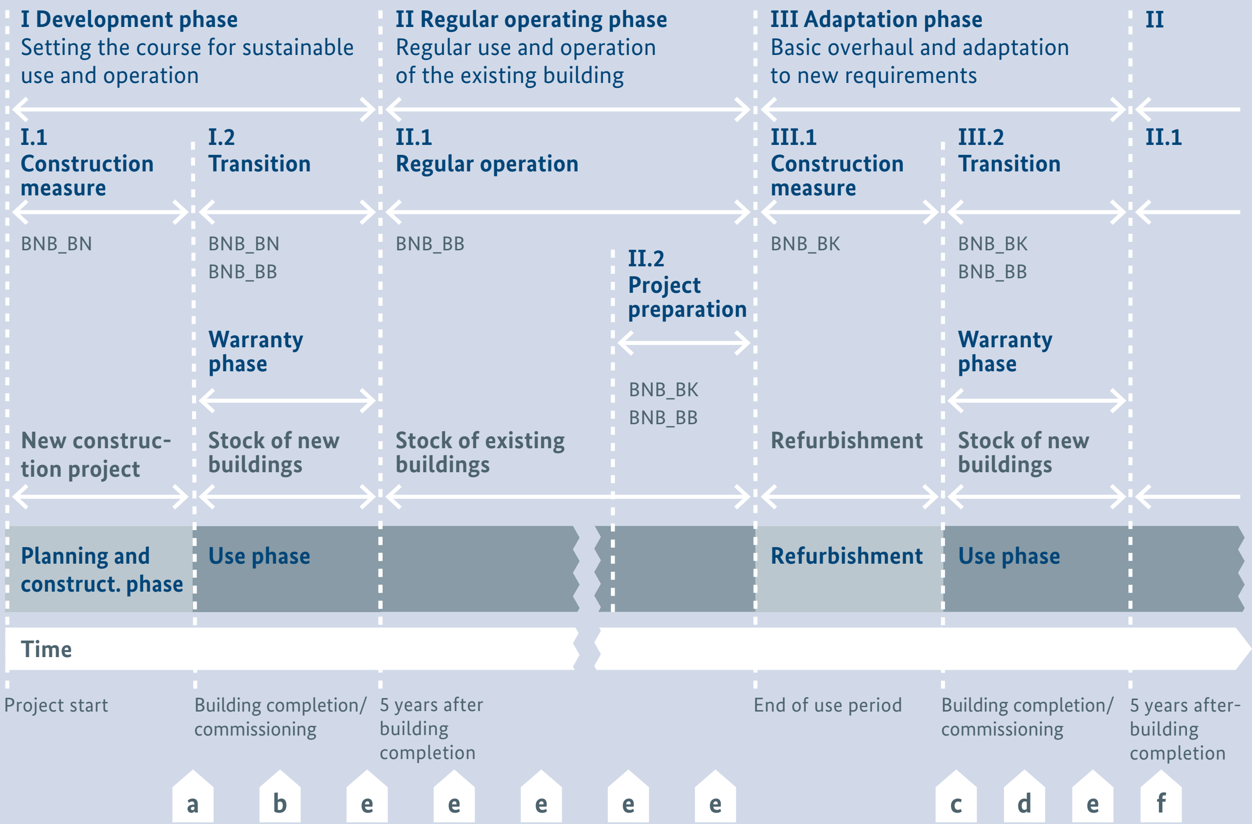
As already explained in the preface, a sustainability assessment can be carried out several times during the life cycle of a building. The BNB has a modular structure for this purpose.

As shown in the following Fig. C4, the following three application cases take place during the use phase:

- I.2/III.2: New building stock with assessment times b and d (see section 4.4)
- II.1: Regular operation with assessment times e and f (see section 4.3)
- II.2: Project preparation with assessment time e (see section 4.5)

The "Use and Operation" BNB-module is the central assessment module of the use phase and is hence applied in all three phases. However, in cases I.2/III.2 and II.2, it is used as a supplementary module in conjunction with the "New Construction" and "Refurbishment" modules.

[9] See http://oeffentlichebeschaffung.kompass-nachhaltigkeit.de



Possible assessment times:
a Assessment of new construction project
b Classification of new building stock as new construction (special solution for the transition phase)
c Assessment of refurbishment
b Classification of new building stock as refurbishment (special solution for the transition phase)
e Assessment of the “Use and Operation” module (examples)
f Special case of building diagnosis not linked to a measure (example)

Fig. C4: Assessment times in the use phase

4.3 Assessment of existing buildings with the “Use and Operation” BNB-module

4.3.1 System rules and methodology

The application of Parts A and B of this Guideline and the related “New Construction” BNB-module ensured that the principles, protective goods and targets of sustainable building were implemented in the planning and construction phase. The building quality achieved forms the basis for sustainable use and operation of the building. It is now therefore the task of all users and operators to guarantee and continuously improve during the use phase the quality of the building that was achieved in planning and execution.

This does not apply any less to existing buildings which were not yet planned and built according to the principles, protective goods and targets of sustainable building. With a view to these buildings too, it is the responsibility of all users and operators to achieve a sustainable use phase in as far as possible.

The “Use and Operation” BNB-module was developed for this specific purpose. The module is used to implement and quantify the general requirements for sustainable building, use and operation described in Parts A and C. With the assessment of individual aspects which are orientated towards the protective targets of sustainable building, use and management processes can be assessed in their totality and compared with a view to sustainability quality.

The “Use and Operation” BNB-module also honours outstanding operator achievements. Using a uniform assessment approach combined with both transparent and objectively understandable system rules, it creates the required

"USE AND OPERATION" BNB-MODULE					
	Sustainability criteria	Target value Score Maximum	Importance factor	Weighting Total rating	Target value
REAL QUALITIES (CRITERIA GROUP 1)				0.000 %	1400
	EFFECTS ON THE GLOBAL AND LOCAL ENVIRONMENT				
BB	1.1.1 Greenhouse Gas Emissions due to Heating and Electric Energy Consumption	100	2	0.000 %	200
	RESOURCE CONSUMPTION				
BB	1.2.1 Heating and Energy Consumption	100	2	0.000 %	200
BB	1.2.3 Drinking Water Consumption	100	2	0.000 %	200
	HEALTH, COMFORT AND USER SATISFACTION				
BB	3.1.1 Actual Thermal Comfort in Winter	100	2	0.000 %	200
BB	3.1.2 Actual Thermal Comfort in Summer	100	2	0.000 %	200
BB	3.1.3 Actual Indoor Air Quality	100	2	0.000 %	200
BB	3.1.9 Actual User Satisfaction	100	2	0.000 %	200
PROCESS QUALITY OF USE AND OPERATION (CRITERIA GROUP 2)				100.0%	1900
BB	5.3.1 User Satisfaction Management	100	3	15.789%	300
BB	5.3.2 Management of Energy and Water Consumption	100	3	15.789%	300
BB	5.3.3 Operation Costs Controlling	100	3	15.789%	300
BB	5.3.4 Inspection, Servicing and Safety Precaution	100	2	10.526%	200
BB	5.3.5 Eco-Friendly and Health-Safe Cleaning	100	2	10.526%	200
BB	5.3.6 Technical Operations Management and Qualification of Technical Staff	100	2	10.526%	200
BB	5.3.7 Building Documentation throughout the Life Cycle	100	2	10.526%	200
BB	5.3.8 Informing and Motivating Users	100	2	10.526%	200

Table C3: Sustainability criteria of the BNB-module "Use and Operation"

transparency for the achievements of all those involved in the use and operation of the building. The "Use and Operation" BNB-module is used to assess use and management processes along with additionally selected actual property quality (real qualities). For this reason, the module is made up of two criteria groups: "real qualities" and "process quality of use and operation".

What's important about the "Use and Operation" BNB-module is that it takes a comprehensive look at use and management processes. The quality of these processes is examined with a view to aspects of equal treatment while at the same time taking ecological, economic, socio-cultural and technical aspects into account. The main criteria groups of the "New Construction" and "Refurbishment" BNB-modules, i.e. "ecological quality", "economic quality", socio-cultural and functional quality" as well as "technical quality", are partially reflected in the "real qualities" criteria group examined. The result of the process qualities of use and operation are expressed in the selected actual building qualities examined there. These are, however, strongly influenced by the given building quality.

The aim of the "Use and Operation" BNB-module is to fully assess and compare the quality of use and management processes with a view to sustainability. Since these processes are always also an expression of the response to building qualities, the building qualities must also be generally known. Information regarding real qualities (criteria group 1) must be included in the assessment of the sustainability of use and operation. However, the assessment is primarily carried out on the basis of the criteria of process qualities (criteria group 2) because these can be influenced by users and operators mainly during the use phase.

The result of the assessment is the total degree of fulfilment which reflects the ratio between the score actually reached and the maximum score possible. The "real qualities" criteria group has no share in the total degree of fulfilment, however, it is shown in the assessment and serves as information and is therefore a basic requirement for testing the conformity of the assessment. This criteria group does, however, also result in additional requirements (see Table C4) which must be generally adhered to in order to be able to reach a certain quality level. The following quality levels can be reached depending on the degree of fulfilment:

Q3	80% or more total degree of fulfilment	Outstanding use and operation
Q2	65 % or more total degree of fulfilment	Very good use and operation
Q1	50 % or more total degree of fulfilment	Minimum level for sustainable building management

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The quality levels of use and operation listed here are deliberately different from the certificate levels of the "New Construction" or "Refurbishment" BNB-modules (gold, silver or bronze) because this is not a comparable assessment. The focus during the use phase is primarily on use and operation processes whereas in the planning phase, it is largely the building qualities that are assessed. This distinct difference is expressed through another type of quality level.

The assessment using the module is carried out in retrospect so that the use and management processes of the past three years are assessed. The building forms the physical system boundary because it lies directly within the operator's range of influence. The assessment is then checked by a third party with a view to conformity with the assessment rules (conformity test). The purpose of this check is quality assurance and the check is carried out by a Conformity Testing Office appointed by the BMUB.

Additional requirements for achieving any quality level

- The "real qualities" criteria group was assessed.
- A degree of fulfilment of 10% or more was reached in each criterion.

Specific additional requirements for achieving quality level Q3:

- **Before the assessment period commenced, goals were defined according to section 4.3.4.2 as part of a target agreement (target agreement table).**
- **Degree of fulfilment of all criteria ≥ degree of fulfilment according to the target agreement table (see section 4.3.4.2)**

BNB_BB 3.1.1	Actual Thermal Comfort in Winter	Degree of fulfilment ≥ 70 %
BNB_BB 3.1.2	Actual Thermal Comfort in Summer	Degree of fulfilment ≥ 70 %
BNB_BB 3.1.3	Actual Indoor Air Quality	Degree of fulfilment ≥ 70 %
BNB_BB 3.1.9	Actual User Satisfaction	Degree of fulfilment ≥ 70 %
BNB_BB 5.3.1	User Satisfaction Management	Degree of fulfilment ≥ 70 %
BNB_BB 5.3.2	Management of Energy and Water Consumption	Degree of fulfilment ≥ 70 %
BNB_BB 5.3.3	Operation Costs Controlling	Degree of fulfilment ≥ 80 %

Specific additional requirements for achieving quality level Q2:

BNB_BB 3.1.1	Actual Thermal Comfort in Winter	Degree of fulfilment ≥ 50 %
BNB_BB 3.1.2	Actual Thermal Comfort in Summer	Degree of fulfilment ≥ 50 %
BNB_BB 3.1.3	Actual Indoor Air Quality	Degree of fulfilment ≥ 50 %
BNB_BB 3.1.9	Actual User Satisfaction	Degree of fulfilment ≥ 50 %
BNB_BB 5.3.1	User Satisfaction Management	Degree of fulfilment ≥ 50 %
BNB_BB 5.3.2	Management of Energy and Water Consumption	Degree of fulfilment ≥ 50 %
BNB_BB 5.3.3	Operation Costs Controlling	Degree of fulfilment ≥ 50 %

Specific additional requirements for achieving quality level Q1:

BNB_BB 3.1.3	Actual Indoor Air Quality	Degree of fulfilment ≥ 50 %
BNB_BB 3.1.9	Actual User Satisfaction	Degree of fulfilment ≥ 50 %
BNB_BB 5.3.1	User Satisfaction Management	Degree of fulfilment ≥ 50 %

Table C4: Additional requirements for achieving certain quality levels

4.3.2 Assessment motives

There are various reasons to perform a sustainability assessment during the use phase using the "Use and Operation" BNB-module. The following motives can be generally distinguished due to their specific issues and decision situations:

Assessment motive 1	Continuous quality management to secure sustainable process and building qualities
Assessment motive 2	Identification of current building qualities in preparation of a building measure, if necessary, in conjunction with a building diagnosis
Assessment motive 3	Monitoring success after a new construction project or complete refurbishment
Assessment motive 4	First-time recording of an existing building, if necessary, in conjunction with a building measure or a comprehensive building diagnosis

An overall assessment of the use phase using the two criteria groups of the "Use and Operation" BNB-module is currently only possible for office and administration buildings. This takes place according to the rules of section 4.3.4 "Quality management to secure sustainable process and building qualities".

4.3.3 Overall assessment and partial assessment

A full assessment (overall assessment) of the use phase using the two criteria groups of the "Use and Operation" BNB-module is only possible for buildings that can be assessed with a system variant for which a "Use and Operation" module has been developed. The Information Portal Sustainable Building (www.nachhaltigesbauen.de) provides details of the system variants for which this module is available.

For all other types of buildings, a partial assessment is currently possible which is carried out exclusively using the "process quality of use and operation" criteria group. This is applied in analogy to the overall assessment using the "Use and Operation" BNB-module. All additional requirements according to section 4.3.1 which refer to the criteria of the "real qualities" criteria group are not applicable.

4.3.4 Quality management to secure sustainable process and building qualities

A regular description and assessment using the "Use and Operation" BNB-module can be carried out after building quality has been assessed using the "New Construction", "New Building Stock" or "Refurbishment" BNB-modules. However, previous assessment of building quality is not necessary.

The "Use and Operation" BNB-module must be used in the use phase of a building as a quality management tool. For this purpose, assessments of use and management processes must be repeatedly carried out at regular intervals throughout the entire use phase. In order for the assessment to be valid, however, the use and operation processes must also be as laid down in the BNB-module. This means that in addition to regular description and assessment, the "Use and Operation" BNB-module must also be continuously applied during use.

4.3.4.1 Regular assessment using the "Use and Operation" BNB-module

Existing buildings with the planning and construction phase previously assessed according to BNB

Quality management to secure sustainable process and building qualities using the "Use and Operation" BNB-module should especially take place if the planning and construction phase of an existing building was already orientated towards the requirements of a BNB-module. This also applies to buildings where the planning and construction phase was assessed with a BNB-module and a degree of fulfilment of more than 50% was reached. The "Use and Operation" BNB-module is used here with the following intention:

- Assessment of sustainability as a method for monitoring success by recording and analysing selected actual building qualities
- Assessment of sustainability to secure sustainable building management so that the qualities foreseen in the planning and construction phase are in fact implemented
- Assessment of sustainability as a measure to secure a building that is in fact sustainable

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It is recommended for federal government buildings that the “Use and Operation” BNB-module usually be applied for the first time three years or five years at the latest after the building was handed over according to Section H of the RBBau Guidelines. In the interest of sustainable building management, the assessment must then be carried out regularly at intervals of no more than five years.

Other existing buildings

In order to objectively identify building quality, existing buildings where the planning and construction phase was not assessed with a BNB-module (“other existing buildings”) should also be assessed using the “Use and Operation” BNB-module. In the case of other existing buildings, process and building qualities are identified and assessed in the use phase as part of an extended building diagnosis which not only includes the criteria of the “Use and Operation” BNB-module, but also covers all technical, functional and other issues. In criteria group 2 “process quality of use and operation”, the assessment result thus makes the quality of the management processes visible.

The use of criteria group 1 “real qualities” makes it possible to examine whether and to what extent shortcomings exist with regard to key features and properties of the building, so that it may be found that refurbishment is overdue. If a significant deviation from the minimum requirements or from a level that appears reasonable for the age and condition of the building is found, the reasons for such deviation must be examined in more detail. In order to secure optimum building management with a view to sustainability, “other existing buildings” should also be regularly assessed with the “Use and Operation” BNB-module.

In the case of federal government buildings, the operator should gear management processes as closely as possible to the “Use and Operation” BNB-module. Every five years, the management processes must undergo partial assessment in which the criteria of “process quality of use and operation” are exclusively assessed. It is recommended that a complete assessment with the “Use and Operation” BNB-module be carried out at regular intervals of no more than 10 years and that this be coordinated with the required renewal of the energy consumption certificate.

4.3.4.2 Continuous application during use

In as far as sustainability is to be regularly assessed with the “Use and Operation” BNB-module, this must be carried out during use. This is the only way in which a positive assessment result (> 50% degree of fulfilment) can be reached and hence sustainable building management ensured.

Since the sustainability assessment is a retrospective assessment, the application of the BNB during use has a steering effect. When it comes to steering management processes, three phases must be distinguished:

Phase 1 Goals	Before the assessment period commences, goals are defined accordingly as part of a target agreement.
Phase 2 Steering	During the assessment period, management processes are steered, so that the goals set can be reached.
Phase 3 Assessment	After the end of the assessment period, the final BNB assessment and the subsequent conformity test are carried out.

Goal phase

In preparation of the target agreement, a preliminary assessment with the “Use and Operation” BNB-module must be carried out at the beginning of the goal phase so that the current status of building and management qualities is known. As part of the goal phase, the operator must make an agreement involving the authority using the building in which the quality goals are defined on the basis of the criteria of the “Use and Operation” BNB-module. The operator and the authority using the building must enter into this agreement, also subject to agreement with the building realization level and the operational monitoring service taking into account their areas of responsibility pursuant to the RBBau Guidelines.

A target agreement table must be drawn up for the target agreement as shown in Annex C7 to this Guideline and must contain at least the following details for each criterion:

- Minimum degree of fulfilment for each individual criterion
- Target value for each individual criterion
- The services to be performed in order to reach the goals set
- The verifications to be furnished
- Responsibilities
- Time schedule

Once the target agreement has been made, the operator must identify measures based on the agreement which must be implemented before the assessment period begins so that the goals can be reached. It is especially important here that the organisational structures needed to secure the required process qualities are established and that suitable tools are drawn up for operating staff.

Steering phase

The steering phase describes the phase of the assessment period that lasts at least three years. During the steering phase, intermediate assessments of the assessment status reached must be carried out at least once a year. The administration using the building, the building realization level and the operational monitoring service must be notified of the intermediate result at the end of each year.

Assessment phase

Following conclusion of the steering phase, final assessment is carried out using the "Use and Operation" BNB-module. Documentation and verifications must be prepared according to the provisions of the BNB audit manual. Once the assessment and verifications have been completed, the complete assessment documents must be submitted to the Conformity Testing Office in charge for examination.

4.4 Assessment of new building stock as a special case

In the transition phase at the beginning of the use phase (see I.2 or III.2 in the figure C4 in section 4.2), the "New Construction" or "Refurbishment" BNB-modules can be used in combination with the "Use and Operation" BNB-module for existing buildings which must still be classified as new building stock.

These are existing buildings which:

- were accepted under construction law and handed over to the authority using the building following erection of a new construction or refurbishment no more than five years previous, and
- were occupied and put into operation either fully or partially by the authority using the building.

The new building stock is described and assessed with a variation of the "New Construction" BNB-module or with a variation of the "Refurbishment" BNB-module. In this case, the "New Construction" or "Refurbishment" BNB-modules are supplemented and replaced in some areas with criteria of the "Use and Operation" BNB-module. The variations of the two BNB-modules are referred to below as the „New Building Stock" BNB-transition module. The variation affects the following issues:

- The assessment methodology of the criteria of environmental impacts and resource consumption (e.g. criteria: BNB_BN 1.1.1 to 1.1.5 and 1.2.1 to 1.2.2) deviates in the section on "Calculation methods for the use scenario". In this case, the energy consumption rates from BNB_BB 1.2.1 (see section 3.2.3.2 "Energy consumption") must be used in the „New Building Stock" BNB-transition module instead of the final energy consumption from the calculation pursuant to the EnEV. This does not affect the remaining assessment methodology.
- The assessment methodology of the criterion of building-related costs in the life cycle (e.g. criterion: BNB_BN 2.1.1) deviates in the section on "Selected operation costs". In the „New Building Stock" BNB-transition module, actual supply and disposal costs (cost categories 310 and 321 according to DIN 18960) as well as actual cleaning costs (cost category 330 according to DIN 18960) must be used as a basis for calculating

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life cycle costs. The results of the BNB_BB 1.2.1 and BNB_BB 1.2.3 criteria must also be used here (see section 3.2.2 "Operation costs controlling"). This does not affect the remaining assessment methodology.
- Assessment of actual thermal comfort in winter (BNB_BN 3.1.1 is replaced by BNB_BB 3.1.1) and in summer (BNB_BN 3.1.2 is replaced by BNB_BB 3.1.2)
- Assessment of actual indoor air quality (e.g. BNB_BN 3.1.3 is replaced by BNB_BB 3.1.3)
- Additional integration of actual user satisfaction (BNB_BB 3.1.9)
- Assessment of the process qualities of use and operation instead of the process qualities from the planning and construction phase (e.g. criteria BNB_BN 5.1.1 to 5.2.3 are replaced by BNB_BB 5.3.1 to 5.3.8)

Annex C6 contains the criteria table of the "New Building Stock" BNB-transition module based on the example of the "office and administration building" system variant. This has no effect on the other rules, including the rules of the "New Construction" and "Refurbishment" BNB-modules concerning the degree of total fulfilment and quality level (gold, silver or bronze) (see Part A).

Two application cases for the „New Building Stock" BNB-transition module must be distinguished and are explained in the following sections:

- Continuation of the conformity-tested assessment of the planning and construction phase as a means of monitoring success
- First-time assessment of new building stock

4.4.1 Continuation of the conformity-tested assessment of the planning and construction phase

The „New Building Stock" BNB-transition module should be applied to existing buildings which are classified as new buildings and for which a conformity-tested assessment with the "New Construction" or "Refurbishment" BNB-modules is available (first-time building assessment). The implementation of the process qualities of use and operation in the assessment ensures that apart from the building quality achieved the organisational foundation for a permanently sustainable use phase has also been laid. In this case, the first-time building assessment must be updated as required by the „New Building Stock" BNB-transition module by applying the "Use and Operation" BNB-module and then subjected to a conformity test (second building assessment).

The result of the second building assessment must be submitted to the Conformity Testing Office responsible for the first-time building assessment no later than five years after the building was handed over to the authority using the building. If the first-time building assessment resulted in a gold, silver or bronze award for the level of quality, the BMUB can revoke this award following a recommendation by the Conformity Testing Office in charge if:

- the second building assessment was not submitted on time,
- the first-time assessment of the building showed a gold award for the level of quality and the degree of fulfilment in the second building assessment is below 65%,
- the first-time assessment of the building showed a silver award for the level of quality and the degree of fulfilment in the second building assessment is below 50%.

The „New Building Stock" BNB-transition module is based on the version of the "New Construction" or "Refurbishment" BNB-module which already formed the basis for the first-time building assessment. This must be combined with the current version of the "Use and Operation" BNB-module.

4.4.2 First-time assessment of new buildings

If no conformity-tested assessment with the "New Construction" or "Refurbishment" BNB-modules is available, this can be subsequently carried out for construction projects which are classified as new building stock using the „New Building Stock" BNB-transition module. In this case, the „New Building Stock" BNB-transition module is based on the version of the "New Construction" or "Refurbishment" BNB-module currently valid at the time the building is handed over to the authority using the building. This must be combined with the currently valid version of the "Use and Operation" BNB-module. It is not permitted to assess new building stock using the "New Construction" or "Refurbishment" BNB-modules.

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4.5 Preparation of a measure to cover an identified demand

The use phase of existing buildings can be assessed in two different phases of covering demand, each with different depths of examination:

- Examination of procurement variants
- Identification of building qualities as a basis for planning construction projects

Examination of procurement variants

It does not make sense to perform a complete sustainability assessment using the "Use and Operation" BNB-module during this phase of the ES – Bau. However, the different procurement variants can be compared using the consumption and GHG emissions criteria (BNB_BB 1.1.1, 1.2.1 and 1.2.3). With a view to existing buildings, the criteria can be applied according to the assessment methods described in the criteria profiles. For buildings which have not yet recorded any consumption data, planned values or target values must be used as a basis for assessment. Generally speaking, a complete target agreement for building and process qualities in the use phase can be carried out according to the "Use and Operation" BNB-module (see section 4.3.4.2 "Continuous application during use"). As part of this target agreement, minimum qualities must be defined which must be generally fulfilled by each procurement variant.

Identification of building qualities as a basis for planning construction projects

With a view to the sustainable development of existing buildings, a building diagnosis must first be carried out in order to describe and assess the current condition of the existing building. Combined with a more in-depth examination, the "Use and Operation" BNB-module can help to identify and analyse shortcomings in the existing building examined compared to today's or a future requirement level. The BNB-module is used in this context as an element of a comprehensive building diagnosis. The identification, analysis and assessment of operation costs, consumption rates and user satisfaction offer an important insight into the actual quality of the building. These findings can serve as a basis for planning for decisions regarding refurbishment, modification or conversion.

The ideal starting point for a building measure in an existing building is when the "Use and Operation" BNB-module was already applied continuously and at regular intervals during use. In this case, other important information regarding actual building quality is supplied by the management of energy and water consumption, cost controlling, user satisfaction management, inspection and servicing planning and building documentation throughout the life cycle.

A comprehensive building diagnosis with integrated application of the "Use and Operation" BNB-module, e.g. combined with the "New Construction" or "Refurbishment" BNB-modules, can help to identify building quality compared to a new building or to identify strengths and weaknesses as well as the potential for optimisation and the risks with the existing building. The further goals of the building diagnosis vary depending on the intended depth of intervention into existing buildings. If the building measure foreseen involves complete refurbishment, a comprehensive building diagnosis can also serve as a tool for determining the qualities worth protecting. In the case of partial refurbishment, on the other hand, it is also necessary to determine the scope of the building measure actually needed. Part D of this Guideline addresses the application of the "Use and Operation" BNB-module in order to identify building qualities as a basis for planning building measures in existing buildings.

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4.6 BNB sustainability coordination in the use phase

The operator must appoint a BNB sustainability coordinator for each existing building. This coordinator is commissioned by the operator to check the building management processes for compliance with the Guideline for Stustainable Building, to coordinate sustainability in the use phase and to perform sustainability assessments. The sustainability coordinator is supported by the authority using the building, the building realization level and the operational monitoring service within the scope of their tasks pursuant to the RBBau Guidelines.

When the “Use and Operation” BNB-module is applied during use, the sustainability coordinator coordinates the goal phase. For this purpose, he performs a preliminary assessment according to BNB and coordinates the target agreement as well as the measures to prepare the steering phase. This is where the BNB sustainability coordinator compiles the information relevant for the assessment and performs intermediate assessments. On behalf of the operator, he is responsible for the reporting obligations pursuant to section 3.2.10.

The BNB sustainability coordinator performs the final BNB assessment and hands over the complete assessment, including verifications, to the Conformity Testing Office according to its requirements. When requested by the Conformity Testing Office, the sustainability coordinator revises the assessment and submits it once again for inspection. He supplies digital copies of the conformity-tested documents to the authority using the building, the building realization level and the operational monitoring service.

Part D Refurbishment of Buildings

Part D – Refurbishment of Buildings

1. Sustainable development of building stock

Buildings owned by the Federal Republic of Germany account for a large share of total energy consumption and a significant portion of total greenhouse gas (GHG) emissions. Planning, design and implementation of energy-efficient new buildings have been fostered for many years. However, an additional aim must be to exploit the enormous savings potential of the around 18 million residential buildings and around 1.5 million buildings used for non-residential purposes. Around two thirds of the building stock was erected before the first Ordinance on Heat Conservation came into effect in 1977. Most of of these buildings have not yet undergone complete energy efficiency improvement. Furthermore, existing buildings represent the resources and energy consumed during their construction and thus represent a high ecological value. Extending the period of use of existing buildings through reuse, refurbishment and/or conversion measures is one way to save resources and protect the environment.

Existing buildings characterise the way urban spaces are perceived. Buildings thus create identity which should be taken into consideration as part of sustainable building stock development, just as much as energy saving potentials. The value of buildings for society is expressed by their cultural diversity and the distinguished and location-specific appearance of our cities.

The economic value of existing buildings should be generally preserved as long as this makes sense from an economic perspective. There may, however, be sometimes functional and safety/security requirements which have to be fulfilled as a general precondition for possible reuse, refurbishment or conversion. If key requirements cannot be met, the option of erecting a new building may be considered in exceptional cases even though this should always be the “last resort”.

Measures to maintain, refurbish and convert existing buildings are particularly important against this background. The principles of sustainable development must be implemented 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 hence be equally taken into consideration.

2. Terminology

2.1 Refurbishment projects

Refurbishment projects within the meaning of this Guideline includes measures which enhance the value of existing buildings (see Sections D and E of the RBBau Guidelines. Refurbishment projects encompasses a host of terms which are used for work on existing buildings, such as rehabilitation, improvement, modification or refurbishment. Many of the customary terms have no standard definitions. This Guideline differentiates between refurbishment projects according to type and degree of complexity of the measure.

The types of measures are defined in the Guideline for Sustainable Building in line with the terminology used in the "Official Scale of Fees for Services by Architects and Engineers" (HOAI) and in analogy to the structure of DIN 18960 "User costs of buildings". Measures designed to achieve the target condition (maintenance work within the meaning of the HOAI, repair and inspection services) do not constitute refurbishment for the purposes of this Guideline (see Section C of the RBBau Guidelines and Part C of the Guideline for Sustainable Building).

2.2 Types of measures

The definitions below apply to the different types of measures.

Types of refurbishment measures:

- **Repair:** measures to restore the condition suitable for the original purpose (target condition) of a building, building part, component or system.
- **Refurbishment:** construction measures other than extension, conversion or repair work designed to achieve a sustainable increase in the use value of the building.
- **Modification:** measures to convert an existing building including changes in structural design. Modification measures are essentially designed to change the layout of an existing building.
- **Interior works:** work related to the interior design of existing or the creation of new interior spaces without any major intervention into building structures or building design. Such work can be related to new construction, extension, conversion, refurbishment, maintenance and repair activities.
- **Extension work:** measures to supplement an existing building, typically leading to greater building use. Extension work usually means annexes or additional storeys, often in combination with other types of measures. The provisions of the Assessment System for Sustainable Building (BNB) determine whether the "Refurbishment" BNB-module or the "New Construction" BNB-module is to be applied to an extension measure. Irrespective of this, Part D of this Guideline must be observed in any case.
- **Conversion measures:** designed to change the type of use. Besides the legal component, these measures are usually also related to refurbishment work which often encompasses several types of measures. Therefore, reuse usually also calls for far-reaching conversion and refurbishment. A change in the type of use also leads to a change in allocation of the applicable system variant of the BNB.

Further types of measures:

- **Reconstruction:** restoring destroyed structures on the basis of existing building or system parts. For the purposes of this Guideline, these structures are considered to be new buildings.
- **Maintenance:** measures to preserve the target condition of a building. Maintenance measures are not refurbishment measures within the meaning of this Guideline, but instead represent use and operation processes (see Part C of this Guideline).

2.3 Complexity of measures

The complexity of refurbishment is a function of the scope of the measure, its intervention depth into the building and the type of measure. Similar to the customary terminology used for the types of measures, there is also no clear-cut definition of the terminology used to describe the complexity of measures. Terms which are often used for differentiation are "core rehabilitation" or "full rehabilitation" as well as "partial rehabilitation" even though these terms cannot be clearly distinguished and are used differently from case to case and depending on who is using them. The term "rehabilitation", too, lacks a precise definition.

The colloquial use of the term encompasses, to different degrees, both the type of measure and its degree of complexity, so that this term is not suitable for defining either of them.

The term “rehabilitation” is therefore avoided in this Guideline. With regard to the description of the complexity of a measure, the terms “complete refurbishment and “partial refurbishment” are used on the basis of the definitions given below (see Fig. D1):

Complete refurbishment

Complete refurbishment is, hereinafter called refurbishment, characterised as follows:

- **Scope of the measure**
  Complete refurbishment means construction work on an independent, existing structure in its entirety.
- **Depth of intervention into the building**
  The purpose of complete refurbishment is to provide an existing building in its entirety with characteristics and features which correspond largely to those of a new building. During complete refurbishment, existing buildings are largely stripped down to the structurally relevant elements of the building (load-bearing and reinforcing elements).
- **Type of measure**
  Complete refurbishment encompasses comprehensive work on existing buildings and generally several types of measures. Complete refurbishment is characterised by interaction between:
  - Repair work in order to achieve more or less the same building use periods as in the case of new buildings
  - Refurbishment work in order to provide the building with technical properties as well as building structures and building services features largely identical to those of new buildings
  - Modification work in order to adapt the physical structure to new requirements
  - Interior works in order to renew or modify interior design

Partial refurbishment

Partial refurbishment encompasses all kinds of construction on existing buildings other than complete refurbishment. Measures are typically characterised as partial refurbishment if one of the following conditions is fulfilled:

- **Scope of the measure**
  Partial refurbishment means that a construction measure involves parts of a building or building elements which form part of the existing building rather than an independent building in its entirety.
- **Depth of intervention into the existing building**
  Partial refurbishment means that it is not the purpose of the construction measure to refurbish the existing building in its entirety to a condition with characteristics and features which are largely equivalent to those of a new building. This is typically the case if refurbishment does not mean the almost complete stripping of the building down to the structurally relevant (load-bearing and reinforcing) elements.
- **Type of measure**
  Partial refurbishment usually means refurbishment which is not characterised by interaction between multiple types of measures.

Rules for construction projects by the federal government

At the time the ES – Bau are drawn up for a refurbishment measure, the technical supervision level analyses whether the criteria for complete refurbishment according to the Guideline for Sustainable Building are fulfilled. The technical supervision level communicates the result of the analysis to the supreme technical authority and the BNB Conformity Testing Office. The supreme technical authority classifies a refurbishment project as complete refurbishment on the basis of the opinion of the BNB Conformity Testing Office and in agreement with the project sponsor (owner).

The building realization level has to inform the technical supervision level when it is found during the further course of the project (for instance, after completion of a design competition) that the criteria for complete refurbishment according to the Guideline for Sustainable Building are not completely fulfilled. The technical supervision level then checks whether the criteria for complete refurbishment

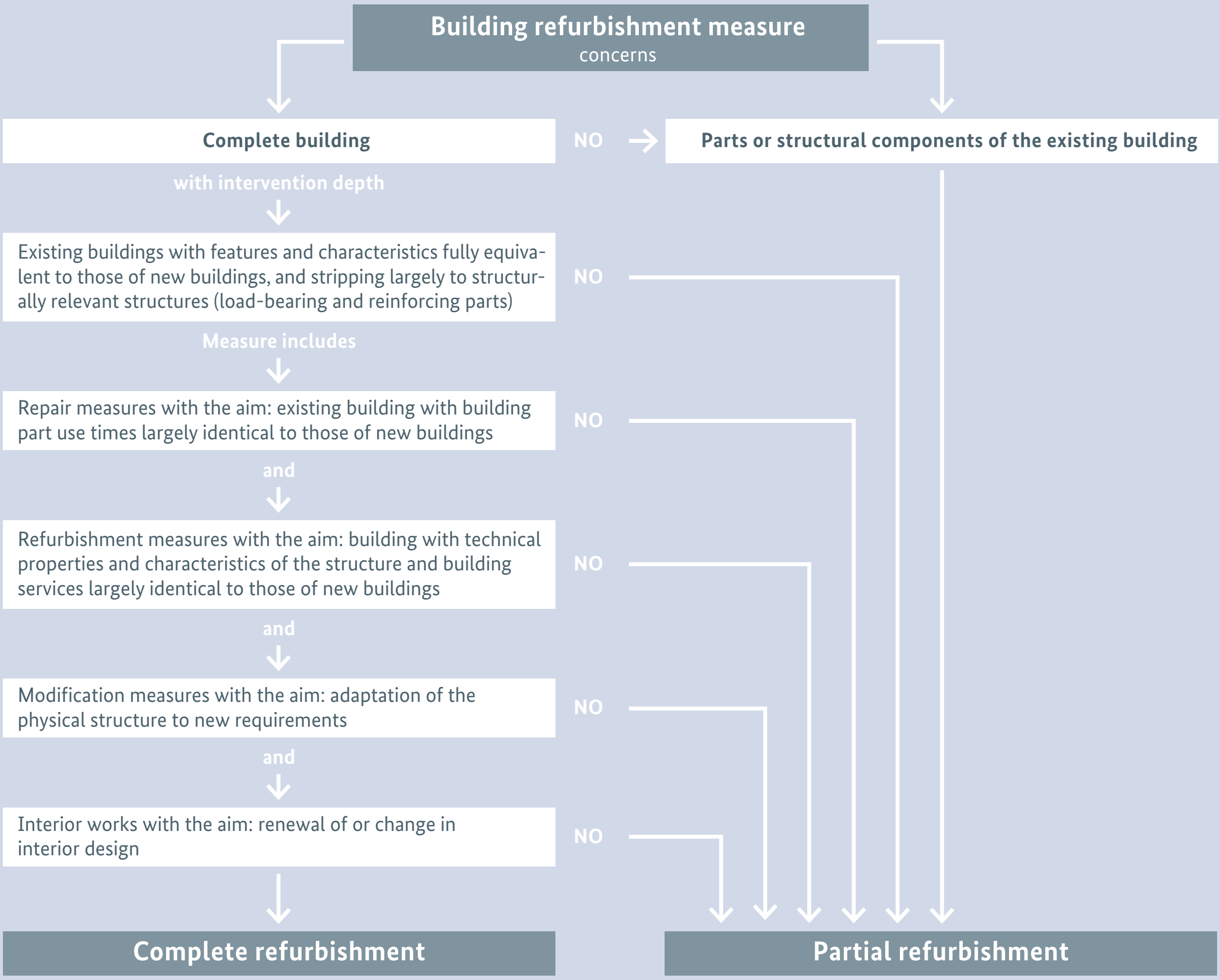

Fig. D1: Intervention depth – distinction between complete and partial refurbishment

according to the Guideline for Sustainable Building are fulfilled and communicates the result to the supreme technical authority and to the BNB Conformity Testing Office. The supreme technical authority classifies the construction projects as partial refurbishment on the basis of the opinion of the BNB Conformity Testing Office and in agreement with the project sponsor (owner). In the event that it is found during the course of a partial refurbishment project that the criteria for complete refurbishment are fully fulfilled, this must then be handled analogously. In the event that this is found at a time when planning/design and construction work has advanced to such an extent that it is unlikely that complete verification according to the BNB will still be possible, the supreme technical authority then has to decide in agreement with the project sponsor (owner) to what extent it is still possible to adopt the BNB complete refurbishment system variant in the sense of complete verification and certification.

2.4 Structural substance of an existing building

Refurbishment work usually does not preserve the entire building structures of an existing building which is supplemented by the new building structures resulting from refurbishment. In conjunction with refurbishment projects, a distinction must hence be made between:

- **Old building structures** (structure and technical systems), broken down into:
  - old building structures which remain in use (unchanged, continued use of the site)
  - reused old building structures (recycling of components or construction materials on site)
  - dismantled old building structures
- **New building structures** (building structure and building services) to be integrated into the existing building in the course of the refurbishment project

3. Principles of building refurbishment

3.1 General principles and principles applicable to existing buildings

Part A of this Guideline introduces the principles of sustainable building. These principles apply to both new construction and, with certain modifications, refurbishment projects. The same applies to the methods for integrating sustainability aspects into the planning and design process explained in Part B. In this case too, new construction and refurbishment projects differ only in part. However, notwithstanding this, a host of special building-specific aspects need to be addressed. On the one hand, the planning and construction processes in refurbishment projects differ in many ways from those in new construction projects. On the other hand, certain sustainability aspects must be looked at from a different perspective when dealing with existing buildings.

This Part D deals with the special characteristics of sustainability in refurbishment projects and thus applies in addition to Parts A and B, however, without completely superseding them. In as far as Part D does not contain any specific explanations, recommendations or rules for action applicable to existing buildings, Parts A and B are also applicable to refurbishment projects.

3.2 Comparison of new construction and refurbishment projects

Users often expect that refurbishment measures in existing buildings can achieve a quality that is comparable to that of new buildings. However, certain special aspects of existing buildings can prevent this. These are, on the one hand, due to the history of the building as well as the fact that the way the building was erected cannot be altered retroactively. Furthermore, legal requirements differ for existing and new buildings. This means that comparable new buildings may sometimes feature qualities which refurbished buildings are either unable to achieve or would mean unreasonable costs.

One example of the many factors to be considered is that refurbished buildings cannot always achieve the energy quality of the building envelope of new buildings. However, this does not mean that refurbished buildings cannot reach high sustainability levels. The construction of new buildings and especially of their structure involves significant energy and material flows and consequently impacts the environment to a higher degree than refurbishment work. This example illustrates the principles of addressing new and existing buildings. Any isolated, direct comparison of individual quality aspects of new construction and refurbishment projects should be avoided, whilst the features and characteristics of new and existing buildings call for a different assessment of certain criteria. Notwithstanding this, however, the assessment of building quality should not differ significantly for new and existing buildings. This is, for instance, reflected by comparable benchmarks for the functional and social quality of a building.

3.3 Framework conditions for building stock development

Refurbishment projects are characterised not only by the given physical condition of a building. Construction work in existing buildings can be subject to even more restrictive legal conditions than new construction projects. Any intervention into the structures of a building must abide by the applicable laws and regulations which are additionally subject to interpretation and the resultant rulings of higher and supreme courts. Building planning law and regulations as well as fire protection regulations related to these are particularly important. Existing buildings often fail to comply with applicable law and very often require a high or even unreasonable effort and cost to be upgraded to a level that complies with the applicable legal situation. One particularly important aspect is grandfathering that ensures protection against retroactive changes in laws and regulations. These provisions may also apply to parts of the building which are not directly affected by conversion. Monument protection sometimes also has a role to play as a basis for exceptional treatment (for instance, pursuant to § 24 (1) of the EnEV) or additional requirements.

3.3.1 Grandfathering in building regulations

The basis of grandfathering is the property guarantee pursuant to Article 14 of the Basic Law for the Federal Republic of Germany. This fundamental law is also rooted in Article 17 of the Charter of Fundamental Rights of the European Union. The property guarantee enables owners to ward off state intervention, with the contents and scope of this protection function being laid down in general laws.

Grandfathering has an active and a passive component. Passive grandfathering grants owners rights of warding off state intervention and thus protects property. Active grandfathering goes further and addresses an owner's rights to intervene into existing buildings.

Passive grandfathering

A building is grandfathered if it was originally built in compliance with applicable law. Passive grandfathering means that the owner's right of use survives changes in the legal situation and that the owner is protected against requests by public agencies to modify an existing building. The contents and limits of the property guarantee under the grandfathering regime are determined by general laws.

Put simply, a building that was lawfully built is grandfathered. However, a more differentiated view and a distinction between formal and material lawfulness are often required.

- Formal lawfulness:
  The construction of a building was lawfully permitted at the time it was built (construction permit). The building is completed as approved.
- Material lawfulness:
  The building was erected in line with public law in effect at the time of its construction or, following its erection, was in conformity with public law over an extended period of time.

These two forms of lawfulness can be combined in different ways with different implications for grandfathering. Grandfathering can, for instance, apply to a building which is unlawful in formal terms and at the same time lawful from a material perspective. Grandfathering also covers the type of use and can terminate when use is interrupted, for instance, when use is abandoned for an extended period time or as a result of changes in the building. The identity of an existing building must be generally maintained in order for passive grandfathering to survive changes in the building.

Active grandfathering

Active grandfathering too can be broken down into simple and qualified active grandfathering. Simple active grandfathering enables owners to perform measures designed to preserve the building structures. This includes repair, maintenance and inspection work. Qualified active grandfathering is to enable owners to adapt the building to new needs or to extend a building. However, an owner's claims in conjunction with qualified active grandfathering are contingent upon such claims being laid down in applicable laws (such as § 35 (4) of the Federal Building Code).

3.3.2 Monument protection and preservation

Monument preservation refers to any measures designed to maintain and repair historic monuments, but generally does not include any measures by authorities designed to ensure their long-term protection. Monument preservation can be mechanical, technical, conservation or scientific measures.

Monument protection, on the other hand, refers to measures by monument protection authorities designed to ensure the lasting conservation of monuments. It thus means the state's right to intervene into the owner's property. A listed building is subject to the laws of the respective federal state for the monument protection. Monument protection does not generally prevent the development and upgrading of listed buildings. Monument protection aims at ensuring the ongoing use of a listed building in a manner that ensures its long-term conservation.

Monuments bear witness to cultural history and have a significant impact on the way cities are perceived. They are of strong identity-creating and social relevance. 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 building. This must also be considered in sustainability assessments. A plain comparison between refurbishment projects of listed and non-listed buildings based on a uniform benchmark cannot reflect the special importance of monuments and the concept of sustainability. The BNB hence comprehensively addresses the issue of listed buildings through a host of building-specific criteria which provide dedicated rules and benchmarks when it comes to handling listed buildings.

A listed building within the meaning of this Guideline is a building with characteristics of a monument building. These should be considered to exist:

- if the building is a monument within the meaning of the listed buildings legislation of the respective federal state (monument),
- if the building forms part of an area or a group, complex or collection of buildings which is protected under the listed buildings legislation of the respective federal state (monument area),
- if the building is of monument value due to its historic, scientific or urban importance (monument-worthy building). Monument-worthiness can be confirmed, for instance, by an expert opinion.

4. Specific criteria for sustainable building refurbishment

With a view to sustainable development, refurbishment projects are subject to the same requirements as new construction projects. However, the special features of the existing building must be taken into consideration without generating excessive costs in relation to the benefits. The “New Construction” BNB-module was hence transferred to the “Refurbishment” BNB-module as follows (see Fig. D2).

Refurbishment projects must hence consider the following specific requirements of sustainable refurbishment in addition to the requirements of Parts A and B of this Guideline.

4.1 Ecological quality

4.1.1 Eco-balance

The energy and material flows which are embodied in the building structures of existing buildings represent the consumption of resources and environmental pollution during their construction phase. The primary energy spent on the construction of a building is often also called “grey energy”. However, beyond the resources consumed during construction and the related environmental pollution, existing buildings also represent potential for avoiding new

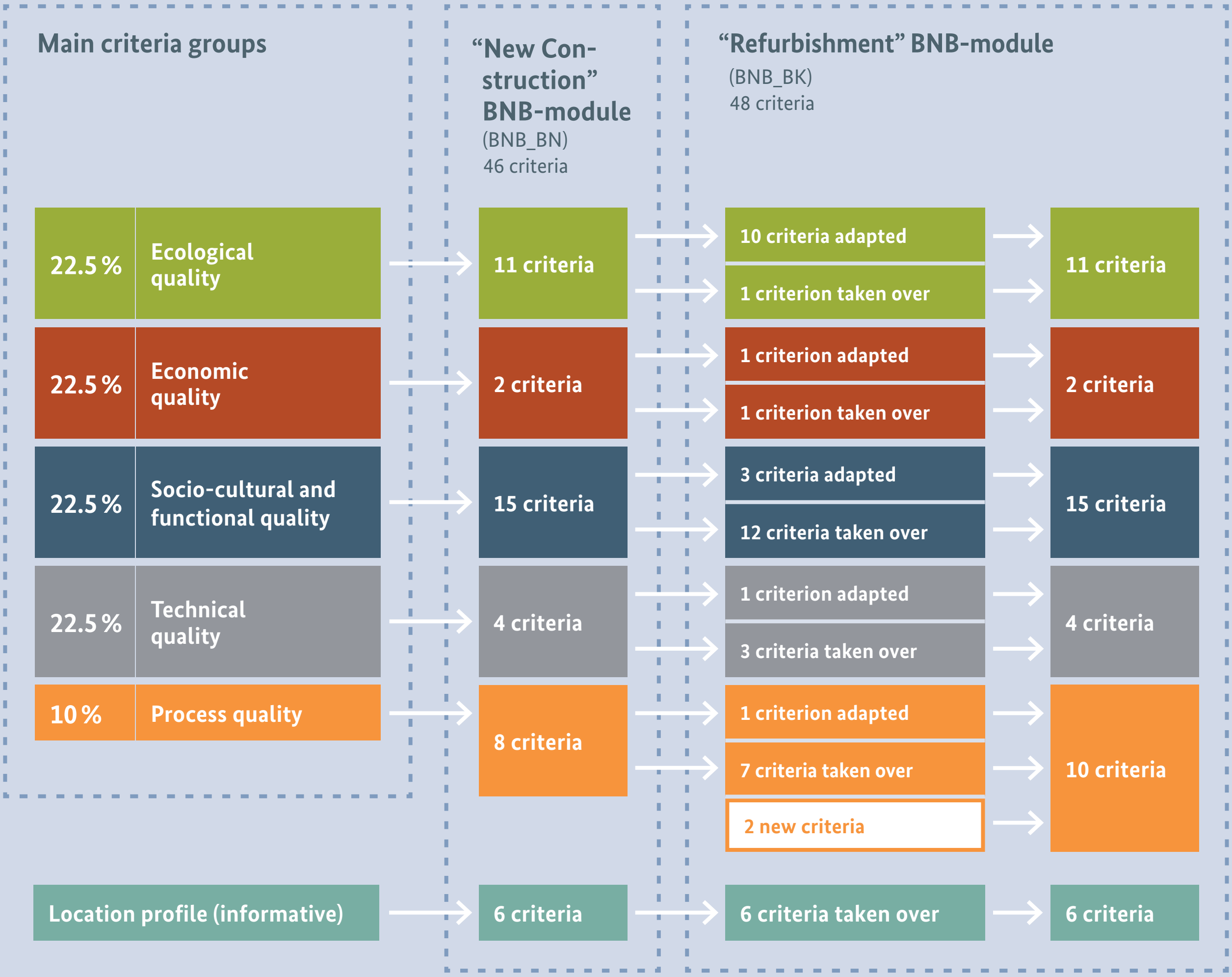

Fig. D2: Adapted and new criteria in the “Refurbishment” BNB-module environmental burdens. This potential is then used if a new building does not have to be erected because existing buildings can be developed and used further. This reduces resource consumption and thus avoids the environmental burdens that result from the manufacture of construction products and the construction of buildings. Enhancing the functional, technical and energy-related qualities of buildings as part of refurbishment projects with the aim of achieving maximum use rates in existing buildings thus helps to reduce the need for new buildings and thereby essentially contributes towards the protection of resources and the environment.

One prerequisite for the sustainable development of existing buildings is that present and future requirements for functional and technical quality can be fulfilled and that this is possible with reasonable material consumption and construction work and at a reasonable cost. The possible cultural value of an existing building and its influence on urban qualities must also be considered here.

In order to assess the ecological benefits of refurbishment measures, the determination of the resultant environmental impact and resource consumption is indispensable. In analogy to the concept for new construction projects, this assessment will, amongst other things, also be based on eco-balances. The life cycle assessment methods should also be generally applied to refurbishment projects. Life cycle assessments allow resource consumption and impacts on the global environment to be identified and assessed. Life cycle assessments for refurbishment measures also aim at influencing design, planning and construction work as well as building use in order to contribute towards reducing environmental impacts and resource consumption. One possible solution is to extend the time of use whilst at the same time exploiting the potential for optimisation.

Life cycle assessments for refurbishment projects are based on the same criteria which are also applied to new buildings. However, the assessment methodology and the assessment standards for the following criteria are adapted to the specific characteristics of refurbishment projects:

Global Warming Ppotential (GWP)	**BNB_BK 1.1.1**
Ozone Depletion Potential (ODP)	**BNB_BK 1.1.2**
Photochemical Ozone Creation Potential (POCP)	**BNB_BK 1.1.3**
Acidification Potential (AP)	**BNB_BK 1.1.4**
Eutrophication Potential (EP)	**BNB_BK 1.1.5**
Primary energy demand, Non-Renewable	**BNB_BK 1.2.1**
Total Primary Energy Demand and Share of Renewable Primary Energy	**BNB_BK 1.2.2**

It is unreasonable and often pointless to determine and assess the energy and material flows already embodied in a building as well as its past impacts on the environment. Existing buildings were constructed under historical framework conditions and typically using different processes so that their environmental influences differ from those of modern methods. It is hence not normally possible to find an adequate data base for an eco-balance for existing buildings. Irrespective of this, it is both a complex and pointless task to determine and assess the energy and material flows already embodied in a building. The most important issue is to avoid energy and material flows as well as unwanted effects on the environment by avoiding new construction projects and by continuing to use existing buildings whilst at the same time enhancing energy quality and addressing present and future user demands.

Planning and design considerations which may eventually lead to a construction project are always demand-driven. If a given demand for space cannot be covered by an existing building or suitable organisational measures, a new building will usually be needed. The environmental impact and resource consumption of new construction projects are hence the standard for refurbishment measures. If, for instance, the environmental effects and the resource consumption of a refurbishment measure over its future life cycle are below those of a new building, refurbishment must be preferred in terms of its global environmental impact and resource consumption.

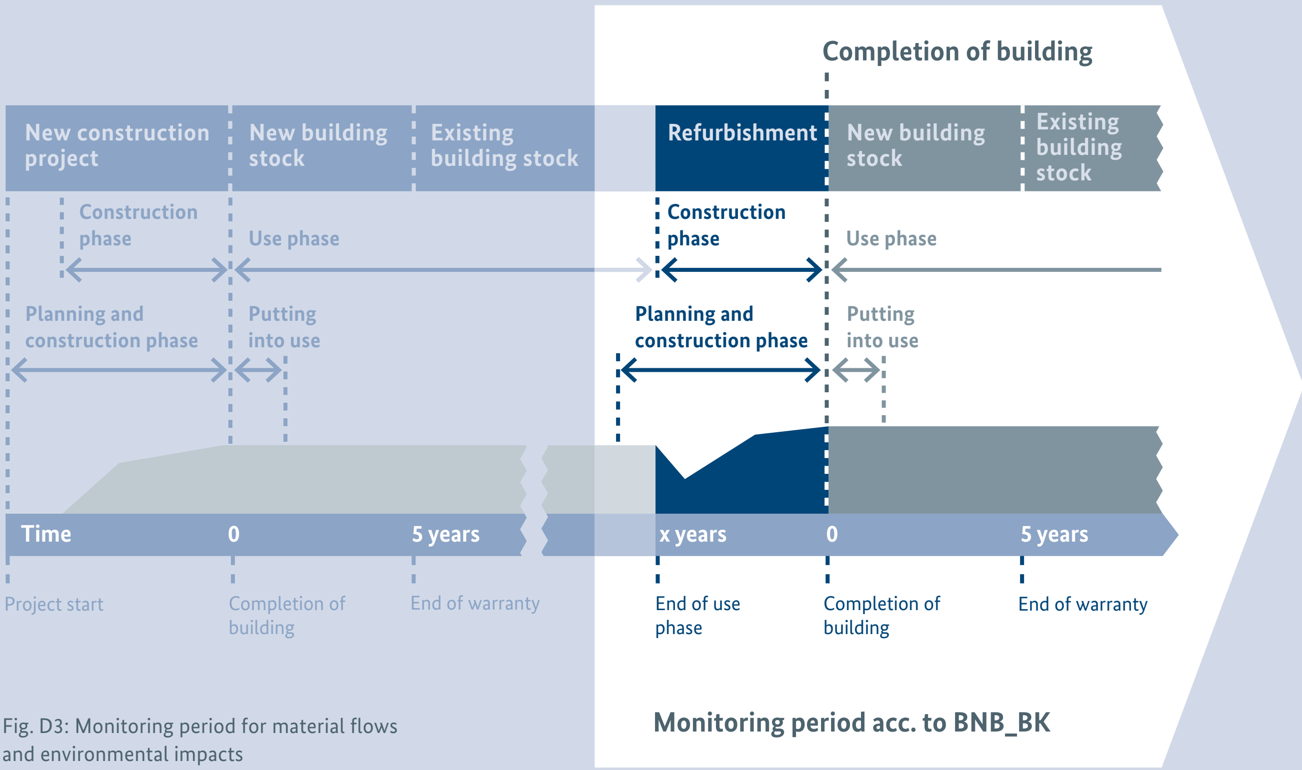

Fig. D3: Monitoring period for material flows and environmental impacts

D4

4.1.1.1 Handling existing building structures and implications for balancing

If existing building structures, which still have a certain use potential or a residual life, are demolished as part of a building measure, this often means forfeiting the potential to avoid energy and material flows and unwanted environmental impacts. However, double balancing must be generally avoided and steering effects through eco-balances must be enabled. This is basically what is expected from those responsible for planning new construction or refurbishment projects in order to minimise material flows and environmental impacts.

The following convention can hence be developed for eco-balances along these lines:

> Material flows and environmental impacts which, at the time the building is completed, have already occurred as a result of construction and demolition, disposal or recycling of building structures are exclusively assigned to the planning, design and construction phase of the respective building structure.

With a view to balancing existing building structures, the following aspects will hence be examined for the existing building structures which continue to be used or reused:

- Maintenance
- Demolition
- Disposal
- Recycling

The example of a refurbishment project in Fig. D3 illustrates the period which is relevant for analysing energy and material flows.

Notwithstanding the above-mentioned convention, it is vital to minimise the share of new building structures in as far as this is compatible with the aim of fulfilling present and future requirements for technical and functional quality. Although the stripping of existing building structures which could be otherwise used further is not directly penalised, it nevertheless has indirect consequences. The advantage which refurbishment projects offer within the scope of the eco-balance, resulting from the fact that existing building structures are reused, declines the more substance is dismantled because this substance will usually have to be replaced with new building structures. A large share of old building structures which can be reused (ideally directly on the site) can thus have a positive effect on the energy aspect of the eco-balance and therefore compensate for any disadvantages of refurbishment projects compared to new construction work.

The assessment of repair cycles must consider the remaining life of the old, reused building structures. This means that the eco-balance must determine and consider the residual life of the reused existing building structures, including the fact that replacement may be necessary earlier than in the case of a new building.

Furthermore, the design and planning process must adequately consider the existing building structures to be dismantled and examine possible reuse or direct recycling on the site. In the interest of the efficient use of resources, existing recycling potential due, for instance, to a design which facilitates dismantling and recycling, must be opened up and exploited. In the sustainability assessment of complete refurbishment projects, this aspect is assigned to the process qualities (BNB_BK 5.1.6 "stock-taking" und BNB_BK 5.1.7 "demolition planning").

4.1.1.2 Balancing new building structures

The eco-balance for the new building structures to be integrated into refurbished buildings includes, in analogy to an eco-balance for new construction projects, the complete mapping of energy and material flows as well as environmental impacts due to the production, manufacture, use, maintenance and disposal of the new building structures.

4.1.1.3 Balancing the future use phase of a refurbishment project

The effects of the refurbishment project on the future use phase of the building to be assessed must be mapped in analogy to the eco-balance of a new construction project. This means that the energy and material flows as well as the environmental impacts must be shown, in addition to the causes discussed in section 4.1.1.2, in as far as these result from the following factors:

- Final energy demand for electricity and heat
- Repair of the building structure (cost category 410 according to DIN 18960) for all elements of cost category 300 according to DIN 276 with a service life of less than 50 years. These include:
  - the reused building structures,
  - the new building structures.
- Repair of the building equipment (cost category 420 according to DIN 18960) for all elements of cost category 400 according to DIN 276 with a service life of less than 50 years. These include:
  - the reused building structures,
  - the new building structures.

One precondition for this is the determination of reused old building structures of cost category 300 and cost category 400 according to DIN 276 in order to identify the time for maintenance work and replacement investment. Furthermore, future utility demand must be determined on the basis of old building structures which may be reused.

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4.1.1.4 Eco-balance assessment

The energy and material flows as well as the environmental impact of refurbishment projects are essentially influenced by the depth of intervention into the existing building structures. It makes no sense to assess the eco-balance without considering the depth of intervention. A distinction must be made here between complete and partial refurbishment.

Assessing the eco-balance of complete refurbishment

Complete refurbishment projects must be completely balanced with a view to their environmental impacts and resource consumption. Eco-balances must be generally performed in accordance with the above-mentioned convention and the criteria of the “Refurbishment” BNB-module. The criteria of BNB_BK 1.1.1 to 1.1.5 as well as BNB_BK 1.2.1 and 1.2.2 are available to this effect.

Complete refurbishment of monuments is an exception and requires complete balancing both with a view to the environmental impacts and resource consumption of such buildings. However, qualitative assessment of the results of eco-balances of monuments is also optionally possible. To these ends, the qualitative parameters of the corresponding criteria of the “Refurbishment” BNB-module are available for historic monuments. A different assessment option for monuments is necessary in order to reflect the specific characteristics of monument-compliant refurbishment whilst at the same time addressing the social importance of historic monuments. In the case of historic monuments, all measures must be generally performed which are compatible with the requirements of the monument protection and preservation and which additionally lead to a reduction in environmental impacts and resource consumption whilst at the same time offering a reasonable cost-to-benefit ratio.

Assessing the eco-balance of partial refurbishment

Assessing a building with a complete eco-balance does not make sense for partial refurbishment measures, all the more so since a quantitative assessment of the results of the eco-balance for partial refurbishment projects is generally not possible. The main reasons are the large variety of underlying conditions (such as age, type of construction) and the strongly varying degree of complexity of partial refurbishment measures. The resultant, wide range of all kinds of construction measures means that partial refurbishment projects cannot be reasonably compared. Furthermore, comparisons of measures that cannot be compared on the basis of the results of a quantitative assessment are not conducive to the purpose of a sustainability assessment. Instead, it must be ensured that the respective measure is optimised in terms of its environmental impact and consumption of resources. The eco-balance must thus be used in partial refurbishment projects as a tool for comparing variants in order to identify the optimum variant with a view to environmental impact and resource consumption. The eco-balance methodology for partial refurbishment measures must also correspond to the above-mentioned convention and follows the methodology described in the criteria profiles of the “Refurbishment” BNB-module.

The requirements for the sustainable procurement of services are additionally applicable. The “Sustainability Compass” of Deutsche Gesellschaft für internationale Zusammenarbeit [1] is available as a tool for this purpose.

Qualitative assessment of the eco-balance

A qualitative assessment for using the eco-balance during the design, planning and construction phases as a tool for optimising environmental impact and resource consumption is exclusively available for buildings with historic monument features. Choosing between quantitative and qualitative assessment (BNB_BK 1.1.1 to 1.1.5 as well as BNB_BK 1.2.1 and 1.2.2) is possible in these cases only. All other complete refurbishment projects require a quantitative assessment.

The alternative option of a qualitative assessment of buildings with historic monument characteristics is ultimately also meant as an incentive to use the eco-balance not just as a means for describing the status quo, but also as a steering instrument for ecologically optimised planning and design. The qualitative assessment can thus be understood as guidance for the use of eco-balances during the design, planning and construction process and can also be used as such for all other measures.

[1] See http://oeffentlichebeschaffung.kompass-nachhaltigkeit.de

The assessment is based on quality levels which reflect four sub-aspects that essentially influence the quality of the eco-balance:

- **Time of the eco-balance**
  The influence of design on resource consumption and emission-related environmental influences of a building declines as the design, planning and building process proceeds. The eco-balance as a steering instrument must be used at the earliest possible stage of the design, planning and building process. Suitable limit values (minimum requirements) for the eco-balance should hence be generally determined at the beginning of the project for the respective measure (ES – Bau or determination of fundamentals). After the limit values have been determined, estimates should be made at the earliest possible stage as soon as first design versions are available. The estimate of the eco-balance here serves as a tool for analysing and selecting suitable variants with which compliance with the limit values can be ensured.

- **Updating the eco-balance**
  The eco-balance as a steering instrument should be successively updated. The limit values as determined must always be compared to the values achieved on the intermediate planning and design levels. This is the only way to ensure that deviations are identified and counter-measures initiated as quickly as possible (quality assurance).

- **Use and influence of the eco-balance**
  On the one hand, the eco-balance enables variant analyses. However, it can also be used to compare the design and planning options with other buildings or indicators. The eco-balance thus becomes a steering instrument for climate and environmentally conscious building.

  Indicators and comparisons with other buildings must be used in order to determine both limit values and targets (ES – Bau or determination of fundamentals). These values should be determined on the basis of values to be identified externally (orientation and best-values/best practice). This helps to enhance the quality of the project because it goes beyond a mere comparison of design variants. As a general rule, limit values must always be adhered to and target values should be aimed at.

- **Result of the eco-balance**
  The results of the eco-balance must be compared on the basis of the limit and target values defined for the specific project. This assessment supports the selection of design variants and is made in analogy to assessments with fixed benchmarks.

4.1.2 Risks for the local environment

The avoidance of risks for the local environment and the protection of human health as well as individual users are among the most important protective targets as part of building use. This means that complete avoidance of any damage from whatever source must be the focus of the analysis. Any use of substances and products must be avoided or reduced in planning, design and tendering processes as well as during their processing on the site and during operation and use of the building in as far as the characteristics or constituent parts of such substances and products pose a potential risk for environmental resources, i.e. groundwater, surface water, soil and air. Risks for man and the environment are of paramount relevance irrespective of the time of installation. Refurbishment projects must hence consider the risks for the local environment from both the materials and elements to be newly installed as well as any materials and elements that will remain in the building.

It should be noted that a refurbished building, after the measure has been completed, consists of both old and new building structures so that all new and reused elements must be analysed at an early stage. A sustainability assessment of a refurbishment project also requires separate assessment of the materials remaining in the building structures and of the newly installed construction materials. Careful examination of the existing building structures must ensure that environmental risks as well as risks related to toxic risks for humans are analysed, assessed and considered during the subsequent design and planning process.

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Risks for the local environment from refurbishment projects are assessed according to the BNB_BK 1.1.6 criterion of the "Refurbishment" BNB-module. This criterion thus addresses two sub-criteria:

- Assessment of risks from construction products which will be additionally or newly installed as part of the refurbishment project (new building structures)
- Assessment of risks from construction products in the old building structures

4.1.2.1 Assessment of risks from construction products in the new building structures

The risks which the new building structures pose to the local environment are assessed in analogy to the methodology for new construction projects. Refurbishment of historic monuments is an exception where the BNB_BK 1.1.6 criterion foresees an alternative approach because the protection of listed buildings often leads to restrictions as a result of which quality specifications cannot be adhered to. This is always the case if the historic building structures can only be preserved or rehabilitated with the original construction product or a comparable product which must, however, be classified as critical according to the BNB_BK 1.1.6 criterion and for which no alternative solution is available.

4.1.2.2 Assessment of risks from construction products in old building structures

The construction products contained in existing buildings are usually not documented. The risks from construction products in old building structures can thus only be assessed on the basis of an examination of building pollutants.

In contrast to new building structures, old building structures can also include materials which are no longer permitted or even have to be removed under current legislation. An analysis of such substances is a prerequisite for assessment according to the BNB_BK 1.1.6 criterion. The purpose is to avoid the presence of highly polluted construction materials and to upgrade the building to the minimum quality standard of a new building.

Further assessment is then carried out according to differentiated quality levels which are defined in terms of the degree of exposure of the respective building parts, construction products or substance compositions. It is not possible to apply the standards for new buildings to existing structures because the data to be disclosed is usually not available for old buildings.

One feature which all quality levels have in common is that demolition or rehabilitation is not necessary in each case. If it can be demonstrated that the construction products that will remain in use will not pose any risk for environmental resources, i.e. groundwater, surface water, soil and air as well as for humans, and additionally comply with the applicable legal requirements, such materials can continue to be used in the building.

An alternative approach can be chosen for listed buildings in analogy to the assessment of new building structures.

4.1.3 Sustainable material production

An overarching goal is to counter global forest destruction by promoting the use of wood as a raw material from sustainable production. The use of wood and wooden materials from tropical, subtropical and boreal forests with no forest stewardship certification must hence be avoided in building measures. Preference should hence be given to products from sustainable forestry. The sustainable production of wood as a material falls into the ecological category of sustainability.

In the case of existing buildings, a problem arises when it comes to considering wooden products which already exist because they were chosen when the building was erected or refurbished. This wood can be of tropical origin or it can come from central European or domestic forests.

The continued use of wooden products from old building structures may not cause additional damage to the environment. In line with the "Eco-balance" section, their continued use will instead reduce environmental burdens.

This means that only wood and wooden materials to be newly installed are to be assessed in conjunction with sustainable refurbishment. Existing elements can be disregarded unless they touch on other criteria, such as risks for the local environment or threats to user health. In as far as wooden products or materials used in existing buildings are of a lower quality but still intact and largely free from defects, demolition and replacement with products of a higher quality should be generally avoided. Instead, measures should be taken to extend the remaining life of the wooden products already used.

4.1.4 Demand of space

Demand of space is a sub-aspect of the ecological dimension of sustainability. Previously sealed, restored land has a positive effect on water balance, micro-climate as well as flora and fauna. The National Sustainability Strategy from 2002 contains a commitment to limit the daily increase in settlement and traffic areas to 30 hectares per day by the year 2020. A balanced land use record is aimed at for Germany by 2050. This means that the sealing of new land is to be avoided or compensated for through suitable measures (BNB_BK 1.2.4). The analysis of the demand of space is limited to the real (construction) site. The sealing and restoration concept already serves as a steering instrument during the early design phase in order to implement measures designed to minimise, reduce and compensate for sealed surfaces (see BNB_BK 5.1.3). This concept encompasses the aspects of stock-taking, measure assessment, variant comparison and recommendations for action.

An analysis of the demand of space must address the following aspects:

- Comparison of the ratio between sealed surface and usable area before and after refurbishment
- Classification of surfaces used for buildings according to the Federal Building Code (for instance, § 34 of the Federal Building Code)
- Historical burdens on the property, such as existing pollution or ammunition
- Implementation of compensatory measures and/or a green roof

The comparison of the ratios of sealed surface and usable area before and after refurbishment must be based on the property and the total surface areas of the existing and, if applicable, the extension building. The brochure "Sustainably designed outdoor facilities on federal properties" by the Federal Building Ministry[2] must also be considered in this context.

If optimisation in the sense of sustainability is aimed at by improving the ratio, this can be achieved by subsequently increasing the useable area However, this can also be achieved by reducing sealed surfaces, for instance, by restoring and planting previously sealed surfaces on the property as well as other compensatory measures, also on a voluntary basis.

4.2 Economic quality

When it comes to developing existing buildings further, the economic dimension of sustainability and at the same time the economic efficiency of the measures must be considered. The aim of the analysis of economic efficiency, even for refurbishment measures, is the integrated optimisation of economic parameters.

Building-related life cycle costs

Both new construction and refurbishment projects require a life cycle cost calculation and analysis. A holistic analysis covers not just production and construction costs, but also operation and maintenance as well as demolition and disposal costs. However, the current version of the criteria profiles of the BNB does not yet consider demolition and disposal costs.

Solutions which may cost less in the short term, but require higher economic costs in total, can be identified and replaced with more advantageous variants at an early stage.

[2] BMVBS (2012 a)

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4.2.1 Life cycle cost analysis methodology for building refurbishment

A life cycle cost analysis considers the costs incurred during refurbishment, use and maintenance as well as demolition of the building. The result of the life cycle cost analysis is – just like in the case of a new building – the cash value in euro of all payments for construction, operation and maintenance minus, if applicable, the cash value in euro of energy sales to third parties per square metre of gross floor area according to DIN 277. Life cycle analyses must be performed in accordance with Part A, section 2.2.1 of this Guideline and take the special aspects discussed below into consideration.

An analysis of selected costs during the life cycle of the building must cover the following costs:

Life cycle costs in the sustainability assessment	
Costs of manufacture acc. to DIN 276-1 [3]	Construction costs
Costs of building use acc. to DIN 18960 [4]	Operating costs
	Costs of cleaning, service and maintenance
Demolition costs acc. to DIN 276-1	Dismantling and disposal costs (not yet considered in the current version of the BNB)

Table D1: Life cycle costs in the sustainability assessment of refurbishment projects

The life cycle cost analysis according to the standards and system boundaries determined in the Guideline and in the Assessment System for Sustainable Building is, first and foremost, a tool to optimise the life cycle costs of a concrete measure. One prerequisite for optimisation is the possibility to intervene. The given condition of a building prior to the commencement of a measure can lead to costs during a refurbishment project which the design and construction process cannot influence or, if so, to a very limited extent only.

The general economic efficiency of a measure is often determined before the design and construction process starts, while demand planning and the analysis of variants which can meet demand have an important role to play here. The life cycle cost analysis according to this Guideline and the BNB is based on the decision for a concrete procurement variant and continues to ensure economic efficiency through the design and construction process. The life cycle cost analysis methodology described below thus focuses on costs which can be influenced by the design and construction process so that the maximum steering effect can be achieved during the design and construction phase. The analysis specifically also addresses the operation costs which will result from planning and design decisions. The parameters used here include, for instance, normalised and convention-based conditions regarding climate, use and exposure, user behaviour, development of economic parameters as well as the lifetime of components in the building.

The sustainability assessment of the building on completion of the design and construction phase includes a life cycle cost calculation which considers fewer cost types to be included than the analysis of the variants suitable to cover the given demand which is performed during earlier planning phases. However, all costs that can be influenced by the design and construction processes are analysed in much greater detail.

The life cycle cost analysis according to Part D of this Guideline considers the costs which can be influenced during a refurbishment measure. For this purpose, the eco-balance convention used to balance the old building structures is applied in analogy to the calculation of costs from the old building structures (see section 4.1.1.1). This means that all costs which, at the time the building is completed, have already been incurred as a result of construction and demolition, disposal or recycling of building structures are exclusively assigned to the planning, design and construction phase of the respective building structures themselves.

[3] See DIN 276-1 (2008)
[4] See DIN 18960 (2008)

The reasons contained in the section on the eco-balance also apply analogously to life cycle costs. The planners and designers in charge are thus primarily responsible for optimising the life cycle costs as contemplated in this Guideline.

This means that the life cycle cost analysis of old building structures must exclusively address the aspects of

- maintenance
- demolition
- disposal or
- recycling

of the old building structures that will continue to be used or reused. Note however, that the current version of the BNB criteria profile does not yet consider the aspects of demolition, disposal and recycling.

The assessment of repair cycles must consider the remaining life of the old, reused building structures. This means that the life cycle cost analysis must consider the residual life of the reused existing building structures, including the fact that replacement may be necessary earlier than in the case of a new building. The methodology of calculating the life cycle costs of refurbishment projects goes beyond the above-mentioned special characteristic of old building structures, but is otherwise the same as the methodology for new construction projects according to Part B of this Guideline.

4.2.2 Life cycle cost assessment

The construction costs in conjunction with refurbishment projects are strongly influenced by the given condition of the building and, also as a result of this, the necessary depth of intervention into the existing building structures. The costs of the project are also strongly influenced by the type and scope of the proposed modification and conversion measures. It hence makes no sense to assess the costs of the new life cycle without considering the depth of intervention. A distinction must be made here between complete and partial refurbishment.

A construction measure is always triggered by demand. If such demand cannot be satisfied by an existing building, which may have to be converted or reused, a new building will then become necessary. The economic quality of new construction projects is hence the standard for refurbishment projects. If the costs of a refurbishment project over the new life cycle and/or the defined observation period are lower than the costs of a new construction measure, refurbishment must then be considered to be economically advantageous.

Assessing the life cycle costs of complete refurbishment

The life cycle cost analysis of complete refurbishment measures must be generally carried out and evaluated in quantitative terms in accordance with the above-mentioned conventions and the criteria of the "Refurbishment" BNB-module. The BNB_BK 2.1.1 criterion is available for this purpose. Corresponding to the definition of the term "Refurbishment", the standard of the BNB criterion is based on the assumption that the existing building will be stripped almost completely to the structurally relevant structure and that the condition of the complete building will be largely equivalent to that of a new building on completion of the measure. This means that the old building structures which remain in use will not generate any significant repair and maintenance costs because the parts which are reused are mainly structurally relevant elements which are upgraded to an almost as-new condition as a result of the refurbishment measure. The assessment standard is thus exclusively applicable to complete refurbishment measures because only these measures feature such a degree of complexity.

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Complete refurbishment of monuments is an exception However, qualitative assessment of the life cycle cost analysis of complete refurbishment project of monuments is optionally also possible. For this purpose, the qualitative standard of the BNB_BK 2.1.1 criterion is available for monuments. A different assessment option for monuments is necessary in order to reflect the specific characteristics of monument-compliant refurbishment whilst at the same time addressing the social importance of monuments. In the case of monuments, all measures must generally be performed which are compatible with the requirements of the monument protection and preservation and which lead to an optimisation of life cycle costs whilst also considering ecological quality.

Assessing the life cycle costs of partial refurbishment

The life cycle cost analysis of partial refurbishment measures must also be carried out according to the above-mentioned conventions and in analogy to the BNB_BK 2.1.1 criterion. However, a quantitative assessment of the results of the life cycle cost analysis of partial refurbishment measures should be generally ruled out. The main reasons are the large variety of underlying conditions (such as age, type of construction) and the strongly varying degree of complexity of partial refurbishment projects. The resultant, wide range of different construction measures means that partial refurbishment projects cannot be reasonably compared using generally valid, fixed performance indicators or benchmarks. Furthermore, comparisons of measures that cannot be compared on the basis of the results of a quantitative assessment are not conducive to the purpose of a sustainability assessment. Instead, it must be ensured that the respective measure is optimised in terms of its life cycle costs.

The life cycle cost calculation and analysis must thus be used in partial refurbishment projects as a tool for comparing variants in order to identify the optimum variant with a view to economic quality. The perspective and subject matter of the life cycle cost calculation must be determined on a project-specific basis depending on the effects of the respective measure. With regard to construction costs, the perspective can refer to those building parts or elements which will be influenced by the respective measure. However, it is generally necessary to analyse the implications for the operation costs of the entire building and to perform a joint assessment of construction and operation costs. The process description of the qualitative assessment of the BNB_BK 2.1.1 criterion should be applied analogously.

The requirements for the sustainable procurement of services are additionally applicable. The “Sustainability Compass” of Deutsche Gesellschaft für internationale Zusammenarbeit is available as a tool for this purpose.

Qualitative assessment of life cycle costs

A qualitative assessment for using the life cycle cost analysis during the design, planning and construction phases as a tool for optimising economic quality is exclusively available for buildings with monument features. Choosing between quantitative and qualitative assessment (BNB_BK 2.1.1) is possible in these cases only. All other complete refurbishment projects require a quantitative assessment.

The alternative option of a qualitative assessment of buildings with monument characteristics is ultimately also meant as an incentive to use the life cycle analysis not just as a means for describing the status quo, but also as a steering instrument for economically optimised planning and design. The qualitative assessment can thus be understood as guidance for the use of the life cycle cost analysis during the design, planning and construction process and can also be used as such for all other measures.

The description of the methodology and possible applications of qualitative assessment in section 4.1.1.4 “Ecobalance assessment” also applies in analogy to the calculation and analysis of life cycle costs. The benchmark values needed for cost controlling and energy management are available from building databases, such as PLAKODA.

4.3 Socio-cultural and functional quality

Socio-cultural and functional qualities are very important for the assessment of a building by its users and society. These qualities are hence equally important when it comes to planning and designing new construction and refurbishment projects. The following socio-cultural targets must hence also be considered in refurbishment projects:

- Maintenance of functionality
- Ensuring design quality
- Protection of health, safety and comfort

The aspects of health, safety and comfort are particularly important. The requirements in Parts A and B of this Guideline are equally applicable to new construction and refurbishment projects. However, special features must be considered in conjunction with certain sustainability criteria related to socio-cultural and functional qualities. These features will be described below in addition to Part A of this Guideline.

An important goal of any construction measure is to achieve a high degree of user satisfaction with workplace and building conditions. Conditions that help to create user satisfaction promote creativity and productivity among employees. Whilst the needs of future users of a new building are generally only planned on the basis of technical building rules and regulations, refurbishment projects may also be based on past user experience. This can help to identify building qualities which should be maintained or optimised during refurbishment. This participatory instrument is addressed by the "stock-taking" criterion in BNB_BK 5.1.6.

4.3.1 Conversion capability

The future adaptability as well as conversion and reuse capability of structures is also very important for sustainable building in conjunction with refurbishment projects. Fulfilment of the requirements of functionality, flexibility and adaptability to changing conditions can influence the acceptance of a building, its use period and the resultant building-related costs during the life cycle as well as material flows and impacts on the environment. A building features a high reuse capability under aspects of sustainability if adaptation to changed use or conditions of use is possible at a reasonable cost and effort.

The following criteria are relevant when it comes to assessing reuse capability just as much as with new buildings:

Building geometry	Headroom, building depth, vertical development
Ground plans	Dimensions and development of use units
Design	Type and design of interior walls and partition walls
Technical equipping	Scope, flexibility, accessibility

Experience from completed refurbishment projects shows that maximum conversion capability often requires considerable and sometimes even unreasonable technical, financial and ecological efforts. The "conversion capability" criterion of the "Refurbishment" BNB-module (BNB_BK 3.2.3) hence exclusively addresses the new building structures of the respective measure within the scope of the sub-criteria which can be influenced by refurbishment. Otherwise, the assessment is carried out in analogy to the assessment of new construction project.

4.3.2 Ensuring design quality

As already discussed in section 1, "Sustainable development of building stock", the design and urban qualities of an existing building should be maintained or even enhanced wherever this is sensible and possible. The aim is to maintain the diversity of building culture and the unique and specific character of cities and residential areas.

The public sector and its buildings are particularly visible to the general public. Buildings owned by the public sector, in particular, constitute cultural assets worth protecting. Maintaining and correctly handling cultural assets is an important social task. This public sector is not only committed to this task, it must also act as a role model here.

When it comes to securing design quality (BNB_BK 3.3.1), two important aspects must be considered for refurbishment projects compared to new buildings:

- Identifying the given design and urban development quality of the existing building
- Addressing and enhancing existing design and urban quality

4.3.2.1 Identifying the given design and urban development quality

The basis for a high quality of stock development is an objective description and assessment of the design qualities of an existing building when the project starts. The historic, artistic, scientific or urban qualities must be identified as a basis for adequate recognition which, for its part, is necessary when it comes to maintaining or enhancing design and urban qualities. This means that the type and scope of the existing qualities must be identified first. A general distinction is made between building stock with and without listed building features.

Buildings with listed building features

Monuments, monument areas and buildings worth listing can be assumed to represent a high design, urban and/or cultural value already by virtue of their listed building properties and the resultant relevance for building culture. In the case of monuments and monument areas, design and construction support by public authorities responsible for the monument protection usually ensures that this quality is maintained or developed further during the refurbishment projects.

Stock-taking takes place in the form of an expert report prepared during the project preparation phase. The form, contents and responsibilities for the preparation of the expert report must be agreed to with the monuments protection authorities and implemented according to their directions. If refurbishment planning involves a property which constitutes a historic monument area, the focus of the monument protection report must be extended to include a so-called “monument preservation plan” for the entire property. The form, contents and responsibilities for the preparation of the monument preservation plan must be agreed to with the monuments protection authorities and implemented according to their directions.

Buildings without listed building features

An analysis and subsequent documentation are required as part of the description of the existing design and urban quality. The analysis should cover at least the following aspects:

Examination of the existing design quality	
Specifications considering any relevant information	on planning-law conditions
	on the urban environment of the building
	on outdoor facilities
	on building design
	on structural elements
	on permanent and non-permanent features (furniture and works of art)
	to be supplemented by photo documentation
Assessment of the building and individual parts with a view to	urban quality
	design quality and/or cultural values
Documentation	as-built drawings (layouts, sections, views)
	existence of high urban or design quality and/or cultural value

Table D2: Aspects to describe the urban and design quality of building stock without listed building features

High quality or cultural importance can be assumed to exist if the existing building:

- was awarded a recognised architectural award for high design quality after its completion,
- was classified by the municipality as “other building structures particularly worth protecting”,
- was classified as featuring “good architectural quality” of its design by a recognised, independent body of experts.

4.3.2.2 Addressing and enhancing existing design and urban quality

Buildings with listed building features

A prerequisite for sustainable refurbishment is complete fulfilment of the demands of the monuments protection authorities. In the case of monuments and monument areas, design and construction support by the monuments protection authorities usually ensures design quality. However, this must also cover those areas which are not subject to any requirements by the monuments protection authorities. In individual cases, a planning competition may be the appropriate solution even for buildings with listed building features. If this is not the case, other instruments must be applied in order to ensure design quality. The section on "Buildings without listed building features" provides a list of tasks which may be necessary under the "Partial refurbishments" keyword.

Buildings without listed building features

The adequate approach in relation to the given design and urban quality depends heavily on the respective type of measure and the depth of intervention. A distinction must be made here between complete and partial refurbishment.

In analogy to the approach for new construction projects, design competitions are also the appropriate solution to ensure design quality of complete refurbishment projects. In order for a design competition to yield a solution which adequately addresses the given design and urban quality, the handling of the existing building structures must explicitly be included in the competition task. Furthermore, documentation of the existing design and urban quality must be available to the entrants.

In individual cases, a planning competition may also be the appropriate solution even for partial refurbishment. However, this will not apply very often because for many partial refurbishment projects the costs and efforts involved in a design competition would be unreasonable or because design aspects have a very marginal role to play, for instance, when it comes to revamping technical systems. If no design competition is performed although certain design aspects have to be considered within the scope of the measure in question, other instruments will have to be used in order to ensure design quality. This can, for instance, call for the following tasks to be performed:

- Preparation of design concepts
- Development of draft design variants
- Preparation of colour and material registers
- Involvement of an independent advisory design body

4.3.3 Art in architecture

Federal construction projects should earmark funds for art in architecture so that artists can be commissioned in as far as this is justified by the purpose and importance of the building. This applies to both new construction and refurbishment projects (see RBBau Guidelines, K 7). This is regularly the case with new construction and refurbishment projects.

When it comes to refurbishment, the aspect of new works of art in architecture is supplemented by the question as to how existing works of art in architecture are to be handled. Existing works of art must be described, preserved and communicated according to their value in order to adequately handle them as part of the refurbishment projects.

The "Guideline Art in Architecture"[5] document from the Federal Building Ministry addresses the creation of new and treatment of existing works of art in architecture. The assessment methodology of the BNB_BK 3.3.2 criterion is designed according to the "Guideline Art in Architecture". Adherence to these guidelines is a prerequisite for assessment according to the "Refurbishment" BNB-module.

5 See BMVBS (2012 b)

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4.4 Technical quality

As already mentioned in section 3.2, “Comparison of new construction and refurbishment projects”, users often expect refurbishment projects to yield a quality that is equivalent to that of new buildings. Given these expectations, the technical quality of new construction projects is generally the benchmark for refurbishment. The only exception permitted under the “Refurbishment” BNB-module are cases in which deviations are absolutely necessary due to specific conditions of the existing building.

Functioning fire protection, sound insulation and a high degree of cleaning and maintenance-friendliness are important aspects of a sustainable building and at the same time also a fundamental demand on the part of users. With regard to these aspects, the standards for new buildings also apply in full to refurbishment projects. Any deviations by refurbishment projects are presented in a transparent manner by the notes regarding the application of the “Refurbishment” BNB-module.

The requirements for structural fire protection are laid down in the applicable federal state building regulations and in the technical construction rules. Furthermore, the “Fire Safety Guide”[6] from the Federal Building Ministry is another binding tool for federal buildings and must be considered in planning and design.

The requirements for structural sound insulation (BNB_BN 4.1.1) are subject to the generally accepted rules of technology. Minimum requirements are laid down in DIN 4109[7] and, as such, are also applicable to refurbishment projects.

The cleaning and maintenance-friendliness (BNB_BN 4.1.3) of the structure strongly influences costs and the environmental footprint of a building during its use phase. Components in an optimum maintenance condition reach their maximum service life and this must also be a key criterion for refurbished buildings.

Many building-specific aspects must be considered for heat insulation and protection against condensation. Based on the criterion for new buildings, a building-specific criterion was hence developed for this sustainability criterion in the “Refurbishment” BNB-module. This will be introduced below.

Heat insulation and protection against condensation

Heat insulation and protection against condensation (BNB_BK 4.1.2) serve to minimise heat demand for air conditioning whilst at the same ensuring a high degree of thermal comfort and avoiding damage to the building. This is characterised in existing and refurbished buildings by the heat and humidity protection quality of the building envelope. In this respect, the following criteria must also be considered in refurbishment projects:

- Component-based average heat transfer coefficient
- Penalty to consider thermal bridges
- Air permeability (joint permeability)
- Condensation water volume within the structure
- Air-tightness of the building envelope
- Solar radiation index

These criteria cannot be directly transferred from new constrcution to refurbishment projects. For the most diverse reasons, the revamping of many existing buildings to a standard equivalent to that of new buildings is either impossible or would involve unreasonable costs. This is also why the EnEV distinguishes between new construction and refurbishment projects. In the case of existing buildings, the aspect of monument protection must be additionally considered.

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6 See BMVBS (2006), also available at: http://www.nachhaltigesbauen.de/leitfaeden-und-arbeitshilfen/weitere-leitfaeden-und-arbeitshilfen.html

7 See DIN 4109 (1989), including corrections

However, in view of user expectations from comprehensive refurbishment projects, new buildings generally set the benchmarks for the technical quality of heat insulation and protection against condensation. Criterion 4.1.2 of the “Refurbishment” BNB-module hence foresees suitable differentiation on the basis of the target values for new buildings in order to adequately consider the special conditions of refurbishment projects. Although the targets are rarely achieved in refurbishment projects, they should nevertheless serve as an incentive for optimising structural thermal insulation. Heat insulation and protection against condensation should be planned and designed on the basis of the above-mentioned criteria as part of the energy concept. It should, however, be noted that some of these tasks are not fully covered by the public verification method foreseen in the EnEV. The results of the design phase must be considered in the invitation to tender and during execution.

Buildings with listed building characteristics require a separate examination. An alternative approach can be adopted in these cases because building preservation rules often contain requirements due to which the applicable standards cannot be achieved. The BNB_BK 4.1.2 criterion differentiates between different intensities of the standards resulting from building preservation requirements:

Case 1	The complete building has features of a listed building
Case 2	Parts (e.g. wings) of the building have features of a listed building
Case 3	Individual elements (e.g. façade, windows) have features of a listed building or are classified by an expert of monument protection as being particularly worth protecting

All measures which are compatible with the requirements for monument protection must be carried out in the respective case. Furthermore, the decision not to implement a higher standard must be justified. In cases 2 or 3, building parts and elements which are not subject to any restrictions must be generally designed and assessed according to the assessment standards for refurbishment projects.

The BNB_BK 4.1.2 criterion must be applied to complete refurbishment and also to partial refurbishment measures in as far as these lead to a change in energy quality. Fulfilment of the minimum thermal protection requirements according to DIN 4108 is mandatory in order to ensure thermal protection from the perspective of building protection and hygiene.

4.5 Process quality

The future quality of a building is essentially determined by decisions which are made at an earlier design stage, for instance, within the scope of the Decision-making Documents (ES – Bau). This is why the quality of the design process has a key role to play in refurbishment projects too because the possibilities to influence environmental impacts, resource savings and costs are best at the beginning of the project. Especially when it comes to refurbishment projects, the legal, technical, functional, urban and architectural basis must be identified at an early stage. The resultant information forms the basis for feasibility studies, economic efficiency analyses and life cycle analyses (LCC and LCA) as well as the starting point for the ongoing planning and design process.

Planning and design of refurbishment projects must also include concepts for the demolition of existing building parts. The following section explains the procedure for determining the condition of the building and for demolition planning.

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4.5.1 Stock-taking

The purpose of stock-taking is to identify the strengths, weaknesses, potentials and risks of an existing building. These result from the condition of the building to be refurbished and from the general conditions of stock development (see section 3.3). Very important aspects in this respect thus include, for instance, the legal situation, such as grandfathering, monument protection, neighbour law or immission control. The stock-taking process described below covers the stock-taking of the building condition as well as the building diagnosis and is based on the complete identification and subsequent consideration of the legal framework conditions as well as the generally accepted state of the art.

The major elements of stock-taking (BNB_BK 5.1.6) are holistic recording of the as-is condition as well as of the building condition using a qualified building diagnosis. Both analytical steps are based on the systematic exploration of the existing building structures. This exploration basically consists of the following elements:

1. Stock-taking

- Geometric stock-taking
- Stock-taking of the building structure and building materials
- Stock-taking of building services
- Exploration of the building and use history
- Stock-taking of exposure

2. Building diagnosis

- Supporting structure
- Energy quality
- Pollutants
- Humidity and salt exposure

The quality of stock-taking basically has a decisive impact on the planning, design and construction process of a refurbishment project. Comprehensive and meticulous stock-taking as part of project preparation work enables a significant reduction in planning uncertainty which is usually much higher in refurbishment projects. Stock-taking enables efficient and optimised construction with a view to technical building quality and construction costs as well as environmental impacts and resource consumption. As one major prerequisite, both stock-taking and building diagnosis must be performed systematically, carefully and to a reasonable extent.

The stock-taking process is broken down into the following phases:

- General and fundamental stock-taking of the building to be examined
- Precise exploration of parts of this property using the building diagnosis

Whilst stock-taking first processes all basic data and features of the existing building for the subsequent planning and design process, the building diagnosis systematically explores key criteria which enable a detailed assessment of the condition of the building.

The stock-taking phase always provides results regarding the geometry of the building, its existing building structures and construction materials as well as the building services installed at the time of the survey. Furthermore, the property's building history can be helpful if the original purpose of the building or striking structural modifications during the use time provide important information regarding boundary conditions for planning and design. Finally, specific influences on the existing building should be addressed under the exposure complex in as far as such influences are due to location or ambient conditions (such as groundwater exposure, high thermal loads in summer or high ambient noise exposure).

The building diagnosis usually aims at generating detailed information regarding the supporting structure of the building, its energy quality, possible hazards for users and the environment due to pollutants as well as increased humidity and salt exposure. In this respect, preliminary diagnostic examinations on the level of the entire building as well as detailed individual examinations of specific structural elements are important.

Numerous examinations of the structures of the building must be carried out during both stock-taking and the building diagnosis. Such examinations often require the local exposure of structures, intervention into the building structures as well as sampling operations. However, in cases like these which can hardly be avoided, a reasonable ratio between the gain in information and the foreseeable loss of structures should be aimed at. This principle applies to all kinds of building stock, but particularly to monuments of high historic value as well as works of art.

The use time of a structural or technical component is defined as the period of time after which the component is likely to need replacement. Typical reference values are mean values which also consider technical, functional and aesthetic aspects as well as legal requirements. The determination of the remaining service life of structures and technical components helps to assess when measures to restore their functionality will have to be initiated. One important tool to this effect is the table "Use periods of building parts for life cycle analyses according to the BNB" [8] from the BBSR as well as VDI 2067.

When performing building diagnostic activities, designers and planners are often faced with the challenge of capturing all data necessary for the ongoing design and planning process with maximum reliability and at a reasonable technical and cost effort. A multi-stage structure of building diagnosis activities is often advisable, with different steps of the analyses being dependent upon upstream results. It should be generally remembered that a poor building diagnosis often leads to a significant lack of information which may jeopardise the success of a repair measure or involve a high cost risk. Planners and designers must hence fulfil high expertise standards. This applies not just to specialists and experts, but also to general technicians who are responsible for the overall success of the construction project. The results of the stock-taking exercise enable the identification of the existing building structures in terms of their structure and quality, design, condition as well as any risks to users and the environment generated by these structures. Furthermore, the structural elements which are suitable for continued use and those which should be removed are systematically examined. Stock-taking (recording of the as-built condition, building diagnosis) forms the basis for the planning of all necessary refurbishment projects. Stock-taking must form part of the ES – Bau phase. To this effect, the BNB_BK 5.1.6 criterion must be applied to complete refurbishment and also to partial refurbishment projects in as far as these involve a significant change in building stock and energy quality. In order to ensure that the stock-taking results are considered during planning, design and execution, these results must be generally made available to all planners and designers.

4.5.1.1 Stock-taking – geometry

All the geometric data and boundary conditions of the subject matter are first recorded during a very early stage of the stock-taking process. Existing as-built drawings and construction documents may also be used in this context if their quality and suitability is verified in the building.

Geometric stock-taking is a prerequisite for the sustainable development of an existing building in order to provide a set of up-to-date planning and design documents for the existing building. This must be available in digital form (CAD) and include at least the following drawings and plans:

- Layouts of all storeys proper, basement and attic storeys as well as usable roof spaces
- Sections for all structurally independent building parts
- Sections of all stairwells
- Views of all façades
- Roof top views

[8] http://www.nachhaltigesbauen.de/de/baustoff-und-gebaeudedaten/nutzungsdauern-von-bauteilen.html

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The accuracy of geometric stock-taking and the scale for the planning and design documents depend on the size of the existing building as well as the scope and intensity of structural intervention. A minimum scale of 1:100 must be chosen for planning and design documents. Important details of existing buildings must additionally be shown at a reasonable scale of between 1:1 and 1:25.

Geometric stock-taking, especially for large buildings, is an interdisciplinary exercise for surveyors and civil engineers. The quality of the results of the analysis is thus also influenced by suitable communications.

4.5.1.2 Stock-taking – building structure and construction materials

Structural stock-taking systematically explores the building structure, including all relevant designs and construction materials. In this context, the structure of the unfinished building is particularly important in as far as this structure is relevant for the supporting structure and future use. However, stock-taking is also performed for the building envelope as the interface between the heated building space and the outdoor air. The structural layers of typical wall, ceiling and floor structures as well as roof cross-sections are analysed and documented. The results of structural stock-taking are documented both in the form of (building) descriptions and as drawings (as-built details).

The results of structural stock-taking are detailed information regarding existing building structures and designs, construction materials as well as relevant layer structures of the different designs. This is an important basis for the technical assessment of existing buildings with a view to preservation worthiness and continued use of the structures concerned. These results are subsequently supplemented by the results of the building diagnosis. Another central precondition for the continued use of existing structural elements is compliance with and/or implementability of construction law and other legal requirements.

Structural stock-taking should be carried out by seasoned engineers and architects who should be specialists for existing building structures.

4.5.1.3 Stock-taking – building services

Stock-taking of building services of the property concerned should be performed parallel to structural stock-taking. This step of the analysis addresses all heating, ventilation and sanitary installations, electrical installations as well as existing air conditioning and building automation systems. This work requires skilled building services engineers.

When assessing the reuse potential of building services, it must be generally considered that their average service life is significantly shorter than that of typical building structures. This means that the analytical depth can be reduced in the case of building services where ongoing use is no longer reasonable in view of their technical obsolescence or wear and tear.

4.5.1.4 Stock-taking – building and use history

The analysis of a property's construction and use history is not an end in itself for interested experts. Instead, it explores the basic influences from the construction and use phase of the building which can be demonstrated to have an influence on building stock. Aspects which have an important role to play in this respect include the time of construction and its technical, economic and political framework conditions, the original client and the original purpose of the building. Furthermore, important conversion and repair work or extensions, including the time of their performance, should be explored. The results of historic stock-taking can help, for instance, to explore special structural characteristics and shortcomings of the existing buildings, problems due to previous intervention as well as pollution risks which are typical for the construction time.

Besides the construction history of the building, reliable information concerning its use phase can also be very important in order to identify weaknesses, the potential for optimisation as well as building qualities worth preserving. In this context, the building can be assessed on the basis of data and experience regarding its ongoing use (information from users, data from facility management, consumption data, etc.). For this purpose, the past use phase of buildings to be refurbished can be evaluated on the basis of the “Use and Operation” BNB-module.

4.5.1.5 Stock-taking – exposure

This sub-aspect of the stock-taking exercise encompasses the analysis of special influences on a building that result from its location or ambient conditions. Besides the status quo at the time of the analysis, the development during the use phase following refurbishment should also be assessed.

The exposure aspect should especially consider environmental influences, such as groundwater or flood risks or high thermal exposure in summer (location in hot urban zones). In the case of a seasonal flood risk, the specific pre-warning times at the location should also be considered. Special anthropogenic influences can occur, for instance, as high noise emissions in the surrounding area.

In any case, however, exposure analyses consider only those external influences at the location which are not covered by customary design and rating algorithms (for instance, for wind and snow loads) and/or which exceed the applicable characteristic values in individual cases.

4.5.1.6 Building diagnosis – supporting structure

When it comes to analysing and assessing the existing supporting structure and to developing a structural model, engineers initially refer to the results of geometric and structural and, if necessary, historic stock-taking. Additional building diagnosis is required for a more precise assessment of the condition of structural and design elements. The existing building structures are assessed according to the criteria of load-bearing capability (also with a view to future requirements), durability (long-term preservation of the value of the asset) and suitability or use (unrestricted usability).

The specification, scope and intensity of the supporting structure diagnosis depend on the particular design and the established intensity of damage. In any case, the task involves exploring the structural design (unless this was already part of structural stock-taking) as well as the extent and intensity of damage including the implications for the load-bearing capacity. Typical aspects of the building diagnosis include, for instance:

- **Wooden structures:**
  identification of plant and animal wood pests, including extent and intensity of damage
- **Brickwork:**
  assessment of single-shell or multi-shell structures, composite characteristics of brickwork and material, properties of bricks and mortar
- **Reinforced concrete:**
  analysis of reinforcement layers and direction, carbonisation depth and reinforcement condition
- **Foundations:**
  assessment of subsoil properties, permissible subsoil compaction and settlement sensitivity
- **Reinforced-concrete parts with corrosion damage:**
  analysis of residual load-bearing cross-sections

In the case of the supporting structure analysis, the results of the building analysis are directly considered in the structural calculations as a basis for concepts for structural rehabilitation measures or reinforcing structures.

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4.5.1.7 Building diagnosis – energy quality

The evaluation of energy quality considers the status quo prior to commencing refurbishment and the potential for energy-related rehabilitation as part of a complete refurbishment project. This evaluation must be based on the results of geometric, structural and building services stock-taking.

The technical stock-taking and evaluation of the existing and possible energy quality of the existing building must specifically address the following aspects:

- Energy balance of the current condition according to the applicable version of the EnEV
- Identification of relevant energy-related weak points
- Evaluation of the consumption structure of the building
- Identification of physical problems and shortcomings of the building (detail analysis)
- Variant analysis in order to determine the potential for energy-related rehabilitation

The potential for energy-related refurbishment should be determined in the form of a rough variant analysis. A host of options and differentiated levels usually apply to the type and extent of energy-related building refurbishment measures. The analysis of the initial energy condition and of the optimisation variants should cover at least the following variants:

- Minimum variant
- Optimised variant
- Target variant

Modernisation measures for the building envelope and building services must be examined in all variants. The final contents of the variants and the differences between them should be determined separately for each refurbishment project. Measures for buildings with listed building features must be generally limited to measures suitable for monuments.

The influence of energy-related refurbishment on annual energy consumption and energy costs must be shown for each variant. The resultant life cycle costs of the different variants must then be compared (see section 4.2).

Modernisation measures of the minimum variant are designed to comply with minimum legal requirements for existing buildings in terms of thermal and humidity protection as well as energy efficiency. Besides the requirements under the EnEV, absence of damage during future use as well as compliance with the hygienically required minimum thermal protection according to DIN 4108-2 must be ensured.

In the case of the optimised variant, it must be examined to what extent ecological, economic and socio-cultural aspects can be considered at the same time and with equal priority. This means that environmental impacts, resource consumption, economic efficiency, functionality and design must be brought in line with each other. An alternative option is to consider specific targets, such as energy-related rehabilitation of a building to new building standards according to the EnEV.

In the target variant, the possibility of particularly demanding energy-related building stock modernisation should be explored. In this way, the option of a nearly zero energy building could be examined if the building in question has no listed building features. In the case of buildings with listed building features, consideration could be given to monument-compliant refurbishment to new building standards according to the EnEV.

4.5.1.8 Building diagnosis – pollutants

Characteristic building pollutants are found in almost every existing building. Since pollutants can directly affect user health, this issue must be given top priority. If pollutants are suspected in a building, or if this cannot be generally ruled out, more in-depth examinations are then always necessary. In the interest of sustainable refurbishment of buildings, measures must be taken to ensure that pollutants will not cause any threat to human health or to the environmental resources of groundwater, surface water, soil and air. The preparation of a pollutant report by a qualified expert is usually indispensable. This report should already be prepared during the project preparation phase.

The building diagnosis regarding pollutants in buildings should consider the results of structural, historical and, if applicable, HVAC stock-taking. Significant correlation is often found between certain construction times, the building designs and technical equipment typical for such times as well as the resultant risk from characteristic pollutants. Certain past building uses can also suggest the existence of certain pollutants.

The handling of pollutants in buildings and the preparation of a pollutant report are subject to several interrelated laws which foresee a number of obligations for clients. These laws include labour protection and chemical substances laws as well as the Social Code and the related accident prevention regulations. Some regulations to be specifically considered are the "Construction Site Ordinance on Protection of Health and Safety" (Construction Site Ordinance) as well as the Technical Rules for Hazardous Substances (TRGS). Furthermore, the "Guidelines for Recycling" by the Federal Building Ministry (www.arbeitshilfen-recycling.de) were introduced for refurbishment projects in order to lay down rules for the preparation of pollutant reports and the elimination of pollutants. The involvement of an expert in the assessment of pollutants and a parallel assessment of the potential for risks for humans and the environment should be mandatory.

A detailed documentation of the pollutant analysis must be provided in a pollutant register. If pollutants remain in the building, suitable measures must be implemented in order to rule out any future potential risks for humans and the environment. Transparent communication of any remaining pollutants, in particular, to building users and recording in the as-built documentation for the building are necessary.

The result of a pollutant report must show proof or exclusion of any need for action regarding the elimination of any risk potential due to pollutants. If the report identifies any need for action, the corresponding measures must be performed.

4.5.1.9 Building diagnosis – humidity and salt exposure

Humidity and salt exposure is a typical problem in existing buildings. This problem occurs particularly often in the following areas of a building:

- Building parts in contact with or covered by soil
- Building parts in contact with inadequate roof covering and, in particular, roof sealing including connecting areas and openings
- Areas near particularly exposed structural elements, such as roof terraces, balconies, pergolas or recessed storeys

Such areas should be carefully inspected in order to identify the extent and intensity of existing humidity exposure and to determine repair measures suitable for the respective construction materials involved on this basis. Humidity analyses can be performed using various methods, from first humidity indications at the building right through to laboratory methods for the precise identification of root causes. Increased humidity exposure generally causes not only aesthetic problems, but also adversely affects room climate and material properties, such as thermal conductivity or the strength of certain construction materials. Furthermore, wet component surfaces are a very good basis for secondary damage processes, such as mould or damage caused by alternating frost and thaw exposure.

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Typical damage mechanisms related to humidity ingress into capillary and porous materials often support ingress of dissolved harmful salts into the material if such a source exists. Relevant harmful salts in this context are chlorides, sulphates and nitrates. These salts adversely affect material properties because the crystallisation pressure primarily causes near-surface structural damage in the evaporation zone and because increased hygroscopicity of wet construction materials, for its part, leads to permanent humidity burdens. Strongly increased salt concentrations always lead to significantly higher rehabilitation costs and, in a few extreme cases, may even require demolition of complete building parts. The recommended methods for diagnosis are qualitative and quantitative salt analyses as a result of which the concrete exposure intensity and the resultant repair measures have to be defined.

4.5.2 Demolition planning and demolition measures

The results of stock-taking must be considered when it comes to demolition planning and the subsequent tendering and commissioning of demolition measures (BNB_BK 5.1.7). The following criteria must hence be examined and coordinated during demolition measures:

- Technical work safety
- Demolition planning
- Selective demolition (considering whether or not the remaining building is used)
- Examination of waste separation and disposal possibilities

Demolition planning at an early stage not only addresses requirements related to sustainability, but is also based on a host of legal requirements (such as the Construction Site Ordinance). The "Guidelines for Recycling" includes standards to be applied when it comes to planning and performing demolition work.

4.5.2.1 Technical work protection

Construction workers are exposed to particularly high accident and health risks. Demanding requirements exist for the coordination of protection measures in order to consider weather influences, time pressure and unexpected situations occurring in existing buildings. The German occupational health and safety legislation forms the basis for the necessary safety measures. Pursuant to § 3 of the Construction Site Ordinance [9], a safety and health coordinator must be appointed for construction sites where workers from several contractors are working. The safety and health coordinator must be appointed irrespective of whether the workers from several contractors work successively or at the same time. Furthermore, the Construction Site Ordinance also sets forth that the safety and health coordinator must be involved during both the planning and execution phase.[10]

4.5.2.2 Demolition planning

Demolition planning must be performed on the basis of stock-taking (see section 4.5.1) in order to determine building parts and materials that can be reused as well as pollutants and historical contamination. Qualified staff must perform demolition planning in advance of demolition as a basis for executing the demolition work. The result of demolition planning is a demolition and disposal concept which should, for instance, include the following aspects:

- Logistics concept
- Analysis of susceptibility to vibration
- Consideration of nuisance to the environment/ surrounding area
- Concept for the handling of construction rubble and contaminated materials
- Time schedule
- Demolition methods
- Responsibilities

The "Guidelines for Recycling" address the extent and contents of demolition planning for construction projects regarding existing federal buildings.

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9 BaustellV (2004)

10 See Suppelt (2000)

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4.5.2.3 Concept for selective demolition (under the conditions of active/inactive buildings)

In contrast to construction sites for new buildings, refurbishment work on buildings which remain in use calls for special precautions because users are in the building and/or because spaces continue to be used while construction work is being carried out. These cases call for the preparation of a demolition concept and a compilation of the necessary user information. Measures must be taken in order to ensure the continued trouble-free use of building areas not affected by work and a suitably coordinated construction schedule must be drafted.

4.5.2.4 Examination of waste separation and disposal options

Relevant requirements during the course of demolition work concern not just the physical safety of individuals but also the controlled disposal of demolition and packaging materials. Since correct waste separation must be controlled and monitored, those responsible for waste separation must be appointed and a corresponding reporting system in the form of a construction site journal must be ensured.

5. Sustainability assessment of building refurbishment projects

In order to be able to address the special characteristics of refurbishment projects, the criteria of the "New Construction" BNB-module were applied to refurbishment projects after certain criteria were modified and other criteria added which are specific for existing buildings. The set of criteria of the "Refurbishment" BNB-module is thus made up of unchanged criteria for new buildings, modified criteria for new buildings as well as specific criteria for existing buildings.

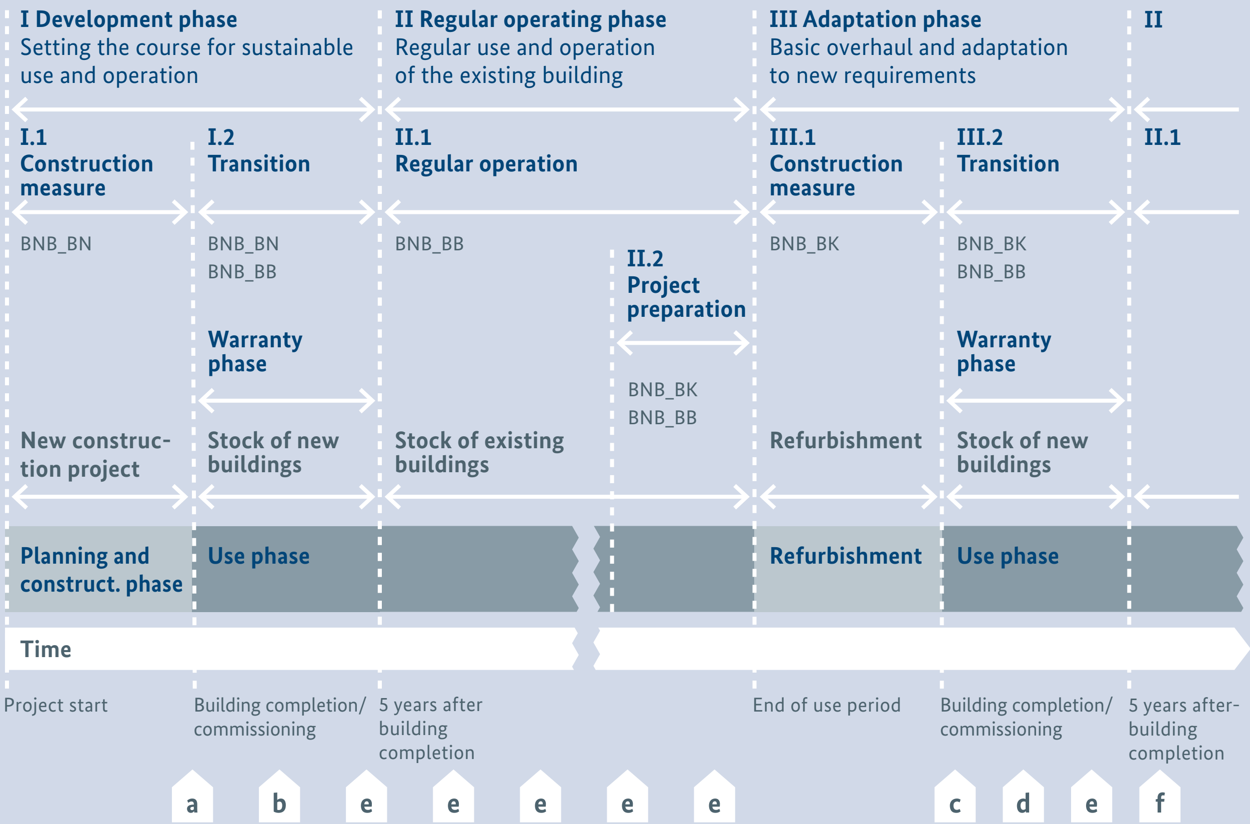
The "Refurbishment" BNB-module provides an holistic assessment system for refurbishment projects which considers the ecological, economic, functional and technical requirements at the same time and on an equally important basis. This module can be used to describe the contribution of a refurbishment measure to sustainable development in a transparent, measurable and verifiable manner.

As already discussed, users often expect that refurbishment measures can achieve a quality which is comparable to that of existing buildings. The "Refurbishment" BNB-module can address these expectations in that it can help to show the contribution of a refurbishment measure towards sustainable development.

In the case of a refurbishment project, the building and the property are always the focus of the examination. This means that the building which results from refurbishment or modification will be considered. The focus is hence not on the individual structural intervention measures alone. 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. This is, for instance, relevant if such products

"REFURBISHMENT" BNB-MODULE			
Adapted and new criteria in the BNB_BK system		**Adapted**	**New**
ECOLOGICAL QUALITY			
BK	1.1.1 Global Warming Potential (GWP)	×	
BK	1.1.2 Ozone Depletion Potential (ODP)	×	
BK	1.1.3 Photochemical Ozone Creation Potential (POCP)	×	
BK	1.1.4 Acidification Potential (AP)	×	
BK	1.1.5 Eutrophication Potential (EP)	×	
BK	1.1.6 Risks to the Local Environment	×	
BK	1.1.7 Sustainable Logging/Wood	×	
BK	1.2.1 Primary Energy Demand, Non-Renewable (PE_{ne})	×	
BK	1.2.2 Total Energy Demand (PE_{total}) and Share of Renewable Primary Energy (PE_{e})	×	
BK	1.2.4 Demand of Space	×	
ECONOMIC QUALITY			
BK	2.1.1 Building-Related Life Cycle Costs	×	
SOCIO-CULTURAL AND FUNCTIONAL QUALITY			
BK	3.2.3 Capability of Conversion	×	
BK	3.3.1 Design and Urban Quality	×	
BK	3.3.2 Art in Architecture	×	
TECHNICAL QUALITY			
BK	4.1.2 Heat Insulation and Protection against Condensation	×	
PROCESS QUALITY			
BK	5.1.3 Complexity and Optimisation of Planning	×	
BK	5.1.6 Stock Taking		×
BK	5.1.7 Demolition Planning		×

Table D3: Adapted and new criteria in the "Refurbishment" BNB-module



Possible assessment times:
a Assessment of new construction project
b Classification of new building stock as new construction (special solution for the transition phase)
c Assessment of refurbishment
b Classification of new building stock as refurbishment (special solution for the transition phase)
e Assessment of the “Use and Operation” module (examples)
f Special case of building diagnosis not linked to a measure (example)

Fig. D4: Evaluation time of complete refurbishment

can have a negative impact on humans and the environment during current and future use phases, or if products and parts can develop a negative impact as a result of refurbishment projects, for instance, dismantling and disposal.

The integration of sustainability aspects into the planning and design process according to the RBBau Guidelines is structurally described in Part B of this Guideline and must be analogously applied to refurbishment measures of existing buildings.

According to the diagram above, the following application case belongs to the refurbishment phase:

- III.1 – Refurbishment with assessment time c (see section 5.1)

5.1 Sustainability assessment of refurbishment measures

The “Refurbishment” BNB-module must be applied to refurbishment projects during the design, planning and construction phase if the measures qualify as “Refurbishment” as defined in this Guideline. The “Refurbishment” as well as the “New Construction” BNB-module must be used at the time of handing over and commissioning at the latest in order to quantify sustainability aspects and determine the total degree of fulfilment. The analysis covers the building and the property in the as-built condition, including the planned course of use. The explanations in Part A of this Guideline are analogously applicable to the “Refurbishment” BNB-module too.

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Furthermore, the "Refurbishment" BNB-module must be applied in analogy to the application process of the "New Construction" BNB-module which is described in detail in Part B of this Guideline. The minimum requirements according to Annex B1 of Part B of this Guideline are also applicable. The main differences between the two modules concern the contents of the assessment criteria. The only structural difference exists in the two additional criteria of the stock taking (BNB_BK 5.1.6) and demolition planning (BNB_BK 5.1.7) which the "Refurbishment" BNB-module additionally contains in conjunction with the description and assessment of process quality. These criteria must already be considered during the project preparation (ES – Bau) phase. The list of criteria which is attached to this Guideline as Annex D1 provides an overview.

5.2 Sustainability assessment of partial refurbishment measures

The determination of the total degree of fulfilment with the "Refurbishment" BNB-module usually means an unreasonable level of effort when performed for partial refurbishment measures and is hence dispensable. Furthermore, a quantitative assessment of partial refurbishment measures using benchmarks is generally impossible for certain criteria because a common benchmark cannot exist in view of the wide range of different construction measures. It is, however, advisable to update an assessment which was already performed in advance of the measure. In this case, the results of the criteria affected by partial refurbishment can be exchanged. Irrespective of sustainability assessments, property documentation must be updated after partial refurbishment projects too.

The individual measures performed within a partial refurbishment project must be in line with the requirements of sustainable building. The contents and requirements of section 4, "Specific criteria for sustainable building refurbishment", must be generally fulfilled by partial refurbishment projects. Moreover, all deliveries and services necessary for a partial refurbishment project must be obtained in a sustainable manner and from sustainable sources. The "Sustainability Compass" of Deutsche Gesellschaft für internationale Zusammenarbeit [11] is available as a tool for this purpose.

Beyond these requirements, partial refurbishment projects additionally require analogous application of the relevant criteria of an existing "Refurbishment" BNB-module.

5.3 System variants

The "Refurbishment" module forms part of a system variant of the BNB. The module is made available for selected buildings and types of use and can only be used for these. Up-to-date information on this topic can be found on the Information Portal Sustainable Building of the BMUB (www.nachhaltigesbauen.de).

The "Refurbishment" BNB-module is currently available for the buildings and types of use classified as "office and administration buildings". During a transitional phase, only an analogous application of the "office and administration buildings" system variant is possible for refurbishment projects where no "Refurbishment" module exists for the respective building and type of use.

5.4 Analogous application

Analogous application is based on the "Refurbishment" BNB-module of the "office and administration buildings" variant. If, subject to the above-mentioned rules, it must be ensured that the principles and quality requirements from the Guideline for Sustainable Building can be implemented analogously, a sustainability-orientated target agreement must be concluded to this effect which must be set up or edited according to Part B of this Guideline, either for investment measures according to Section D of the RBBau Guidelines during the determination of construction demand (Section D2 of the RBBau Guidelines) or, in the case of investment measures according to Section E of the RBBau Guidelines during the preparation of the ES – Bau (Section E2 of the RBBau Guidelines).

[11] http://oeffentlichebeschaffung.kompass-nachhaltigkeit.de

In analogy to Annex B5 of the Guideline for Sustainable Building, a target agreement table must be set up for this purpose without determining the total degree of fulfilment nor any partial degrees of fulfilment. Instead, the qualitative requirements must be laid down which ensure the sustainability of the measure. The quality levels of the relevant criteria of the Assessment System for Sustainable Building have to be used for this purpose. The target agreement table becomes part of the ES – Bau. The target agreement remains binding throughout the entire term of the project. In the case of analogous application to partial refurbishment projects, those criteria of the "Refurbishment" BNB-module must be identified first which can be influenced by the measure in question (influenced criteria). The target agreement is only necessary for the influenced criteria. The construction administration has to prepare the target agreement table with the support of a BNB sustainability coordinator who ensures analogous application of the criteria concerned. The BNB sustainability coordinator must document the implementation of the target agreement as part of the planning, design and construction process in analogy to the verification procedure of the BNB.

Appendix

Abbreviations

AMEV Arbeitskreis Maschinen- und Elektrotechnik staatlicher und kommunaler Verwaltungen (Mechanical and Electrical Engineering Working Party of National, Regional and Local Authorities)
AP Acidification Potential
ASR Technische Regeln für Arbeitsstätten (Technical Rules for Workplaces)
BauNVO Baunutzungsverordnung (German Federal Land Utilisation Ordinance)
BBR Bundesamt für Bauwesen und Raumordnung (Federal Office for Building and Regional Planning)
BBSR Bundesinstitut für Bau-, Stadt- und Raumforschung (Federal Institute for Research on Building, Urban Affairs and Spatial Development)
BFR GBestand Baufachliche Richtlinien Gebäudebestandsdokumentation (Building-related guidelines for documentation of existing buildings)
BFR Verm Baufachliche Richtlinien Vermessung (Building-related guidelines for surveying)
BGF Bruttogrundfläche (Gross floor area)
BGG Behindertengleichstellungsgesetz (German Act on Equal Opportunities for Disabled Persons)
BHO Bundeshaushaltsordnung (Federal Budget Code)
BImSchG Bundes-Immissionsschutzgesetz (Federal Immission Control Act)
BMUB Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit (Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety)
BMVBS Bundesministerium für Verkehr, Bau und Stadtentwicklung (Federal Ministry of Transport, Building and Urban Development)
BMVg Bundesministerium für Verteidigung (Federal Ministry of Defence)
BNB Bewertungssystem Nachhaltiges Bauen (Assessment System for Sustainable Building)
BREEAM Building Research Establishment Environmental Assessment Method
CAFM Computer-Aided Facility Management
CLP Classification, Labelling and Packaging; Regulation (EC) No. 1272/2008
CO_2 Carbon dioxide
DGNB Deutsche Gesellschaft für Nachhaltiges Bauen (German Sustainable Building Council)
DIN Deutsches Institut für Normung e.V. (German Institute for Standardization)
EEG Erneuerbare-Energien-Gesetz (Renewable Energy Sources Act)
EEWärmeG Erneuerbare-Energien-Wärme-Gesetz (Renewable Energies Heat Act)
EMIS Energie- und Medieninformationssystem des Bundes und der Länder (Energy and media information system of the federal government and federal states)
EnEV Verordnung über den energiesparenden Wärmeschutz und energiesparende Anlagentechnik bei Gebäuden (Energieeinsparverordnung) (Energy Saving Ordinance)
EP Eutrophication Potential
EPD Environmental Product Declaration
ES – Bau Entscheidungsunterlage – Bau (Decision-making Documents)
EW – Bau Entwurfsunterlage – Bau (Design Specification Documents)
GED Gemeinschaft Energielabel Deutschland (German energy label group)
GG Grundgesetz (Basic Law of the Federal Republic of Germany)
GHG Greenhouse gas
GWP Global Warming Potential
HOAI Honorarordnung für Architekten und Ingenieure (Official Scale of Fees for Services by Architects and Engineers)
IBU Institut Bauen und Umwelt e.V. (Institute Construction and Environment)
ImmoWertV Immobilienwertermittlungsverordnung (Ordinance Regarding the Principles for the Determination of the Fair Value of Properties)
INKA Instrument für Nutzerbefragungen zum Komfort am Arbeitsplatz (Tool for user surveys on comfort at the workplace)
KG Kostengruppe (Cost Category)
KrW-/AbfG Kreislaufwirtschafts- und Abfallgesetz (Closed Substance Cycle and Waste Management Act)
LAK Liegenschaftsbezogenes Abwasserentsorgungskonzept (Estate Sewage Disposal Concept)
LCA Life Cycle Assessment
LCC Life Cycle Costs
LEED Leadership in Energy and Environmental Design
LUBW Landesanstalt für Umwelt, Messungen und Naturschutz Baden-Württemberg
NGF Nettogrundfläche (Net floor area)
ODP Ozone Depletion Potential
PE_e Primary energy demand (renewable)
PE_{ne} Primary energy demand (non-renewable)
PLAKODA Planungs- und Kostendatenmodule der Länder und des Bundes (Planning and cost-data module of the federal states and federal government)
POCP Photochemical Ozone Creation Potential
POE Post Occupancy Evaluation
RBBau Richtlinien für die Durchführung von Bauaufgaben des Bundes (Guidelines for Federal Construction Measures)
REACH REACH Regulation: Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals
RPW 2013 Richtlinie für Planungswettbewerbe 2013 (2013 Design Competition Guideline)
RÜV Richtlinie für die Überwachung der Verkehrssicherheit von baulichen Anlagen des Bundes (Guideline for monitoring the safe use of federal government buildings and structures)
SLA Service Level Agreements
SNAP Systematik für Nachhaltigkeitsanforderungen in Planungswettbewerben (System for Sustainability Requirements in Design Competitions)
SVOC Semi Volatile Organic Compounds
TRGS Technische Regeln für Gefahrstoffe (Technical Rules for Hazardous Substances)
UBA Umweltbundesamt (Federal Environment Agency)
VDI Verein Deutscher Ingenieure (Association of German Engineers)
VOB Vergabe- und Vertragsordnung für Bauleistungen (General Provisions Relating to the Award of Construction Contracts)
VOC Volatile Organic Compounds
WECOBIS Webbasiertes ökologisches Baustoffinformationssystem (Web-based Ecological Building Material Information System)
WertR Richtlinien für die Ermittlung der Verkehrswerte (Marktwerte) von Grundstücken (Guidelines for the Determination of Fair Values (Market Values) of Properties)
WINGIS Gefahrstoffinformationssystem der Berufsgenossenschaft der Bauwirtschaft (Information System for Hazardous Substances)
ZBau Baufachliche Ergänzungsbestimmungen (Additional Engineering Criteria)

Glossary

Abiotic resources/abiotic resource consumption: an action category which describes the reduction in the global stock of raw materials and commodities due to the consumption of non-renewable, abiotic resources, such as minerals, fossil fuels.

Air change: pursuant to DIN 15242, a characteristic value (besides air volume flow) for the air-tightness of the building envelope at a given differential pressure.

Assessment period: the period which serves as the reference period within the framework of an assessment.

Benchmark: a scale for comparing performance in several different disciplines.

Discounting: this compound interest computation method serves to determine initial capital (if end capital, interest rate and term are known).

Final energy: the energy volume (e.g. fuel oil) which is available to the end user and which results from the useful energy (the energy, such as heating energy, which the end user needs) plus losses during conversion, distribution and handing over.

Floor area index: indicates, pursuant to § 20 (2) of the BauNVO, the surface area in square meters of floor space which is permitted per square meter of property surface area within the meaning of § 19 (3) of this ordinance.

Heating and/or cooling period: pursuant to DIN 13790, that period of the year during which significant heating and/or cooling demand exists.

Heating demand: pursuant to DIN 4108-2, the calculated heat supply via a heating system which is necessary to maintain a defined average room temperature in a building or in a zone of a building – also referred to as net heating energy demand.

Improvement: pursuant to DIN 31051, the combination of all technical and administrative as well as management measures designed to enhance the functional reliability of an item without changing the functionality this item is expected to provide.

Inspection: pursuant to DIN 31051, a measure to identify and assess the actual condition of an item, including the determination of causes for wear and tear as well as the identification of the necessary consequences for future use.

Life cycle/life: pursuant to DIN 14040, successive and connected stages of a product system (combination of process modules) from raw material extraction or production until final disposal.

Maintenance: pursuant to Part C of the RBBau Guidelines, this includes all consumptive measures to maintain buildings, including technical building equipment and outdoor facilities. Scheduled servicing and inspection do not form part of building maintenance nor does preparation work which becomes necessary due to a new function (see Section C of the RBBau Guidelines).

Material flow: pursuant to VDI 4091, a substance and material flow from point A to point B resulting from the extraction, processing, use/consumption and disposal (recycling/removal) of raw, ancillary and operating substances, energy, products and waste.

Micro-climate: the climate of an atmospheric layer near the ground up to a level of around 2m in the horizontal direction for areas extending over up to 100m.

Monitoring: the permanent observation of a particular system using technical equipment.

Overheating time/hours: the period of time during which a corresponding limit value for the interior temperature in heated buildings is exceeded.

Primary energy demand: pursuant to DIN 4108-6, the amount of energy that is needed to cover annual heating and hot water (drinking water) energy demand, including the additional energy resulting from upstream process chains outside the building boundaries, i.e. during production, conversion and distribution of the respective fuels.

Quality assurance: term used to describe the organisational and technical measures to ensure specifications-compliant concept and execution quality. Quality assurance encompasses quality planning (selecting the quality features for a product), quality management (specifying the planned execution requirements and monitoring, and adjustment when necessary) and quality control.

Radiation temperature asymmetry: pursuant to DIN 7730, asymmetric radiation caused, for instance, by hot ceilings or cold walls (windows) which users perceive as unpleasant.

Refurbishment: pursuant to the HOAI, construction measures other than extension, conversion or repair work designed to achieve a sustainable increase in the use value of the building.

Repair: pursuant to the HOAI, construction measures to restore the condition suitable for the original purpose (target condition) of a building, building part, component or system.

Room air conditioning: heating, cooling, ventilation, humidification, lighting and hot drinking water supply using energy in order to achieve defined interior conditions in rooms.

Servicing: pursuant to DIN 31051, measures to delay the reduction of the existing wear reserve.

Site occupancy index: indicates, pursuant to § 19 (1) of the BauNVO, the surface area in square meters of ground floor area which is permitted per square meter of property surface area within the meaning of § 19 (3) of this ordinance.

Solar radiation index: pursuant to DIN 4108-2, a calculated requirement characteristic to assess the solar energy transmission of transparent exterior building elements with a view to avoiding overheating in summer.

Use period: pursuant to DIN 18960, the handover and optimisation, operation, refurbishment and return phase until the beginning of the disposal phase.

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Annexes

A1	Health
B1	Minimum requirements for federal buildings
B2	Criteria according to the BNB in the phases of the RBBau Guidelines (differentiated in each case according to new construction and refurbishment with/without listed building features)
B2.1	Overview of the criteria to be considered during the phases of the RBBau Guidelines
B2.2	Verification requirements during the phase of the ES – Bau
B2.2	Verification requirements during the phase of the EW – Bau
B3	Pre-check (template)
B4	Sustainability requirements in design competitions
B5	Target agreement tables
B5.1	Target agreement table "New Construction"
B5.2	Target agreement table "Refurbishment"
B6	Sustainability assessment report (template)
B7	Energy Target Specifications (template)
C1	Minimum requirements and recommendations for use and operation
C2	Template questionnaire for operation and repair costs with minimum degree of detail
C3	Criteria table for building maintenance measures (quality assurance check-list)
C4	Operator sustainability report (check-list)
C5	Assessment table for the "Use and Operation" BNB-module
C6	Criteria table for the "New Building Stock" BNB-transition module
C7	Target agreement table "Use and Operation"
D1	Criteria table for the "Refurbishment" BNB-module
D2	Assessment table for the "Refurbishment" BNB-module

The annexes can be downloaded from the Information Portal Sustainable Building www.nachhaltigesbauen.de under the "Leitfäden und Arbeitshilfen" (guides and tools) heading.