Simply GREEN

A quick guide to environmental and energy certification systems for sustainable buildings

SWEGON AIR ACADEMY

CONTENTS

FOREWORD

The assessment of buildings has seen considerable growth over the past decade. There are well established building certification systems such as BREEAM and LEED as well as many more recent variants serving different countries. Such is the impact of building assessment and certification that few large construction projects do not come under their influence. Certification has a big impact on how buildings are designed and engineered, how they are constructed and serviced, and how they are valued on completion.

The assessment of the buildings from an environmental and energy perspective can be a complex business. It brings together many key stakeholders such as architects, engineers, constructors, clients, representatives of building users and property valuers. Both prior to construction and at the post occupancy evaluation (POE) stage, building assessment and then certification act as a catalyst to help deliver sustainable development. What started as a fairly straightforward testing of environmental performance has, in many cases, become a complex, expensive and technically demanding task. That is why this book 'Simply GREEN: a quick guide to environmental and energy certification systems for sustainable buildings' is badly needed. It presents an overview of all the main global and some national environmental assessment systems and sets them alongside energy certification systems such as Passivhaus. In effect 'Simply GREEN' allows those new to assessment to understand how systems work in different countries and how broadly based ecological assessment compares with those systems aimed primarily at high energy performance.

One of the most well-known and earliest assessment methods, BREEAM, started out as an environmental assessment method. It morphed into certification and has like other followers become a global standard and increasingly a brand. However, under BREEAM and other systems of assessment, energy (or carbon emissions more precisely) account for only a limited share of the total credit points available. This is why, for example, Passivhaus and other energy assessment methods have become popular, especially with clients who want high energy performance rather than low environmental impact and ecological well-being.

Many forms of environmental assessment have standards of energy efficiency, water conservation, comfort and air quality far in excess of national laws. Since the standards expected of environmental certification are high, there have been three somewhat overlooked consequences. The first concerns technological innovation and design. In many cases systems of certification have changed how buildings are designed, constructed and managed and a number of well known buildings, with very high assessment ratings, now act as valuable sources of inspiration for others.

The second area is the way certification carries in its wake new skills and design methods. This is expressed in the adoption by large architectural practices of parametric design tools linked to thermal, energy, acoustic, wind and other environmental modelling software. In effect, certification has brought the design, engineering and construction fields together in the common pursuit of sustainable building. New digital tools allow energy and ecological impacts to be predicted with greater breadth and accuracy. This reduces exposure to rising energy prices or environmental litigation later, enhances the performance of the building in use, and improves the ability of building managers to adjust controls to meet changing energy scenarios.

The third consequence concerns the users of buildings. Typically, around a quarter of the aspects that are considered in environmental certification systems involve issues of indoor air quality, comfort, daylight, views, ecological well-being and public transport, and the user is thus well protected. In many cases this has resulted in buildings with excellent indoor climates which, in turn, have provided conditions for more productivity in human terms and reduced levels of absence due to illness. Even small improvements in workforce output can often more than well compensate for possible higher energy costs and investments in indoor climate technology.

Certification has had a beneficial impact on design and construction over the past decade. However, there remain one or two issues which need to be addressed. As this admirable publication demonstrates, there are many different certification systems. Some of them are widely adopted while others are tailored mainly to the needs of single countries and specific climates. The problem for an increasingly international construction industry is that local environmental assessment and certification schemes could act as a barrier to the free movement of goods and services. Conversely, to adopt a template globally can ignore the essentials of sustainability such as climate, culture and local energy sources.

In this publication I am struck by the way a complex field is reduced to simple language and straightforward principles and facts. Too often building certification is mired by excessive technical description and construction jargon. In the spirit of knowledge sharing and technological exchange,

Swegon Air Academy has served Europe's construction industry well by funding this simple GREEN guide to environmental and energy certification.

Professor Brian Edwards

Dr Brian Edwards is the author the 'Rough Guide to Sustainability', 'Green Buildings Pay', 'Sustainable Architecture' and many other books and journal articles. He is Emeritus Professor of Architecture at ECA Edinburgh University and served for many years on the Sustainable Futures Group of the Royal Institute of British Architects.

1 INTRODUCTION

The purpose of this book is to give the reader an overview of what environmental and energy certification systems for buildings *are* and *how* the most widespread systems are structured. Since the first certification system was introduced at the beginning of the 1990s, the demand for certified buildings and further certification systems has grown considerably and, to date, there are hundreds of thousands of certified buildings around the world and hundreds of different certification systems in use. Despite this, only a few of these are actually applicable for international use, i.e., have been designed so that they can be used in different countries or parts of the world.

This book first discusses six *environmental* certification systems: the British BREEAM Assessment Method, the US LEED Rating System, the German DGNB Certification System, the Australian Green Star Rating System, the Swedish Miljöbyggnad system and the French HQE system. Three purely *energy-based* systems are then discussed: the European Green Building Programme, the Swiss Minergie Building Standard and the German Passive House (Passivhaus) Standard.

Finally, a further four systems are described very briefly: the Japanese CASBEE assessment system, the Indian IGBC rating system, the US ENERGY STAR program and the French Effinergie system, of which CASBEE and IGBC are regarded as *environmental* certification systems.

BREEAM and LEED are by far the most widespread and internationally well-known systems and we have therefore dedicated proportionately more space to them in this book. Most of the environmental and energy certification systems are managed and administered by national Green Building Councils around the world. The World Green Building Council, World GBC, is an international organisation that promotes green building and is, in turn, a coalition of the national Green Building Councils in 78 countries. There are regional networks in Europe, Africa, MENA (Middle East and North Africa), the Americas and the Asia Pacific region. It is important to note that Green Building Councils are non-profit making organisations.

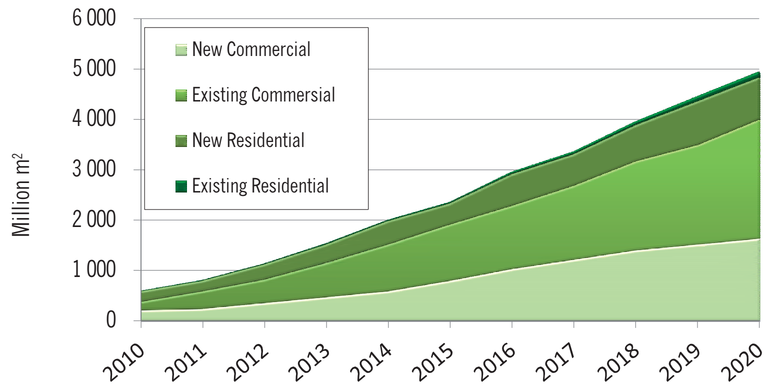
In total, the book describes thirteen certification systems of which four are only covered very briefly. The authors believe that this book will be used primarily for orientation purposes and as a basis for helping to decide which system to use. However, the level of detail in the different systems is limited and for deeper studies readers should refer to the respective organisations behind the different systems.

In order to clarify the similarities and differences between the different environmental and energy classification systems, the energy parts of the environmental systems are described in more detail. However, this information is far from complete. For readers who wish to take an even deeper look at the energy aspects there are numerous sources that can be investigated, for example, the standards used for energy calculations in different countries.

Unfortunately, the certification systems described in the book use different terms for some of the common key words which is, of course, confusing. Examples of these include the term ‘category’ which can be referred to as a ‘quality section’ or an ‘evaluation area’. Another term is ‘issue’, which is sometimes referred to as a ‘credit’ and sometimes as a ‘criterion’. The reason why the use of key words in this book is not always consistent is to avoid confusion when carrying out further investigations into the respective certification systems.

A number of the certification systems described in this book are based on or have, at least, been influenced by national and international standards in the relevant subject areas pertaining to buildings and construction. These standards include: EN 15978, EN 15804 and ISO 21930 (predecessor to EN 15804). However, the degrees to which they have been implemented vary. Perhaps the effects of standards on certification systems in the future will be more significant. Discussions with key members of the Nordic Green Building Council movement seem to indicate that there is a current and growing trend to use the EN standards as cornerstones in several of the systems available today, especially concerning the use of KPIs, key performance indices, as a basis for comparison.

And finally… In 2010, US-based marketing analysts Pike Research presented a forecast of the future of building certification. They predicted that the total certified floor area would increase from round 600 million m^2 in 2010 to around 5,000 million m^2 in 2020!



Source: Pike Research

Whether or not this dramatic prediction will prove true remains to be seen. However, one thing is clear: certification systems are here to stay in the foreseeable future. If developments continue at the same rates as they have done, the majority of future buildings will be certified as a natural part of the building process.

Gothenburg, August 2012
Catrin Heincke and Daniel Olsson, CIT Energy Management

2 WHY CERTIFY BUILDINGS AT ALL?

Perhaps there is no simple answer to this question in the sense of there being a single universal benefit that would always hold true. There are, of course, a number of reasons why someone might want to certify a building and these would depend on who they are and how the term *benefit* is defined. For example, is the primary purpose, and corresponding benefit, to increase the financial value of a building or is it an attempt to limit the building's ecological footprint as much as possible?

The purpose of certification from a holistic perspective does not have to be the same as the purpose from a more limited perspective but the benefit, in part, can just as well be the same. For example, efficient use of energy in a building can be beneficial to both the environment and the property owner's financial commitment. Furthermore, the benefits of certification can be regarded from different perspectives and primarily, perhaps, from the following four interested parties: the developer, the design engineer, the architect and the user. And, of course, there is the question of the environmental perspective as such and the environmentally-related benefits to society.

In some cases, it is difficult to determine unequivocally whether certification of a particular building has actually increased its economical value and market attraction. It might well have been the case that the very reasons for certification were the estimated benefits.

Although we cannot claim to have provided an exhaustive list of all the reasons for certification and all the following estimated benefits, our compilation of added values does include a number of the more pertinent points. Whether or not they are actually achieved in reality depends on a number of circumstances that will soon become obvious. They are presented without any order of precedence, even if the first three mentioned are generally regarded as being among the most common, especially by the four interested parties mentioned above. As the reader will see, the real benefits coupled to some of the reasons are not entirely clear and verifiable.

Stronger branding with an environmental profile

The certification of a building can be regarded as a positive contribution to the external profile and image of a company owning or renting the building: environmental awareness and acting responsibly are regarded as strengths. The added value is difficult to assess in purely financial terms.

In a new Finnish study[1], in which 150 of the largest companies in Northern Europe were asked about environmental responsibility, just over 80 percent of them believed that environmentally adapted buildings strengthened a company's external image.

Ensuring a good indoor environment

Most certification systems place importance on indoor environments (see each respective system for details). From a developer's point of view, for example, this can lead to a positive image of a company and its concern for its employees. This could even be a part of the branding argument above. For the user, certification with a high rating could be perceived as a guarantee for good comfort and a healthy indoor environment. In fact, a couple of investigations[2,3] have shown that the users of certified buildings are more satisfied with their indoor climates than similar users in uncertified buildings. However, one should be aware that experience-based studies like these, investigating indoor climates, can be complex and difficult to interpret.

Energy efficiency

Relatively speaking, good energy performance means low energy costs. This benefit is more obvious when the certification systems that address energy aspects only are used. It must also be remembered that the more comprehensive *environmental* certification systems also have significant energy efficiency requirements. However, it can be mentioned here that even highly rated buildings (according to the environmental systems) do not necessarily display better energy performance than comparable non-certified buildings[4].

"Guaranteed" building quality

That a building has been certified is not, in itself, a guarantee that the quality of the building is irreproachable. However, one can, of course, expect a certified building to have been built with greater care than otherwise, which could be seen in a sort of figurative sense as a quality guarantee. For example, a relatively large degree of precision is necessary to construct energy-efficient building as, in most cases, this requires a well-designed building envelope with a high level of airtightness.

1 Newsec 2012. The Role of Real Estate in Corporate Responsibility Survey.
2 Wiley et al. 2009. Do Green Buildings Make Dollars and Sense?
3 Catarina and Illouz 2009. Retour d'expérience de bâtiments certifiés HQE.
4 Carassus 2011. Are "Green" office buildings keeping their promises?

More tenants and higher occupancy rates

Some commercial tenants require their buildings to have achieved a certain level of certification. Choosing certified buildings, where these are an option, can be part of their own environmental strategy and policy. This means that the number of prospective tenants ought to be greater for certified than uncertified buildings.

Two US surveys from 2010 show that the potential for renting out certified buildings was 5 to 15% greater than for that of similar uncertified buildings[5,6].

The survey was based on so-called hedonistic price comparisons where the buildings were neutralised with respect to factors such as age and location in order to illustrate the effects of certification.

Increased financial value of a building

According to a number of US surveys[7,8,9,10] carried out between 2003 and 2010, certification increases the market value of office buildings by 5 to 35%. These results are also based on hedonistic price comparisons. Similar surveys[11,12,13,14,15] of housing in France, the Netherlands, Switzerland and the US show increases in market values between 3 to 9%. One of the surveys11 also showed that certified housing can be sold quicker than uncertified.

It should be noted here that, when sold, a general increase in value is not always attainable for all buildings. However, certification often seems

5 Fuerst and McAllister 2010. ECO-labeling in Commercial Office Markets: Do LEED and Green Star obtain multiple premiums?
6 Wiley et al. 2010. Green Design and the Market for Commercial Office Space. Journal of Real Estate Finance and Economics, Vol. 41, no.1 2010.
7 Pivo and Fischer 2008. Investment Returns from Responsible Property Investments.
8 Miller et al. 2008. Does Green Pay Off? Journal of Real Estate Portifolio Management, Vol. 14, no 4.
9 Eichholtz et al. 2009. Doing Well By Doing Good?
10 Fuerst and McAllister 2009 New Evidence on the Green Building Rent and Price Premium.
11 Bounen and Kok 2009. Energy Performance Certification in the Housing Market.
12 Griffin et al. 2009. Certified Home Performance: Assessing the Market Impacts of Third Party Certification on Residential Properties.
13 ADEME 2011. Microeconomic study of ADEME. Green value for accommodation.
14 Salvi et al. 2008-2010. Studies by the BCZ: Impact of the "Minergie" label on the market value and rental value in Switzerland.
15 Kaufman 2011. Green Homes Outselling the Rest of the Market.

to lead to a higher financial value of a building and, most probably, never the opposite when compared to similar uncertified buildings.

Higher rents

In a number of the surveys above, rent levels were also investigated. According to one of the surveys, certified buildings could attain up to 17% higher rent levels than similar uncertified buildings[6]. However, most of the surveys[7 8 9 10] had a span of 0 to 6%.

A survey from 2010 also showed that rent levels in certified office buildings in the US seemed to have withstood the property crisis in 2007–2009 better than uncertified office buildings[16].

Improved borrowing conditions and less tax

In some countries banks offer better terms for mortgages and, in some cases, lower interest rates for certified buildings. This is because banks consider the long-term value of a building to be more secure and that it might even increase, thanks to certification. There are examples of countries where tax reductions and other benefits are offered when a building has been certified.

Increased attractiveness

The idea of attraction value is difficult to define and quantify. It is more a question of the feeling that is experienced that influences someone to prefer being in a particular building. Although this is a purely speculative idea, let's address a situation where this sort of attractiveness could be important by considering someone attending a job interview and their reaction afterwards. It would be hard to prove in practice but wouldn't it be a reasonable assumption that a certified building, with a high rating, would be a more attractive place in which to work than a similar uncertified building, even if other aspects, in most cases, would quite probably outweigh this consideration?

To a certain extent this particular point is related to a number of the reasons given above and the estimated benefits of certification, but is mentioned here as a separate point to emphasize its importance.

Simplified comparison of buildings (benchmarking)

Not least at management level in large organisations, the certification systems can be a useful tool and provide a basis for policy decisions and comparisons within its building stock. Without having to possess profound structural engineering knowledge, the management of an organisation can make a decision on the basis of wanting at least a 'silver' certification level for its building stock.

How comparable are two certified buildings? If you consider them from a technical point of view and use their respective certification systems for the comparison you will find that these do not provide the unequivocal information that you might reasonably expect. One of the questions that arises immediately is: comparable in relation to what? If the two buildings have been certified using the same *energy* certification system then their energy performances will most probably be roughly the same, especially if they are located in the same country and are used for the same purposes. Unfortunately, their respective total environmental footprints will be unknown. If, on the other hand, the buildings are certified using the same *environmental* certification system and have achieved the same ratings, then the total environmental impact of the two buildings can, hopefully, be regarded as being similar, with the exception of any national adaptations. However, no conclusions can be drawn with regard to individual criteria, for example, their use of energy. This means that even if two buildings are certified using the same certification system and achieve similar ratings they are still not completely comparable.

Fulfilment of requirements for building permission

In some countries there are specific regional requirements and certification is a must if a building is to be built at all in some areas. This could be the case, for example, in certain parts of a town, where all new buildings would be required to be certified according to a certain system and also attain a minimum rating level.

Improved use of resources

The reduction of environmental footprints ought to be the most important general benefit to strive for when certifying buildings. However, the ways in which the use of resources are managed and reported are often quite different and depend on the stipulations in each certification system. *How* the different certification systems are structured and *what* factors are considered by each of them are the subjects of the remainder of this book.

16 Eichholtz et al. 2010. The Economics of Green Building.

3 ENVIRONMENTAL CERTIFICATION SYSTEMS

Two of the world's largest environmental certification systems are described first: the British BREEAM Assessment Method and the US LEED® Rating System. Descriptions then follow of the German DGNB Certification System, the French HQE system, the Australian Green Star Rating System and the Swedish Miljöbyggnad system, all of which are considerably smaller than BREEAM and LEED but have become increasingly more used.

The first four systems can be regarded as being international in as much as they already either include national versions or that they are designed so that they can be used internationally. The actual international adaptation of these systems is discussed later. Although only used in Sweden, the Miljöbyggnad system has been included here to illustrate recently developments on the authors' home market.

In contrast to the pure energy certification systems presented in the next chapter, the environmental certification systems provide a larger overall picture of a building's total environmental impact.

In short, these six certification systems can be said to be based on similar structures. A number of environmentally important areas, often called 'categories' or 'fields', such as water use, energy use, indoor climate, etc. are evaluated. Points scored for these areas are converted into ratings on a scale defined by the system in question. Although the focus put on each category can vary, if a high final rating is being aimed for then high points will be required for the majority of the areas. Additionally, there are often minimum requirements for the lowest acceptable rating level that must be attained in each area.

3.1 BREEAM

The following information is based on the content posted on the BREEAM website, www.breeam.org. According to BREEAM, their assessment and rating system is the most widely used in the world.

BREEAM has its origins in the UK and was developed by BRE, the Building Research Establishment. BREEAM is an abbreviation for Building Research Establishment Environmental Assessment Method.

To date, more than 200,000 buildings have been assessed, rated and certified using BREEAM, the majority of them in the UK. Since BREEAM was launched, more than one million buildings have been registered for assessment.

3.1.1 BREEAM – THE BASICS

BREEAM allows buildings to be certified in two different ways: via preliminary certification of the design or via final certification on completion of the building. In order to obtain a final certificate it is not required to have first obtained a preliminary certificate, it's up to the clients to choose.

However, it must be emphasized that BREEAM certification is always carried out with respect to the first tenant. If a new tenant then moves in, the certification remains the same.

Buildings that can be certified

Newly built, refurbished and existing buildings can be certified using BREEAM. Both domestic and non-domestic buildings can be certified and, for more unusual buildings, special adaptations can be made; read more about BREEAM Other Buildings below. BREEAM can also be applied to communities.

BREEAM formats

BREEAM has developed a number of schemes with manuals and tools for assessment and rating of different types of buildings. The greatest diversity of schemes can be found in the UK, the BREEAM UK schemes, while schemes that have been specially designed for use outside the UK are designated BREEAM International schemes.

Schemes available *in the UK*

BREEAM UK schemes comprise six groups:

BREEAM New Construction is the most comprehensive and offers the following schemes:

- BREEAM Courts for all types of courts
- BREEAM Data Centres
- BREEAM Domestic Refurbishment for refurbished dwellings
- BREEAM Education for schools, colleges and institutions
- BREEAM Healthcare for hospitals
- BREEAM Industrial
- BREEAM Multi-residential for apartments that do not fulfil the requirements for CSH and EcoHomes
- BREEAM Offices
- BREEAM Other Buildings for buildings that do not fit any of the above types

• BREEAM Prisons for prisons
• BREEAM Retail for commercial buildings

BREEAM Refurbishment comprises two schemes:
• BREEAM Domestic Refurbishment
• BREEAM Non-domestic Refurbishment

The UK government's Code for Sustainable Homes (CSH) is based on BRE Global's EcoHomes Scheme for new homes (not applicable in Scotland)

BREEAM Communities is used for developments at neighbourhood scale or larger

BREEAM In-Use is used to assess performance aspects of existing buildings

Under BREEAM Other Buildings lies **BREEAM UK Bespoke**, which provides schemes for buildings that do not have an own scheme, as listed above. Within UK Bespoke are a number of predefined criteria that BRE can choose between to suit the building type in question. Bespoke is only used for buildings that are not covered by other ordinary schemes. For example, Bespoke is not normally used for certification of a building which includes both office and shopping space. In order to certify a building like this both BREEAM Offices and BREEAM Retail are used.

Schemes available *outside the UK*
BREEAM International comprises both assessment schemes developed by BRE and assessment schemes developed by national scheme operators (NSOs), see Fig. 3.1. For countries outside the UK, BRE has, among other things, developed BREEAM Europe Commercial and BREEAM International Bespoke. BREEAM Europe Commercial can only be used for commercial buildings and industrial buildings in EU member states and the rest of Europe.

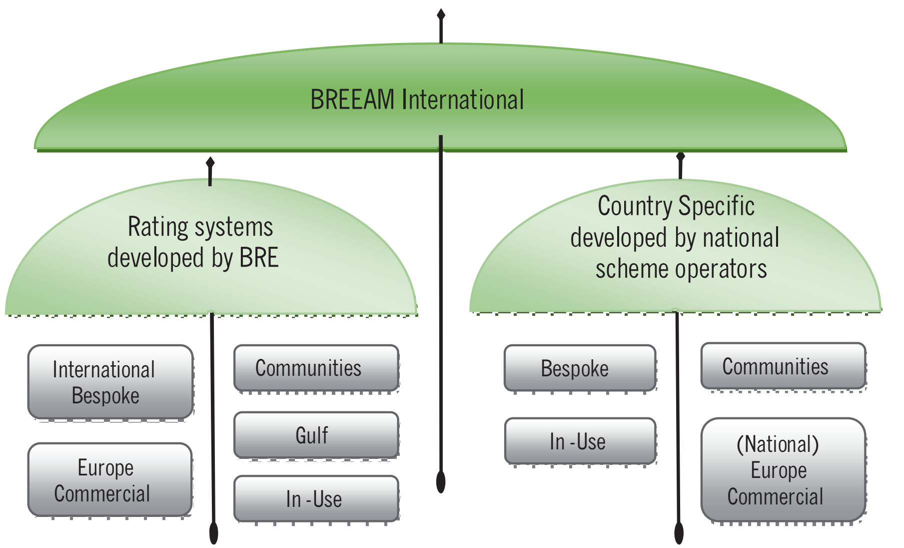


Figure 3.1 BREEAM Assessment schemes available internationally.

BREEAM country specific schemes are nationally adapted schemes developed for specific countries by national scheme operators. Country specific schemes are now available in Norway, the Netherlands, Sweden and Spain. When BREEAM country specific schemes are used each scheme is adapted individually based on the schemes that BRE has developed for international use. A national assessment scheme is one that has been adapted to local, social and cultural conditions, for example, to take into account differences in climate conditions. Adaptation also means that relevant manuals are produced in the local language, that local assessors are trained (read more about assessors in Sub-section 3.1.4) and that the scheme is in compliance with the building regulations in the country in question. When a new scheme is approved for a particular country a framework agreement is signed with a national scheme operator, which can be a state authority, a national Green Building Council or other relevant organisation. The role of the scheme operator is to be responsible for the national version of the assessment scheme and, in certain cases, offer training within the scheme.

If a building is not covered by the schemes mentioned above then BREEAM International Bespoke or BREEAM (national) Bespoke, which is part of the BREEAM Other Buildings family, can be used instead. Using these schemes means that BRE or national operators choose criteria from the predefined list to suit the building type in question. In the UK this can mean that a building with both office space and commercial space has to be assessed using two schemes, BREEAM Office and BREEAM Retail, as mentioned above. For countries in Europe where BREEAM Europe Commercial can be used, different parts of the assessment scheme are applied to the building when assessing dual-use.

It is also possible for companies to have schemes specially developed for their own buildings. Toyota is an example and they have created an assessment scheme for all Toyota's showrooms all over the world.

Other schemes *in the world*

BRE has also developed BREEAM Communities which is an assessment scheme for whole communities and neighbourhoods. This scheme was developed for the UK but can be adapted for use in other countries.

BREEAM In-Use is a scheme developed for assessing the management and use of a building. This scheme was also developed for use in the UK but can be adapted to create a national version to take into account laws and regulations.

Shell and Core

The term 'Shell and Core' applies to the design of a building, its climate shell/building envelope and common spaces and, in some cases, certain installations when the future use of the building has not been finalized. Within BREEAM, Shell and Core buildings are included in some of the assessment schemes described above. For example, BREEAM Europe Commercial, BEEAM Offices and BREEAM Industrial are schemes that can be used for Shell and Core certification.

Basically, there are four ways in which Shell and Core can be implemented, with each alternative developed to a different extent to suit future tenants. In the first alternative there is a binding agreement between the tenant and the property owner, a so-called **Green Lease Agreement**. The second alternative means that the property owner produces a **Green Building Guide** that is then distributed to all future tenants in the building. The guide is not binding as it only comprises recommendations as to how the tenant might be able to adapt their spaces in order to environmentally certify the building. The third alternative requires collaboration between the property owner and the tenant(s) so that they can jointly produce data on which the building can be certified. The fourth alternative means that if

the property developer cannot confirm compliance with a particular issue or the issue is not included in the documents for one of the first three alternatives then credits for this issue must be withheld.

The alternatives mean that the total possible number of points can be selectively accumulated to different levels where Shell and Core credits are concerned. Read more about credits and points in Sub-section 3.1.2.

Manuals

For every assessment scheme there is a corresponding manual to facilitate the assessment of the building in question. Each manual has an introductory text with information about the criteria for the building, the requirements to be fulfilled and how the distribution of credits (points) between the categories is carried out.

3.1.2 WHAT DOES BREEAM ASSESS?

Categories

Most of the BREEAM assessment schemes are made up of ten categories (also referred to as sections) comprising issues that can be given a different number of credits depending on which scheme is used. The issues cover everything from sustainability and energy use to indoor climate, innovation and commissioning. The categories and their main issues are shown in Table 3.1.

Table 3.1 Categories and their main issues provide an overall picture of what is assessed in BREEAM schemes.

Management • Commissioning • Security • Construction site impacts	**Waste** • Construction waste • Recycled aggregates • Recycling facilities
Health and well-being • Daylight • Acoustics • Lighting • Occupant thermal comfort • Air and water quality	**Pollution** • Refrigerant use and leakage • NOx emissions • External light and noise pollution • Flood risk • Water course pollution
Energy • CO_2 emissions • Energy sub-metering • Low or zero carbon technologies • Energy-efficient building systems	**Land use and ecology** • Site selection • Protection of ecological features • Mitigation/enhancement of ecological value
Transport • Public transport network connectivity • Access to amenities • Pedestrian and cyclist facilities • Travel plans and information	**Materials** • Embodied life cycle impact of materials • Materials re-use • Responsible sourcing • Robustness
Water • Water consumption • Water re-use and recycling • Leak detection	**Innovation** • Exemplary performance levels • New technologies and building processes • Use of BREEAM Accredited Professionals

A certain number of credits can be attained within each category. The number of credits varies depending on which scheme is used. One *example* of how the credits are allocated can be seen in Fig. 3.2.

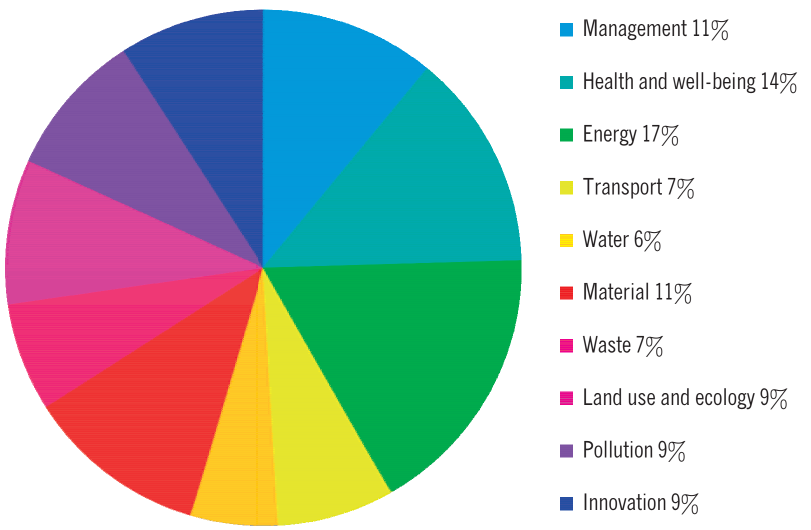


Figure 3.2 Weighted distribution of credits between categories in BREEAM Europe Commercial.

Issues

As mentioned above, a number of issues are highlighted within each category. The manuals describe which issues are relevant for each category and each issue has a number and a name. For example, Ene 1 denotes the category Energy and Issue no. 1, which, in one of the schemes, is *Energy efficiency*. The number of issues varies depending on which scheme is being used and for which type of building. For instance, for retail and commercial buildings there is an issue regarding *cold storage*, which is obviously not included in the list for office buildings. For each issue there are a number of credits that can be gained depending on how well the building meets the specific criteria. The total possible number of credits varies between the different schemes but is normally around 110 credits. The number of credits for each issue can also vary depending on type of building and scheme used. For example, where the issue *Provision of public transport* is concerned, commercial buildings can score more credits than offices and industrial buildings.

In the manuals, each issue, for example Ene 1, is explained in detail and the aims of each issue are also described.

3.1.3 RATINGS AND REQUIREMENTS IN BREEAM

Rating limits

Ratings are based on the number of credits scored for each issue and the weighting between the different categories. To achieve a Pass level rating (the lowest rating), at least 30% of the maximum number of credits must be attained. Fig. 3.3 shows the percentages required to reach a particular rating: Pass, Good, Very good, Excellent and Outstanding. In addition to the total number of credits there are a number of basic requirements (see below under Credits requirements) that must be fulfilled so that the building can attain a certain final rating level. It is thus not only the total number of credits that determines the rating.

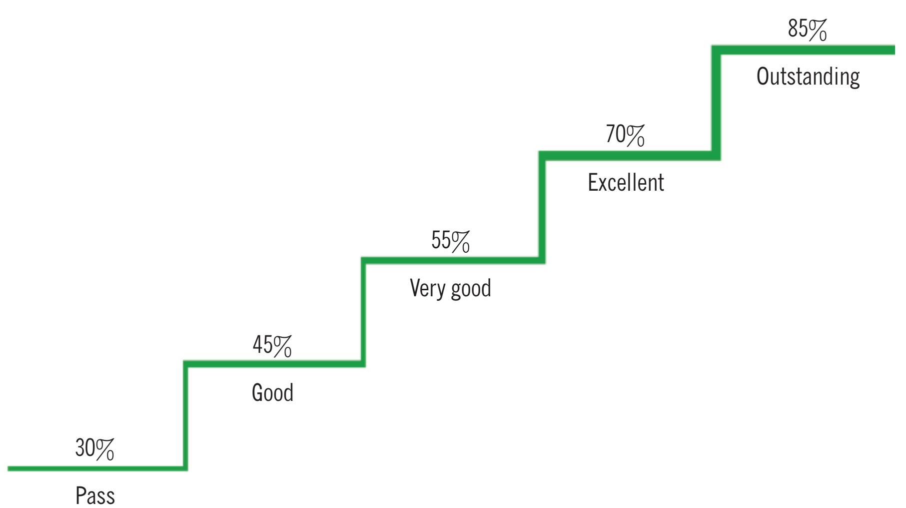


Figure 3.3 BREEAM ratings.

Credit requirements

The requirements for the different ratings depend on the scheme by which the building is being assessed. For some schemes, a certain number of credits might be required for a certain issue while in other schemes the same issue might not have any requirements at all.

Some issues also require a minimum number of credits, if the building is to attain a certain rating. Although these requirements often have to be

fulfilled in order to attain the higher ratings, there are also instances where there are issues for which the building must score a certain number of credits to be classified at all.

Weighting

In order to avoid credits being accumulated from only a few categories, BRE has introduced a weighting system. Each category has a weighting percentage and these indicate the categories that BRE considers having the most impact on the environment. For example, the weightings for Energy and Health and well-being are 19% and 15% respectively in BREEAM Europe Commercial while in BREEAM Data Centres the corresponding figures are 37% and 10% for large computer centres. For all categories the weighting percentages total 100% and there are a further 10% that can be gained from the Innovation category. The innovation category gives credits for new technologies used within the other categories.

Other requirements

One way in which a higher rating can be reached is by following up a building after it has been completed, which gives extra credits. In order to achieve the rating Outstanding some of the assessment schemes require the building to be followed up for three years after completion.

Final rating

Table 3.2 shows how the rating system works and is similar to the tables used by BREEAM for summing up credits and ratings. All issues are investigated and scores compiled for each and every category. In the first column of the table the number of credits gained for each category is specified. The second column gives the maximum number of credits attainable in each category and the proportion gained, in percent, is calculated and shown in column three. The environmental weighting is given in column four and the total weighted number of credits is then given in column five. These percentages, for all categories, are added to give the final total and appropriate rating of the building.

Table 3.2 An example of BREEAM certification.

Category	Points gained	Possible points	Points gained (%)	Weighting	Weighted points
Management	7	10	70%	0.12	8.40%
Health and well-being	11	14	79%	0.15	11.79%
Energy	10	21	48%	0.19	9.05%
Transport	5	10	50%	0.08	4.00%
Water	4	6	67%	0.06	4.00%
Materials	6	12	50%	0.125	6.25%
Waste	3	7	43%	0.075	3.21%
Land use and ecology	4	10	40%	0.10	4.00%
Pollution	5	12	42%	0.10	4.17%
Innovation	1	10	10%	0.10	1.00%
	Total points				55.87%
	Breeam rating				VERY GOOD

3.1.4 BREEAM IN PRACTICE

In order to certify a building according to BREEAM the correct assessment scheme must first be chosen, see Fig. 3.4 below. A relatively easy Excel based tool, Pre Assessment Estimator, can then be used. This will provide a preliminary assessment and indication of which rating the building will eventually achieve and, based on this, what needs to be done to achieve the desired rating. The Pre Assessment Estimator can be downloaded free of charge from BREEAM's website. After carrying out this preliminary assessment an assessor is contacted and the registration documents are sent to BRE.

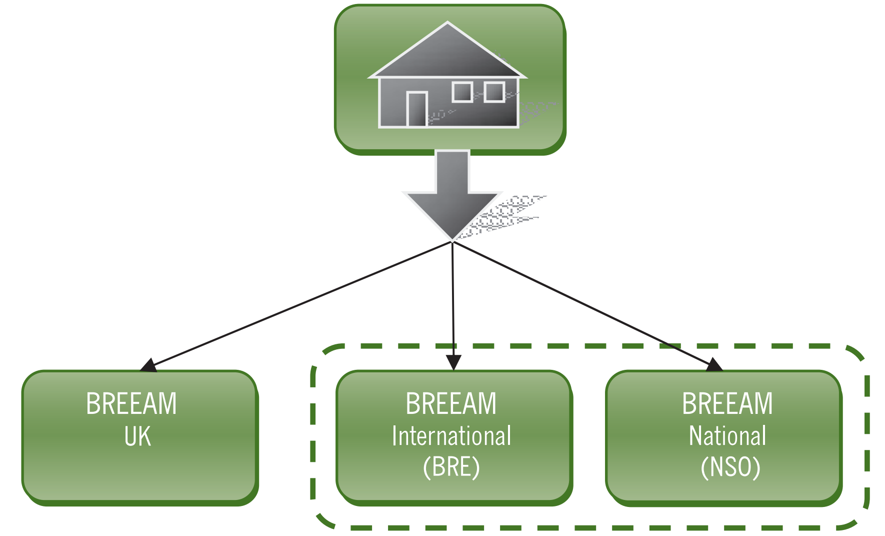


Figure 3.4 Choosing a scheme for a particular building.

BREEAM Assessor

A BREEAM rating is a so-called third party certification and requires an independent certified assessor, a BREEAM Assessor, who has been trained by BRE or by a national Green Building Council, if this body is the national scheme operator. Different assessors are used depending on which scheme is used to assess the building. The role of the assessor is to interpret the requirements for every issue, communicate these to the client and help them to compile the data which, together with the assessment report, is sent to BRE or the national scheme operator for approval. The environmental certification coordinator required for certifying the building according to BREEAM is often the same person as the Assessor.

Aids

The manuals, described in Section 3.1.1, were developed to facilitate deeper understanding of the schemes during the assessment work. BRE has also produced a book called the Green Guide, in which individual building materials and environmental performances of products are evaluated.

3.1.5 BREEAM AND ENERGY

The Energy category is divided into four main issues: CO_2 emissions, low or zero carbon technologies, energy monitoring and energy-efficient building systems. Within these main issues are a number of issues that address, for example, energy consumption, energy sub-metering and energy-efficient cold storage, etc.

A large proportion of the points allocated in the Energy category concern the energy performance of a building. The building is compared with a hypothetical reference building in an energy calculation program and the points awarded are based on the differences between the actual and the hypothetical building. Which energy calculation program is allowed to be used is determined by BRE. There are alternative ways of calculating points for the energy performance of a building but the method mentioned above is most often used. BREEAM bases parts of the results on carbon dioxide, which means that energy is recalculated to carbon dioxide equivalents to make it possible to give points to some of the issues in the energy category. Local differences are allowed in national adaptations. For example, in Sweden, the results are based on the building regulations, which, in brief, means that the energy usage per square metre heated floor area is the relevant unit for assessment.

The Energy category is weighted according to the scheme used. In Fig. 3.2 it can be seen that energy here is weighted at 17% but there are instances in which this category is weighted at more than 40%, for example in Data Centres.

3.1.6 BREEAM – ORIGIN AND ORGANISATION

The world's first environmental certification system, the BRE Environmental Assessment Scheme, which originated in the UK, was launched in 1990 by BRE, the Building Research Establishment. BRE dates back to 1921 when it was a Government institution carrying out research into building materials and building design. In 1997 BRE was reorganised and became a private company. Besides being engaged in research, it also started to offer consultancy, training and building advisory services. In order to retain the reputation and independence gained when it was an institute, the Foundation for the Built Environment was formed and became the new owner of BRE. Today, this foundation is called the BRE Trust. The BRE Trust comprises three sections: BRE which is engaged in research, training and advisory services, BRE Global which is engaged in environmental issues and handles the applications for assessment and certification, and BRE Ventures which develops new ideas in building technology. The BRE organisation chart is shown in Fig. 3.5.

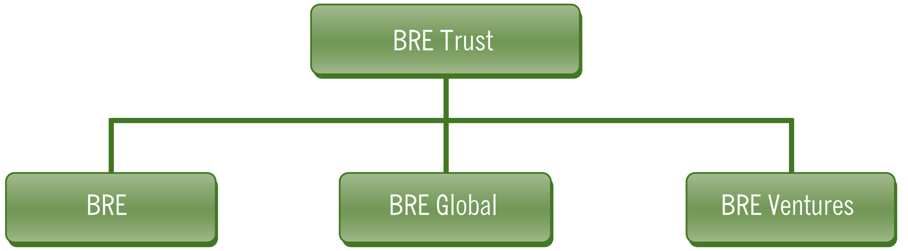


Figure 3.5 The BRE organisation chart.

3.2 LEED

The following information about the LEED® rating systems is based on the content posted on the U.S. Green Building Council website, www.usgbc.org. This information is used and reproduced with the permission of, and with the authorship and copyright attributed to, the U.S. Green Building Council.

LEED® is one of the largest environmental certification systems in the world and has been developed by the U.S. Green Building Council (USGBC). LEED is an abbreviation for Leadership in Energy and Environmental Design.

Some 32,200 (July 2012) buildings around the world have been certified using LEED, with a majority of them in USA. Just over 107,000 (July 2012) buildings have been registered for future certification.

3.2.1 LEED – THE BASICS?

LEED is suitable for a number of types of buildings and can be used at the design stage and for new constructions as well as for existing buildings and renovations. Most types of buildings in the homes and non-residential building categories can be certified.

LEED systems

LEED has designed and developed five main groups of rating systems. No rating systems have been specially developed for other countries; however, there are local adaptations of LEED in Canada, India, Cuba and Italy. In other countries, the rating processes have to be carried out via the U.S. Green Building Council, which means that American building standards are used. For example, ASHRAE standards are used for designing air conditioning systems and calculating energy performance. ASHRAE, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, is a trade organisation that, among other things, produces industry standards. For some of the rating systems there are so-called Alternative Compliance Paths that can be used in other parts of the world, see below.

LEED comprises a collection of rating systems that is divided into five main groups depending on whether the ratings refer to design, interiors, operation, homes or neighbourhoods. The U.S. Green Building Council has chosen to designate these groups and systems as follows:

Green Building Design & Construction
- LEED for New Construction and Major Renovations
- LEED for Core & Shell
- LEED for Schools
- LEED for Healthcare
- LEED for Retail

Green Interior Design & Construction
- LEED for Commercial Interiors
- LEED for Retail Interiors

Green Building Operation and Maintenance
- LEED for Existing Buildings: Operations & Maintenance

Green Homes Design and Construction
- LEED for Homes

Green Neighborhood Development
- LEED for Neighborhood Development

Green Building Design & Construction

LEED for New Construction and Major Renovations (LNCMR) was the first system to be developed and is primarily used for both new construction and renovation of commercial and institutional buildings. Building types include offices, museums, churches, libraries and hotels, as well as housing with four or more storeys. LNCMR is also used for projects that do not fit into the other systems. If less than 50% of a building is used by the property owner or tenants, then Core & Shell is to be used instead.

LEED for Core & Shell is only used to rate a building's envelope/climate shell, when it is not known what future activities will take place in the building. Certain communal spaces and installations are included in a Core & Shell rating. In principle, a Core & Shell rated building is an empty building that has been built for an unknown category of tenants.

LEED for Schools is a version of LNCMR that directly addresses questions concerning buildings for education, for example, regarding acoustics in classrooms. LEED for Schools can be used for both new constructions and major renovations.

LEED for Healthcare is another version of LNCMR and addresses questions concerning new construction and major renovations of buildings used for health care purposes. When major renovations are carried out to building services installations LEED for Existing Buildings: Operations and Maintenance is a better system, see below.

LEED for Retail is used for new construction and major renovations of buildings included in the definition of commercial buildings, for example, retail, banking and restaurants.

Green Interior Design & Construction

LEED for Commercial Interiors and LEED for Retail Interiors are used to rate spaces in a building used by a tenant. In these spaces the interiors and the tenant's use of electricity for their business are rated. The scheme is designed to be used together with LEED for Core & Shell, in which the building envelope etc. is rated.

Green Building Operation and Maintenance

LEED for Existing Buildings: Operations & Maintenance (LEBOM) is used for a number of types of buildings. LEBOM can be used for both existing buildings seeking to be rated for the first time and for projects which have been previously rated using LNCMR.

Green Homes Design and Construction

LEED for Homes is used to rate homes and, up to now, the system has only been used in the US. However, LEED has recently developed a pilot system, LEED for Homes International Pilot, that is now being tested in the Middle East and China. Canada already has a locally adapted system for homes.

Green Neighborhood Development
LEED for Neighbourhood Development is a system for rating whole communities and town districts.

3.2.2 WHAT DOES LEED ASSESS?

All LEED systems comprise a number of credit categories with associated credits (issues) that can be awarded a certain number of points. For some of these credits there are so-called Alternative Compliance Paths (ACP), and these are used for buildings outside USA. There are Minimum Program Requirements that must be met so that the building can be registered at all and the rating process begun. For example, in LEED New Construction the building must be greater than 1000 ft^2 (approx. 93 m^2) and there are also requirements that the building has to be a permanent structure.

Credit categories
A rating system comprises seven credit categories with credits that can score a certain number of points, depending on which system is being used. The key areas and examples of their associated credits are presented in Table 3.3. In addition to these seven key areas there are two extra key areas for homes: Locations & Linkages, and Awareness & Education.

Table 3.3 Credit categories with examples of credits used to provide an overall picture of what is assessed in LEED systems.

Sustainable sites • Site selection • Alternative transportation • Stormwater design	**Water efficiency** • Water efficient landscaping • Innovative wastewater technologies • Water use reduction
Indoor environmental quality • Indoor air quality • Low-emitting materials • Lighting • Thermal comfort • Daylight and views	**Materials and Resources** • Construction waste management • Materials reuse • Regional materials • Sustainable purchasing
Energy and Atmosphere • Optimize energy performance • On site renewable energy • Green power • Energy-efficient building systems	**Regional priority** • Regional priority
Innovation in Design • LEED Accredited Professional • Innovation in design • Exemplary performance	
Locations & Linkages (LEED for Homes) • Existing infrastructure • Site selection	**Awareness & Education (LEED for Homes)** • Education of the home owner or tenant • Education of Building Manager

There are a further three credit categories for the LEED for Neighbourhood Development system.

A certain number of points can be scored in each key area. These points vary depending on which rating system is used. An example of the distribution of points between the different key areas is shown in Fig. 3.6.

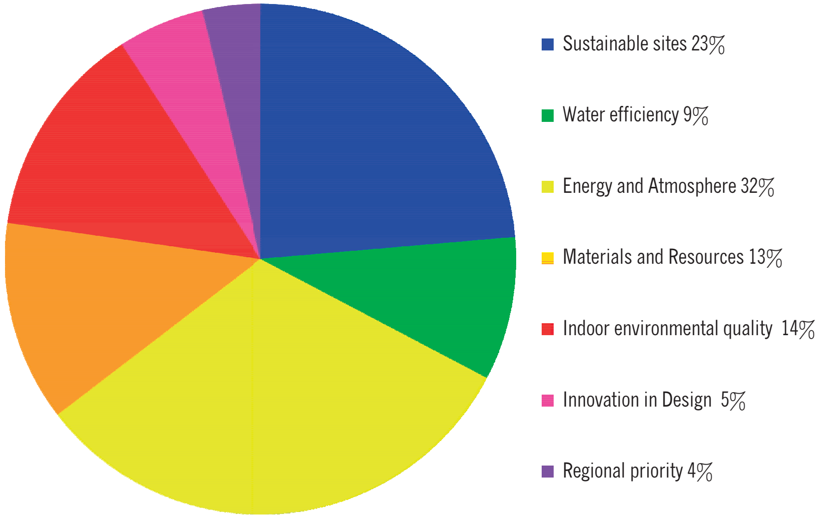


Figure 3.6 Example of distribution of points between key areas in most systems.

Credits

For every rating system there is a manual that shows which credits are included under each key area. The number of credits varies depending on which rating system is used. An example of this is seen in LEED for New Construction and Major Renovations (LNCMR) where there is a credit for *Site Selection* which is not included in LEED for Existing Buildings: Operations & Maintenance (LEBOM). The credit *Site Selection* is included with respect to the sustainability perspective in which ecology, arable land and previously undeveloped land is to be protected.

The number of points that can be scored varies between credits: for some of them the points vary between 1 and 19. For other credits there are just 2 points, i.e. 2 points or no points at all. The total possible number of points attainable in all rating systems (apart from LEED for Homes (LH), see below) is 110, of which 100 are considered basic points. 6 additional points can be given for Innovation & Design and another 4 for Regional Priority. The number of points for each credit can vary between the different rating systems. For example, the *Green Power* credit in LNCMR can score 2 points while in LEBOM it can score 5 points.

It can be worth noting here that LEED for Homes (LH) is different both with respect to system structure and point distribution. In LH there is no Regional Priority key area and the maximum number of points for LH is 136.

Alternative Compliance Paths (ACPs)

Recently, USGBC created a program they call the LEED International Program, at present supported by 21 member nations. The reason for creating this program was to make it easier for countries outside the US to use LEED. USGBC, together with the member nations, has developed Alternative Compliance Paths (ACPs) as a substitute for some of the credits in each key area. ACPs can only be used in countries outside the US. On the other hand, it is possible to choose to use the original credits despite there being an ACP. ACP is simply a local adaptation of a credit and this makes it easier for buildings that do not perfectly match US standards. Analyses to show that a local standard is comparable with ASHRAE requirements are carried out by each member nation. They then apply to USGBC for verification before communicating approval to the projects in their respective countries.

ACPs are available for the following systems:

- LEED for New Construction and Major Renovations
- LEED for Core & Shell
- LEED for Existing Buildings: Operations & Maintenance
- LEED for Schools

3.2.3 RATINGS AND REQUIREMENTS IN LEED

Rating limits

Ratings are based on points collected from the different credits. In order to gain a Certified rating (the lowest rating level), 40 points of a maximum of 110 must be scored. In LEED for Homes, 45 points of a maximum of 136 are required to gain a Certified rating. In Fig. 3.7, the four rating levels for LEED are shown: Certified, Silver, Gold and Platinum.

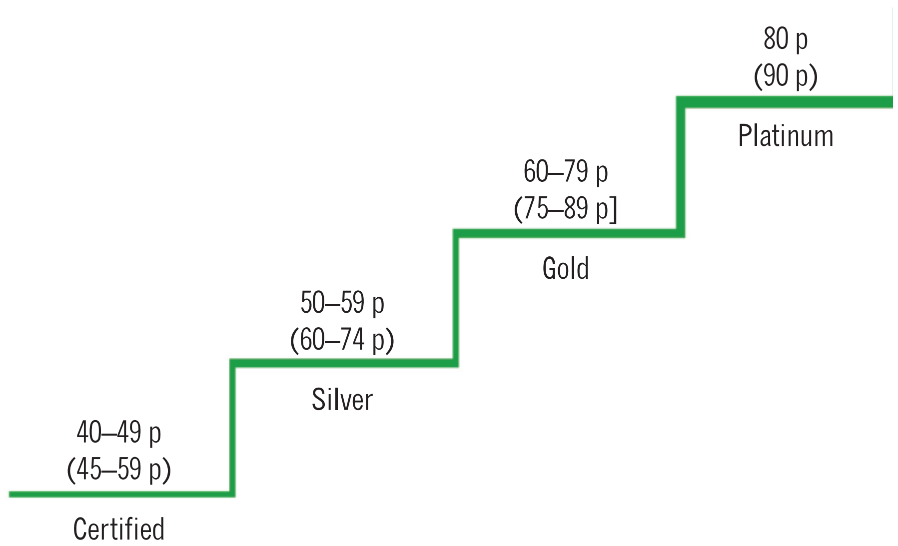


Figure 3.7 LEED ratings, the limits within brackets are for LEED for Homes.

Requirements
In each LEED certification system there are a number of prerequisites that must be fulfilled so that a building can be rated. These prerequisites do not carry any points nor are they included in the total number of points scored in the key area in question. The prerequisites that have to be met vary between the systems and not all systems have prerequisites. Otherwise, points can be freely accrued from different key areas.

Examples of prerequisites are: Water Use Reduction, where there are requirements regarding flush volumes in toilets and flows through shower-heads, etc. Another example of a prerequisite is Storage and Collection of Recyclables for which an easily accessible area for collecting must be provided, at least for newspapers, cardboard, glass, plastic and metal.

In LEED for Homes some of the key areas require a minimum number of points to be able to rate a building.

Weighting
There are no direct weightings imposed between the different key areas. On the other hand, it is possible to score a wide range of points in different key areas, for example, up to 35 of a maximum of 110 points can be gained in the key area Energy and Atmosphere in most of the systems.

Final rating
In LEED it is possible, as pointed out earlier, to freely accrue points from the key areas (except in LEED for Homes) in addition to the prerequisites specified for every system. Table 3.4 shows an example of how the final rating of a building is created.

Table 3.4 Example of LEED rating.

Categories	Possible Points	Points achieved
Sustainable sites	26	15
Water efficiency	10	5
Energy and Atmosphere	35	21
Materials and Resources	14	8
Indoor Environmental Quality	15	10
Innovation in Design	6	4
Regional Priority	4	2
Total	110	65
Rating		GOLD

3.2.4 LEED IN PRACTICE
If it has been decided to use LEED for rating a building, the first step is to make sure that the correct system is chosen, see Fig. 3.8 below. An Excel-based check list is connected to each system and this will give an idea of what rating the building will eventually receive. The check list is a good tool to determine any additional work that might have to be done to attain the final desired rating. The list can be downloaded free of charge from U.S. Green Building Council's website.

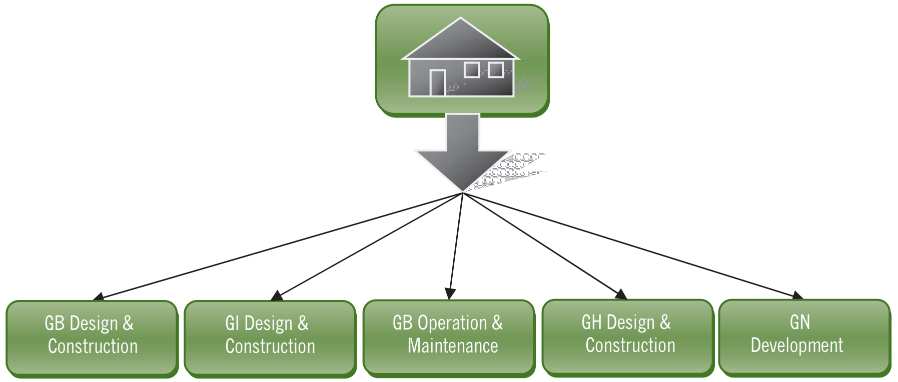


Figure 3.8 Choosing a scheme for a particular building.

After completing a preliminary survey, in which it is possible to see that the Minimum Program Requirements have been fulfilled, a project is registered on the Green Building Certification Institute (GBCI) website, LEED Online, which handles the whole LEED process from documentation to rating. No matter in which country the project is carried out, it has to be registered via LEED Online. If the building is located in one of the countries mentioned in Sub-section 3.2.1, the Green Building Council in that country is to be contacted first. In LEED projects it can be advantageous if there is a LEED AP (LEED Accredited Professional), although this is not a requirement. A qualified LEED AP has previous experience of LEED projects and has been trained by the GBCI. As mentioned previously, points are given for engaging a LEED AP in the project. There are three levels to which people can be trained by LEED. The first level is Green Associate and the second level LEED AP. Extra points will be awarded if a LEED AP is engaged in a project. The highest level, LEED Fellow, can be attained after nomination by other highly experienced LEED APs. All rating in LEED is administered via the GBCI, which means that rating a project using LEED provides third party certification.

3.2.5 LEED AND ENERGY

The key area Energy and Atmosphere is the one of the seven areas that can give the most points. In this key area the energy performance of the building is of primary interest. In order to score high points the installations must be energy-efficient and adjusted for optimal operation and the energy usage

must be measured and verified. The allocation of points also takes into consideration the use of renewable energy sources, for example, electric power created by solar cells and wind turbines.

In order to calculate the energy use in a building it is compared to a hypothetical reference building in an energy calculation program. Data for the reference building can be obtained from the ASHRAE standard 90.1-2007, unless an Alternative Compliance Path has been approved. The allocation of points is based on the difference between the performance of the reference building and the building under investigation, where energy costs is the factor that is assessed. The USGBC decides which energy calculation program is to be used. There are also other ways of calculating the energy performance of a building but using an energy calculation program is the most common.

3.2.6 LEED – ORIGIN AND ORGANISATION

LEED was launched by the U.S. Green Building Council (USGBC) in 2000. A first pilot version was developed in 1998 by a committee comprising property owners, architects, and trade and industry representatives.

All certification of buildings using LEED is carried out via the GBCI, Green Building Certification Institute, a third party organisation formed in 2008. Fig. 3.9 shows how LEED is organised.

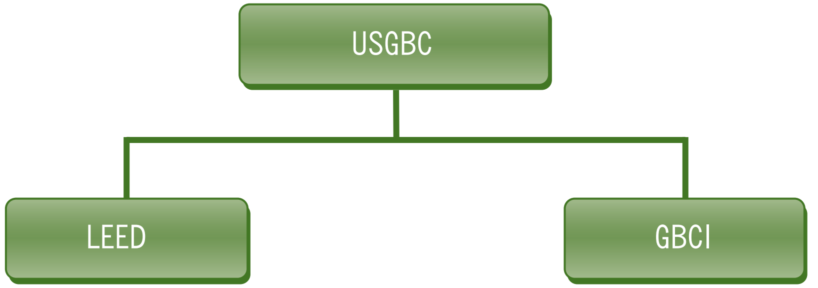


Figure 3.9 The LEED organisation.

3.3 DGNB

The following information is based on the content posted on the DGNB website, www.dgnb.de.

The most recently launched environmental certification system covered in this book is DGNB, which was created in 2009 by the German Sustainable Building Council (GeSBC), Deutsche Gesellschaft für Nachhaltiges Bauen(DGNB). The Council was founded in 2007 and is a non-profit making and non-governmental organisation.

In July 2012 there were 316 certified buildings and 382 registered buildings, most of them in Germany. The system is also used outside Germany.

3.3.1 DGNB – THE BASICS

Certification using DGNB covers all aspects of a building's life cycle and is the same for all types of buildings, and even for whole neighbourhoods.

Buildings that can be certified

DGNB offers certification for new and existing buildings. Furthermore, it is possible to pre-certify buildings in the planning phase. Table 3.5 shows which types of buildings that can be certified at present. In addition to the buildings shown in the table, DGNB is in the process of developing systems for new construction of sports centres, multi-storey car parks, assembly buildings and airport terminals.

Table 3.5 Buildings that can be certified using DGNB. In addition to the above buildings, whole neighbourhoods – Mixed City Districts – can also be classified (new construction).

Type of building	New	Existing
Offices and administrative buildings	x	x
Educational facilities	x	
Commercial buildings, shopping malls	x	x
Industrial buildings	x	x
Residential buildings	x	x
Hotels	x	
Retail	(x)	
Hospitals	x	
Laboratory buildings	x	

Certification systems in DGNB

There are two basic core catalogues (criteria lists) in DGNB: one for certification of buildings and one for certification of urban districts. The certification system for urban districts is a complement to the system for buildings as it first and foremost focuses on questions regarding the areas between the buildings and the location of the neighbourhood. The certification systems developed by DGNB focus on different 'schemes', equivalent to 'types of buildings' in other systems.

Systems available *in Germany*

The two basic core catalogues described above were developed in Germany and are based on German legislation, standards, and guidelines.

Systems available *outside Germany*

DGNB systems are marketed as being flexible and easily adaptable for use in other countries. DGNB has established an international network, DGNB International, with the aim of creating a common quality standard based on EU legislation, standards and guidelines. This international quality standard will thus contribute to making direct comparisons between buildings in different countries possible.

Some countries have, in fact, created local adaptations of DGNB and here the certification systems for the different schemes have been translated and adapted to local legislation and regulations. Countries with local adaptations are, at present, Denmark, Bulgaria, Austria, Switzerland and Thailand.

3.3.2 WHAT DOES DGNB ASSESS?

Quality sections (categories)

A DGNB certification system is divided into six quality sections (categories). Table 3.6 shows the sections and the criteria (issues) to which they refer.

Table 3.6 Quality sections with examples of the main criteria provide an overall picture of what is assessed in the DGNB system.

Environmental quality • Life cycle impact assessment • Local environmental impact • Responsible procurement • Land use	**Socio-cultural and functional quality** • Comfort with respect to the air, temperature and acoustics • Accessibility (handicapped, cycles, etc) • Design and urban quality
Technical quality • Building envelope quality • Ease of cleaning and maintenance • Noise protection • Fire prevention	**Site quality** • Access to transportation • Local environment • Access to amenities
Economic quality • Life cycle costing • Flexibility and adaptability	**Process quality** • Design concept and sustainability aspects • Construction quality assurance

A certain number of points can be scored within each section and how these are apportioned is shown in Fig. 3.10.

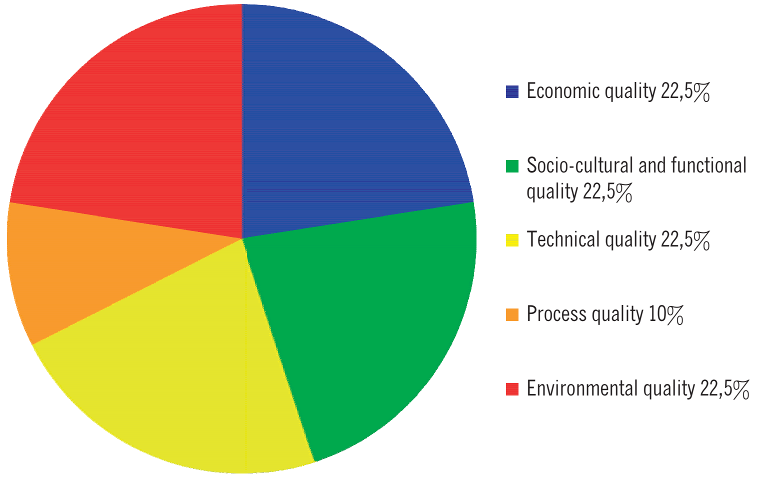


Figure 3.10 Distribution of points between the different DGNB sections. Site Quality is weighted separately and is not included in the final rating.

Criteria (issues)

From the two basic core catalogues DGNB has chosen a number of criteria, from about 50 possible, so that the issues reflect the type of building being classified. The basic system that is used most often is that for buildings, as this covers all schemes/types of buildings. The other system, as mentioned earlier, is used for certification of whole neighbourhoods/urban districts. The issues that are chosen within a specific certification system vary depending on which type of building is to be certified. Some issues are not relevant, for example, for industrial buildings but they would be for offices. Each issue can render a highest score of 10 points.

3.3.3 RATINGS AND REQUIREMENTS IN DGNB

Certification scores (rating limits)

DGNB has three different certification levels. Certification is based on the accumulation of points from the different criteria. The points awarded are weighted firstly for each criteria and then again when summed up for each section. To attain the lowest certification, the total number of points awarded must be at least 50% of the total possible number of points. Fig. 3.11 shows the minimum percentages required for each certification level.

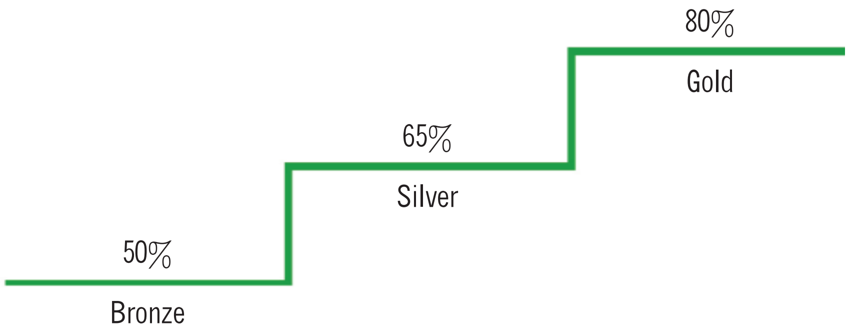


Figure 3.11 DGNB certification levels.

Points requirements

In order to avoid an uneven accumulation of points between the sections, i.e., with focus being placed on particular sections, DGNB has introduced a requirement regarding so-called nominal performance. This means that in addition to the total number of points gained a certain number of points, converted to percentages, must be scored for each section in order to be able to certify the building. For each criterion there is a weighting factor of 1, 2 or 3. If, for example, a criterion has 8 points and the weighting factor is 3 the final score will be 24 points. Another criterion might gain 5 points but have a weighting factor of 1, which means that the total score will be 5.

When all the criteria in a section have been awarded points and multiplied by their respective weighting factors, the total number of points gained in that section is compared to the maximum total possible, see Table 3.7. In this example the total number of points for section A is 78% and for section B 77%.

Table 3.7 Illustration showing the total number of points for two different sections.

Section	Criteria	Points scored	Maximum points	Weighting	Weighted points	Maximum weighted points	Category points	Maximum category points	Accumulated for category
A	A.1	10	10	1	10	10	86.2	110	78%
A	A.2	8	10	3	24	30			
A	A.3	7.1	10	3	21.3	30			
A	A.4	8.2	10	2	16.4	20			
A	A.5	5	10	1	5	10			
A	A.6	9.5	10	1	9.5	10			
B	B.1	5	10	2	10	20	46.2	60	77%
B	B.2	10	10	3	30	30			
B	B.3	6.2	10	1	6.2	10			

A certain minimum level, nominal performance, must be scored for each of the first five sections (i.e. not Site quality) for the building to be certified. The minimum percentages are:

- 35% for a Bronze rating
- 50% for a Silver rating
- 65% for a Gold rating

This means that both sections A and B in the example in Table 3.7 attain a Gold rating with regard to their nominal performance. If the building is to gain an overall Gold rating then the combined sum of the percentages must be at least 80% as shown in Fig. 3.11.

Weighting

In addition to the weighting carried out for every criterion, a final weighting is also applied to each section. With the exception of when whole neighbourhoods/urban districts are classified the category Site quality is not included in the weighting and thus does not have any effect on the final rating. The categories Economic quality, Socio-cultural and functional quality, Technical quality and Environmental quality all have weighting factors of 22.5%. The remaining 10% are applied to Process quality.

Final rating

In order to illustrate how the final rating is reached, an additional calculation is carried out as shown in Table 3.8. Note that some of the columns in Table 3.7 have been deleted to make it easier to understand the rating process. Table 3.8 picks up where Table 3.7 stops, in other words after the weighting for each category. What is included, compared to Table 3.7, is the weighting of the sections and the final accumulated percentages.

Table 3.8 Table illustrating a final DGNB rating.

Section	Section points	Maximum section points	Percentage points	Section weighting	Weighted total
Economic quality	47.0	50.0	94.0%	22.5%	86.3%
Socio-cultural and functional quality	251.1	280.0	89.7%	22.5%	
Technical quality	74.0	100.0	74.0%	22.5%	
Environmental quality	178.5	200.0	89.3%	22.5%	
Process quality	188.6	230.0	82.0%	10.0%	

The example shown in Table 3.8 shows that the building has gained a Gold rating. It can also be seen that each category also fulfils the minimum level for certification of 65% for Gold.

3.3.4 DGNB IN PRACTICE

If DGNB is chosen as for certification, it is important to first find out within which scheme the building lies. If there is no locally adapted DGNB system in the country where the building is to be constructed, there is a good possibility of being able to use a system developed by DGNB International based on European standards and guidelines.

DGNB offers a number of different manuals to provide help in the building certification process and these too can be bought via their website.

When applying for a building to be certified an authorised DGNB Auditor is required to fill in and submit the required documentation. There are contact details on the website and it is also possible to see for which schemes an Auditor has been authorised.

3.3.5 DGNB AND ENERGY

Energy is considered under the field Environmental quality. The criteria that can score the most points are: global warming potential, risks to the local environment and the total primary energy demand and the proportion of non-renewable primary energy demand. Total primary energy demand and proportion of renewable primary energy are also criteria that can score a lot of points. Energy aspects are also considered in the section Technical quality, where the quality of the building envelope with regard to heat and humidity is investigated.

3.3.6 DGNB – ORIGIN AND ORGANISATION

DGNB has more than 1,100 members (July 2012) representing the whole spectrum of the building construction and property industries: architects, planners, industrial representatives, investors and scientists. The members are represented by an elected board of directors.

DGNB plays a prominent international role and is represented on the board of directors of the World Green Building Council. The organisation is also a member of the Council Development Committee of the World Green Building Council.

3.4 Green Star

The following information is based on the content posted on the Green Building Council Australia website, www.gbca.org.au

Green Star is an environmental certification system that was developed by the GBCA (Green Building Council Australia). GBCA was formed in 2002 and the first version of Green Star was launched in 2003. Today, more than 400 buildings have been certified in Australia and over 500 buildings have been registered for future certification.

3.4.1 GREEN STAR – THE BASICS

Green Star is a certification system that was developed in and for Australia. However, it is also used in New Zealand and South Africa where the climate is similar to that in Australia. In New Zealand and South Africa the GBCA has collaborated with the local Green Building Councils to convert the certification system to national versions.

Buildings that can be certified

Both new construction and refurbished buildings can be assessed and rated using Green Star. Table 3.9 shows the types of buildings for which individual rating tools have been developed.

Table 3.9 Types of buildings that can be certified.

• Offices	• Multi-unit residential
• Industrial buildings	• Education
• Retail centres	• Healthcare

There is also a rating tool that is more general, covering a number of types of public buildings such as libraries, courthouses, galleries, museums, etc. If a building does not fit into any of the above types, a rating tool that was launched by Green Star in 2010 called Custom can be used. This is similar to BREEAM's Bespoke scheme.

Green Star – Communities PILOT was released in June 2012. This is a rating tool for whole neighbourhoods and districts.

Green Star certification systems/rating systems

- Green Star – Education
- Green Star – Healthcare
- Green Star – Industrial
- Green Star – Multi unit Residential
- Green Star – Office
- Green Star – Office Interiors (för klassning av inredning och material)
- Green Star – Retail Centre

• Green Star – Public Building (Pilot)
• Green Star – Custom
• Green Star – Communities (Pilot)
• Green Star – Performance (under development)
• Green Star – Interiors (under development)

Manuals
Manuals with guidelines are available for each individual rating system and these can be bought via the GBCA website. As a complement to the detailed manuals, assessment criteria are available in an Excel document that can be downloaded from the GBCA website.

3.4.2 WHAT DOES GREEN STAR ASSESS?

Categories
All Green Star systems have nine categories that are used as a basis for assessing the environmental impact when selecting a site, carrying out construction, designing the building and carrying out its maintenance. Table 3.10 shows the categories and their respective credits (main issues).

Table 3.10 Categories and examples of credits provide an overall picture of what is assessed in Green Star systems.

Management Development Commissioning Operation	**Indoor Environment Quality** Light Thermal comfort Pollutants
Energy CO_2 emissions reduction Peak energy demand Energy-efficient indoor climate systems	**Transport** Commuting Parking Facilities for cyclists
Water Water reuse Alternative water sources (rainwater) Efficient design of building services	**Materials** Recycling of materials Material management
Land Use & Ecology Sustaining ecological values Discouragement of degradation Immediate ecosystem	**Emissions** Pollution of water courses Refrigerants Legionella
Innovation Technologies that promote sustainable construction	

A certain number of points can be scored within each category depending on which system is used. Fig. 3.12 shows an example of how points are apportioned in Green Star – Office.

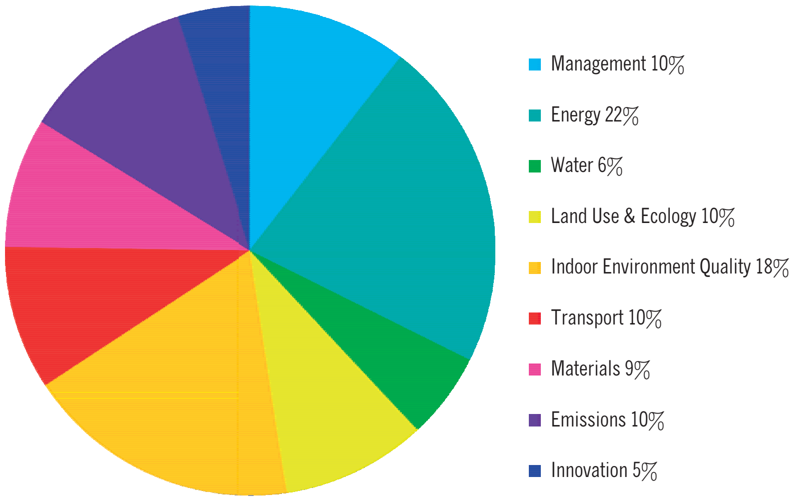


Figure 3.12 An example of how weighted points are apportioned in Green Star – Office. Innovation is not weighted but is included in the final number of points before the rating is awarded.

Credits (main issues)
A rating tool for each system is available on the GBCA website for free downloading. In each one of the nine categories there are a number of credits, each of which can score a different numbers of points. The number of credits and points that can be scored in each category also vary from system to system. Just as in other certification systems innovative solutions can score extra points. In Green Star the points for innovative solutions are not included in the Environmental weighting, see Sub-section 3.4.3 below.

3.4.3 RATINGS AND REQUIREMENTS IN GREEN STAR

Rating limits
Green Star ratings are based on the points accumulated for each category and the sum of the weighted category scores, which depend on their ecological impact, see under ‘weighting’ below. The sum of the points determines the number of stars awarded, which in turn forms the basis for the

total assessment of the building. A building can be awarded 1 to 6 stars but to be Green Star certified it must be awarded at least four stars. The maximum award of six stars corresponds to the rating 'World Leadership'. Fig. 3.13 shows the relationship between the number of stars and the rating.

Figure 3.13 Green Star ratings.

Basic requirements

Before a Green Star certification can be considered at all, certain requirements regarding emissions of greenhouse gases must be fulfilled. New constructions also have to fulfil requirements regarding the choice of site, which means, in principle, that a building must not be constructed on a site that has high ecological value.

Weighting

Environmental weighting is applied to each and every category except 'Innovation'. Instead, these points are added to the other points given to the building after weighting. The total number of points for the building can then be ascertained. The maximum number of points possible for the weighted categories is 100, plus any points given for 'Innovation', maximum 5 points. How the different categories are weighted depends on which system is used and the geographical location of the building.

Final rating

To illustrate how a Green Star rating is attained, an example is given in Table 3.11 for Green Star – Office. The accumulated total number of points is achieved by multiplying the points attained, as percentages, by the respective weighting factors.

Table 3.11 An example of Green Star – Office certification.

Category	Points scored	Possible Points	Points scored (%)	Environmental Weighting	Weighted total
Management	10	12	83%	11%	9
Energy	18	29	62%	23%	14
Water	7	12	58%	6%	4
Land use & Ecology	7	8	88%	10%	9
Indoor Environment Quality	22	27	81%	19%	15
Transport	9	11	82%	10%	8
Materials	20	25	80%	9%	7
Emissions	15	19	79%	12%	9
				Poäng före innovation	76
Innovation	3	5			3
				Total points	79
				Green Star rating	World Leadership

3.4.4 GREEN STAR IN PRACTICE

As the GBCA does not actively market and develop Green Star in other countries it is difficult to use their certification systems outside Australia. New Zealand and South Africa, as mentioned previously, have national adaptations that have been developed in collaboration with their own Green Building Councils and the GBCA. However, there are no formal obstacles when it comes to developing further adaptations, if another country should choose to do so.

In New Zealand and South Africa, ratings and certification are carried out in the same way as described in the Australian systems. When a building is to be certified and a suitable system is available a project application is submitted via the GBCA website. The certification process is divided into two parts: the first results in a report in which any unfulfilled basic requirements are noted; in the second part any necessary complementary details are submitted, after which certification is awarded by the GBCA.

The project group has a so-called Case Manager who is the main point of contact for the project team within the GBCA.

Green Star Assessor

The GBCA uses an Assessment Panel during the certification process. This comprises 2 or 3 certified assessors, a representative from GBCA and an independent third-party chairman. Each assessor conducts an individual assessment prior to meeting with the panel to finalize the results. The role of the independent chairman is to make sure that the assessment is correct and fair. The GBCA representative is often a Case Manager who is present to register the results and inform the project group. The applicants do not know which assessors have been involved; their work is always done anonymously.

As in a number of other certification schemes, Green Star also has Accredited Professionals (GSAPs). A GSAP is someone who is trained and familiar with Green Star and its certification process. If a project chooses to engage a GSAP it is awarded an extra 2 points. A GSAP is not the same as a Certified Assessor. However, to become a Certified Assessor one must first become a GSAP.

3.4.5 GREEN STAR AND ENERGY

In the category Energy, a large proportion of the points can be gained under the credit Greenhouse gas emissions. The points scored for this credit are based on the energy performance of the building. All the design and measured energy data is reported, using a tool that can be downloaded from the GBCA website, and the appropriate number of points awarded. These points are based on carbon dioxide emission, which means that the use of energy is recalculated to carbon dioxide equivalents.

Weightings for the Energy category are different for different geographical locations and different types of buildings but as a rule make up about 25% of the total weighting.

3.4.6 GREEN STAR – ORIGIN AND ORGANISATION

GBCA was formed in 2002 and the first certification system, Green Star – Office, was introduced in 2003. GBCA is a national, non-profit making organisation that works to develop a sustainable property market in Australia. Their work is aimed at promoting the construction of energy-efficient and eco-friendly buildings around the country. The GBCA is supported by both industry and the Australian government.

3.5 Miljöbyggnad

The following information is based on the content posted on the Sweden Green Building Council website, www.sgbc.se

Miljöbyggnad – Environmental Building – is an environmental certification system that is used in Sweden and is based on the Swedish building regulations and regulatory requirements. As of April 2012, there are 34 buildings that have been certified using the Miljöbyggnad system, all of them in Sweden.

3.5.1 MILJÖBYGGNAD – THE BASICS

Miljöbyggnad can be used to certify new constructions, refurbished buildings and existing buildings. It is possible to certify detached and semi-detached houses, blocks of flats and most types of commercial and non-commercial buildings such as offices, schools, day nurseries, hotels, health care buildings, nursing homes, restaurants, sports centres and theatres.

Manuals

The manual for Miljöbyggnad is divided into three parts. The first part is for existing and newly constructed buildings, and provides a background and introduction to certification work. The second and third parts contain information about current assessment criteria for existing and newly constructed buildings. The part on newly constructed buildings also covers refurbished buildings.

3.5.2 WHAT DOES MILJÖBYGGNAD ASSESS?

Areas (categories)

Miljöbyggnad comprises four assessment areas:

- Energy
- Indoor environment
- Building materials
- Special environmental requirements

The last mentioned area only applies to buildings with their own water supplies and waste water systems.

Indicators (issues)

Each area is divided into different aspects which in turn are divided into a number of indicators. Indicators correspond to the previously mentioned issues or credits.

Table 3.12 shows a compilation of the indicators treated in each area. The aspects are important where the rating of a building is concerned and these are described in more detail in Sub-section 3.5.3.

Table 3.12 Areas with corresponding aspects and the indicators assessed in Miljöbyggnad systems.

No.	Indicator	Aspect	Area
1	Energy use	Energy use	Energy
2	Heat power demand	Power demand	
3	Solar heating load		
4	Type of energy	Type of energy	
5	Noise environment	Noise environment	Indoor environment
6	Radon gas	Air quality	
7	Ventilation standard		
8	Nitrogen dioxide		
9	Moisture resistance	Moisture	
10	Thermal climate in winter	Thermal climate	
11	Thermal climate in summer		
12	Daylight	Daylight	
13	Legionella	Legionella	
14	Documentation of building materials	Documentation of building materials	Materials
15	Phasing out dangerous substances	Phasing out dangerous substances	
16	Removal of dangerous substances	Removal of dangerous substances	

3.5.3 RATINGS AND REQUIREMENTS IN MILJÖBYGGNAD

Miljöbyggnad has four rating levels: Rated, Bronze, Silver and Gold. To be certified at Gold level all indicators must be at least at Silver level.

The rating level Rated means that the requirements have not been fulfilled. Despite this, the Rated level is used to indicate that there is room for improvement or when verifying a new building. For new constructions a preliminary assessment is carried out and this must be later verified.

Certification also entails a questionnaire being given to the users/tenants and at least 80% of the answers regarding the indoor environment must be deemed to be 'Very good', 'Good' or 'Acceptable' for the building to be awarded a Gold rating.

Rating

Ratings in Miljöbyggnad are divided into five steps:

Step 1. Rating at room level
Step 2. Rating at indicator level
Step 3. Rating at aspect level
Step 4. Rating at area level
Step 5. Rating at building level

Some of the indicators are measured or assessed at room level, for example, the solar heat load, others at building level. The areas of the assessed rooms are added together for each rating so that it can be seen how many square metres of the floor area attain Rated, Bronze, Silver or Gold levels respectively. Indicator rating is then awarded according to the lowest room level rating. This rating can be raised one level if at least half of the total assessed area has a higher rating. The rating given for each indicator is then used as a basis for the rating at aspect level. The aspect level is given the same rating as the indicator with the lowest rating. To obtain a rating at the area level, the lowest rating at the aspect level is used. The area rating can be raised by one level if at least half of the other aspect ratings are higher. And, finally, to obtain the rating at the building level the lowest rating from the area level is used. This is illustrated in Table 3.13 below.

Basic requirements

There are a number of basic requirements that must be fulfilled in order to be able to certify a building using a Miljöbyggnad system. A number of these basic requirements depend on the rating level being aimed at. For example, the rating Gold for the indicator 'Moisture resistance' requires the involvement of two certified moisture experts, one representing the client and one representing the contractor. An inventory for this indicator must also be carried out by a person who has completed relevant specialist training. This is also required for the indicator 'Removal of dangerous substances'. For the indicator 'Noise environment' an acoustics expert must be engaged no matter what rating is being aimed for. When assessing 'Ventilation standards' a certified inspector must have carried out a mandatory ventilation inspection, if one is required in the building in question.

Final rating

Table 3.13 illustrates how the final rating in the Miljöbyggnad system is reached, based on the ratings awarded at the different levels.

Table 3.13 A rating example using the Miljöbyggnad system.

Indicator		Aspect		Area		Building
Energy use	GOLD	Energy use	GOLD	Energi	GOLD	SILVER
Heat power demand	GOLD	Power demand	SILVER			
Solar heating load	SILVER					
Type of energy	GOLD	Type of energy	GOLD			
Noise environment	SILVER	Noise environment	SILVER	Innemiljö	SILVER	
Radon gas	SILVER	Air quality	SILVER			
Ventilation standard	SILVER					
Nitrogen dioxide	GOLD					
Moisture resistance	BRONZE	Moisture	BRONZE			
Thermal climate in winter	GOLD	Thermal climate	GOLD			
Thermal climate in summer	GOLD					
Daylight	SILVER	Daylight	SILVER			
Legionella	GOLD	Legionella	GOLD			
Documentation of building materials	SILVER	Documentation of building materials	SILVER	Material	SILVER	
Phasing out dangerous substances	GOLD	Phasing out dangerous substances	GOLD			
Removal of dangerous substances	SILVER	Removal of dangerous substances	SILVER			

In order to obtain final certification, a verification of the building must be carried out. Verification means that the assessment data for the awarded rating, which, among other things, was reached via Table 3.13, is compared to the results achieved in the completed or refurbished building. This is to be done at the earliest one year and at the latest two years after the building has been put to use.

3.5.4 MILJÖBYGGNAD IN PRACTICE

Miljöbyggnad recommends that a certified Miljöbyggnad Coordinator is employed on a project no matter whether it is a new construction, a refurbishment, an extension or an existing building that is being classified. For new constructions, an application based on the buildings design documents and site plans can be made. These will be later verified, as described above, before a final rating can be awarded.

Calculations and other verifications of the project can be carried out by the respective members of the planning group. On the Sweden Green Building Council's (SGBC's) website certain aids are available in the form of calculation tools and questionnaires for the assessment of the indoor environment. These can be downloaded free of charge.

Applications are sent to the SGBC who inspect the documents and award the rating certificate. Independent inspectors are involved in this work, which means that Miljöbyggnad offers third-party certification.

3.5.5 MILJÖBYGGNAD AND ENERGY

Miljöbyggnad defines a building's energy performance as: normal year corrected energy for heating, domestic hot water, non-domestic power use (but not including power for any business equipment or machines) and comfort cooling. The Swedish Building regulations are used as a reference for new constructions. If the building fulfils the building regulations requirements it will be awarded a Bronze rating for energy. If energy use is at least 25% lower than this, it will get a Silver rating and at least 35% lower, a Gold rating. Note that this only applies to buildings that are not heated using electricity. For new construction of electrically heated buildings a Bronze rating will apply if the regulations for electrically heated buildings are met, Silver if they use at least 5% less energy and Gold if they use at least 10% less. If the building regulations are updated, the rating levels will be required to meet any new stipulations, which means that a building is always rated according to the latest version of the building regulations.

In order to calculate the energy performance of a building, a calculation program that has been approved by the SGBC and stipulated in the manual must be used. The use of energy is then measured in the completed building for at least 12 months.

Where existing buildings are concerned there is no direct reliance on the building regulations. In this case, Miljöbyggnad will define an energy performance limit level itself. These limit levels vary depending on the type of building in question. Energy for heating is also adjusted to a normal year.

Miljöbyggnad also assesses a building according to the type of energy used. Depending on how large the proportion of renewable energy is, different ratings for the indicator 'Energy' can be obtained.

3.5.6 MILJÖBYGGNAD – ORIGIN AND ORGANISATION

Previously, Miljöbyggnad was managed by ByggaBoDialogen, which was a collaboration between a large number of companies and researchers, municipalities and the government. Subsequently, Miljöbyggnad was developed by the Swedish building and property industry together with public authorities, banks, insurance companies and universities.

The Miljöbyggnad system, previously known as the Miljöklassad byggnad system, has been managed by the Sweden Green Building Council since 1 January 2011.

3.6 HQE

The greater part of the following information about this certification system is based on content posted on HQE's website www.assohqe.org and on the websites of the two certification organisations Groupe QUALITEL /CERQUAL (www.qualite-logement.org) and Certivéa (www.certivea.com).

The French HQE (Haute Qualité Environmentale) method was first developed by a French organisation of the same name. For independent third party assessment, the certification process and framework was then developed by QUALITEL and Certivéa. The first buildings were certified in 2004. Today, HQE is internationally promoted by the France Green Building Council and HQE Association, while the certification process and related activities are carried out by two other organisations: Certivea for non-residential buildings, and Groupe QUALITEL for housing (namely CERQUAL for multi-residential, and CEQUAMI for detached houses). By the end of 2011, approximately 7,200 buildings had been certified and a considerably larger number registered for future certification. Of the total number of HQE certified buildings, just over 10% were existing buildings and some 850 non-residential buildings.

In a similar way to a number of other certification systems, the awareness of the existence of the system is gradually increasing and, consequently, the demand for its application. For example, recent studies have led HQE to believe that 85% of all large office projects built in 2013 in the Paris region will be HQE certified.

In addition to buildings in France and its overseas territories, buildings are also HQE certified in Brazil, Morocco, Algeria, Belgium, Luxembourg, UK and Italy. At present, the greater majority of the certified buildings are to be found in France itself.

3.6.1 HQE – THE BASICS

The HQE system, like a number of other certification systems, is performance and function-oriented in the sense that it is how a building actually performs that is assessed, for example, its energy performance and acoustic properties.

Buildings that can be certified

Most types of new and existing buildings, such as houses, non-residential buildings and industrial buildings can be certified using HQE. Even roads and motorways can be certified but projects like these are not discussed in

this book. HQE certification schemes are also available for more complex and larger building projects such as communities and neighbourhoods.

Where single buildings are concerned, these can be certified at the design and construction stages or when renovated/extended and, as mentioned initially, even existing buildings – both housing and non-residential buildings – can be certified during the in-use stage.

Table 3.14 Buildings that can be certified (also internationally) using HQE.

Type of building	New construction	Renovated	Existing
Detached houses	X	X	X
Apartment blocks	X	X	X
Non-residential buildings	X	X	X
Industrial buildings	X	X	X

When existing buildings are certified this signals the beginning of a long-term commitment including follow-ups and audits for which the auditor is physically present. A number of the assessed aspects, such as air quality and noise levels, are in fact followed up on a yearly basis. If it is seen, after a time, that a building no longer fulfils the requirements nor follows the guidelines applicable to the certification awarded, then measures are taken to amend the situation. These follow-ups are carried out jointly by the certification organisation and the property owner.

HQE certification systems

There are five HQE certification systems. They are quite similar in scope and structure even though there are differences with regard to some of the categories, the assessed issues and the requirement levels, depending on the type of building assessed. The years when the systems were launched are shown in brackets.

1) NF Bâtiments Tertiaires HQE – for non-residential buildings (2005)
2) NF Maison Individuelle HQE – for detached houses (2006)
3) NF Logement HQE – for multi-residential projects [apartment blocks or groups of houses] (2007)
4) NF Equipements Sportifs HQE – for sports centres (2011)
5) HQE International – for non-residential buildings outside France (June 2012). An international version for residential buildings is currently being developed.

The HQE International system is not based on French building regulations or legislation but refers instead to European or international/ISO standards. Before this system was introduced, buildings outside France were certified using the then existing French certification systems together with appropriate national legislation. Certification work was rather laborious as in every individual project the requirements and the guidelines in the applicable certification system had to be compared to those in the corresponding national legislation to be able to determine suitable assessment levels. This is still the case when houses are certified abroad. However, HQE is planning to launch an international system for houses at the end of 2012.

In addition to the five systems mentioned above, HQE can also be implemented as a nationally adapted system in different countries. After introduction of the system, the certification process will be managed by an organisation in the country in question. Brazil was the first and, to date, only country to implement, a nationally adapted HQE system for certifying residential and non-residential buildings. Their system is called "Processo AQUA". A similar system will be introduced shortly in Lebanon.

3.6.2 WHAT DOES HQE ASSESS?

The certification systems are based on two so-called dimensions: *Environment and Sustainability*, and *Quality and Environmental Management*. The Environment and Sustainability dimension comprises three levels: Firstly there are two target areas covering a range of categories which, in turn, comprise a number of issues or environmental performance targets. The Environment and Sustainability dimension is assessed at these three levels. The Quality and Environmental Management dimension is not assessed in this way but is included as a mandatory part of the certification process.

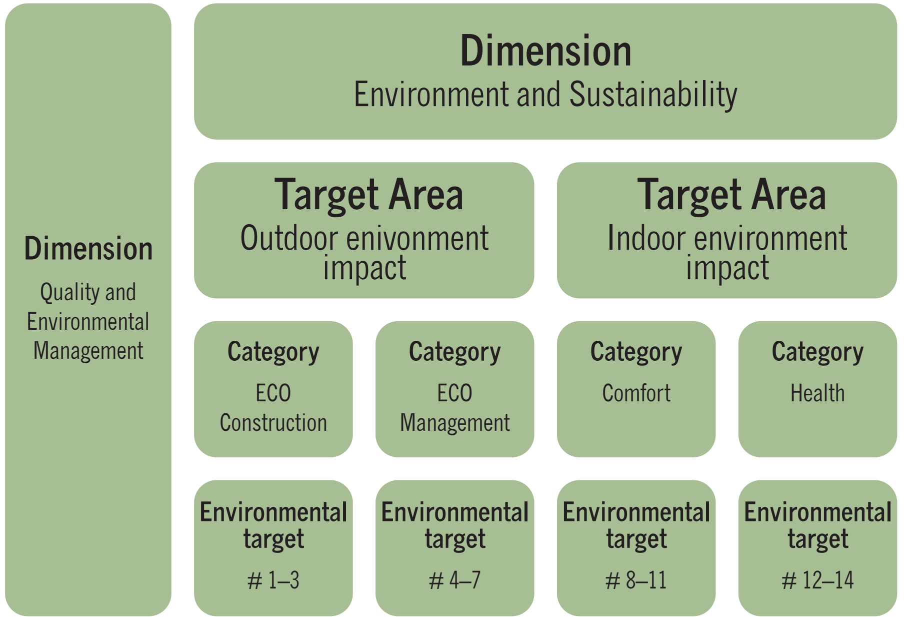


Figure 3.14 The 'Dimension – Target Area – Category – Environmental target' schematic for non-residential buildings.

Environment and Sustainability

Issues dealt with under this dimension depend on the type of building being certified. In the certification system for non-residential buildings, the first dimension, *Environment and sustainability,* comprises two target areas: *Outdoor environmental impact* and *Indoor environmental impact*. These in turn each comprise two categories: *ECO Construction* and *ECO Management,* and *Comfort* and *Health* respectively. These categories comprise in total 14 environmental and sustainability targets (below denoted as environmental targets). The environmental targets presented in Table 3.15 are for non-residential buildings; for housing there are additional targets. These include measures to prevent trespassing (safety), the design of kitchens to make them user-friendly, accessibility, the durability of the buildings, and shell and roof properties.

Table 3.15 Environmental goals for non-residential buildings, comprising two target areas and four categories.

Outdoor environmental impact	
ECO Construction	
Target 1	Relationship between a building and its immediate environment
Target 2	Integrated choice of construction methods, products and processes
Target 3	Low impact construction worksite
ECO Management	
Target 4	Energy management
Target 5	Water management
Target 6	Management of waste generated by activities
Target 7	Management of servicing and maintenance
Indoor environment	
Comfort	
Target 8	Hygrothermal comfort
Target 9	Acoustic comfort
Target 10	Visual comfort
Target 11	Odour comfort
Health	
Target 12	Quality of the indoor spaces
Target 13	Air quality
Target 14	Water quality

Some of the environmental targets appear to be quite similar, for example, Targets 11, 12 and 13, but these are further differentiated by more detailed descriptions.

Environmental targets are awarded different numbers of points, see Subsection 3.6.3 below.

Quality and environmental management

Where the *Quality and Environmental Management* dimension is concerned, HQE has a lot in common with ISO 14001, the international environmental management system, and HQE systems cover the whole building process, from planning to management. The purpose of a quality and environmental management system is to highlight relevant environmental issues and create routines and tools so that they can be followed up. A system like this allows users to choose levels of involvement, policies, energy-savings goals, etc. The idea is that the users can then emphasize their engagement in environmental work; in other words, that they are not just involved in certifying buildings.

HQE certification can thus be said to comprise a static part linked to the basic quality of the building (*the Environmental and Sustainability dimension*) and a dynamic part linked to the interaction between all stakeholders (*the Management System*).

3.6.3 RATINGS AND REQUIREMENTS IN HQE

Unlike most environmental certification systems, HQE did not provide just one overall rating for a building and this was the case until 2011. Up to then, the levels for all the environmental targets used to be shown in an *environmental profile* for the building (this is still the case in residential projects but no longer in non-residential projects). Previously, it was up to the interested parties to decide how well the profile agreed with their own opinions as to what constituted a good building. On the other hand, there were minimum requirements for a building's environmental profile that had to be met:

– **At least three** of the environmental targets had to be rated at the "Very Good" level.

– **A maximum of seven** of the environmental targets were allowed to be rated at the "Pass" level.

According to HQE, buildings and assessments of them are too complex to be summed up in one rating, and consequently results were not aggregated in order to preserve the transparency of the results achieved in each target. However, changes in approach have recently been made and in order to simplify the comparability of different HQE certified buildings, it is now possible to add together the assessments and convert them into one total rating. This simplification was introduced at the end of 2011 and is initially only applicable to non-residential buildings, both in France and internationally. Where housing is concerned, the somewhat more complex, though comprehensive, environmental profile assessment is still used. However, it is expected that it will also be possible to apply the new rating system to housing by the end of 2012.

Rating limits

The new way in which buildings are rated retains the partial rating concept, though not as previously for each environmental target. Additional rating factors have been introduced, here denoted as Rating categories. For rating purposes, the weighting and aggregation of results are structured differently from the groups of environmental targets shown in Table 3.15, where the categories were *ECO Construction, ECO Management, Comfort* and *Health*. The rating categories each comprise a different number of environmental targets. For example, the rating category Energy takes only one environmental target into consideration while the rating category Environment jointly rates six environmental targets. Table 3.16 below shows the target categories and their corresponding rating categories.

Table 3.16 Target categories and corresponding rating categories according to the new rating certificate for non-residential buildings (for national and international use).

Outdoor environmental impact		Rating			
ECO Construction		**Energy**	**Environment**	**Healt**	**Comfort**
Target 1	Relationship between a building and its immediate environment		Target 1		
Target 2	Integrated choice of construction methods, products and processes		Target 2		
Target 3	Low impact construction worksite		Target 3		
ECO Management					
Target 4	Energy management	Target 4			
Target 5	Water management		Target 5		
Target 6	Management of waste generated by activities		Target 6		
Target 7	Management of servicing and maintenance		Target 7		
Indoor environment					
Comfort					
Target 8	Hygrothermal climate				Target 8
Target 9	Acoustic comfort				Target 9
Target 10	Visual comfort				Target 10
Target 11	Odour comfort				Target 11
Health					
Target 12	Quality of the indoor spaces and EMF [1]			Target 12	
Target 13	Air quality			Target 13	
Target 14	Water quality			Target 14	

1 Electromagnetic field

The rating categories – *Energy, Environment, Comfort* and *Health* – are rated using stars. A maximum of four stars can be awarded per rating category depending on how well the individual targets are fulfilled. The summations of the number of stars for each rating category can vary depending on the category in question. The greater the number of environmental targets that reach the “Very good” or “Excellent” levels, the greater the number of stars awarded to the rating category in question. The total rating for a building is then based on the total number of stars according to the following:

0 stars	HQE PASS (Pass)
1–4 stars	HQE BON (Good)
5–8 stars	HQE TRÉS BON (Very Good)
9–11 stars	HQE EXCELLENT (Excellent)
12–16 stars	HQE EXEPTIONNEL (Exceptional)

The individual environmental targets (14 for non-residential buildings, see Table 3.16) each comprise a number of issues, each one of which can score up to 2 points depending on how well the building meets the points criteria for each issue. Points are awarded as follows:

- *Prerequisite:* 0 points – the first level, approximately corresponding to current legislation and normal practice.
- *Performing:* 1 point – middle level, corresponding to good practice.
- *High Performing:* 2 points – the highest level, corresponding to best practice.

In the HQE International certification system the actual assessment of the environmental targets, as mentioned earlier, is base on European and international/ISO standards. Some parts of the certification system are also based on relative comparisons with national building regulations and guidelines where these exist. This means that a building that has been awarded the HQE rating “Very good” in a country where the building regulations and guidelines require high performance levels might, in practice, perform better than one which has been awarded the HQE “Excellent” rating, but has been built in a country where legislation is not so strict. This paradox is not unique to the HQE system; similar anomalies can be seen in other certification systems.

Weighting
In the rating system that was still applicable to housing in 2012, single categories were not weighted, as the rating of the building was shown as an environmental profile in which the ratings of the individual themes (or targets) were shown in detail.

In the new rating system, which in 2012 is only applicable to non-residential buildings, there is, in fact, a 'built-in' weighting factor as each rating category comprises a different number of targets, although all four rating categories can only award the same maximum number of stars. Looking at the right hand side of Table 3.16, it is clear that each of the six environmental targets under the rating category *Environment* has to be worth less than the environmental target under the rating category *Energy*, which has only one target, energy management.

Final rating
To avoid a situation in which only the property owners are aware of the certification and its contents, the tenants in a building are also informed by means of a user's certificate. For example, in a block of flats, each and every flat is given its own individual certificate. This certificate can be truly said to be applicable to a particular flat as every flat is, in fact, assessed individually. The idea behind this is, among other things, to make it possible for potential tenants to choose a flat from an environmental point of view.

3.6.4 HQE IN PRACTICE

Depending of the type of building, different HQE certification organisations are contacted, namely, Certivéa for non-residential buildings and QUALITEL Group for housing (CERQUAL for multi-residential buildings or CEQUAMI for detached houses). See Sub-section 3.6.6 for more information about these organisations. Certification is carried out by staff from the certification organisations and is, essentially, a process between them and the property owner in which no consultancy is allowed to avoid conflicting with the independent third party assessment process.

For buildings outside France, certification can be carried out via a national HQE partner office (at present available in Brazil, and under development in Lebanon), Otherwise, contact is made directly with one of the certification organisations mentioned above. For readers who would like to extend their knowledge of any of the HQE systems, further information and a number of brochures are available for download from the HQE certification bodies and the HQE website. Most of the information is in French, but some parts are available in English. Among other things, there are descriptive manuals for the different certification systems which also list criteria for awarding points for environmental targets. Software developed by HQE certification bodies is also available for downloading. With the help of this software and a manual, it is possible to make a preliminary assessment of the rating a building ought to achieve.

3.6.5 HQE AND ENERGY

The energy aspect (rating category *Energy*, which is based on Environmental target 4) can be awarded a maximum of four stars out of a total of sixteen possible for all the categories in the system. It can thus be said to make up 25% of the system. However, it can be worth noting that certain aspects here are not directly connected to the building's energy performance in the normal sense. For example, in the category *Energy*, measures to reduce electromagnetic radiation and levels of sulphur dioxide are also included.

The energy part of the HQE certification system comprises three focus areas:

- Reduction of energy use through good building design
- Reduction of primary energy use
- Reduction of the creation of emissions to the atmosphere

Reduction of primary energy use addresses usage linked to:

- Heating
- Cooling
- Domestic hot water
- Ventilation
- Lighting

Since HQE has a *performance-oriented* approach, it places almost no significant technical requirements on, for example, thermal insulation in walls or the thermal efficiency of heat recovery equipment. However, there is a general exception where air leakage is concerned and there are different requirements depending on the type of building being certified. In addition, there are specific exceptions for cooling in department stores, where detailed technical requirements are specified for certain aspects.

3.6.6 HQE – ORIGIN AND ORGANISATION

The association behind HQE was formed 1996 with the development of safe, comfortable and environmentally adapted buildings on its agenda. Development work has since been carried out in close cooperation with public authorities, certification bodies and the building industry in France.

The certification of housing is developed and administered by the independent and non-profit organisation Group QUALITEL, founded as early as 1974. Since then, the organisation has been involved in the promotion and verification of the quality and performance of residential buildings. CEQUAMI and CERQUAL are certification subsidiaries of Group QUALITEL.

Non-residential buildings are certified by Certivéa, which is a subsidiary of CSTB (Centre Scientifique et Technique du Bâtiments), a public building research institute. Certivéa's business operations include certification of buildings and services.

Both QUALITEL Group and Cerivéa are members of the France Green Building Council and of the HQE Association.

4 ENERGY CERTIFICATION SYSTEMS

This chapter looks at three of the largest and most widely used energy certification systems: the European GreenBuilding programme, the Swiss Minergie standard and the German Passivhaus/Passive House standard.

Unlike the environmental certification systems, the energy certification systems focus entirely on energy performance and are, therefore, sometimes called 'one-issue' systems. However, as we will soon see, there are also systems among these that place certain requirements on, for example, the choice of building materials and the indoor environment.

The main focus of these systems is on energy, which means that their descriptions here are more oriented towards energy questions than the corresponding descriptions of the environmental certification systems.

The Swiss Minergie standard actually comprises a number of certification systems and more space has therefore been dedicated to Minergie than the other energy systems in this chapter. Furthermore, Green Building, Minergie and Passive House are quite different in their structures and cannot be described in the same uniform and consistent ways as the environmental certification systems in Chapter 3.

4.1 GreenBuilding

The following information is based on the content posted on the GreenBuilding website, www.eu-greenbulding.org

GreenBuilding started as a development and pilot project in 2005 following an EU initiative via the IEE (Intelligent Energy – Europe) programme. The programme, for more efficient energy use, is used in many parts of Europe and to date some 600 buildings have been certified, of which a third are located in Sweden.

4.1.1 GREENBUILDING – THE BASICS

Non-residential buildings in Europe can be certified using GreenBuilding. The system has a simple structure with a general requirement that the energy performance of a building must be 25% better than the minimum requirements stipulated by legislation in the country in question. Alternatively, the energy performance of a refurbished existing building must have been increased by at least 25% thanks to the improvement works. In this way, the system automatically becomes nationally adapted.

Buildings that can be certified

GreenBuilding can only be used for non-residential buildings. The system can be used for new constructions, existing buildings or refurbished buildings. GreenBuilding certification is not graded – a building is either certified or not certified. There are no hierarchical levels such as Bronze, Silver and Gold.

Systems within GreenBuilding

GreenBuilding is not actually divided up into a number of different and defined certification systems as in BREEAM and LEED. To facilitate comparison with other certification systems we have divided GreenBuilding into two levels of involvement, one at the *building* level and one at the *company* level. Within these, further divisions can be made for new construction and existing buildings as well as for refurbished and extended buildings.

4.1.2 WHAT DOES GREENBUILDING ASSESS?

The short answer is energy performance. But this is not particularly surprising in an energy certification system. However, what does distinguish the different energy certification systems from each other is the scope of their respective energy requirements and which other requirements and aspects that have to be considered.

As far as the GreenBuilding requirements concerning energy performance are concerned it can be readily seen that these are rather similar and it is only necessary to keep a '25% better' factor in mind, even if there are a number of other criteria. Let us first take a look at the energy performance criteria, see Table 4.1 below.

Table 4.1 Energy performance criteria in GreenBuilding.

Building phases	Energy performance requirements
New construction	25 % better energy performance than stipulated in the national building regulations
Existing buildings	Alternative1: 25 % better than before Alternative 2: 25 % better than stipulated for similar new construction
Refurbished/ extended buildings (the whole building is certified)	25 % better energy performance for the whole building than before National requirements are sometimes applicable. In Sweden, for example, the requirements are specified as follows: Alternative 1: 25 % better energy performance for the refurbished/ extended part than stipulated in the national building regulations and 25% better for the whole building than before Alternative 2: 25% better performance than stipulated for the whole building regarded as a new construction

The EU guidelines for GreenBuilding do not require any special measures to be taken, only that the energy performance is improved according to Table 4.1 and that the measures must not, of course, result in the air quality or thermal indoor climate not fulfilling the requirements in the national building regulations. On the other hand, GreenBuilding encourages certain types of measures, for example, optimised operation of building services. In addition, all energy performance requirements need only be fulfilled if they are economically viable. How this is determined is shown in documents supplied by GreenBuilding.

The requirements to be fulfilled for GreenBuilding certification according to EU guidelines are:

- Improved energy performance as stipulated in Table 4.1.
- An energy management system in operation for the building in question.
- The possibility to check savings improvements by yearly audits (reports, calculations, and/or measurements).

An energy management system is a cyclic process, often covering the following steps: planning, execution, follow up and improvements. Since September 2009, a European Standard for energy management systems, EN 16001, has been available. However, GreenBuilding does not require the energy management system used to comply with this standard.

When it comes to checking energy savings in existing buildings the energy performance comparison is made with respect to a so-called reference year. A reference year is the 12-month period directly before the energy saving measures were begun. It is important that the energy use can be reported in a reliable way, as this will form the basis of both the calculated and verified energy saving. The reference year must lie within five years of its data being used for comparison.

4.1.3 GREENBUILDING IN PRACTICE

The GreenBuilding regulations have, to a great extent, been devised at EU level. On the other hand, the methods used to certify buildings have been adapted to national conditions. In countries where GreenBuilding has national contact points, NCPs, these are contacted first. In countries without NCPs, the GreenBuilding organisation is contacted at European level.

Even though the certification process can be different, depending on which country is involved, it can be roughly divided up into the following steps:

1) Contact and registration via the NCP or European office.
2) The application is sent to the NCP or European office.
3) The application is registered and scrutinized.
4) The applicant is asked to supply clarifications and complementary data.
5) A diploma and logotype is sent to the applicant.
6) Publication on the GreenBuilding website.
7) Energy savings are reported annually to the NCP or European office.

4.1.4 GREENBUILDING – ORIGIN AND ORGANISATION

The European Commission initiated the GreenBuilding Programme (GBP) in 2004 with the aim of encouraging property owners of non-residential buildings to implement, on a voluntary basis, cost-effective energy efficiency measures and to increase their use of renewable energy.

The GBP was introduced as a pilot project in ten EU countries. In each participating country NCPs were set up to provide support for organisations that wanted to find out more about GreenBuilding and become engaged in the movement.

Partners and supporting companies

GreenBuilding provides a network for so-called *partners* and *corporate partners*. Companies decide for themselves at which level they want to

become involved. A company can become involved in GreenBuilding in two different ways, either at the building level or company level. A company can become a GreenBuilding Partner by certifying at least one building. If the company owns more than 10 buildings and at least 30% of these fulfil the GreenBuilding requirements, the company can apply to become a GreenBuilding Corporate Partner. The company then signs an agreement committing it to ensuring that at least 30% of the company's buildings and at least 75% of the company's new construction will fulfil the GreenBuilding requirements.

For a company to become a GreenBuilding Partner the following are required:

1) Energy audits and descriptions of the energy use in the building(s) in question.
2) Action plans with proposals for energy efficiency improvement measures and estimations of the reduced energy use. For new constructions the energy calculations are presented and motivated, showing how the energy savings will be attained. A report is submitted regarding the company's energy management system.
3) The application is sent to the national GreenBuilding NCP or to the JRC (Joint Research Centre – Institute for Energy and Transport, which is the European Commission's internal scientific service) where the documents are scrutinized.
4) When the company has been approved as a GreenBuilding Partner all that remains is to put the action plan into play and submit an annual report about the energy efficiency work to the NCP or JRC.
5) To retain partnership status, a GreenBuilding Partner must certify at least one more building every third year.

In March 2012, there were 340 partners, of which 6 were corporate partners.

Over and above this, a company can choose to become a GreenBuilding Endorser. The role of an endorser is to market the GreenBuilding concept to potential customers and to help existing and new partners to improve the energy efficiency of their buildings. Almost any company connected to the energy and property industries can become an endorser, providing they fulfil certain requirements. For example, the company must have helped a property owner to achieve GreenBuilding certification.

According to GreenBuilding, the following types of companies might be interested in becoming endorsers:
– Product manufacturers
– Consultants
– Energy services providers
– Building contractors

One of the benefits of being an endorser is that the company is then listed on the GreenBuilding website and allowed to use the GreenBuilding logotype, for example, for marketing purposes.

In March 2012 there were around 100 GreenBuilding Endorsers.

4.2 Minergie

The following information is based on the content posted on the Minergie website, www.minergie.ch and from a Swedish report[17].

The Minergie standard is a Swiss certification system dating from 1998. Although it is primarily used in Switzerland, it has also been used in France, Italy, Liechtenstein, Luxemburg, Germany and Austria. To date, more than 24,000 buildings have been certified, of which 98% are to be found in Switzerland. The standard has become so common in Switzerland that the number of newly constructed buildings certified using Minergie now make up 15 to 20% of all dwellings and commercial buildings in the country. In addition, a large number of buildings are built in Switzerland with a so-called 'Minergie performance rating' without actually being formally certified.

One of the main reasons why Minergie has had such a success in Switzerland is that property owners who certify their buildings using the standard can get advantageous bank loans (for example, with lower interest rates) if they can produce a Minergie registration document.

Minergie comprises a number of different certification systems of which all, except the original Minergie, are designated Minergie followed by an abbreviation connected to the type of certification. For example, Minergie-P is for passive buildings and Minergie-ECO for ecological buildings.

As the suffix ECO suggests, not all the Minergie certification systems are purely energy certification systems and could therefore have been

17 CIT Energy Management AB 2008. Minergie – En förstudie om förutsättningarna att införa Minergie i Sverige. A preliminary study of the preconditions for introducing Minergie into Sweden.

described in Chapter 3 as types of environmental certification systems. However, the by far largest of the Minergie family and the system that most people generally associate with the standard, only considers the energy performance aspect. This is why the other Minergie systems are also described in this chapter.

It can be noted that in typical 'Swiss spirit' the system is known and marketed as a quality certification system according to the motto 'Indoor comfort first, lower energy costs second'. Energy performance is thus regarded as being part of the concept of quality.

Even if the Minergie certification system is used in a number of neighbouring countries, Minergie is regarded today as a Swiss phenomenon. However, there are plans for the near future, maybe by the end of 2012, to internationalise the system. At present, it is unclear how this might affect the future structure of Minergie.

4.2.1 MINERGIE – THE BASICS

Basically, Minergie is a family of certification systems for buildings. However, the Minergie-Modul system can only be used to certify parts of buildings, for example, windows, walls and ventilation systems. In addition, Minergie provides a network for property owners and people in the building industry. More about this in Sub-section 4.2.3.

Buildings that can be certified

Minergie systems can be used for nearly all types of buildings, see Table 4.2 below, as well as for modernisation (refurbished and extended buildings). Modernised buildings that have been certified make up around 8 to 9% of the total number of certified buildings.

Table 4.2 Types of buildings that can be certified using Minergie.

Single family homes	Meeting venues
Apartment buildings	Hospitals
Offices/administration buildings	Industrial buildings
Schools	Warehouses
Shops	Sports centres
Restaurants	Indoor swimming pools*

* Not all Minergie systems.

Minergie certification systems

There are six different certification systems for buildings in the Minergie concept and there is also a system for certifying parts of buildings. The systems are briefly described below in the order in which they were introduced onto the market.

Generally, the requirements for a building's energy performance are based on weighted energy use per square metre heated gross floor area. Furthermore, the requirements depend on the annual average temperature where the building is located and the type of building. The weighted energy use also takes the production of the energy used in the building into account. Weighting factors are often based on both technical and political factors, see Table 4.3 below.

Table 4.3 Weighting factors for different types of energy in Minergie.

Type of energy	Weighting factor
Solar	0
Biomass	0.7
District heating*	0.6
Fossil fuel	1.0
Electricity	2.0

*From waste heat in industrial plants or waste incineration for heating.

The term energy performance refers to heat-related energy performance and this is calculated according to a Swiss calculation standard. First, the energy performance is adjusted to take into account any ventilation heat recovery, as this is not included in Swiss standards. Then the efficiency of the heating system and the quality factor that is predefined for heat pumps, oil-fired boilers, etc. are compensated for. When this has been done the compensated energy performance is then multiplied by a weighting factor which depends on the type of energy used (gas, biomass, etc.). Finally the total weighted energy use for heating, domestic hot water, ventilation, etc. is compared to the maximum limits for the Minergie certification being used, see Fig. 4.1 below.

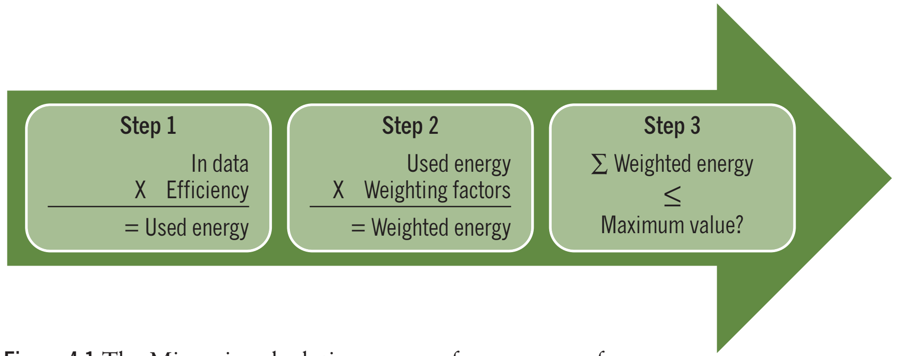


Figure 4.1 The Minergie calculation process for energy performance.

Table 4.4 below shows an example of how input data is converted to energy to suit the Minergie format.

It is worth noting that comfort cooling is seldom used in buildings that are built according to the Minergie concept, irrespective of the Minergie version used for certification. There are no formal restrictions but, in order to comply with the energy performance requirements, mechanical comfort cooling is not used, especially as electrical power is unfavourably weighted so heavily. In many cases cooling needs are taken care of by letting the supply air pass through large buried channels in the ground and thereby cooling it. In the winter the channel functions as a pre-heater for the supply air. This solution has been in use in Switzerland and neighbouring countries for quite some time.

Table 4.4 Energy performance requirements for the Minergie system – this example is for an apartment building where the local requirements are 38 kWh/m² heated floor area. The calculated energy performance is compared to the requirements.

	Energy input data [kWh/m²]	Efficiency [–]	Energy-compensated [kWh/m²]	Weighting factor [–]	Energy-weighted [kWh/m²]
Calculated heat energy (according to standard)	50				
Heat savings from heat recovery	15				
Effective use of heat energy	35	3.2	10.9	2	21.8
Domestic hot water	14	2.9	4.8	2	9.6
Electric power for ventilation			3	2	6.0
Energy performance				Total	37.4≤38*

*Limit value for apartment buildings in a location with an annual mean temperature of + 8,5 °C (Zürich).

As mentioned earlier, Minergie at present is a Swiss scheme in so far as structure, energy calculations, criteria, etc. are concerned. This applies similarly to the weighting factors in Table 4.3, which obviously have a strong influence on the performance results in Table 4.4 above. Perhaps a future internationalisation of the Minergie concept would make it possible to introduce local adaptations of these factors.

Minergie
Introduced: 1998
Number of certified buildings: 22,415 (March 2012)

As mentioned above, Minergie is the first and by far the biggest of the Minergie certification systems. This particular system is therefore described in more detail.

This is the easiest system to comply with, which might, of course, be the reason why it is the most used of all the versions. Certification does not place any requirements, over and above what is stipulated in the relevant building standards, on design, indoor climate or choice of building materials. It is only required to show, via calculations, that a building will not use more energy than a number of maximum limits.

With the aim of simplifying the certification procedure (described in Subsection 4.2.3) property owners can commit themselves to using a number of different standard technical solutions with regard to the building and its installations. This 'short cut' can only be taken for residential buildings. A property owner will then choose between five suggested standard solutions for heating and domestic hot water and also a couple of boundary conditions for ventilation and the climate shell/building envelope, see Table 4.5 below.

Table 4.5 Simplified way to achieve Minergie certification, for residential buildings only.

Building solutions (One solution is chosen)	Ventilation and climate shell (Both must be fulfilled)
1) Geothermal heat pump	Mechanical supply and extract air with heat recovery (FTX), at least 80% efficiency
2) Wood-fired heating in winter and solar heating in summer (for domestic hot water)	A number of maximum U-values. Examples: Roofs, walls, floors: 0.2 W/m² K Windows: 1.3 W/m² K
3) Automatically controlled wood-based heating (pellets, etc.)	
4) District heating*	
5) Water-air (outdoor air) heat pump	

*Based on waste heat from industrial sources or waste incineration for heating.

Minergie-P
Introduced: 2002
Number of certified buildings: 1,257 (March 2012)

Minergie P, where P stands for passive buildings, was the second certification system to be developed. This system puts higher demands on energy performance. Minergie-P is basically equivalent to the international (German) Passive House standard, see Section 4.3.

Unlike in the original Minergie system, a number of specific requirements must be fulfilled in this version with regard to the building and its installations, partly in the form of technical solutions and partly with regard to technical performance levels. Among other things, there is a requirement regarding the verification of the airtightness of the climate shell/building envelope by pressure testing as well as of the design heating power and heat recovery from the extract air (there are exceptions). White goods must also fulfil the requirements for energy class A or better. In addition, at least 20% of the heat energy for the domestic hot water must be supplied by a renewable energy source.

Minergie-P can be used for all types of buildings shown in Table 4.2, except indoor swimming pools.

Minergie-ECO
Introduced: 2006
Number of certified buildings: 220 (March 2012)

Minergie-ECO primarily adds an ecological dimension. Although certification requires fulfilment of the same energy performance levels as in Minergie, there are also requirements regarding choice of building materials, recycling after demolition and more far-reaching demands regarding the indoor climate (including air quality, acoustics and daylight). Measurements are carried out to verify that the indoor climate is as designed. The measurements are carried out with regard to TVOC, formaldehyde, CO^2 and radon gas.

Minergie-P-ECO
Introduced: 2006
Number of certified buildings: 321 (March 2012)

Minergie-P-ECO is a combination of Minergie-P and Minergie-ECO. In principle, it can be said that the requirements from both these systems are combined to form a single system. Minergie-P-ECO places the same very high demands on energy performance as Minergie-P and at the same time places the same demands on choice of building materials, recyclability and indoor climate as Minergie-ECO.

Minergie-A
Introduced: 2011
Number of certified buildings: 7 (March 2012)

Minergie-A is in many respects like Minergie-P. However, Minergie-A has been adapted to future EU requirements that state that buildings built after 2020 must be near zero energy buildings. At present there is no internationally accepted definition of what is meant by near zero energy buildings. Minergie-A can be seen as a proposal with regard to how such a definition could be formulated. Unlike the other Minergie certification schemes, Minergie-A stipulates requirements regarding how much energy may be used to produce and erect a building. This energy is termed 'grey energy'.

Minergie-A-ECO
Introduced: 2011
Number of certified buildings: 9 (March 2012)

Minergie-A-ECO has similar energy requirements to Minergie-A but

includes special requirements with regard to health aspects and choice of building materials, see also Minergie-ECO above.

Minergie-Modul
This is not a certification system for whole buildings but for parts of buildings. Here, Minergie has chosen to approve a number of building components that can carry their logotype and be included on their website as examples of good building components. A basic requirement for products to be included in Minergie-Modul is that they are energy efficient, i.e., have high performance levels, making it possible to achieve effective energy performance in the buildings where they are used.

The following building components are included in Minergie-Modul:
- windows
- heaters
- solar heat installations
- lighting
- walls and roofs
- doors
- sun-shading

Now that the different Minergie certification systems have been described, it would be a good idea to look at a couple of tables summarizing their differences and similarities. In the first table, Table 4.6 below, we can see which aspects (issues) are investigated in four Minergie systems.

Table 4.6 Aspects that are investigated in four Minergie certification systems.

Aspect	Minergie	Minergie-P	Minergie-ECO	Minergie-P-ECO
Energy				
Energy performance	Yes	Yes	Yes	Yes
Heat power requirements	–	Yes	–	Yes
Type of energy source	Yes	Yes	Yes	Yes
Airtightness	–	Yes	–	Yes
Indoor environment				
Acoustics/noise	–	–	Yes	Yes
Radon gas concentration	–	–	Yes	Yes
Outdoor airflow	Yes	Yes	Yes	Yes
Transmission factors	Yes	Yes	Yes	Yes
Daylight	–	–	Yes	Yes
Lighting	–	–	Yes	Yes
Chemical substances				
Presence of dangerous substances	–	–	Yes*	Yes*
Documentation of building materials	–	–	Yes	Yes
Demolition	–	–	Yes	Yes

*TVOC and formaldehyde in the indoor air.

As mentioned earlier, the buildings are divided into different categories depending on their uses. All these different types of buildings have different limit values for energy performance and all of them have different standardised input data (indoor temperature, outdoor airflows, specific electric power use, etc.) for calculating energy performance. However, the energy performance requirements for all building categories after modernisation are much lower than those for new construction.

Table 4.7 shows the energy performance requirements for Minergie certification (electric power and heating). There are also requirements for heat energy performance, but these are not shown here.

Table 4.7 Energy performance requirements for the Minergie and Minergie-P systems for new construction and refurbishment.

Type of building	Energy performance requirements [kWh/m²]			
	Minergie		Minergie-P	
	New	Refurb	New	Refurb
Single family dwellings	38	60	30	30
Block of flats	38	60	30	30
Offices/administration buildings	40	55	25	25
Schools	40	55	25	25
Shops	40	55	25	25
Restaurants	45	65	40	40
Meeting venues	40	60	40	40
Hospitals	70	85	45	45
Industrial buildings	20	40	15	35
Warehouses	20	35	15	15
Sports centres*	25	40	20	20

* excluding domestic hot water.

4.2.2 MINERGIE IN PRACTICE

When a property owner has decided to certify a building using one of the Minergie systems, see Fig. 4.2 below, a registered specialist (Fachpartner in German) is contacted.

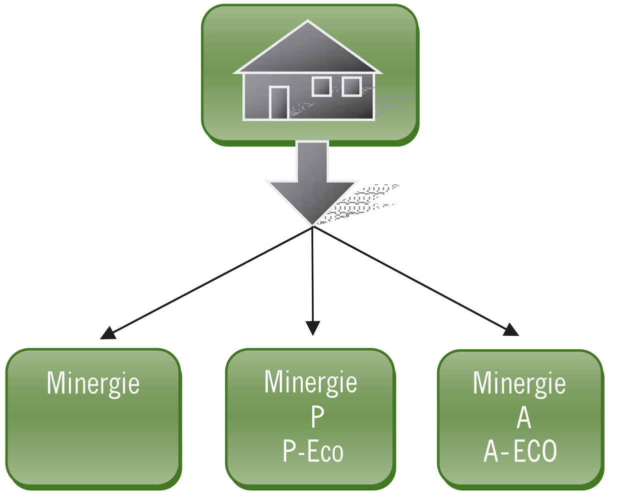


Figure 4.2 Choosing a Minergie system.

As described earlier, the energy performance of a building is calculated and compared with the requirements for the chosen Minergie system. The calculations are then sent to a Minergie administrator who has been authorised to handle the particular system that has been chosen. The administrator checks the calculations and sends a provisional Minergie certificate to the property owner. When a building has been completed, and sometimes even during construction, around one in every ten buildings is checked to verify that it meets the levels indicated by the calculations before the final certificate sent to the property owner. In the case of Minergie-P certification an airtightness test is carried out on the climate shell/building envelope. The person carrying out the test certifies that the work has been carried out in accordance with the chosen Minergie system.

4.2.3 MINERGIE – ORIGIN AND ORGANISATION

The Minergie brand name is administered by the non-profit making organisation Minergie. This organisation is primarily financed by certification fees, membership and partnership fees, sponsoring and by the Swiss state. Its head office is located in Bern.

Members and partners

Companies and organisations can choose to become Minergie members or partners. They are then mentioned on the Minergie website in the list of companies and organisations that are certified to carry out work according to the Minergie concept. Examples of such firms include architects, building contractors, painters, floor layers, etc. These companies are authorised to use the Minergie logotype in connection with their marketing activities.

4.3 Passive House

The following information is based on the content posted on the Passive House websites www.passiv.de and www.igpassivhus.se.

Passive House (Passivhaus) certification originated in Germany, where the system was created by Dr. Wolfgang Feist in 1998. Basically, the Passive House system is based on passive building technology whereby heating losses (due to transmission and ventilation losses) are minimized. This leads to a low remaining heat demand that can be met by a relatively small heating system, often located in the supply air system. In short, the technology requires the construction of airtight and well-insulated climate shells/building envelopes as well as installing windows and doors with low transmission losses. The remaining heat demand is often supplied via the supply air, which is heated using heat recovery from the extract air. Numerous buildings around the world have been built using passive building technology, although not all of these have chosen to be certified according to the Passive House certification system. At present, around 4,400 building units (one unit = 100 m2) have been certified around the world.

4.3.1 PASSIVE HOUSE – THE BASICS

All types of buildings can be certified using the Passive House system as long as they fulfil the stipulated criteria.

Passive House certification can be used for new constructions, refurbished buildings and existing buildings, if the specific requirements are met. When a building is refurbished it is possible to gain a slightly different type of certification if the refurbishment has been carried out using ‘Passive house components’. The two types of certification are called ‘Quality-Approved Passive House’ and ‘Quality-Approved Modernisation with Passive House Components’.

It is not possible to certify individual flats in a block or individual premises in a multi-storey building and when refurbishing a building the building must comprise at least an outer wall, a roof and a foundation slab or a suspended floor.

Passive House certification systems

As mentioned above, there are two ways in which a passive building can be certified and these are, in turn, divided into systems for dwellings and non-domestic buildings. Refurbishment criteria, however, are the same for all types of buildings. Passive House certification systems do not have a scale of ratings as in many other energy and environmental certifications systems. Either the building receives its certification or it doesn’t.

4.3.2 WHAT DOES PASSIVE HOUSE ASSESS?

Passive House is a system that assesses a building’s energy performance. The system does not, therefore, assess the other environmental questions described for the environmental certification systems described in Chapter 3. In order to be certified, data and calculations carried out in the PHPP (Passive House Planning Package) have to be reported, including U-values, the designing out of thermal bridges, types of windows and heat demands. In order to gain Passive House certification, the performance requirements in the following areas must be met:

1) Specific annual heat demand or design heat power demand
2) Total specific primary energy demand
3) Airtightness
4) Comfort cooling

Passive House requirements focus primarily on the heating performance of a building. The heating demand must first be minimized after which the heating system is chosen. As the choice of heating system and use of domestic hot water do not affect the quality of the building these are not included in the heat demand under point 1) above. On the other hand, the choice of system for production of heat and domestic hot water are taken into account in the primary energy demand in point 2) above.

The requirements that must be fulfilled to attain Passive House certification are the same for the whole world, and are independent of, for example, the indoor climate. This means that buildings must be designed differently depending on the prevailing outdoor climate conditions.

Table 4.8 lists the energy performance requirements for dwellings, non-residential buildings and refurbished buildings. The PHPP, Passive House Planning Package, contains a check list, a calculation program and handbook that can be used to check the criteria in Table 4.8.

Table 4.8 Criteria for Passive House certification. The area (m^2) corresponds to the usable area (net living area/usable area within the climate shell/building envelope).

Criteria	Dwellings	Non-residential	Refurbished*
Specific annual heating demand or heat power demand excluding domestic hot water	15 kWh/m² 10 W/m²	15 kWh/m² 10 W/m²	25 kWh/m²
Total weighted specific primary energy demand** including all domestic, non-domestic and end-user electric power	120 kWh/m²	120 kWh/m²	120 kWh/m²
Air change rate at testing pressure of 50 Pa (η_{50} measurement)	0,6/h	0,6/h	Limit value: 1.0/h Target value: 0.6/h
Specific energy demand for comfort cooling	–	15 kWh/m²	-

*Refurbishment of both dwellings and non-residential buildings.
**According to type of energy.

Certification after refurbishing is called 'Quality-Approved Modernisation with Passive House Components', if the requirements in Table 4.8 are fulfilled or if passive building technologies have been used for the relevant parts during refurbishment, so-called EnerPHit classified thermal bridge solutions. The certification 'Quality-Approved Passive House' can also be attained after refurbishing, provided that the requirements for dwellings or non-residential buildings have been fulfilled.

Passive House certification is associated with the term passive building technology. At present (Spring 2012) there are around 37,000 buildings registered around the world that have been built using this technology. Most of the buildings have not been certified according to the Passive House system.

In addition to the criteria in Table 4.8 above, buildings that are built using passive building technologies should, as far as possible, also follow the guidelines and recommendations in Table 4.9 below.

Table 4.9 Guidelines and recommendations to achieve Passive House certification.

Criteria	Dwellings	Non-residential	Refurbishment*
U-values for Opaque building components	< 0,15 W/m²K	< 0,15 W/m²K	External insulation: < 0,15 W/m²K Internal insulation: < 0,35 W/m²K
U-values for Windows, external doors	U < 0,80 W/m²K (windows) U < 0,85 W/m²K (installed windows)	U < 0,80 W/m²K (windows) U < 0,85 W/m²K (installed windows)	U < 0,80 W/m²K (windows) U < 0,85 W/m²K (installed windows)
Thermal bridges	< 0,01 W/mK	< 0,01 W/mK	All thermal bridges must be accounted for and approved
Upper temperature in summer	Max 10% of the annual hours > 25°C	Max 10% of the annual hours > 25°C	Max 10% of the annual hours > 25°C
Ventilation Heat recovery Electric power	η> 75% (unit) SFP < 1,62 kW/(m³/s)	η> 75% (unit) SFP < 1,62 kW/(m³/s)	η> 75% (unit) SFP < 1,62 kW/(m³/s)
Noise	Max 25 dB(A) in living spaces, max 35 dB(A) in clothes closets, ventilation plant rooms, etc	Max 25 dB(A) in occupied spaces, max 35 dB(A) in plant rooms and secondary areas	Max 25 dB(A) in living spaces, max 35 dB(A) in clothes closets,ventilation plant rooms, etc

*Refurbishment of both dwellings and non-residential buildings.

PHPP includes tools for:

- Calculating transmission losses through windows and the solar heat contribution
- Calculating heat power demand
- Calculating heating demand (annual and monthly use)
- Calculating and assessing heating systems with primary energy factors
- Calculating airflows, different operating conditions and degrees of heat recovery
- Calculating heat distribution losses and domestic hot water use

4.3.3 PASSIVE HOUSE IN PRACTICE

When a building is certified using Passive House systems the planning and calculations used for the building are carried out using the PHPP. The national authorised Passive House certifier is then contacted. This person represents the Passive House Institute in Darmstadt, which is also responsible for the certification. In addition to the calculations, drawings and commissioning reports that have to be submitted, an airtightness test must also be carried out. Passive House certification can only be awarded when the building is ready for its tenants to move in and all the criteria have been verified and approved.

The PHPP software is required in order to carry out the certification work and this can be bought via the Passive House website. Three different criteria documents are available:

- 'Quality-Assured Passive House' – with certification criteria for dwellings
- 'Quality-Assured Passive House' – with certification criteria for non-domestic buildings
- 'Quality-Assured Modernisation using Passive House Components'– with certification criteria for components

All the assessment criteria can be found in the above mentioned criteria documents. Information and guidelines are also available to help the builder fulfil the requirements. There are also recommendations regarding the involvement of energy coordinators or trained passive house building experts who can help during the project. However, this is not a requirement.

As shown in Table 4.8 above, there are requirements regarding the airtightness of the climate shell/building envelope and an airtightness test must be carried out to verify that the building meets these requirements. Preferably the first test is carried out at a point in time when the airtight materials are still accessible, in case improvements have to be carried out. When the building is completed a final airtightness test is carried out. This final test is the one that is included in the certification and is recorded in the PHPP.

It is a good idea to follow the eleven steps in the following check list in order to gain Passive House certification. The check list functions as a guide when carrying out the work and can be purchased via the Passive House website. The steps are as follows:

Step 1. Site planning
Step 2. Pre-planning
Step 3. Building permission planning
Step 4. Planning for building elements
Step 5. Planning for ventilation systems
Step 6. Planning for other building services
Step 7. Design of the building structure
Step 8. Design of the ventilation system
Step 9. Design of other building services
Step 10. Introduction for owners and tenants
Step 11. Certification

4.3.4 PASSIVHUS – ORIGIN AND ORGANISATION

Passive House certification was originally conceived in Germany where it was developed by Dr. Wolfgang Feist. The certificate for a Passive House includes the initials PHI, which stand for Passive House Institute, as part of the logotype.

In a similar way to the other certification systems described in this book, it is possible to become a member of the organisation behind the Passive House certification system. To become a member of an international or national Passive House organisation a manufacturer's products or a property owner's building must be quality assured and the steps for further training and information retrieval followed.

5 OTHER CERTIFICATION SYSTEMS

In this chapter another four certification systems are described in brief: the Japanese CASBEE, the Indian IGBC, the US ENERGY STAR program and the French Effinergie. The reason why these systems are described here, and not in great detail in the previous chapters, is because they are at present only used in their respective countries of origin.

5.1 CASBEE

Country of origin:	Japan
Introduced:	2002 (CASBEE for Offices)
Number of certified buildings:	216, all in Japan (June 2012)
Type of certification system:	Environmental
Source of information:	www.ibec.or.jp/CASBEE/english

CASBEE (Comprehensive Assessment System for Built Environment Efficiency) is an environmental certification system that is supported by the Japanese state and is administered by the Japan Sustainable Building Consortium (JSBC). Certification is carried out via the Institute for Built Environment & Energy Conservation (IBEC). The system has been developed primarily for the Japanese market but according to the IBEC there is nothing to stop the system being used outside Japan.

CASBEE can be used for both individual buildings and other aspects of the built environment. There are four basic assessment tools for the lifecycle categories Pre-design, New Construction, Existing and Renovation, and a further eight tools for specific purposes. There are also four brief versions, which are simplified tools to facilitate, among other things, the formulation of environmental goals and assessments in the planning phase.

Table 5.1 CASBEE tools.

Basic	Specific purposes
CASBEE for Pre-design	CASBEE Detached Houses – new constructions
CASBEE for New Construction *	CASBEE Detached Houses – existing constructions
CASBEE for Existing Building	CASBEE for Temporary constructions
CASBEE for Renovation	CASBEE for Heat Islands
	CASBEE for Urban Development *
	CASBEE for Cities *
	CASBEE for Urban Area + Building *
	CASBEE for Market Promotion (pilot version)
Brief versions	
CASBEE for New Constructions – brief	CASBEE for Renovation – brief
CASBEE for Existing Buildings – brief	CASBEE for Urban Development – brief

*Available in English.

In a similar way to most environmental certification systems, CASBEE encourages high end-user quality, in other words, a good perceived indoor climate and low environmental impact. To these ends the certification systems are split into two assessment categories: Q (quality) and L (load), each of which comprises a number of items that are awarded points.

- Q – Built Environment Quality
  This category takes into consideration the items the Indoor Environment (Q1), the Quality of Services (Q2) and the Adjacent Outdoor Environment (Q3).
  Q1 is used to assess noise and the noise environment, thermal comfort, daylight/lighting and air quality.
  Q2 is used to assess the user environment (for example, floor area per person), strength and reliability (for example, earthquake-safe design) and flexibility and adaptability with regard to future changes (for example, new uses).
  Q3 is used to assess, among other things, the ecological conditions in the immediate environment and how a building will fit in with the townscape and landscape.

- L – Built Environment Load
  Here, the external environmental impact is taken into account by assessing the following items: the building's energy performance (LR1), its use of natural resources (for example, water) and building

materials (LR2), and global warming with respect to greenhouse gases and impact on the immediate environment (for example, light pollution) (LR3).

The total number of points for the items in ‘Q’ is divided by the total number of points for the items in ‘L’. The ratio is called the BEE (Built Environment Efficiency) and forms the basis for a certification rating which goes from ‘Poor’ to ‘Superior’. The higher the BEE ratio, the better the rating. To achieve a ‘Superior’ rating, both a high BEE ratio and a minimum number of points must be acquired in ‘Q’.

5.2 IGBC

Country of origin:	India
Introduced:	2007 (IGBC Green Homes)
Number of certified buildings:	17, all in India (April 2012), another 630 will be certified soon
Type of certification system scheme:	Environmental
Source of information:	www.igbc.in

For a number of years India’s infrastructure and building industry have seen enormous growth and the country faces great challenges when it comes to environment-friendly modern building. To meet these challenges and in order to promote development towards more environmentally adapted buildings, India’s GreenBuilding Council (IGBC) was formed in 2001 by the Confederation of Indian Industry (CII). The IGBC has, among other things, developed four environmental certification systems for the home market. IGBC can also be used outside India as long as national legislation and standards are followed. At present two of the schemes developed by the IGBC are being introduced in Nepal and Bangladesh.

Originally, the IGBC only offered LEED certification of buildings but they can now also offer an own system. The number of buildings classified using their own system is at present very small but interest is mounting and at the time of writing (July 2012) some 630 buildings have been registered for certification in the near future. If the LEED certifications are also included, the IGBC has managed a considerably larger number of projects, totalling 1,687 as of July 2012.

Compared to many other environmental certification systems the IGBC systems place great emphasis on the use of water. The relative focus is most

probably because India, in a similar way to many other Asian countries, has a serious fresh water situation. In fact, this environmental certification system is, to a great extent, marketed as a tool to reduce water use.

In IGBC there are four certification systems that can be used for both individual buildings (dwellings and non-residential buildings) and for whole neighbourhoods. Three of the four systems are, however, still at the pilot stage.

- – IGBC Green Homes
- – IGBC Green Factory Buildings (pilot)
- – IGBC Green SEZ – Special Economic Zones (pilot)
- – IGBC Green Townships (pilot)

As in the other environmental certification systems described in this book, these systems are divided into categories that are given points by assessing a number of issues. Under nearly every category there are one or two issues with requirements that must be fulfilled and in addition there are a number of issues that are not mandatory but do give points if they are fulfilled.

The structures of the systems for the different types of buildings are similar, with, for the most part, the same categories being assessed in each system. Under each category the issues and points are adapted to the target groups for each certification system. The first system that was developed, IGBC Green Homes, can be used for single family dwellings, blocks of flats, gated communities and terraced houses. The scheme can also be used for refurbishment and extensions to existing buildings.

At present, India is experiencing a great wave of urbanisation and recently it was forecast that some 70 new towns with populations over 500,000 will be seen on the map by 2020. With this in mind, the IGBC has developed the IGBC Green Townships Rating System for use in the development of neighbourhoods, satellite towns, gated communities, campus areas, etc. The structure of Green Townships is different to that of the other systems and cannot be used for individual buildings.

Table 5.3 below shows the categories that are included in each system. The category percentages of the total number of possible points are shown in brackets.

Table 5.2 Categories assessed in the four different IGBC certification systems. The figures in brackets show the percentages for each category of the total number of available points.

Green Homes*	Green Factory Building	Green SEZ	Green Township
Site Selection & Planning (12%)	Site Selection & Planning (16%)	Site Preservation (16%)	Site Selection & Planning (20%)
Water Efficiency (27%)	Water Efficiency (21%)	Site Planning & Design (25%)	Land Use Planning (22%)
Energy Efficiency (28%)	Energy Efficiency (23%)	Water Efficiency (15%)	Transportation Planning (15%)
Materials & Resources (16%)	Materials & Resources (16%)	Energy Efficiency (30%)	Infrastructure. Resource Management (35%)
Indoor Environmental Quality (12%)	Indoor Environmental Quality (19%)	Materials & Resources (10%)	Innovation in Design & Technology (8%)
Innovation and Design Process (5%)	Innovation and Design Process (5%)	Innovation and Design Process (4%)	

*Green Homes can be used for both single family dwellings and blocks of flats. However, the points given for these two types of buildings differ. Those shown here are for blocks of flats.

The total number of points for the different categories forms the basis for the ratings that are divided into four levels: Certified, Silver, Gold and Platinum.

5.3 ENERGY STAR

Country of origin: USA
Introduced: 1992
Number of certified buildings: 18,000 buildings (July 2012)
Type of certification system: Energy
Source of information: www.energystar.gov

ENERGY STAR is a programme set up by the EPA (U.S. Environmental Protection Agency) with the aim of reducing energy use in the country. Since 1999, buildings with an energy use equivalent to that of the top 25% of similar buildings in the country can be awarded an ENERGY STAR certificate. At present, ENERGY STAR is only used in the US and for buildings abroad that are owned by the state.

ENERGY STAR is not only an energy certification system for buildings; it is also known for its original areas of application with energy labelling of

products such as TV sets, air conditioning systems, fans, computers, building materials and much more.

EPA has a Portfolio Manager, an on-line tool for determining energy use, which provides commercial buildings with the opportunity to measure and follow up their use of energy. Some buildings can even attain an ENERGY STAR certificate for energy use from the EPA's 1–100 scale, which ranks buildings in relation to other similar buildings in the US. Attaining 50 points on the scale denotes an average use of energy. EPA bases its 1–100 scale on survey information gathered by the Commercial Building Energy Consumption Survey (CBECS) for the US Energy Authority. This survey presents data from representative buildings throughout the country for, among other things, energy use, areas, building use and operation. The surveys are carried out every four years and details from them, together with details from other sources and industrial surveys, form the reference basis for the 1–100 scale for ENERGY STAR ratings.

For non-commercial buildings, such as houses, certification is carried out in another way. For buildings like these, the EPA has stipulated specific requirements for energy levels. In order to be awarded the ENERGY STAR, each building must be inspected and tested separately to see whether stipulated requirements are met.

Certification

Where a commercial building is concerned, the building can apply for the ENERGY STAR if it attains a points total of 75.Attaining this points total means, in practice, that the building is one of the top 25% of buildings of its particular type. Before a building can be awarded the ENERGY STAR, its use of energy and its indoor environment must be verified by a professional engineer or registered architect.

Where a non-commercial building is concerned, it is also possible to be awarded ENERGY STAR certification. In this case, a number of measures must be taken and requirements regarding energy performance and energy efficiency, compared to existing and typical new constructions, must be fulfilled.

Unlike many of the other environmental and energy certification systems, ENERGY STAR certification is awarded for actual verified energy use. This means that a building must apply for a new ENERGY STAR every year in order to keep its certification. However, there is a category that ENERGY STAR calls 'Designed to Earn the ENERGY STAR, and this temporary designation can be awarded to a new building design before a building has been in use for one whole year and before it has been possible to gather sufficient details about the building's actual energy use.

EPA carries out random checks of certified buildings to ensure that all requirements have been fulfilled.

5.4 Effinergie

Country of origin:	France
Introduced:	2007
Number of certified buildings:	21,200 (June 2012)
Type of certification system:	Energy
Source of information:	http://www.effinergie.org, www.observatoirebbc.org

Effinergie launched its original certification system for newly constructed buildings in 2007. In September 2009, a second system was introduced for renovation projects. Today, some 21,200 buildings have been certified, all of them in France. The greater majority of these are residential buildings and only a hundred or so are renovated buildings.

On certification, a building is awarded a BBC-effinergie certificate, where BBC stands for *Bâtiments Basse Consommation*, which can be translated as 'low energy buildings'. BBC-effinergie certification is based on the French regulations for thermal performance in new construction: Réglementation Thermique 2005 (RT 2005), which will be superseded in 2012 by RT 2012. In connection with this, Effinergi will be launching Effinergie+, with stricter requirements. Renovated buildings can also be certified and this is done by using a specially adapted version of RT 2005. This is in line with the country's endeavour to reduce the use of energy within the whole of its building stock. The Effinergie system was developed after France had signed the Kyoto Agreement. Regulations include a calculation method for determining the energy use in buildings with regard to heating, domestic hot water, ventilation, lighting and air conditioning.

New construction

To gain a BBC-Effinergie certificate, the energy performance of a building must meet certain requirements. For example, in houses, the specific energy use must not exceed 50 kWh/m2.yr. The net floor area in square metres is the area within the external walls. When the new Effinergie+ certification is introduced the requirements for energy performance will be even stricter, with an upper limit of 40 kWh/m^2.yr.

As France has a wide spectrum of climate conditions, there is a significant spread in the energy requirements of the country's building stock. Two climate coefficients have therefore been introduced to compensate for regional differences. The first one, coefficient "a", compensates for the geographical location of the building and the second one, coefficient "b", compensates for its height above sea level, see Fig. 5.1. This means that energy performance requirements for buildings can vary from 40 to 60 kWh/m2.yr, depending on where they are located and at what altitudes.

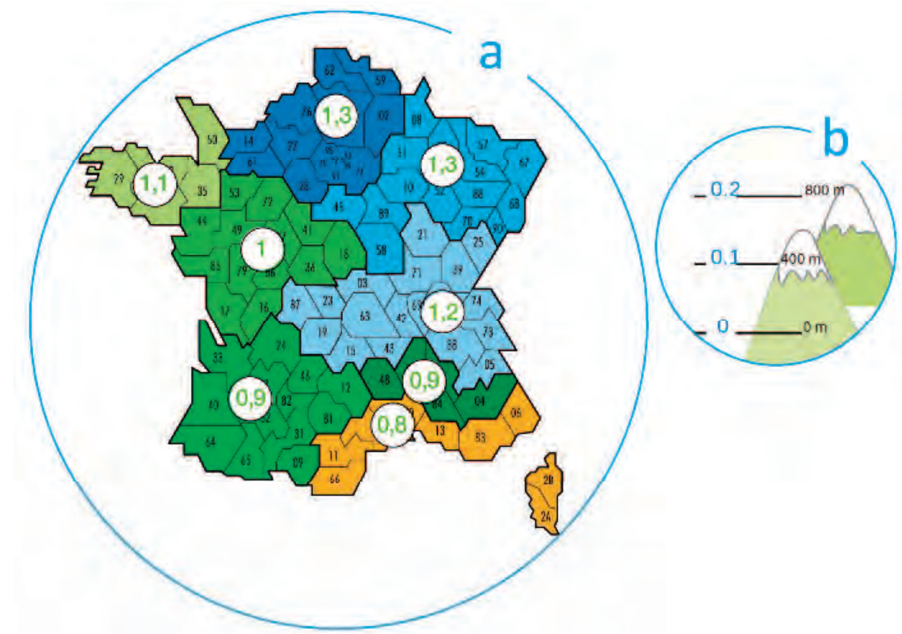


Figure 5.1 Climate coefficients based on geographical location and altitude.
Source: www.effinergie.org

In addition to the energy performance requirements, there are also requirements stipulating that airtightness tests must be carried out after a building has been completed. In detached houses the maximum allowable air leakage rate is 0.6 $m^3/(h.m^2)$ at a pressure difference of 4 Pa across the building envelope. The corresponding difference in apartment blocks is 1 $m^3/(h.m^2)$.

When compared to the requirements in RT 2005, the nationally prescribed calculation method, Effinergie has four additional conditions:

1. CO_2 emissions and the amount of renewable energy used in a building must be calculated and reported in order to obtain certification.
2. To allow and facilitate the use wood-fired heating, a conversion factor of 0.6 can be applied when wood is used as a primary energy source.
3. The local production of electrical power from solar cells is to be deducted from the total energy use, up to a maximum of 35 kWh/m^2.yr, depending on the domestic hot water energy source.
4. If the net area is at least 20% larger than the residential floor area, the net area is to be multiplied by a factor of 1.2.

Renovation

When a building is renovated its primary energy requirement must not exceed 80 kWh/m^2.yr. Variations based on geographical location and altitude are allowed in a similar way to those for new construction. The system of certification for renovated buildings has not advanced as much as that for new construction and is, at present, only at the pilot stage. Renovation is not included in the RT 2005 regulations as these are only applicable to new construction.

In the near future, a certification system for energy-positive houses and a system for buildings constructed in French overseas territories will be introduced.

6 CERTIFICATION SYSTEMS IN A NUTSHELL

The different certification systems discussed in this book have been brought together in Table 6.1, to provide the reader with a quick overview and to make general comparisons between the systems possible. The table is by no means complete – it only contains a selection of all the information available. Chapters 3 to 5 deal with the systems in more detail.

6.1 General information – Table 6.1

Table 6.1 contains a short summary of all the systems. The information provides an overview with regard to number of certified buildings, geographical distribution, applicable types of buildings, etc.

6.2 Assessed categories and parameters – Tables 6.2 and 6.3

Table 6.2 shows a selection of the parameters that are taken into account and assessed in each certification system. The idea here is to give a good picture of both the focus and diversity of the different systems.

Obviously the compilation could be more extensive and include parameters such as disability adaptations, humidity, charging facilities for battery-driven vehicles, earthquake resistance and much more. On the other hand, an extensive listing would make it difficult to get a clear overall picture.

As we have seen in Chapters 3 to 5, a number of the certification systems are divided into sub-systems, for example, for dwellings and neighbourhoods, for which the assessed parameters and requirements can be quite different. Tables 6.2 and 6.3 show some of the categories and parameters that are assessed in a selection of sub-systems which are regarded here as being representative for their respective certification systems. All examples shown are for systems used for new construction, though not neighbourhoods.

The following sub-systems have been chosen to represent the different main certification systems in Tables 6.2 and 6.3:

- BREEAM Europe Commercial 2009 – Office
- LEED 2009 for New Constructions and Major Renovations – Commercial
- Green Star Office

– HQE International
– CASBEE for New Constructions
– IGBC Green Homes

None of the certification systems described in this book are divided into identical assessment categories and parameters even though the systems are reasonably similar. Comparisons of the categories and parameters summarised in these tables are thus only valid in the context of this book. It must also be noted that the categories and parameters shown are only examples to illustrate the scope of the different systems. Increasing the number of parameters would have made it difficult to provide a comprehensible overview. In Tables 6.2 and 6.3, the certification systems comprise the following categories: *Energy, Indoor environment, Water, Materials, Waste, Site, Construction phase, Transport, Economy, Information* and *Other.*

The tables show, among other things, the proportional weights, as percentages, of the different categories in each system. However, to simplify comparisons between the different systems, some of the parameters have been recategorized and the distribution of points and subsequent weightings are therefore not always the same as those in the original system descriptions. For example: the risk of Legionella bacteria spreading is regarded differently in a number of systems. In some of them, this parameter is included in the category *Indoor environment* and in others in *Water*. In Tables 6.2 and 6.3, the Legionella parameter has been placed under the category *Water*. This means that, for some systems, the *Indoor environment* category 'misses out' when this parameter is not included: the category has a lower apportioned weight than it would have had otherwise. On the other hand, the weight of the *Water* category increases correspondingly. This recategorization of parameters is a result of the certification systems having different structures and has been implemented in order to provide the reader with a simple overview. Other examples of differences, as a result of recategorizing parameters, can be found between the categories *Transport/Site* and *Materials/Waste*.

It should also be mentioned that systems with a large proportion of mandatory parameters in the categories shown in Tables 6.2 and 6.3 could be interpreted unfairly. LEED, for instance, takes into account the categories *Waste* and *Life cycle phase* but deals with them as mandatory measures. This means that these aspects are not apportioned any weight in the tables, and they can therefore be perceived as being of less importance in LEED than they actually are.

The category heading *Other* comprises aspects that are not included in the listed categories and examples of these are given in Table 6.2. In particular, the DGNB certification system has a large number of *Other* parameters and this is mainly due to the system placing extra emphasis on points for planning and building process related issues (management), aspects which do not have an own category in Tables 6.2 and 6.3.

Finally, in Table 6.2, the proportional weight of the *Energy* category for the energy certification systems is given as 100%, despite the fact that some of them do take the indoor environment into consideration. However, points (or similar) in these systems are not apportioned between the energy and indoor environmental categories: it is more a question of fulfilling mandatory environmental requirements than evaluating them.

TABLE 6.1	General		Types of buildings	Phases		Geographical spread	Type of certification system	Number of rating steps
BREEM	Country of origin	Great Britain	All including neighbourhoods	New construction	Yes	Worldwide	Environmental	5
	Year launched	1990		Refurbishment	Yes			
	Certified buildings	200,000		Management	Yes			
LEED	Country of origin	USA	All, in principle, including neighbourhoods	New construction	Yes	Worldwide	Environmental	4
	Year launched	2000		Refurbishment	Yes			
	Certified buildings	32,200		Management	Yes			
DGNB	Country of origin	Germany	All, in principle, including neighbourhoods [1]	New construction	Yes	Germany, parts of Europe. China, Brazil and Thailand	Environmental	3
	Year launched	2009		Refurbishment	Yes [2]			
	Certified buildings	224		Management	Yes [3]			
Green Star	Country of origin	Australia	All including neighbourhoods	New construction	Yes	Australia, New Zealand and South Africa	Environmental	3 [4]
	Year launched	2002		Refurbishment	Yes			
	Certified buildings	400		Management	Yes			
Miljöbyggnad	Country of origin	Sweden	Houses, apartment blocks and most non-residential buildings	New construction	Yes	Sweden	Environmental	4
	Year launched	2009		Refurbishment	Yes			
	Certified buildings	34		Management	Yes			
HQE	Country of origin	France	Houses Non-residential buildings	New construction	Yes	France, Belgium, Germany, Great Britain, Italy, Luxemburg, Morocco, Algeria, Brazil	Environmental	5
	Year launched	2004		Refurbishment	Yes			
	Certified buildings	7,200		Management	Yes			
GreenBuilding	Country of origin	EU	Non-residential buildings	New construction	Yes	Europe	Energy	1
	Year launched	2005		Refurbishment	Yes			
	Certified buildings	600		Management	Yes			
Minergie	Country of origin	Switzerland	Houses Non-residential buildings	New construction	Yes	Switzerland and neighbouring countries, Luxemburg	Energy	1 [5]
	Year launched	1998		Refurbishment	Yes			
	Certified buildings	24,000		Management	No			
Passive House	Country of origin	Germany	Houses Non-residential buildings	New construction	Yes	Worldwide	Energy	1
	Year launched	1998		Refurbishment	Yes			
	Certified buildings	4,400 [6]		Management	No			
CASBEE	Country of origin	Japan	Houses Non-residential Neighbourhoods	New construction	Yes	Japan	Environmental	5
	Year launched	2002		Refurbishment	Yes			
	Certified buildings	216		Management	Yes			
IGBC	Country of origin	India	Houses Non-residential [7] Neighbourhoods [7]	New construction	Yes	India	Environmental	4
	Year launched	2007		Refurbishment	Yes [8]			
	Certified buildings	17		Management	Yes [9]			
ENERGY STAR	Country of origin	USA	Houses Non-residential	New construction	Yes	USA	Energy	1
	Year launched	1999 [10]		Refurbishment	Yes			
	Certified buildings	18,000		Management	No			
Effinergie	Country of origin	France	Houses Non-residential	New construction	Yes	France	Energy	1
	Year launched	2007		Refurbishment	Yes			
	Certified buildings	16,925		Management	No			

TABLE 6.2	BREEAM	LEED	DGNB[11]	Green Star	Miljöbyggnad[28]	HQE[12]	Green Building	Minergie	Passiv haus	CASBEE	ENERGY STAR	IGBC	Effinergie
Energy	17%	32%	5%	22%	27%	18%	100%	100%	100%	20%	100%	19%	100%
Energy performance	X	X	X[13]	X	X	X	X	X	X	X	X	X	X
Power demand (heating/cooling)	X	X		X	X			X[14]	X				
Type of energy (environmental perspective)	X	X		X	X	X		X				X	
Indoor environment	13%	14%	14%	18%	53%	38%		X[15]		20%		16%	
Air quality	X	X	X	X	X	X		X[15]	X	X		X	
Thermal comfort	X	X	X	X	X	X		X[15]		X			
Daylight	X	X	X		X	X		X[15]		X		X	
Lighting	X	X	X	X		X		X[15]	X	X			
Acoustics/noise	X		X		X	X				X			
Water	6%	9%	1%	6%	6%	11%				5%		19%	
Use	X	X	X	X		X				X		X	
Quality	X			X[16]	X[16, 17]	X							
Reuse/recycling	X	X		X		X				X		X	
Rainwater	X	X		X						X		X	
Materials	11%	13%	1%	8%	13%	4%				10%		11%	
Recycling	X	X	X	X		X				X		X	
Environmental aspects	X	X	X		X	X				X			
Origin	X	X				X				X		X	
Waste	7%	X[18]	4%	2%		3%				<1%		4%	
Waste management	X	X	X	X		X						X	
Site	13%	13%	10%[19]	10%		4%				20%		11%	
Choice of site[20]	X	X	X	X		X				X		X	
Light pollution	X	X				X				X			
Noise	X		X			X							
Ecology	X	X		X		X							
Heat islands		X									X	X	
Construction phase	4%	X[18]	1%			1%							
Total effect of building site	X	X	X										
Transport	7%	11%	~3%[21]	10%		2%				~1%			
Commuting	X	X	X	X									
Pedestrian & cycle access.	X		X	X									
Economy	2%	X[22]	20%										
LCC	X	X	X										
Innovation	9%	5%		5%								4%	
Innovation, new technologies	X	X		X								X	
Other	10%	~5%	~42%	20%		19%				22%		15%	
Example	Safety	Engaging a LEED AP[23]	GHP[24]	Emissions		O&M[25]				Accessibility		Charging battery-driven vehicles	
	Pollutants	Pollutants	Safety	Commissioning		Ease of cleaning				Service		Guest car parking	
	Commissioning	Commissioning	Aesthetics	Development		EMF[26]				Safety		IGBC AP[27]	

1 Neighbourhoods are under development.
2 Only offices, commercial buildings and houses.
3 Only offices.
4 There are six steps of which the first three do not qualify for certification.
5 There are more Minergie systems covering different areas.
6 Number of certified units, one unit equivalent to 100 m².
7 At pilot stage (2012).
8 Only for houses at present.
9 Factories.
10 Energy Star launched in 1992 for products, and in 1999 for buildings.
11 The respective proportions of the different categories in DGNB are only approximative as they cannot be unequivocally determined in the compilation above. This is because the category *Site Quality* is not included in this rating system. Here, the points for Site Quality are added to the other points scored and are assumed to make up approximately 13% (130 points of a total of 990 points) of the total number of points.
12 The respective proportions of the different categories in HQE are only approximative as they cannot be unequivocally determined in the compilation above. This is because the total rating in HQE contains a number of boundary conditions that cannot be combined with the division of assessment issues presented in this book.
13 Energy performance can be said to be assessed under the parameter *Building envelope*. If the whole possible score for building envelope is taken into account, the energy performance will be 9%.
14 Minergie-P, Minergie-P-ECO.
15 Minergie-Eco, Minergie-P-ECO.
16 Legionella.
17 Own water source/well.
18 A prerequisite, scores no points.
19 Not included in the total rating but is presented separately. The proportion is therefore only approximative. See footnote 11.
20 For example regarding closeness to playgrounds, flood risk, etc but not closeness to services such as shops, banks, etc.
21 Part of the category *Site*, the proportion of which is only approximative, see footnote 11.
22 Economy is one of the fundamental ideas in LEED, in which a number of the assessments are based on cost calculations. However, the economics part is not a part that can gain points nor is it a specific parameter on its own.
23 LEED Accredited Professional.
24 Global Heating Potential.
25 Routines for operation and maintenance.
26 Electromagnetic field.
27 IGBC Accredited Professional.
28 Miljöbyggnad does not have a scoring system. The proportion of the categories is here based on the number of indicators in the respective category in relation to the total number of indicators available.

Table 6.3 The proportions of the different categories in the environmental certification systems discussed in the book.

	BREEAM	LEED	DGNB	Green Star	Miljöbyggnad	HQE	CASBEE	IGBC
Energy	17 %	32 %	5 %	22 %	27 %	18 %	20 %	19 %
Indoor environment	13 %	14 %	14 %	18 %	53 %	38 %	20 %	16 %
Water	6 %	9 %	1 %	6 %	7 %	11 %	5 %	19 %
Materials	11 %	13 %	1 %	8 %	13 %	4 %	10 %	11 %
Waste	7 %		4 %	2 %		3 %	< 1 %	4 %
Site	13 %	13 %	10 %	10 %		4 %	22 %	11 %
Construction phase	4 %		1 %			1 %		
Transport	7 %	11 %	2 %	10 %		2 %	< 1 %	
Economy	2 %		20 %					
Innovation	9 %	5 %		5 %				4 %
Other	10 %	5 %	42 %	20 %		19 %	22 %	15 %

EPILOGUE

The reason for publishing this book is that even we had found it difficult to understand the full implications of all the different environmental and energy certification systems for buildings. And, when discussing these matters with our business colleagues, it became clear that we were far from alone. The truth was that many of us had only vague ideas about how the different systems actually affected our daily work from a practical point of view.

One of the primary goals of the Swegon Air Academy is to explain complicated air-handling and energy issues, and how they are interconnected, as simply as possible, so that as many as possible can understand what is going on. So, why not tackle this important and complex area too?

Our previously books “AIR” and “Simply EPBD” were received very well by the market. We believe and hope that this new book “Simply GREEN” will be received in a similar positive way: we have understood that there is great need of a publication that summarizes the subject and that is the aim of this book. However, it does not follow that the contents cover every aspect of the issues involved. Comprehensive information can be found by contacting the respective organisations behind the different certification systems.

The descriptions of the different systems have been checked and commented on by representatives of the respective organisations.

As we ourselves have not had the time nor a comprehensive overview of the subject matter, we have once again enlisted the help of CIT Energy Management in Gothenburg, where Daniel Olsson and Catrin Heincke have written and compiled all the material. As the book is published in both Swedish and English, we have again engaged the services of John Bitton, Helsingborg, who has translated and helped edit the final manuscripts.

Not wishing to change a winning team, we have also engaged the services of Lennart Nilsson at No Stress Advertising, Hjo, to oversee the production of the book and Torbjörn Lenskog, Kungsör, to manage the design and layout.

Finally, I would like to thank all those involved for their dedicated work. In addition to those already mentioned, I would like to thank my successor at the Swegon Air Academy, John Woollett, who asked me to manage this project – despite me retiring last year.

Conny Nilsson
Former Director of the Swegon Air Academy.

WEBBADDRESSES

CERTIFICATION SYSTEMS

BREEAM: www.breeam.org
LEED: www.usgbc.org
DGNB: www.dgnb.de
Green Star: www.gbca.org.au
Miljöbyggnad: www.sgbc.se
HQE: www.assohqe.org
Green Building: http://re.jrc.ec.europa.eu/energyefficiency/greenbuilding
Minergie: www.minergie.ch
Passivhaus: www.passiv.de samt www.igpassivhus.se
Casbee: www.ibec.or.jp/CASBEE/english
IGBC: www.igbc.in
Energy Star: www.energystar.gov
Effinergie: www.effinergie.org

OTHERS

BRE (BREEAM): www.bre.co.uk
Green Building Certification Institute(GBCI): www.gbci.org
ASHRAE: www.ashrae.org
World Green Building Council: www.worldgbc.org
Fuktcentrum LTH: www.fuktcentrum.lth.se
Boverket: www.boverket.se
HQE certifieringsorgan (Groupe QUALITEL/CERQUAL):
www.qualite-logement.org

HQE certifieringsorgan (Certivéa): www.certivea.com
HQE, CSTB (Centre Scientifique et Technique du Bâtiments): www.cstb.fr
Franska GBC: www.francegbc.fr
IEE (Intelligent Energy Europe): http://ec.europa.eu/eaci/iee_en.htm
IBEC (Institute for Built Environment & Energy Conservation):
www.ibec.or.jp/jsbd

Confederation of Indian Industry (CII): www.cii.in
EPA (U.S Environmental Protection Agency): www.epa.gov
U.S Energy Information Administration: www.eia.gov
Effinergie: www.observatoirebbc.org

COLOPHON

Publisher: Conny Nilsson, SWEGON AIR ACADEMY, Box 300, 535 23 Kvänum,
Sweden. Phone: +46 (0) 512 322 00. Website: www.swegonairacademy.com

Authors: Catrin Heincke and Daniel Olsson, CIT Energy Management,
Gothenburg, Sweden. www.energy-management.se
Project manager: Lennart Nilsson, No Stress Advertising, Hjo, Sweden
Graphic design and Art Director: Torbjörn Lenskog, Kungsör, Sweden
Translation: John Bitton, Helsingborg, Sweden
Art work and Reprographics: Reijs & Co, Stockholm, Sweden
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The SWEGON AIR ACADEMY is a forum for objective and company-neutral sharing of knowledge and experiences related to air handling and indoor climate issues.

One of our primary goals is to explain complex relationships in an intelligible way, so that those who are interested in a special subject can understand it at a deeper level.

Via seminars, newspaper articles and literature, the SWEGON AIR ACADEMY contributes to a greater awareness of the importance of indoor air quality for health and well-being, to an increased understanding of the energy issue and to a higher level of involvement in matters concerning the outdoor environment.

The SWEGON AIR ACADEMY provides information and educational activities all over Europe and co-operates with well-known experts in relevant fields.

SWEGON AIR ACADEMY