



57th LCA Discussion Forum

LIFE CYCLE ASSESSMENT IN THE BUILDING SECTOR: ANALYTICAL TOOLS, ENVIRONMENTAL INFORMATION AND LABELS

December 2, 2014, ETH Zürich, Alumni Pavillon

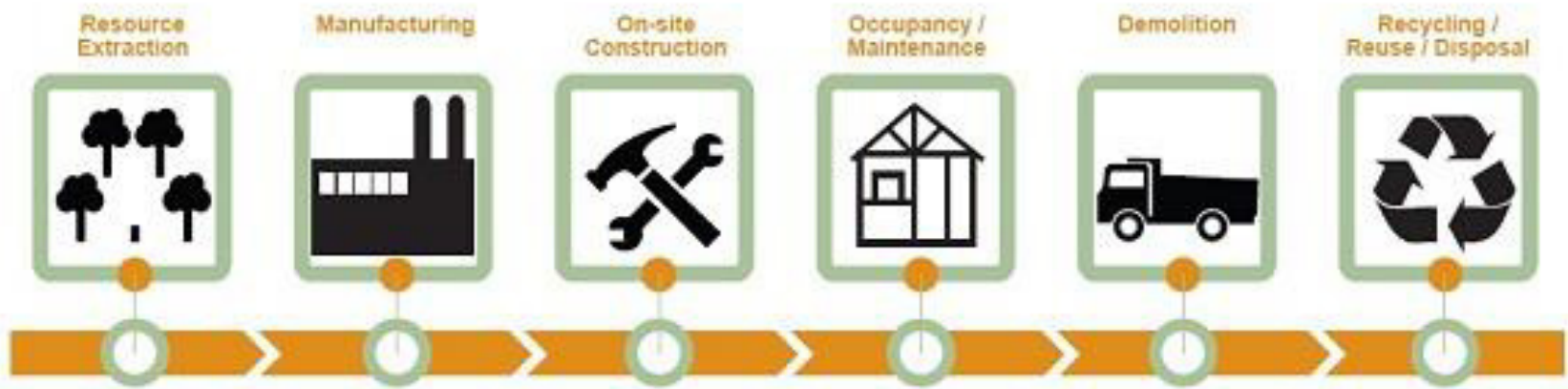
**Situation in Europe – selected examples
from Germany, Austria and France**

Environmental assessment of buildings in Germany as part of an overall sustainability assessment approach



Thomas Lützkendorf

Department of economics and business engineering - Chair for sustainable management of housing and real estate



http://www.naturallywood.com/sites/default/files/content_files/lca_0.jpg

- How is the sustainability assessment of buildings fitted into the context of **national sustainability strategy**?
- What are the requirements placed by the current state of **the European standardization**?
- How is the **sustainability assessment of buildings** structured in Germany?
- What assessment criteria are taken into account for the **environmental performance**?
- What are the **databases and tools** available for the assessment of environmental performance?
- What advice and **recommendations** can be given?

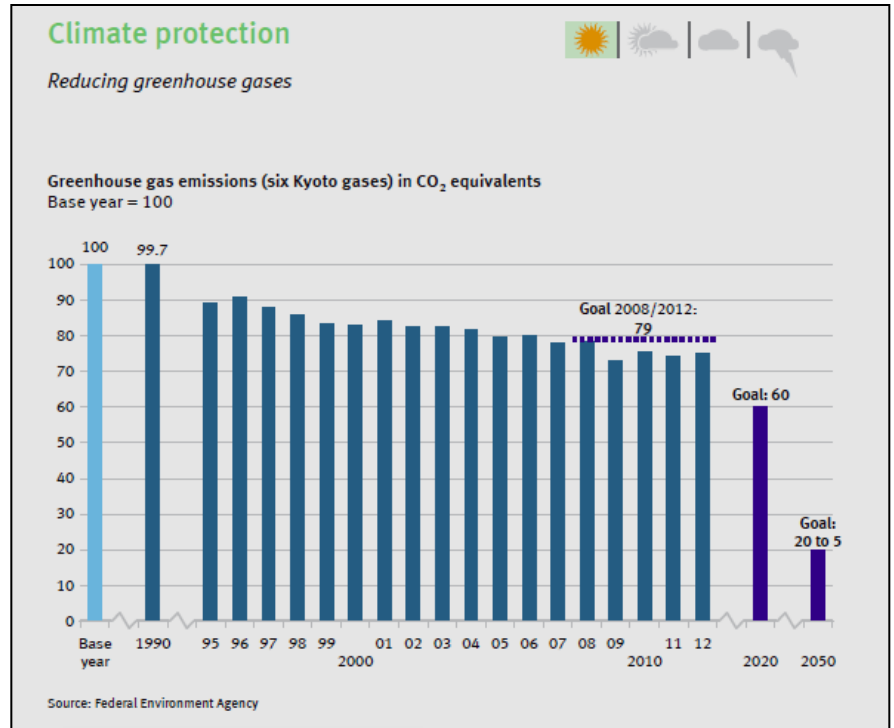
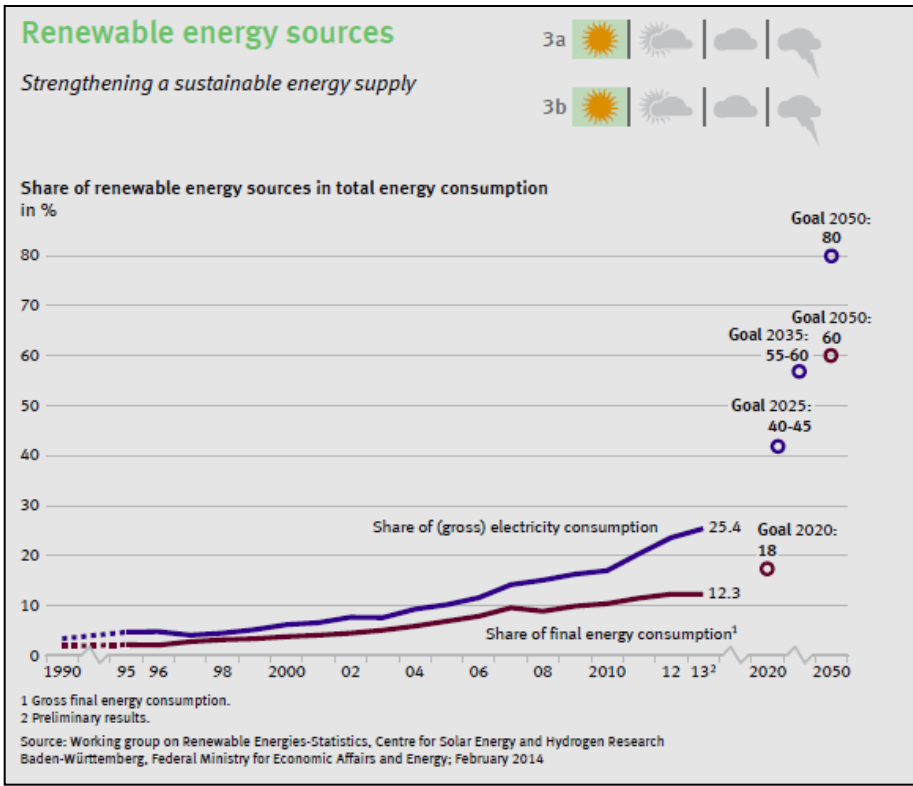


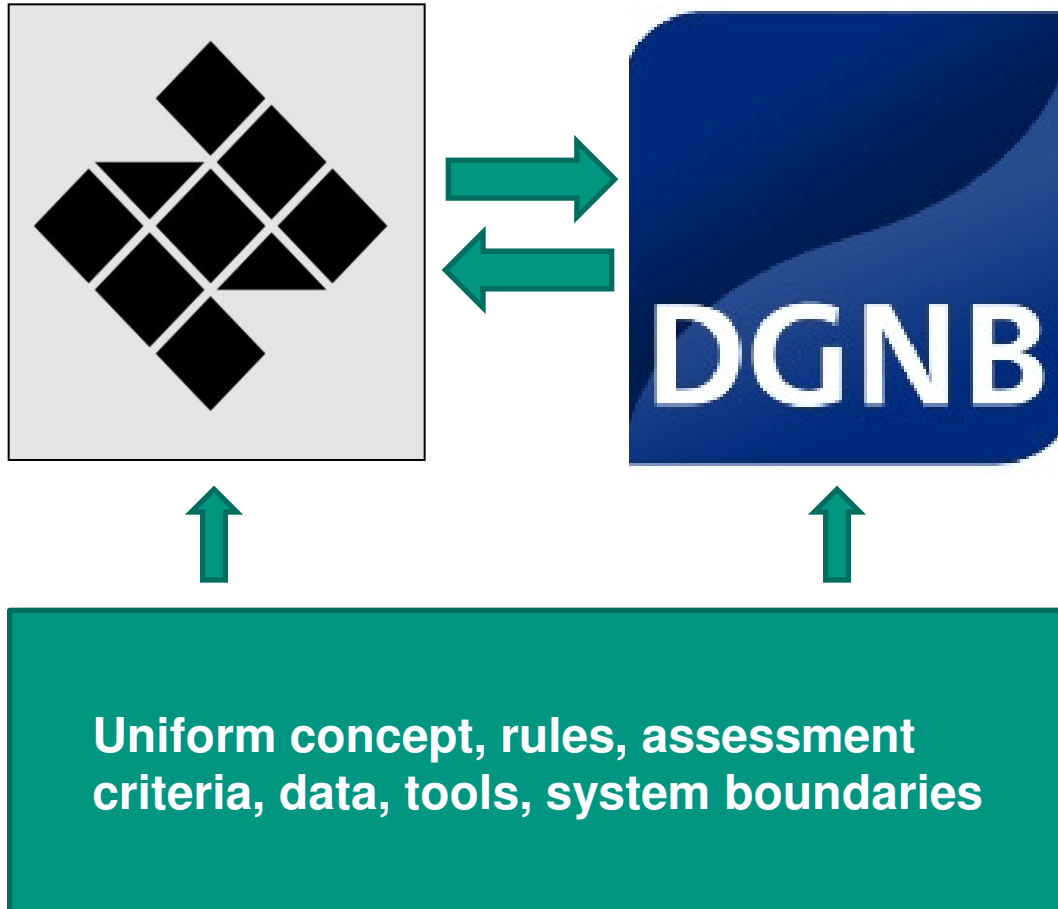
Foundations for the sustainability assessment of buildings in Germany are the:

- targets of the **national sustainability strategy**
- generally acknowledged **areas of protection** and protection goals
- state of the international and **European standardization**
- state of the development of methods (**LCA** und LCC)
- availability of **data** (including LCA data)



Targets of the national sustainability strategy (example)





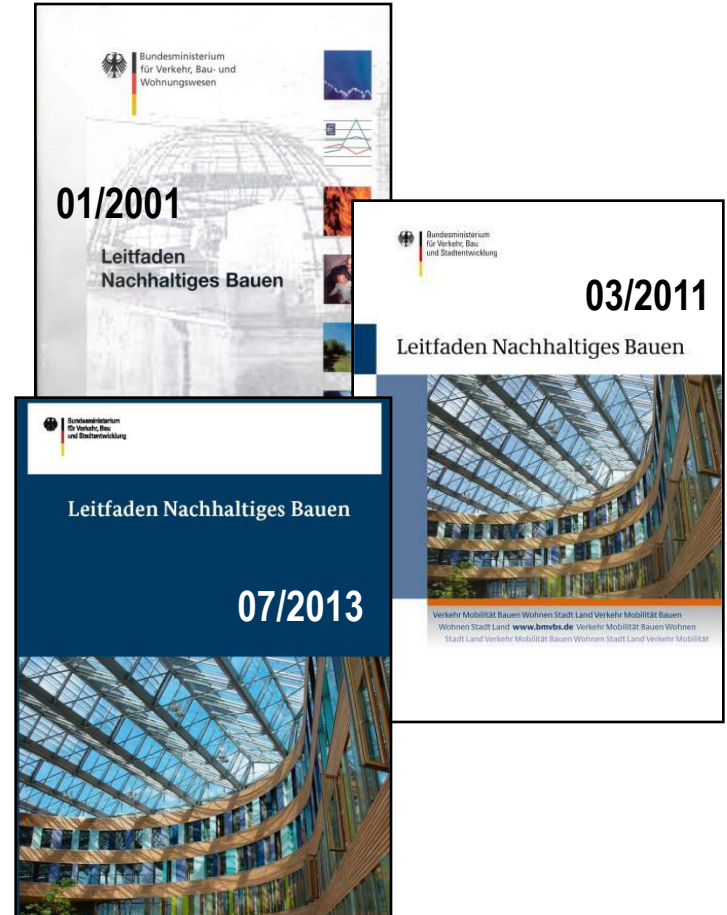
Both **public and private sector** use the sustainability assessment method developed and shared by BMUB and DGNB to evaluate building's sustainability.

The assessment system focuses on the entire life cycle.

Development in Germany (BNB)

- ▶ introduced 2001
- ▶ since 2013 **mandatory for all federal buildings**
- ▶ sets principles
- ▶ describes requirements and assessment criteria
- ▶ identifies benchmarks and aims
- ▶ offers tools and supporting documents

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



Müller, BBSR

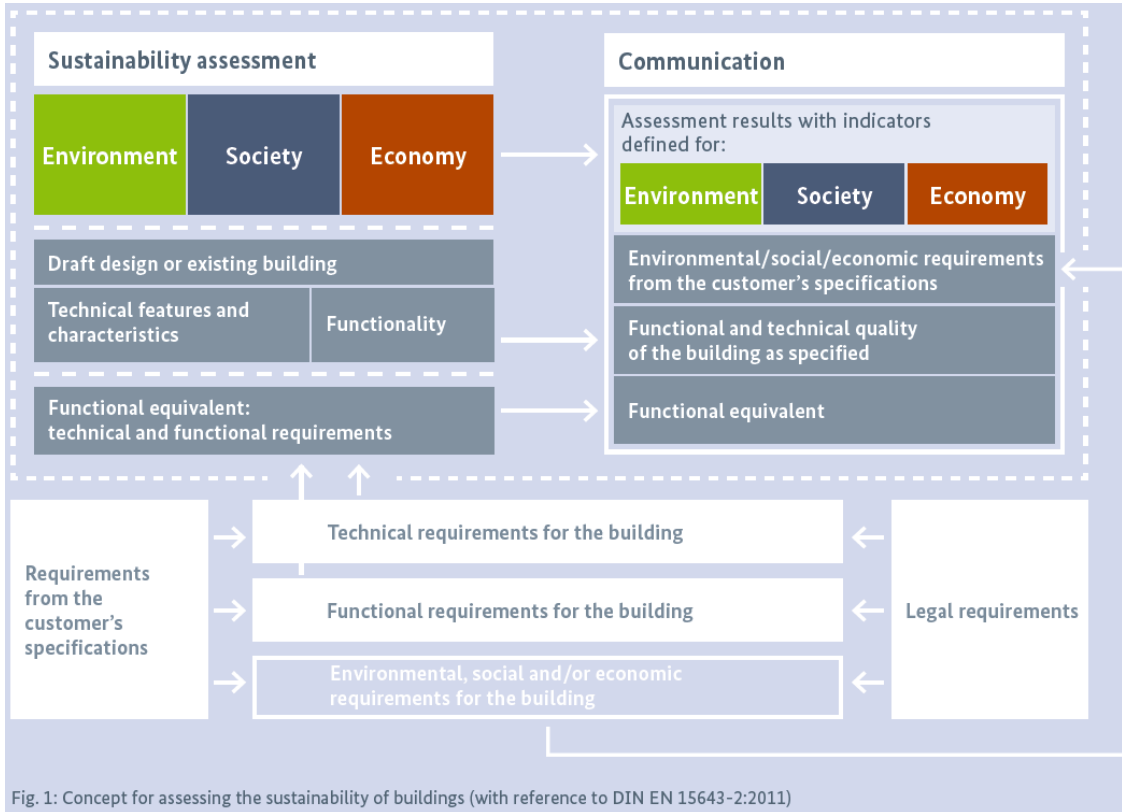


Fig. 1: Concept for assessing the sustainability of buildings (with reference to DIN EN 15643-2:2011)

The current state of sustainability assessment in Germany is guided, among others, by the following standards:

- ISO 15392
- EN 15643-1
- EN 15643-2
- ISO 21929-1
- ISO 21931-1
- EN 15878

Sustainability assessment principles

	Ecology	Economy	Socio-cultural aspects
Protective goods	Sustainability in general <ul style="list-style-type: none"> Natural resources Natural environment 	<ul style="list-style-type: none"> Capital/assets Economic performance 	<ul style="list-style-type: none"> Human health Social and cultural values
	Sustainable building <ul style="list-style-type: none"> Natural resources Global and local environment 	<ul style="list-style-type: none"> Capital/assets 	<ul style="list-style-type: none"> Health User satisfaction Functionality Cultural value
Protective targets	Sustainability in general <ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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
	Sustainable building <ul style="list-style-type: none"> Protection of natural resources Protection of the ecosystem 	<ul style="list-style-type: none"> Minimising life cycle costs Improvement of economic efficiency Protection of capital/assets 	<ul style="list-style-type: none"> 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

The principles and criteria for the sustainability assessment are based on the “areas of protection” (protective goods) and “protection goals” (protective targets)

In the area of environment, these are:


- natural resources
- global environment
- local environment

The system follows a top-down approach.



Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Guideline for Sustainable Building



Federal Ministry for the
Environment, Nature Conservation,
Building and Nuclear Safety

Assessment System for Sustainable Building

Administration Buildings



Guideline for Sustainable Building



Assessment System for Sustainable Building



Part A:
Principles of Sustainable Building

Part B:
Sustainable Building Projects

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

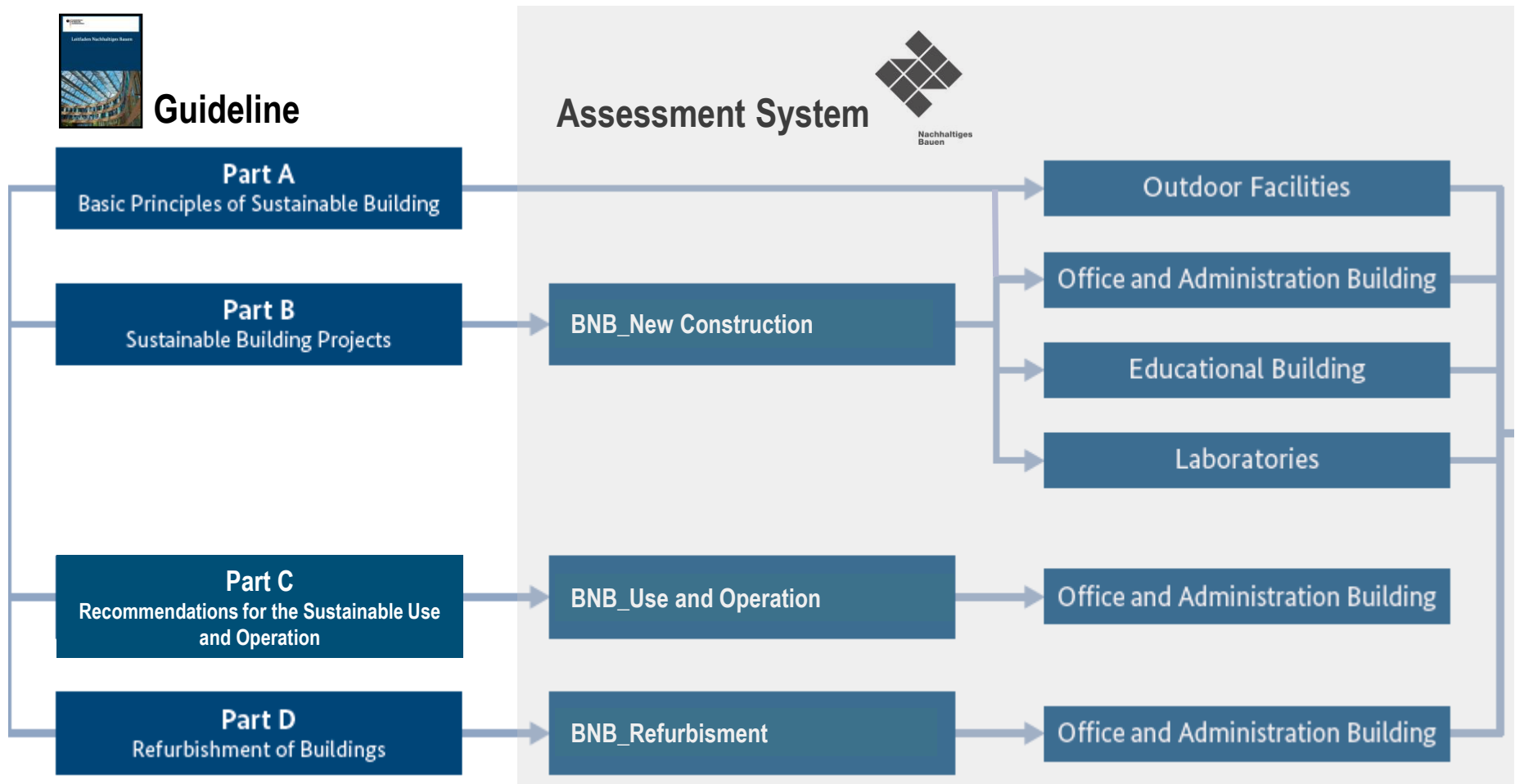
Part D:
Refurbishment of Buildings

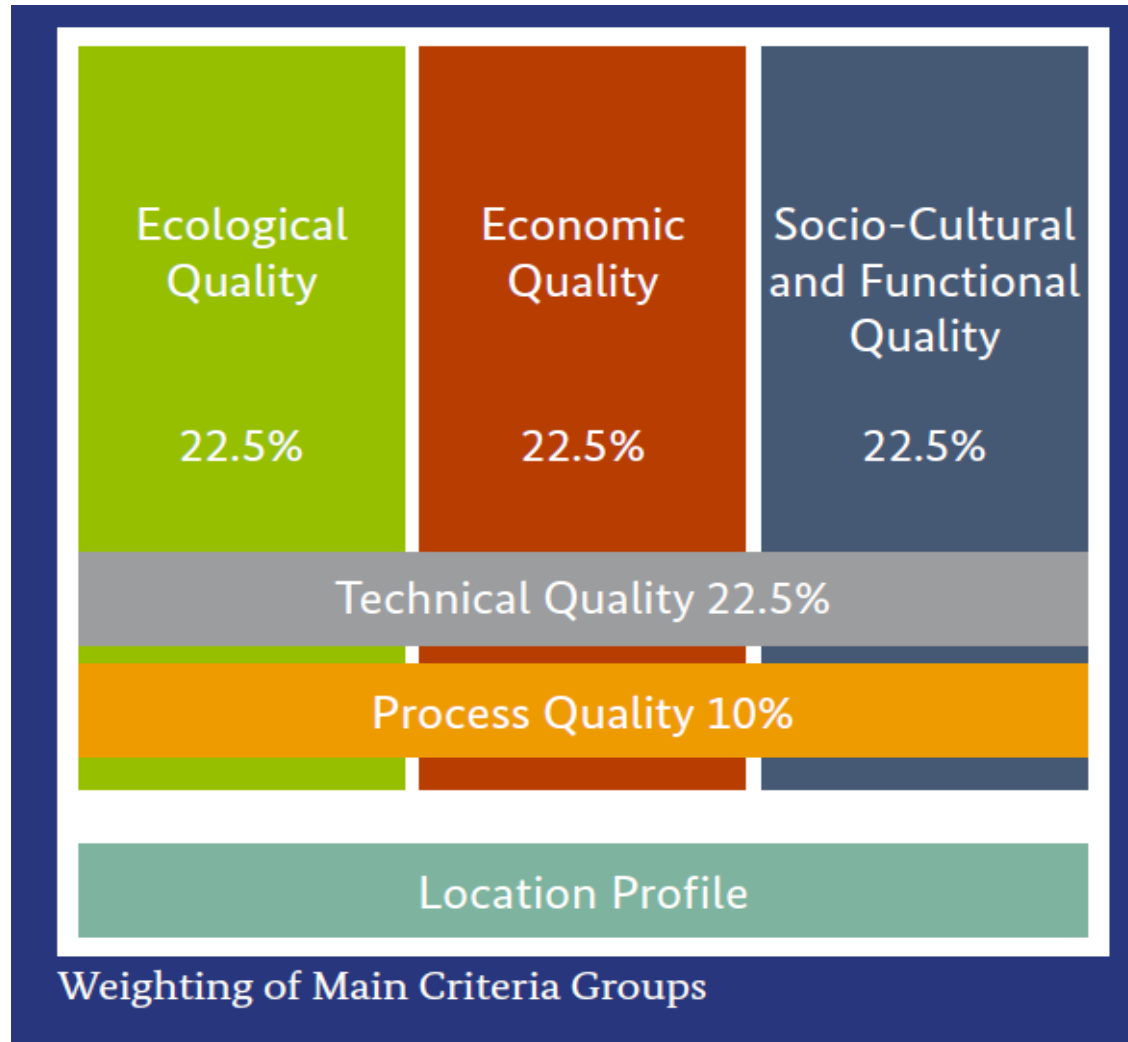
“New Construction” BNB-module
e.g. office/administration buildings BNB_BN

“Use and Operation” BNB-module
e.g. office/administration buildings BNB_BB

“Refurbishment” BNB-module
e.g. office/administration buildings BNB_BN

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

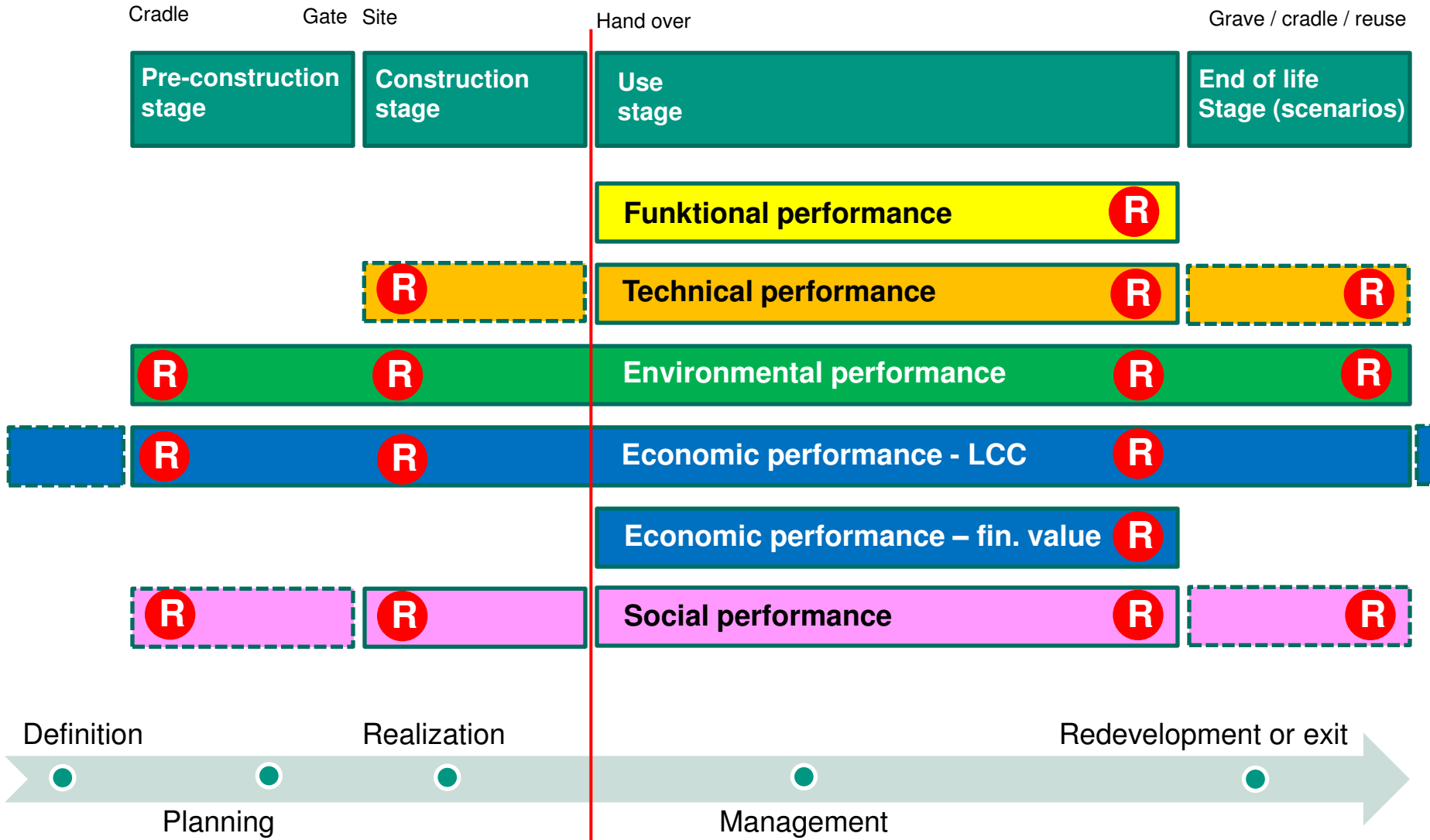




According to an accepted convention in Germany, the environmental, economic, social and technical performance are considered **simultaneously and treated equally** in the sustainability assessment. Therefore, an **identical weighting factor** is applied.

BMUB

Life cycle model(s) for construction works



Bundesministerium für Verkehr, Bau und Stadtentwicklung

Zertifikat

SILBER

Nachhaltiges Bauen

Kategorie: Neubau Büro- und Verwaltungsgebäude
 Version: 2008 - konsolidiert
 Objekt: Hauptzollamt Rosenheim - Erweiterungsbau
 Standort: Rosenheim
 Fertigstellung: 2007
 Bauherr: Bundesrepublik Deutschland
 Auditor: Dipl.-Ing. Nicolas Kerz, Bundesinstitut für Bau-, Stadt- und Raumforschung im BBR, Staatliches Bauamt Rosenheim
 Architekt / Planer: Staatliches Bauamt Rosenheim

Bewertungsnummer: V 2008_kerz_0001
 ausgestellt am: 16.02.2010

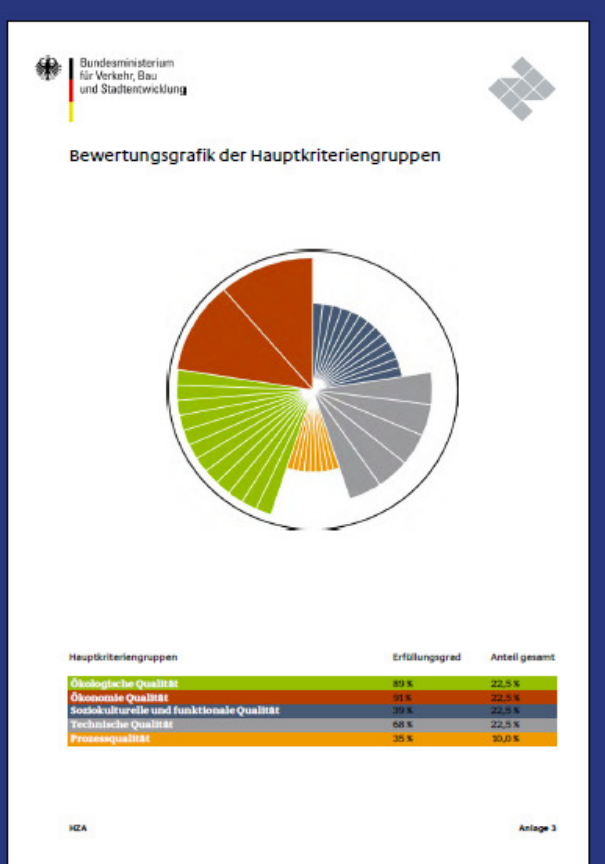
Günther Hoffmann
 Leiter der Abteilung Bauwesen,
 Bundeswirtschaft und Bundesbaubau im BMVBS

Bundesministerium für Verkehr, Bau und Stadtentwicklung

Einzelbewertung

Kriterium	Erfüllungsgrad	Note
Übergeordnete Kriterien	70%	
1. Anforderungen an die globale Umwelt		1,2
1.1 Treibhausgasemission (GWP)	100%	
2. Ozonabbauvermögen (ODP)	100%	
3. Ozonabbauvermögen (POCP)	100%	
4. Versauerungspotenzial (AP)	100%	
5. Ozonabbauvermögen (OP)	100%	
6. Belastung durch saure Regen	100%	
7. Sonstige Wirkungen auf die globale Umwelt	100%	
8. Mülldeponie	100%	
9. Ressourcenverbrauchsreduktion		
10. Wasserverbrauch (inkl. Wasserentzug)	100%	
11. Energieeffizienz (inkl. Kälteenergieverbrauch)	100%	
14. Treibhausgasemission und Klimawandelrisiko	77%	
15. Mülldeponierung	100%	
Ökonomische Qualität	91%	
16. Lebenszykluskosten	100%	1,1
17. Wertentwicklung	100%	
Wohnqualität	20%	
Gesundheit und funktionale Qualität	20%	
18. Gesundheit, Behaglichkeit und Nutzerzufriedenheit	100%	
19. Thermischer Komfort im Winter	100%	
20. Thermischer Komfort im Sommer	100%	
21. Akustischer Komfort	0%	
22. Visueller Komfort	42%	
23. Lichtklima im Winter	100%	
24. Tageslicht	100%	
25. Sichtfreiheit und Sichtbeziehungen	100%	
Funktionalität	3,7	
26. Barrierefreiheit	100%	
27. Abwasserentlastung	100%	
28. Umweltschutzfähigkeit	100%	
29. Energieeffizienz	100%	
30. Materialverbrauch	100%	
Sicherung der Gebäudesicherheit	0%	
31. Sicherung der globalen Umwelt und des Klimawandels	0%	
32. Brand im Fall	0%	
Technische Qualität	6%	
Qualität der technischen Ausführung	1,9	
33. Brandschutz	100%	
34. Schallschutz	100%	
35. Energieeffizienz und Treibhausgasemissionen	100%	
40. Befähigung und Bestandhaltung	100%	
42. Einbaufähigkeit, Einbaufähigkeit, Einbaufähigkeit	100%	
Prozessqualität	4,0	
Qualität der Planung	4,0	
43. Qualität der Projektorganisation	100%	
44. Bauplanung	100%	
45. Organisierung und Ausführung der Hauptphasen der Planung	100%	
46. Umsetzung der Umweltauflagen im Baubereich und im Betrieb	0%	
47. Einhaltung von Voraussetzungen für eine optimale Nutzung und Bestandhaltung	100%	
Qualität der Bauausführung	4,0	
48. Baueinführung	100%	
49. Qualität der Ausführung (Einbaufähigkeit, Einbaufähigkeit)	100%	
50. Qualität der Ausführung der Baueinführung	100%	
51. Systematische Baueinführung	100%	
Standortmerkmale	7%	
Standortmerkmale	1,7	
54. Flächen- und Ressourcenverbrauch	100%	
57. Vermeidung von Mülldeponierung	100%	
58. Energie- und Treibhausgasemissionen	100%	
59. Verkehrsmittelbindung	100%	
60. Flächen- und Ressourcenverbrauch	100%	
61. Ausgewählte Standorteigenschaften	100%	

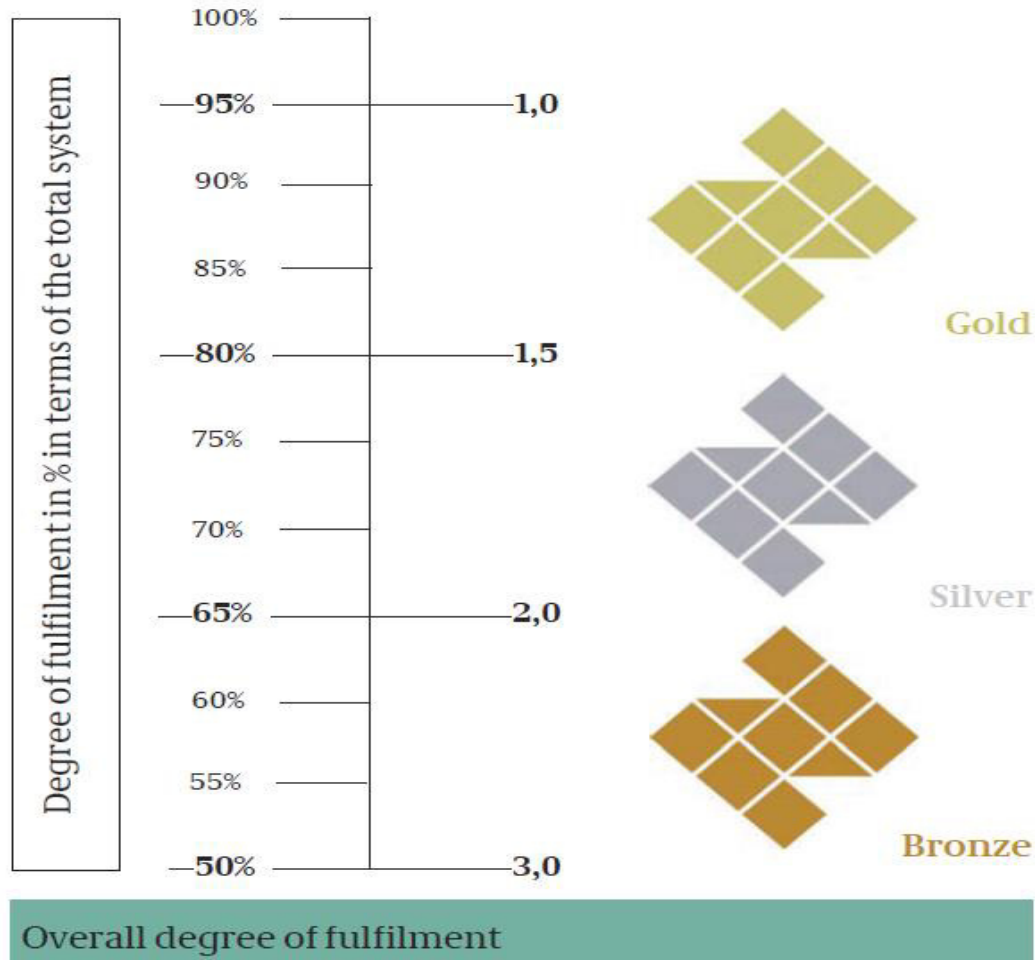
HZA Anlage 2



Certificate, Front Page

Certificate, Appendix 2

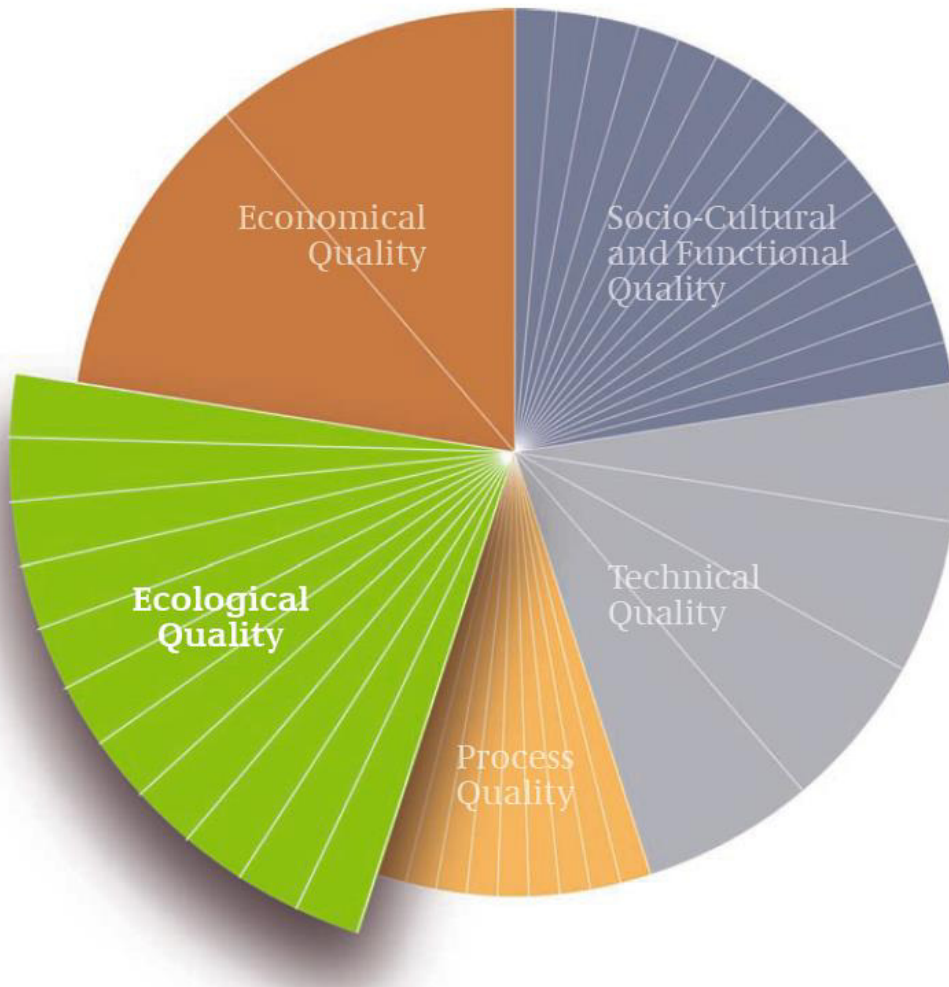
Certificate, Appendix 3



The assessment result may be expressed as

- degree of fulfillment
- score
- medal

In any case, the description of the functional equivalent and a detailed documentation must be provided.



The assessment of **environmental performance** (ecological quality) is a component of a comprehensive assessment of the sustainability and the overall performance of buildings.

Issues such as indoor air quality, thermal comfort and user satisfaction can be assigned to the **social performance**.

The environmental situation at the location/site is considered separately.

Overview of Criteria

			Relevant life phase	Assessment method	Verification management	Time of documentation	Factor of relevance	Percentage share of overall result
1. Ecological Quality								
1.1 Effects on Global and Local Environment								
LCA	1.1.1	Global Warming Potential	↻	→	E	DE ■■■	3	3,375%
LCA	1.1.2	Ozone Depletion Potential	↻	→	E	DE ■■■	1	1,125%
LCA	1.1.3	Photochemical Ozone Creation Potential	↻	→	E	DE ■■■	1	1,125%
LCA	1.1.4	Acidification Potential	↻	→	E	DE ■■■	1	1,125%
LCA	1.1.5	Eutrophication Potential	↻	→	E	DE ■■■	1	1,125%
	1.1.6	Risks to the Local Environment	📁	↙	P	TP ■■■	3	3,375%
	1.1.7	Sustainable Logging / Wood	📁	↙	P	TP ■■■	1	1,125%
1.2 Demand of Resources								
LCA	1.2.1	Primary Energy Demand Not Renewable (PE_{nre})	↻	→	E	DE ■■■	3	3,375%
LCA	1.2.2	Total Primary Demand (PE_{tot}) and Amount of PE_{re}	↻	→	E	DE ■■■	2	2,250%
	1.2.3	Fresh Water Demand and Quantity of Wastewater	🏠	→	P	DE ■■■	2	2,250%
	1.2.4	Demand of Space	📁	✓	C	PD ■■■	2	2,250%

22,5%

BMUB

Integration into design process

PHASE ALLOCATION							
Criteria group	Description	Phases acc. to RBBau					
		ES-Bau	Competition	EW-Bau	Final planning	Construction	Comissioning and building documentation
ECOLOGICAL QUALITY							
Effects on the global and local environment	1.1.1 Global Warming Potential (GWP)			*			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			x		x	o
	1.1.7 Sustainable Logging/Wood				x	x	o
Demand of resources	1.2.1 Primary Energy Demand, Non-Renewable (PE _{ne})	x *		*			o
	1.2.2 Total Primary Energy Demand and Share of Renewable Primary Energy (PE _e)	x *		*			o
	1.2.3 Fresh Water Demand and Wastewater Volume	x *		x *			o
	1.2.4 Demand of Space	x *		x			o

Primary Energy Demand, Non-Renewable	BNB 1.2.1⁷ LCA	Protection of limited fossil fuels
Primary Energy Demand, Renewable	BNB 1.2.2 LCA	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 (LCA)	Protection of limited raw material resources



Table A1: Criteria serving to protect natural resources

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

ENVIRONMENTAL IMPACT CATEGORIES



Table A2: Global impact on the environment

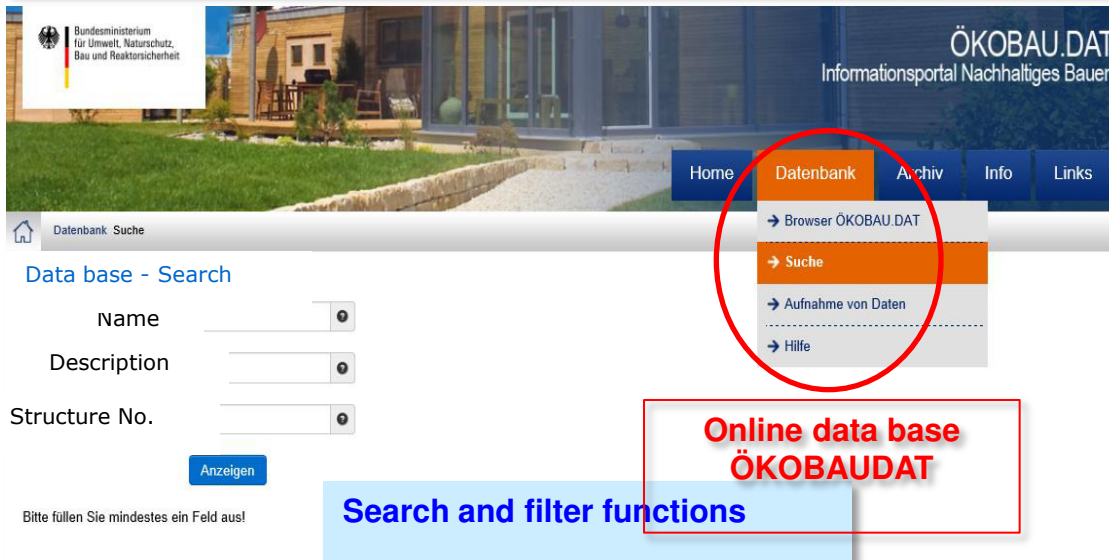
Risks to the Local Environment	BNB 1.1.6	Potential risks to water, soil, air resulting from the processing of materials at the construction site or due to weather exposure during the use phase
Microclimate	Set aside in BNB	Building-specific heat island effects of urban structures compared to the surrounding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



Table A3: Local impact on the environment

Characteristic	Situation in Deutschland
Methods	mainly LCA
LCA-Data base	national database Ökobaudat
LCA-System boundary	entire lifecycle
LCA-Reference study period	50 years
LCA-Tools	z.B. eLCA, LEGEP, bauloop,
LCA-Modules	A-D
Benchmarks	Limit-, reference- and target values Based on generic or reference building approach

Webpage www.oekobaudat.de and Online Database ÖKOBAUDAT



Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit

ÖKOBAUDAT
Informationsportal Nachhaltiges Bauen

Home Datenbank Archiv Info Links

Datenbank Suche

Data base - Search

Name

Description

Structure No.

Anzeigen

Bitte füllen Sie mindestens ein Feld aus!

Online data base
ÖKOBAUDAT

Search and filter functions

- Basis for LCA on building level
- generic data and product specific data
- publicly available, free of charge
- compulsory within BNB
- data format conform to EN 15804
- Quality of data (verification, EPD-programmes)
- Import of data from other countries possible

Dr. Brockmann, BBSR

- ▶ Prozess-Information
- ▶ Modellierung und Validierung
- ▶ Administrative Information
- ▼ Umweltindikatoren

Parameter zur Beschreibung des Ressourceneinsatzes und sonstige Umweltinformationen

Einheit ⇅	Produktion A1-A3	Einbau A5	Abfallbehandlung C3	Beseitigung C4	Modul D
kg Sb-Äqv.	0.0009389	4.667E-9	5.211E-10	2.133E-7	-1.372E-7
kg R11-Äqv.	2.839E-8	3.694E-11	2.1E-12	5.4E-10	6.833E-12
kg SO2-Äqv.	0.03972	0.00005444	0.000005356	0.003667	-0.01228
kg Phosphat-Äqv.	0.005367	0.00001067	0.000001133	0.0006611	-0.001
kg CO2-Äqv.	21.26	0.5056	0.1	2.994	-3.5
MJ	313	0.1444	0.01111	7.978	-42.21
kg Ethen-Äqv.	0.004867	0.000003406	6.333E-7	0.001044	-0.001839

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The calculation tool “eLCA”

Auswertungen

330 Außenwände BAUWERK - B
Fassade_Ost (1835) BAUTL

Allgemein

Name *
Fassade_Ost

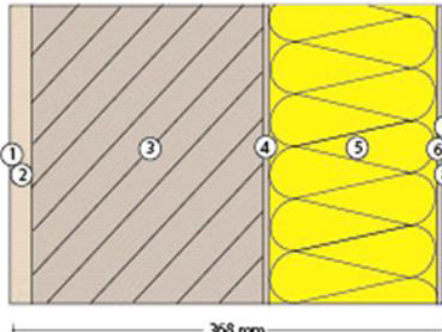
OZ

Beschreibung

Verbaute Menge * BezugsgröÙ
400 m²

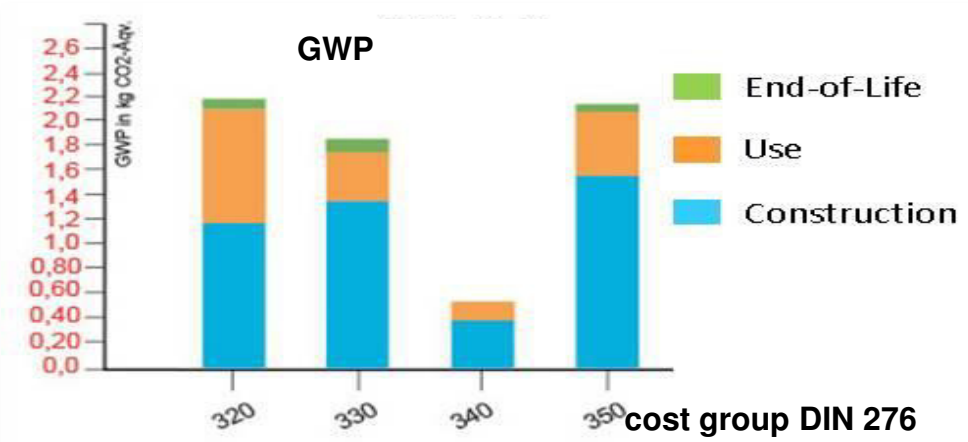
Verknüpfte Bauteilkomp. Bauteilkomponente (Liquor)

1	2	3	4	5	6	7
1	2	3	4	5	6	7
► Gips-Platz/Anstrich	► Mauerziegel 24 cm	► WDVS				
350 m²	350 m²	350 m²				
336 Außenwände	331 Tragende Auß.	335 Außenwände				



1. interior paint
2. gypsumplaster20 mm
3. masonry 240 mm
4. basecoat2 mm
5. insulationmaterial 100 mm
6. finishcoat 4 mm
7. plaster 2 mm

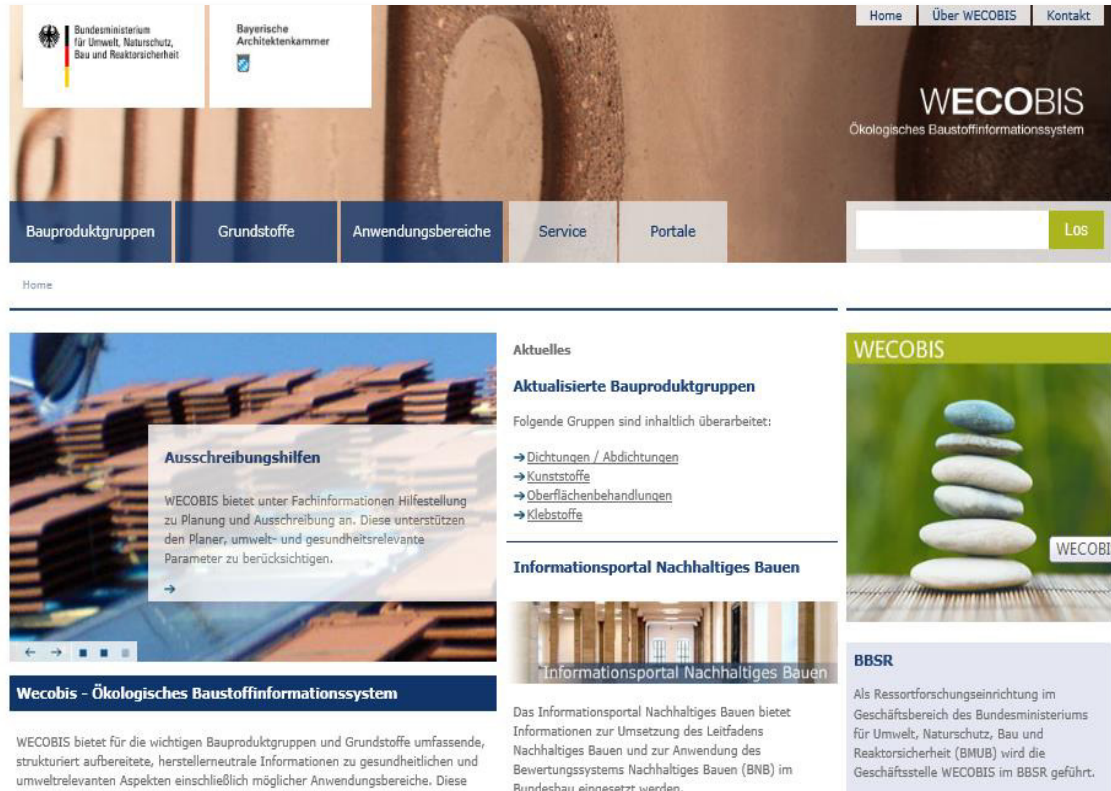
Dynamic graph – visual check of input parameters



Dynamic graph – better analysis of results

- Directly linked to ÖKOBAUDAT
- Conformity with BNB (i.e. calculation method, life cycle, reference service life; configuration production/end-of-life)
- Integrated examples for building elements (building materials)
- Dynamic (visual) construction of building elements
- Graphs and visual analysis of results
- Modular system, flexible for other applications
- Transparent
- Basis for benchmarks of BNB
- Administration – planning and project phases (*ES-Bau, EW-Bau*)

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The screenshot shows the WECOBIS website interface. At the top, there are logos for the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and the Bavarian Chamber of Architects. The main header features the WECOBIS logo and the tagline 'Ökologisches Baustoffinformationssystem'. Below this is a navigation menu with categories: Bauproduktgruppen, Grundstoffe, Anwendungsbereiche, Service, and Portale. A search bar with a 'Los' button is also present. The main content area is divided into several sections: 'Aktuelles' with a sub-section 'Aktualisierte Bauproduktgruppen' listing 'Dichtungen / Abdichtungen', 'Kunststoffe', 'Oberflächenbehandlungen', and 'Klebstoffe'; 'Ausschreibungshilfen' with a text box explaining the system's support for planning and tendering; 'Informationsportal Nachhaltiges Bauen' with a description of the portal's role in implementing sustainable building standards; and 'BBSR' (Bundesarbeitsgemeinschaft für Ressortforschung) with a description of its research focus.

- Information about construction product groups, independent from industry
- Which materials hold environmental and health risks? (life cycle)
- Are there alternative materials?
- How to regard this in tenderings?
- Where to find product specific information and data?
- Which product groups for certain quality standards of BNB? (criteria 1.1.6)

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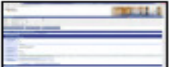




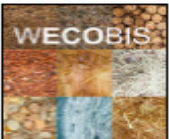
- Development / tightening of the **LCA-benchmarks**
- **Adaptation of the LCA-benchmarks** to specific building types and types of use
- Discussion on the introduction of **ADP**
- Discussion on consequences of **PEF**
- Discussion on the interpretation of **Module D**
- Discussion on the duration of the **reference study period** (How can the durability of structures be adequately taken into account?)
- Discussion on the responsibility of designers
- Discussion on the integration into design goals
- Discussion on system boundaries of net-zero- and net-positive buildings (energy or emission related)

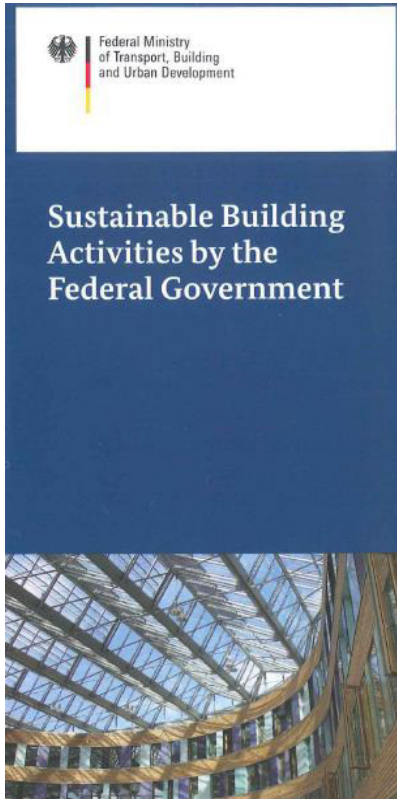


- In the current situation, **database, calculation tool and benchmarks must form a unit**
- The **transparency** in the presentation of data bases and building descriptions must be improved
- The presentation of results must follow - as required by the standards – a **modular approach** (A-D).
- The development of system boundaries and accounting rules for **net-zero and net-positive buildings** provide an opportunity for cooperation in Europe or between **D-A-CH**
- The question of the use of data both in **early and late design phases** needs further discussion.
- The assessment of the environmental performance **can not be limited to LCA**. Also **other environmental impacts** (shading, glare, risks, contribution to heat islands, etc.) must be considered.



www.nachhaltigesbauen.de

News	GUIDELINES & WORKING AIDS Guideline for Sustainable Building  Federal Guidelines and working aids with various topics	LIFE CYCLE DATA BASES ÖKOBAU.DAT Data base with generic and product specific information on the ecological quality of building material (environmental indicators). 
Sustainable Building		
English Information		
Guidelines and Working Aids		
Building Material and Building Data	 www.bnb-nachhaltigesbauen.de	Link to Environmental Product Declarations (EPD) by the Institute Construction and Environment e. V. 
Assessment System for Sustainable Building		
Assessment System for Sustainable Housing		
Accepted Stakeholders		
Research		
Standardisation of Sustainability in Building		
EU Lead Market Initiative		
Conferences and Events		
Best Practice		
Internal Member Area "Round Table"		
Network Sustainable Building		
Activities of Federal States	More information  www.nachhaltigesbauen.de	USEFUL LIFE TABLE Data base with generic information on the average useful life of building material. 
		WECOBIS Web-based ecological building material information system with qualitative information to sanitary and ecological aspects of building material. 



www.nachhaltigesbauen.de

Information Platform on Sustainable Building Activities (BNB) by the Federal Government

www.bauteileditor.de

Life Cycle Assessment Tool **eLCA**

www.oekobaudat.de

Building Materials Online Database for LCA in Sustainable Construction

www.wecobis.de

Webpage, Information Platform on Environmental and Health relevant Aspects of Building Materials

