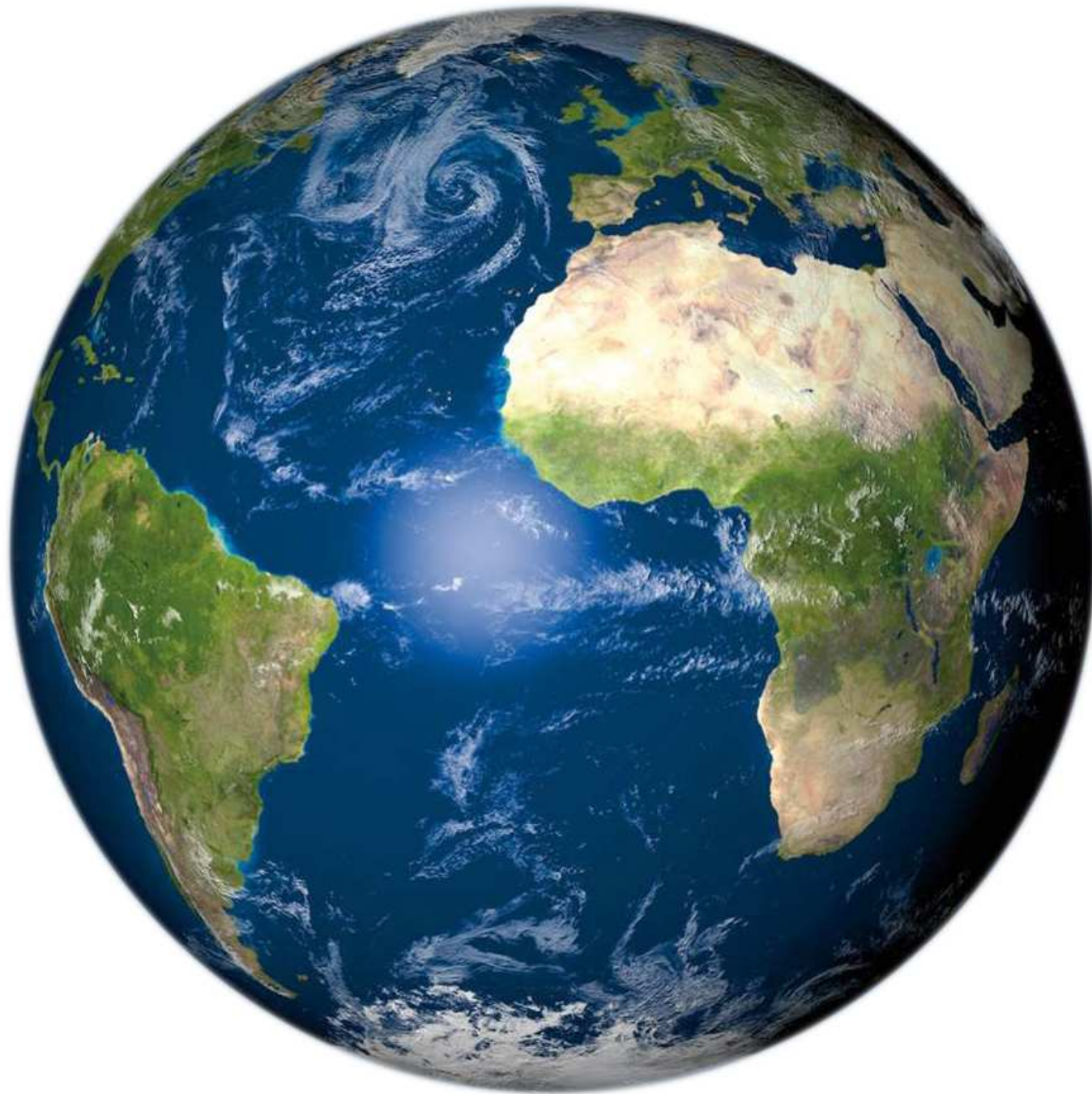


Sustainability in the Construction Industry

DGNB - Making Sustainability Measurable

Prof. Alexander Rudolphi



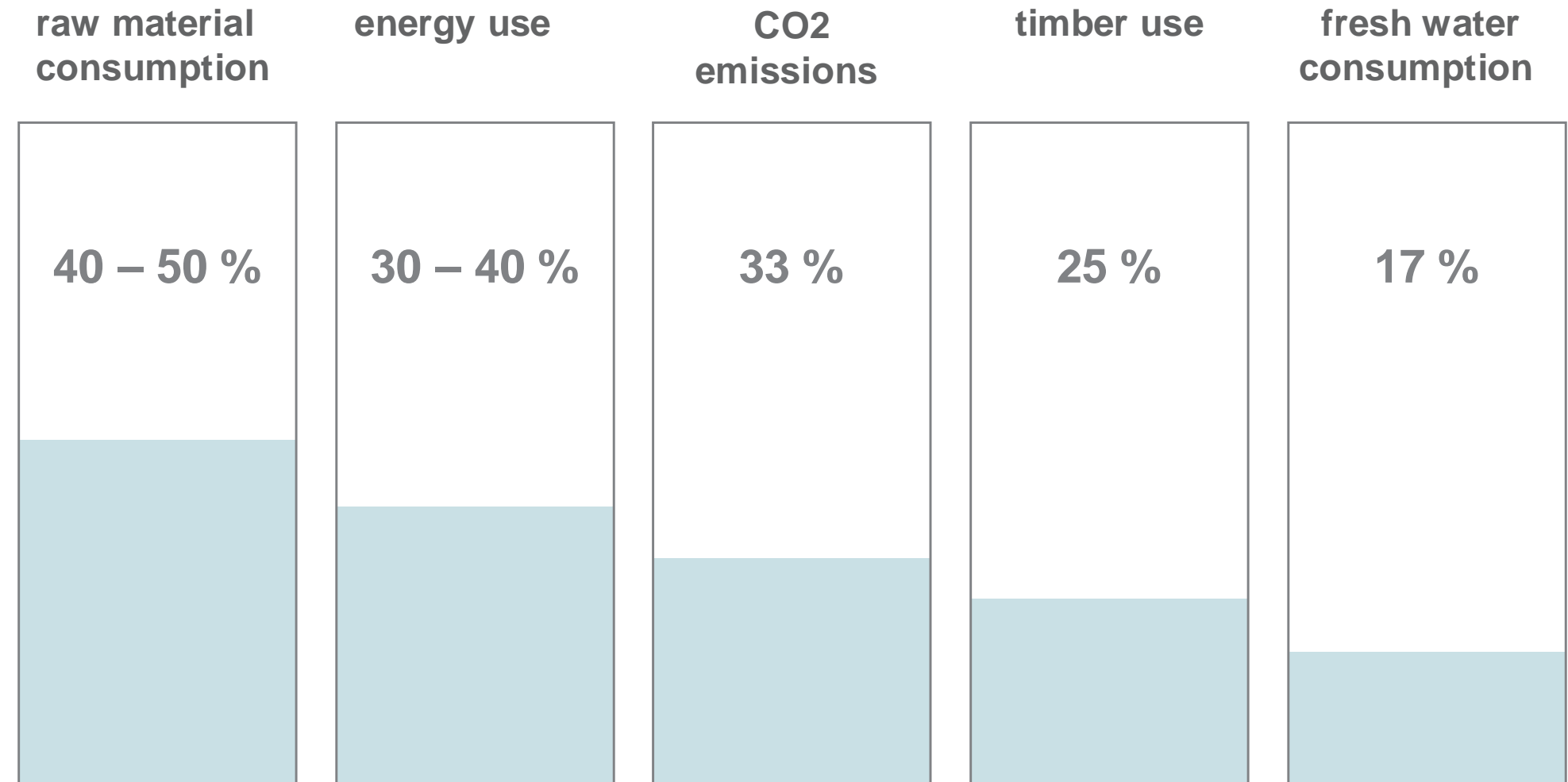


Our Common Future, also known as the Brundtland Report, from the United Nations World Commission on Environment and Development (WCED) was published in 1987 (Rio) with a definition of sustainable development:

“Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.”

Global effects of building and real estate Sectors

(Source: UNEP Information note 2008, World GBC)



Consequences for the Building and Real Estate Sectors

- Sustainable planning, construction and operation of the built environment
- Saving resources during construction and operation
- Consideration of the entire lifecycle of a building
- Optimized risk management

..... however :

- The technical optimization and innovation alone is a substantial base, however not yet a final solution for solving the global needs for resources

Greenbook of the European Union :

Social standards and technical environmental standards
are made of equal importance:

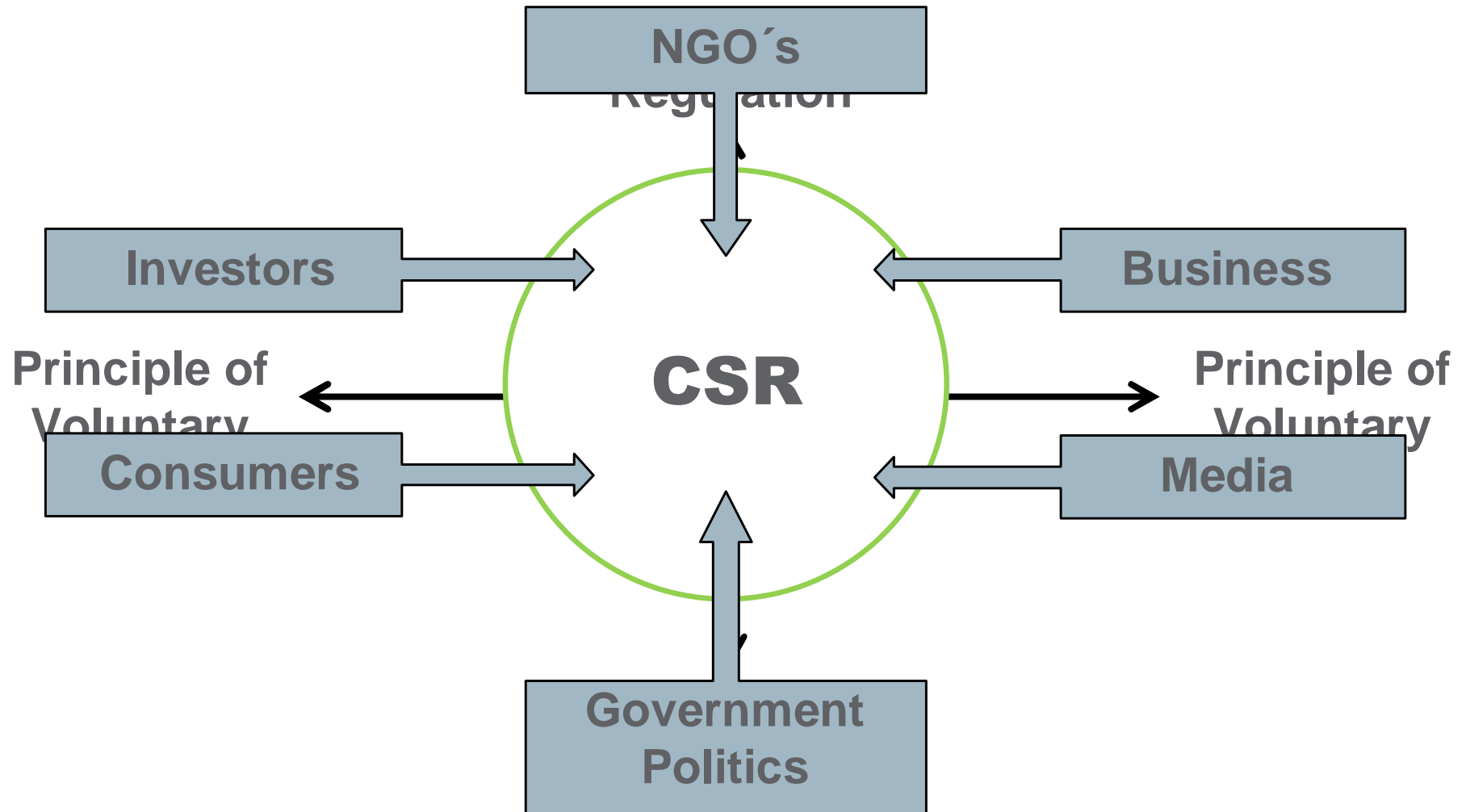
Corporate Social Responsibility - CSR

Parallel discussions in the same context:

Sustainability and „**Corporate Citizenship**“

and at the organizational level, „**Corporate Governance**“

Sustainability – the european Discussion



The German Sustainable Building Council

The association for sustainable building in the building and real estate sectors

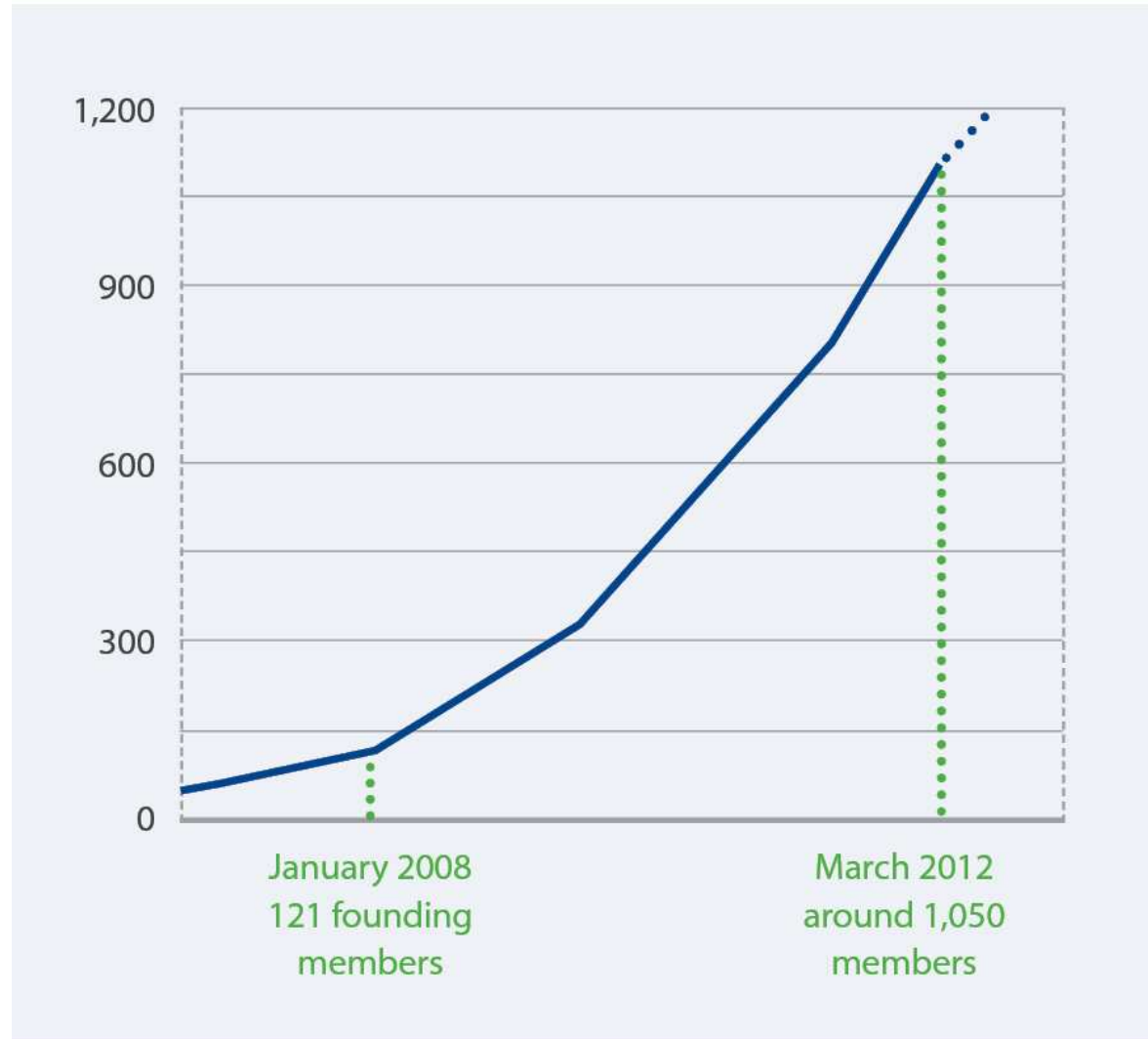
- Initiative 2007: 5 Member Organizations
- Founding 2007: 40 Members Organizations
- Non-profit and non-governmental organization
- Independent community of experts
- Approximately 500 volunteers in DGNB Working Groups and Committees
- National and international knowledge platform



DGNB[®]

Deutsche Gesellschaft für Nachhaltiges Bauen e.V.
German Sustainable Building Council

DGNB Membership Growth



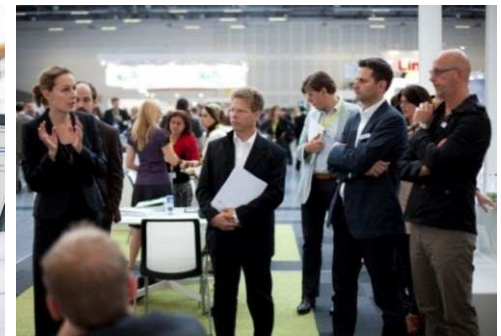
Mission and Implementation

Mission

- The mission of the DGNB is to promote solutions in the planning, construction and operation of buildings which realize the goals of sustainable building

Implementation

- Ongoing development of the DGNB Certification System and awarding of DGNB Certificates
- Knowledge transfer to a broad professional audience through:
 - > The DGNB Academy
 - > The DGNB Navigator
 - > Public Events



The DGNB Academy

The DGNB has made it a priority to make its extensive expertise in the field of sustainable building available to all interested parties and stakeholders.

The DGNB Academy provides opportunities for:

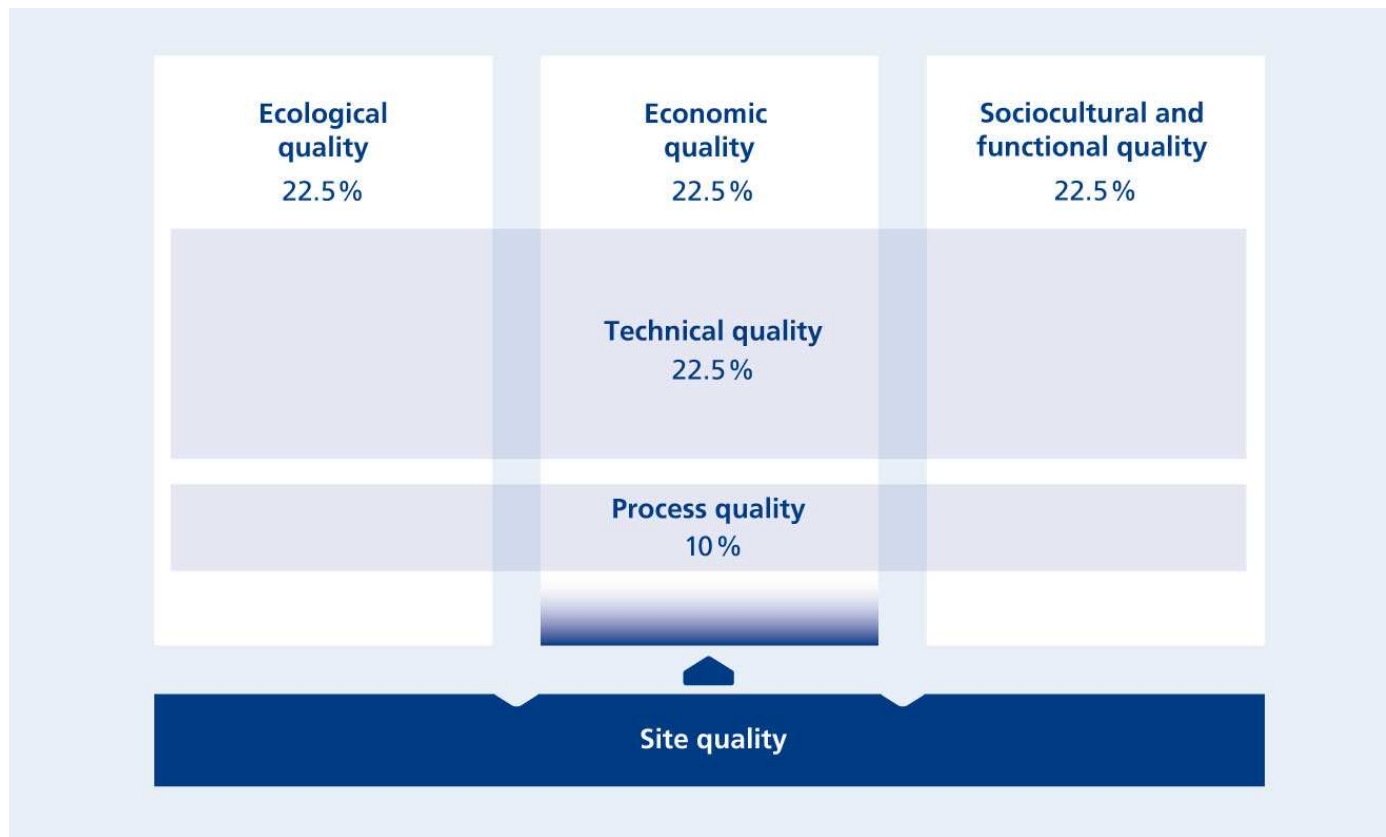
- Building owners
- Architects
- Planners
- Contractors
- Students



2nd Generation Certification System

Holistic Approach

- Covering all of the main aspects of sustainability



2nd Generation Certification System

Embedded LCA (Life Cycle Assessment)

- Systematic analysis of the environmental impact of products during their entire life-cycle. Harmonized by international standards (ISO 14040 / 14044)

Emphasis on LCC (Life Cycle Costing)

- Total cost throughout the entire life-cycle incl. selected construction, operation and maintenance costs directly attributable to owning or using the asset

Oriented towards performance and targets

- Assessment of the building as a whole, not individual measures

Evaluation Matrix

EVALUATION AREA	CRITERIA GROUP	CRITERIA	CRITERIA POINTS ACHIEVED	CRITERIA POINTS MAX. POSSIBLE	WEIGHTING FACTOR	WEIGHTED POINTS ACHIEVED	WEIGHTED POINTS MAX. POSSIBLE	GROUP POINTS ACHIEVED	GROUP POINTS MAX. POSSIBLE	GROUP PERFORMANCE INDEX	GROUP WEIGHT
ENVIRONMENTAL QUALITY	LIFE CYCLE ANALYSIS	Global Warming Potential	10.0	10.0	3	30.0	30.0	178.5	200.0	89.3%	22.5%
		Ozone Depletion Potential	10.0	10.0	1	10.0	10.0				
		Photochemical Ozone Creation Potential	10.0	10.0	1	10.0	10.0				
		Acidification Potential	10.0	10.0	1	10.0	10.0				
		Eutrophication Potential	7.1	10.0	1	7.1	10.0				
	GLOBAL AND LOCAL ENVIRONMENTAL IMPACT	Local Environmental Impact	8.2	10.0	3	24.6	30.0				
		Sustainable Use of Resources / Wood	10.0	10.0	1	10.0	10.0				
		Nonrenewable Primary Energy Demand	10.0	10.0	3	30.0	30.0				
	RESSOURCE CONSUMPTION AND WASTE GENERATION	Total Primary Energy Demand and Proportion of Renewable Primary Energy	8.4	10.0	2	16.8	20.0				
		Drinking Water Demand and Volume of Waste Water	5.0	10.0	2	10.0	20.0				
Land Use		10.0	10.0	2	20.0	20.0					
ECONOMIC QUALITY	LIFE CYCLE COSTS	Building-Related Life Cycle Costs	9.0	10.0	3	27.0	30.0	47.0	50.0	94.0%	22.5%
	ECONOMIC PERFORMANCE	Suitability for Thiry-Party Use	10.0	10.0	2	20.0	20.0				

Example of an evaluation matrix of a DGNB gold certified building, occupancy profile “New Office and Administrative Buildings, version 2009”

Definition of System Values

- Target Value: Best Practice
- Reference Value: Good Practice
- Limit Value: Typical Practice

	EVALUATION POINTS	
TARGET VALUE	10	➔ Achievable Goals
REFERENCE VALUE	5	
LIMIT VALUE	1	

Comprehensive Quality

- Minimal requirements have to be fulfilled in each evaluation area

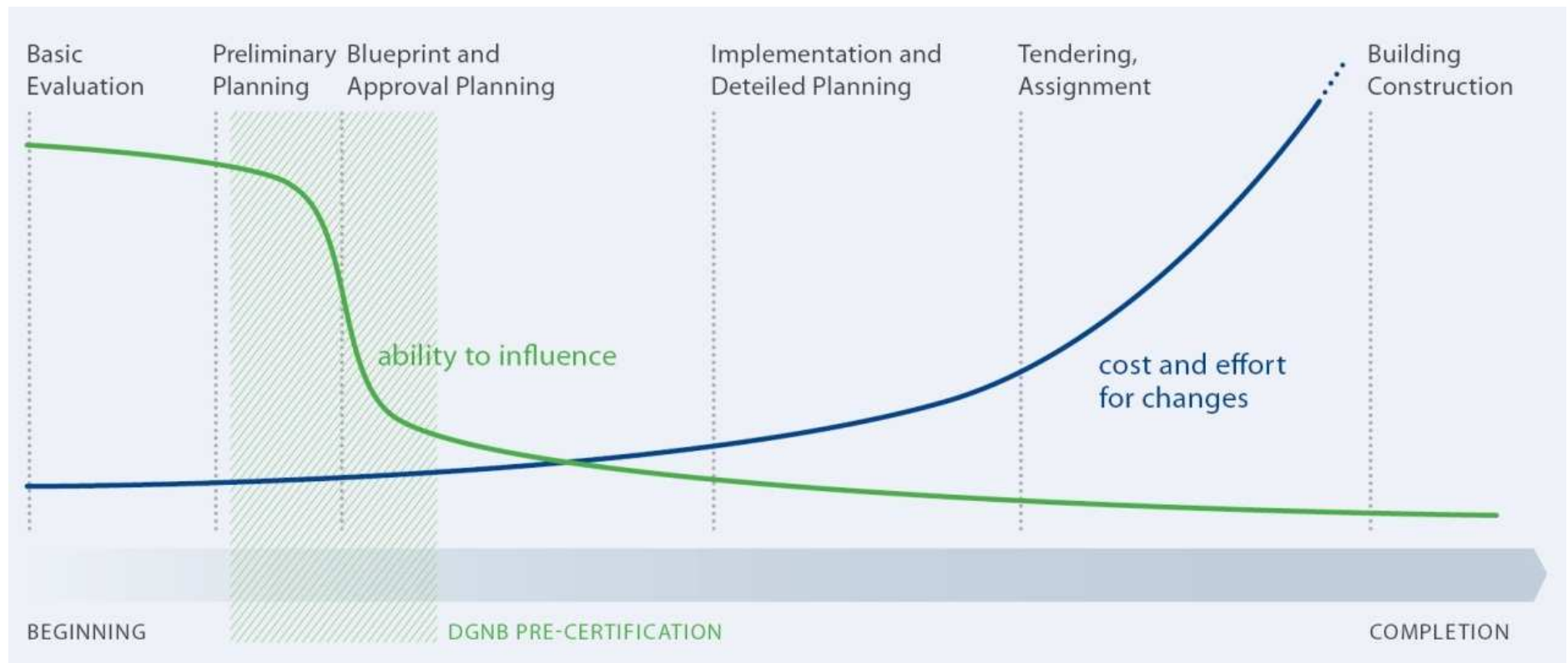
Total Performance Index	Nominal Performance Index	Award	
≥ 50%	≥ 35%	Bronze	
≥ 65%	≥ 50%	Silver	
≥ 80%	≥ 65%	Gold	

Pre-Certification

- DGNB Criteria as guiding instrument in the planning phase
- Supports risk management
- Insures transparency and clear processes
- Defines specific performance objectives
- Promotes integrated planning and early establishment of communication

2nd Generation Certification System

Pre-Certification



Important criteria

- **Process quality**



2nd Generation Certification System

Unified Basis

- Evaluation profiles tuned to every stage of the building life cycle
- Based on the same comprehensive quality approach



Occupancy profiles in use

New Constructions:

- Office and Administrative Buildings
- Retail Buildings
- Residential Buildings
- Industrial Buildings
- Hotels
- Educational Facilities
- Hospitals
- Laboratory Buildings
- Mixed City Districts

Existing Buildings:

- Complete Renovation of Office and Administrative Buildings
- Modernization Office and Administrative Buildings
- Existing Office and Administrative Buildings
- Modernization Residential Buildings

The DGNB Criteria

Selection and evaluation of
sustainable building products





ENV1.1	Life Cycle Impact Assessment
ENV1.2	Local Environmental Impact
ENV1.3	Responsible Procurement
ENV2.1	Life Cycle Assessment - Primary Energy
ENV2.2	Drinking Water Demand and Wastewater Volume
ENV2.3	Land Use

LCA – Ecological Footprint of the physical building components in compliance with DIN EN ISO 14040 and 14044.

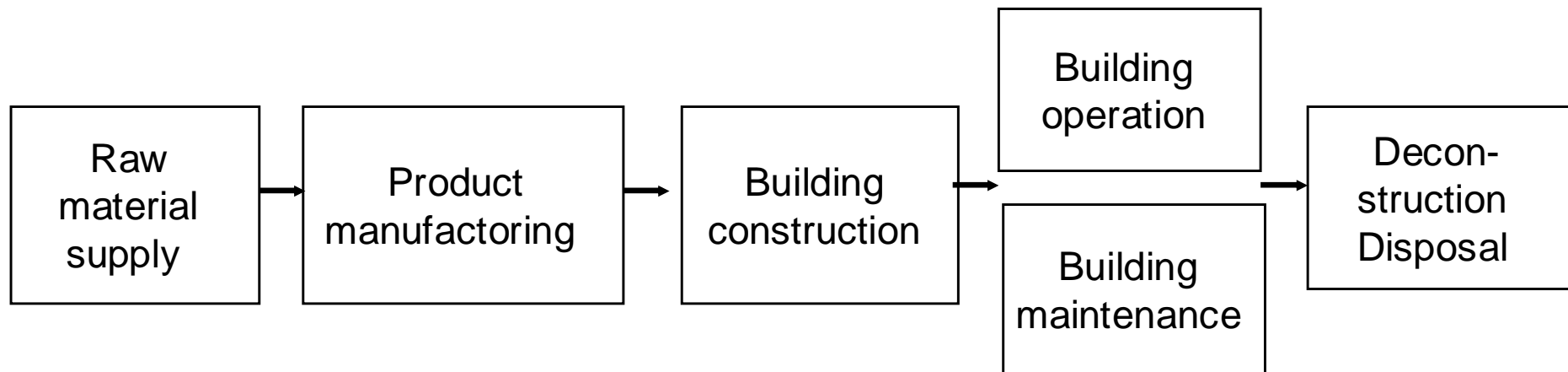
Incorporates all involved lifecycle stages:

- **Construction**
- **Operation** incl. supply & disposal, maintenance, repairs and replacements
- **End-of-Life** incl. recycling and disposal of all building materials

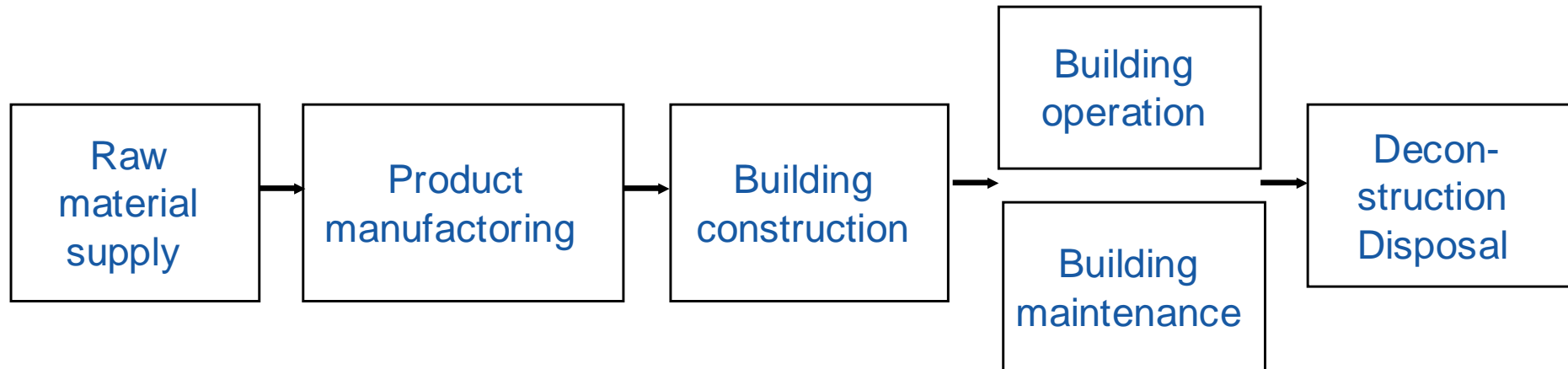
Life Cycle Orientation

Integration of the system view and the life cycle perspective

Efficient sustainable Construction is based on the holistic view on a building; the **life cycle orientation prevents** the postponing of problems; **Environmental Product Declarations (EPD)** for building products are an important source for **life cycle assessments (LCA)** of constructions as well as the whole building.



Source of the LCA Data



Manufacturer specific datas EPD

Average data. Associations, institutes and science

Empirical data from the building operation

Selection of the main materials

A new building consists of an average of 300 – 500 single products

Approximately 10 - 20% of products are required for the shell

However, they account for about 80% of the building mass

The selection and evaluation of mass-intensive products significantly influenced the Life Cycle Assessment (LCA) of the building

Protection goals:

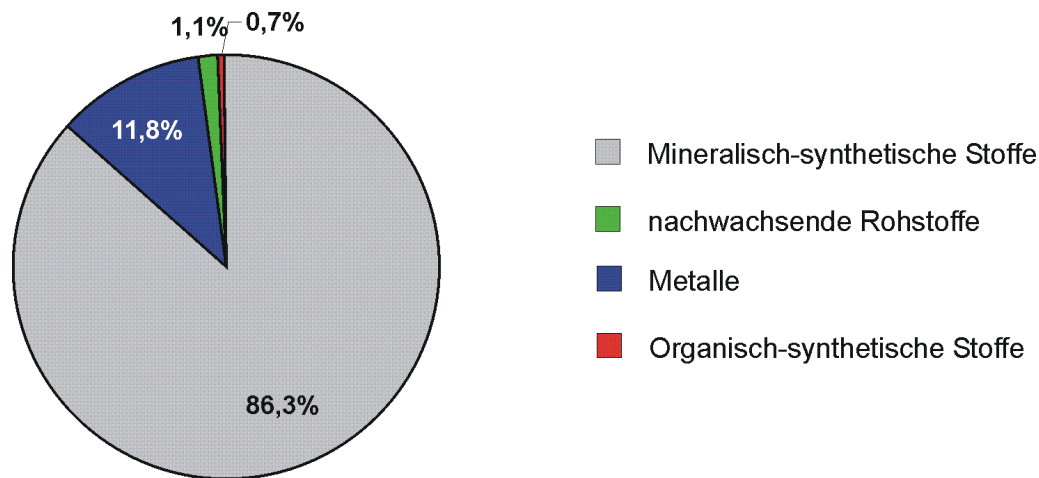
Protection of the ecosystem and the natural environment

Protection of natural resources

Environmental impact and embodied energy

Example: Importance of concrete shell construction for the LCA

The mineral products and materials
representing 60 – 80 % of the mass of
the whole building



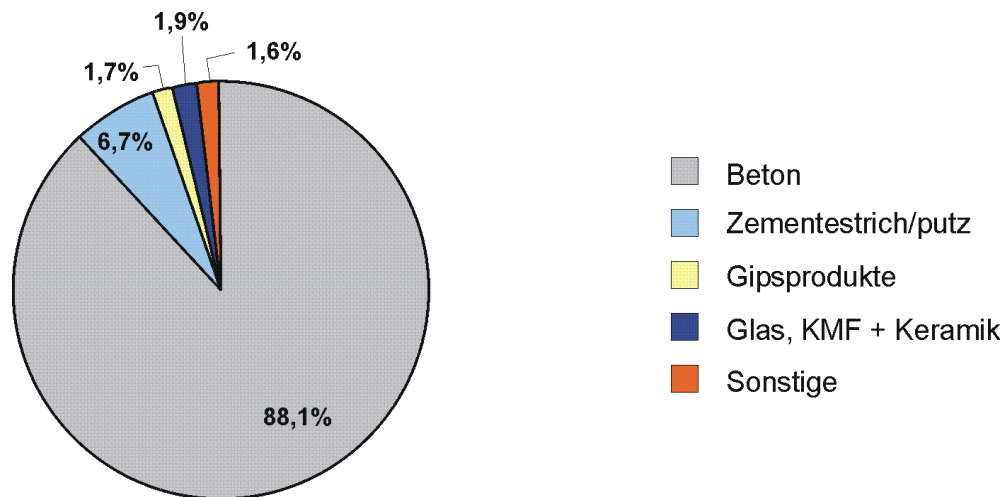
Material groups with mass in %
(data Example: UBA Dessau)



Environmental impact and embodied energy

Example: Importance of concrete shell construction for the LCA

The concrete shell representing
60 – 80 % of the mass of the whole
building



Distribution of mineral materials
(data example: UBA Dessau)

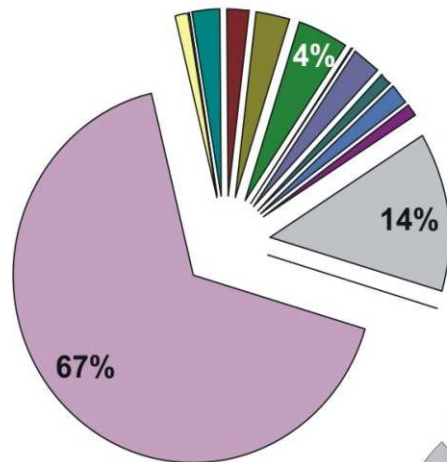


Environmental impact and embodied energy

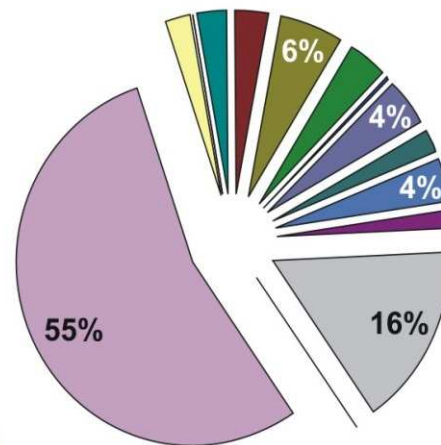
Example: Importance of concrete shell construction for the LCA

Non-renewable primary energy for the building construction and use phase (only materials and products)

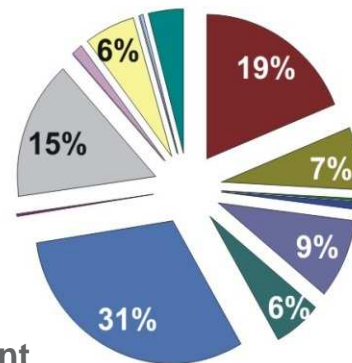
Construction



Total effect



Replacement



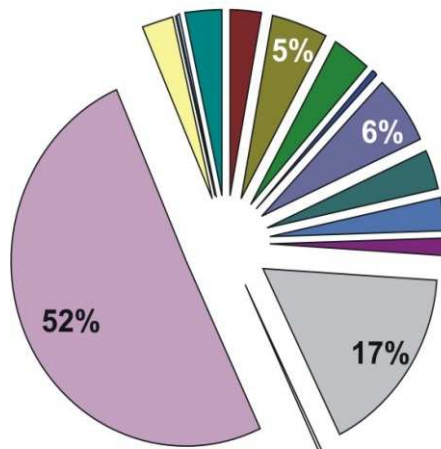
- Bodenbelagsarbeiten
- Dachdeckungsarbeiten
- Estricharbeiten
- Fliesen- und Plattenarbeiten
- Holzbauarbeiten Aussenfassade
- Holzbauarbeiten Innenfassade
- Malerarbeiten
- Metallbauarbeiten Fenster, Türen, Roste
- Metallbauarbeiten Sheddach, Atrium
- Putzarbeiten
- Rohbauarbeiten
- Tischlerarbeiten Fenster
- Tischlerarbeiten Heizkörperblenden
- Tischlerarbeiten Innenausbau
- Trockenbauarbeiten

Environmental impact and embodied energy

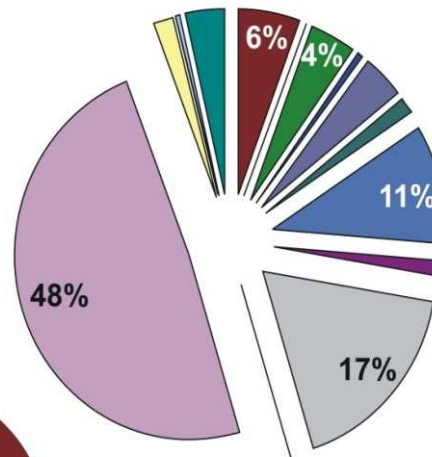
Example: Importance of concrete shell construction for the LCA

GWP kg CO₂ equiv. The concrete shell representing 50 - 60 % of the kg CO₂ äquiv. for the entire building

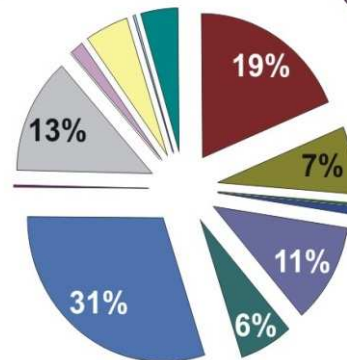
Construction



Total effect



Replacement



- Bodenbelagsarbeiten
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- Trockenbauarbeiten

Reduction of building mass

Planning of high-strength and leaner concrete components

Planning of lightweight constructions

Use of renewable resources

Use of solar energy

Reduction of climate impact through CO2 neutrality

Protection of natural resources

Increasing the durability



ENV1.1	Life Cycle Impact Assessment
ENV1.2	Local Environmental Impact
ENV1.3	Responsible Procurement
ENV2.1	Life Cycle Assessment - Primary Energy
ENV2.2	Drinking Water Demand and Wastewater Volume
ENV2.3	Land Use

The DGNB Certification System determines and evaluates **high-risk material** and harmful substance groups.

- Halogens and halogen bonds
- Heavy metals
- Organic solvents
- Substances and products included in the **European Biocidal Products Directive**
- Substances and products listed in **REACH** as harming water, soil, and air or detrimentally affecting or generally endangering the environment

European requirements for construction products

Estimated new approach of the for the European **Construction Products Directive (CPD)**

became replaced in 8 / 2011 is since 9.03.2011 by the
European Construction Products Regulations (CPR), validity July 2013

Regulations are directly binding (no national implementation like for directives required)

Introduces sustainability especially with the new **basic work requirements**
(**BWR 3 and 7**), based on the EPA Network (Environmental Protection Agencies)

European requirements for construction products

Establishment of ...

- harmonized conditions for the marketing construction products, no trade barriers for the internal market.
- harmonized requirements for the declaration of properties

BWR 1 : Mechanical resistance and stability

BWR 2 : Fire protection performance

BWR 3 : Hygiene, health and environmental protection

BWR 4 : Safety in use

BWR 5 : Noise Protection

BWR 6 : Energy saving and heat insulation

BWR 7 : Sustainable use of natural resources

Environmental Product Declaration (EPD)

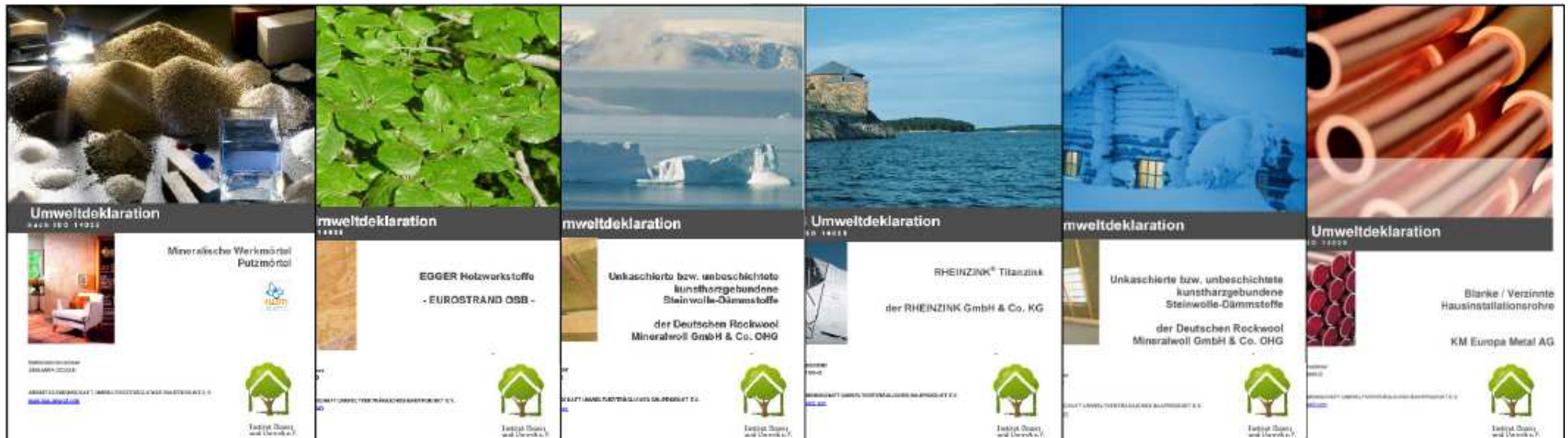
The following amendment to the CPR was in the reading of the European Parliament adopted in 24.4. 2009:

(11a) To assess the sustainable use of resources and to assess the impact of buildings on the environment the environmental statements (**Environmental Product Declarations - EPD**) shall be used.

Environmental Product Declaration (EPD)

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Environmental Quality



Useage of sustainable wood from tropical and subtropical regions with the certification

FSC Forest Stewardship Council

Environmental Quality

Useage of natural stone from socially sound mining

FairStone Germany





ECO1.1 Building-Related Life-Cycle Costs

ECO2.1 Flexibility and Adaptability

ECO2.2 Commercial Viability



Building-related life-cycle costs are determined at **net present value** over a period of 50 years:

- Selected construction costs
- Selected occupancy costs
- Selected operation costs (supply and disposal, cleaning, operation, inspection and maintenance)
- Selected repair costs



SOC1.1	Thermal Comfort
SOC1.2	Indoor Air Quality
SOC1.3	Acoustic Comfort
SOC1.4	Visual Comfort
SOC1.5	Occupant Control
SOC1.6	Quality of Outdoor Spaces
SOC1.7	Safety and Security
SOC2.1	Access for All
SOC2.2	Public Access
SOC2.3	Cyclist Facilities
SOC3.1	Design and Urban Quality
SOC3.2	Integration of Public Art
SOC3.3	Layout Quality

Comfort criteria to evaluate the benefit of the building to the users.

Each criteria includes different indicators such as:

- Operating temperature
- Draught
- Radiant temperature asymmetry
- Relative humidity

- Availability of daylight in line of sight to the outside
- Lack of glare in daylight and artificial light
- Light distribution
- Color rendering

Example – Criterion SOC 1.2 „Indoor air quality“

Health problems - Impairments due to indoor air pollution

Syndroms:

- Sick Building Syndrom (SBS)
- Building related Illness (BRI)
- Multiple Chemical Sensitivity (MCS)
- Chronic Fatigue Syndrom (CFS)

Specific disturbance of health

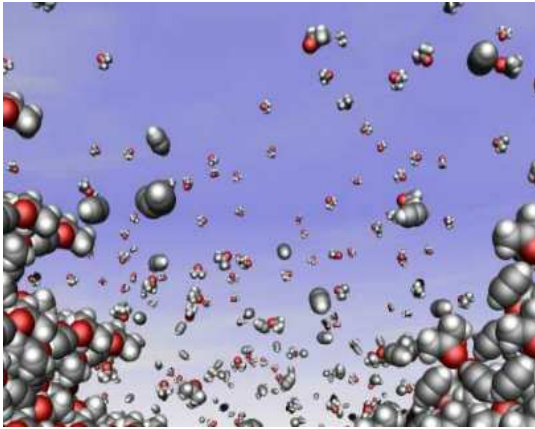
- allergy / extrinsic asthma (Formaldehyde, dust allergy, mould allergy ...)
- Respiratory disease (VOC)
- Cancers (Tobacco smoke, Tabakrauch, Benzene, Radon ...)

Unspecific disturbance of health

- Sensory effects (Smell, indisposition)
- Neurovegetative effects (Headache, Fatigue, impaired Conzentration)
- Irritative effects (Nose, Throat, Eyes, Skin ...)

What means „VOC“

Emissions of volatile organic compounds



- Chemical Industry : Production of well over 400,000 chemical products and substances.
- Most chemicals have a vapor pressure, they evaporate over time.
- Are these gas emissions harmful?
 - **VOC** (volatile organic compounds)
 - **SVOC** (semi-volatile organic compounds)
 - **POM** (particulate organic matter)

Example – Criterion SOC 1.2 the benchmarks

Indoor air concentrations for all of the tested rooms:

VOC [$\mu\text{g}/\text{m}^3$]	FORMALDEHYDE [$\mu\text{g}/\text{m}^3$]	CHECKLIST POINTS
≤ 500	≤ 60	50
≤ 1000	≤ 60	25
≤ 3000	≤ 120	10
> 3000	> 120	0

Volatile Organic Compounds



SOC1.1	Thermal Comfort
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SOC2.3	Cyclist Facilities
SOC3.1	Design and Urban Quality
SOC3.2	Integration of Public Art
SOC3.3	Layout Quality

Functional criteria addressing topics of efficiency and flexibility.

The suitability for conversion is analyzed on four levels:

- Modularity of the building
- Spatial structure
- Supply of electricity and other media
- Heating, supply and disposal of water



TEC1.1	Fire Prevention
TEC1.2	Noise Protection
TEC1.3	Building Envelope Quality
TEC1.4	Adaptability of Technical Systems
TEC1.7	Ease of Cleaning and Maintenance
TEC1.8	Ease of Deconstruction and Disassembly
TEC1.9	Sound Emissions

Requirements are based on the specification of the German Energy Conservation Directive.

Median thermal transmittance coefficients of building components
Thermal bridge adjustment
Air permeability class (window air-tightness)
Amount of condensation within the structure
Air exchange rate n50 and if necessary q50



PRO1.1	Comprehensive Project Brief
PRO1.2	Integrated Design
PRO1.3	Design Concept
PRO1.4	Sustainability Aspects in Tender Phase
PRO1.5	Documentation for Facility Management
PRO2.1	Environmental Impact of Construction
PRO2.2	Construction Quality Assurance
PRO2.3	Systematic Commissioning

This criterion is assessed by summing up the following two indicators:

- **Documentation** of materials, auxiliary materials, and safety data sheets
- **Measurements** for quality control (e.g. blower door test, thermography, footfall sound tests, indoor air quality measures)

Declaration and verification of products

Material and product declaration

The products and auxiliary products selected for the construction service offered are to be declared in accordance with the technical introductions to demonstrate compliance with the specifications required product features and product quality.

The Declaration must include the **manufacturer's name, exact description of the product and the technical sheet**

The Declaration of synthetic products (Paints and Varnishes, Adhesive, Primer and Impregnations, Resin) must include **the Material data safety sheet (EC Directive 2001 /58/EG)**

The products are binding. Changes even with auxiliary products during the execution are to be announced in due time and require the approval of construction management



SITE 1.1	Local Environment
SITE 1.2	Public Image and Social Conditions
SITE 1.3	Access to Transportation
SITE 1.4	Access to Amenities



The criteria include topics such as:

- Avalanches, storm
- Outdoor air quality, outdoor noise
- Soil and building plot
- Upkeep and condition of the neighborhood
- Accessibility of public transport systems
- Existence of use-specific facilities

**If you have any questions,
please do not hesitate to contact us**

www.dgnb.com

Prof. Alexander Rudolphi

Thank you for your attention