

Guide to

Sustainable Building Certifications

Guide to

Sustainable Building Certifications

Foreword

With this book – Guide to Sustainable Building Certifications – we hope to increase knowledge levels and transparency in the construction industry by providing an accessible and comparative overview of the most important building certifications.

As with all the work of GXN innovation, this publication is about knowledge sharing and open source.

Today, sustainability has become the basis of the construction industry in comparison with about ten years ago, when only a few first movers consisting of visionary building owners and their consultants pushed sustainable buildings forward.

However, it has been our experience that clients and practitioners involved in the design process often lack overview of what different certification systems really certify. All the systems we have examined vary in focus and content, and they are all being used as tools for quantifying and confirming the sustainability of buildings.

Our focus has been on markets where Danish advisors experience export growth and potential. However, it is our conviction that this book can be used by actors in the construction sector as an easy-to-understand strategic overview with both regional and global perspectives.

A thorough analysis was conducted to support the findings and published in the supporting SBI report ^{P1}.

We hope this book will give its readers insights into how we can understand the sustainability of buildings and which certification systems can be used as tools and inspiration to achieve measurable quality.

Kasper Guldager Jensen and Harpa Birgisdottir

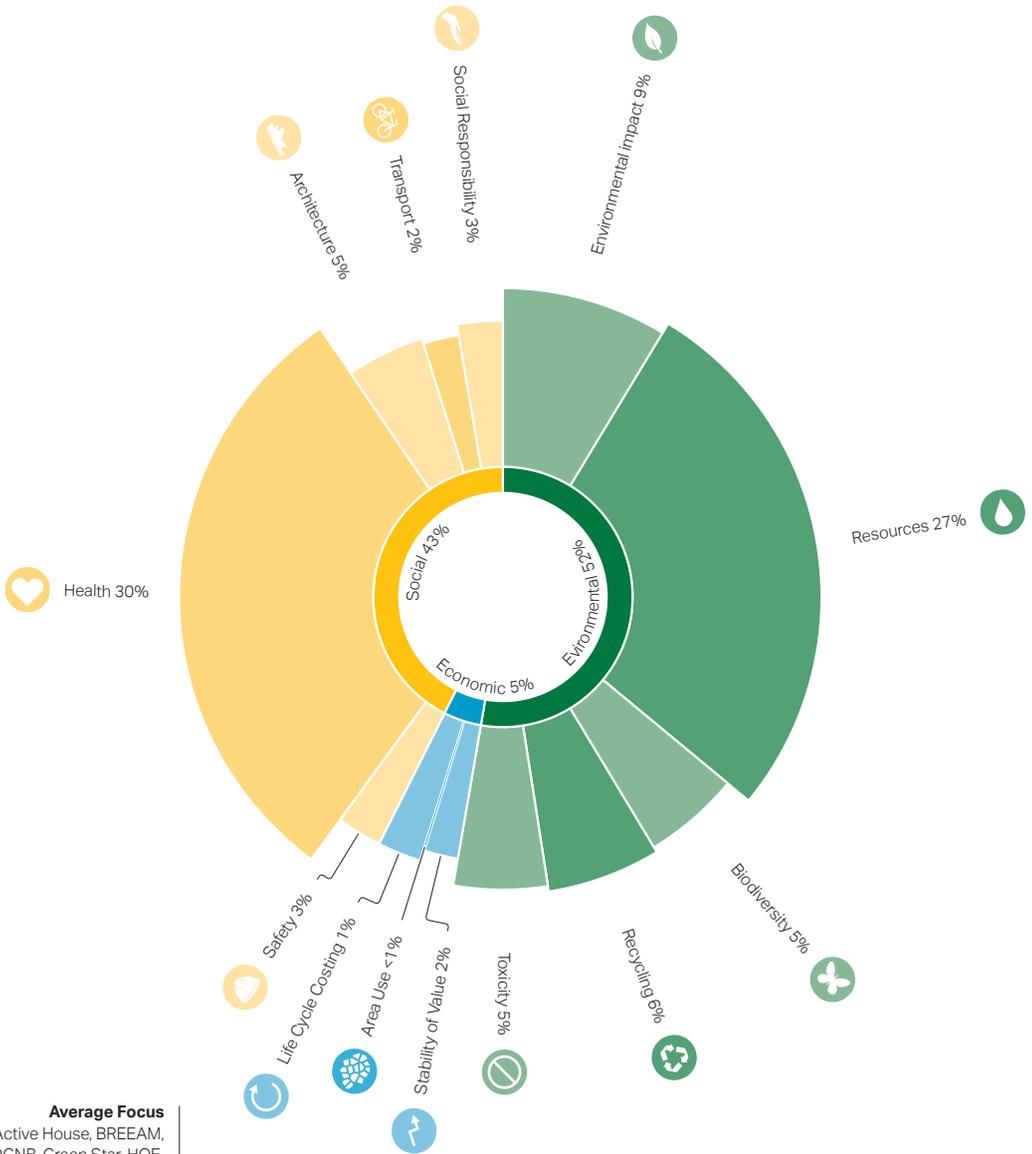
Editors and Lead Auditors

Collaboration

Guide to Sustainable Building Certifications is a collaboration between the Danish Building Research Institute – SBI, and the innovation company of 3XN Architects – GXN.

References

References are marked with the C, P and W prefixes for **C**ertification schemes, **P**ublications and **W**ebsites.



Average Focus

Active House, BREEAM, DGNB, Green Star, HQE, LBC, LEED, Miljöbyggnad, Nordic Swan and WELL

Aspects of sustainability from SBI report ^{P1}

Executive summary

There are currently hundreds of sustainability certifications for the built environment ^{P2} and the number is set to rise as the focus on certifying buildings continues to increase. This book provides a global overview of sustainable building certifications and an in-depth description, analysis and comparison of ten certification schemes based on their focus and strategic relevance to stakeholders in the built environment.

Strategic comparison

The ten certifications selected for analysis and comparison are Active House, BREEAM, DGNB, Green Star, HQE, LEED, Living Building Challenge, Miljöbyggnad, Nordic Swan and WELL. They have been chosen due to their relevance for the Danish construction industry.

Each of these ten certifications are presented with a description that provides insight into the history and scope of the certification as well as a guide to the certification process. Case studies illustrate the practical value of the certifications.

Collectively, the case studies show that the focus on sustainable building certification is only increasing, that the market is diversifying, and that some projects therefore can benefit from using multiple certifications in conjunction to strengthen their specific sustainability agenda.

Environmental, economic and social dimensions

The comparative analysis gives an overview of the ten building certification systems based on their environmental, economic and social dimensions, which are further sub-divided into 13 aspects. The certifications generally rely most heavily on the environmental dimension, largely represented by the resources aspect. The social dimension follows closely after environmental, with a focus on the health aspect, where indoor climate and comfort plays a large part. The economic dimension is generally less represented in all certifications except for DGNB, although it could be argued that economic aspects follow as consequences of many of the other aspects within the social and environmental dimensions.

The comparison of the certifications shows variation in focus. A primary focus on the environmental dimension can be seen in Active House, BREEAM, Green Star, LEED, Miljöbyggnad and Nordic Swan, while a primary focus on the social dimension is seen in HQE, Living Building Challenge and WELL, indeed WELL is almost entirely focused on social aspects. DGNB is distinguished by focusing almost equally on the three sustainability dimensions: social, environmental and economic.

A decision-making guide

This guide is a resource for strategic decision making in relation to the use of sustainable building certifications. It can be used as a tool to show, describe, and explain certification systems, thus providing the basis for a better dialogue between parties in the construction industry such as clients and consultants.

The contents have been third-party verified by an expert panel consisting of:

Gitte Gylling
Chief Specialist, Rambøll

Paul Stoller
Director, Atelier Ten

Stefan Holst
Managing Partner,
Transsolar

Tiffany Broyles Yost
Associate, Arup

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Part one |

Context

Why certifications matter

Certified sustainable buildings outperform conventional building on environmental, economic and social parameters ^{P5}. The economic and societal benefits of certified sustainable buildings are thus clear and, increasingly, certifications are also used actively to ensure a high level of quality during design and construction phases while strengthening sustainable agendas. In a world of accelerated growth and development, building designers, consultants and investors are constantly challenged to meet sustainability demands by making informed decisions that have great impact on both the project's economy and the environment. Furthermore, the term sustainability is becoming increasingly broad in its meaning. As a result, sustainability certifications now differ vastly in scopes and applications, but, if used correctly, this field of possibilities can provide comprehensive design tools for creators as well as valuable verification tools for investors and buyers.

A Danish perspective with global reach

Sustainability has become an integrated part of the Danish construction industry; the rising demand for proven sustainability means that key certification systems are quickly becoming integral components in Danish architecture.

As the need to certify buildings increases and additional certification

systems are launched around the world, the markets in which Danish construction stakeholders operate is subject to a growing complexity. In Denmark, DGNB is currently the most popular certification system. Certifications such as Nordic Swan, BREEAM and LEED are also present in Denmark and are increasingly becoming central for Danish actors working on international projects.

To achieve a strategic overview, this guide adopts a new approach for better analysis and comparison of the ten certification systems deemed most relevant to the Danish construction sector. Together, these certifications encompass Danish, Scandinavian, and global markets. This approach will enable Danish and international actors to make informed decisions on potential opportunities when approaching new projects and building certification systems both inside and outside Denmark.

A new approach to comparing sustainability

Certification systems offer the possibility to measure and compare the sustainable performance of buildings by applying a set of quantifiable criteria. Before certification systems were developed it was near impossible to compare sustainable performance from one building to another. Today, the overall certification scores make it possible to compare buildings certified under the same system, but, so far,

Sustainability

The most frequent use of the term sustainability originates in the publication "Our Common Future", written in 1987 by the UN-established Brundtland Commission. This report put forth the definition that sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs ^{P3}. Today, the United Nations maintains this definition, currently outlined in the 17 UN Sustainable Development Goals for the 2030 Agenda ^{P4}.

Gitte Gylling
Chief Specialist
Rambøll

'Sustainable building certifications are tools we can use to measure and document sustainability as well as support integrated design and interdisciplinary collaboration'

not buildings certified by different certification systems, let alone the systems themselves.

With an increase in certification systems there follows a growing difficulty in making comparisons; different systems advance a vast variety of principles that are not always common or relatable. This lack of unity raises the question: how do we compare certification types to best qualify their applicability and strategic relevance for the specific sustainability goals of any given building?

A strategic understanding of certification requires the ability to investigate each using a common language and structure. The methodology developed for this book provides the means for comparing and assessing different certifications that buildings can achieve based on a shared definition of sustainability in the built environment. The method recognises sustainability to be based on the balance between environmental, economic and social dimensions^{P3}. These three dimensions are further divided into 13 aspects, which are used to understand each system and its corresponding advantages.

Certification Types

Sustainability certifications can be categorised into three types: single attribute product certifications, multiple attribute product certifications and multiple attribute

building certifications. This publication exclusively deals with multiple attribute building certifications.

Single attribute product certifications

Labels that focus on a single sustainability aspect or quality of a product's performance, such as energy efficiency rating, reduced water usage, or sustainable procurement of natural resources, such as timber. Such specificity improves possibilities for comparison but can mislead buyers into thinking the product is sustainable in its entirety.



Multiple attribute product certifications

Labels that 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

Ratings and systems that look beyond individual products and address the building or project assembly as a whole; 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.



Which certifications exist

A Growing Industry

New building certifications continually emerge on the global stage. At the same time, established certification systems dating from the 1990s award more and more certifications. BREEAM, HQE and LEED have currently awarded more than 1,000,000 certifications combined and continue to be amongst the dominant actors in the industry ^{w1 w2 w3}.

There are over 600 sustainability certifications for products and buildings being used in the world today ^{p2}. No complete global list exists, making a full overview very difficult to achieve. For this publication, we have investigated 45 multiple attribute building certifications; while this is not a comprehensive investigation of all building certification systems, it does outline the most widely used systems today. Based on this investigation we have selected ten certifications for a comparative analysis and description.

The development of sustainable building certifications

Dating back to 1990, BREEAM was the first sustainable building certification system. Other certification systems from western European and North American countries, such as LEED, HQE, Minergie and Green Star, were launched in its wake during the 1990s ^{p6}.

Asia followed. Throughout the 2000s an array of Asian national standard certification systems was established. However, these certifications, although still active, remain slow to progress in terms of implementation and development. Launched just before the change of the millennium, the nationally used Taiwan EEWH certification has awarded just 1,600 certifications. Even more internationally known systems, such as CASBEE and BEAM Plus, have only awarded 850 certifications combined.

In 2008, Brazil launched Processo AQUA, the first, and now dominant, sustainable building certification system in South America. This certification was later merged into the HQE certification (AQUA-HQE) in 2014 ^{w4}. The same period also saw the launch of multiple new national certifications in the region including Casa Columbia and GBC Brazil Casa.

Africa has yet to commit to a cohesive implementation of sustainable building certification systems. LEED, BREEAM and HQE are present in some countries but are not typically advanced through a national green building council as they are in other regions. An exception is Green Building Council South Africa, which launched the Green Star SA certification in 2008. Since 2014, this council has been certifying buildings outside its own borders in countries such as Ghana, Rwanda, Namibia and Kenya ^{w5}.

Selection for analysis and comparison

Ten systems have been chosen as the most significant for the Danish construction sector, however collectively they represent Danish, Scandinavian, and global markets. The selected certification systems are: Active House, BREEAM, DGNB, Green Star, HQE, LBC, LEED, Miljöbyggnad, Nordic Swan and WELL.

'Sustainable building certifications help shift the industry and drive innovation by formalising design and performance criteria so that what was once innovative becomes the norm'

Tiffany Broyles Yost
Associate
Arup

World Map

Building certifications and their origin location.

The certification landscape is constantly evolving.





Certification Index
 This index is a result of ongoing research on sustainable building certifications. There are certifications not represented.

01



activehouse
Active House
 Denmark 2017

02



ARZ
 Building Rating System
ARZ BRS
 Lebanon 2012

03



BCA GREEN MARK
BCA Green Mark
 Singapore 2005

04



BEAM
 建築環保評估協會
BEAM Plus
 Hong Kong 2010

05



Berde
 Philippines 2009

06



BREEAM
 United Kingdom 1990

07



Built Green
 Canada 2012

08



Casa Clima
 Italy 2002

09



Casa Columbia
 Columbia 2017

10



CASBEE
 Japan 2004

11



ÇEDBIK-Konut
 Turkey 2013

12



DGNB
 Germany 2007

13



EDGE
 United States 201

14



EEWH
 Taiwan 1999

15



GBC Brazil Casa
 Brazil 2014

16



GBI
 Malaysia 2011

17



Green Globes
 United States 2004

18



Green Key
 Canada 1998

19



Green Point
 United States 2003

20



Green Star
 Australia 2003

21



Greenship
Indonesia 2011

22



GreenSL
Sri Lanka 2009

23



GRESB
Canada 2012

24



GRIHA
India 2007

25



GSAS
Quatar 2009

26



Home Star
New Zealand 2010

27



HPI
Ireland 2016

28



HQE
France 1995

29



IGBC
India 2009

30



KGCBC
South Korea 2000

31



LBC
United States 2006

32



LEED
United States 1993

33



LOTUS
Vietnam 2008

34



Miljöbyggnad
Sweden 2005

35



Minergie
Switzerland 1994

36



NABERS
Australia 1998

37



NGBS
United States 2008

38



Pearl
Abu Dhabi 2009

39



Protocol ITACA
Italy 2004

40



SBTool
Canada 2007

41



SEED
Pakistan 2016

42



Nordic Swan
The Nordics 2009

43



Three Star
China 2012

44



Verde
Spain 2002

45



WELL
United States 2014

Paul Stoller
Director
Atelier Ten

'The process of evolving certification tools forces stakeholders to raise green building standards in response to new factors such as the Paris Agreement'

What is our methodology

There are many different sustainable building certifications in use globally and it is far from easy to understand their similarities and differences.

The various systems have not been developed with a uniform focus: some focus on a single subject such as health and well-being, others on environmental factors and others again on sustainability from a broader perspective. The systems have been developed using differing structures and evaluation methods, and each scheme can have a long list of unique criteria beneath the overall structure. Without knowing all the criteria within a certification scheme, as well as understanding how they are evaluated, it remains difficult to understand the value of the certification for specific building projects. In addition, it is difficult to understand how the qualities of a given certification system differ from other systems.

Our comparative methodology, specifically developed for this analysis, is to evaluate and group certification systems according to how they weigh overall sustainability values.

The analysis categorises individual criteria from the certification systems within three overall dimensions of sustainability – an environmental, an economic and a social dimension – and further subdivides these dimensions into 13 aspects^{P1}. By illustrating how a dimension breaks

down into specific aspects, we can achieve a comparative analysis of the focus and themes of the different certification systems.

Dimensions

Sustainable development is threefold in responsibility and demands attention to three dimensions: environmental sustainability, social sustainability and economic sustainability. Environmental sustainability deals with a building's impact on nature, the environment, climate and resources. Economic sustainability handles the balance between total costs and quality of the building. Finally, social sustainability deals with the health and well-being of residents and users.

Aspects

A total of 13 aspects are defined across the three dimensions. This enables each certification system to be evaluated and compared within each sustainability dimension. These aspects follow the European standards for sustainable buildings^{P7} as well as Danish national guidelines^{P8}. The inclusion of aspects allows us to establish a wider perspective on sustainability, including a long-term focus that recognises a building's life cycle impact as well as its relationships to surrounding environments.

Categorisation

To evaluate the certification systems, their criteria are weighted and placed into the 13 aspects. The weighted aspects show how the individual certifications systems focus on the different dimensions of sustainability. The weighting is carried out through percentages. If certification criteria cannot be placed within a specific aspect, they have not been considered in the analysis. These criteria include process and documentation requirements.

Categorising and weighting the criteria is not an exact science and this method includes elements of subjective interpretation. The weighting of criteria can rely on a matter of judgement, for instance, in a certification where there is a mix of obligatory and point criteria. It should also be noted that categorisation does not represent the sustainable ambition of the certification criteria, but simply the theme that they represent. For instance, a demand for energy use of the building can be low or high and still belong to the same aspect.

'Certification systems have been extremely successful in raising awareness of sustainability in the building industry. Our next focus should be on real building behaviour and the impact on global warming'

Stefan Holst
Managing Partner,
Transsolar

Three Dimensions

Definitions

The analysis categorises the certification criteria into 13 sustainable aspects within three sustainable dimensions.

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Environmental Sustainability

Environmental sustainability covers impacts on the natural environment such as climate and resources. This dimension leans toward optimisation of resources through reuse and recycling, as well as lowering of environmental impact throughout the building life cycle – in the production of building materials, operation of the building, and recycling or disposal of materials. Additional focus may be on reducing the use of toxic substances and mitigating negative impacts on land-use and biodiversity.

Economic Sustainability

Economic sustainability deals with the balance between total costs and the quality of the building. This dimension focus on achieving balance between total building costs, including operational costs, and the quality and life cycle value of the building, potentially including preparations for the possibility of changing the use of the building.

Social Sustainability

Social sustainability addresses the health and safety implications of both the building and its surroundings. This dimension focuses on human well-being both inside and around the building, spaces that encourage good social interactions, and the promotion of healthy transportation to and from the building as well as inside it.

Thirteen Aspects



Environmental Impact

Reduce Environmental impact throughout the entire lifecycle of the building by using Life Cycle Assessment (LCA) to evaluate different design strategies.



Resources

Lower use of resources such as energy, materials, fuels and water. Use LCA to evaluate different design strategies. Avoid the use of limited or non-renewable resources



Biodiversity

Limit the use of undeveloped or greenfield areas for construction and optimise the use of developed and brownfield areas. Focus on effective use of the building site. Contribute to increased biodiversity and remediate contaminated sites.



Recycling

Prepare building components for separation and recycling using design for disassembly. Consider the use of reused or recycled material. Limit construction waste through good planning on the construction site. Dispose of waste at the highest possible value via reuse or recycling.



Toxicity

Reduce or avoid the use of toxic materials. Account for the use of problematic substances, and where they are in the building.



Life Cycle Costing

Calculate the life cycle costing of the building, including construction cost and operational costs such as those related to cleaning, maintenance and replacements.



Area Use

Optimise layout for the utilisation of areas to the best of their ability.



Stability of Value

Use of materials of high quality/robustness, which age well and will remain valuable over a longer time-period. Prepare the building for future changes and scenarios. Design flexible spaces.



Safety

Ensure human safety and the safety of buildings and supplies, such as fire safety, climate change adaptation, load-bearing structures, stability etc. Create procedures in cases of emergency. Design for universal accessibility.



Health

Promote the well-being of the daily users of the building in respect to physical and experienced comfort in the indoor climate. Ensure thermal and visual comfort, and high-quality acoustics, air, water, light and daylight and user control.



Architecture

Create design quality in the aesthetics and spatial planning. Ensure access to attractive outdoor areas. Contribute to existing environment.



Transport

Design opportunities for healthy transport to site as well as inside the building e.g. bike parking and stairs. Include facilities that encourage healthy and sustainable transport.



Social Responsibility

Ensure traceable and responsible procurement of services and materials for construction. Focus on working environment, particularly in construction phase.

Part two |

Certifications

Selection

Sustainable building certifications operate under diverse sets of objectives and guidelines. Grasping each system's evolution, levels, processes and fees plays an important role in developing transparency and a comprehensive understanding. This chapter elaborates upon the ten selected certifications in alphabetical order, both generally and within our methodology framework.

Selected Certifications

Active House, BREEAM, DGNB, HQE, LEED, Miljöbyggnad and Nordic Swan have each been selected due to their significant presence within the geographical reach of the Danish building industry.

Green Star, LBC and WELL do not have a strong regional presence, however they are each challenging the current condition of sustainable building certifications in the Danish construction industry.

Green star was selected for its presence in the Australian market and growing presence in Africa. LBC was chosen for its extremely demanding criteria that encourage the creation of net positive buildings. WELL was selected for its devotion to the social dimension.

01



Active House
Denmark 2017

12



DGNB
Germany 2007

28



HQE
France 1995

32



LEED
United States 1993

42



Nordic Swan
The Nordics 2009

06



BREEAM
United Kingdom 1990

20



Green Star
Australia 2003

31



LBC
United States 2006

34



Miljöbyggnad
Sweden 2005

45



WELL
United States 2014

Three Scopes

The Danish Association of Architectural Firms emphasised that actors in the Danish construction industry carry out activities across the globe and particularly in neighbouring countries⁹⁹. As a result, this selection has a focus on three geographic scopes; the Danish, the Scandinavian and the global.



Green Solution House

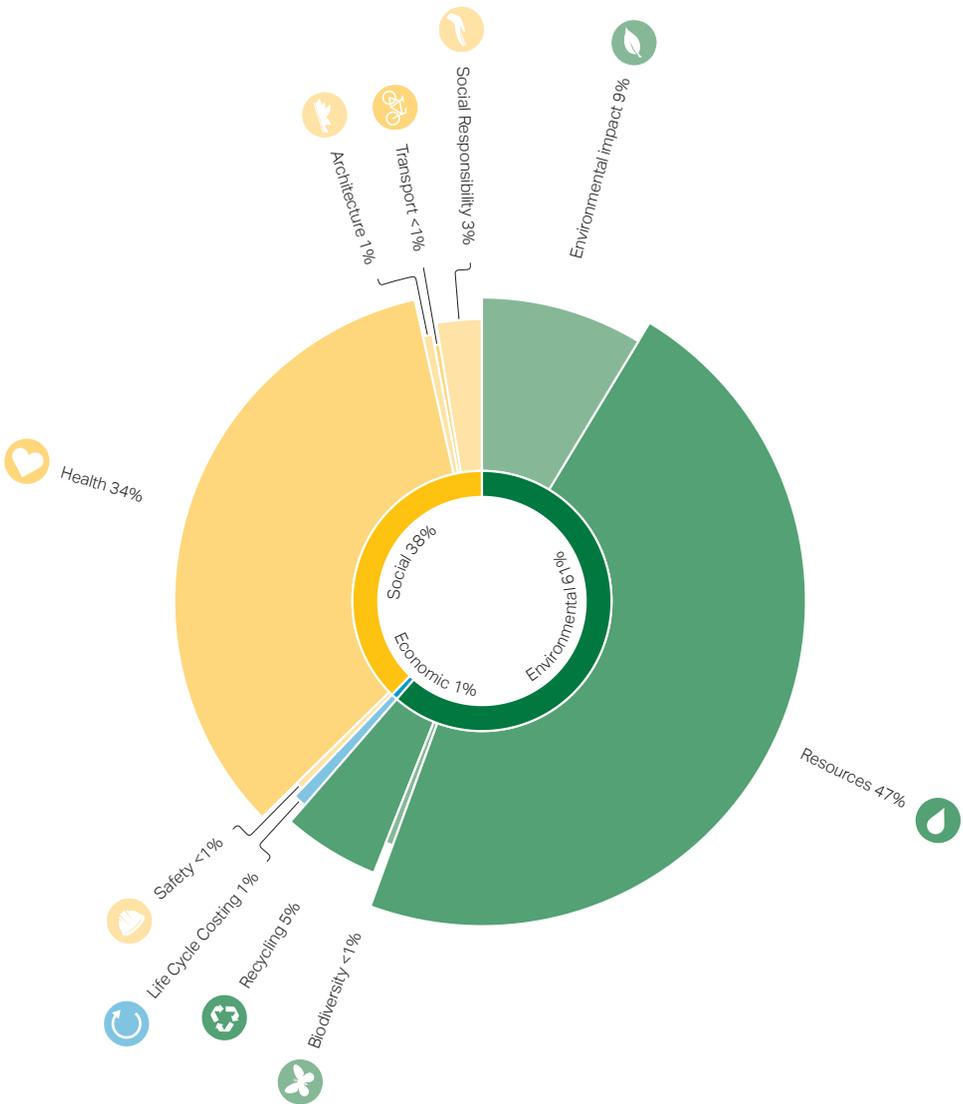
Active House Label
DGNB Silver

Photo © Adam Mørk

Active House

2017





Active House Analysis
 Residential buildings
 2nd edition ^{C1}
 Aspects of sustainability
 from SBI report ^{P1}

Active House

Applications

New buildings
Renovations
Existing buildings

Levels

Active House Label

Principles

Comfort
Energy
Environment

Administrator

Active House Secretariat
rue d'Arlon 25
1050 Brussels
Belgium
www.activehouse.info
secretariat@activehouse.info



activehouse

Origin Denmark

Year 2017

General Statistics

May 2018

Certifications 20

Certified m² n/a

Fee 2.000 to 5.000€



Active House Worldmap

May 2018

Countries 10

● Certifications awarded

○ No certifications

Certification Criteria

The analysis categorizes the Active House criteria into 13 sustainable aspects⁶¹. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

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.

Environmental Sustainability

Active House consists of an environmental principle and an energy principle, resulting in a heavy focus on resources.

Economic Sustainability

Economic sustainability is represented through consideration of life cycle costs.

Social Sustainability

Active House consists of a comfort principle with three subdivisions including daylight, thermal environment and indoor air quality. These parameters mainly deal with the well-being of users.



9%

Environmental Impact

Reduce environmental impact through conducting a Life Cycle Assessment (LCA) on the building. Use the LCA to optimise the design. Limit CO₂ emissions from energy use.



47%

Resources

Reduce the energy demand of the building. Reduce primary energy use by conducting an LCA on the building. Use the LCA to optimise the design. Minimise freshwater consumption. Use certified wood. Limit energy demand of appliances. Validate solutions for reduction of energy use. Utilise grey water or rain water.



<1%

Biodiversity

Consider the fauna and flora and environment via green vegetation. Regard local ecology and land use.



5%

Recycling

Use building materials made with recycled content. Design for disassembly.



Toxicity

Active House does not directly address this aspect.



1%

Life Cycle Costing

Choose products and construction solutions with life cost and maintenance perspective. Use a cost-effective energy supply. Use of commissioning.



Area Use

Active House does not directly address this aspect.



Stability of Value

Active House does not directly address this aspect.



<1%

Safety

Ensure safe access for all in the building, including groups with special needs. Consider risks from climate change, such as storms and flooding.



34%

Health

Allow adequate amounts of daylight and fresh air as well as good thermal environment. Ensure visual comfort. Allow for individual thermal control of rooms. Create low-noise environments. Secure good control and management of operation systems.



1%

Architecture

Reflect local building traditions relating to materials and craftsmanship. Encourage outdoor living. Have a positive impact on the local public space.



<1%

Transportation

Support healthy, comfortable and ecological transport. Promote easy and safe use of bicycles.



3%

Social Responsibility

Use timber certified by FSC or PEFC. Use materials certified by EMS. Respect workers at job site.

Active House Radar
Green Soution House

Before transformation ●
After transformation ●



Introduction

Active House is a new certification system established in 2017 and managed by a board of members and a group of 47 partners. Its partner organisations include universities, architecture studios and companies related to the building sector e.g. VELUX and Somfy. The Active House Label can be applied for buildings up to approximately 2,000 m² and there are plans to expand evaluation to include larger offices ^{W6}.

The certification system is organised by three main principles: comfort, energy and environment. The comfort principle deals with the notion of creating healthier conditions for the users of buildings; securing adequate amounts of daylight and fresh air. The energy principle focuses on balancing the energy usage of the building; all energy consumed is to be produced by renewable energy sources either on the site or by nearby facilities. The

environment principle ensures the building has a positive impact on the environment; using resources from a local context and calculating the building's impact over its entire life cycle encourages efficiency.

Evolution

Discussions on what would later be developed into the comfort principle of Active House started in 2007 between different actors in the building sector. The original ambition was for these discussions to make a framework that assists designers to create buildings that are comfortable and sustainable. Following these early discussions, an initial round table was held in Copenhagen. In 2011, The Active House Alliance was founded as a non-profit organisation. The Alliance was established as an NGO around a set of guidelines for creating healthier and more comfortable lives for occupants without negative impact to the environment. In 2017 these guidelines evolved into a verification system, making it possible to quantify and measure the sustainability of buildings. It is mostly used for single-family houses but has also been applied to larger buildings in Denmark and China.

Levels

Active House is a pass/fail certification with the option to get a rating by Active House Radar. The Radar is based on the three main principles that are split into three

subdivisions. Within each, buildings are scored on a scale starting at one (One being the best achievable score). To be considered for the active house certification, it is required that the building scores a maximum of four in each subdivision.

The radar displays all parameters dependent of one another. It is designed as a tool for setting goals within the three principles when designing new buildings or renovating existing ones.

Process

The Active House certification process can begin with or without a membership of the Active House Alliance. Firstly, a radar must be created by inputting required information into a downloadable program. The application is then sent to the alliance - including the radar itself, architectural drawings and descriptions of technical installations within the building. If the project meets the standards, a certification is awarded.

Fee

The Active House certification has three pricing categories: Single family homes up to 350 m² cost 1,000€ to certify. Renovation projects also cost 1,000€ to certify (projects can be both pre- and post-evaluated for a total price of 1,500€). For buildings above 350 m², the price will vary between 1,000€ and 5,000€. All prices include the validation and a sample test.



Green Solution House
Active House Label
DGNB Silver

Photo © Adam Mørk



Active House case study

Green Solution House

Green Solution House is a conference extension and hotel refurbishment of Hotel Ryttergården located on the Danish Island Bornholm. The extension fans out from the existing building mass into the landscape, which was converted into a seasonal wetland as part of the transformation. It utilises 75 green solutions focusing especially on material circularity, reusability and water cycles. The hotel aims to continuously adapt to holistic approaches of sustainability by embracing state-of-the-art green technologies and developments ^{w7 w8}.

Daylight is the foundation for the design of each room in the building. Materials have been selected for their ability to balance, capture, neutralise and purify air quality. With the help of a green wall, proper insulation and building technologies, energy use is optimised and can be tracked with an interactive energy visualisation.

Energy is considered throughout the entirety of the building's lifecycle; local materials and labour are sourced where possible, solar balconies produce approximately 5,000 kWh per year and food waste is recycled using pyrolysis. The overall construction is made of sustainably-forested timber.

Monetary revenue from the hotel and the conference center's operations is channeled to fund the ongoing integration of new solutions and the assessment of existing systems and products.

The building was one of the first to achieve the Active House Label. Additional sustainable building certifications were also used: Cradle to Cradle as well as DGNB synergistically promote and document sustainable transparency, design for disassembly and material accountability.

Typology Conference

Location Rønne, DK

Size 4,500 m²

Architect 3XN,
Steenbergs Tegnestue

Completed 2015

Certification DGNB Silver

Year 2016

Certification Active

House Label

Year 2017

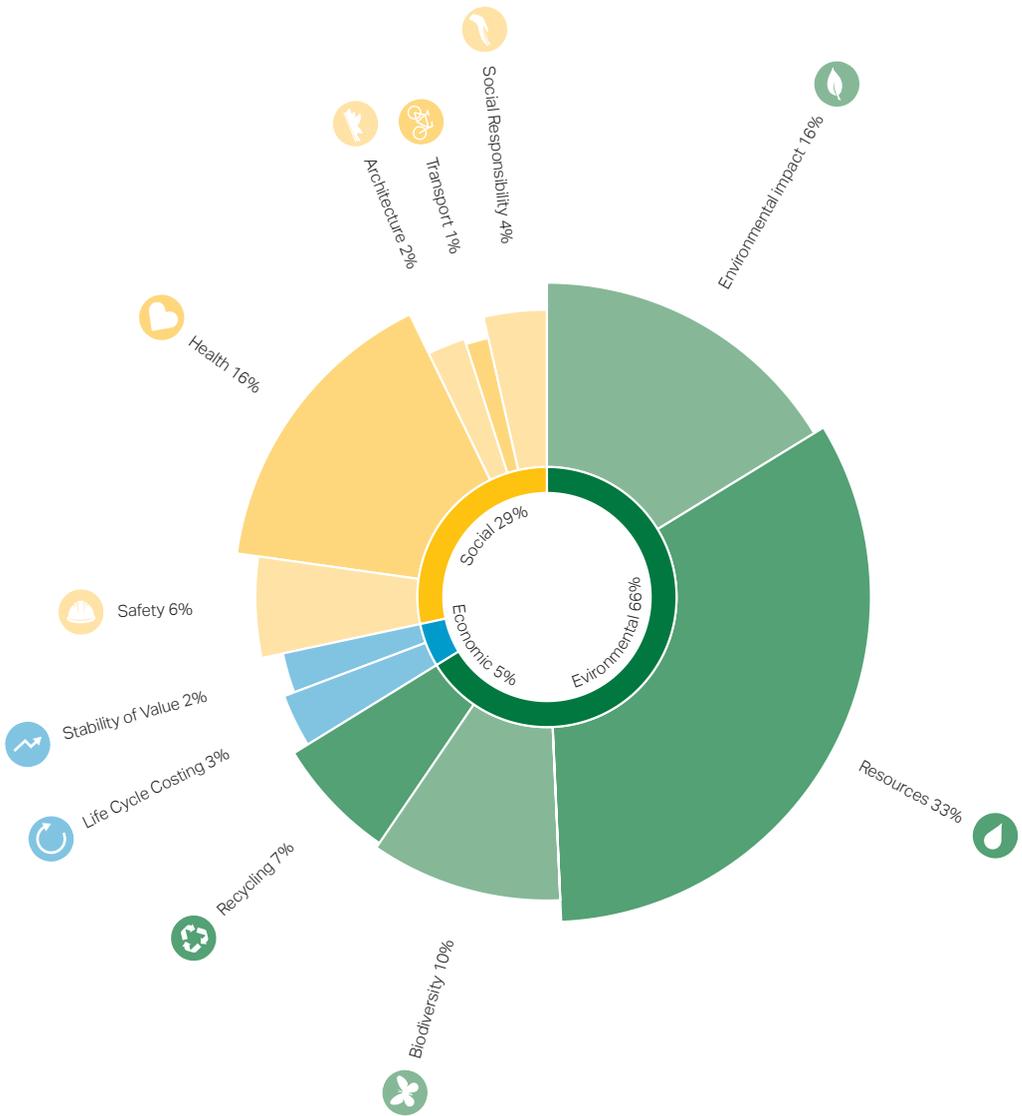


Fornebu S
BREEAM Outstanding
Photo © KLP Eiendom



BREEAM

1990



BREEAM Analysis

BREEAM International
 New Construction 2016 ^{C2}
 Office, fully fitted

Aspects of sustainability
 from SBI report ^{P1}

BREEAM

Building Research Establishment Environmental Assessment Method

Applications

- New buildings
- Interiors
- Renovations
- Existing commercial buildings
- Urban areas

Levels

- Outstanding
- Excellent
- Very good
- Good
- Pass
- Acceptable

Principles

- Energy
- Health and Well-being
- Innovation
- Land use
- Materials
- Management
- Pollution
- Transport
- Waste
- Water

Administrator

Building Research Establishment
Bucknalls Lane
Watford WD25 9NH
United Kingdom
www.breem.com
breem@bre.co.uk



Origin United Kingdom
Year 1990

General Statistics

May 2018
Certifications 564,000
Certified m² n/a
Fee 1,100 to 4,500€



BREEAM Worldmap

May 2018

Countries 77

- Certifications awarded
- No certifications

Certification Criteria

The analysis categorizes the BREEAM criteria into 13 sustainable aspects ^{Q2}. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

BREEAM is primarily focused on the environmental dimension of sustainability followed by the social dimension. Economic aspects are represented at 5%, which is greater than most of the analysed certifications. The main sustainable aspects in this certification are resources, environmental impact and health.

Environmental Sustainability

BREEAM has defined principles of energy, water, materials and waste, land use and ecology, which are all mainly focused on the environmental dimension. Resources are the most represented, but biodiversity and environmental impact have significant influence, more than in other certifications.

Economic Sustainability

BREEAM includes the economic dimension through life cycle costing and adaptation strategies for future changes integrated in the design of the building.

Social Sustainability

Within the social dimension BREEAM is mainly focused on the indoor climate and comfort of the user. It is also slightly more focused on safety, accessibility and social responsibility than most of the other certifications. The focus on the social dimension is mostly via BREEAM's health and well-being principle.



16%

Environmental Impact

Reduce carbon emission from energy use. Use low and zero carbon technologies. Encourage low carbon transportation modes. Reduce environmental impact through making a Life Cycle Assessment (LCA) of building elements. Reduce the level of gas emissions from refrigerants used to heat or cool the building. Contribute to a reduction in NOx emissions.



33%

Resources

Use legally harvested timber and durable materials. Monitor energy and water use in building and on construction site. Reduce operational energy demand and use energy efficient equipment and transport within the building. Use passive design strategies to reduce energy consumption. Reduce resource use through an LCA of building elements. Use of commissioning process and aftercare planning to optimise use of energy.



10%

Biodiversity

Use previously occupied land. Clean site if contaminated. Protect ecological features and increase the ecological value of site. Minimise watercourse pollution on site.



7%

Recycling

Use measures to optimise material efficiency through the design and construction phases. Reduce construction waste and divert it from ending as landfill. Use recycled aggregate for construction. Provide facilities for recycling operational waste. Reduce waste from refurbishment by letting the occupant choose finishes.



Toxicity

BREEAM does not directly address this aspect.



3%

Life Cycle Costing

Perform life cycle costing at different stages of the project and in different scales. Use it to influence the design of building and systems. Include commissioning process and aftercare planning to reduce costs over time.



Area Use

BREEAM does not directly address this aspect.



2%

Stability of Value

Consider future changes of function and use of the building in different scales within the initial design. Minimise impact from possible extreme weather from climate change over the building's lifespan. Use durable and resilient materials.



6%

Safety

Prepare the building for impact from future extreme weather due to climate changes. Provide safe access to and from the building. Design for all potential users such as disabled people and all age groups.



16%

Health

Have good lighting conditions etc on building site. Minimise air pollution from paints etc. Create thermal zones with individual control. Control daylight, glare, views and light. Provide a good acoustic performance. Provide clean water with no contamination. Use of commissioning process and aftercare planning for optimal indoor climate.



2%

Architecture

Ensure proximity to amenities for all users. Reduce light pollution at night and reduce noise in the area.



1%

Transportation

Encourage and provide alternatives to transportation by car.



4%

Social Responsibility

Use only legally harvested and traded timber for construction process and building material. Use responsibly sourced construction products.

Introduction

BREEAM was the first certification system in the world to assess, rate and certify the sustainability of buildings. It is currently one of the most used systems in the world and is administrated by the Building Research Establishment located in the UK ^{w2}.

BREEAM was the first system of its kind; it has been the template for many subsequent certification systems that have been developed throughout the world, including major American certification systems such as LEED. Originally it was solely intended for the United Kingdom, but it is used to certify sustainable buildings on a global scale and is especially present in Europe.

Evolution

The Environmental Assessment Method was developed in the 1980s by the Building Research Establishment and in 1990 was launched for office buildings in the United Kingdom. New versions were developed for typologies such as superstores, industrial units and existing offices in later years. By 1998, BREEAM's layout was changed extensively; a reorganisation changed focus to different sustainability issues. The development of BREEAM then continued with annual updates to typologies and the premises by which they were evaluated. In 2008, a major update of the system resulted in the introduction of mandatory

post-construction reviews, minimum standards and innovation credits. International versions of BREEAM were also launched that year. Another significant update, in 2011, resulted in the launch of BREEAM New Construction now being used to assess and certify all new United Kingdom buildings.

Levels

BREEAM uses six levels of adjectives to describe points the project achieves: outstanding (above 85%), excellent (70-85%), very good (55-70%), good (45-55%), pass (30-45%) and acceptable (Under 30%). These adjectives are also complimented with one to six stars. Less than one percent of all newly constructed non-domestic buildings in the United Kingdom can achieve the Outstanding rating ^{w2}. BREEAM certifications are given all over the world but, as of March 2018, no "Outstanding" certifications have been given outside Eurasia.

Process

BREEAM can be applied to many different types of buildings and communities. The first step is to find the correct certification scheme; Communities, New construction, In-Use or Refurbishment. Next, a BREEAM assessor is contacted - the assessor will guide the certification process, ensure all requirements are fulfilled and can predict a likely score using a pre-assessment estimator. The assessor will then



Fornebu S
BREEAM Outstanding

Photo © KLP Eiendom

register the project. The final step is building certification (the most time-consuming part of the process). It includes collating the necessary project information and documentation and submitting it to the certification body. If the project meets the required specification, it will be awarded with one of the possible six certification levels.

If the project is a new construction, the in-use scheme is recommended during the first three years following completion to ensure stability of performance requirements.

Fee

The total fee for a BREEAM certification depends on the certification scheme used, the country and the gross area. For the BREEAM New Construction scheme the price varies from 1,100 to 4,500€ depending on gross area. The area size categories start at <math><500\text{ m}^2</math> and ends at $>10,000\text{ m}^2$ with two payment levels in-between for a total of four. The total fee is the result of a registration fee plus the certification fee. If the provided documentation is not in English, translation costs approximately 1,725€.



Fornebu S
BREEAM Outstanding

Photo © KLP Eiendom



BREEAM case study

Fornebu S

Fornebu S is a shopping centre in Fornebu, a new town built on the site of Oslo's previous main airport. The new town is to house 25,000 inhabitants and provide 30,000 jobs in the future. The centre was designed to act not only as a shopping centre but as a green hub for the entire area ^{W9}.

Approximately 60% reduction in energy use is achieved through a combination of passive design, monitoring and thoughtful building technology. Responsibly sourced and manufactured materials are selected for use to limit a carbon footprint and establish a non-hazardous environment. All construction waste is recycled. Bike, electric car and dog parking is provided to enhance the quantity of sustainable transport.

The green roof imitates a rare and local natural habitat thus promoting biodiversity while curating

aesthetically pleasing views. During construction, seeds were collected from local grass- and flowering plants at the Fornebu peninsula and nearby islands in the fjord. The seeds were then planted on the roof and now account for a large part of the different plant species. The diversity of plants furthermore results in a diversity of insects and small birds.

Fornebu S has a BREEAM scoring of 89.5 which earns it the Outstanding certification level. There are no other shopping centres in the world with this certification. The certification ensures transparency towards long-term quality and furthermore allowed the building to become an icon of sustainability. It does not have other sustainable building certifications but was awarded 'Building of the year 2014' at the annual Norwegian Building gala.

Typology Shopping Centre
Location Snarøya, NO
Size 65,000 m²
Architect AMB arkitekter
Completed 2015

Certification BREEAM
Outstanding
Year 2015



EY Headquarters
DGNB Gold

Photo © Adam Mørk



DGNB

2007



DGNB Analysis
 DGNB System Denmark
 kontorbygninger 2016 ^{C3}
 Aspects of sustainability
 from SBI report ^{P1}

DGNB

Deutsche Gesellschaft für Nachhaltiges Bauen

Applications

New buildings
Commercial interiors
Renovations
Existing buildings
Urban areas

Levels

Platinum
Gold
Silver
Bronze

Principles

Environmental quality
Economic quality
Sociocultural and functional quality
Process quality
Technical quality

Administrator

German Sustainable Building Council
Tübinger Straße 43
70178 Stuttgart
Germany
www.dgnb.de
info@dgnb.de



Origin Germany
Year 2007

General Statistics

May 2018
Certifications 1229
Certified m² 7,500,000
Fee 2,500 to 73,500€



DGNB Worldmap

May 2018

Countries 21

● Certifications awarded
○ No certifications

Certification Criteria

The analysis categorizes the DGNB criteria into 13 sustainable aspects⁶³. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report⁶¹

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

DGNB 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.

Environmental Sustainability

The main contribution in the environmental dimension comes from the DGNB principle; Environmental Quality with contributions from the principles of technical and process quality. DGNB has the most focus on resources, followed by environmental impact and toxicity.

Economic Sustainability

DGNB assesses economic sustainability primarily through its Economic Quality principle. The main aspect is stability of value which is also represented in DGNB's technical and process principles. Life cycle costing is also valued highly in DGNB.

Social Sustainability

DGNB's principle Sociocultural and Functional Quality provides most impacts to the social dimension. The indoor climate is valued highest through the health aspect. Safety and access to the building is valued high in DGNB compared to the other analysed certifications.



9%

Environmental Impact

Reduce the environmental impact of the building with Life Cycle Assessment (LCA). Use of products where an EPD (Environmental Product Declaration) exists. Use the LCA as a tool to make solutions in the design.



15%

Resources

Minimise resource use of the building with LCA. Use of products where an EPD exists for products. Use the LCA as a tool to make solutions in the design. Use responsibly sourced timber and natural stones. Provide a tight and insulated thermal envelope to reduce energy use through the lifetime of the building as well as good heating and cooling systems for adjustment of energy use. Use of commissioning process for optimal running of building systems. Ensure strategies for energy, water and metering in the building.



2%

Biodiversity

Minimise of the use of virgin land. Clean site, if contaminated. Calculate a "bio-factor" of the area. Preserve trees. Consider the destiny of soil from construction. Protect the site during construction.



3%

Recycling

Design technical systems and spaces for easy access to facilitate repair, future changes and modernising. Design for disassembly. Minimise and sort waste on building site.



4%

Toxicity

Avoid or reduce building materials that contains problematic substances.



13%

Life Cycle Costing

Perform LCC (Life Cycle Costing) to minimise costs over the life time of the building. Use the LCC as a tool to make solutions in the design. Use commissioning process to reduce costs of systems over time. Reduce costs for cleaning and maintenance of building products by including this aspect in the design.



1%

Area Use

Optimise the areas that have an economic value by reducing hallway areas etc.



16%

Stability of Value

Ensure robust solutions throughout the choosing of building products and technical systems. Provide flexible systems that are future proof in technical systems, space plan and passive design strategies.



6%

Safety

Provide safe access to and from the building. Reduce fire risks and increase safety beyond national regulations. Provide access for all in the building, including elderly and disabled.



21%

Health

Enhance the user comfort in terms of thermal comfort, indoor air quality, daylight and artificial light. Ensure views to the outside. Provide user control of technical systems and use commissioning process for optimal indoor climate conditions. Ensure good acoustic and sound insulation. Provide a tight and well insulated thermal envelope to achieve a good indoor climate.



8%

Architecture

Provide good outdoor areas and areas available for the public. Enhance the architectural quality of the building through architecture competition with jury evaluation. Implementation of building integrated art. Design multifunctional areas and high quality of use.



1%

Transportation

Encourage use of bicycles by providing good bicycle facilities.



1%

Social Responsibility

Procure socially responsible timber and stone.

In 2016, DGNB had over **80%** of the German market share for certifying new sustainable buildings.

Introduction

DGNB 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 certifying focuses not only on sustainability, but also on good technical and process quality, and its flexibility allows easy adoption for various building types. The system has several schemes, the most used being "New construction offices" ^{W10} ^{W11}.

Evolution

The DGNB Standard was first introduced by the German Sustainability Council in 2007. Before the launch of the DGNB system, Germany had already been developing

sustainable buildings; the oil crisis of the 1970s incentivised buildings that minimise the consumption of energy. Since the 1990s, BREEAM and LEED had been the two most well-known sustainable building certification systems. They were both based on foreign British and American standards, so DGNB was developed based on the German standards and aimed to be the Central European counterpart certification system.

In 2010, The Danish Green Building Council was founded with the goal to promote the sustainable development of the Danish building sector. To choose the most relevant certification system for the Danish market, a consortium of experts from the building industry set up a comparison of the four leading sustainability certification systems (BREEAM, LEED, HQE and DGNB). DGNB was chosen due to its holistic and near-equal division of environmental, social and economic aspects. The greater focus on economy compared to the three other respective certification systems makes DGNB a more balanced certification system, rather than an environmental certification system. In 2012, the first Danish scheme was launched. All the schemes are adjusted and translated to correspond to Danish standards.

Levels

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.

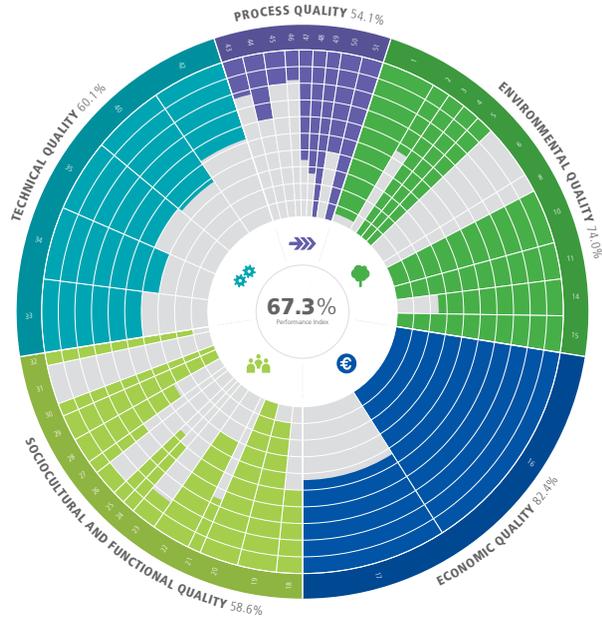
It is also possible to get an additional DGNB diamond certification, along with a silver, gold or platinum certification, if the project achieves high architectonic quality. To achieve the certification a jury must find extraordinary architectonic beauty and/or quality in the detailing and choice of materials.

Process

In general, there are two types of DGNB certifications: a pre-certification and a final certification. They are both independent of each other. If the project has pre-certification it is much less time consuming to gather all the required information for the final certification.

The first step to obtaining a certification is registering the project online. The certification requires a DGNB consultant or auditor to carry

DGNB Evaluation Graph
EY Headquarters



out the process. When a consultant has been associated to the project, the comprehensive process of gathering all relevant documentation begins. It is the role of the consultant to guide the client and help with obtaining required points, if possible. When all the documentation is collated, the next step is to send the documentation to the relevant green building council (in Denmark, the Green Building Council). If the projects meet the defined requirements (verified by a third party), it will be certified.

Fee

The fee for a DGNB certification varies from 2,500 to 73,500€ and is dependent on three factors. The first factor is the building typology and thereby the certification scheme (e.g. large parking structures are roughly half the price of new office buildings). The second and most significant factor is the gross area. DGNB has 20 area categories starting at <2,500 m² and ending at 120,000-130,000 m². The last deciding factor is the DGNB membership status. Being a member will save up to 13,850€ in fees.



EY Headquarters
DGNB Gold

Photo © Adam Mørk



KPMG Headquarters
DGNB Gold

Photo © Adam Mørk



DGNB case study

EY Headquarters

Located in the Frederiksberg district in the Copenhagen area, the EY Headquarters was designed with the goal of becoming a good neighbour. The ambition was to blend into the existing urban fabric while exemplifying high sustainability and overall building quality. The cloverleaf shape of the plan and the natural stone façade blend in smoothly with the adjacent buildings ^{W12}.

The building is seven floors high and consists of three connected volumes, assembled around three large glass-covered atria. Generous natural daylight, temperature regulation, and an active façade reduces the energy consumption to a minimum. Movement sensor triggered lighting further limits energy use and recycled rainwater irrigates the landscape. Green commuting is promoted by space for 700 bicycles and the inclusion of electric car chargers.

The EY Headquarters was one of the first Danish buildings to achieve a DGNB certification. The office scored particularly well in the Environmental and Economic principles of DGNB and achieved DGNB Silver in May 2012 which, at the time, was the highest DGNB certification achieved in Denmark. This is now recognised as a DGNB Gold certification due to the 2017 DGNB levels update.

Typology Office
Location Copenhagen, DK
Size 56,800 m²
Architect 3XN
Completed 2011
Certification DGNB Gold
Year 2012



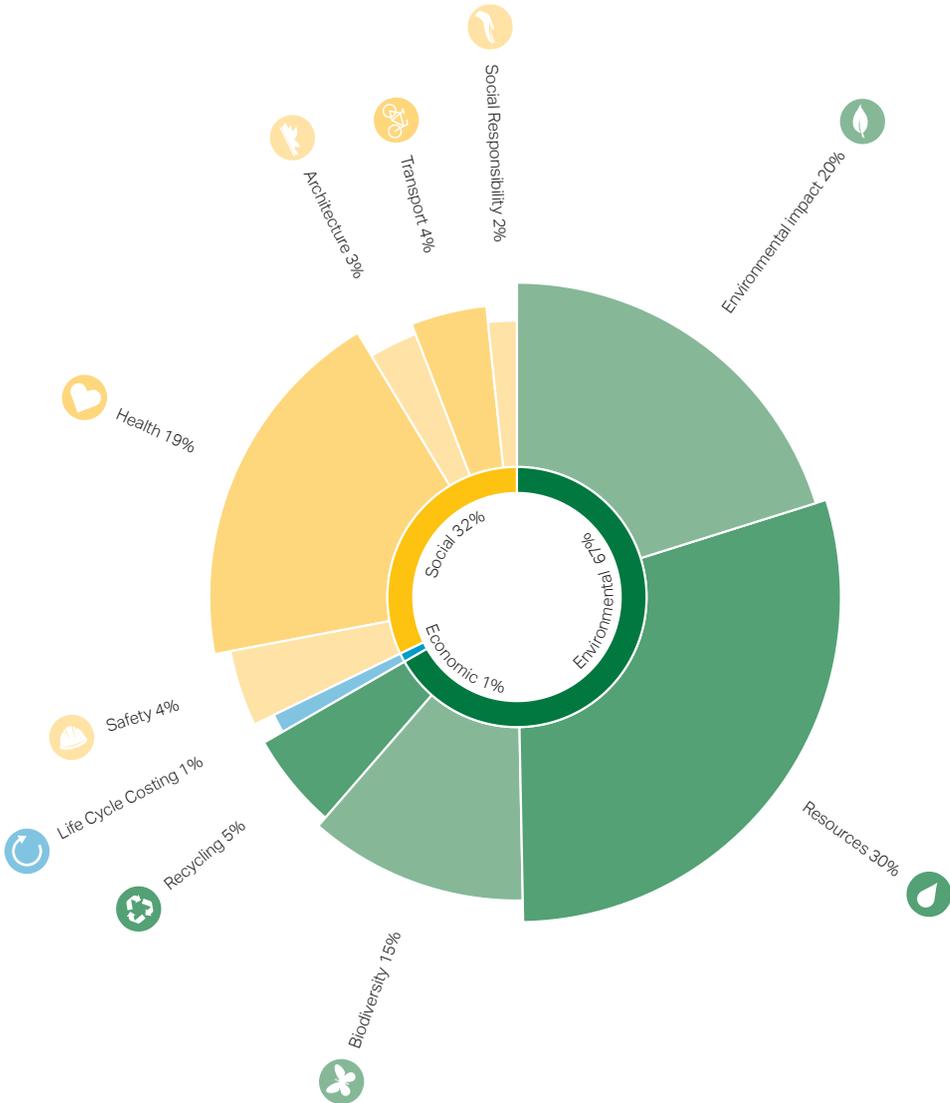
1 Bligh Street
Green Star 6 Star

Photo © H. G. Esch

A high-angle, wide shot of a modern building's glass facade. The structure features a grid of dark grey metal beams supporting large glass panels. In the foreground, a curved wooden deck with a person standing on it is visible. The background shows a cityscape with a bridge and water under a clear blue sky. A white rectangular frame is overlaid on the image, containing the text.

Green Star

1998



Green Star Analysis
 Design & As Built v1.2 ^{C4}
 Office use

Aspects of sustainability
 from SBI report ^{P1}

Green Star

Applications

New buildings, except single family houses
Interiors
Renovations
Existing buildings
Urban areas

Levels

6 Star: International excellence
5 Star: Australian excellence
4 Star: Best practice

Principles

Management
Indoor Environmental Quality
Energy
Transport
Water
Materials
Land use and Ecology
Emissions
Innovation

Administrator

Green Building Council of Australia
200 Barangaroo Ave
Barangaroo NSW 2000
Australia
www.new.gbca.org.au
info@gbca.org.au



Origin Australia
Year 2003

General Statistics

May 2018
Certifications 2,254
Certified m² 26,000,000
Fee 4,700 to 34,800€



Green Star Worldmap

May 2018

Countries 7

- Certifications awarded
- No certifications

Certification Criteria

The analysis categorizes the Green Star criteria into 13 sustainable aspects ⁶⁴. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

Green Star focuses around 2/3rds on the environmental dimension and 1/3rd on the social dimension of sustainability, with a minimal but present focus on the economic dimension. The majority of its principles target environmental aspects and resources is the main aspect covered, followed by health and environmental impact.

Environmental Sustainability

Green Star prioritises the lowering of resource use such as water and electricity combined with a relatively high focus on biodiversity compared to the other selected certifications.

Economic Sustainability

Green Stars addresses the life cycle costing aspect of economic sustainability though the Green Star section called “Commissioning and Tuning”.

Social Sustainability

Green Stars focus on the health aspect, in the social dimension, is mainly related to human comfort in criteria such as thermal comfort, lighting comfort and acoustic comfort.



20%

Environmental Impact

Perform Life Cycle Assessment (LCA) and achieve a lower impact than a reference building. Use of LCA to improve material choices in building as well as for the construction process. Use of products with EPDs (Environmental Product Declaration). Limit greenhouse gas emissions from energy use. Reduce carbon emissions from transport. Avoid refrigerants.



30%

Resources

Implement metering and monitoring systems for energy and water. Reduce the peak electricity demand. Lower potable water consumption. Increase insulation in building envelope and reduce energy use of building installations. Use commissioning process and provide information on operation and maintenance of building. Use of products with EPDs (Environmental Product Declaration). Use responsibly sourced building materials such as certified timber.



12%

Biodiversity

Avoid building sites with endangered, threatened or vulnerable species. Use previously developed land. Improve ecological value of the site. Reduce the heat island effect. Clean site if contaminated. Make a comprehensive environmental management plan (EMP) for construction and use auditing to ensure compliance.



5%

Recycling

Use reused products of products with recycled content. Minimise operational waste as well as construction and demolition waste. Plan for end-of-life of internal fit out.



Toxicity

Green Star does not directly address this aspect.



1%

Life Cycle Costing

Encourage and recognising commissioning, handover and tuning initiatives that ensure all building services operate to their full potential.



Area Use

Green Star does not directly address this aspect.



Stability of Value

Green Star does not directly address this aspect.



4%

Safety

Develop climate change scenarios. Implement a climate adaption plan. Handle and discharging storm-water responsibly. Control microbials.



19%

Health

Design good ventilations facilities. Limit noise pollution. Provide adequate light and daylight. Ensure views to the outside. Avoid indoor pollutants. Provide the users with thermal comfort. Use commissioning process to secure good indoor environment.



3%

Architecture

Avoid light pollution into the neighbourhood and the sky.



4%

Transportation

Increase active transportation to site. Provide a walkable path to the site.



2%

Social Responsibility

Provide good conditions for workers on construction site to enhance mental and physical health. Use responsibly sourced building materials such as certified timber.

Green Star buildings save **1,320 Olympic swimming pools** of water per year.

Introduction

Green Star is a built environment sustainability rating system created by the Green Building Council of Australia. 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 ^{W5}.

The Green Star rating system assesses the sustainability of projects at all stages of the lifecycle. 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. On average, Green Star-certified buildings produce 45% fewer greenhouse gas emissions and use 50% less electricity than comparable buildings

built to Australian code minimum standards ^{P11}. Green Star buildings have also been found to use 51% less potable water and recycle 96% of their construction and demolition waste, compared to the national average of 58% ^{W13}.

Evolution

The Green Building Council of Australia (GBCA) was established in 2002 to develop a sustainable property industry in Australia and drive the adoption of green building practices through market-based solutions. The Green Star rating was launched in 2003.

Green Star has been used in New Zealand since 2007 and in South Africa under the name Green Star SA since 2008. Currently, the Green Building Council of South Africa is working to expand the Green Star SA system to other African countries.

Levels

The Green Star rating system is based on a 1 to 6 Star framework with 1 Star as the lowest score and 6 Star as the highest. To achieve a Green Star certification, a project must have 4 stars or more. The full rating system is defined the following way:

- 6 Star: International excellence
- 5 Star: Australian excellence
- 4 Star: Best practice
- 3 Star: Good Practice
- 2 Star: Average practice
- 1 Star: Minimum practice

To achieve a 4 Star rating the project must score at least 45% of the available points, for a 5 Star rating 60% or more, and a 75% or more for the highest 6 Star rating. The 6 Star rating has been achieved by 233 projects in Australia, seven in New Zealand and 23 in South Africa.

Process

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 need.

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.

Fee

The certification fee for a Green Star certification varies from 4,700 to 34,800€ depending on the type of project, total cost of project and GBCA membership status. To receive the member rate – a reduction of around 10-20% – the applicant company must be a financial member of the GBCA. Unlike other rating systems, the applicant must be the project owner. Team members or project managers are not allowed to apply on behalf of the project owner.

The fee is different in the four schemes Green Star offers; Communities, Buildings, Interiors and Operational performance. For certifying buildings, the cost will vary from 7,900 to 27,900€. The price of certifying a building is based on the gross contract value and split into 7 tiers based on the value range. The lowest tier being 0 to 1,900,000€ and the highest tier 95,000,000€ or more.



1 Bligh Street
Green Star 6 Star

Photo © H. G. Esch



Green Star case study

1 Bligh Street

Located in the Sydney Central Business district, 1 Bligh Street is a modern office building designed by Architectus and Ingenhoven Architects. The transparent office building with an elliptical floor plan offers unobstructed views of the world-famous Sydney Harbour Bridge ^{W14}.

The tower is the first one in Australia to have a double-skin glass façade. The outer layer of the façade uses a computer-controlled system of shades to protect the inner curtain wall from the sun, while still providing plenty of daylight. This is one of the most energy efficient features a tower can have in the Australian climate.

The naturally ventilated glass atrium provides a fresh air flow and natural light to every floor. It is also an arrival point for all floors and provides

views through the entire building thereby enhancing connections and community.

The building also includes solar thermal collectors on the roof to inject high temperature energy into a solar cooling system. Rainwater is collected and spread throughout the building to irrigate planting such as the roof terrace trees and the green walls.

The building received the highest score in the Australian Green Star certification, 6 Stars, and is the first office tower in Sydney to be awarded this rating by the Green Building Council of Australia (GBCA). The building has furthermore received a 5 Star Nabers Energy rating, and it has won 19 building awards.

Typology Mixed-use
Location Sydney, AU
Size 42,700 m²
Architect Architectus,
Ingenhoven Architects
Completed 2011

Certification Green Star
6 Star
Year 2015



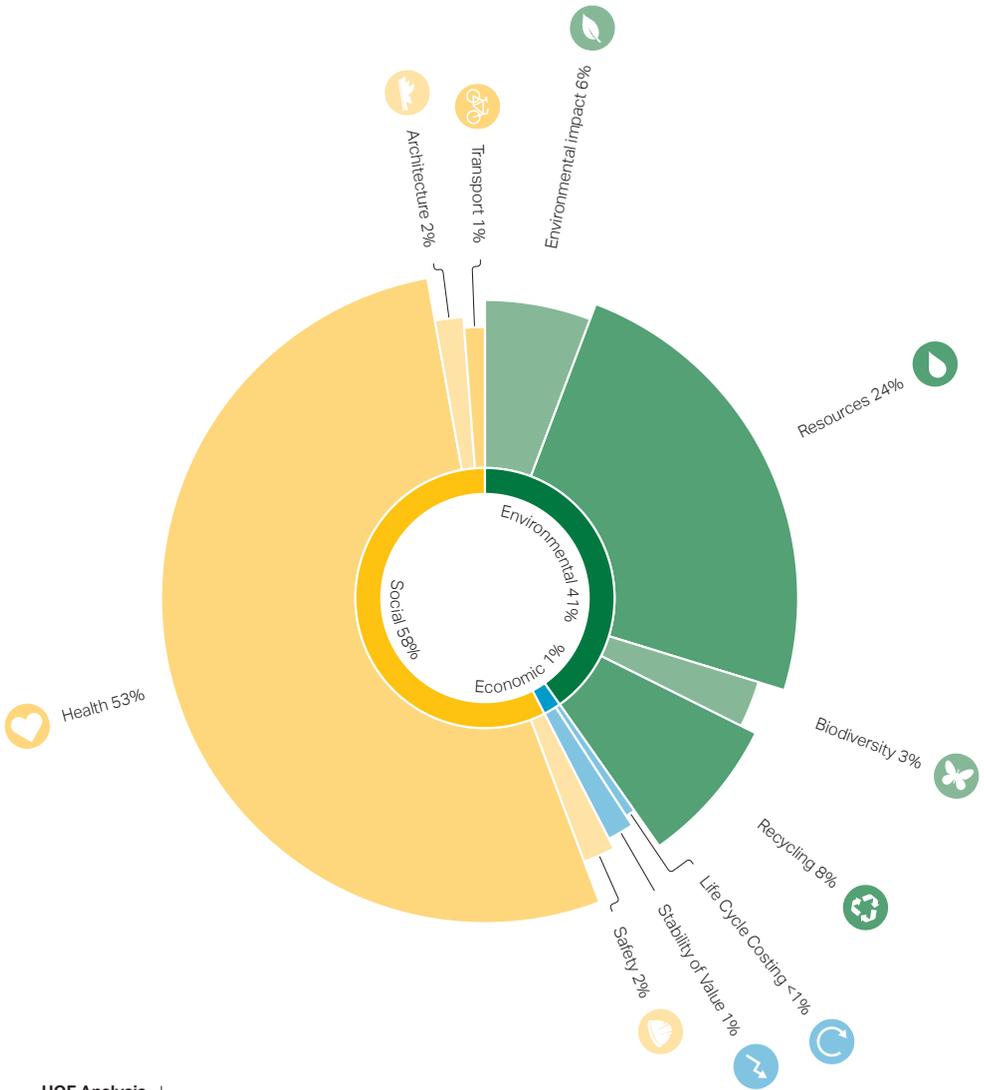
ICADE Premier House
HQE Exceptional
DGNB Gold

Photo © Werner
Huthmacher
landau + kindelbacher



HQE

1995



HQE Analysis

Environmental
Performance
Non residential buildings
01 January 2016 ^{CS}
Office sector/spaces

Aspects of sustainability
from SBI report ^{P1}

HQE

Haute Qualité Environnementale

Applications

New buildings
Interiors
Renovations
Existing buildings
Urban areas

Levels

Exceptional
Excellent
Very Good
Good
Pass

Principles

Energy
Environment
Health
Comfort

Administrator

Cerway
4, avenue du Recteur Poincaré
75016 Paris
France
www.cerway.com
cerway@cerway.com



Origin France
Year 1995

General Statistics

May 2018
Certifications 530,227
Certified m² 59,000,000
Fee 1,850€ to 42,250€



HQE Worldmap

May 2018

Countries 24

● Certifications awarded
○ No certifications

Certification Criteria

The analysis categorizes the HQE criteria into 13 sustainable aspects ⁶⁵. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

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.

Environmental Sustainability

HQE is has the largest environmental focus on the resources aspect, which is represented within HQE's Energy and Environment principle. Recycling and environmental impact also has an influence on the environmental dimension.

Economic Sustainability

HQE's focus on the economic dimension is limited. The aspect most addressed is stability of value followed by life cycle costing.

Social Sustainability

The social dimension is primarily addressed in HQE's comfort and health goals. It has a very large focus on indoor environment and comfort through the aspect Health. Of HQEs 14 goals, 7 deal solely with comfort.



6%

Environmental Impact

Reduce environmental impact from maintenance of construction products by choosing products with limited maintenance. Determine the environmental impact of products and make solutions based on this. Determine the least CO₂ emitting transport supply line. Implement materials and products that trap CO₂. Reduce emissions from energy use.



24%

Resources

Reduce water and energy use from maintenance of construction products by choosing products with limited maintenance. Reduce water and energy consumption on the worksite. Use passive design to reduce the energy demand of the building. Improve the air permeability of building envelope. Reduce primary energy use from building services. Limit water use and recycle grey water. Use renewable energy. Monitor water and energy use.



3%

Biodiversity

Encourage the greening of areas. Preserve and improve existing biodiversity. Preserve biodiversity during the construction of the building.



8%

Recycling

Determine the separability of construction products including for finishes, building envelope and building structure. Identify and quantify worksite waste by type and use techniques to reduce the amount of waste and increase recycling. Enhance operational waste recycling by using removal channels with preference to recycling. Design good waste areas. Ensure easy access to the structure and systems for easy maintenance.



Toxicity

HQE does not directly address this aspect.



<1%

Life Cycle Costing

Choose materials that need little maintenance. Use verified products, systems and services. Monitor and control systems.



Area Use

HQE does not directly address this aspect.



1%

Stability of Value

Choose materials that are easy to maintain. Ensure adaptability over the life span of the building.



2%

Safety

Separate pedestrians and bicycles from motor vehicles on site. Manage rainwater on site.



53%

Health

Optimise the acoustic quality of spaces. Ensure hygrothermal comfort in all building modes. Have a minimum level of natural lighting and views to the outside and provide comfortable artificial lighting. Reduce the sources of odours. Provide effective ventilation. Control sources of indoor air pollution. Limit the emission of substances in contact with indoor air. Limit nuisance and pollution on building site. Provide healthy water in the building. Improve the air permeability of building for increased comfort. Monitor the comfort conditions within the building such as heating, cooling, ventilation and lighting.



2%

Architecture

Ensure good outdoor spaces that regards climate and acoustics. Ensure local residents their right to sun and natural light. Limit noise and light pollution from the building.



1%

Transportation

Encourage healthy transport such as walking and cycling. Make an urban mobility study. Promote public transportation.



Social Responsibility

HQE does not directly address this aspect.

Introduction

The Haute Qualité Environnementale (High Environmental Quality) certification system, also known as HQE, is the most commonly used certification system in France. Along with LEED and BREEAM, it is one of the major internationally used certification systems ^{P6 W1}.

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.

Evolution

HQE is based on the principles of sustainable development first set out during the 1992 Earth Summit. HQE was registered at the French patent office in 1995 and the HQE Association was established the following year. In 2004, it was recognised as a non-profit

organisation. The international scheme for HQE was launched in 2012, and it differs from some other rating systems in its acceptance of local codes and practices as alternative benchmarks for project performance.

Previously, membership of HQE was limited to public institutions and building associates, hereby excluding individuals and companies. This changed in January 2017 when The French Green Building Council and HQE merged to form the Alliance HQE-GBC. The Alliance is open to both public and private individuals, associations and companies.

Levels

The five HQE certification levels are Exceptional, Excellent, Very Good, Good and Pass. 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. Previously HQE has used a three-part structure; Very Good, Good and Basic.

Process

The HQE certification process differs from many other systems in its flexible method for dealing with schemes. HQE has the following different certification schemes: new buildings, refurbishment of non-residential buildings, residential buildings and existing buildings in use. These are all assessed differently.



ICADE Premier House

HQE Exceptional
DGNB Gold

Photo © Werner
Huthmacher
landau + kindelbacher

Non-residential buildings must pass through a three-step assessment program to obtain a certification. An auditor from Certivéa certification body inspects submitted documents.

When certifying residential buildings, it is not the building which is certified, but the property developer or the building contractor. When addressing HQE goals in a single-family home, the building contractor is responsible for carrying out the certification. The contractors and property developers must obtain a license that validates

their experience in developing and building sustainable buildings; these licenses must be renewed every three years to ensure the quality of the developers and contractors.

Fee

For non-residential buildings, the fee for registration and inspection is 1,868€. Additional fees are charged depending on the building type and gross floor area. The overall tariffs for new office buildings are in the range of 9,618€ to 42,245€. There are additional fees for annual audits.



ICADE Premier House
HQE Exceptional
DGNB Platinum

Photo © Werner
Huthmacher
landau + kindelbacher



HQE case study

ICADE Premier House

The French project developer ICADE has built four office buildings on a revitalised plot extending over two hectares in Munich between the Donnesberger bridge and the Central Station. The ICADE Premier House, a 29,000 m² complex with 600 workplaces, was the first of these to be built. In the courtyard of the building there is a central auditorium. The auditorium breaks through the façade to connect the interior and exterior with three recurring materials; wood, natural stone and Corian^{W15 W16}.

The building consumes around 50% less energy than the average of its typology. This has been achieved by energy-optimisation of the building. All building services are controlled by a building automation system that uses bespoke software. The roof, and especially the courtyard, are complimented with greenery. The central auditorium has a fully covered

sedum roof only broken by four strips of skylights, providing natural light to the users.

The custom-made shell has unique ecological qualities. It has a greater resistance to weathering and UV. From an economical view it is low maintenance and can be repaired easily. These features allow the façade to achieve a high sustainable standard.

As a French-owned building located in Germany, both HQE and DGNB certification systems have been applied to the building. ICADE premier house scored HQE exceptional and DGNB Platinum (previously Gold), the highest achievable score in both the certification systems.

Typology Office
Location Munich, DE
Size 29,000 m²
Architect GHU Architekten,
Landau + Kindelbacher
Completed 2011

Certification DGNB
Platinum
Year 2011

Certification HQE
Exceptional
Year 2012



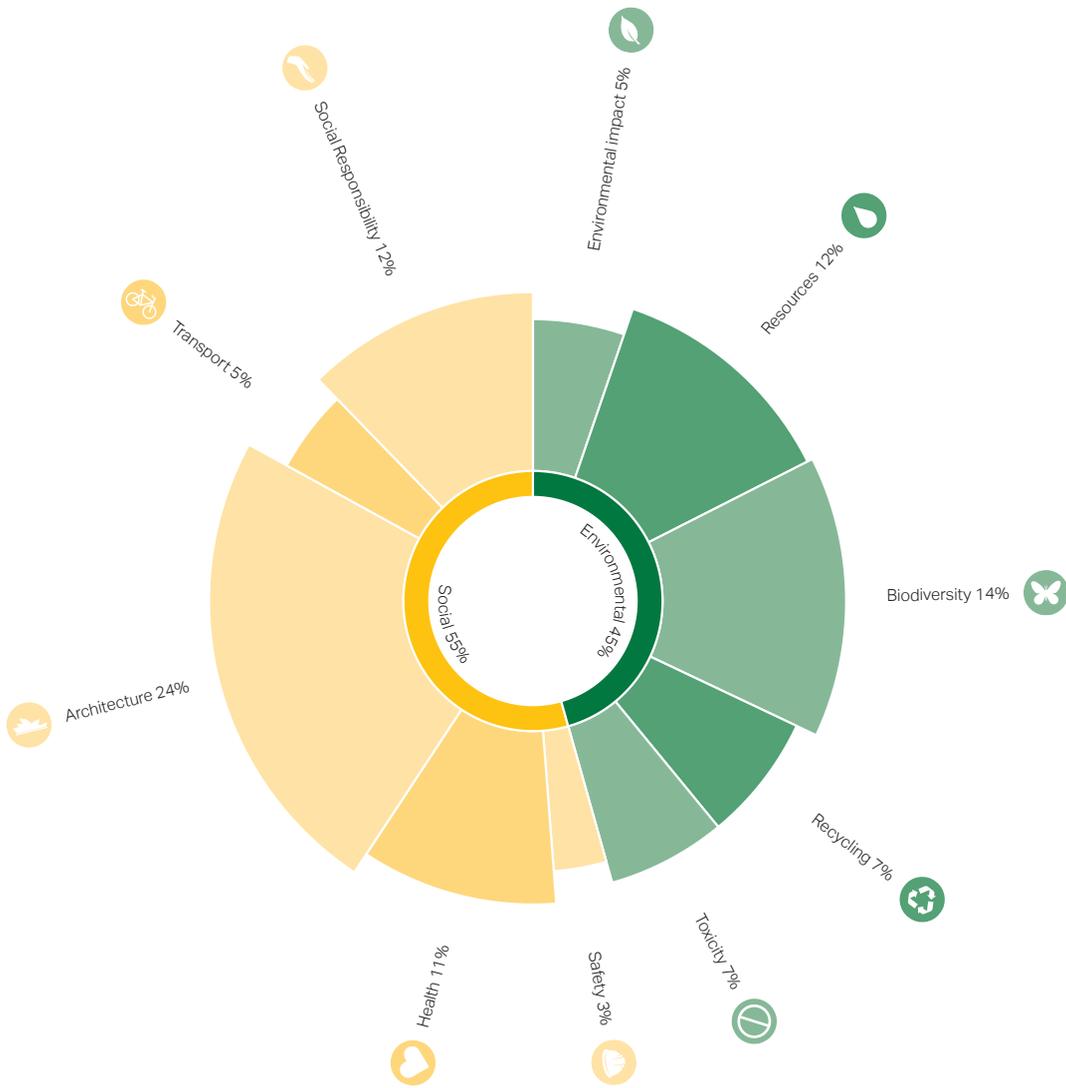
Bullitt Center
LBC Living

Photo © Nic Lehoux



LBC

2006



LBC Analysis

Living Building Challenge
v3.1 ^{CS}
Office use

Aspects of sustainability
from SBI report ^{P1}

LBC

Living Building Challenge

Applications

New buildings
Renovations
Existing buildings
Urban areas

Levels

Living certified
Petal certified

Principles

Place
Water
Energy
Health and Happiness
Materials
Equity
Beauty

Administrator

International Living Future Institute
1501 E Madison Street, Suite 150
Seattle, WA 98122
USA
www.living-future.org
info@living-future.org



Origin USA
Year 2006

General Statistics

May 2018
Certifications 43
Certified m² n/a
Fee 2,150 to 21,000€



LBC Worldmap

May 2018

Countries 24

● Certifications awarded
○ No certifications

Certification Criteria

The analysis categorizes the LBC criteria into 13 sustainable aspects ⁰⁶. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

The Living building challenge is mainly focused on the social dimension of sustainability. This is primarily due to all 7 principles touching on social sustainability, while only some principles focus on environmental sustainability. The certification has no focus on economic sustainability. The social and environmental dimensions are distributed across several aspects. The largest focus is on the architecture aspect, followed by biodiversity and social responsibility.

Environmental Sustainability

The Living Building Challenge addresses environmental sustainability through a demand for closed loops and net positive impacts. The main aspect in the environmental dimension is biodiversity.

Economic Sustainability

LBC does not directly address this dimension.

Social Sustainability

All 7 principles of the Living Building Challenge have a strong or partial focus on social sustainability. The equity principle has the social dimension as its only focus.



5%

Environmental Impact

Account for and reduce the embodied carbon (tCO₂e) impact of the construction. Purchase of carbon offset.



12%

Resources

Produce at least 105% of the energy used by the building on-site by renewable energy. Supply 100% of the water in natural closed loop systems or recycle water on site such as grey water and black water. Use certified or responsible sourcing of timber and advocate for certification of metal, stone and rock.



14%

Biodiversity

Use previously developed land. Avoid building on or adjacent to sensitive ecological habitats. Make a landscape plan including native plant species and consideration about landscape. Use outside areas for food production. Set aside at least 0.4 hectare of land through a land trust organisation.



7%

Recycling

Reduce waste through all the phases of the building. Use at least one salvaged material per 500 m² building area. Divert more than 90% of all waste materials from landfills. Create dedicated waste infrastructure.



7%

Toxicity

Avoid the use of fertilisers or pesticides to maintain the landscape. Avoid the use of the red listed materials.



Life Cycle Costing

LBC does not directly address this aspect.



Area Use

LBC does not directly address this aspect.



Stability of Value

LBC does not directly address this aspect.



3%

Safety

Calculate and handle excess storm water adequately. Ensure safe access for the physically disabled and allow public access to areas of the building or site.



11%

Health

Have operable windows in all regularly occupied rooms to provide the inhabitants with daylight and fresh air. Create a plan for a healthy interior environment which prohibits smoking, lives up to standards for heating and ventilation, measures air quality, meets levels of VOC emissions, etc.



24%

Architecture

Create a biophilic environment by, for instance, using natural shapes and forms, use of nature's patterns, relationship to the place, climate and culture. Do not reduce the quality of existing area by diminishing the opportunities for fresh air, sunlight or access to natural waterways. Support the local area with sustainable practices by buying materials from regional area. Build in dimensions for human scale. Integrate art and design features.



5%

Transportation

Encourage human powered transportation by providing facilities for bikes and pedestrians. Design interior layout and stairs in a way that encourage users to take the stairs. Advocate for facilities supporting human-powered transport in the community.



12%

Social Responsibility

Use certified or responsible sourcing of timber and advocate for certification of metal, stone and rock. Donate 0.50€ to charity per dollar used. Include at least one organisation with the JUST (business disclosure to support an equitable society) label involved in the design and construction phases.

In 2014, the Bullitt Center generated **160%** of the buildings energy use by PV panels and treated **69%** of the on-site precipitation.

Introduction

The Living Building Challenge (LBC) is an ambitious and demanding certification administered by the International Living Future Institute (ILFI). It can be used all over the world but is mainly used for buildings in North America on the east and west coasts. The Institute describes the challenge as a philosophy, an advocacy tool and a certification system, which promotes the most advanced measurement of sustainability in the built environment. To attain the certification, buildings must generate more energy than they use, capture and treat sufficient water on site, and be constructed using healthy materials. The logo of Living Building Challenge is a metaphor for the ecological efficiency and contextual benefits of a flower^{W18}.

LBC is more rigorous than certification systems such as LEED or BREEAM. It is known as the most advanced and strict sustainable building certification.

Evolution

The Living Building Challenge was developed by Jason F. McLennan and Bob Berkebile and launched in 2006 by the Cascadia Green Building Coalition - a chapter of both the US and Canadian Green Building Councils. In 2009, the non-profit International Living Future Institute was created to manage certifications. The institute has since expanded LBC and created other certifications and

tools to strengthen and compliment both the Living Building Challenge and to lead transformation towards a civilisation that is socially just, culturally rich, and ecologically restorative.

The institute's portfolio of programs includes:

Living Building Challenge

– A certification for buildings

Zero Energy

– An energy certification for buildings

Living Product Challenge

– A certification for products

Living Community Challenge

– A certification for masterplans

Reveal

– Energy profiles for buildings

Declare

– Transparent product labels

Just

– Transparent organisation labels

The Biophilic Design Initiative

– Advocating for plant implementation in buildings

In 2014, the ILFI established a list of chemicals that are deemed harmful to include in materials. These banned materials cannot be used to obtain the Material Petal of the Living Building Challenge.

Levels

LBC has two certification degrees; Living and Petal. To get the full Living certification, all demands of the petals (principles) must be met. There are seven petals in the Living Building Challenge system; Place, Water,

Energy, Health, Materials, Equity and Beauty. If the project can reach the standards of at least three out of the seven petals (with at least one being either Water, Energy or Health), it can receive a Petal Certification. The full living certification is very demanding in its criteria and can only be compared to the highest levels of other certifications e.g. DGNB platinum, LEED platinum and BREEAM Outstanding.

Process

The process of achieving a Living Building Challenge certification is split into three parts. Part one is registration. A 750€ registration fee is paid, which, among other things, includes access to the Living futures Institutes community, three personal memberships and ten dialogue posts. Part two is the documentation and operation phase. Documentation of the project must be compiled and sent. The building must then undergo a 12-month performance period, in which significant data is recorded to prove that the project is meeting the requirements of the certification. Part three is the audit and certification. In this phase, an auditor reviews the documentation and performs a site inspection. If the project meets the criteria the certification is awarded.

Fee

Following the 750€ registration, the fee of the project will vary based on its typology, size and if the two audits needed are bought as a package

or separately. The three typology types are; Single Family Residential, Commercial/Institutional/Multi-family Residential and Landscape/Infrastructure, with the cheapest being the Single Family Residential starting at 2,150€ for the total fee. The Commercial/Institutional/Multi-family Residential typology is the most expensive to certify and can cost up to 21,500€ for buildings up to 50,000 m². For buildings above 50,000 m² the price is multiplied by the gross area, at a rate of 0.44€/ m².



Bullitt Center
LBC Living

Photo © Nic Lehoux



Bullitt Center
LBC Living

Photo © Nic Lehoux



LBC case study

Bullitt Center

Located in the Central Area of Seattle Washington, the Bullitt Center is a six-storey commercial building designed to demonstrate sustainably prosperous ecosystems and exemplify the highest level of sustainability. With an expected lifespan of 250 years, the structure is a commercially viable example of the sustainable potentials for office typology ^{W18}.

The structure of the building is based on two lower concrete floors with four timber-based floors on top. Besides its structural properties, the wood stores 545 tons of embodied CO₂. Heavy materials have been sourced from within a 500 km radius and all timber has been sourced within 1,000 km.

The Bullitt Center extracts geothermal heat via 26 wells at 122 meters depth. Rain water on site is captured and

treated for potability and services the building. The building is powered by 575 PV panels producing a total of 244kW. The placement of stairs and bicycles facilities promotes human activity over mechanic commutes. All materials are screened and cross referenced with the IFLEI Material Red List. Automated blinds and operable windows optimise daylight, air and temperature while a green roof and exposed structural timber create an architecturally beautiful atmosphere.

The Bullitt Center is certified to the highest level of LBC, the Living certification. In achieving full certification, the building demonstrates the highest level of building sustainably.

Typology Office
Location Seattle, US
Size 4,830 m²
Architect Miller Hull Partnership
Completed 2013
Certification LBC Living
Year 2015



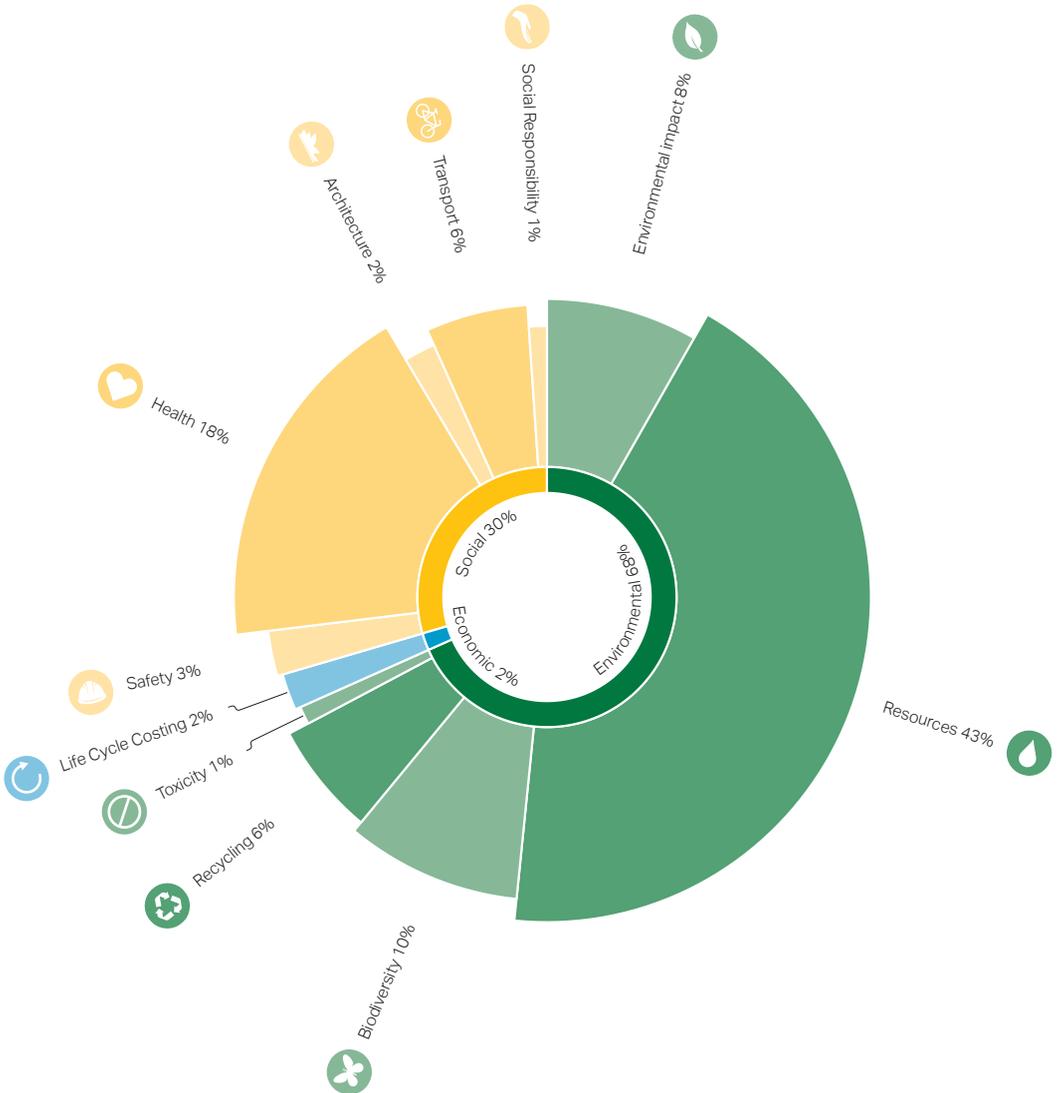
UN City
LEED Platinum

Photo © Adam Mørk



LEED

1998



LEED Analysis

LEED v4 for Building
Design and
Construction v7
Office

Aspects of sustainability
from SBI report P1

LEED

Leadership in Energy and Environmental Design

Applications

New buildings
Interiors
Renovations
Existing buildings
Urban areas

Levels

Platinum
Gold
Silver
Certified

Principles

Location and Transportation
Sustainable Sites
Water Efficiency
Energy and Atmosphere
Materials and Resources
Indoor Environmental Quality
Innovation
Regional Priority

Administrator

U.S. Green Building Council
2101 L Street
Washington, DC 20037
USA
www.usgbc.com
leedinfo@usgbc.org



Origin USA
Year 1998

General Statistics

May 2018
Certifications 108,779
Certified m² 1,280,000,000
Fee 425 to 27,200€



LEED Worldmap

May 2018

Countries 164

● Certifications awarded
○ No certifications

Certification Criteria

The analysis categorizes the LEED criteria into 13 sustainable aspects ²⁷. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

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.

Environmental Sustainability

The LEED certification has a high focus on environmental sustainability, which is very dominant in LEED's principles of Water Efficiency, Energy and Atmosphere, and Materials and Resources. Each of these principles almost solely consists of aspects within the environmental dimension. The environmental dimension of sustainability is also visible in most of LEED's other principles.

Economic Sustainability

LEED has a small focus on economic sustainability, including only the aspect of life cycle costing.

Social Sustainability

Within the social dimension of sustainability LEED puts most focus on the health aspect. The major focus on this aspect comes from LEED's Indoor Environment Quality principle.



8%

Environmental Impact

Make a Life Cycle Assessment (LCA) and use indicators to reduce environmental impact compared with the baseline building. Use Environmental Product Declarations (EPDs). Enhance management of refrigerants. Use carbon offsets. Reduce greenhouse gas emissions through providing alternative modes of transport.



43%

Resources

Carry out an LCA to evaluate and reduce resource use compared with the baseline building, using indicators. Reduce indoor and outdoor water usage and meter water. Use commissioning process to optimise use of resources for building systems. Reduce energy use and meter energy. Reduce the use of fossil fuels by producing local renewable energy. Use green energy from grid. Source raw materials responsible. Use certified timber.



10%

Biodiversity

Avoid the use of environmentally-sensitive lands. Preserve and restore greenfield areas. Minimise effects on microclimates by reducing heat islands. Prevent erosion and pollution of the site during the construction phase.



6%

Recycling

Dedicate areas for collecting recyclables during the operation of the building. Plan and manage construction and demolition waste. Recover, reuse and recycle construction waste. Reduce the creation of construction waste. Use products where a complete inventory has been published.



1%

Toxicity

Use products and materials that provide information regarding chemical ingredients.



2%

Life Cycle Costing

Follow the commissioning process to ensure the technical systems work and thereby reduce costs for maintenance in the operational phase.



Area Use

LEED does not directly address this aspect.



Stability of Value

LEED does not directly address this aspect.



3%

Safety

Manage rainwater securely.



18%

Health

Exceed requirements in indoor air quality standards. Create good indoor air quality with low-emitting interior materials and test air quality or perform a flush-out of the building after construction. Prohibit smoking outside of designated places. Ensure a good thermal comfort and sufficient daylight and interior lightning. Create quality views and good acoustical performance. Use commissioning process to ensure that systems function optimally for enhanced indoor climate.



2%

Architecture

Create open exterior spaces to encourage interactions. Reduce light pollution at night.



6%

Transportation

Improve the health of users by encouraging daily physical activity through transportation. Promote bicycling and transportation efficiency.



1%

Social Responsibility

Reward project teams for selecting products verified to have been extracted or sourced in a responsible manner such as using certified timber.

Introduction

The LEED certification, developed by the U.S. Green Building Council, is one of the largest existing certification systems. It is inspired by BREEAM and primarily focuses on the environmental and social aspects of building sustainability. 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 ^{W3}.

Evolution

LEED was developed in the United States by the U.S. Green Building Council (USGBC). The pilot project began in 1993 and the first version was launched in 1998. From 1994 to 2015, LEED grew from a scheme for new construction to a system of multiple schemes covering everything from design and construction to maintenance and operation.

The motivation for this development was to have an American certification system. LEED was designed as a structured framework that enables the identification and assessment of sustainability in design, construction, operation and maintenance. The development of this certification system also established a way to promote public awareness of

sustainable buildings using efficient and appropriate insulation.

In the 90s and early 00s, USGBC was completely responsible for all aspects of the LEED certification system. This included the development of the rating systems, both existing and new, training programmes, examinations, reviewing submitted projects and awarding certifications. Since 2008, the Green Business Certification Inc. (GBCI) has been affiliated within the USGBC, and the business area of LEED is now managed by GBCI. This includes the entire certification process.

Levels

The certification levels for LEED are Certified, Silver, Gold and Platinum. These certifications can be achieved in compliance with the assessments point system which consist of 110 attainable points in total. For projects with 40+ points the Certified level is achieved, for 50+ the Silver, for 60+ the Gold and for 80+ the Platinum certification. While the number of certifications is quite well dispersed between the 3 lower certifications, only 5% of the certifications awarded are platinum. This may be a result of the large 20 points gap between gold and platinum, while the gaps between other levels are only ten points.

Process

For LEED-NC (new construction) in the United States, the certification process is split into two phases; the

design phase and the construction phase. In the first phase, design documents and the location of the building are submitted to GBCI, which then evaluates the documents. The result of this first review is a list that either approves or rejects the respective sustainable solutions used in the project. This first step gives the building owner the possibility to enhance or correct the relevant topics to enhance the certification level, if desired. The next step regards the materials used for construction, as well as the construction process itself. At the end of the construction phase, these documents are submitted and then reviewed by GBCI. If the documentation is incomplete or lacking information, the project is granted a 25-day period to complete the documentation. Due to the many different LEED certification schemes used all over the world, the certification process can vary.

Fee

The fee for a LEED certification follows the process phases; design review and construction review. The price is calculated according to gross floor area and certification scheme and varies from 425 to 27,200€. For non-members, the total fee for LEED-NC starts at 2,800€ and ends at 26,700€. Discounts for the certification is given to members.

LEED Facts	
for LEED BD+C: New Construction (v2009)	
Certification awarded Dec 2013	
Platinum	84
Sustainable sites	20/26
Water efficiency	10/10
Energy & atmosphere	30/35
Material & resources	3/14
Indoor environmental quality	12/15
Innovation	5/6
Regional priority credits	4/4

LEED Scorecard
UN City



UN City
LEED Platinum

Photo © Adam Mørk



LEED case study

UN City

UN City is the regional head office of the United Nations, located in the northern harbour of Copenhagen. It brings together various agencies and functions into one of Denmark's most energy efficient buildings. Inside the building, daily life is centred around a light atrium offering visual and physical connections across and between floors ^{W12 W19}.

The sustainable features of UN City are designed to match the 7 LEED principles. The roof is coated with a white, recyclable, plant-based membrane. This reflects more sunlight than a typical dark surface, thereby reducing the heat island effect. It also reduced air conditioning requirements in summer, minimising CO₂ emissions. The roof is furthermore equipped with over 1,400 solar panels, generating an estimated 297,000 kWh onsite of renewable energy per year. The panels have an 15° angle to optimise

the sun exposure in a Danish context.

To ensure the quality of the indoor environment, UN City has been designed to limit the use of chemicals and pollutants during both its construction and its use. CO₂ sensors have been placed throughout the building to monitor air quality and ensure an optimal airflow with a seawater-cooled conditioning system. Filters are installed at all entry points thereby restricting dirt, dust, pollen, smoke and other particles from entering the buildings.

UN City has a LEED score of 84 points, out of a possible 110, earning it the LEED platinum certification. It has furthermore been awarded the European Commission's Green Building Award for New Buildings.

Typology Office
Location Copenhagen, DK
Size 45,000 m²
Architect 3XN
Completed 2013

Certification LEED
Platinum
Year 2013

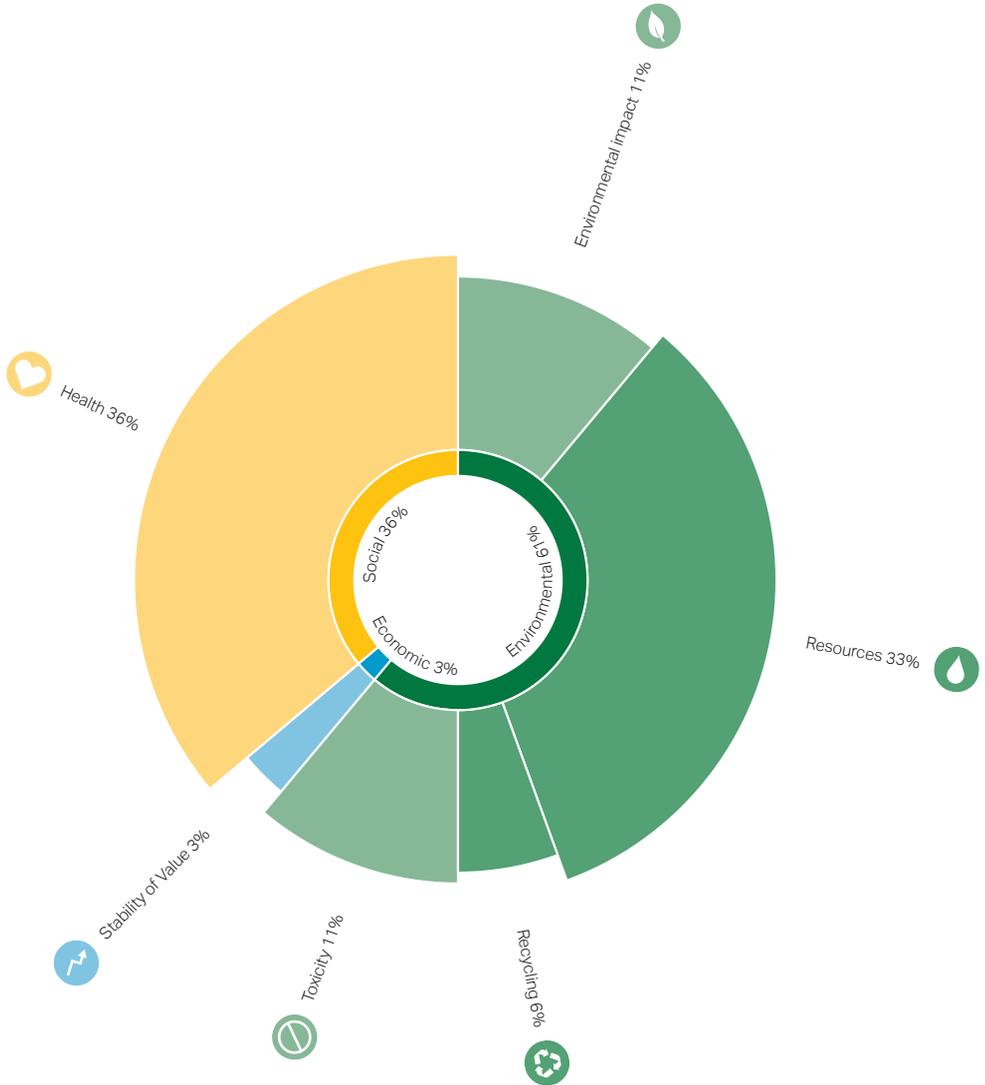


Swedbank Headquarters
Miljöbyggnad Gold
Photo © Adam Mørk



Miljöbyggnad

2005



Miljöbyggnad Analysis

Miljöbyggnad 3.0
 nyproducerade
 byggnader v170510 ^{CS}
 Office use

Aspects of sustainability
 from SBI report ^{P1}

Miljöbyggnad

Applications

New buildings
Renovations
Existing buildings

Levels

Gold
Silver
Bronze

Principles

Energy
Indoor climate
Materials

Administrator

Sweden Green Building Council
Långholmsgatan 34
117 33 Stockholm
Sweden
www.sgbc.se
miljobygggnad@sgbc.se



Origin Sweden
Year 2005

General Statistics

May 2018
Certifications 1,090
Certified m² 6,300,000
Fee 1,800 to 12,100€



Miljöbyggnad Worldmap

May 2018

Countries 1

- Certifications awarded
- No certifications

Certification Criteria

The analysis categorizes the Miljöbyggnad criteria into 13 sustainable aspects ⁵⁸. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

Miljöbyggnad is mainly focused on the environmental and social dimensions of sustainability. It only covers six of the 13 sustainable aspects. Of the represented aspects, resources and health are by far the most prioritised in the certification, accounting for majority of the certifications focus.

Environmental Sustainability

Miljöbyggnad focuses mainly on resources within the environmental dimension. Miljöbyggnad has an Energy principle, which focuses on the resources aspects and a Material principle with focus on other environmental aspects.

Economic Sustainability

Miljöbyggnad has a minimal focus on economic sustainability, which is only represented through securing the future value of the building in relation to water damages.

Social Sustainability

Miljöbyggnad has a big focus on social sustainability, achieved via the indoor climate principle.



11%

Environmental Impact

Calculate, document and reduce the impact of global warming from the building mass and the basic structure in the early life cycle stages, such as production and transport to construction site. Use EPDs for specific products.



33%

Resources

Design and build for a low heating and power requirement. Reduce the energy demand beyond that of the demands from the national Swedish code. Limit the need for cooling in the summer by reducing the heat load from the sun. Use renewable energy.



Biodiversity

Miljöbyggnad does not directly address this aspect.



6%

Recycling

Make a document of products and materials used in the building and store this document in the building. Update the document when necessary.



11%

Toxicity

Minimise the use of problematic substances in building materials. Document substances that are considered harmless now but have potential to change status in the future.



Life Cycle Costing

Miljöbyggnad does not directly address this aspect.



Social Responsibility

Miljöbyggnad does not directly address this aspect.



Area Use

Miljöbyggnad does not directly address this aspect.



Stability of Value

3%

Design the building for minimal risk of water damage and problems relating to moisture.



Safety

Miljöbyggnad does not directly address this aspect.



Health

36%

Create a low noise environment. Keep radon gases out of the house. Design a good ventilation system. Keep moisture levels low. Maintain a good thermal climate in both summer and winter. Design for good daylight conditions. Reduce emissions of harmful substances from materials in the indoor environment.



Architecture

Miljöbyggnad does not directly address this aspect.



Transportation

Miljöbyggnad does not directly address this aspect.

Introduction

Miljöbyggnad is a Swedish certification system, which translated means "Environmental building". The certification is administered by the Swedish Green Building Council (SGBC) and used exclusively in Sweden. The goals of Miljöbyggnad have been the same since it was first developed as Miljöklassad byggnad: contribute to environmental goals, be cost efficient, be simple, use the minimum number of criteria, use scientifically proved indicators, have quality control of cases, only have influenceable criteria, verify the building and only use obligatory criteria for certifying ^{W20 W21}.

Evolution

Miljöbyggnad is a further development of "Miljöklassad byggnad", which was developed in 2003. The goal of developing Miljöklassad byggnad was to establish a tool that could measure the sustainability and/or the environmental impact of buildings. The development of the assessment system was carried out by a large group of architects, technical consultants, developers, material manufactures, energy companies, banks and insurance companies.

In 2011, the Swedish Green Building Council overtook the management of Miljöklassad byggnad and the system was adapted into a certification system, which meant verification by a third party. During this process the name was changed to Miljöbyggnad.

Levels

Miljöbyggnad has three certification levels: Bronze, Silver and Gold. They relate to performance in comparison with Swedish building regulations. The Bronze certification suffices to comply with legal requirements or existing recommendations. If a building performs well over the set values, it can reach Silver. For example, the sun protection, sound environment and ventilation must be significantly better than legal requirements. Gold is the highest certification. The requirements set are even higher, e.g. the radon content may not exceed one quarter of legal requirements. To reach Gold, those living and working in the property need to agree that it is a good building. Therefore, users have to be surveyed after two years on their opinions on and experience of the indoor environment.

Process

To apply for the Miljöbyggnad certification, the first step is to register at SGBC to determine which of the certification schemes is the correct for the project. The application is then handed in to the SGBC. The content of the application is verified by professional verifiers in accordance with SGBC. If there are any requirements that are insufficient or incorrect, the applicant has the possibility to submit additional material. When the application is approved for existing buildings, the owner receives a certification. For new buildings a pre-certification is

Byggnad	Områden	Klass	Aspekter	Klass	Indikatorer	Klass
GULD	Energi	GULD	Energianvändning	GULD	Köpt energi	GULD
			Energibehov	GULD	Värmeförlusttal	GULD
			Energislag	GULD	Solvärmelasttal	GULD
	Innemiljö	GULD	Ljudmiljö	GULD	Bedömning allt ljudklassning	GULD
			Luftkvalitet	SILVER	Radonhalt	GULD
					Ventilation	GULD
			Fukt	SILVER	Kvävedioxid i inneluften	SILVER
					Fuktsäkerhet	SILVER
			Termiskt klimat	GULD	Transmissionsfaktor	GULD
					Solvärmefaktor	GULD
	Dagsljus	GULD	Dagsljus	GULD		
	Vatten	SILVER	Tappvarmvatten-temperatur - legionella	SILVER		
	Material och kemikalier	GULD	Dokumentation	GULD	Dokumentation av byggarvaror och kemiska ämnen	GULD
			Utfasning	SILVER	Verifiering av att särskilt farliga ämnen inte byggts in	SILVER

awarded. After two years, the building is then verified, and if all requirements are fulfilled, the final certification is awarded. The final certification must be checked every five years to maintain its validity.

building or of the documentation be needed, this will be charged with additional fees up to 1,100€ per measure.

Fee

A Miljöbyggnad certification will cost between 1,800 and 8,450€ for members of the Swedish Green Building Council. For non-members, a 43% additional charge is added. The price is determined by typology and size. The lowest fee is for existing houses and the most expensive is charged for large new constructions. Should additional revisions of the



Swedbank Headquarters

Miljöbyggnad Gold

Photo © Adam Mørk



Miljöbyggnad case study

Swedbank Headquarters

The architectural theme of Swedbank's headquarters is a folded triple-V structure that breaks up volumes and creates an inviting democratic environment in and around the building. The legs of the Vs are linked across atria by open footbridges. These bridges are more than internal shortcuts: they provide additional office space, visual contact and connection, and variation between the floors. The office floors thus feature a high degree of openness and variation, ensuring a healthy working environment with a clear, human scale in a large building ^{W12 W22}.

The building's features, such as customised lighting and ventilation, contribute to significant energy savings. Furthermore, Swedbank offers an opportunity for each employee to monitor their own consumption of electricity through

their own computer. In this way, employees can influence their impact through concrete activities, such as turning off the computer, monitor and lighting when leaving their workplace.

The building features a green roof. All materials were chosen for their long lifespan, robustness, and ease of maintenance and cleaning. The furniture has also been approved by the Swedish Environmental Management Council (MSR) criteria for procurement of furniture and fitting.

In 2014 the building achieved the Miljöbyggnad Gold certification.

Typology Office
Location Stockholm, SE
Size 45,000 m²
Architect 3XN
Completed 2014
Certification Miljöbyggnad Gold
Year 2014



Krøyers Plads

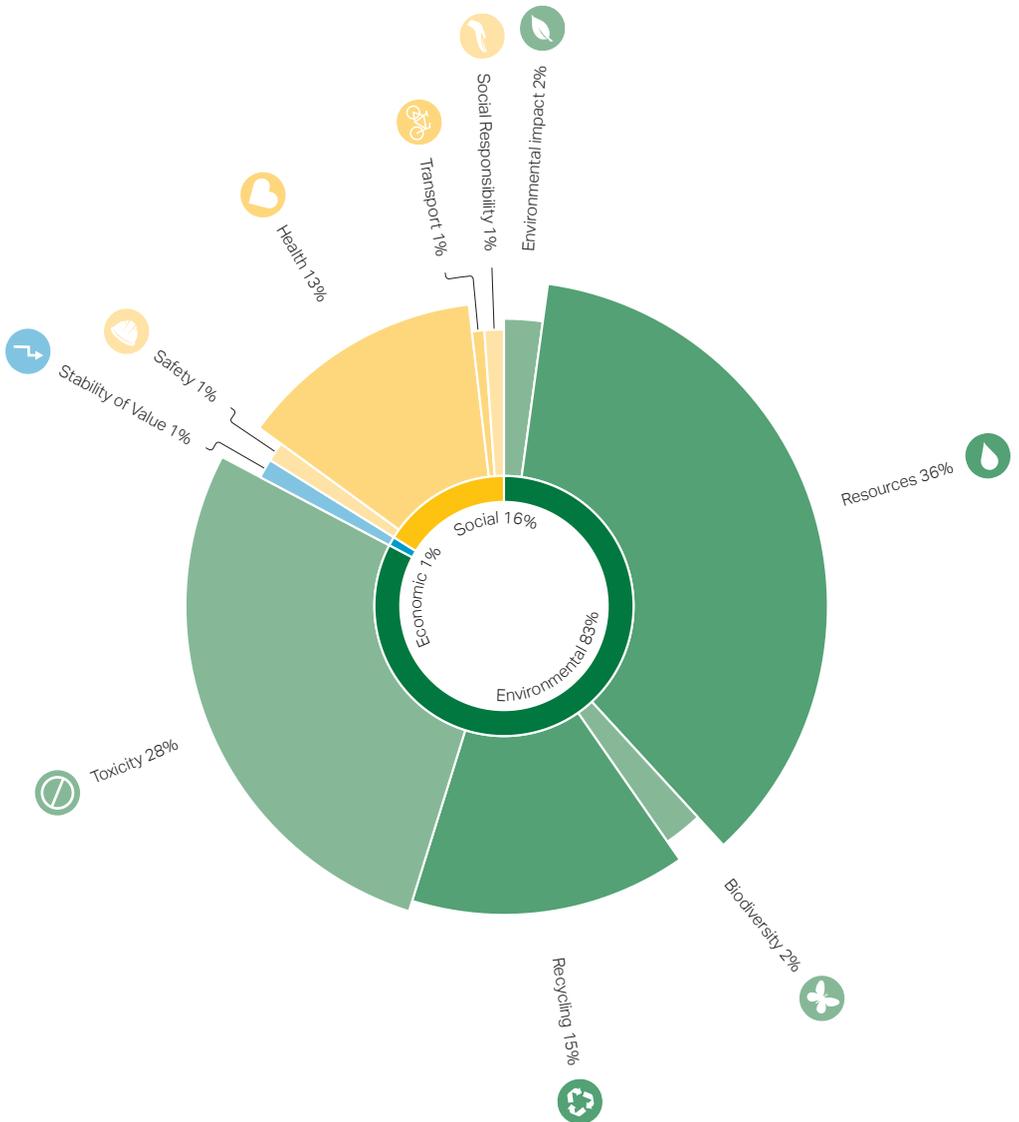
Nordic Swan Ecolabel

Photo © Rasmus Hjortshøj
- COAST -



Nordic Swan

2005



Nordic Swan Analysis

Nordic Ecolabelling for buildings v3.2 ^{C9}
 Apartment buildings

Aspects of sustainability from SBI report ^{P1}

Nordic Swan

The Nordic Ecolabel

Applications

New residential buildings
New schools and pre-schools

Levels

Nordic Swan Ecolabel

Principles

Energy and Resources
Indoor Environment
Materials and Chemicals

Administrator

Miljømærkning Danmark
Göteborg Plads 1
2150 Nordhavn
Denmark
www.ecolabel.dk
info@ecolabel.dk



Origin The Nordics
Year 2005

General Statistics

May 2018
Certifications n/a
Certified m² n/a
Fee 1,500€ to 33,350€



Nordic Swan Worldmap

May 2018

Countries 4

- Certifications awarded
- No certifications

Certification Criteria

The analysis categorizes the Nordic Swan criteria into 13 sustainable aspects⁶⁹. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

Nordic Swan is primarily focused on the environmental dimension of sustainability, followed by the social dimension. With its roots in the advocacy of healthy materials and products, the Nordic Swan Ecolabel concentrates on reducing resource consumption and banning toxic materials and compounds. Of the selected ten certifications, Nordic Swan has the strongest focus on the toxicity aspect.

Environmental Sustainability

Nordic Swans deals with the environmental dimension through the principles of Energy and other Resources, Materials, and Chemicals. Resources and toxicity are the most addressed aspects in this certification.

Economic Sustainability

Nordic Swan has a minimal focus on economic sustainability, which is only represented in securing the future value of the building in relation to moisture prevention.

Social Sustainability

Socially, the main concern of the Nordic Swan certification is human health, as demonstrated by criteria such as radon, daylight and noise. This is particularly addressed through the Indoor Environment principle, which deals with the health aspect.



2%

Environmental Impact

Use cement and concrete with a reduced climate impact. Use Ecolabelled products.



36%

Resources

Limit the energy consumption of the building. Manage the usage of artificial light. Use energy efficient white goods, appliances and sanitaryware. Limit the use of copper. Monitor systems during construction. Provide instructions for installations to achieve best energy efficiency. Meter hot water usage. Use timber as a structural material. Use concrete with a reduced energy impact.



2%

Biodiversity

Design green roofs and facades. Allow for urban cultivation. Create gardens and habitats for insects, birds and bats.



15%

Recycling

Sort waste at the construction site for recovering and recycling. Sort operational waste. Document all products used in the building for easier future recycling of materials. Specify construction products with recycled materials.



28%

Toxicity

Document all chemical products used in the building. Avoid and limit use of specified chemical products and substances such as the use of preservatives and chemical products releasing nanoparticles. Avoid use of interior surfaces containing chlorinated plastics.



Life Cycle Costing

Nordic Swan does not directly address this aspect.



Area Use

Nordic Swan does not directly address this aspect.



1%

Stability of Value

Prevention of moisture in the building.



6%

Safety

Provide relevant knowledge on avoiding risks when handling chemical products to all employees involved in construction process.



16%

Health

Provide a good indoor environment through the proper handling of radon gases, prevention of moisture and adequate amounts of ventilation. Provide a minimum amount of daylight per room. Limit emissions of formaldehyde to the indoor environment. Prevent noise transfer. Monitor systems for ventilation etc. during construction phase to enhance quality.



Architecture

Nordic Swan does not directly address this aspect.



1%

Transportation

Make it easier to use bicycles as a means of transport by providing large sheltered areas for bicycles and repair workshops.



4%

Social Responsibility

Use certified timber.

Krøyers Plads

Nordic Swan Ecolabel

Photo © Rasmus Hjortshøj
– COAST –



Introduction

The Nordic Swan Ecolabel, also known as Nordic Swan or Swan, is the official ecolabel for Nordic countries. A survey from 2017 claimed that nine out of ten consumers in Nordic countries are familiar with this label. More than 25,000 products are certified by The Nordic Swan Ecolabel. The majority of these certifications are awarded to personal care, housekeeping and cleaning products ^{W23}.

For buildings, the Swan label focuses on minimising the levels of toxicity in the materials during the entirety of the lifecycle. This means that the impact of materials is considered during the construction phase, the use phase, and in relation to the dismantling and recycling of the building. The focus on non-toxic materials means that many chemicals and substances are banned from use, e.g. it is not allowed to use materials containing Bisphenol A.

Evolution

The Nordic Swan Ecolabel was introduced by the Nordic Council of Ministers in 1989. Originally, the label was only for household products, but it has slowly evolved through adding more and more product groups to the labelling system. Norway and Sweden implemented the use of Nordic Swan in 1989, Finland in 1990, Iceland in 1991 and Denmark in 1998. In 2005, Nordic Swan released a building-specific certification scheme. The goal of this scheme is to reduce

the overall environmental impact of the specific building. The label's two general focus areas are energy and toxicity. In terms of energy, the aim is to minimise demand and incentivise renewable energy sources.

Levels

The Nordic Swan Ecolabel is a pass/fail certification with no levels or graduations. Each of the product groups has its own set of requirements to achieve. Once the base requirements are achieved, it is not possible to achieve higher levels of recognition within the Nordic Swan.

Process

To receive a Swan certification, the applicant must deliver full documentation of the relevant building components. The building must achieve a minimum of points, which is set based upon typology and location. The certification process also includes a site inspection by Nordic Ecolabeling. Criteria used in the certification have an expiry date, which means that they must be reassessed and renewed in order for the building to keep its certification. This process must be initiated at least one year prior to the expiration of the current criteria.

Fee

The fee for obtaining a certification begins at 1,500€ to certify smaller structures and houses. For larger buildings and apartment complexes the price can vary up to 33,500€.



Krøyers Plads

Nordic Swan Ecolabel

Photo © Rasmus Hjortshøj
- COAST -



Nordic Swan case study

Krøyers Plads

Krøyers Plads is a 105-unit apartment complex with retail units on the ground floor, located on a harbour site in the centre of Copenhagen. The development consists of three five-storey volumes, which reference the local warehouse typology of the harbour. The structure is pushed back from the waterfront to allow generous space for public access to a plaza, promenade and shops ^{W24}.

The Krøyers Plads development is constructed using recyclable materials, a green roof, and a highly-insulated envelope, in order to conserve energy. It uses passive design to strategically benefit from natural lighting and ventilation, as well as to optimise moisture protection. Materials are tightly regulated to avoid hazardous environments and eliminate unsafe chemical use. As demanded by the Nordic Swan criteria, Krøyers Plads energy and

material responsibility surpasses Danish legal standards by 40%.

Krøyers Plads is the first Danish apartment building to receive a Nordic Swan Ecolabel. The development does not have any other sustainable building certifications, but it has won a Green Good Design Award and the MIPIM Award for "Best Residential Development 2015".

Typology Housing and retail
Location Copenhagen, DK
Size 20,000 m²
Architect COBE,
Vilhelm Lauritzen architects
Completed 2015
Certification Nordic Swan
Ecolabel
Year 2015



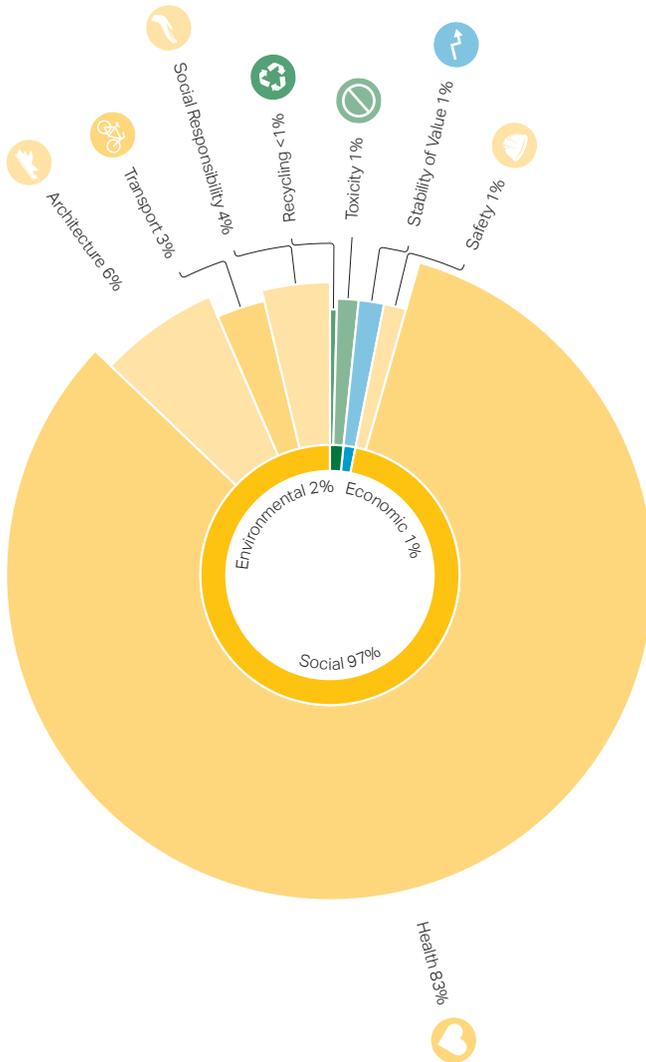
Phipps CSL
WELL Platinum
LEED Platinum
LBC Living

Photo © Denmarsh
Photography Inc.



WELL

2014



WELL Analysis
 v1 with Q2 2017 Addenda
 New and existing
 buildings^{C10}
 Office use

Aspects of sustainability
 from SBI report^{P1}

WELL

Applications

New buildings
Interiors
Renovations
Existing buildings
Urban areas

Levels

Platinum
Gold
Silver

Principles

Air
Water
Nourishment
Light
Fitness
Comfort
Mind
Innovation

Administrator

International WELL Building Institute
381 Park Avenue South
New York, NY 10016
USA
www.wellcertified.com
info@wellcertified.com



Origin USA
Year 2014

General Statistics

May 2018
Certifications 175
Certified m² 3,677,000
Fee starting at 11,100€



WELL Worldmap

May 2018

Countries 32

● Certifications awarded
○ No certifications

Certification Criteria

The analysis categorizes the WELL criteria into 13 sustainable aspects ^{C10}. The descriptions provide selected themes within an aspect but not the complete content.

For further reading see the SBI report ^{P1}

- Environmental aspects ●
- Economic aspects ●
- Social aspects ●

Certification Summary

As a certification that measures the well-being and health of a building's users, WELL is focused almost entirely on the social dimension of sustainability. The health aspect is by far the most significant aspect, covering over 4/5th of the entire focus of the certification. The WELL certification can work in conjunction with other certifications to ensure holistic sustainability for any given project. The WELL certification has several criteria focused on the operation of the building.

Environmental Sustainability

WELL has little focus on environmental sustainability. The focus it does have concerns, amongst other things, improved knowledge of building materials in terms of chemical substances.

Economic Sustainability

Economically, WELL only focuses on the future adaptability of the building, thus addressing the stability of value aspect.

Social Sustainability

WELL focuses on the health aspect, but also includes requirements for other social aspects. In WELL's seven principles, many of the criteria sets overlap between different social aspects.



Environmental Impact

WELL does not directly address this aspect.



Resources

WELL does not directly address this aspect.



Biodiversity

WELL does not directly address this aspect.



Recycling

<1%

Ensure material descriptions of interior finishes.



1%

Toxicity

Reduce toxic building materials inside the building, such as PFCs and halogenated flame retardants. Avoid harmful substances by, for instance, ensuring a Declare LBC Red List Free project. Ensure material descriptions of interior finishes to provide transparency of the chemicals used.



Life Cycle Costing

WELL does not directly address this aspect.



Area Use

WELL does not directly address this aspect.



1%

Stability of Value

Design for materials that facilitate easy cleaning and maintenance. Enable the building to be adaptable to future changes. Ensure that the building will not have issues with moisture.



1%

Safety

Ensure that physically disabled individuals have safe access into and within the building.



83%

Health

Ensure good air and water quality and comfort through ventilation, VOC reduction, operable windows, water quality testing etc. Promote healthy food and high levels of hygiene. Create good daylight and artificial lighting conditions including good colour quality. Minimise glare. Encourage users to live an active, healthy lifestyle. Establish a comfortable human habitat with low sound pollution and good thermal conditions and control. Design for good mental health using material transparency and biophilia.



6%

Architecture

Design eating spaces for employees that encourage socialisation. Create physical activity areas. Design unique and culturally-rich spaces. Nurture the human-nature connection through incorporating nature element designs in the building as well as real nature inside and around the building. Design adaptable spaces that support different work functions and provide areas optimised for focused work. Design for high ceilings and artwork integration.



3%

Transportation

Promote movement by designing accessible, safe, and visually appealing stairways inside the building. Provide facilities for healthy transportation to site such as bicycle storage and changing rooms.



4%

Social Responsibility

Support the health of employees by e.g. health insurance. Support staying home when ill and provide family support and programs for stress. Support charitable work. Buy only humane certified agriculture.

92% of CBRE
employees feel
the company's
new WELL
certified office
is having a
positive impact
on their health
and wellbeing.

Introduction

The WELL building standard is the first system for measuring, certifying and monitoring features of buildings that impact human health and well-being. It was created by the International WELL Building Institute to promote the improvement of spaces in terms of assessing the nutrition, fitness, mood, sleep patterns, productivity and performance of the people working, living, shopping or playing inside of them. The certification is used all over the world - primarily in the United States and China where more than 2/3rds of all WELL certified projects are located ^{W25}.

WELL provides a framework for project teams to incorporate a variety of strategies aimed towards placing human health and well-being at the heart of building design, construction and operations. The WELL certification is about guaranteeing the well-being of those who occupy a building and it is designed to work synergistically with environmentally focused or holistic building certifications.

Like LEED, WELL is third-party certified by Green Business Certification Inc. (GBCI).

Evolution

In 2013, following a Clinton global initiative commitment made by founder Paul Scialla, the International WELL Building Institute (IWBI) founded WELL. In 2014, the WELL building

standard was launched. In order to promote both environmental and social sustainability, WELL was designed to work harmoniously with LEED from its inception.

Currently, IWBI continues to be aligned with LEED but has also formed Crosswalks with Green Building Council of Australia (Green Star), BRE (BREEAM), and the International Living Future Institute (Living Building Challenge). Even though aligned with LEED, the two schemes still overlap in some criteria like ventilation, whereby WELL has much stricter standards. Lighting is another major overlap, with which a project can either gain many points in both schemes or struggle, depending on design.

Levels

The certification levels for WELL are Silver, Gold and Platinum. These certifications can be achieved in compliance with the assessment's point system, which consist of a total attainable score of 105 points. For projects with 50+ points the Silver level is achieved, for 60+ the Gold and for 80+ the Platinum. Currently, the majority of WELL certified projects have been certified Gold.

Process

The WELL certification process is comprised of a registration, followed by documentation handover, a performance verification and a WELL report resulting in a certification if the requirements are met.

Registration requires submitting basic information about the project and declaring the project path by indicating the primary project typology and project scope. Projects must complete documentation submission within five years of registration. After documentation submission, Green Business Certification Inc. will assign a WELL Assessor to the project. The WELL Assessor then completes a performance verification entailing a site visit, during which the assessor performs or oversees tests and inspections to verify that all applicable requirements of WELL features have been met. A comprehensive WELL report will then be available online within 40-45 business days of the site visit. The WELL report provides a feature-by-feature assessment of whether the requirements pursued by the project have been approved. Projects that have satisfied the requirements of WELL and have accepted the WELL report will receive a WELL award package from IWBI.

To maintain status as a WELL Certified project, there are specific ongoing requirements. Projects must provide ongoing records of the following:

- Results of post-occupancy surveys
- Proof of maintenance
- Ongoing environmental parameter measurements

These documents must be submitted within 15 months of certification to

GBCI for reviewing. Thereafter, the documents must be submitted every 12 months to keep the certification status of the project.

Fee

The WELL certification is expensive compared to other certifications. The initial registration fee ranges from 1,200€ to 8,000€ and is intended as a commitment to achieving the full certification. Pricing for a full certification, including registration, starts at 11,100€ for small buildings and rise with no price limit according to the location and size of the building. WELL has developed an online pricing calculator which can estimate the certification price ^{W25}. For a 10,000 m² new construction in Denmark, the online tool estimates a total fee of 46,500€.



Phipps CSL
WELL Platinum
LEED Platinum
LBC Living

Photo © Denmarsh
Photography Inc.



Phipps CSL
WELL Platinum
LEED Platinum
LBC Living

Photo © Denmarsh
Photography Inc.



WELL case study

Phipps CSL

In 2012, Phipps Conservatory and Botanical Garden opened a mixed-use Centre for Sustainable Landscapes (CSL) in Pennsylvania, United States. With a design goal of bridging the gap between human and ecological health, the building is sensitive to both the well-being of inhabitants and the surrounding environment ^{W26}.

Sensors are conditioned to open and close windows based on air quality. Water is tested, filtered and treated on site to be equal to - if not better- than municipal standards. Produce is grown on site in hormone and anti-biotic free gardens. Natural light illuminates habitable space 80% of the time. Stairs and walking trails are promoted in the landscape. Adjustable workstations, including desk heights, ergonomic chairs and thermostats, ensure individual comfort. Biophilic design is incorporated in artwork, expansive views and water features.

Phipps CSL was the first institution to achieve the WELL Platinum Certification – the highest rating awarded achievable (scoring 64/70). With a WELL certification, the Phipps CSL is proven sustainable for its occupants. To address the environmental dimension of sustainability, it also achieved LBC Living and LEED Platinum certifications. Due to its committed design choices and top scores in three independent certification systems, Phipps CSL is considered one of the world's greenest buildings.

Typology Mixed-use
Location Pittsburgh, US
Size 2,262 m²
Architect The Design Alliance
Completed 2012
Certification LEED Platinum
Year 2013
Certification WELL Platinum
Year 2014
Certification LBC Living
Year 2015

Part three |

Comparison

How do the certifications compare

How do the certifications compare
Each sustainable building certification consists of a unique set of criteria based on a range of principles. When distributed amongst the three dimensions and 13 aspects, comparing sustainability concepts and methodologies becomes much more accessible and we can begin to see similarities and differences across the ten certifications.

It should be noted that the comparisons only focus on sustainability criteria. Some certifications also include criteria not pertaining to sustainability, such as process and documentation requirements, which are not taken into account in this analysis. These requirements account for an average of 6% of the overall weighting of criteria in the ten certifications ^{P1}.

Comparing dimensions

The environmental dimension is most heavily weighted in the ten certifications, followed by the social dimension, and then the economic dimension. While the environmental and social dimensions are close to equally weighted, there is a noticeable lack of consideration towards economic sustainability; merely one out of the ten selected certifications focuses more than 5% of its overall weighting on the economic dimension.

Comparing aspects

In our analysis and comparison of the ten systems, the resources and health

aspects appear to be foundational for certifying sustainability in buildings; considerations towards toxicity, life cycle costing, area use, and stability of value are less in demand but still figure broadly.

Each certification has its own focus areas and goals as shown in the analysis. It is quite evident that WELL is focused on well-being through the health aspect, and Nordic Swan on banning toxic elements though the toxicity aspect. On the other hand, the analysis cannot show that LBC focuses on net positive impacts in all aspects and we recommend reading through the descriptions in the certifications chapter to get a full overview of the ten sustainable building certifications.

Comparing applications

New commercial and residential buildings are the primary application area for the analysed certifications schemes. Long established certifications tend to address a range of application possibilities with a large selection of different schemes, including new constructions, interiors, renovations, and existing buildings. New certification systems and certifications that were not originally established for buildings tend to have the same range but with fewer and more general schemes. The same applies for those of very specific and ambitious standards such as LBC, Nordic Swan, and WELL.

How do the dimensions compare

How do the dimensions compare

The graphs on the left show the result of comparing the ten certification systems when divided into the three overall dimensions and 13 aspects. A fairly equal weighting of all three dimensions is important for a true holistic approach to sustainability ^{P7} ^{P8}, yet it is evident that the individual certification systems place very different levels of focus on each of the dimensions. Most of the certifications in our analysis have been developed with a specific focus on either environmental or social dimensions, while the economic dimension is lagging at present.

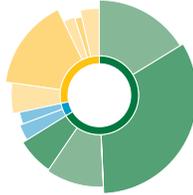
The majority of the certifications place the largest focus on criteria within the environmental dimension which accounts for an average of 52% of the overall weighting across the ten schemes. The social dimension accounts for 43% of the overall weighting across schemes, with a large focus on the indoor environment represented by the health aspect. With the exception of DGNB, economy is only represented in the certifications to a very low degree (an average of 5% of the overall weighting). However, the aspects in the environmental and social dimensions can potentially have an impact on the economic value of the building and thus the economic dimension could be argued to indirectly become a focus through the other dimensions.

DGNB is the only certification system with an almost equal balance between the three sustainability dimensions. The reason behind this is that DGNB was developed later than most of the other certifications and follows the European standards for sustainable buildings.

WELL is a certification system that focuses almost exclusively on social sustainability due to its attention to the well-being of the user inside the building.



Active House
 Environmental 61%
 Economic 1%
 Social 38%



BREEAM
 Environmental 66%
 Economic 5%
 Social 29%

Sustainable dimensions
 For further reading see the SBI report ^{P1}

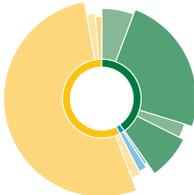
- Environmental aspects
- Economic aspects
- Social aspects



DGNB
 Environmental 33%
 Economic 30%
 Social 37%



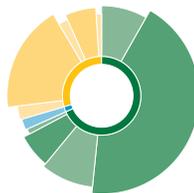
Green Star
 Environmental 67%
 Economic 1%
 Social 32%



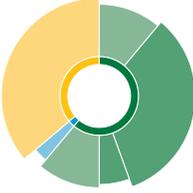
HQE
 Environmental 41%
 Economic 1%
 Social 58%



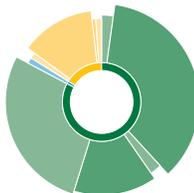
LBC
 Environmental 45%
 Social 55%



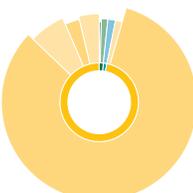
LEED
 Environmental 68%
 Economic 2%
 Social 30%



Miljöbyggnad
 Environmental 61%
 Economic 3%
 Social 36%



Nordic Swan
 Environmental 83%
 Economic 1%
 Social 16%



WELL
 Environmental 2%
 Economic 1%
 Social 97%

How do the aspects compare

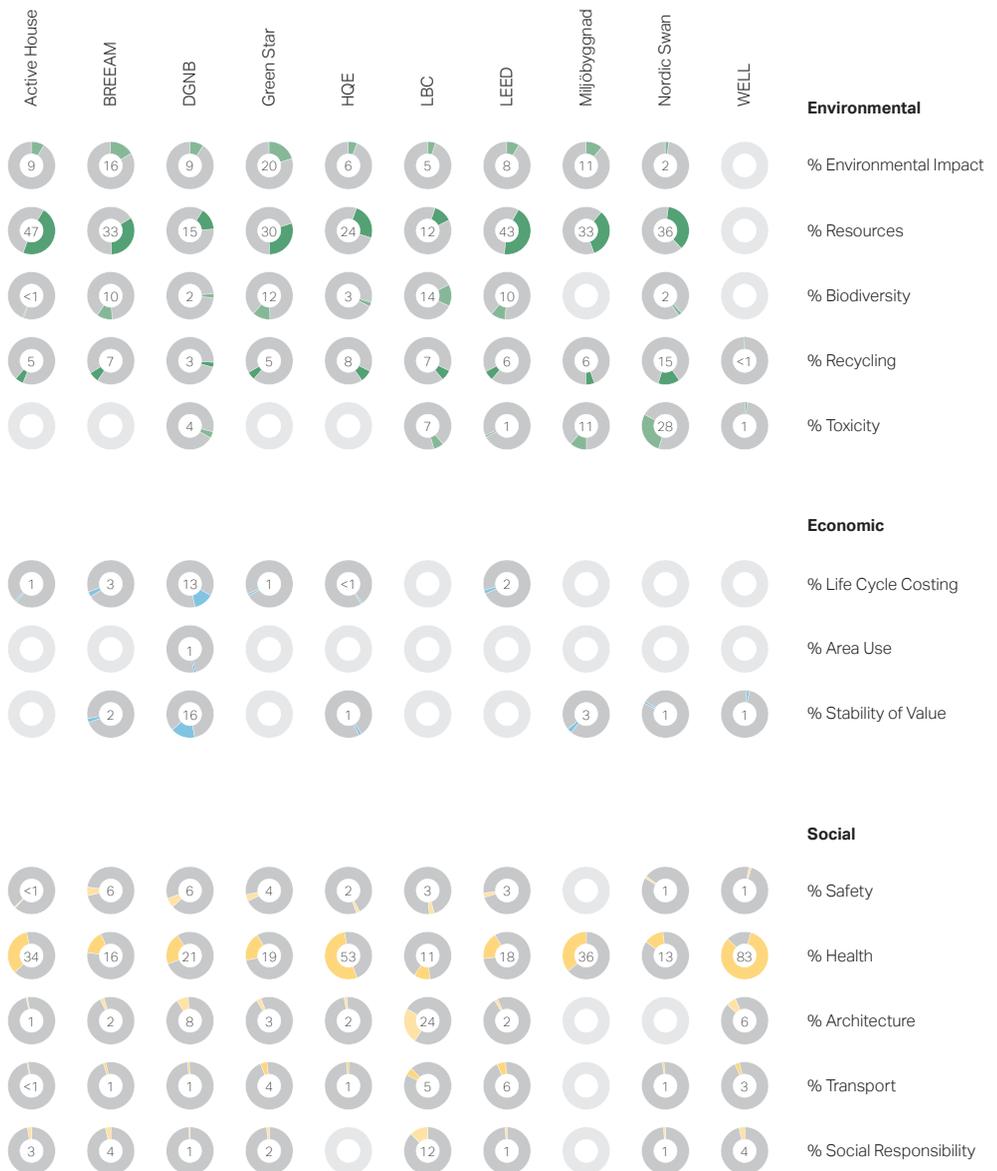
The graph on the right shows how the sustainable building certifications break down into the 13 aspects included in the analysis^{P1}. The aspects given the most focus across the ten certification systems are resources from the environmental dimension and health from the social dimension.

The aspects are handled very differently from certification to certification. The resources aspect often focuses on energy and water consumption and the metering of systems. Health includes all improvements to the indoor climate of a building. The environmental impact aspect often consists of a Life Cycle Assessment (LCA) for either buildings or building components, but with variations in scope across the certifications. The recycling aspect is a broad category which contains both the use of recycled materials but also design that eases future recycling of the building elements.

Within the architecture aspect many certifications have a large focus on contribution to the existing environment in a positive way. HQE and Living Building Challenge both emphasise the right to natural light and sun for both building residents and the surrounding areas. WELL further focus on unique interior design and supporting functions for different human work and comfort needs.

Of the ten certifications, WELL stands out by being primarily focused on health. The Living Building Challenge puts significant weight on aspects in the social dimension such as architecture, contribution to existing environment, and social responsibility. Nordic Swan is marked by focusing more on toxicity themes than any of the other certifications. DGNB is the only certification to significantly represent the economic aspect, however, it can be argued that economic aspects can follow from many of the other aspects.

Reading this graph horizontally and making direct comparison across the respective certification systems should be done carefully, since it only shows weighting and not ambition. The requirements within the respective systems are different and it would be misleading to conclude that the HQE certification is more demanding than the DGNB certification in terms of resource use. The overview in the graph rather shows that out of the total amount of criteria within HQE our analysis finds that approximately 24% of the total amount of weighted criteria within the whole HQE system includes evaluation of resources, while it is 14% for DGNB.



Applications

Overview of the applications for the ten certification systems.

- Applicable ●
- No noted use ○

*Excluding single family houses
 **Only schools and pre-schools

	 Active House	 BREEAM	 DGNB	 Green Star	 HQE
	●	●	●	●*	●
	●	●	●	●	●
	○	●	○	●	●
	○	●	●	●	●
	●	●	●	●	●
	●	●	●	●	●
	●	○	●	●	●
	●	●	●	●	●
	○	●	●	●	●



LBC



LEED



Miljöbyggnad



Nordic Swan



WELL



New buildings
Residential



New buildings
Commercial



Interiors
Residential



Interiors
Commercial



Renovations
Residential



Renovations
Commercial



Existing buildings
Residential



Existing buildings
Commercial



Urban areas
Residential and commercial

Appendix |

References

Certification Schemes

- C¹ **Active House - the specifications for residential buildings 2nd edition**
The Active House Alliance, 2013
- C² **BREEAM International New Construction 2016**
Technical Manual SD233 2.0
BRE Global Ltd, 2016
- C³ **DGNB system Denmark manual for kontorbygninger 2016**
Green Building Council Denmark, 2016
- C⁴ **Green Star Design & As Built v1.2**
Green Building Council of Australia, 2017
- C⁵ **HQE Scheme environnemental performance non residential building, Version: 01 Janvier 2016**
Cerway, 2016
- C⁶ **Living Building Challenge 3.1 – A Visionary Path to a Regenerative Future**
International Living Future Institute, 2016
- C⁷ **LEED v4 for building design and construction**
U.S. Green Building Council, 2017
- C⁸ **Miljöbyggnad 3.0 Bedömningskriterier för nyproducerade byggnader, Version 170510**
Sweden Green Building Council, 2017
- C⁹ **Nordic Ecolabelling for small houses, apartment buildings and buildings for schools and pre-schools, Version 3.2, 09 March 2016 – 31 March 2020**
Nordic Ecolabelling, 2016
- C¹⁰ **The WELL Building Standard® v1 with 2017 addenda**
International WELL Building Institute, 2017

Publications

- P¹ **Analyse af bæredygtige bygningscertificeringer - Supplerende materiale til udgivelsen "Guide to Sustainable Building Certifications"**
SBI 2018:03
- P² **International Comparison of Sustainable Rating Tools**
Richard Reed, Anita Bilos, Sara Wilkinson, Karl-Werner Schulte, 2009
- P³ **Our Common Future – Brundtland Report**
World Commission on Environment and Development, Oxford University Press, 1987
- P⁴ **Transforming our world: the 2030 Agenda for Sustainable Development**
United Nations, 2015
- P⁵ **The business case for green buildings**
World Green Building Council, 2013
- P⁶ **Green building certification systems**
Thilo Ebert, Natalie EBig, Gerd Hauser, DETAIL, 2011
- P⁷ **EN 15643-1:2010. Sustainability of construction works – Sustainability assessment of buildings – Part 1: General framework**
CEN/TC 350, 2010
- P⁸ **Bæredygtigt byggeri**
Trafik- og Byggestyrelsen, 2016
- P⁹ **Export Profile 2016 Danish Architects, Consulting Engineers and Contractors on Foreign Markets**
Danish Association of Architectural Firms, 2016
- P¹⁰ **Market Focus 2016, Investment market green buildings**
BNP Paribas, 2016
- P¹¹ **The Value of Green Star: A Decade of Environmental Benefits Research Key Findings**
Green Building Council of Australia, 2013

Websites

- ^{W1} **behqe.com**
HQE, March 2018
- ^{W2} **breeam.com**
BREEAM, March 2018
- ^{W3} **new.usgbc.org**
LEED, March 2018
- ^{W4} **vanzolini.org.br**
AQUA, March 2018
- ^{W5} **gbcsa.org.za**
Green Star expands trough Africa, March 2018
- ^{W6} **activehouse.info**
Active House, March 2018
- ^{W7} **greensolutionhouse.dk**
Green Solution House, April 2018
- ^{W8} **gxn.3xn.com**
Green solution House, March 2018
- ^{W9} **fornebu-s.no**
Fornebu S Miljøprofil, March 2018
- ^{W10} **dgnb-system.de**
DGNB, March 2018
- ^{W11} **dk-gbc.dk**
DGNB, EY Headquarters, March 2018
- ^{W12} **3xn.com**
EY Headquarters, UN City, Swedbank Headquarters, March 2018
- ^{W13} **new.gbca.org.au**
Green Star, March 2018
- ^{W14} **1bligh.com.au**
1 Bligh Street Sustainability, Awards, March 2018
- ^{W15} **icade.fr**
ICADE Premier House, April 2018
- ^{W16} **landaukindelbacher.de**
ICADE Premier House, March 2018
- ^{W17} **bullittcenter.org**
Bullitt Center Vision, March 2018
- ^{W18} **living-future.org**
Living Building Challenge, March 2018
- ^{W19} **un.dk**
UN City, April 2018
- ^{W20} **miljobyggnad.se**
Miljöbyggnad, March 2018
- ^{W21} **sgbc.se**
Miljöbyggnad, March 2018
- ^{W22} **swedbank.it**
Swedbank Headquarters, April 2018
- ^{W23} **nordic-ecolabel.org**
Nordic Swan, March 2018
- ^{W24} **cobe.dk**
Krøyers Plads, March 2018
- ^{W25} **wellcertified.com**
WELL, Pricing, March 2018
- ^{W26} **phippis.conservatory.org**
Center for Sustainable Landscapes, March 2018

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Sustainable building certifications are increasingly used to ensure higher quality and advance sustainable agendas in construction.

As a result, more and more certification systems are emerging, and they differ vastly in their focus and applications.

This guide presents a comprehensive analysis and comparison of ten relevant sustainable building certifications in a visual and accessible manner, to enable strategic comparison and assessment.

Guide to Sustainable Building Certifications is a collaboration between the Danish Building Research Institute – SBI, and the innovation company of 3XN Architects – GXN.