HI-SMART

HI-SMART: HIGHER EDUCATION PACKAGE FOR NEARLY ZERO ENERGY AND SMART BUILDING DESIGN

MODULE #6

CHAPTER 5: CERTIFICATION SCHEMES

Co-funded by the
Erasmus+ Programme
of the European Union

MŰEGYETEM 1782
STU SLOVAK UNIVERSITY OF TECHNOLOGY IN BRATISLAVA
TECHNISCHE UNIVERSITÄT KAISERSLAUTERN
ENERGIAKLUB CLIMATE POLICY INSTITUTE APPLIED COMMUNICATIONS

6.5.1 INTRODUCTION

The globalized industrial productions create negative effects that result in the formulation of many regulatory approaches and international environmental agreements about building sustainability. Many private or public actors create sustainable/energy certification schemes to set and enforce standards for sustainability performance. These regulations have been continuously established by governments and accepted/implemented by more and more stakeholders in the building industry sector. They are used around the world as a mechanism to determine building energy rating scores. However, the building energy performance represents only one part of a comprehensive package to achieve sustainable policy objectives. Additionally, the scope of schemes is different according to the implementation process and requirements of local jurisdictions. The main goal of building certification schemes is to help reduce greenhouse gas emissions caused by the building sector and to provide actionable information to key decision makers.

The International Partnership for Energy Efficiency Cooperation (IPEEC) is a voluntary, high-level international forum that provides global leadership on energy efficiency by identifying and facilitating government implementation of policies and programs that yield high energy-efficiency gains. Its membership now includes 17 of the Group of 20 (G20) economies, which represent over 80% of global energy use and over 80% of global greenhouse gas (GHG) emissions (OECD, 2015). IPEEC's Buildings Energy Efficiency Taskgroup (BEET) was established in 2013 to increase multilateral cooperation in the field of building energy efficiency, specifically in relation to:

- The development and implementation of national building energy efficiency rating systems.
- Identify and assess existing building energy rating schemes and instruments that enable effective implementation of energy efficiency policy measures.
- Analyse the various implementation mechanisms and assess the impacts of rating tools and other buildings programs.
- Enhance the development of instruments that enable effective implementation of energy efficiency policy measures.

The task group published the report in 2014 „Building Energy Rating Schemes – Assessing Issues and Impacts". **BuildingRating.org** – an international exchange for information on building rating, policies, and programs.

The development of Certification schemes in the European Union (EU) provides an influential information tool to quantify the energy rating of a building. Energy Performance of Building Directive (EPBD) represents a major legislative instrument in the EU. It is a key document in processes of the building (new and existing) transformation into Nearly Zero Energy Buildings (NZEBs), where Energy Performance Certificate (EPC) plays a major role. The EPC is a

mandatory requirement in the EU member states and includes an energy efficiency rating system. Each member state has developed its own approaches for certification, but the main objective is the same. Most of the certification systems are managed and administered by national Green Building Councils around the world. The World Green Building Council, World GBC, is an international organisation that promotes green building and forms a coalition of the national Green Building Councils in 78 countries over the world.

Additional group of certification schemes more related to sustainability called "Building Sustainability Assessment Schemes" (BSAS). They are focused to measure, evaluate, and implement sustainability goals through the life/cycle of buildings. The establishment of BSAS determines trends of green and sustainable buildings based on environmental protection aspirations (limit the building's ecological footprint) together with improved indoor air quality conditions. Moreover, the concept of sustainable building is also usually related to social, economic and cultural indicators, together with the interactions with its surroundings. It is important to properly consider and understand local climate conditions (microclimate) and work in harmony with them. The key principles in these certification schemes – energy, environment, ecology and economy. The main purpose of BSAS is to gather and report information for decision/making through all phases of a building project. Accordingly, it gathers key stakeholders such as engineers, architects, investors, building users and others. However, sustainability is not just about green and high-performance buildings but also about a healthy community, quality way of life, improving employee productivity and reducing its overall negative impact to the environment.

Worldwide, there are a number of different sustainability programs/certification schemes that outline various important green criteria. They play a major role in raising awareness and in popularizing green building design. However, most of them have been specifically tailored for the local building industry of the country or union where they were developed. All stakeholders in the design process of new or renovated buildings should have a clear understanding of available certification programs to remain competitive in a green real estate market.

6.5.2 BACKGROUND OF CERTIFICATION SCHEMES

Since the second half of the 1980s, the development of various methods/schemes has started for evaluating the green building performance. The main purpose is to guide developers and designers in their attempts to design for high performance building, and to measure and assess building performance in as objective a way as possible. It means, the application of a holistic approach considering a wide range of aspects of the building performance (from building materials until the availability of the nearest station of public transportation). Certification schemes represents voluntary environmental assessment and labelling programs for **GREEN BUILDINGS**. They are not compulsory schemes unlike national codes or standards, but determinate labels of sustainability. Some public organizations mandatory

determinate certification schemes for their buildings. They mainly represent a certain signature of prestige of sustainability or ecology (increase of the financial value of a building). A lot of them are managed by private organizations, which determines a conflict of interests at governmental level. Certification systems with holistic approach provide a larger overall objective of a building's impact on the ecology and environment. Additionally, they suggest different credits to different parameters according to type and usage of buildings. These credits are mainly based on the standards of the origin country or union, requesting a minimum of the set standards, and targeting higher rankings within the system.

They can be categorized into three types:

- **Single attribute product certifications** – focus on a single sustainability aspects or quality of a product's performance, such as energy efficiency rating, reduced water usage, or sustainable procurement of natural resources, such as timber.
- **Multiple attribute product certifications** – examine a range of sustainable aspects; the range of these may vary, but these systems look at several characteristics of a product e.g. life cycle costs, quality control and energy usage.
- **Multiple attribute building certifications** – these systems variously consider factors like surroundings, emissions, toxicity, performance efficiency, water and energy use, and more, to establish a holistic rating that goes beyond aggregating individual components of the project.

Building codes – minimum healthy conditions
Certification schemes – exceptional conditions

CERTIFICATION SCHEMES ≠ BUILDING CODES

Certification schemes operate under different sets of objectives, guidelines, and their own scoring systems according to type of building. To Successfully achieve the target label of sustainable building, it is very important to set goals at an early stage of a project.

FROM CRADLE TO GRAVE or FROM CRADLE TO CRADLE

A significant disadvantage of these assessment systems is that each is simply one organization's vision of a green sustainable building, and often, because of time and financial constraints, assessment systems leave much to be desired. For example, many assessment systems rely on energy modelling to forecast energy consumption rather than using actual energy data. The result can occasionally report that the actual energy consumption is much higher than was originally predicted by the energy model. The rationale for not working with real building energy consumption data is that gathering the data takes time (generally a minimum of a year), and the cost of this process is significant (Charles J. Kibert, 2016).

Most certification schemes have key standards categories (energy, water, and indoor environmental quality) for rating the building. However, there is no one single approach in the building certification process, although there seems to be convergence on the need to provide a life-cycle assessment (LCA) of the building materials. The evaluation can be performed at local, regional, national and global scales, where the various key characteristics are measured with different values (energy, density, volume, location, surrounding, waste threatening, air quality, etc.). However, the local certification schemes could be a barrier to the free movement of goods between states. On the other side, the global adoption of a template can ignore the essentials of sustainability such as climate, culture and local energy sources.

Key characteristics of certification schemes:

- **Environmental sustainability**
  environmental impact, resources, biodiversity, recycling, toxicity
- **Economic sustainability**
  life cycle costing, area use, stability of value
- **Social sustainability**
  safety, heath, architecture, transport, social responsibility

Time is important in building certification. A building that is certified as being high performance at the start of its life cycle can eventually perform poorly if a program of continuous monitoring and assessment is lacking. Also, if during maintenance, alterations, and renovation, the new and replacement systems do not meet the high-performance requirements of the original building, it would be questionable whether the facility would maintain its green certification. To cope with this situation, the various building assessment schemes have what are generally referred to as existing building rating tools for periodically assessing building performance across time (Charles J. Kibert, 2016).

Building certification schemes are created mainly to promote sustainable high-performance buildings for increasing market demand for sustainable property. Additionally, the certification schemes can help governments in processes of energy neutrality in accordance with global protocols and agreements.

6.5.3 PRINCIPLES OF CERTIFICATION SCHEMES

Various certification systems have been influenced by national and international standards in the relevant subject areas of buildings. The main differences between certification schemes are determined by different weights given to environmental and energy aspects within various environmental categories. These follow the main environmental and social issues for the scheme's region, resulting in rating systems tailored to account for climate and

local culture. Some schemes also give credits for compliance with building regulations. This makes benchmarking or comparison between schemes difficult as their baselines, scope and indicators differ. The problem of building sustainability is an internationally strategic issue, which requires a common language and common tools to be evaluated by the certification schemes. The International Organization of Standardization (ISO) has defined the requirements for sustainable building management.

- ISO 21931:2010 Sustainability in building construction: Framework for methods of assessment of the environmental performance of construction works – Part 1: Buildings.
- ISO 21930:2007 Sustainability in building construction: Environmental declaration of building products.
- ISO 23045:2008 Building environmental design: Guidelines to assess energy efficiency of new buildings.
- ANSI/ASHRAE 189.1 (2012)-2011 Standard for the design of High-Performance Green Buildings.

The certification schemes use different common key words:
- the term '**category**' which can be referred to as a 'quality section' or an 'evaluation area';
- another term is '**issue**', which can be referred to as a 'credit' or a 'criterion'.

The certification schemes share a series of common approaches and aims:
- Energy and environmental evaluation of buildings based on criteria concerning site potential, building structures and materials, energy efficiency, water conservation, indoor air quality, operation and maintenance.
- Inspiration to find innovative solutions that minimize the impact on the environment.
- Design a system to help reduce running costs, improve working and living conditions.
- Market recognition for low environmental impact buildings.

The certification schemes typically consist of three major components:
- **the structure** – a declared set of environmental performance criteria organised in a logical fashion.
- **the scoring** – the assignment of several possible points or credits for each performance issue that can be earned by meeting a given level of performance.
- **the output** - a means of showing the overall score of the environmental performance of a building or facility.

6.5.4 BREEAM

BREEAM (Building Research Establishment Environmental Assessment Method) was the first certification system in the world to assess, rate and certify the sustainability of buildings. It is currently world's leading sustainability assessment method for master planning projects, infrastructure, and buildings, recognizes and reflects the value in higher performing assets

across the built environment lifecycle, from new construction to in-use and refurbishment. It was the first system of its kind and has been the template for many subsequent certification systems that have been developed throughout the world. It is primarily focused on the environmental dimension of sustainability followed by the social dimension. BREEAM measures sustainable value in a series of categories, ranging from energy to ecology. Each of these categories addresses the most influential factors, including low impact design and carbon emissions reduction; design durability and resilience; adaptation to climate change; and ecological value and biodiversity protection. Economic aspects are represented at 5%, which is greater than most of the analysed certifications.

Origin: United Kingdom (1990), first certification system, administered by the Building Research Establishment.

Level of certification: outstanding (above 85%), excellent (70-85%), very good (55-70%), good (45-55%), pass (30-45%), acceptable (under 30%) and it is reflected in a series of stars on a certificate.

Awarding credits: Each category is subdivided into a range of assessment issues, each with its own aim, target and benchmarks. When a target or benchmark is reached, as determined by the BREEAM assessor, the development or asset score points, called credits. The category score is then calculated according to the number of credits achieved and its category weighting. Once the development has been fully assessed, the final performance rating is determined by the sum of the weighted category scores.

Schemes:

- **BREEAM Communities** for the master-planning of a larger community of buildings
- **BREEAM New Construction**: Buildings for new build, domestic and non-domestic buildings
- **Home Quality Mark** for new-build domestic buildings (UK only)
- **BREEAM New Construction: Infrastructure** for new build infrastructure projects
- **BREEAM In-Use** for existing non-domestic buildings in-use
- **BREEAM Refurbishment** and Fit Out for domestic and non-domestic building fit-outs and refurbishments

Category weightings: fundamental to any building environmental assessment method providing a means of defining and ranking the relative impact of environmental issues. BREEAM uses an explicit weighting system to determine the overall BREEAM score.

Table 6.5.1 – BREEAM UK Environmental section weightings. Source: www.breeam.com

Environmental section	Weighting Fully fitted out	Simple building	Shell and core only	Shell only
Management	11%	7.5%	11%	12%
Health and Wellbeing	14%	16.5%	8%	7%
Energy	16%	11.5%	14%	9.5%
Transport	10%	11.5%	11.5%	14.5%
Water	7%	7.5%	7%	2%
Materials	15%	17.5%	17.5%	22%
Waste	6%	7%	7%	8%
Land Use and Ecology	13%	15%	15%	19%
Pollution	8%	6%	9%	6%
Total	100%	100%	100%	100%
Innovation (additional)	10%	10%	10%	10%

Calculating a building's BREEAM rating:

A BREEAM Assessor must determine the BREEAM rating using the appropriate assessment tools and calculators and only a certified assessment can claim a BREEAM Rating. An indication of performance against the BREEAM scheme can be determined by anyone using a BREEAM Pre-Assessment Estimator available from the BREEAM website www.breeam.com.

The process of determining a BREEAM rating and an example calculation, see Table 6.5.2.

1. Firstly, the scope of the project being assessed needs to be determined. The appropriate BREEAM assessment tool or calculator then adjusts the scoring and weightings to reflect the categories and individual credits assessed.
2. For each of BREEAM's nine categories the number of credits awarded is determined by the BREEAM Assessor according to the number of credits available when the criteria of each assessment issue have been met.
3. The percentage of available credits achieved is calculated for each section.
4. The percentage of credits achieved in each section is multiplied by the corresponding weighting for each section to give the overall environmental category score.
5. The section scores are added together to give the overall BREEAM score.
6. The overall score is compared with the BREEAM rating benchmark levels and, provided all minimum standards have been met, the relevant BREEAM rating is achieved.
7. An additional 1% can be added to the final BREEAM score for each innovation credit achieved (up to a maximum of 10% with the total BREEAM score capped at 100%).

Table 6.5.2 – Example BREEAM UK score and rating calculation. Source: www.breeam.com

BREEAM section	Credits achieved	Credits available	% of credits achieved	Category weighting (fully-fitted)	Section score (%)
Management	14	21	66.67	0.11	7.33
Health and Wellbeing	12	22	54.55	0.14	7.64
Energy	15	31	48.39	0.16	7.74
Transport	8	12	66.67	0.10	6.67
Water	4	10	40.00	0.07	2.80
Materials	8	14	57.14	0.15	8.57
Waste	3	6	50.00	0.06	3.00
Land Use and Ecology	5	10	50.00	0.13	6.50
Pollution	8	12	66.67	0.08	5.33
Innovation	2	10	20.00	0.10	2.00
Final BREEAM score				57.58%	
BREEAM Rating				VERY GOOD	

In order to provide weightings that are adapted for local conditions, the weightings are reviewed for the first project that registers for assessment in a country or region. These weightings are then set as appropriate for that project and all other projects thereafter in that country or region for the life of the current BREEAM International New Construction version. The development of these weightings is based on robust and independent information forwarded from 'local experts' who understand local conditions. This may be a member of the design team if they can demonstrate sufficient knowledge of the environmental conditions of the region or country.

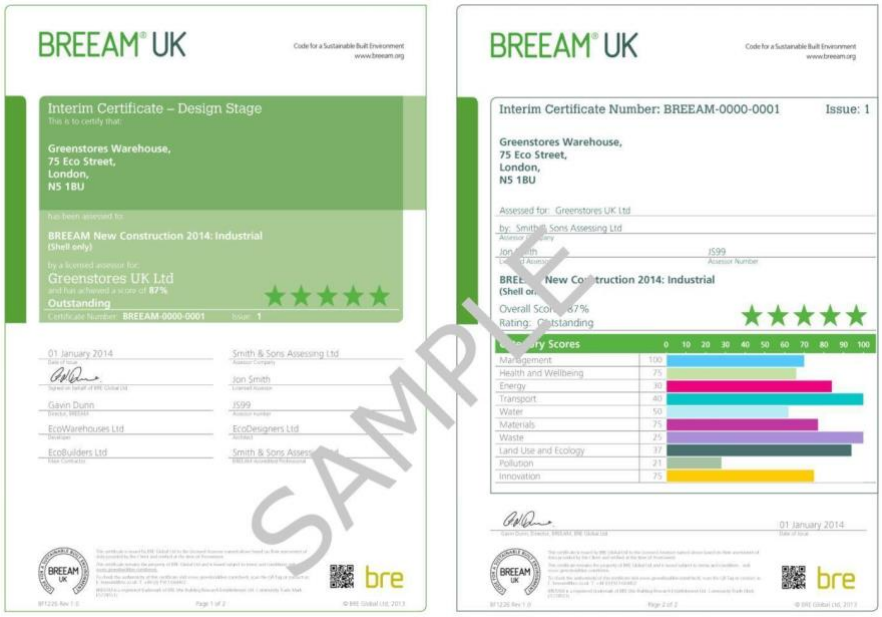

Figure 6.5.1 – The example of the BREEAM certificate. Source: www.breeam.com

6.5.5 LEED

LEED (Leadership in Energy and Environmental Design) was developed by the U.S. Green Building Council and represents one of the largest existing certification systems. It is inspired by BREEAM and primarily focuses on the environmental and social aspects of building sustainability. LEED is a framework for identifying, implementing, and measuring green building and neighbourhood design, construction, operations, and maintenance. It is a voluntary, market driven, consensus-based tool that serves as a guideline and assessment mechanism for the design, construction, and operation of high-performance green buildings and neighbourhoods. LEED rating systems currently address commercial, institutional, and residential building types as well as neighbourhood development. Today's version of LEED, LEED v4.1, raises the bar on building standards to address energy efficiency, water conservation, site selection, material selection, day lighting and waste reduction. The system specialises in the promotion of water and energy efficiency, the reduction of CO2 emissions, promoting a healthy and comfortable indoor climate, and renewable construction materials. LEED is the most geographically widespread certification used, despite the total number of certifications awarded being lower than BREEAM or HQE. LEED focuses roughly 2/3rds on the environmental dimension and 1/3rd on the social dimension with a small focus on the life cycle costing aspect in the economic dimension. The prioritisation of environmental sustainability is a result of three of LEED's principles almost exclusively addressing the environmental dimension. Its major sustainable aspects are resources and health.

Origin: USA (1998), developed by U.S. Green Building Council-USGBC. The rating system is still developing – actual version LEED v4.1.

LEED has four levels of certification, depending on the point thresholds achieved (www.usgbc.org/leed):

- Certified, 40–49 points
- Silver, 50–59 points
- Gold, 60–79 points
- Platinum, 80 points and above

LEED includes a minimum set of conditions that all participating projects need to meet to ensure a level set and entry into the system. These conditions or criteria are known as LEED prerequisites.

Rating systems:

- LEED Building Design and Construction (BD+C)
- LEED for Interior Design and Construction (ID+C)
- LEED for Building Operations and Maintenance (O+M)
- LEED for Neighborhood Development (LEED ND)
- LEED for Homes
- LEED for Cities and Communities

Prerequisites and credits in the LEED Green Building Rating Systems address topics:

- Location and transportation (LT)
- Sustainable Sites (SS)
- Water Efficiency (WE)
- Energy and Atmosphere (EA)
- Materials and Resources (MR)
- Indoor Environmental Quality (IEQ)
- Innovation in Design (ID)
- Regional Priority (RP)

There are also two alternative certification processes for owners with multiple buildings pursuing LEED certification:

- LEED volume certification
- LEED campus certification

The process begins when the owner selects the rating system and registers the project. The project team than meets the requirements for all prerequisites and for the credits the team has chosen to pursue. After documentation has been submitted for certification, a project goes through preliminary and final reviews. The preliminary review provides technical advice on credits that require additional work for achievement, and the final review contains the project's final score and certification level.

LEED v4 for BD+C: Core and Shell
Project Checklist

Project Name:
Date:

Y	?	N				
			Credit	Integrative Process	1	
0	0	0		**Location and Transportation**	**20**	
			Credit	LEED for Neighborhood Development Location	20	
			Credit	Sensitive Land Protection	2	
			Credit	High Priority Site	3	
			Credit	Surrounding Density and Diverse Uses	6	
			Credit	Access to Quality Transit	6	
			Credit	Bicycle Facilities	1	
			Credit	Reduced Parking Footprint	1	
			Credit	Green Vehicles	1	
0	0	0		**Sustainable Sites**	**11**	
Y			Prereq	Construction Activity Pollution Prevention	Required	
			Credit	Site Assessment	1	
			Credit	Site Development - Protect or Restore Habitat	2	
			Credit	Open Space	1	
			Credit	Rainwater Management	3	
			Credit	Heat Island Reduction	2	
			Credit	Light Pollution Reduction	1	
			Credit	Tenant Design and Construction Guidelines	1	
0	0	0		**Water Efficiency**	**11**	
Y			Prereq	Outdoor Water Use Reduction	Required	
Y			Prereq	Indoor Water Use Reduction	Required	
Y			Prereq	Building-Level Water Metering	Required	
			Credit	Outdoor Water Use Reduction	2	
			Credit	Indoor Water Use Reduction	6	
			Credit	Cooling Tower Water Use	2	
			Credit	Water Metering	1	
0	0	0		**Energy and Atmosphere**	**33**	
Y			Prereq	Fundamental Commissioning and Verification	Required	
Y			Prereq	Minimum Energy Performance	Required	
Y			Prereq	Building-Level Energy Metering	Required	
Y			Prereq	Fundamental Refrigerant Management	Required	
			Credit	Enhanced Commissioning	6	
			Credit	Optimize Energy Performance	18	
			Credit	Advanced Energy Metering	1	
			Credit	Demand Response	2	
			Credit	Renewable Energy Production	3	
			Credit	Enhanced Refrigerant Management	1	
			Credit	Green Power and Carbon Offsets	2	
0	0	0		**Materials and Resources**	**14**	
Y			Prereq	Storage and Collection of Recyclables	Required	
Y			Prereq	Construction and Demolition Waste Management Planning	Required	
			Credit	Building Life-Cycle Impact Reduction	6	
			Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2	
			Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2	
			Credit	Building Product Disclosure and Optimization - Material Ingredients	2	
			Credit	Construction and Demolition Waste Management	2	
0	0	0		**Indoor Environmental Quality**	**10**	
Y			Prereq	Minimum Indoor Air Quality Performance	Required	
Y			Prereq	Environmental Tobacco Smoke Control	Required	
			Credit	Enhanced Indoor Air Quality Strategies	2	
			Credit	Low-Emitting Materials	3	
			Credit	Construction Indoor Air Quality Management Plan	1	
			Credit	Daylight	3	
			Credit	Quality Views	1	
0	0	0		**Innovation**	**6**	
			Credit	Innovation	5	
			Credit	LEED Accredited Professional	1	
0	0	0		**Regional Priority**	**4**	
			Credit	Regional Priority: Specific Credit	1	
			Credit	Regional Priority: Specific Credit	1	
			Credit	Regional Priority: Specific Credit	1	
			Credit	Regional Priority: Specific Credit	1	
0	0	0		**TOTALS**	Possible Points:	**110**

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

Figure 6.5.2 – The example of the LEED certificate. Source: www.usgbc.org/leed

6.5.6 DGNB

DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen) is a German certification system created by the German Sustainability Council and primarily used in Germany and its neighbouring countries. It varies in criteria and process from nation to nation e.g. by referencing national building codes such as energy performance and water consumption. This analysis deals with the Danish version. The certification has an exceptionally large presence in Denmark where it has been adapted as the standard certification system by Green Building Council Denmark. The certification focuses not only on sustainability, but also on good technical and process quality, and its flexibility allows easy adoption for various building types. It is the certification system that comes closest to an equal focus on each sustainable dimension. Within the social dimension DGNB has a high focus on the health aspect, which accounts for more than 1/5th of the total focus. Stability of value, resources and life cycle costs are also amongst the main aspects of DGNB.

Based on three key paradigms:

- Life cycle assessment,
- Holistic,
- Performance orientation.

	DGNB Platinum	DGNB Gold	DGNB Silver	DGNB Bronze*
Total performance index	80% and higher	65% and higher	50% and higher	35% and higher
Minimum performance index	65%	50%	35%	-- %

* This award only applies to certification of existing buildings/the Buildings in Use certificate.

Figure 6.5.3 – Levels of certification. Source: www.dgnb.de/en/

Until 2017, the certification levels were gold, silver and bronze. However, to correspond to other systems, DGNB levels have been updated to platinum, gold and silver along with a new lower tier bronze certification for existing buildings only. The requirements and the standards are the same. If you had a DGNB Gold certification from before 2017, this would be automatically "upgraded" to a platinum. To achieve a platinum certification, the project must obtain at least 80% of the total points available. For gold, a minimum of 65% is required and for silver 50%. For the bronze certification (existing buildings only) a minimum of 35% of points must be achieved. It is also possible to get an additional DGNB diamond certification,

along with a silver, gold or platinum certification, if the project achieves high architectonic quality. To achieve the certification a jury must find extraordinary architectonic beauty and/or quality in the detailing and choice of materials.

The certification criteria are determined individually for different use types and are applicable both for new construction, existing buildings, and renovations. There is also a separate certification for buildings in use. This is a transformation and management instrument for the development of a sustainable, future-proof and climate action orientated real-estate strategy. Every building, from planning to demolition, goes through different phases, which are linked to different requirements and conditions. These can be accompanied by the DGNB certification system in terms of a holistic sustainable construction method. The following diagram shows exactly which phases these are.

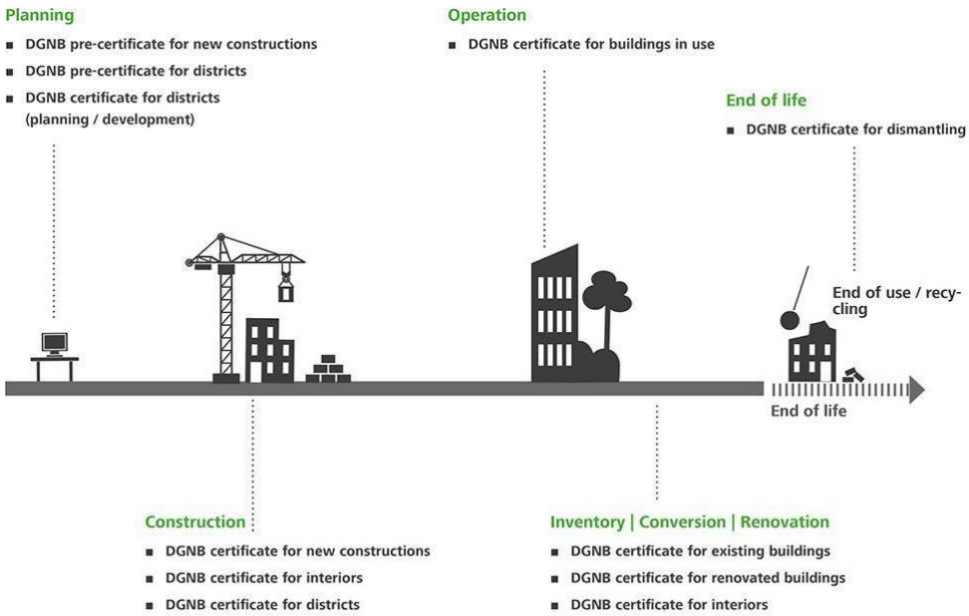

Figure 6.5.4 – The certification for different use types. Source: www.dgnb.de/en/

DGNB 'Climate Positive' Award – is granted by the DGNB to buildings for a period of one year, which meet the technical requirements and provide the relevant evidence as part of a certification for buildings in use.

DGNB Flex has following objectives:

DGNB Flex – enables the drafting of a project-specific DGNB certification framework to optimise and evaluate projects where no fully-specified scheme is currently applicable. The time effort and costs associated with the DGNB Flex process should be target-oriented and appropriate. DGNB Auditors receive a pragmatic and reliable framework to advise their clients in early planning phases.

- **Direct impact**: Qualitative and quantitative features/ properties of a concrete product within the construction context. ENV1.1 Building life cycle assessment, ENV1.2 Local environmental impact, ENV1.3 Sustainable resource extraction, ENV2.2 Potable water demand and waste water volume, ECO1.1 Life cycle cost, ECO2.1 Flexibility and adaptability, SOC1.1 Thermal comfort, SOC1.2 Indoor air quality, SOC1.3 Acoustic comfort, SOC1.4 Visual comfort, TEC 1.2 Sound insulation, TEC1.3 Quality of the building envelope, TEC1.5 Ease of cleaning building components, TEC1.6 Ease of recovery and recycling, TEC1.7 Emissions control

- **Indirect impact**: Planning-based services in relation to construction products (defining environmental requirements for construction products in the tender phase) or methods of resolution which can be implemented either through planning or also through the concrete product selection (for example, reducing potable water consumption through the greywater utilisation or water-saving fixtures). ENV2.4 Biodiversity at the site, SOC1.5 User control, SOC1.6 Quality of indoor and outdoor spaces, SOC1.7 Safety and security, SOC2.1 Design for all, TEC1.1 Fire protection, TEC1.4 Use and integration of building technology, PRO1.4 Sustainability aspects in tender phase, PRO1.5 Documentation for sustainable management, PRO2.1 Construction site/Construction process.

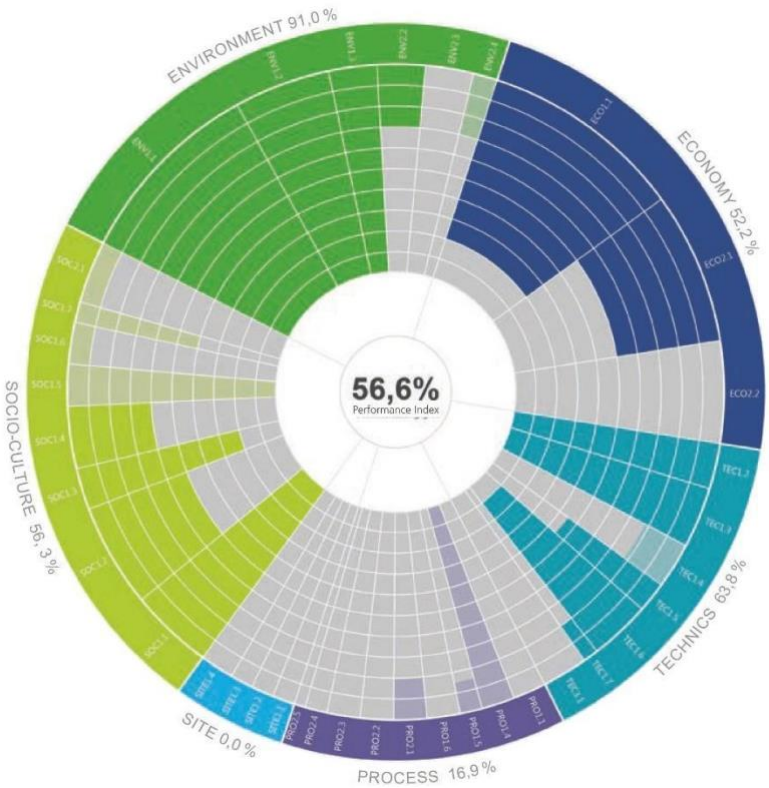

Figure 6.5.5 – The evaluation chart with coloured amplitudes. Source: www.dgnb.de/en/

6.5.7 CASBEE

Comprehensive Assessment System for Built Environment Efficiency (CASBEE) is a method for evaluating and rating the environmental performance of buildings and the built environment. CASBEE was developed by a research committee established in 2001 through the collaboration of academia, industry and national and local governments, which established the Japan Sustainable Building Consortium (JSBC) under the auspice of the Ministry of Land, Infrastructure, Transport and Tourism (MLIT). CASBEE has been designed to both enhance the quality of people's lives and to reduce the life-cycle resource use and environmental loads associated with the built environment, from a single home to a whole city. Consequently, various CASBEE schemes are now deployed all over Japan and supported by national and local governments. It is a comprehensive assessment of the quality of a building, evaluating features such as interior comfort and scenic aesthetics, in consideration of environment practices that include using materials and equipment that save energy or achieve smaller environmental loads. It focuses on the Japanese geographical conditions while integrating the earthquake resistance into the system.
The CASBEE assessment is ranked in five grades:

- Superior (S)
- Very Good (A)
- Good (B+)
- Slightly Poor (B-)
- Poor (C)

CASBEE is a suite of assessment tools tailored to different scales: construction (housing and buildings), urban (town development) and city management. These tools are collectively known as the “CASBEE Family”. CASBEE consists of a set of basic assessment tools:

- **Housing scale**
    - CASBEE for Detached House
        - CASBEE for New Construction (CASBEE-DH/NC)
        - CASBEE for Existing Building" (CASBEE-DH/EB)
    - CASBEE for Housing Unit
    - CASBEE Housing Health Checklist
- **Building scale**
    - CASBEE for Building Design
        - CASBEE for New Construction (CASBEE-BH/NC)
        - CASBEE for Existing Building" (CASBEE-BH/EB)
        - CASBEE for Renovation" (CASBEE-RN)
        - CASBEE for Temporary Construction (CASBEE-TC)
        - CASBEE for Heat Island Relaxation (CASBEE-HI)
        - CASBEE for Schools
        - Locally Customized Edition for Municipalities
    - CASBEE for Interior Space

- CASBEE for Market Promotion (CASBEE-MP)

- **District scale**
  - CASBEE for Urban Development (CASBEE-UD)
  - CASBEE Community Health Checklist
- **City scale**
  - CASBEE for Cities
  - CASBEE for Cities -Pilot version for worldwide use

The key characteristics of CASBEE are as follows:

- **Clear definition of spatial boundaries to be assessed.**

The virtual boundary is introduced as an area surrounding the building concerned and is treated as a site boundary. The inside and the outside of the virtual space boundary are specifically framed to be evaluated separately. The key here is that the surrounding area of the building is explicitly included for the on-site assessment.

- **Clear definition of environments to be assessed.**

A pair of different aspects represented by an incompatible vector, that is, improvement of Q (environmental quality) and reduction of L (environmental load) are included for building environmental assessment in this global environment era. Each item to be evaluated is first associated with either Group Q or Group L and is further assigned to the respective sub-group for more detailed categorization.

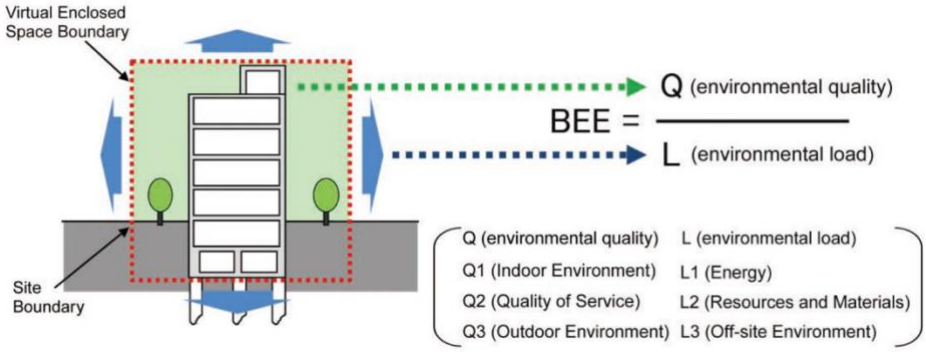

Figure 6.5.6 – Setting of the spatial boundary for CASBEE assessment and the definition of Built Environment Efficiency (BEE). Source: https://www.ibec.or.jp/CASBEE/english/

- **Scoring method**

The originality of the method stems from use of the aforementioned Q and L to obtain a scalar indicator determined by Q/L (referred to as the Built Environment Efficiency; BEE).

- **LCCO2 emission assessment (for housing and building scale)**

It evaluates CO2 emissions during the entire building life cycle from construction and operation to demolition and disposal. A method automatically provides a simplified estimation of LCCO2 based on data already entered in a CASBEE spreadsheet.

- **Stratified structure of a scale of defined areas for assessment**

CASBEE gradually expanded so as to perform the assessment on a scale of a district (or local area or neighborhood). CASBEE for Cities is the only tool enabling city-scale assessment.

- **Inclusion of time scale for assessment**

In CASBEE for Cities, urban environments can be assessed in the context of past, present and future. The outcomes of urban environment policy can be better presented by comparing how the city was in the past, how it is in the present, and how it would be in the future.

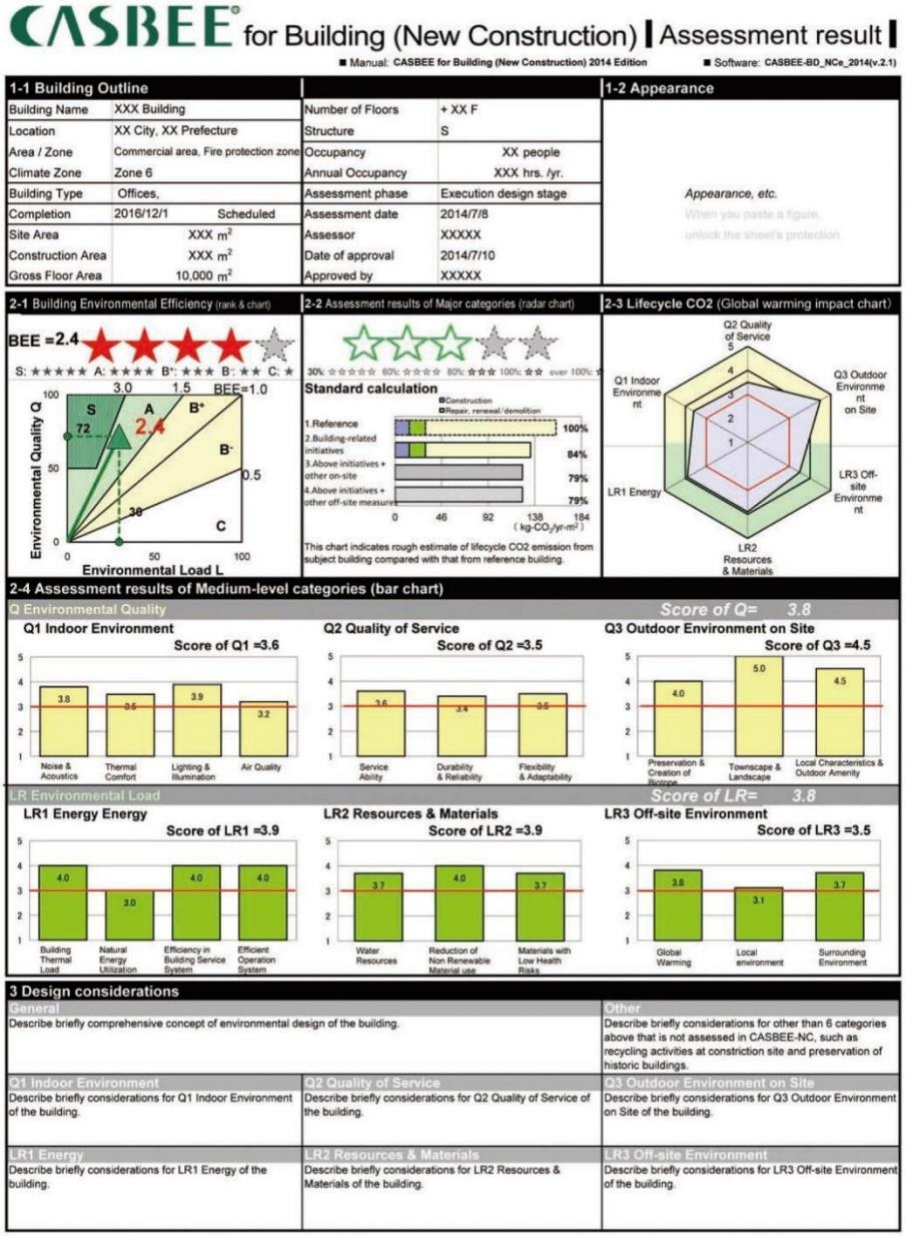

Figure 6.5.7 – Assessment result of CASBEE for Building (New Construction). Source: https://www.ibec.or.jp/CASBEE/english/

6.5.8 HQE

The Haute Qualité Environnementale (High Environmental Quality) certification system, also known as HQE, is the most commonly used certification system in France. It was developed in 1995 on the basis of research carried out by CSTB (Scientific and Technical Centre for Buildings) and Qualitel and is updated continuously thanks to feedback from professionals. HQE is a certification primarily focused on the social dimension of sustainability. In several of the certification's 14 goals, the only sustainable aspect being addressed is health, which accounts for more than half of the entire certification system. HQE has little focus on the economic dimension of sustainability. HQE has four principles with 14 goals used to structure a set of criteria. The goals are weighted equally between the well-being of humans and the protection of the planet.

In France, HQE is operated through 3 different certification bodies:

- **CertiVéA** is the certification body responsible for local planning and non-residential buildings that are being built, renovated or used.
- **Cerqual** is responsible for residential buildings, renovated or used.
- **Cequami** is for detached houses.

Worldwide, each HQE system adapts to meet the specific context of any given country. The international certification scheme is managed by Cerway.

HQE certification applies to residential, commercial, administrative and service buildings, whether in construction, refurbishment or in operation, as well as urban planning and development projects.

The five HQE certification levels:

- Exceptional (5 stars)
- Excellent (4 stars)
- Very Good (3 stars)
- Good (2 stars)
- Pass (1 star)

These are determined by a maximum of up to four stars indicating the level of achievement in the four principles: energy, environment, health and comfort.

Figure 6.5.8 – Targets of the HQE certification scheme. Source: www.behqe.com

There are three possible performance levels for the 14 environmental targets previously presented:

- Prerequisite
- Performing
- High Performing

The Prerequisite level is obtained when all of the minimum requirements for a target are met, while the Performing and High Performing levels are obtained based on a percentage of points given per target, which allows for significant flexibility in the choice of concerns. An aggregate of the levels of the various targets is then used to calculate the number of stars for the four environmental themes. Based on the total number of stars obtained, an overall HQE level is then given according to the scale.

TARGET 4	ASSESSMENT
PR	Compliance with PREREQUISITES
PERFORMING	Compliance with PREREQUISITES **AND** ≥ 30% of APPLICABLES points Including 5 POINTS for requirement 4.2.1
HIGH PERFORMING	Compliance with PREREQUISITES **AND** ≥ 50% of APPLICABLES points Including 5 POINTS for requirement 4.2.1

Figure 6.5.9 – Example of assessment target. Source: www.behqe.com

The scheme uses on-site audits attended by the architect, the contractor and the other team members (mechanical engineering, electrical engineering, acoustician). The conduct of the HQE audit is based on an analysis of the HQE assessment table, which can be prepared by the HQE certification Référent. During the review process, the HQE auditor (a third party mandated by Cerway) analyses the quality of the supporting presented documentation and may request any additional technical information from the present team.

The HQE scheme recognises European and international standards (in particular the ISO and ASHRAE standards). Generally speaking, the language used by the HQE scheme places a major emphasis on local regulations, making it easier to apply. If necessary, the recognition of a specific local characteristic can be approved by a principle of equivalency (shared by Cerway in an openly accessible database), to be submitted to the certification body.

6.5.9 GREEN STAR

Green Star is a built environment sustainability rating system created by the Green Building Council of Australia. It was launched in 2003 to develop a sustainable property industry in Australia and drive the adoption of green building practices through market-based solutions. The rating tools allow certification of all building types, including district scale development, and caters for design, delivery, and ongoing performance. The system is currently used in Australia, New Zealand and South Africa, with plans to expand throughout Africa. The Green Star rating system assesses the sustainability of projects at all stages of the life cycle. Ratings can be achieved at the planning phase for communities, during the design, construction and fit out phase of buildings, and during ongoing operations of buildings.

Green Star rating tools:

- **Green Star Buildings and Green Star - Design & As Built**
  Guiding the sustainable design and construction of schools, offices, universities, industrial facilities, public buildings, retail centres and hospitals.
- **Green Star – Communities**
  Improving the sustainability of projects at the precinct or community scale.
- **Green Star – Interiors**
  Transforming the interior fit outs in everything from offices and hotels to bank branches and shops.
- **Green Star – Performance**
  Supporting higher levels of operational efficiency within existing buildings.

Figure 6.5.10 – Green Star rating scheme. Source: www.new.gbca.org.au/rate/green-star

Green Star assesses the sustainability attributes of a project through impact categories. Each category groups a number of issues related to a certain sustainability impact; these are known as 'credits'. Credits are weighted in relation to each other by varying the number of points available. Each credit defines a clear outcome that a project must meet.

The Green Star rating is a 5-step process. First, projects are registered through an on-line process when general information about the project is recorded. Next, the project's sustainable attributes, which are measured by individual Green Star credits, must be documented through a mix of standard design and construction documents and Green Star specific forms and templates. During this process, the applicant can receive technical support from the Green Building Council if needed. Documents are then submitted via website to be assessed by the Council. If no problems are encountered, a certified rating is awarded. The project will then receive a certification and is granted rights to the use of the Green Star trademark. Building projects can choose to rate design-related credits before completion of construction, which they often do to gauge progress toward the desired rating.

Figure 6.5.11 – The example of the assessment result of Green Star. source: www.new.gbca.org.au/rate/green-star

6.5.10 ACTIVE HOUSE

Active House mainly focuses on the environmental dimension of sustainability, followed by an attention to the social dimension. Active House defines its three principles as Comfort, Energy and Environment, which results in very little representation of economic aspects. The main aspects of the certification are resources and health, which together make up more than 4/5th of the entire certification.

Origin: Denmark (2017), managed by a board of members and a group of 47 partners

The Active House key principles:

COMFORT

- a building that provides an indoor climate that promotes health, comfort and sense of well-being.
- a building that ensures good indoor air quality, adequate thermal climate and appropriate lighting levels and acoustical comfort.
- a building that provides an indoor climate that is easy for occupants to control and at the same time encourages responsible environmental behaviour.

ENERGY

- a building that is energy efficient and easy to operate
- a building that substantially exceeds the statutory minimum in terms of energy efficiency
- a building that exploits a variety of energy sources integrated in the overall design.

ENVIRONMENT

- a building that exerts the minimum impact on environmental and cultural resources
- a building that avoids ecological damage
- a building that is constructed of materials with focus on reuse and repurpose.

Active House is a pass/fail certification with the option to get a rating by Active House Radar The Radar shows the level of ambition of each of the three main Active House principles, containing four criteria for Comfort, three for Energy, and two for Environment. The integration of each principle describes the level of ambition of how 'active' the building has become. For a building to be considered as an Active House, the level of ambition can be quantified into four levels, where 1 is the highest level and 4 is the lowest passing level.

Because there are so many differences between buildings, it is unrealistic to compare them all against the same criteria at the same levels. Some buildings have strong emphasis on energy efficiency, others focus more on indoor climate, or having a low environmental footprint. This may result in differences in scores for the nine criteria expressed in the Radar diagram. All buildings can be Active Houses, if on the whole they provide a good performance. Emphasis on criteria may vary, but as long as the average score of all nine criteria equals 2,5

or less for new construction (renovation of existing buildings should score at least an average of 3,5), the building may call itself an Active House.

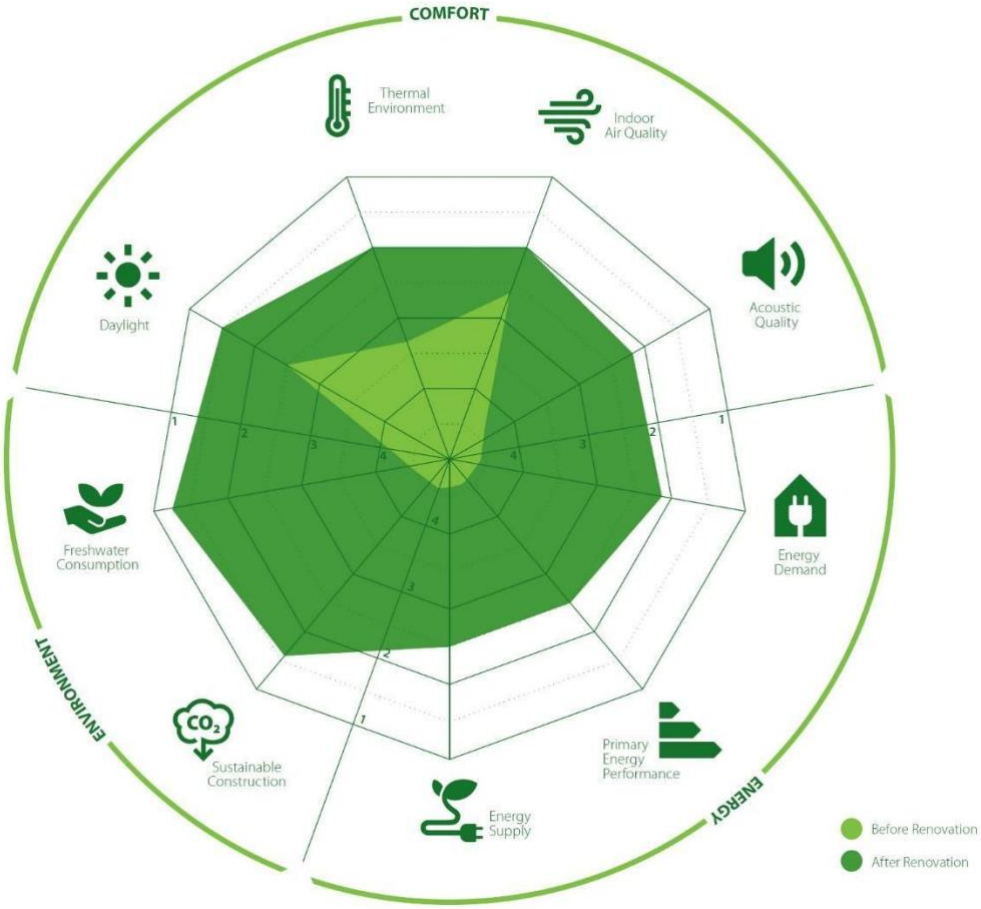

Figure 6.5.12 – The Active House Radar. source: www.activehouse.info

Table 6.5.3 – Example calculation of average daylight factor using default number for different rooms in a house. Source: www.activehouse.info

ROOM	DF SCORE		HOURS		NO. OF PEOPLE		WEIGHTED SCORE
Kitchen	3	x	2.5	x	3	=	22.5
Living room	2	x	3	x	3	=	18
Bedroom parents	1	x	0.5	x	2	=	1
Bedroom child	2	x	1.5	x	1	=	3
SUBTOTAL			19				44.5
TOTAL AVERAGE SCORE							2.3

In this example, the living room is used 9 times more intensively than the master bedroom during daylight hours. This is expressed in the weighted score (score x intensity of use), which

is 18 in this example, while the weighted score of the master bedroom is 1. The resulting Daylight score is (44.5 / 19) = 2.3

6.5.11 SUMMARY

Why should we bother to certify a project?

- If you do not go through the certification process, how do you know what you actually did?
- Certification provides a recognized third-party verification of achievement.
- The sustainability certification provides an economic advantage over the market competition.
- It reduces operating costs and increases the cost of the building.
- In the market, it stimulates the demand for environmentally friendly buildings with a small negative impact on the environment.
- It ensures that the building uses proven and verified principles of sustainability and environmental friendliness.
- It inspires when looking for innovative solutions that minimize the building's impact on the environment and operating costs.
- This is a standard that largely exceeds the minimum requirements in regulations.
- It improves the working and living environment in buildings and supports the creation of a healthy and comfortable working environment for employees.
- It gives companies the opportunity to develop corporate and organizational goals related to environmental protection and improves the company's market presence.

The main intention of this chapter was to collect the widest range of available information from technical manuals, official websites, scientific reviews/papers of these above-mentioned certification schemes. Over the last 20 – 30 years, comprehensive methodologies and systems were developed for assessing a broad range of environmental impacts caused by buildings. The main purpose of the rating systems is to measure the building sustainability and assess the environmental impact of building in a consistent and comparable manner, with respect to pre-established standards, directives, regulations or criteria. Each of these certification schemes are presented with their own characterization and principles of the certification. A key understanding of the certification process strongly requires the ability to investigate each using a common language and structure. Sustainability certifications of buildings are categorised as multiple attribute building certifications that look beyond individual products, with the consideration of additional factors (surroundings, water and energy use, toxicity, etc.).

The future of the building certification - IT sector brings Green Building Certification into the Age of Big Data.

"Give me a little data and I'll tell you a little. Give me a lot of data and I'll save the world."
Darrell Smith, Director of Facilities and Energy Microsoft

6.5.12 REFERENCES

Kasper Guldager, Jensen and Harpa Birgisdottir. (2018). Guide to Sustainable Building Certifications, Published by SBi and GXN, 1st Edition PDF, ISBN: 978-87-563-1881-5. Available online: https://www.buildup.eu/en/practices/publications/sustainable-building-certifications-comparative-guide

Catrin Heincke, & Daniel Olsson. (2012). Simply Green: A quick guide to environmental and energy certification systems for sustainable buildings. Swegon Air Academy, Kvänum, Sweden. ISBN: 978-91-977443-5-5.

Sam Kubba. (2012). Handbook of green building design and construction: LEED, BREEAM, and Green Globes. Elsevier. ISBN 978-0-12-385128-4.

Charles J. Kibert. (2016). Sustainable construction: green building design and delivery. Fourth edition, John Wiley & Sons. ISBN: 978-1-119-05532-7.

Gregor Herda et al. (2017). Building sustainability assessment and benchmarking: An introduction. United Nations Settlements Programme UN-Habitat. ISBN: 978-92-1-132728-1.

Sustainable building certification schemes - a comparison. (2018). EU project: Interreg Alpine Space CaSCO.
Available online: www.smart-places.net/images/9/90/Sustainable_building_certification.pdf

INTERNATIONAL SUSTAINABILITY SYSTEMS COMPARISON Key International Sustainability Systems: Energy and Water Conservation Requirements. Prepared for CoreNet Global by Ove Arup & Partners Ltd., March (2014). Available online: https://www.arup.com/perspectives/publications/research/section/international-sustainability-systems-comparison

R. Apanavičienė, K. Maliejus and P. Fokaides. (2020). Sustainability Assessment of the Building Construction Stage Using Building Sustainability Assessment Schemes (BSAS). SBE19 Thessaloniki, IOP Conference Series: Earth and Environmental Science 410, 012064, doi:10.1088/1755-1315/410/1/012064

Y. Li, S. Kubicki, A. Guerriero, Y. Rezgui. (2019). Review of building energy performance certification schemes towards future improvement. Renewable and Sustainable Energy Reviews 113, 109244, https://doi.org/10.1016/j.rser.2019.109244.

Elena Bernardi, Salvatore Carlucci, Cristina Cornaro and Rolf Andé Bohne. (2017). An Analysis of the Most Adopted Rating Systems for Assessing the Environmental Impact of Buildings. Sustainability, 9, 1126, doi:10.3390/su9071226.Market study for a voluntary common European Union certification scheme for the energy performance of non-residential buildings – Final report. (2014). Triple E Consulting, European Commission, DG Energy. Available online: https://ec.europa.eu/energy/

World Green Building Council Rating Tools Task Group: Quality assurance guide for green building rating tools. Version 1.1 September 2015.

www.ipeec.org

www.buildingrating.org

www.breeam.com

www.usgbc.org/leed

www.dgnb.de/en/

www.ibec.or.jp/CASBEE/english/

www.behqe.com/home

www.new.gbca.org.au/rate/green-star/

www.activehouse.info/

Co-funded by the
Erasmus+ Programme
of the European Union